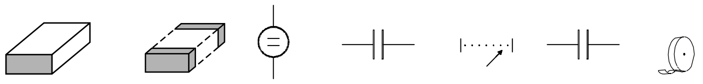
Multilayer ceramic capacitors

Chip capacitors, HQF

Date: October 2006

Ordering code system



B37923 **K** **5** **100** **J** **0** **60**

Packaging

60 ≙ cardboard tape, 180-mm reel
70 ≙ cardboard tape, 330-mm reel

Decimal place for cap. values <10 pF, otherwise not used

Capacitance tolerance

C_R < 10 pF: **B ≙ ±0.1 pF (standard for capacitance values ≤3.9 pF)**
C ≙ ±0.25 pF (standard for capacitance values ≤8.2 pF)
D ≙ ±0.5 pF

C_R ≥ 10 pF: F ≙ ± 1%
G ≙ ± 2%
J ≙ ± 5% (standard)
K ≙ ±10%

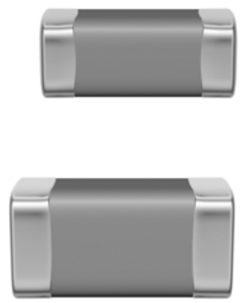
Capacitance, coded (example) 100 ≙ <u>10</u> · 10^0 pF = 10 pF

Rated voltage

Rated voltage [VDC]	50
Code	5

Termination Standard: K ≙ nickel barrier for all case sizes

Type and size	
Chip size (**inch** / mm)	Temperature characteristic HQF
0402 / 1005 **0603** / 1608	B37923 B37933



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
- To AEC-Q200

Applications

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

Termination

- For soldering: Nickel barrier terminations (Ni)

Options

- Alternative capacitance 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 δ	$<1.0 \cdot 10^{-3}$	
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	

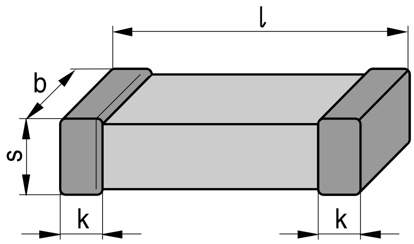
1) For C_R >10 nF the time constant $\tau = C \cdot R_{ins}$ is given.

Capacitance tolerances

C_R	$C_R \leq 3.9$ pF		4.7 pF $\leq C_R \leq 8.2$ pF		
Code letter	B (standard)	C	B	C (standard)	D
Tolerance	±0.1 pF	±0.25 pF	±0.1 pF	±0.25 pF	±0.5 pF

C_R	$C_R \geq 10$ pF			
Code letter	F	G	J (standard)	K
Tolerance	±1%	±2%	±5%	±10%

Dimensional drawing



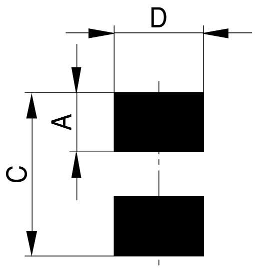
KKE0329-N

Dimensions (mm)

Case size (inch) (mm)	0402 1005	0603 1608
l	1.0 ±0.10	1.6 ±0.15
b	0.5 ±0.05	0.8 ±0.10
s	0.5 ±0.05	0.8 ±0.10
k	0.1 –0.40	0.1 –0.40

Tolerances to CECC 32101-801

Recommended solder pad



KKE0308-1

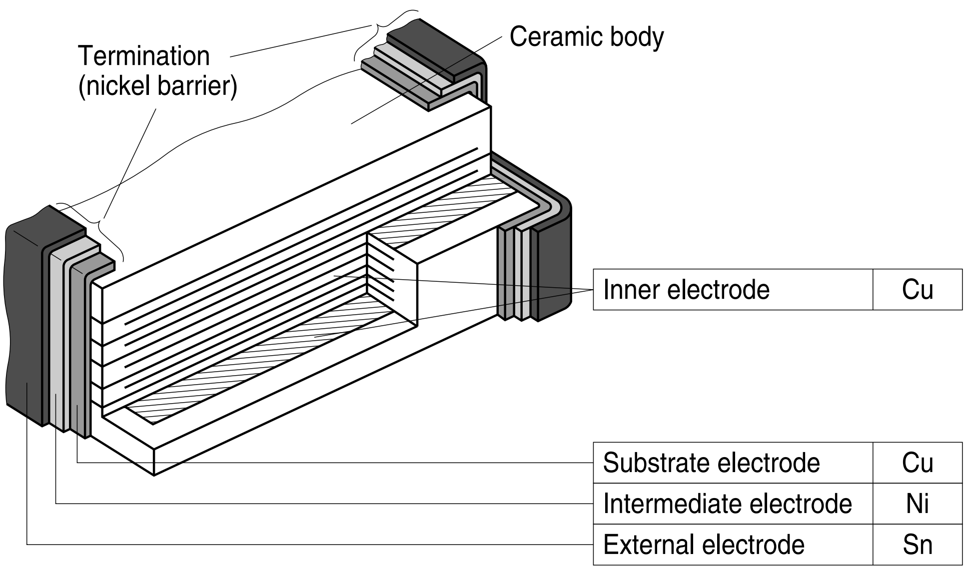
Recommended dimensions (mm) for reflow soldering

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	0.60 … 0.70	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



KKE0486-D

Product range for HQF chip capacitors

Size[1)] inch / mm	**0402** 1005		**0603** 1608	
Type	B37923		B37933	
V_R (VDC) / C_R	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			■	

1) l × b (inch) / l × b (mm)

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

Case size 0402, 50 VDC

C_R	Ordering code[1)]	Chip thickness mm	Cardboard tape, ∅ 180-mm reel ** ≙ 60 pcs/reel	Cardboard tape, ∅ 330-mm reel ** ≙ 70 pcs/reel
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

1) The table contains the ordering codes for the standard capacitance tolerance.
For other available capacitance tolerances see page 154.

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

Case size 0603, 50 VDC

C_R	Ordering code[1)]	Chip thickness mm	Cardboard tape, ∅ 180-mm reel ** ≙ 60 pcs/reel	Cardboard tape, ∅ 330-mm reel ** ≙ 70 pcs/reel
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

1) The table contains the ordering codes for the standard capacitance tolerance.
For other available capacitance tolerances see page 154.

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

Capacitance pF	f_{res} 1) MHz	ESR @ 1 GHz2) mΩ	Q @ 1 GHz2)	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 E 4991A, parts not soldered.
2) Measured with network analyser HP 8753D, parts soldered.

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

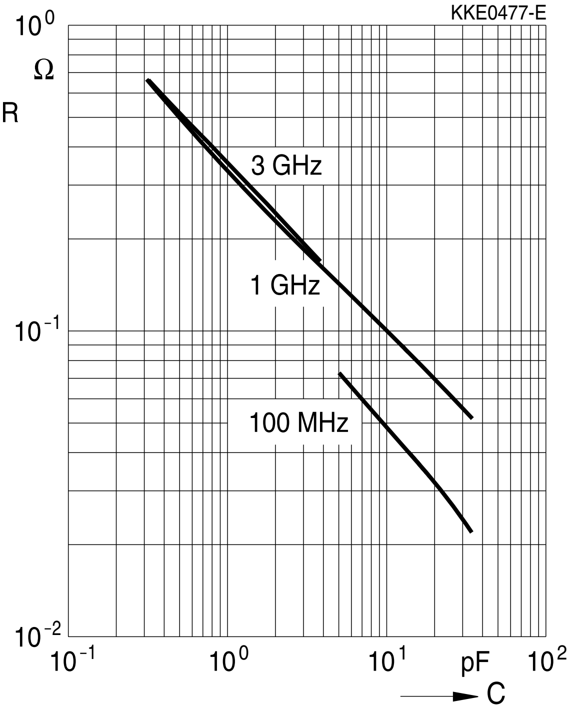
Capacitance pF	f_{res}[1] MHz	ESR @ 1 GHz[2] mΩ	Q @ 1 GHz[2]	ESR @ f_{res}[2] mΩ
0.4	17800	445	860	595
0.5	17100	400	805	540
0.6	13600	385	755	510
0.7	12200	345	635	440
0.8	11400	325	595	410
0.9	10600	315	560	390
1.0	9600	300	525	365
1.2	8800	275	455	335
1.5	7900	250	395	300
1.8	6900	240	360	285
2.2	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}[1] MHz	ESR @ 300 MHz[2] mΩ	Q @ 300 MHz[2]	ESR @ f_{res}[2] mΩ
82	930	52	105	52

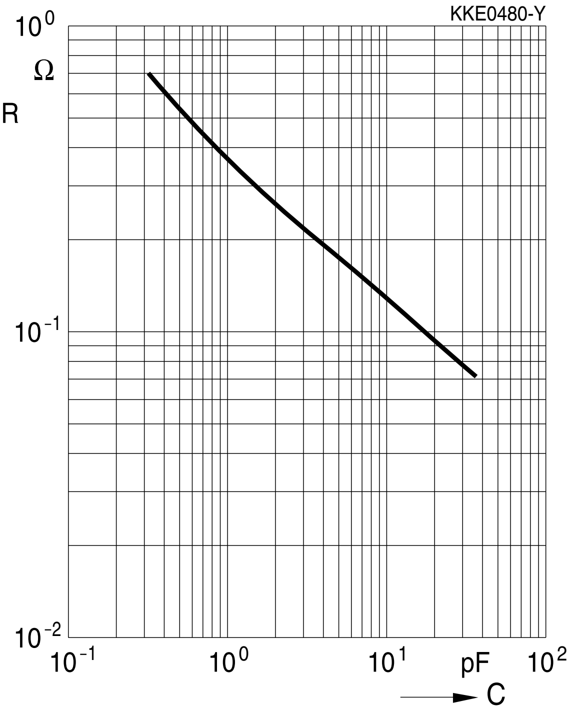
1) Measured with impedance analyser E 4991A, parts not soldered.
2) Measured with network analyser HP 8753D, parts soldered.

Typical characteristics for case size 0402 [1]

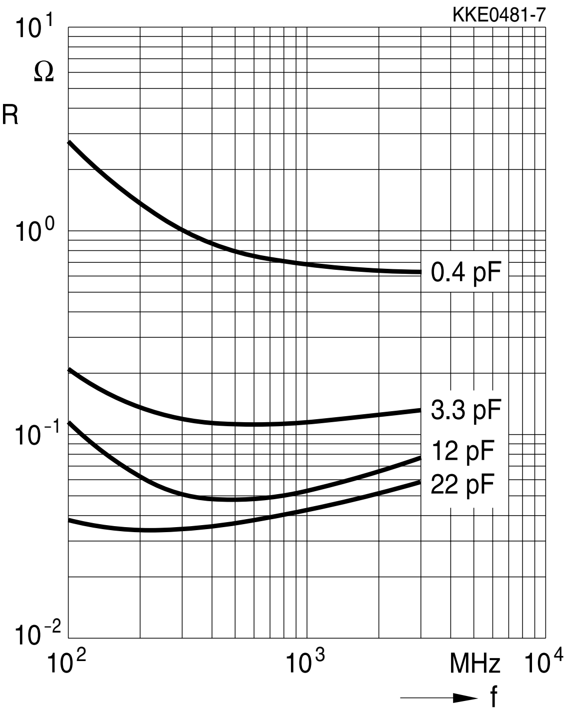
ESR versus capacitance C
(for not soldered parts)



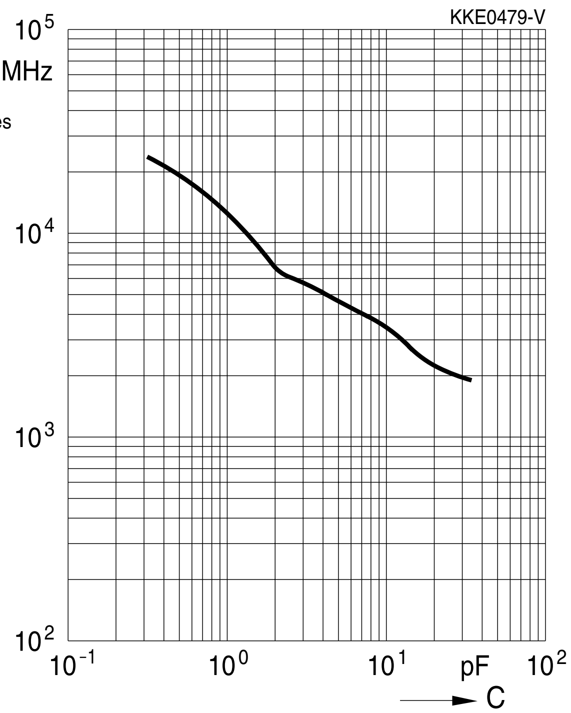
ESR versus capacitance C
at self-resonant frequency (for soldered parts)



ESR versus frequency f



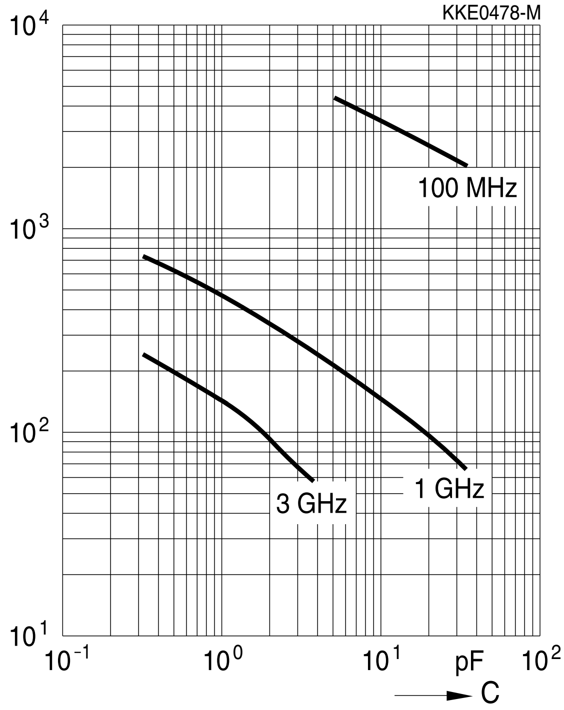
Self-resonant frequency f_{res} versus
capacitance C



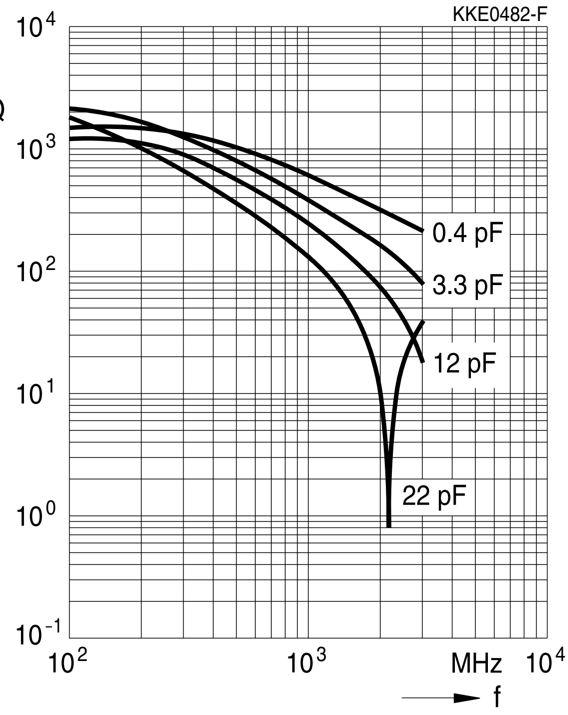
1) For more detailed information on frequency behavior and characteristics see www.epcos.com/mlcc_impedance.

Typical characteristics for case size 0402 1)

Q factor versus capacitance C



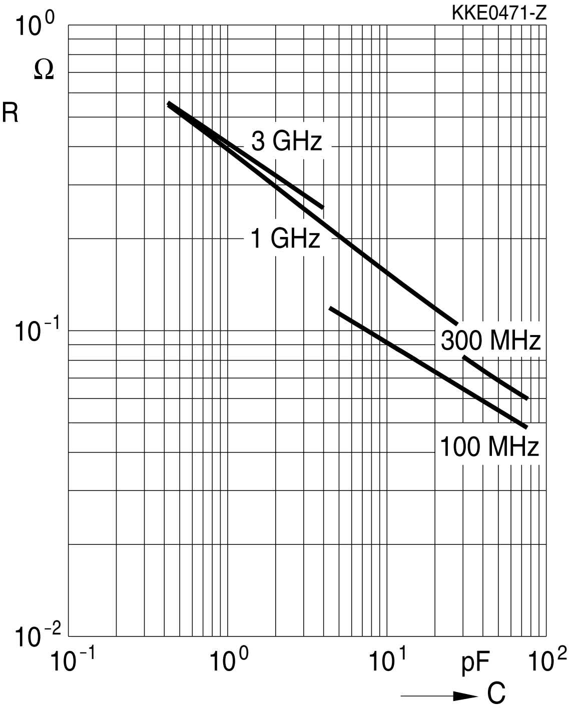
Q factor versus frequency f



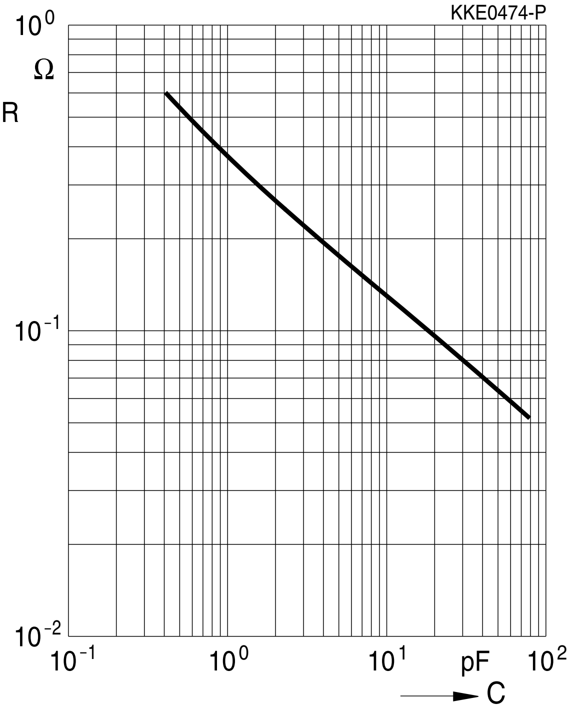
1) For more detailed information on frequency behavior and characteristics see www.epcos.com/mlcc_impedance.

Typical characteristics for case size 0603[1)]

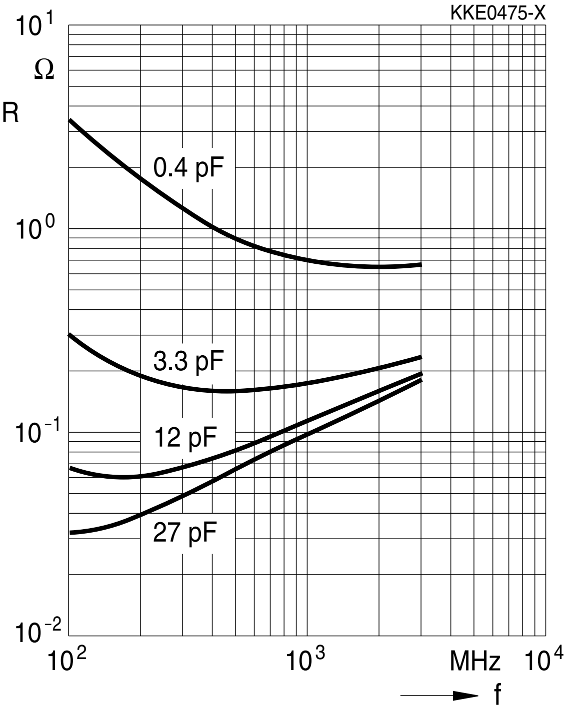
ESR versus capacitance C
(for not soldered parts)



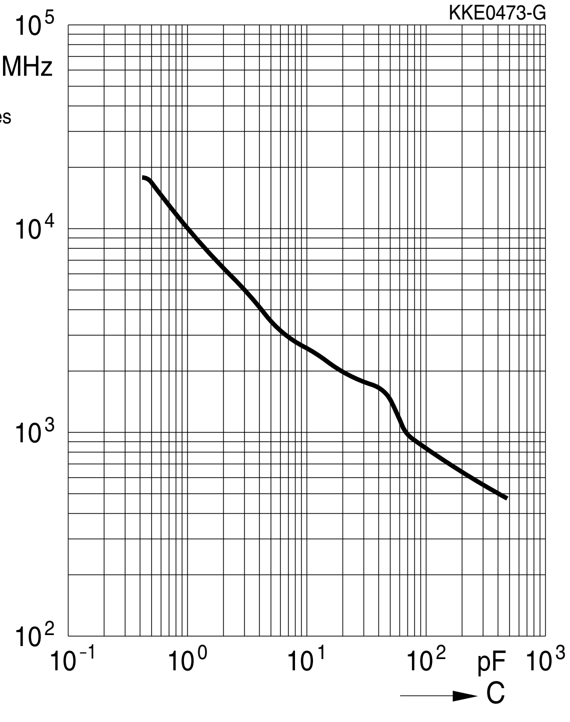
ESR versus capacitance C
at self-resonant frequency (for soldered parts)



ESR versus frequency f



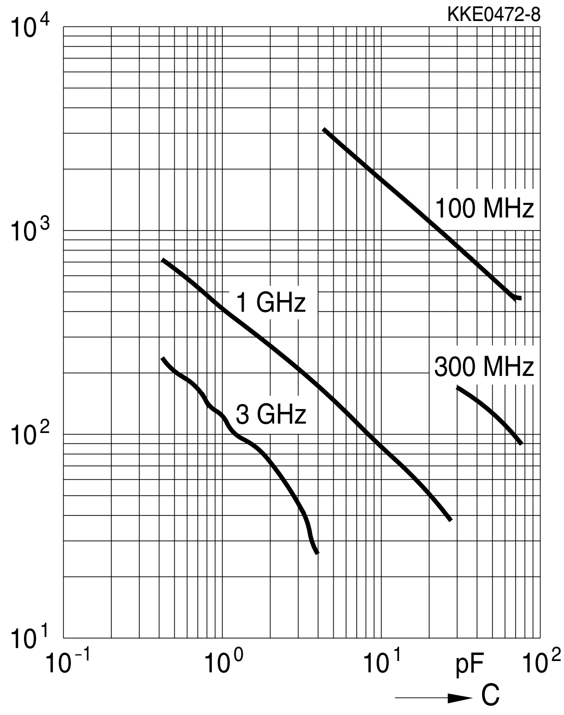
Self-resonant frequency f_{res} versus
capacitance C



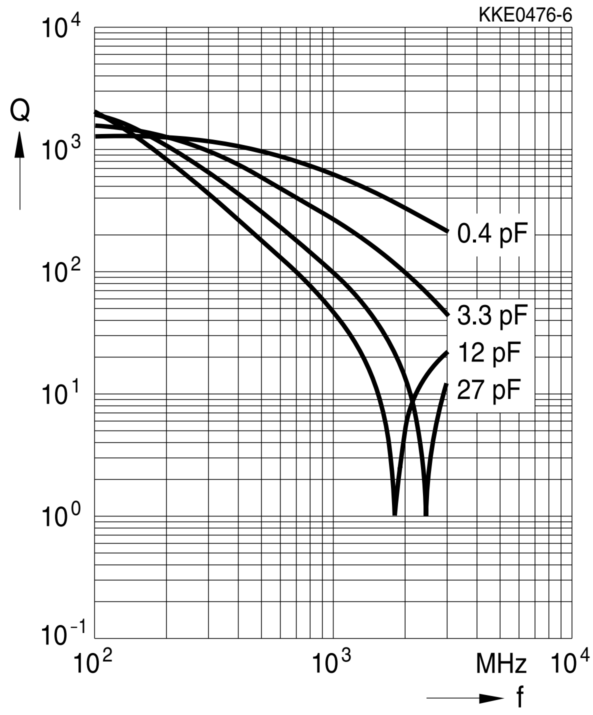
1) For more detailed information on frequency behavior and characteristics see www.epcos.com/mlcc_impedance.

Typical characteristics for case size 0603 1)

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.

Notes on the selection of ceramic capacitors

In the selection of ceramic capacitors, the following criteria must be considered:

1. Depending on the application, ceramic capacitors used to meet high quality requirements should at least satisfy the specifications to AEC-Q200. They must meet quality requirements going beyond this level in terms of ruggedness (e.g. mechanical, thermal or electrical) in the case of critical circuit configurations and applications (e.g. in safety-relevant applications such as ABS and airbag equipment or durable industrial goods).
2. At the connection to the battery or power supply (e.g. clamp 15 or 30 in the automobile) and at positions with stranding potential, to reduce the probability of short circuits following a fracture, two ceramic capacitors must be connected in series and/or a ceramic capacitor with integrated series circuit should be used. The MLSC from EPCOS contains such a series circuit in a single component.
3. Ceramic capacitors with the temperature characteristics Z5U and Y5V do not satisfy the requirements to AEC-Q200 and are mechanically and electrically less rugged than C0G or X7R/X8R ceramic capacitors. In applications that must satisfy high quality requirements, therefore, these capacitors should not be used as discrete components (see the chapter “Effects on mechanical, thermal and electrical stress”, point 1.4).
4. For ESD protection, preference should be given to the use of multilayer varistors (MLV) (see the chapter “Effects on mechanical, thermal and electrical stress”, point 1.4).
5. An application-specific derating or continuous operating voltage must be considered in order to cushion (unexpected) additional stresses (see the chapter “Reliability”).

The following should be considered in circuit board design

1. If technically feasible in the application, preference should be given to components having an optimal geometrical design.
2. At least FR4 circuit board material should be used.
3. Geometrically optimal circuit boards should be used, ideally those that cannot be deformed.
4. Ceramic capacitors must always be placed a sufficient minimum distance from the edge of the circuit board. High bending forces may be exerted there when the panels are separated and during further processing of the board (such as when incorporating it into a housing).
5. Ceramic capacitors should always be placed parallel to the possible bending axis of the circuit board.
6. No screw connections should be used to fix the board or to connect several boards. Components should not be placed near screw holes. If screw connections are unavoidable, they must be cushioned (for instance by rubber pads).

The following should be considered in the placement process

1. Ensure correct positioning of the ceramic capacitor on the solder pad.
2. Caution when using casting, injection-molded and molding compounds and cleaning agents, as these may damage the capacitor.
3. Support the circuit board and reduce the placement forces.
4. A board should not be straightened (manually) if it has been distorted by soldering.
5. Separate panels with a peripheral saw, or better with a milling head (no dicing or breaking).
6. Caution in the subsequent placement of heavy or leaded components (e.g. transformers or snap-in components): danger of bending and fracture.
7. When testing, transporting, packing or incorporating the board, avoid any deformation of the board not to damage the components.
8. Avoid the use of excessive force when plugging a connector into a device soldered onto the board.
9. Ceramic capacitors must be soldered only by the mode (reflow or wave soldering) permissible for them (see the chapter “Soldering directions”).
10. When soldering the most gentle solder profile feasible should be selected (heating time, peak temperature, cooling time) in order to avoid thermal stresses and damage.
11. Ensure the correct solder meniscus height and solder quantity.
12. Ensure correct dosing of the cement quantity.
13. Ceramic capacitors with an AgPd external termination are not suited for the lead-free solder process: they were developed only for conductive adhesion technology.

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

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 passive 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 a passive electronic component could endanger human life or health (e.g. in accident prevention or life-saving 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 a passive 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). 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.
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