



Multilayer ceramic capacitors

Chip, HQF

Series/Type: **Chip**

Date: February 2009

The following products presented in this data sheet are being withdrawn.

Substitute Products: See www.epcos.com/withdrawal_mlcc

| Ordering Code | Substitute Product | Date of Withdrawal | Deadline Last Orders | Last Shipments |
|-----------------|--------------------|--------------------|----------------------|----------------|
| B37923K5100J070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5120J060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5120J070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |

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| Ordering Code | Substitute Product | Date of Withdrawal | Deadline Last Orders | Last Shipments |
|-----------------|--------------------|--------------------|----------------------|----------------|
| B37933K5000B460 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5150J060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5000B470 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5150J070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5000B560 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5180J060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5000B570 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5180J070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5000B660 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5220J060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5000B670 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5220J070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5000B760 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5000B770 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5000B860 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5000B870 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5000B960 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5000B970 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5010B060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5010B070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5010B260 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5010B270 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5010B560 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5010B570 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5010B860 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5010B870 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5020B260 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5020B270 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5020B760 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5020B770 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5030B360 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5030B370 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5030B960 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5030B970 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5040C760 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5040C770 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5050C660 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5050C670 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |



| Ordering Code | Substitute Product | Date of Withdrawal | Deadline Last Orders | Last Shipments |
|-----------------|--------------------|--------------------|----------------------|----------------|
| B37933K5060C860 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5060C870 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5080C260 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5080C270 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5100J060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5100J070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5120J060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5120J070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5150J060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5150J070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5180J060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5180J070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5220J060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5220J070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5270J060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5270J070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5820J060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37933K5820J070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B360 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B370 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B460 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B470 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B560 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B570 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B660 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B670 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B760 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B770 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B860 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B870 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B960 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5000B970 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5010B060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5010B070 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5010B260 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5010B270 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5010B560 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5010B570 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |



| Ordering Code | Substitute Product | Date of Withdrawal | Deadline Last Orders | Last Shipments |
|-----------------|--------------------|--------------------|----------------------|----------------|
| B37923K5010B860 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5010B870 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5020B260 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5020B270 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5020B760 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5020B770 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5030B360 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5030B370 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5030B960 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5030B970 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5040C760 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5040C770 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5050C660 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5050C670 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5060C860 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5060C870 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5080C260 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5080C270 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |
| B37923K5100J060 | | 2009-06-26 | 2010-06-30 | 2010-12-31 |

For further information please contact your nearest EPCOS sales office, which will also support you in selecting a suitable substitute. The addresses of our worldwide sales network are presented at www.epcos.com/sales.

SMD

HQF

Ordering code system



| | | | | | | |
|--|---|---|-----|---|---|----|
| B37923 | K | 5 | 100 | J | 0 | 60 |
| <p>Type and size Chip size (inch/mm) = Temperature characteristic HQF 0402/1005 \triangle B37923 0603/1608 \triangle B37933</p> | | | | | | |
| <p>Termination Standard: K \triangle nickel barrier for all case sizes</p> | | | | | | |
| <p>Rated voltage 5 (Code) \triangle 50 VDC</p> | | | | | | |
| <p>Capacitance, coded (example) 100 \triangle 10 · 10⁰ pF = 10 pF</p> | | | | | | |
| <p>Capacitance tolerance C_R < 10 pF: B \triangle ± 0.1 pF (standard for capacitance values ≤ 3.9 pF) C \triangle ± 0.25 pF (standard for capacitance values ≤ 8.2 pF) D \triangle ± 0.5 pF C_R ≥ 10 pF: F \triangle $\pm 1\%$ G \triangle $\pm 2\%$ J \triangle $\pm 5\%$ (standard) K \triangle $\pm 10\%$</p> | | | | | | |
| <p>Decimal place for cap. values < 10 pF, otherwise not used</p> | | | | | | |
| <p>Packaging 60 \triangle cardboard tape, 180-mm reel 70 \triangle cardboard tape, 330-mm reel</p> | | | | | | |

SMD
Features

- Ultra-low ESR and high Q factor
- Tight capacitance tolerances
- High stability with respect to time, temperature (T_{CC} : 0 ± 60 ppm/°C), frequency and voltage
- Class 1 characteristic with copper inner electrodes
- Excellent attenuation
- High self-resonant frequency
- Lower power dissipation / Less energy absorption
- Based on AEC-Q200 Rev-C


Applications

- High-frequency applications
- Matching circuits
- Cellular communication, Bluetooth, DECT
- Cable TV, satellite TV (LNB), GPS, satellite radio
- Filters, RF amplifiers, VCOs

Termination

- Nickel barrier terminations (Ni) for lead-free soldering

Options

- Alternative capacitance values and tolerances available on request

Delivery mode

- Cardboard tape, 180-mm and 330-mm reel available

Electrical data

| | | | | |
|-------------------------------------|---------------|---------------|----------------------------|-----|
| Temperature characteristic | | | C0H | |
| Climatic category | (IEC 60068-1) | | 55/125/56 | |
| Standard | | | EIA | |
| Dielectric | | | Class 1 | |
| Rated voltage | | V_R | 50 | VDC |
| Test voltage | | V_{test} | $2.5 \cdot V_R/5$ s | VDC |
| Capacitance range | | C_R | 0.3 pF ... 82 pF | |
| Temperature coefficient | | | $0 \pm 60 \cdot 10^{-6}/K$ | |
| Dissipation factor | (limit value) | $\tan \delta$ | $< 1.0 \cdot 10^{-3}$ | |
| Insulation resistance ¹⁾ | (at +25 °C) | R_{ins} | $> 10^5$ | MΩ |
| Insulation resistance ¹⁾ | (at +125 °C) | R_{ins} | $> 10^4$ | MΩ |
| Time constant ¹⁾ | (at +25 °C) | τ | > 1000 | s |
| Time constant ¹⁾ | (at +125 °C) | τ | > 100 | s |
| Operating temperature range | | T_{op} | -55 ... +125 | °C |
| Ageing | | | none | |

1) For $C_R > 10$ nF the time constant $\tau = C \cdot R_{ins}$ is given.

HQF

Multilayer ceramic capacitors

HQF

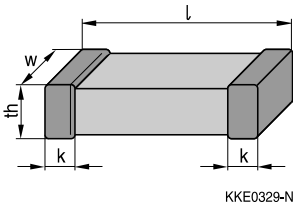
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Capacitance tolerances

| | | | | | |
|-------------|---------------------------|-----------------------|---|-----------------------|----------------------|
| C_R | $C_R \leq 3.9 \text{ pF}$ | | $4.7 \text{ pF} \leq C_R \leq 8.2 \text{ pF}$ | | |
| Code letter | B (standard) | C | B | C (standard) | D |
| Tolerance | $\pm 0.1 \text{ pF}$ | $\pm 0.25 \text{ pF}$ | $\pm 0.1 \text{ pF}$ | $\pm 0.25 \text{ pF}$ | $\pm 0.5 \text{ pF}$ |

| | | | | |
|-------------|--------------------------|-----------|--------------|------------|
| C_R | $C_R \geq 10 \text{ pF}$ | | | |
| Code letter | F | G | J (standard) | K |
| Tolerance | $\pm 1\%$ | $\pm 2\%$ | $\pm 5\%$ | $\pm 10\%$ |

Dimensional drawing



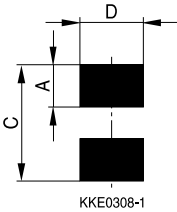
Dimensions (mm)

| | | | |
|-----------|--------|----------------|----------------|
| Case size | (inch) | 0402 | 0603 |
| | (mm) | 1005 | 1608 |
| l | | 1.0 ± 0.10 | 1.6 ± 0.15 |
| w | | 0.5 ± 0.05 | 0.8 ± 0.10 |
| th | | 0.5 ± 0.05 | 0.8 ± 0.10 |
| k | | $0.1 - 0.40$ | $0.1 - 0.40$ |

Tolerances to CECC 32101-801

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Recommended solder pad



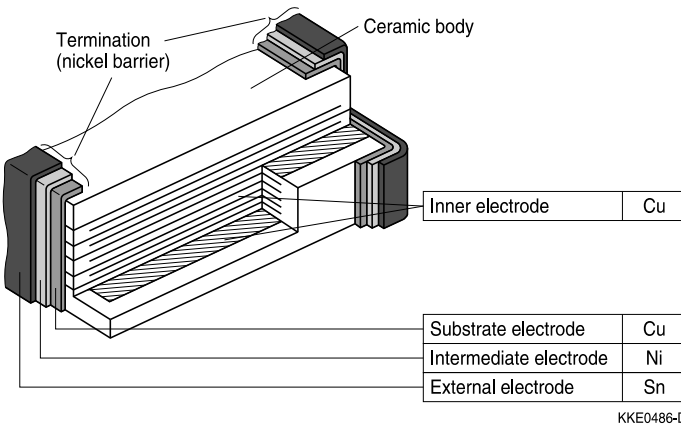
Recommended dimensions (mm) for reflow soldering

| Case size | (inch/mm) | Type | A | C | D |
|-----------|-----------|-------------|---------------|-------------|-------------|
| 0402/1005 | | single chip | 0.35 ... 0.45 | 1.0 ... 1.4 | 0.4 ... 0.6 |
| 0603/1608 | | single chip | 0.6 ... 0.7 | 1.8 ... 2.2 | 0.6 ... 0.8 |

Recommended dimensions (mm) for wave soldering

| Case size | (inch/mm) | Type | A | C | D |
|-----------|-----------|-------------|-------------|-------------|-------------|
| 0603/1608 | | single chip | 0.8 ... 0.9 | 2.2 ... 2.8 | 0.6 ... 0.8 |

Termination



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Product range for HQF chip capacitors

| Size | | |
|---------------------------|-------------|-------------|
| inch (l x w) | 0402 | 0603 |
| mm (l x w) | 1005 | 1608 |
| Type | B37923 | B37933 |
| $C_R \setminus V_R$ (VDC) | 50 | 50 |
| 0.3 pF | | |
| 0.4 pF | | |
| 0.5 pF | | |
| 0.6 pF | | |
| 0.7 pF | | |
| 0.8 pF | | |
| 0.9 pF | | |
| 1.0 pF | | |
| 1.2 pF | | |
| 1.5 pF | | |
| 1.8 pF | | |
| 2.2 pF | | |
| 2.7 pF | | |
| 3.3 pF | | |
| 3.9 pF | | |
| 4.7 pF | | |
| 5.6 pF | | |
| 6.8 pF | | |
| 8.2 pF | | |
| 10 pF | | |
| 12 pF | | |
| 15 pF | | |
| 18 pF | | |
| 22 pF | | |
| 27 pF | | |
| 82 pF | | |

SMD
Ordering codes and packing for HQF, 50 VDC, nickel barrier terminations

| C _R | Ordering code | Chip thickness mm | Cardboard tape, Ø180-mm reel | Cardboard tape, Ø330-mm reel |
|----------------|---------------|----------------------|---------------------------------|---------------------------------|
| | | | ** \triangle 60 | ** \triangle 70 |
| | | | pcs./reel | pcs./reel |

Case size 0402, 50 VDC

| | | | | |
|--------|-----------------|-----------|-------|-------|
| 0.3 pF | B37923K5000B3** | 0.5 ±0.05 | 10000 | 50000 |
| 0.4 pF | B37923K5000B4** | 0.5 ±0.05 | 10000 | 50000 |
| 0.5 pF | B37923K5000B5** | 0.5 ±0.05 | 10000 | 50000 |
| 0.6 pF | B37923K5000B6** | 0.5 ±0.05 | 10000 | 50000 |
| 0.7 pF | B37923K5000B7** | 0.5 ±0.05 | 10000 | 50000 |
| 0.8 pF | B37923K5000B8** | 0.5 ±0.05 | 10000 | 50000 |
| 0.9 pF | B37923K5000B9** | 0.5 ±0.05 | 10000 | 50000 |
| 1.0 pF | B37923K5010B0** | 0.5 ±0.05 | 10000 | 50000 |
| 1.2 pF | B37923K5010B2** | 0.5 ±0.05 | 10000 | 50000 |
| 1.5 pF | B37923K5010B5** | 0.5 ±0.05 | 10000 | 50000 |
| 1.8 pF | B37923K5010B8** | 0.5 ±0.05 | 10000 | 50000 |
| 2.2 pF | B37923K5020B2** | 0.5 ±0.05 | 10000 | 50000 |
| 2.7 pF | B37923K5020B7** | 0.5 ±0.05 | 10000 | 50000 |
| 3.3 pF | B37923K5030B3** | 0.5 ±0.05 | 10000 | 50000 |
| 3.9 pF | B37923K5030B9** | 0.5 ±0.05 | 10000 | 50000 |
| 4.7 pF | B37923K5040C7** | 0.5 ±0.05 | 10000 | 50000 |
| 5.6 pF | B37923K5050C6** | 0.5 ±0.05 | 10000 | 50000 |
| 6.8 pF | B37923K5060C8** | 0.5 ±0.05 | 10000 | 50000 |
| 8.2 pF | B37923K5080C2** | 0.5 ±0.05 | 10000 | 50000 |
| 10 pF | B37923K5100J0** | 0.5 ±0.05 | 10000 | 50000 |
| 12 pF | B37923K5120J0** | 0.5 ±0.05 | 10000 | 50000 |
| 15 pF | B37923K5150J0** | 0.5 ±0.05 | 10000 | 50000 |
| 18 pF | B37923K5180J0** | 0.5 ±0.05 | 10000 | 50000 |
| 22 pF | B37923K5220J0** | 0.5 ±0.05 | 10000 | 50000 |

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|-----|
| HQF |
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Multilayer ceramic capacitors
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Ordering codes and packing for HQF, 50 VDC, nickel barrier terminations

| C _R | Ordering code | Chip thickness mm | Cardboard tape, Ø180-mm reel | Cardboard tape, Ø330-mm reel |
|----------------|---------------|----------------------|---------------------------------|---------------------------------|
| | | | ** \triangle 60 | ** \triangle 70 |
| | | | pcs./reel | pcs./reel |

Case size 0603, 50 VDC

| | | | | |
|--------|-----------------|----------|------|-------|
| 0.4 pF | B37933K5000B4** | 0.8 ±0.1 | 4000 | 16000 |
| 0.5 pF | B37933K5000B5** | 0.8 ±0.1 | 4000 | 16000 |
| 0.6 pF | B37933K5000B6** | 0.8 ±0.1 | 4000 | 16000 |
| 0.7 pF | B37933K5000B7** | 0.8 ±0.1 | 4000 | 16000 |
| 0.8 pF | B37933K5000B8** | 0.8 ±0.1 | 4000 | 16000 |
| 0.9 pF | B37933K5000B9** | 0.8 ±0.1 | 4000 | 16000 |
| 1.0 pF | B37933K5010B0** | 0.8 ±0.1 | 4000 | 16000 |
| 1.2 pF | B37933K5010B2** | 0.8 ±0.1 | 4000 | 16000 |
| 1.5 pF | B37933K5010B5** | 0.8 ±0.1 | 4000 | 16000 |
| 1.8 pF | B37933K5010B8** | 0.8 ±0.1 | 4000 | 16000 |
| 2.2 pF | B37933K5020B2** | 0.8 ±0.1 | 4000 | 16000 |
| 2.7 pF | B37933K5020B7** | 0.8 ±0.1 | 4000 | 16000 |
| 3.3 pF | B37933K5030B3** | 0.8 ±0.1 | 4000 | 16000 |
| 3.9 pF | B37933K5030B9** | 0.8 ±0.1 | 4000 | 16000 |
| 4.7 pF | B37933K5040C7** | 0.8 ±0.1 | 4000 | 16000 |
| 5.6 pF | B37933K5050C6** | 0.8 ±0.1 | 4000 | 16000 |
| 6.8 pF | B37933K5060C8** | 0.8 ±0.1 | 4000 | 16000 |
| 8.2 pF | B37933K5080C2** | 0.8 ±0.1 | 4000 | 16000 |
| 10 pF | B37933K5100J0** | 0.8 ±0.1 | 4000 | 16000 |
| 12 pF | B37933K5120J0** | 0.8 ±0.1 | 4000 | 16000 |
| 15 pF | B37933K5150J0** | 0.8 ±0.1 | 4000 | 16000 |
| 18 pF | B37933K5180J0** | 0.8 ±0.1 | 4000 | 16000 |
| 22 pF | B37933K5220J0** | 0.8 ±0.1 | 4000 | 16000 |
| 27 pF | B37933K5270J0** | 0.8 ±0.1 | 4000 | 16000 |
| 82 pF | B37933K5820J0** | 0.8 ±0.1 | 4000 | 16000 |

SMD
Typical RF performance for HQF capacitors, case size 0402, 50 VDC

| Capacitance pF | $f_{res}^{1)}$ MHz | ESR @ 1 GHz ²⁾ mΩ | Q @ 1 GHz ²⁾ | ESR @ $f_{res}^{2)}$ mΩ |
|-------------------|-----------------------|---------------------------------|-------------------------|----------------------------|
| 0.3 | 23400 | 560 | 920 | 710 |
| 0.4 | 20350 | 490 | 805 | 605 |
| 0.5 | 19700 | 440 | 720 | 535 |
| 0.6 | 17400 | 405 | 650 | 485 |
| 0.7 | 15100 | 375 | 600 | 445 |
| 0.8 | 14450 | 355 | 560 | 415 |
| 0.9 | 12600 | 335 | 520 | 385 |
| 1.0 | 12000 | 320 | 490 | 365 |
| 1.2 | 10600 | 295 | 440 | 330 |
| 1.5 | 8900 | 265 | 390 | 290 |
| 1.8 | 7100 | 245 | 350 | 265 |
| 2.2 | 6400 | 225 | 310 | 235 |
| 2.7 | 6000 | 205 | 275 | 210 |
| 3.3 | 5500 | 185 | 245 | 190 |
| 3.9 | 5350 | 170 | 225 | 175 |
| 4.7 | 4650 | 155 | 200 | 155 |
| 5.6 | 3950 | 145 | 175 | 140 |
| 6.8 | 4100 | 130 | 155 | 125 |
| 8.2 | 3650 | 120 | 140 | 115 |
| 10 | 3350 | 110 | 120 | 105 |
| 12 | 3350 | 102 | 104 | 94 |
| 15 | 2600 | 92 | 88 | 82 |
| 18 | 2300 | 84 | 70 | 74 |
| 22 | 2200 | 78 | 56 | 66 |

1) Measured with impedance analyser E4991 A, parts not soldered.

2) Measured with network analyser HP 8753D, parts soldered.

HQF
Multilayer ceramic capacitors
HQF
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Typical RF performance for HQF capacitors, case size 0603, 50 VDC

| Capacitance pF | $f_{res}^{3)}$ MHz | ESR @ 1 GHz ⁴⁾ mΩ | Q @ 1 GHz ⁴⁾ | ESR @ $f_{res}^{4)}$ mΩ |
|-------------------|-----------------------|---------------------------------|-------------------------|----------------------------|
| 0.4 | 17800 | 445 | 860 | 595 |
| 0.5 | 17100 | 400 | 805 | 540 |
| 0.6 | 13600 | 385 | 755 | 510 |
| 0.7 | 12200 | 345 | 635 | 440 |
| 0.8 | 11400 | 325 | 595 | 410 |
| 0.9 | 10600 | 315 | 560 | 390 |
| 1.0 | 9600 | 300 | 525 | 365 |
| 1.2 | 8800 | 275 | 455 | 335 |
| 1.5 | 7900 | 250 | 395 | 300 |
| 1.8 | 6900 | 240 | 360 | 285 |
| 2.2 | 5750 | 215 | 305 | 250 |
| 2.7 | 5100 | 200 | 270 | 235 |
| 3.3 | 4700 | 185 | 235 | 210 |
| 3.9 | 4150 | 175 | 210 | 200 |
| 4.7 | 3550 | 165 | 185 | 185 |
| 5.6 | 3130 | 150 | 160 | 170 |
| 6.8 | 2850 | 140 | 135 | 155 |
| 8.2 | 2730 | 130 | 115 | 140 |
| 10 | 2580 | 120 | 96 | 130 |
| 12 | 2400 | 110 | 76 | 118 |
| 15 | 2150 | 102 | 62 | 108 |
| 18 | 2050 | 96 | 50 | 100 |
| 22 | 1870 | 88 | 34 | 90 |
| 27 | 1780 | 80 | 26 | 82 |

| Capacitance pF | $f_{res}^{3)}$ MHz | ESR @ 1 GHz ⁴⁾ mΩ | Q @ 1 GHz ⁴⁾ | ESR @ $f_{res}^{4)}$ mΩ |
|-------------------|-----------------------|---------------------------------|-------------------------|----------------------------|
| 82 | 930 | 52 | 105 | 52 |

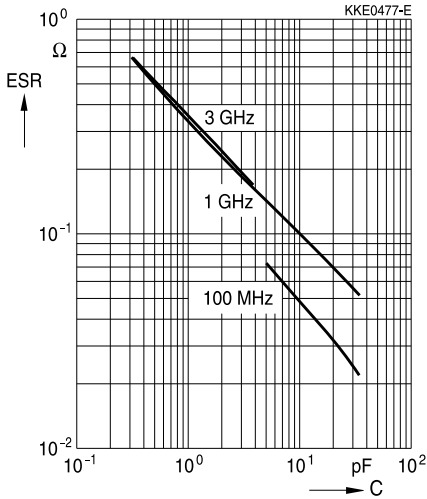
3) Measured with impedance analyser E4991 A, parts not soldered.

4) Measured with network analyser HP 8753D, parts soldered.

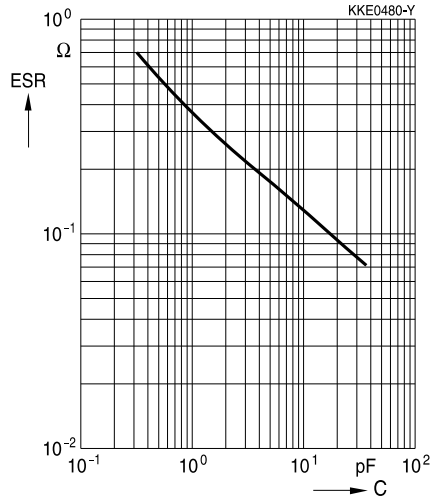
SMD

Typical characteristics for case size 0402¹⁾

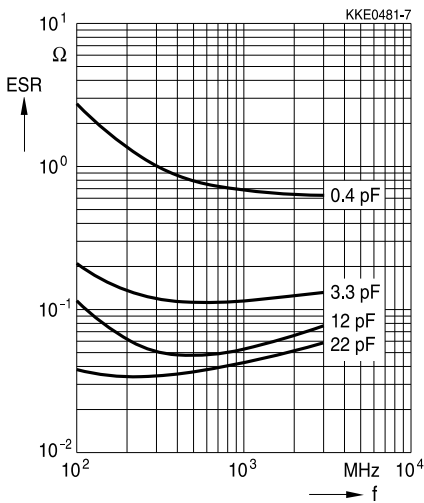
ESR versus capacitance C
(for not soldered parts)



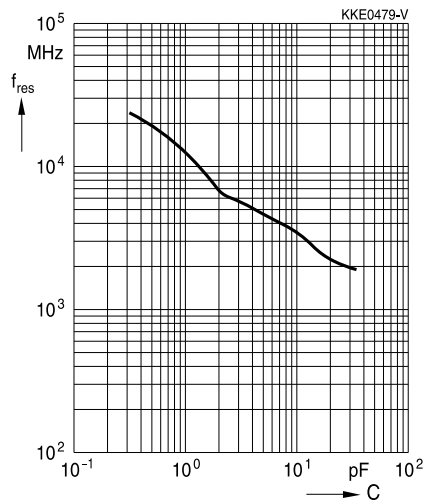
ESR versus capacitance C
at self-resonant frequency (for soldered parts)



ESR versus frequency f



Self-resonant frequency f_{res} versus capacitance C

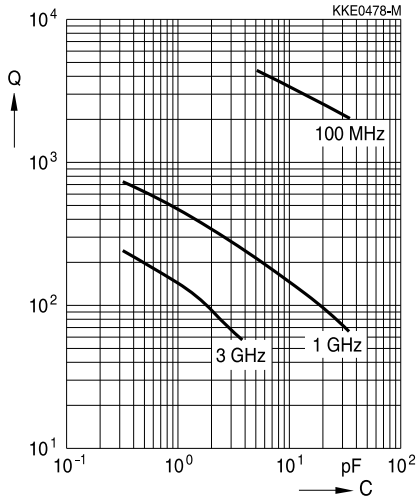


1) For more detailed information on frequency behavior and characteristics see www.epcos.com/mlcc_impedance.

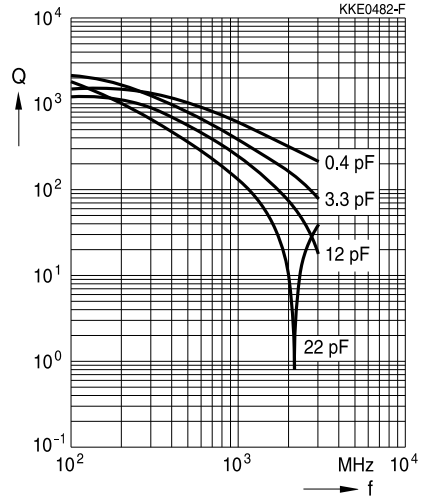
SMD

Typical characteristics for case size 0402¹⁾

Q factor versus capacitance C



Q factor versus frequency f

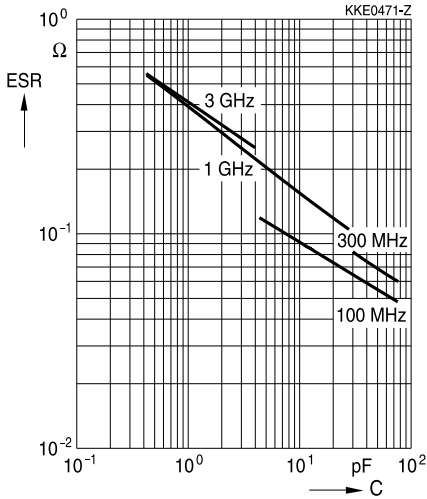


1) For more detailed information on frequency behavior and characteristics see www.epcos.com/mlcc_impedance.

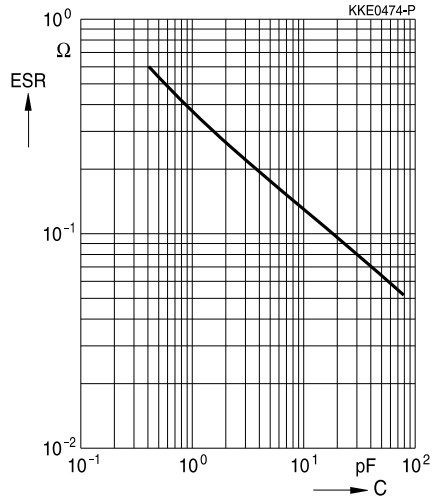
SMD

Typical characteristics for case size 0603¹⁾

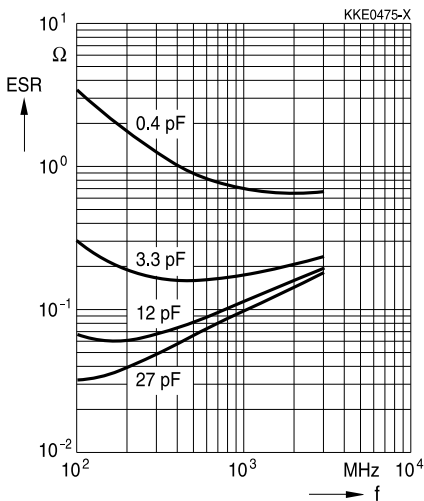
ESR versus capacitance C
(for not soldered parts)



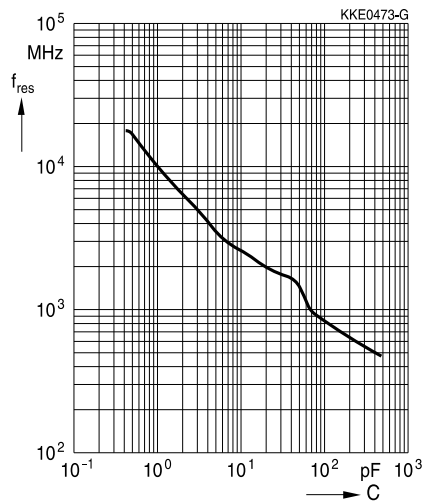
ESR versus capacitance C
at self-resonant frequency (for soldered parts)



ESR versus frequency f



Self-resonant frequency f_{res} versus capacitance C

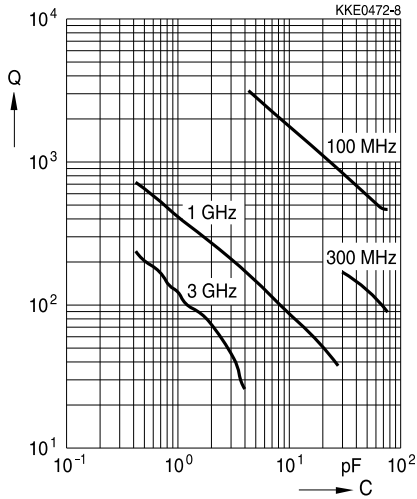


1) For more detailed information on frequency behavior and characteristics see www.epcos.com/mlcc_impedance.

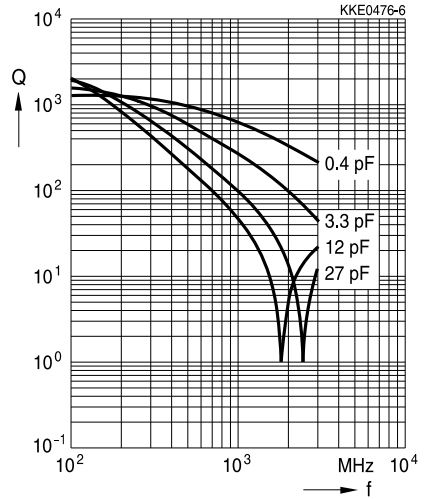
SMD

Typical characteristics for case size 0603¹⁾

Q factor versus capacitance C



Q factor versus frequency f



1) For more detailed information on frequency behavior and characteristics see www.epcos.com/mlcc_impedance.

Cautions and warnings

How to select ceramic capacitors

Remember the following when selecting ceramic capacitors:

1. Ceramic capacitors that must fulfill high quality requirements must be qualified based on AEC-Q200 Rev-C.
2. When ceramic capacitors are used at the connection to a battery or power supply (e.g. clamp 15 or 30 in an automobile) or for safety-relevant applications, two single ceramic capacitors should be connected in series. Alternatively a ceramic capacitor with integrated series circuits should be used in order to reduce the possibility of a short circuit caused by a fracture. The MLSC from EPCOS contains such a series circuit in a single component.
3. The use of multilayer varistors (MLVs) is recommended for ESD protection (see chapter "Effects on mechanical, thermal and electrical stress", section 1.4).
4. Additional stress factors such as continuous operating voltage or application-specific derating must be taken into account in the selection of components (refer to chapter "Reliability").

Recommendations for the circuit board design

1. Components with an optimized geometrical design are preferable where permitted by the application.
2. Use at least FR4 circuit board material.
3. Geometrically optimized circuit boards are preferable, especially those that cannot be deformed.
4. Ceramic capacitors should be placed with a sufficient minimum distance from the edge of a circuit board. High bending forces may be exerted there when boards are separated and during further processing of a board (e.g. when incorporating it in a housing).
5. Ceramic capacitors should always be placed parallel to the possible bending axis of a circuit board.
6. Screw connections should not be used to fix a board or connect several boards. Components should not be placed near screw holes. If screw connections are unavoidable, they should be cushioned, for instance using rubber pads.

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Recommendations for processing

1. Ensure correct positioning of a ceramic capacitor on the solder pad.
2. Be careful when using casting, injection-molded and molding compounds and cleaning agents. They can damage a capacitor.
3. Support a circuit board and reduce placement forces.
4. Do not straighten a board (manually) if it is distorted by soldering.
5. Separate boards with a peripheral saw, or preferably with a milling head (no dicing or breaking).
6. Be careful when subsequently placing heavy or leaded components (e.g. transformers or snap-in components) because of the danger of bending and fracture.
7. When testing, transporting, packing or inserting a board, avoid any deformation of it so that components are not damaged.
8. Avoid excessive force when plugging a connector into a device soldered onto a board.
9. Only mount ceramic capacitors using the soldering process (reflow or wave) that is permissible for them (see chapter "Soldering directions").
10. When soldering, select the softest solder profile possible (heating time, peak temperature, cooling time) to avoid thermal stress and damage.
11. Ensure the correct solder meniscus height and solder quantity.
12. Ensure correct dosing of the cement.
13. Ceramic capacitors with external silver-palladium terminations are intended for conductive adhesion - they are not suited for lead-free soldering processes.

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

SMD
Symbols and terms

| Symbol | English | German |
|-------------------|--|--|
| A | Area | Fläche |
| C | Capacitance | Kapazität |
| C ₀ | Initial (original) capacitance | Anfangskapazität |
| C ₁ | Capacitance value after one hour's use | Kapazitätswert nach einer Stunde |
| C _R | Rated capacitance | Nennkapazität |
| C ₂₀ | Capacitance at 20 °C | Kapazität bei 20 °C |
| C ₂₅ | Capacitance at 25 °C | Kapazität bei 25 °C |
| ΔC | Capacitance change | Kapazitätsänderung |
| D | Bending displacement | Durchbiegung |
| E _a | Activation energy | Aktivierungsenergie |
| ESR | Equivalent series resistance | Ersatzserienwiderstand |
| F | Force | Kraft |
| f | Frequency | Frequenz |
| f _{meas} | Measuring frequency | Messfrequenz |
| f _{res} | Self-resonant frequency | Eigenresonanzfrequenz |
| I _{test} | Test current | Prüfstrom |
| k | Ageing constant | Alterungskonstante |
| L | Inductance | Induktivität |
| N | Quantity (integer values) | Anzahl (ganzzahliger Wert) |
| P _{loss} | Power dissipation or loss | Verlustleistung |
| Q _{el} | Electrical charge | Elektrische Ladung |
| Q | Quality | Güte |
| R _{ins} | Insulation resistance | Isolationswiderstand |
| R _p | Parallel resistance | Parallelwiderstand |
| R _s | Series resistance (circuit resistance) | Serienwiderstand |
| S _v | Rate of rise of a voltage pulse | Flankensteilheit eines Spannungsimpulses |
| T | Temperature | Temperatur |
| T _{meas} | Measuring temperature | Messtemperatur |
| T _{op} | Operating temperature | Betriebstemperatur |
| T _{ref} | Reference temperature | Bezugstemperatur |
| T _{test} | Test temperature | Prüftemperatur |
| t | Time | Zeit |
| t _r | Rise time of a voltage pulse | Anstiegszeit eines Spannungsimpulses |
| t _{test} | Test duration | Prüfdauer |
| tan δ | Dissipation factor | Verlustfaktor |

SMD

| Symbol | English | German |
|-------------------|--|---|
| V | Voltage | Spannung |
| V ₀ | Initial (original) voltage (basic voltage level) | Anfangsspannung (Spannungsgrundpegel) |
| V _{meas} | Measuring voltage | Messspannung |
| V _R | Rated voltage | Nennspannung |
| V _S | Amplitude of a voltage pulse | Hub des Spannungsimpulses |
| V _{RMS} | Measuring (root-mean-square or effective) AC voltage | Effektivspannung |
| V _{test} | Test voltage | Prüfspannung |
| Z | Magnitude of impedance (AC resistance) | Betrag der Impedanz (Wechselstromwiderstand) |
| α | Temperature coefficient | Temperaturkoeffizient |
| ε ₀ | Absolute dielectric constant | Absolute Dielektrizitätskonstante |
| ε _r | Relative dielectric constant | Relative Dielektrizitätskonstante |
| λ | Failure rate | Ausfallrate |
| τ | Time constant | Zeitkonstante |

Abbreviations / Notes

| Symbol | English | German |
|-------------------|--|---|
| $\square e$ | Lead spacing (in mm) | Rastermaß (in mm) |
| <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. | Platzhalter für einen Buchstaben. |
| | All dimensions are given in mm. | Alle Maße sind in mm angegeben. |
| | The commas used in numerical values denote decimal points. | 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.
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