

DATA SHEET

**Class 1, NP0 50/100/200/500 V
Noble Metal Electrode
Surface mount ceramic
multilayer capacitors**

Product specification
Supersedes data of 24th May 2000
File under Discrete Ceramics, ACM2

2000 Sep 11

Surface mount ceramic multilayer capacitors

Class 1, NP0 50/100/200/500 V Noble Metal Electrode

FEATURES

- Seven 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, 100 V, 200 V and 500 V (IEC)
Capacitance range (E12 series); note 1: 50 V; note 2 100 V 200 V 500 V	0.47 pF to 47 000 pF 10 pF to 22 nF 10 pF to 5600 pF 10 pF to 3300 pF
Tolerance on capacitance: $C \geq 10$ pF $C < 10$ pF	$\pm 5\%$; $\pm 2\%$ ± 0.5 pF; ± 0.25 pF
Test voltage (DC) for 1 minute: 50 V and 100 V 200 V 500 V	$2.5 \times U_R$ $3 \times U_R$ $2 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Notes

1. Other values below 10 pF and non E12 series are available on request.
2. Also applicable for applications up to 63 V.

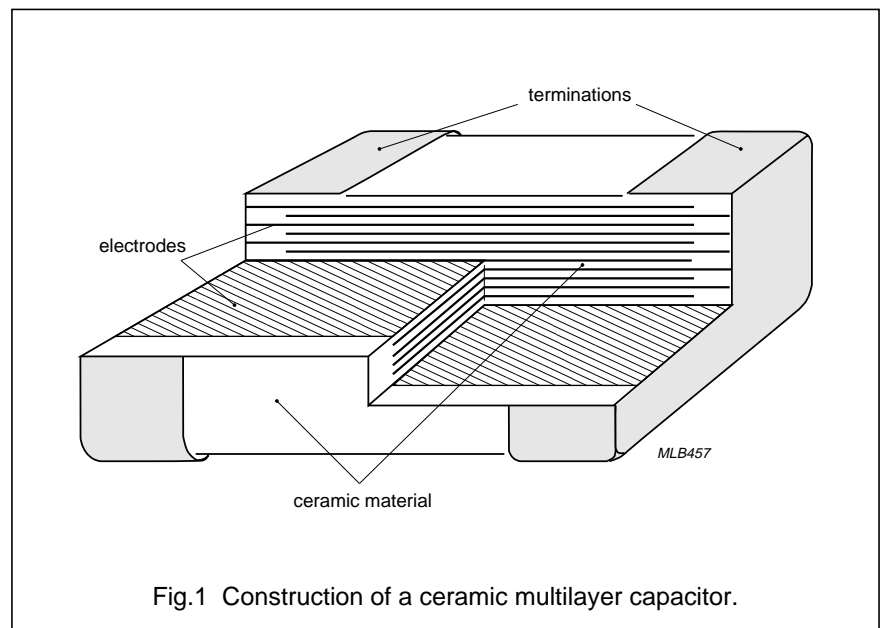
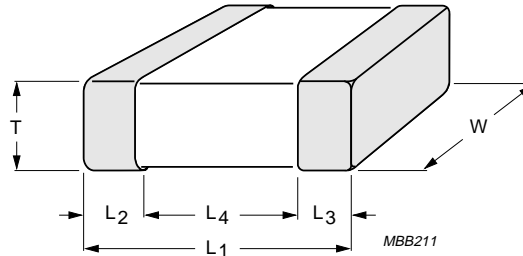


Fig.1 Construction of a ceramic multilayer capacitor.

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MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
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	0.50	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.50	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.50	1.80	0.25	0.75	1.40
1812	4.5 ±0.20	3.2 ±0.20	0.50	1.80	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.50	1.80	0.25	0.75	2.90
Dimensions in inches							
0402	0.040 ±0.002	0.020 ±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
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056
1812	0.177 ±0.008	0.126 ±0.008	0.020	0.072	0.010	0.030	0.088
2220	0.224 ±0.008	0.197 ±0.008	0.020	0.072	0.010	0.030	0.114

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Class 1, NP0 50 V
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SELECTION CHART FOR 50 V

C (pF)	LAST THREE DIGITS OF 12NC	50 V							
		0402	0603	0805	1206	1210	1812	2220	
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								
10	109	0.5 ±0.05							
12	129								
15	159								
18	189		0.8 ±0.07						
22	229								
27	279								
33	339			0.6 ±0.1					
39	399								
47	479								
56	569				0.6 ±0.1				
68	689								
82	829								
100	101								
120	121								
150	151								
180	181								
220	221								
270	271								
330	331								
390	391								
470	471						S		
560	561								
680	681								
820	821					0.5 to 1.0			
1000	102								
1200	122								
1500	152			0.85 ±0.1					
1800	182								
2200	222			1.25 ±0.1			0.5 to 1.0		
2700	272								
3300	332								
3900	392				0.85 ±0.1				
4700	472								
5600	562				1.15 ±0.1				
6800	682								
8200	822	Values in shaded cells indicate thickness classification.							
10000	103							0.5 to 1.0	
12000	123								

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Class 1, NP0 50 V Noble Metal Electrode

C (pF)	LAST THREE DIGITS OF 12NC	50 V						
		0402	0603	0805	1206	1210	1812	2220
15000	153						0.5 to 1.0	
18000	183						0.9 to 1.3	
22000	223							0.5 to 1.0
27000	273							
33000	333							
39000	393							
47000	473							0.9 to 1.3

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE		
	Ø180 mm; 7"		Ø330 mm; 13"		Ø180 mm; 7" BLISTER				
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805
0.5 ±0.05	10000	–	50000	–	–	–	50000	–	–
0.6 ±0.1	4000	–	20000	–	–	–	–	–	10000
0.85 ±0.1	4000	–	15000	–	–	–	–	–	8000
0.5 to 1.0	–	4000	–	10000	2000	1500	–	–	–
0.8 ±0.07	4000	–	15000	–	–	–	–	15000	–
0.9 to 1.3	–	3000	–	10000	1500	–	–	–	–
1.15 ±0.1	–	3000	–	10000	–	–	–	–	–
1.25 ±0.1	–	3000	–	10000	–	–	–	–	5000

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V Noble Metal Electrode

ORDERING INFORMATION FOR 50 V

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

Clear text code

EXAMPLE: 0805CG102J9B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402	CG = NP0	102 = 1000 pF;	C = ±0.25 pF	9 = 50 V	B = NiSn	2 = 180 mm; 7" paper	0 = no marking	0 = conv. ceramic
0603		the third digit signifies the multiplying factor:	D = ±0.5 pF		A = AgPd (2220 only)	3 = 330 mm; 13" paper	2 = 2-character marking in North America only	
0805		8 = × 0.01	G = ±2%			B = 180 mm; 7" blister		
1206		9 = × 0.1	J = ±5%			F = 330 mm; 13" blister		
1210		0 = × 1				P = bulk case		
1812		1 = × 10						
1812		2 = × 100						
2220 (AgPd only)		3 = × 1000						

Ordering code 12NC

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

Carrier type

- 22 blister
- 38 paper
- 54 bulk

Size

- 9 0402
- 7 0603
- 1 0805
- 3 1206
- 2 1210
- 5 1812
- 6 2220 (AgPd only)

Packaging⁽²⁾

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

Capacitance value⁽¹⁾

Tolerance

NiSn terminations

- 4 ±0.25 pF for C = 5.6 to 8.2 pF
- ±2% for C ≥ 10 pF
- 5 ±0.25 pF for C = 0.47 to 4.7 pF
- ±0.5 pF for C = 5.6 to 8.2 pF
- ±5% for C ≥ 10 pF

AgPd terminations

- 1 ±2% for C ≥ 10 pF
- 2 ±5% for C ≥ 10 pF

CCA622

(1) Refer to chapter "Selection chart for 50 V".

(2) Amount on reel depends on thickness classification, see section "Thickness classification and packaging quantities".

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Class 1, NP0 100 V
Noble Metal Electrode

SELECTION CHART FOR 100 V

C (pF)	LAST TWO DIGITS OF 12NC	100 V				
		0603	0805	1206	1210	1812
10	23					
12	24					
15	25					
18	26					
22	27					
27	28					
33	29					
39	31					
47	32					
56	33					
68	34					
82	35	0.8 ±0.07				
100	36					
120	37		0.6 ±0.1			
150	38					
180	39					
220	41			0.6 ±0.1		
270	42					
330	43					
390	44					
470	45					
560	46					
680	47					
820	48					
1000	49					
1200	51					
1500	52		0.85 ±0.1			
1800	53					
2200	54		1.25 ±0.1			
2700	55					
3300	56					
3900	57			0.85 ±0.1		
4700	58					
5600	59			1.15 ±0.1		
6800	61					
8200	62	Values in shaded cells indicate thickness classification.			0.5 to 1.0	
10000	63					
12000	64				0.5 to 1.0	
15000	65					
18000	66				0.9 to 1.3	
22000	67					
27000	68					
33000	69					
39000	71					
47000	72					

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Class 1, NP0 100 V Noble Metal Electrode

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL	AMOUNT PER BULK CASE	
	Ø180 mm; 7"		Ø330 mm; 13"		Ø180 mm; 7" BLISTER	0603	0805
	PAPER	BLISTER	PAPER	BLISTER	1812		
0.6 ±0.1	4000	–	20000	–	–	–	10000
0.85 ±0.1	4000	–	15000	–	–	–	8000
0.5 to 1.0	–	4000	–	10000	2000	–	–
0.8 ±0.07	4000	–	15000	–	–	15000	–
0.9 to 1.3	–	3000	–	10000	1500	–	–
1.15 ±0.1	–	3000	–	10000	–	–	–
1.25 ±0.1	–	3000	–	10000	–	–	5000

ORDERING INFORMATION FOR 100 V

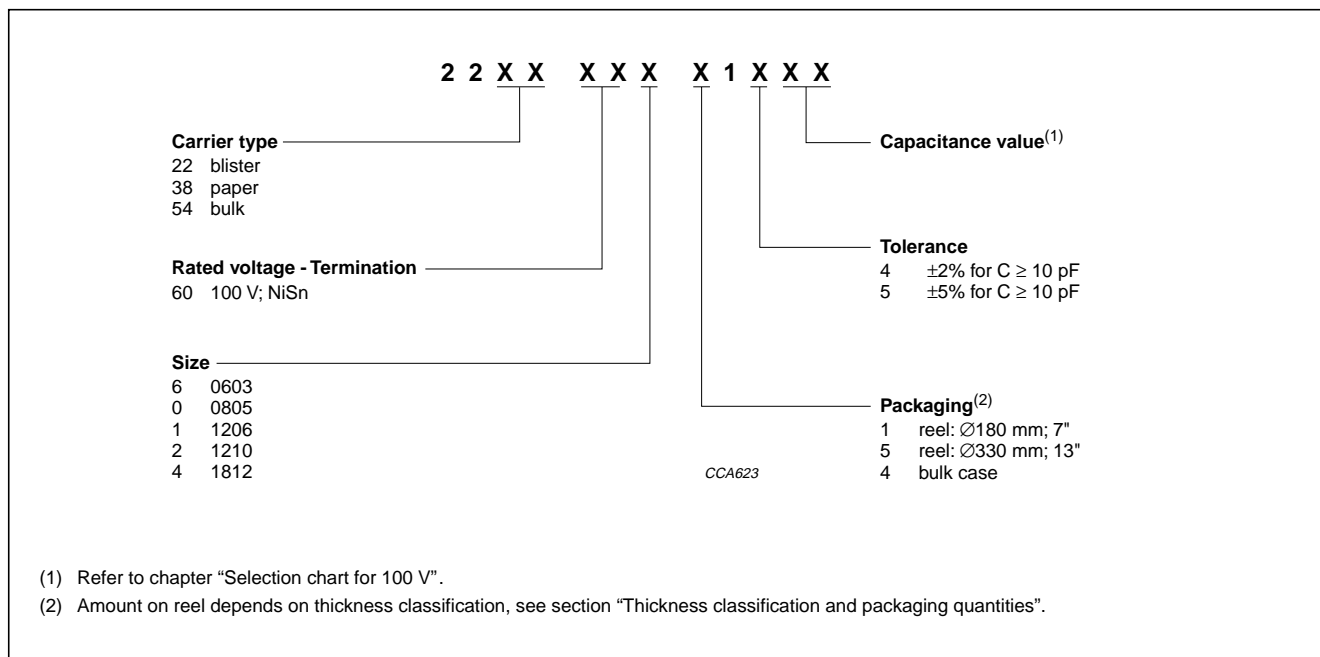
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 0805CG102G0B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603	CG = NP0	102 = 1000 pF; the third digit signifies the multiplying factor: 0 = × 1 1 = × 10 2 = × 100 3 = × 1000	G = ±2% J = ±5%	0 = 100 V	B = NiSn	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
0805								
1206								
1210								
1812								

Ordering code 12NC



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Class 1, NP0 200 V and 500 V
Noble Metal Electrode

SELECTION CHART FOR 200 V AND 500 V

C (pF)	LAST TWO DIGITS OF 12NC	200 V				500 V			
		0805	1206	1210	1812	1206	1210	1812	
10	23								
12	24								
15	25								
18	26								
22	27								
27	28								
33	29								
39	31					0.6 ±0.1			
47	32	0.6 ±0.1							
56	33								
68	34		0.6 ±0.1						
82	35								
100	36								
120	37								
150	38								
180	39								
220	41						0.8 to 1.0		
270	42								
330	43	0.85 ±0.1							
390	44								
470	45								
560	46	1.25 ±0.1				0.85 ±0.1			
680	47								
820	48					1.15 ±0.1			
1000	49		0.85 ±0.1						
1200	51						0.9 to 1.3		
1500	52		1.15 ±0.1						
1800	53			0.8 to 1.0			1.2 to 1.75		
2200	54								
2700	55			0.9 to 1.3				0.9 to 1.3	
3300	56								
3900	57				0.8 to 1.0				
4700	58				0.9 to 1.3				
5600	59								
6800	61	Values in shaded cells indicate thickness classification.							
8200	62								
10000	63								

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL	AMOUNT PER BULK CASE
	Ø180 mm; 7"		Ø330 mm; 13"		Ø180 mm; 7" BLISTER	
	PAPER	BLISTER	PAPER	BLISTER	1812	
0.6 ±0.1	4000	-	20000	-	-	10000
0.85 ±0.1	4000	-	15000	-	-	8000
0.8 to 1.0	-	4000	-	10000	2000	-
0.9 to 1.3	-	3000	-	10000	1500	-
1.15 ±0.1	-	3000	-	10000	-	-
1.25 ±0.1	-	3000	-	10000	-	5000
1.2 to 1.75	-	2500	-	7000	1200	-

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Class 1, NP0 200 V and 500 V
Noble Metal Electrode

ORDERING INFORMATION FOR 200 V AND 500 V

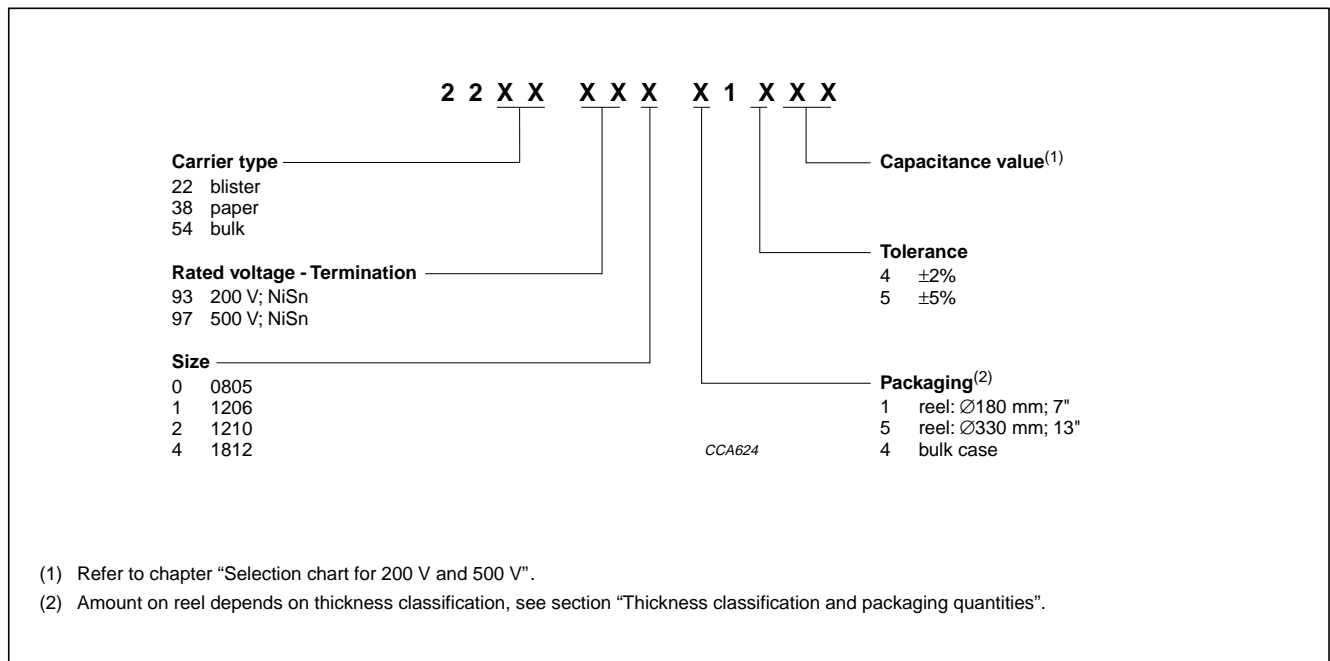
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 1206CG102GBB200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0805 1206 1210 1812	CG = NP0	102 = 1000 pF; the third digit signifies the multiplying factor: 0 = × 1 1 = × 10 2 = × 100 3 = × 1000	G = ±2% J = ±5%	B = 200 V D = 500 V	B = NiSn	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



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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 ± 1 °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

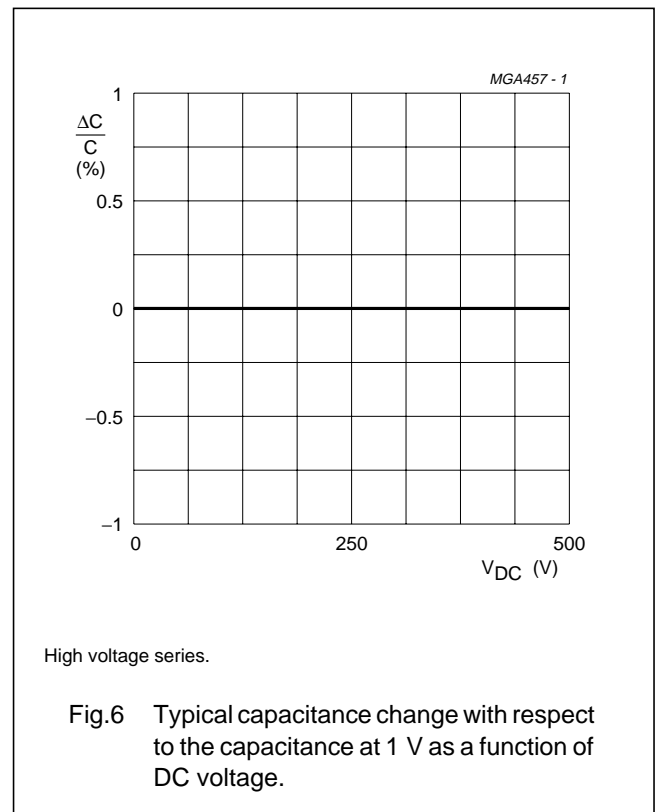
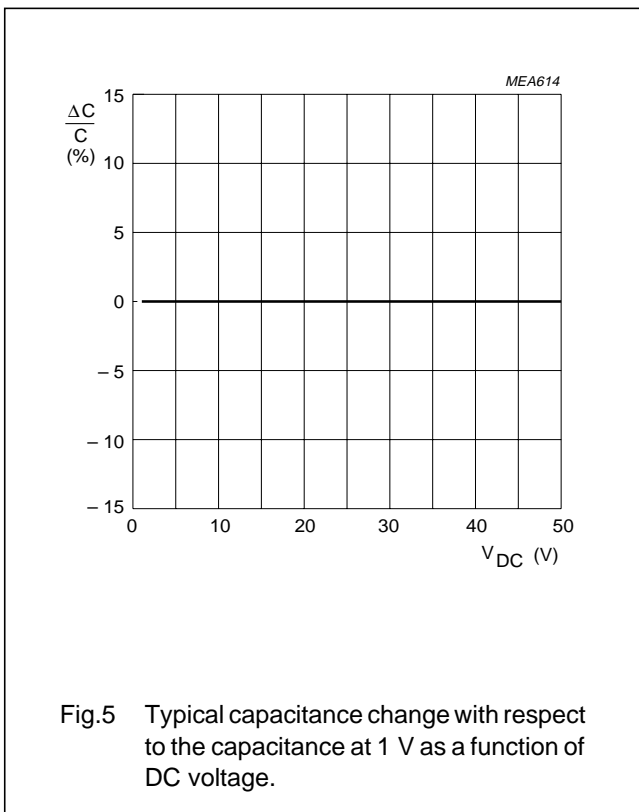
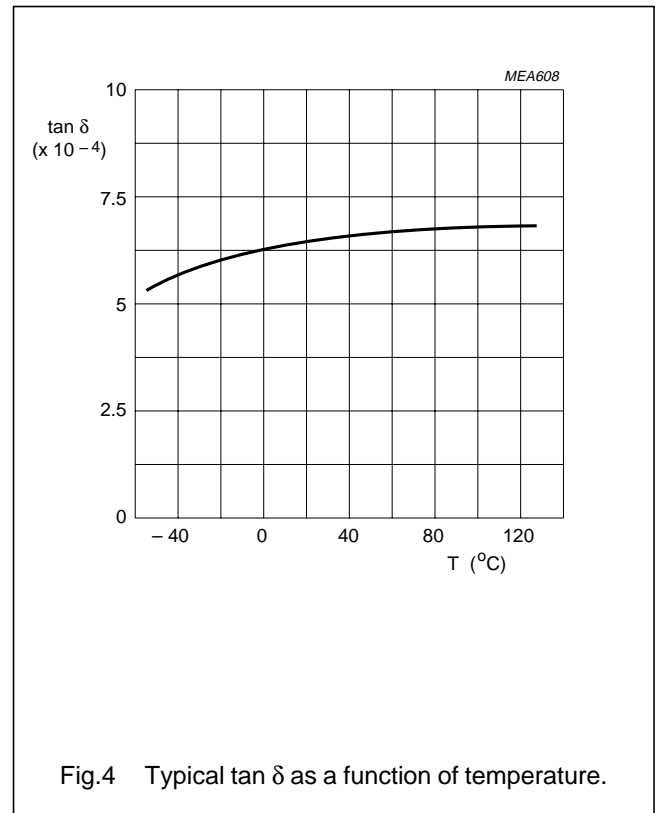
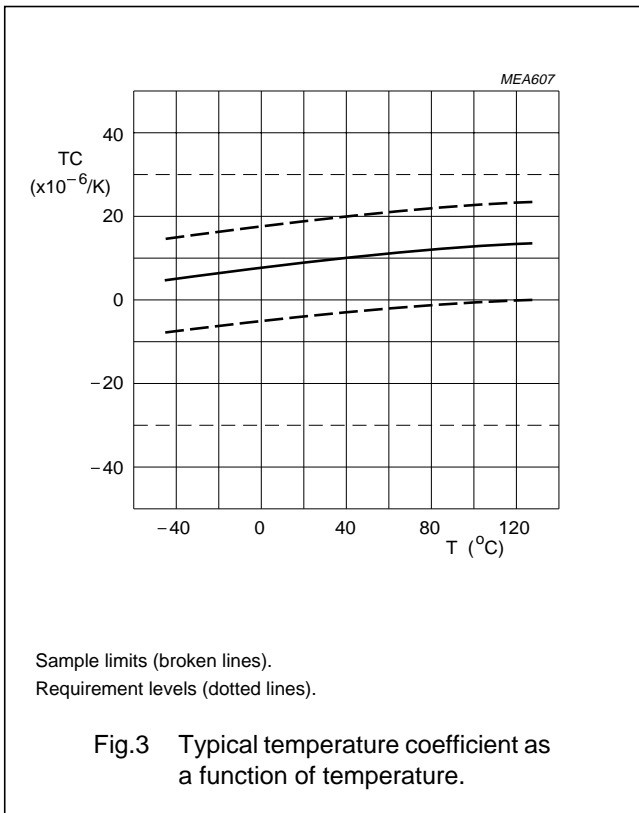
DESCRIPTION	VALUE
Capacitance range (E12 series); note 1: 50 V 100 V 200 V 500 V	0.47 pF to 47000 pF 10 pF to 22 nF 10 pF to 5600 pF 10 pF to 3300 pF
Tolerance on capacitance after 1000 hours: $C \geq 10$ pF $5 \text{ pF} \leq C < 10$ pF $C < 5$ pF	$\pm 5\%$; $\pm 2\%$ ± 0.5 pF, ± 0.25 pF ± 0.25 pF
Tan δ ; note 1: $C < 10$ pF $C \geq 10$ pF	$\leq 10 \left(\frac{3}{C} + 0.7 \right) \times 10^{-4}$ or 30×10^{-4} , whichever is smallest $\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 100 \text{ G}\Omega$
Temperature coefficient: $C < 10$ pF $C \geq 10$ pF	$(0 \pm 150) \times 10^{-6}/\text{K}$; note 2 $(0 \pm 30) \times 10^{-6}/\text{K}$; note 2
Ageing	not applicable

Notes

1. Measured at 1 V, 1 MHz for $C \leq 1000$ pF and 1 V, 1 kHz for $C > 1000$ pF, using a four-gauge method.
2. For sizes 0402 and 0603 all capacitance values from 0.47 pF to 150 pF have a temperature coefficient of $(0 \pm 30) \times 10^{-6}/\text{K}$.

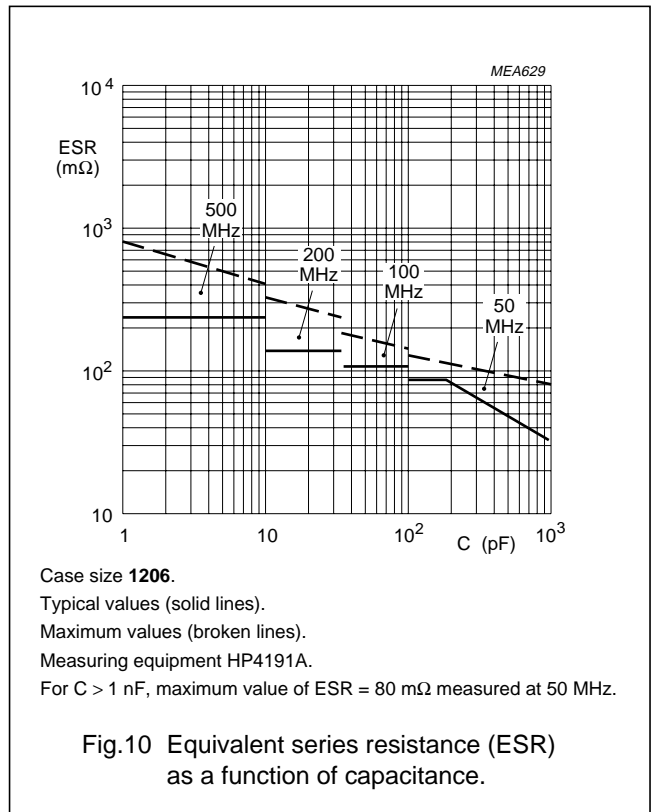
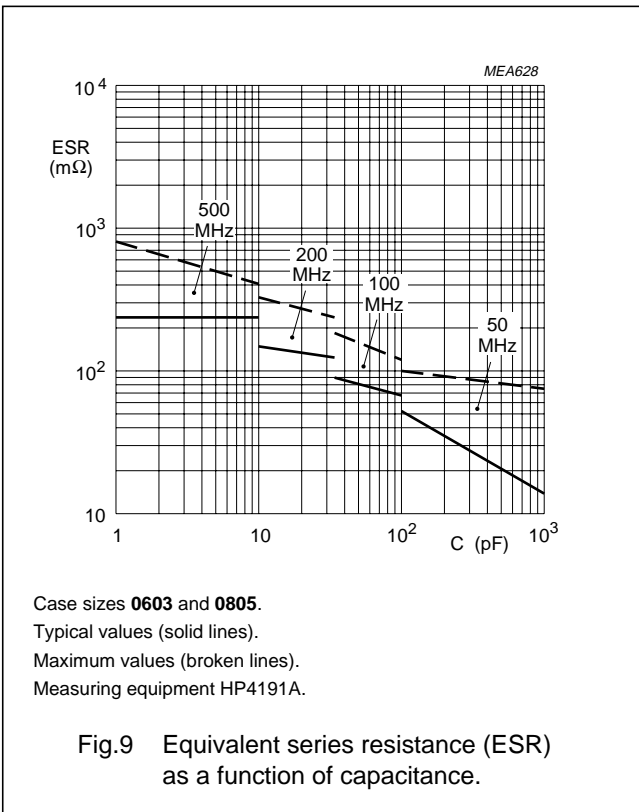
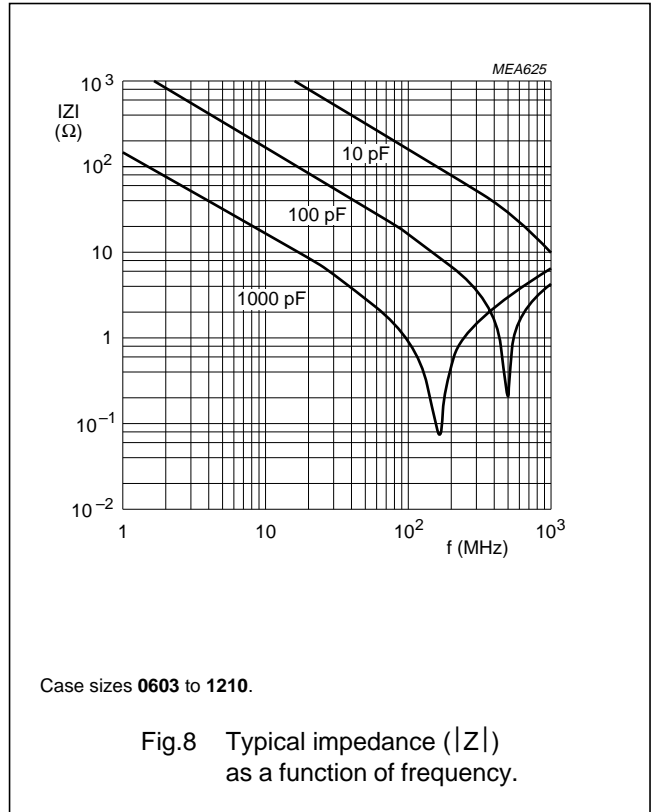
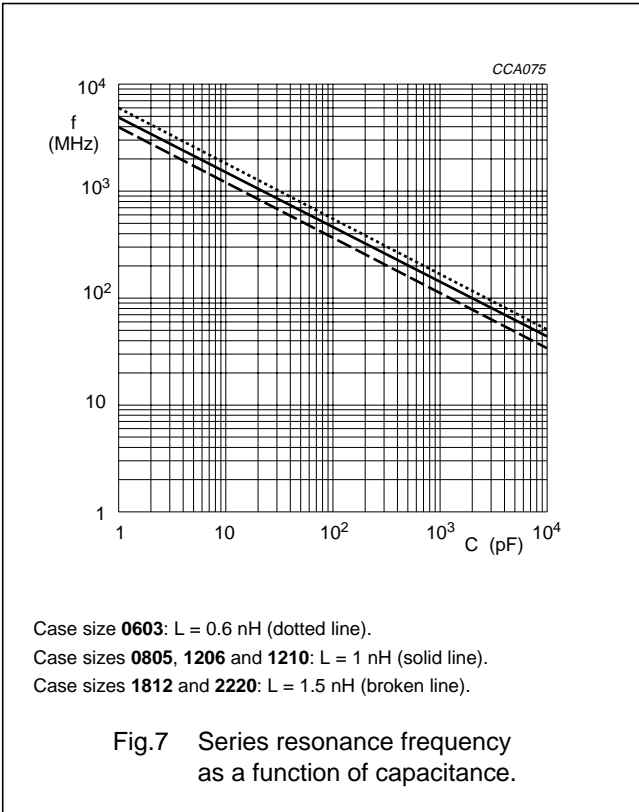
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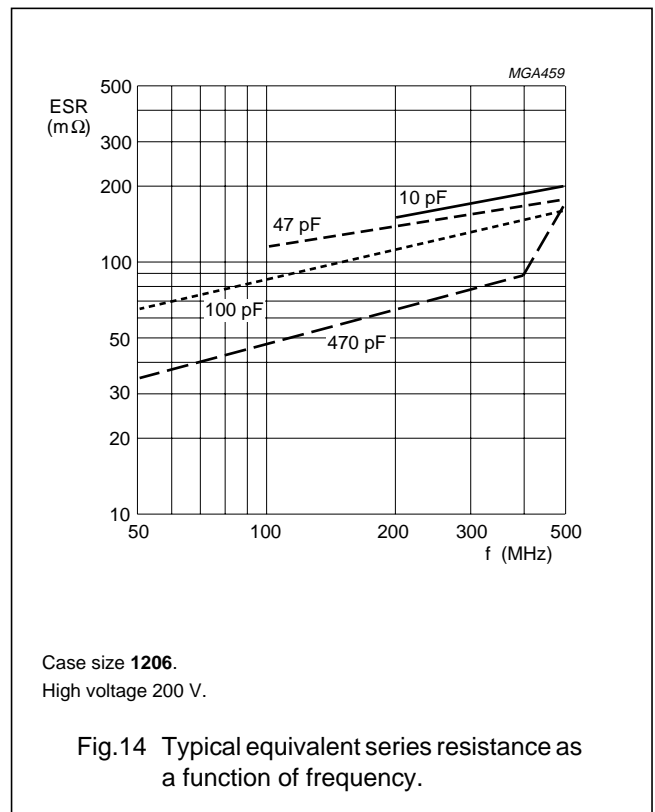
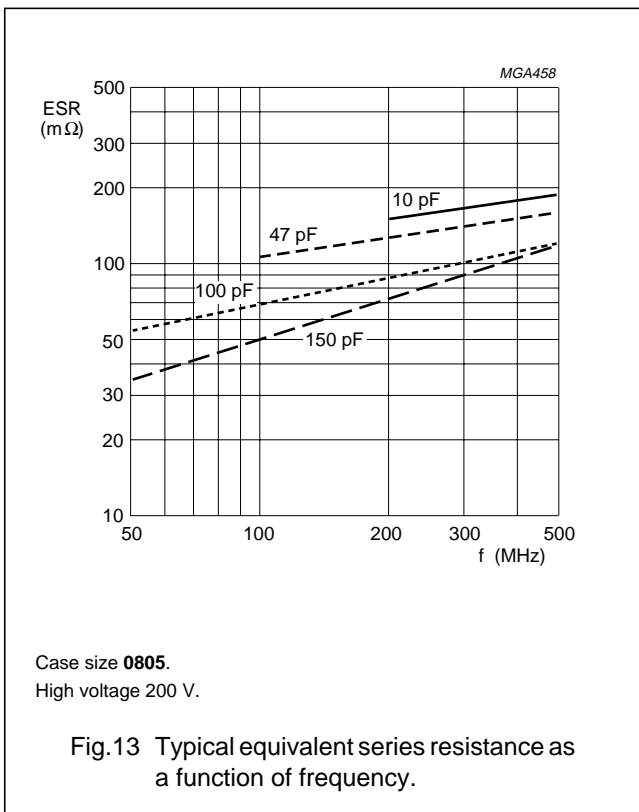
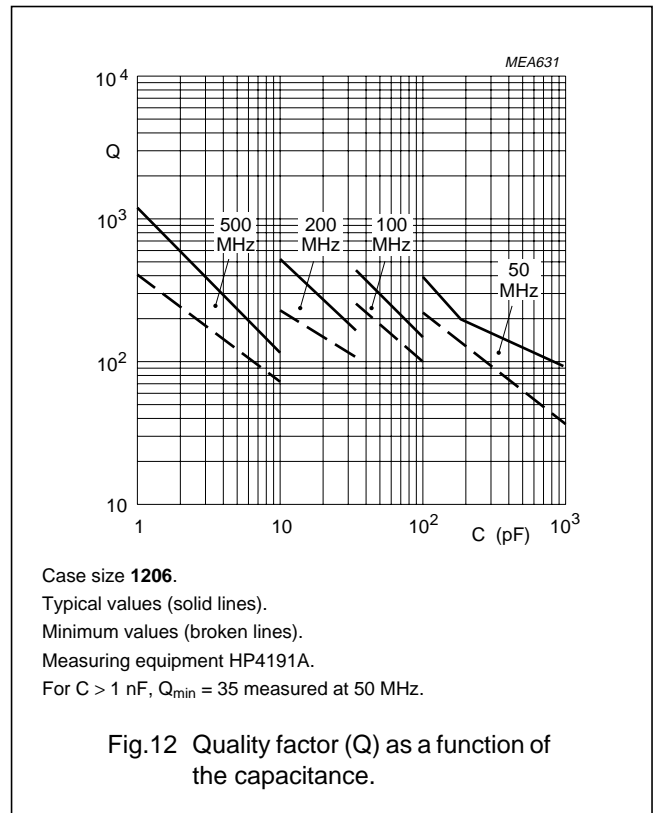
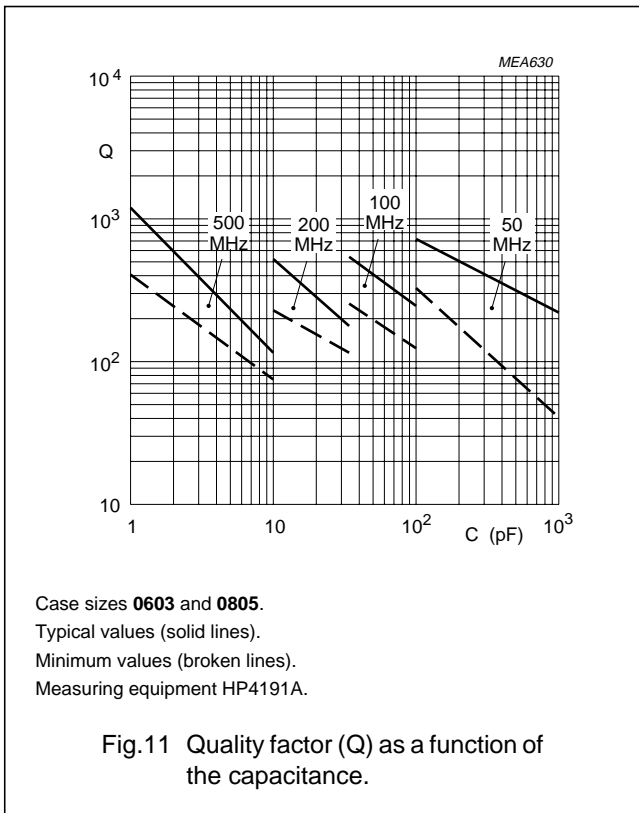
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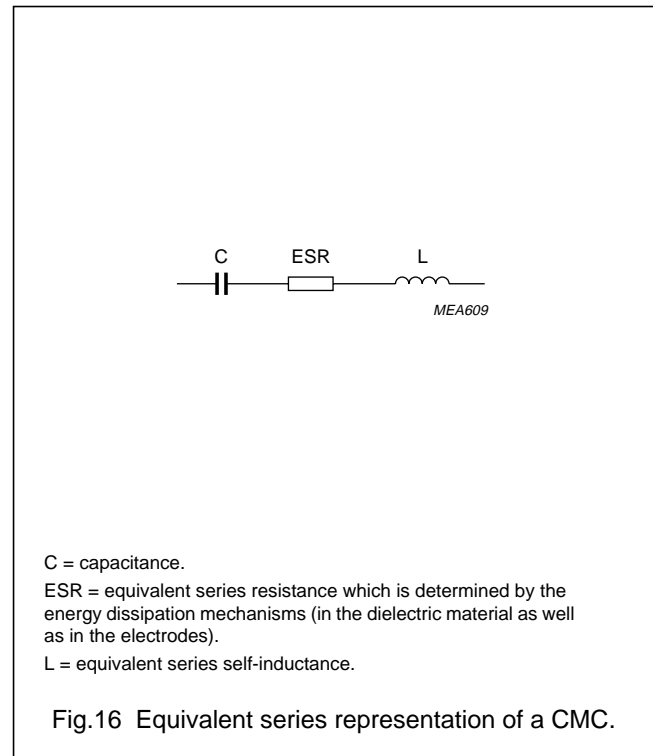
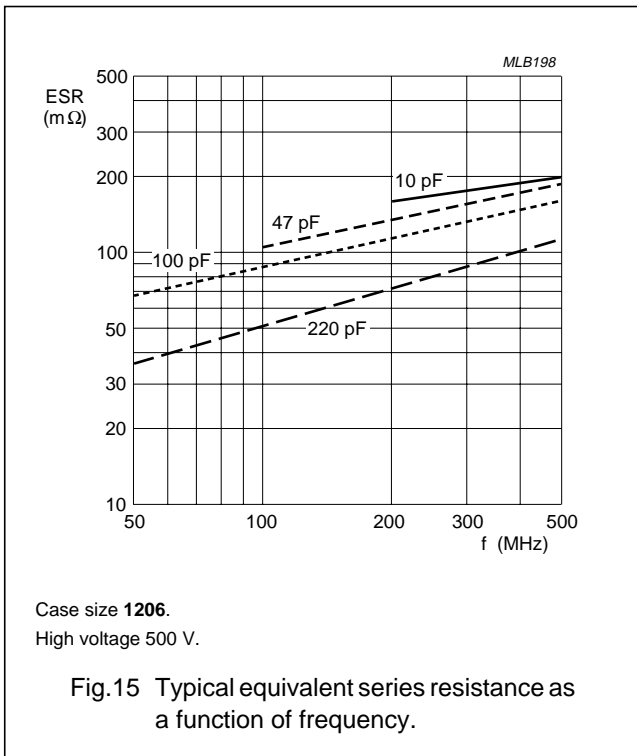
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HIGH FREQUENCY BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

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.16.

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, 1206 and 1210
 - 1.5 nH for case sizes 1812 and 2220.

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:

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

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:

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

The quality factor (Q) is given by:

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