

# Surface mounted ceramic multilayer capacitors

## Class 1, NP0 50 V narrow tolerance series

### FEATURES

- Four standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case (case sizes 0402, 0603 and 0805 only)
- For high frequency applications
- NiSn terminations (AgPd on request).

### APPLICATIONS

- Consumer electronics
- Telecommunications
- Automotive
- Data processing.

### DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations, either by silver palladium (AgPd) alloy in the ratio 65 : 35, or silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (NiSn). A cross section of the structure is shown in Fig.1.

### QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage $U_R$ (DC)	50 V (IEC)
Capacitance range (E12 series); note 1	0.47 pF to 6800 pF
Tolerance on capacitance: $C \geq 10$ pF $C < 10$ pF	$\pm 1\%$ $\pm 0.1$ pF
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 68)	55/125/56

### Note

1. Other values below 10 pF and non E12 series are available on request.

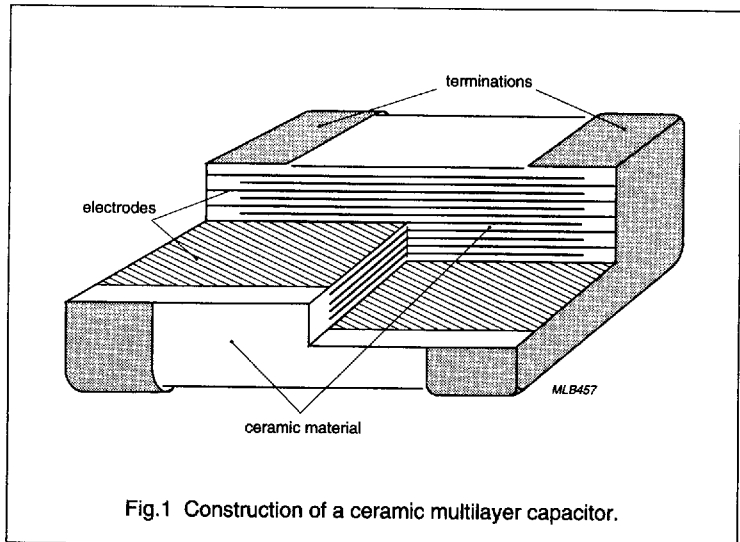
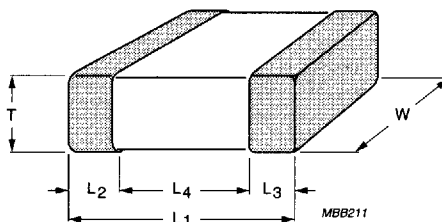


Fig.1 Construction of a ceramic multilayer capacitor.

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MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L <sub>1</sub>	W	T		L <sub>2</sub> and L <sub>3</sub>		L <sub>4</sub> MIN.
			MIN.	MAX.	MIN.	MAX.	
<b>Dimensions in millimetres</b>							
0402	1.0 ±0.05	0.5 ±0.05	0.45	0.55	0.20	0.30	0.40
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
<b>Dimensions in inches</b>							
0402	0.04 ±0.002	0.02 ±0.002	0.018	0.022	0.008	0.012	0.016
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056

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SELECTION CHART

C (pF)	LAST THREE DIGITS OF 12NC	50 V				
		0402	0603	0805	1206	
0.47	477					
0.56	567					
0.68	687					
0.82	827					
1.0	108					
1.2	128					
1.5	158					
1.8	188					
2.2	228					
2.7	278					
3.3	338					
3.9	398					
4.7	478					
5.6	568					
6.8	688					
8.2	828	0.5 ±0.05				
10	109			0.6 ±0.1		
12	129					
15	159					
18	189		0.8 ±0.07			
22	229					
27	279				0.6 ±0.1	
33	339					
39	399					
47	479					
56	569					
68	689					
82	829					
100	101					
120	121					
150	151					
180	181					
220	221					
270	271					
330	331					
390	391					
470	471					
560	561					
680	681					
820	821					
1000	102					
1200	122					
1500	152			0.85 ±0.1		
1800	182					
2200	222			1.25 ±0.1		
2700	272					
3300	332					
3900	392				0.85 ±0.1	
4700	472	Values in shaded cells indicate thickness classification.				
5600	562					
6800	682					

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## Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE		
	Ø180 mm; 7"		Ø330 mm; 13"		0402	0603	0805
	PAPER	BLISTER	PAPER	BLISTER			
0.5 ±0.05	10000	–	50000	–	50000	–	–
0.8 ±0.1	4000	4000	20000	10000	–	–	10000
0.85 ±1.0	4000	4000	15000	10000	–	–	8000
0.8 ±0.07	4000	4000	15000	15000	–	15000	–
1.15 ±0.1	–	3000	–	10000	–	–	–
1.25 ±0.1	–	3000	–	10000	–	–	5000

## ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

### Clear text code

Example: 0805CG102F9BB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402 0603 0805 1206	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	B ±0.1 pF F ±1%	9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

## Ordering code 12NC

**2 2 X X 8 6 X X X X X**

**Carrier type**

- 22 blister
- 38 paper
- 54 bulk

**Size**

- 9 0402
- 7 0603
- 1 0805
- 3 1206

**Capacitance value<sup>(1)</sup>**

**Tolerance**

- 4 ±0.1 pF for C = 0.47 to 4.7 pF
- 8 ±0.1 pF for C = 5.6 to 8.2 pF
- 8 ±1% for C ≥ 10 pF

**Packaging<sup>(2)</sup>**

- 1 reel: Ø180 mm; 7"
- 7 reel: Ø330 mm; 13"
- 4 bulk case

CCA615

(1) Refer to Chapter "Selection chart".  
 (2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

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## ELECTRICAL CHARACTERISTICS

### Class 1 capacitors; NP0 dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of  $20 \pm 1$  °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

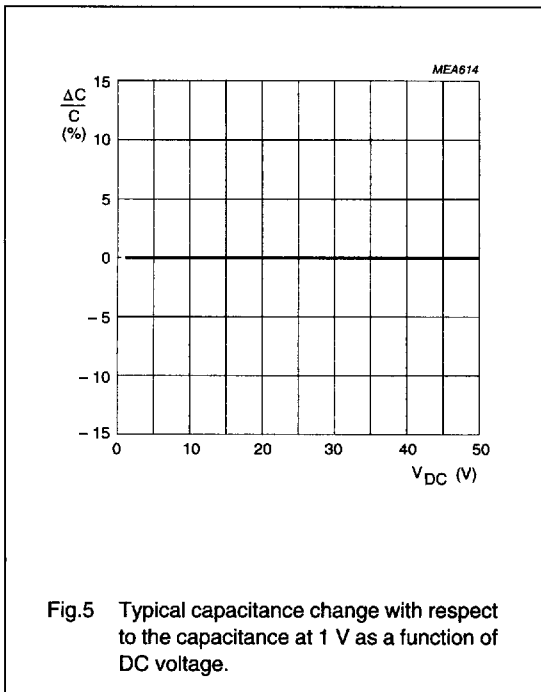
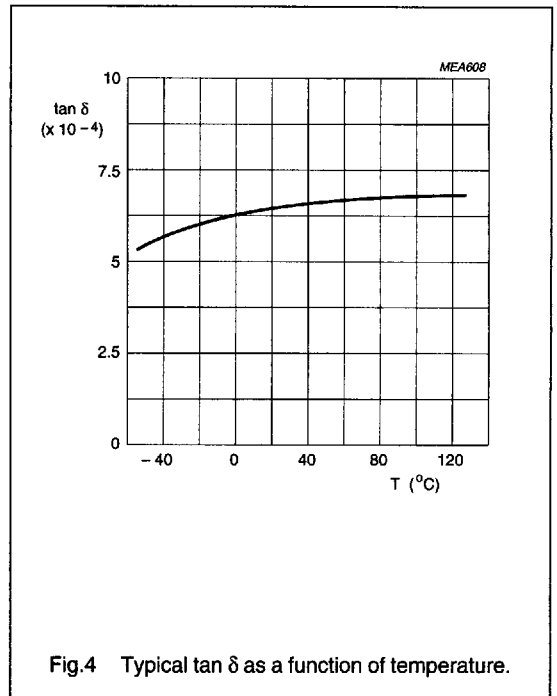
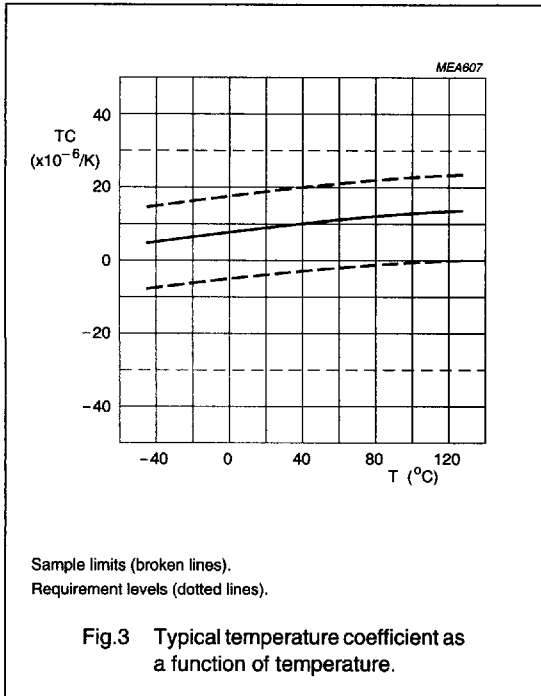
DESCRIPTION	VALUE
Capacitance range (E12 series); note 1: narrow tolerance; 50 V	0.47 pF to 3300 pF
Tolerance on capacitance after 1 000 hours: C ≥ 10 pF 5 pF ≤ C < 10 pF	±1% ±0.1 pF
Tan δ; note 1: C < 10 pF C ≥ 10 pF	$\leq 10 \left( \frac{3}{C} + 0.7 \right) \times 10^{-4}$ or $30 \times 10^{-4}$ , whichever is smallest $\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U <sub>R</sub> (DC)	R <sub>ins</sub> > 100 GΩ
Temperature coefficient: C < 10 pF C ≥ 10 pF	$(0 \pm 150) \times 10^{-6}/K$ ; note 2 $(0 \pm 30) \times 10^{-6}/K$ ; note 2
Ageing	not applicable

### Notes

1. Measured at 1 V, 1 MHz for C ≤ 1000 pF and 1 V, 1 kHz for C > 1000 pF, using a four-gauge method.
2. For sizes 0402 and 0603 all capacitance values have a temperature coefficient of  $(0 \pm 30) \times 10^{-6}/K$ .

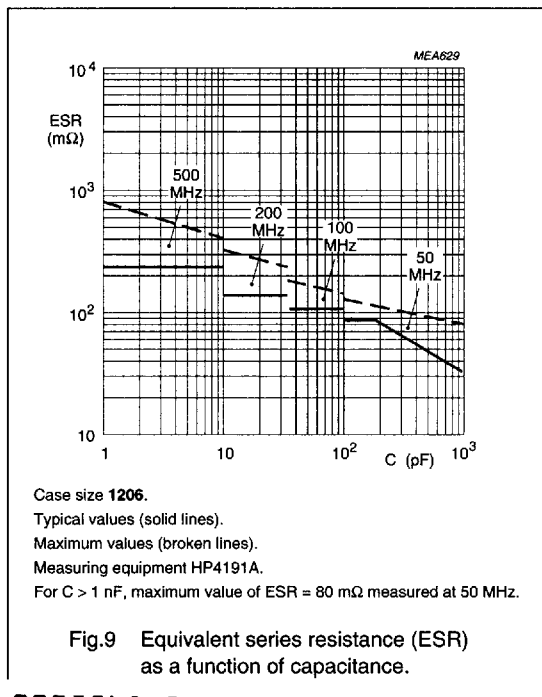
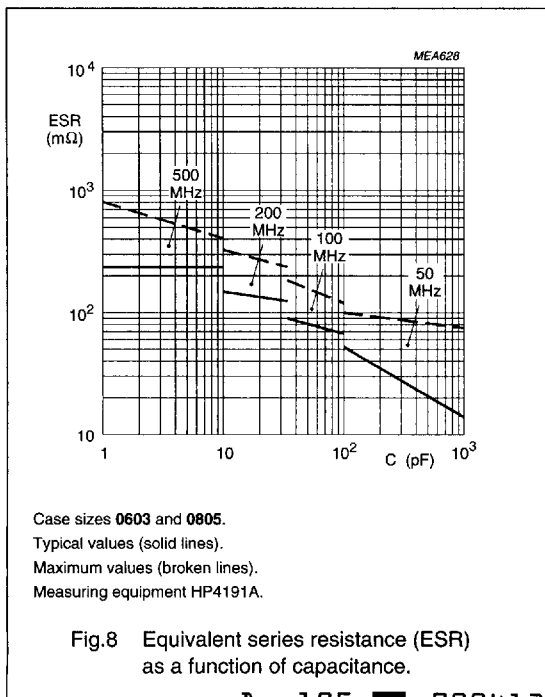
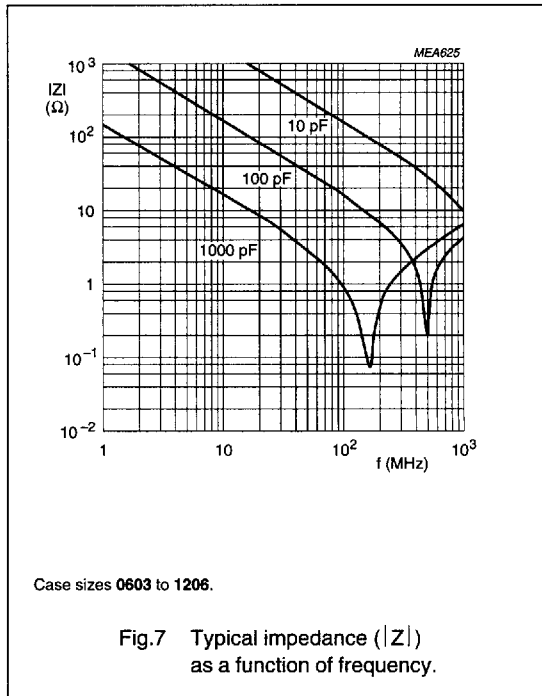
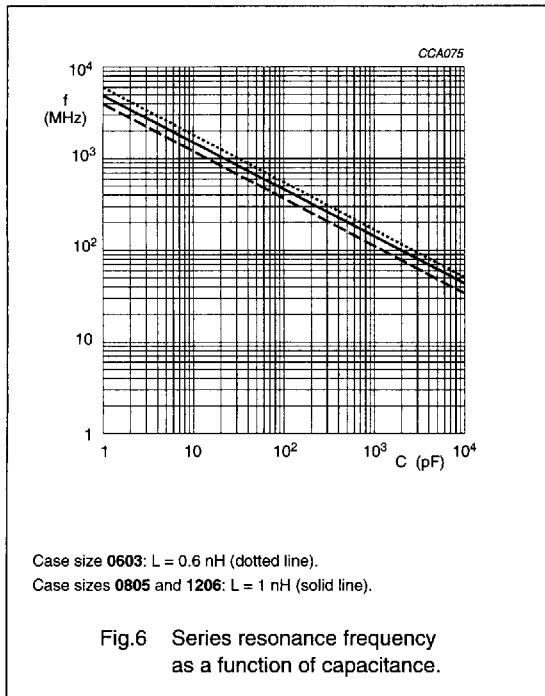
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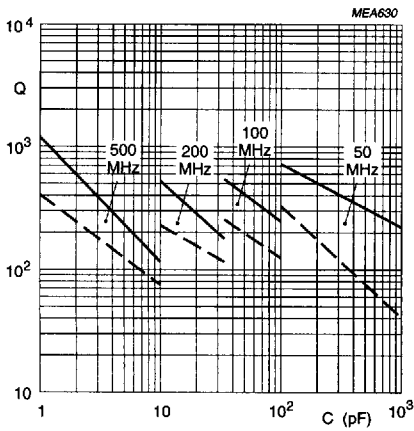
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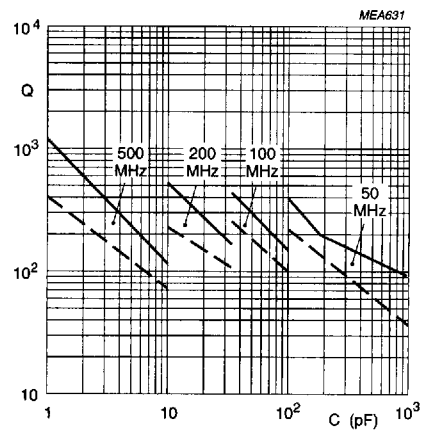
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Case sizes **0603** and **0805**.  
Typical values (solid lines).  
Minimum values (broken lines).  
Measuring equipment HP4191A.

Fig.10 Quality factor (Q) as a function of the capacitance.



Case size **1206**.  
Typical values (solid lines).  
Minimum values (broken lines).  
Measuring equipment HP4191A.  
For  $C > 1$  nF,  $Q_{min} = 35$  measured at 50 MHz.

Fig.11 Quality factor (Q) as a function of the capacitance.



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### HIGH FREQUENCY BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

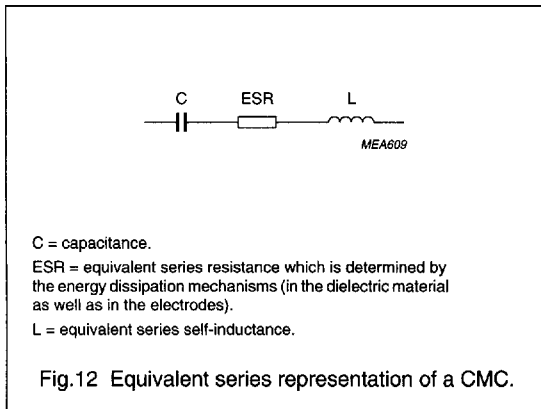
Ceramic multilayer capacitors (CMC) are suitable for use at high frequencies. At frequencies below the series resonance frequency, the CMC can be represented by an equivalent circuit as shown in Fig.12.

In general, the quantities C, ESR and L are frequency dependent. For most applications, C and L can be regarded as frequency independent below 1 GHz.

The equivalent series self-inductance L is:

- Independent of the dielectric material.
- Dependent on the size of the capacitor, it increases with increasing length and decreases with increasing width or thickness of the product.
- The value of L is approximately:
  - 0.6 nH for case size 0603
  - 1 nH for case sizes 0805.

These figures are accurate to within 20%.



Because of the inductance L, associated with the CMC, there will be a frequency at which the inductive reactance will be equal to the reactance of the capacitor.

This is known as the series resonance frequency (SRF) and is given by:

$$\text{SRF} = \frac{1}{2\pi\sqrt{LC}}$$

At the SRF, the CMC will appear as a small resistor. The transmission loss through the CMC at this series resonance frequency will be low.

Using the values of C, L = 1 nH and the ESR at a specific frequency (f), two often used quantities can be derived.

The impedance (Z) is given by:

$$Z = \frac{1 - (2\pi f)^2 LC}{2j\pi f C} + \text{ESR}$$

The quality factor (Q) is given by:

$$Q = \frac{|1 - (2\pi f)^2 LC|}{2\pi f \text{ESR} C}$$