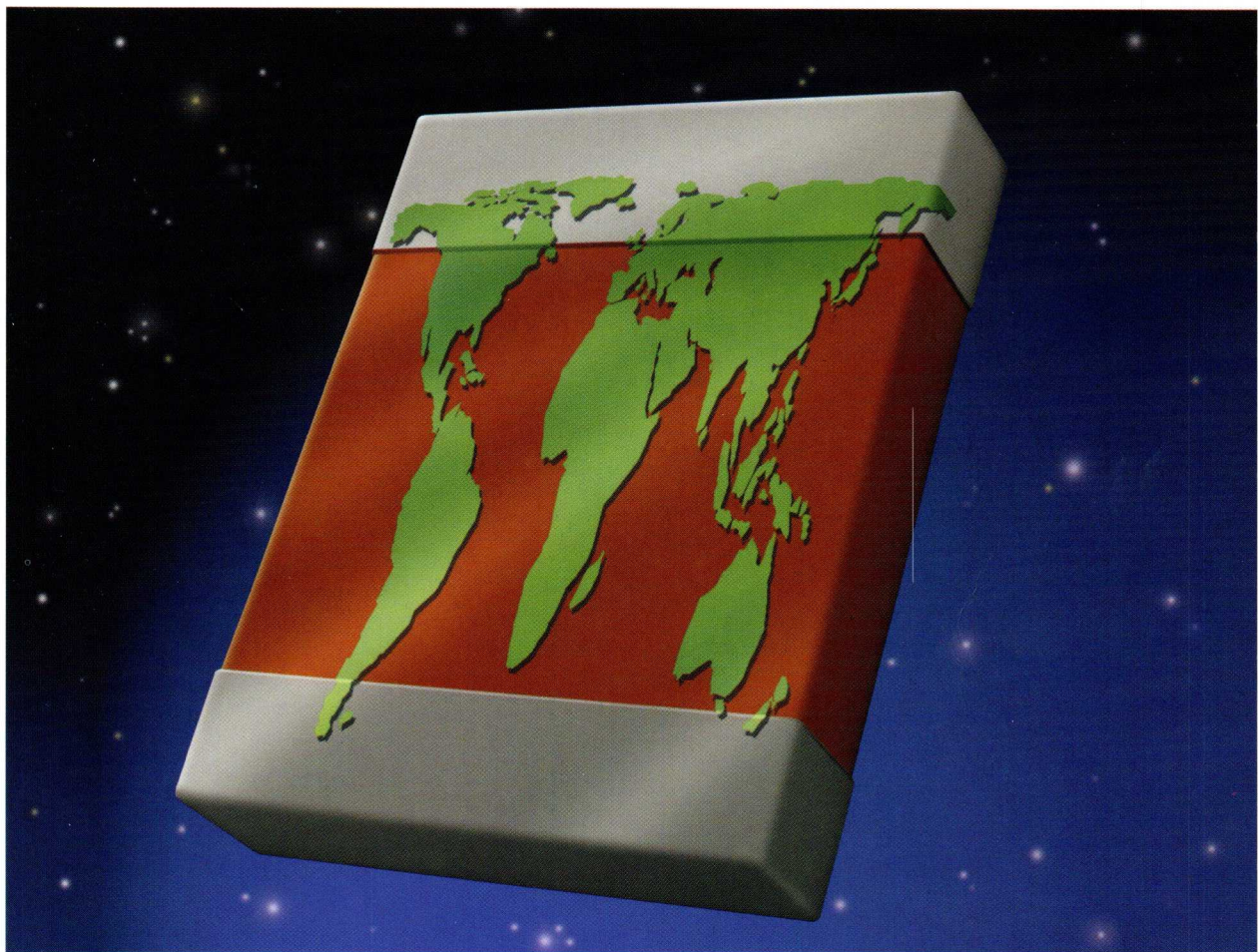


PASSIVE COMPONENTS

Surface Mount Ceramic Multilayer Capacitors



1997

Data Handbook PA06a

Philips
Components



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In striving for state-of-the-art perfection, we continuously improve components and processes with respect to environmental demands. Our components offer no hazard to the environment in normal use when operated or stored within the limits specified in the data sheet.

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Surface Mounted Ceramic Multilayer Capacitors

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DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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Ceramic capacitors

Introduction

GENERAL DATA

Ceramic capacitors are widely used in electronic circuitry for coupling, decoupling and in filters. These different functions require specific capacitor properties.

Ceramic capacitors can be divided into two classes:

- Class 1
In these capacitors dielectric materials are used which have a very high specific resistance, very good Q and linear temperature dependence (ϵ_r from 6 up to 550). They are used in such applications as oscillators and filters where low losses, capacitance drift compensation and high stability are required.
- Class 2
These capacitors have higher losses and have non-linear characteristics ($\epsilon_r > 250$). They are used for coupling and decoupling.

CONSTRUCTION

The capacitance of a ceramic capacitor depends on the area of the electrodes (A), the thickness of the ceramic dielectric (t) and the dielectric constant of the ceramic material (ϵ_r); and on the number of dielectric layers (n) with multilayer ceramic capacitors:

$$C = \epsilon_r \times \epsilon_0 \times \frac{A}{t} \times n$$

The rated voltage is dependent on the dielectric strength, which is mainly governed by the thickness of the dielectric layer and the ceramic structure. For this reason a reduction of the layer thickness is limited.

Figure 2 shows the construction of a multilayer capacitor.

The electrodes are normally palladium or platinum since the electrodes are applied before the ceramic is fired at a temperature where silver would oxidize.

MANUFACTURING OF CERAMIC CAPACITORS

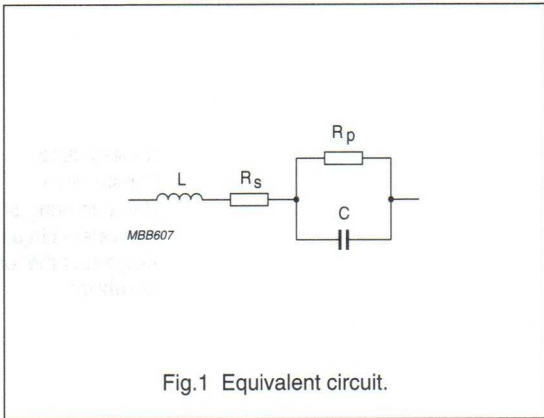
The raw materials are finely milled and carefully mixed. Thereafter the powders are calcined at temperatures between 1100 and 1300 °C to achieve the required chemical composition. The resultant mass is reground and dopes and/or sintering means are added.

The finely ground material is mixed with a solvent and binding matter. Thin sheets are obtained by casting or rolling.

For multilayer capacitors electrode material is printed on the sheets and after stacking and pressing of the sheets cofired with the ceramic compact at temperatures between 1000 and 1400 °C.

The totally enclosed electrodes of a multilayer capacitor guarantee good life test behaviour as well.

EQUIVALENT CIRCUIT FOR CERAMIC CAPACITORS



Definition of symbols; see Fig.1

SYMBOL	DESCRIPTION
C	Capacitance between the two electrodes, plus the stray capacitance at the edges and between the leads.
R _p	Resistance of insulation and dielectric. Generally R _p is very high, and of decreasing importance with increasing frequency. R _p also represents the polarization losses of the material in an alternating electric field.
R _s	Losses in the leads, the electrodes and the contacts. Up to several hundreds of MHz the current penetration depth is greater than the conductor thickness so that no skin-effect occurs. For ceramic capacitors R _s is extremely low.
L	Inductance of the leads and the internal inductance of the capacitor; the latter, however, is almost negligible. The inductance is only important in high frequency applications, since the capacitor will act as an inductance when the frequency is higher than its resonance frequency.

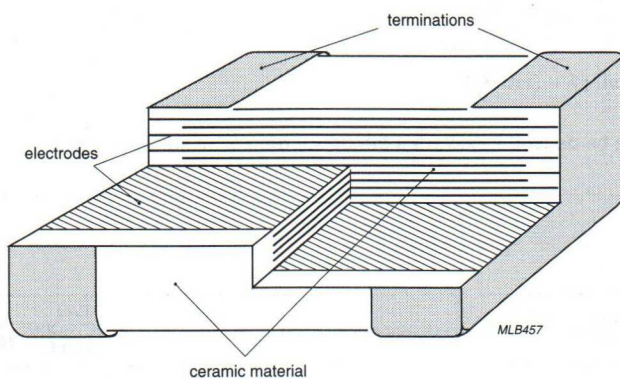


Fig.2 Cross-section of a multilayer capacitor.

Ceramic capacitors

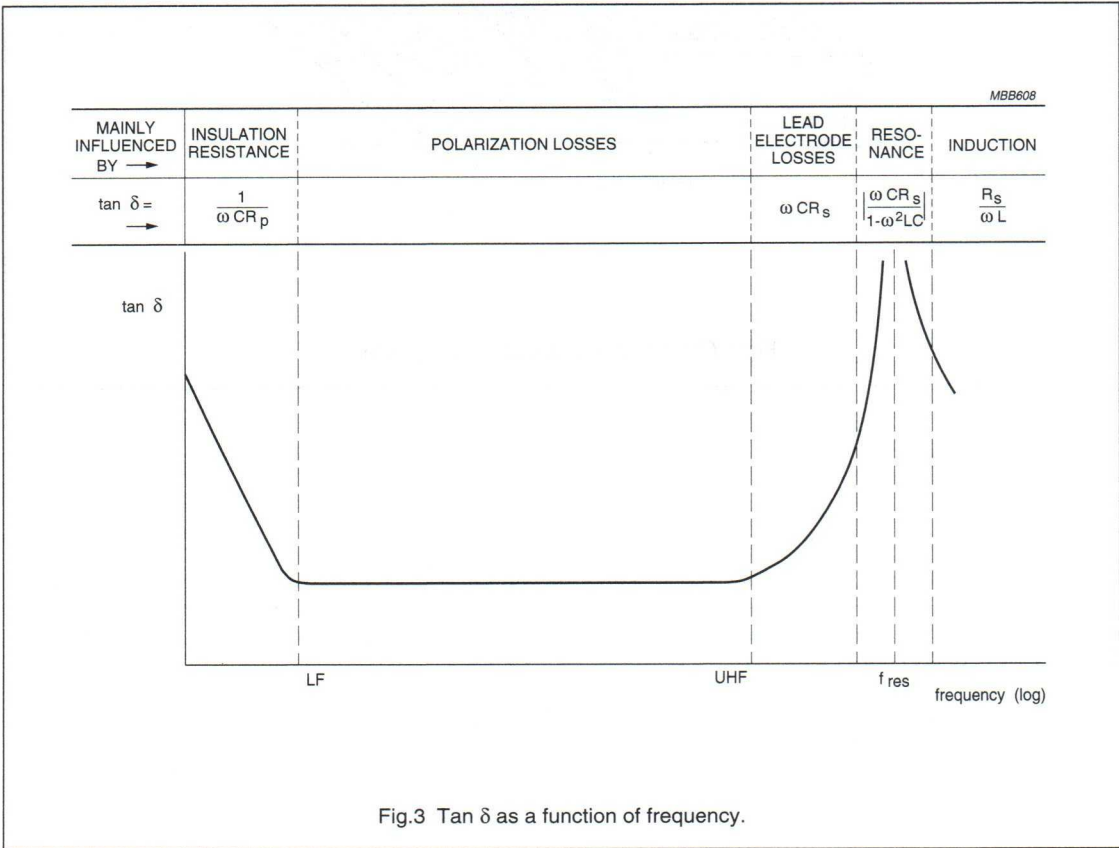
Introduction

TANGENT OF THE LOSS ANGLE

The losses of a capacitor are expressed in terms of $\tan \delta$ which is the relationship between the resistive and reactive parts of the impedance, specified as follows:

$$\tan \delta = \frac{|R|}{|X|} = \frac{R_p + R_s \{ 1 + (\omega C R_p)^2 \}}{(\omega C R_p)^2 - \omega L \{ 1 + (\omega C R_p)^2 \}}$$

From this formula, $\tan \delta$ can be derived for different frequency ranges as shown in Fig.3.



Ceramic capacitors

Introduction

RELIABILITY

The failure rates shown in Table 1 have a confidence level of 60% and refer to observations of ceramic multilayer capacitors (CMC) up to and including 1995.

Table 1 Reliability

CAPACITOR TYPE	NUMBER OF COMPONENT HOURS	FAILURE RATE AT NORMALIZED CONDITIONS
CMC	32 130 000	2.5 FIT

Remarks

1 FIT = 1 failure rate within 10^9 component hours.

Failure rates are given under normalized conditions, i.e. at $0.5 \times$ rated DC voltage and $T_{amb} = 40^\circ\text{C}$.

Failures include capacitance, $\tan \delta$ and insulation resistance values which do not meet the requirements after endurance test.

The determination of failure rates is based on the rated conditions as stated in "MIL-HDBK-217D".

All the test results should be interpreted as results under rated conditions even if the temperature and voltage exceed the rated values.

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Surface mounted ceramic multilayer capacitors

General data

PACKAGING

Tape on reel

Packaging conforms fully with "IEC 286-3", "EIA 481-1" and "JIS C0806" industrial standards.

Ceramic Multilayer Capacitors are supplied on tape on reel or in bulk case. For CMCs with a product thickness of <1 mm, paper tape is preferred. CMCs with a product thickness of ≥ 1 mm, are supplied in embossed blister tape.

CARRIER TAPE

Polycarbonate.

Table 1 Properties of carrier tape

PARAMETER	WIDTH	
	8.1 $\pm$ 0.2 mm	12 $\pm$ 0.2 mm
Thickness	190 to 280 μ m	240 $\pm$ 20 μ m
Tensile strength at break	>60 N/mm ²	>60 N/mm ²
Elongation at break	100 to 150%	100 to 150%
Surface resistance	>10 ¹² Ω /sq.	>10 ¹² Ω /sq.

COVER TAPE

Polyester (antistatic).

Table 2 Properties of cover tape

PARAMETER	WIDTH	
	5.5 $\pm$ 0.1 mm	9.5 $\pm$ 0.1 mm
Breaking force	≥ 10.7 N	≥ 17.6 N
Elongation at break	$\geq 63\%$	$\geq 63\%$
Surface resistance	<10 ¹⁰ Ω /sq.	<10 ¹⁰ Ω /sq.
Softening point	71 $\pm$ 5 °C	71 $\pm$ 5 °C
Thickness	62 μ m	62 μ m

General information

For the combination carrier/cover tape no electrostatic behaviour is observed (relative humidity $\geq 30\%$). The products do not stick to the cover tape.

The technical and thermal properties of polycarbonate tapes are excellent, so there is no change in dimensions as a function of time. The peel off force is very stable as a function of time and temperature, and it is defined as 0.1 to 0.7 N at a peel-off speed of 120 mm/minute.

Bulk packaging

For bulk case; see Fig.5 and Table 7.

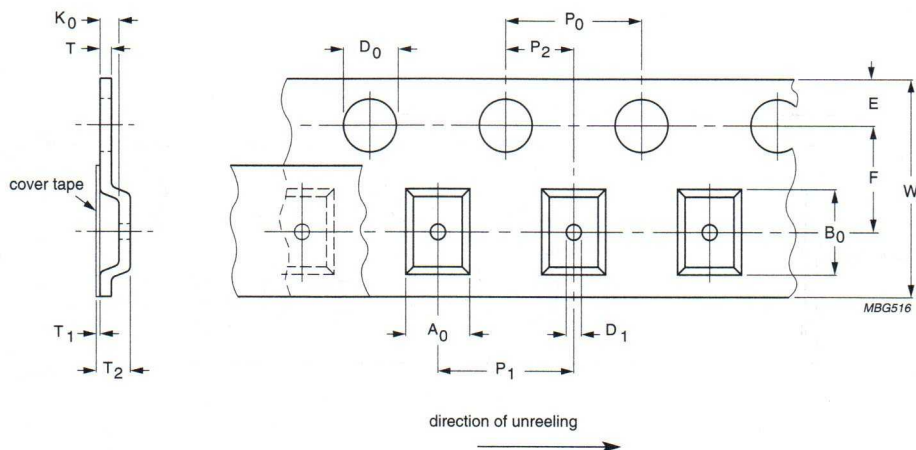
Environmental considerations

- Cover tape, carrier tape and reel do not contain the environmentally-harmful PVC materials.
- Because the carrier tape is made of a homogeneous material (so called mono-plastic), it is ideally suited for recycling.
- Compared to other PVC-free materials polycarbonate shows very little deformation as a function of temperature and has excellent stiffness.

Surface mounted ceramic multilayer capacitors

General data

Blister tape specifications



K_0 : so chosen that the orientation of the component cannot change.

For $W = 8 \text{ mm}$: $T_2 = 2.5 \text{ mm max.}$

For $W = 12 \text{ mm}$: $T_2 = 4.5 \text{ mm max.}$

For dimensions see Table 3.

Fig.1 Blister tape.

Table 3 Dimensions of blister tape for relevant product size code; see Fig.1

DIMENSION	PRODUCT SIZE CODE						TOLERANCE (mm)
	0603	0805	1206	1210	1812	2220	
A_0 nominal clearance; note 1	0.15	0.20	0.30	0.30	0.40	0.40	—
B_0 nominal clearance; note 1	0.15	0.20	0.30	0.30	0.40	0.40	—
K_0 minimum clearance; note 1	0.05	0.05	0.05	0.05	0.05	0.05	—
W	8.1	8.1	8.1	8.1	12.0	12.0	± 0.2
E	1.75	1.75	1.75	1.75	1.75	1.75	± 0.1
F	3.5	3.5	3.5	3.5	5.5	5.5	± 0.05
D_0	1.5	1.5	1.5	1.5	1.5	1.5	$+0.1/-0.0$
D_1	—	≥ 1	≥ 1	≥ 1	1.5	1.5	$+0.1/-0.0$
P_0 ; note 2	4	4	4	4	4	4	± 0.1
P_1	4	4	4	4	8	8	± 0.1
P_2	2	2	2	2	2	2	± 0.05

Notes

1. Typical capacitor displacement in pocket.
2. P_0 pitch tolerance over any 10 pitches is $\pm 0.2 \text{ mm}$.

Surface mounted ceramic
multilayer capacitors

General data

Paper tape specifications

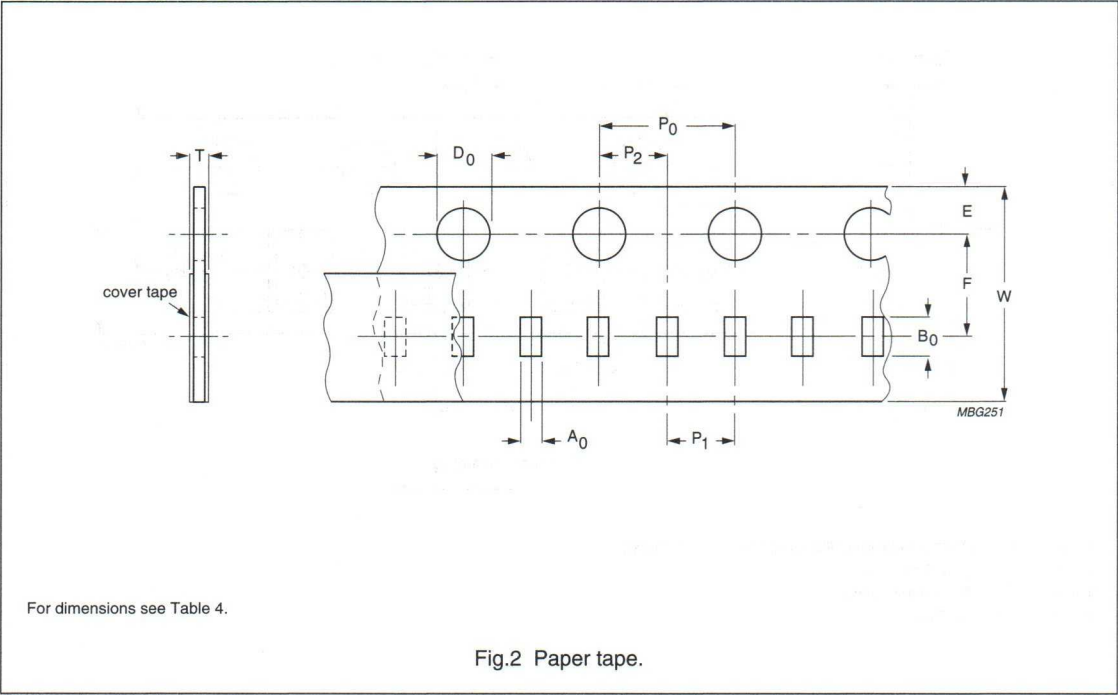


Table 4 Dimensions of paper tape for relevant product size; see Fig.2

SYMBOL	PRODUCT SIZE CODE								UNIT
	0402		0603		0805		1206		
	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	
A ₀	0.62	±0.05	1.10	±0.05	1.65	±0.05	2.0	±0.1	mm
B ₀	1.12	±0.05	1.90	±0.05	2.40	±0.05	3.5	±0.1	mm
W	8.0	±0.2	8.0	±0.2	8.0	±0.2	8.0	±0.2	mm
E	1.75	±0.1	1.75	±0.1	1.75	±0.1	1.75	±0.1	mm
F	3.5	±0.05	3.5	±0.05	3.5	±0.05	3.5	±0.05	mm
D ₀	1.5	+0.1/−0	1.5	+0.1/−0	1.5	+0.1/−0	1.5	+0.1/−0	mm
P ₀ ; note 1	4	±0.05	4	±0.05	4	±0.05	4	±0.05	mm
P ₁	2	±0.05	4	±0.1	4	±0.1	4	±0.1	mm
P ₂	2	±0.05	2	±0.05	2	±0.05	2	±0.05	mm
T _{max}	0.6	±0.05	1.0	±0.05	1.0	±0.05	1.0	±0.05	mm

Note

1. P₀ pitch tolerance over any 10 pitches is ±0.2 mm.

Surface mounted ceramic
multilayer capacitors

General data

Reel specifications

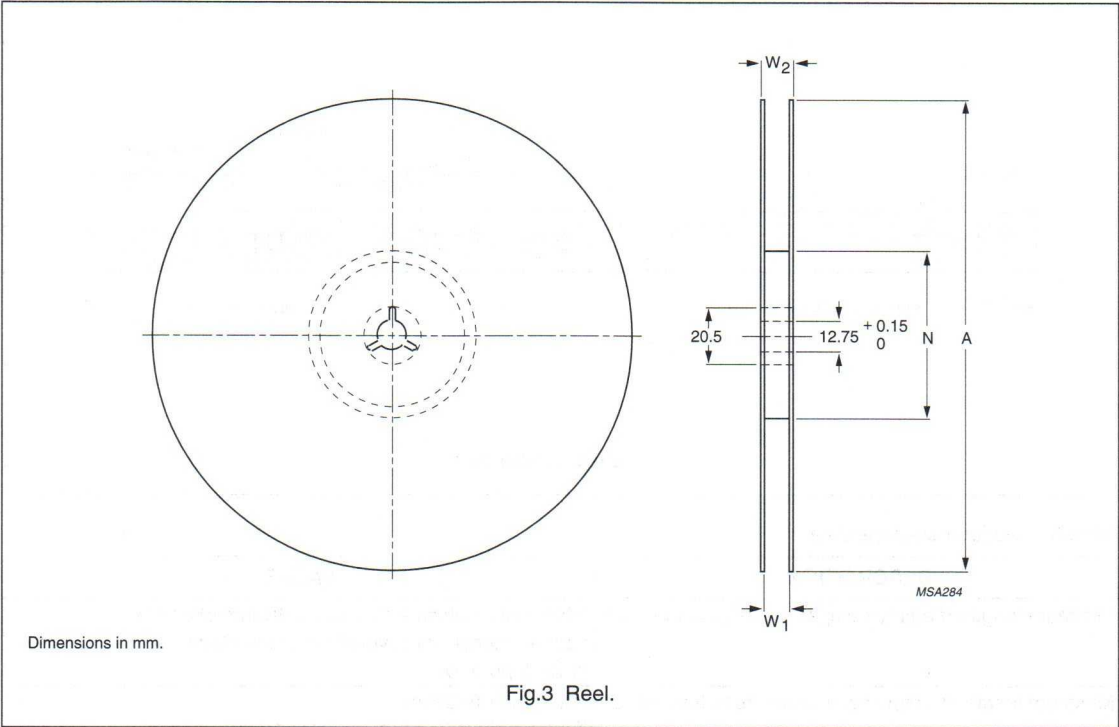


Table 5 Reel dimensions; see Fig.3

TAPE WIDTH (mm)	A (mm)	N (mm)	W ₁ (mm)	W ₂ MAX. (mm)
8	180	62 ±1.5	8.4 +1.5/-0.0	14.4
8	330	62 ±1.5	8.4 +1.5/-0.0	14.4
12	180	62 ±1.5	12.4 +2/-0.0	18.4

Properties of reel

Material: polystyrene
Surface resistance: <10¹⁰ Ω/sq.

Surface mounted ceramic
multilayer capacitors

General data

Leader/trailer tape specification

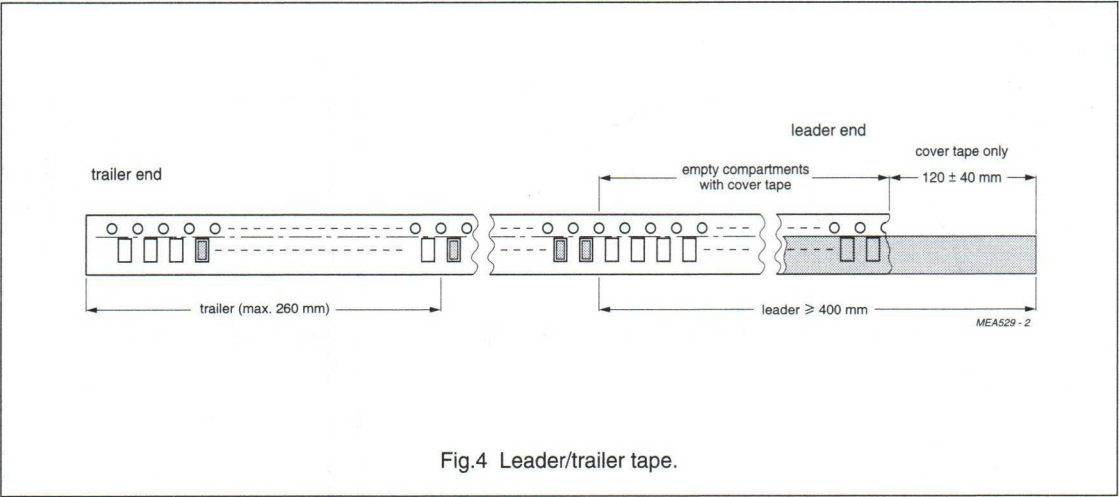


Table 6 Leader/trailer tape data

DESCRIPTION	VALUE
Minimum length of empty compartments at leader end	≥400 mm of which a minimum 240 mm of empty compartments are covered with cover tape and 120 ±40 mm cover tape only.
Minimum length of empty compartments at trailer end	208 mm or 260 mm. If the length is 260 mm an extra product is placed at 208 mm to mark this position.

Surface mounted ceramic
multilayer capacitors

General data

Bulk case specification

Features and benefits:

- Reduced costs
 - Storage
 - Transport
 - Machine handling
 - Packaging
- Customized labelling (bar codes).

Table 7 Packaging quantities for component size; see note 1 and Fig.5

SIZE CODE	DIMENSIONS OF CAPACITOR (mm)			QUANTITY
	L ₁	W	T	
0402	1.0	0.5	0.5	50000
0603	1.6	0.8	0.8	15000
0805	2.0	1.25	0.6	10000
0805	2.0	1.25	0.9	8000
0805	2.0	1.25	1.25	5000

Note

1. Refer to the selection charts in product data for specific values.

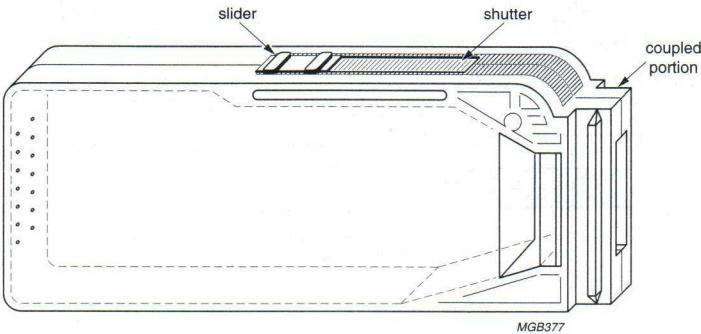


Fig.5 Bulk case outline.

Surface mounted ceramic multilayer capacitors

General data

Multi-pack box specification

Features and benefits:

- Minimum recycling costs
- Maximum environmental friendliness
- Reduced handling time
- Economic usage of packaging
- Customized labelling (bar codes).

Table 8 Number of reels per box; see Fig.6

REEL SIZE (mm)	TAPE SIZE (mm)	QUANTITY PER BOX	
		MIN.	MAX.
Ø180	8	5	25
	12	5	10
Ø330	8	5	15

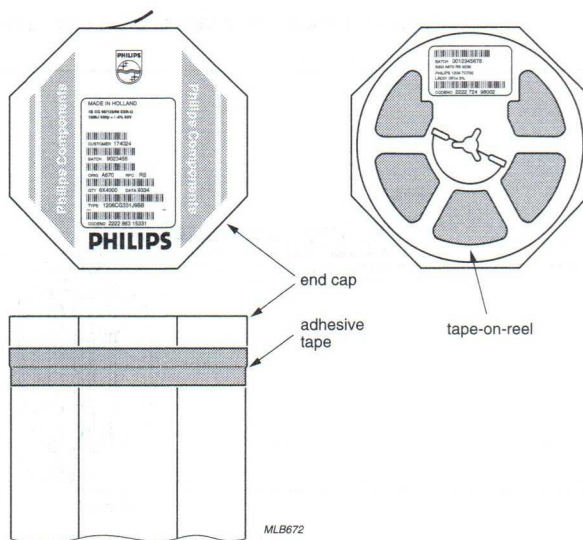


Fig.6 Multi-pack box outline.

Surface mounted ceramic multilayer capacitors

General data

LABELLING

Label examples are shown in Figs 7 and 8 (bar code according to EN 800 code 39).

1. MADE IN HOLLAND *

2. 1B CG 55/125/56

3. 1206J 100N +/-10% 50V

4. BATCH 6490251

5. ORIG A670 RPC RS

6. QTY 4000 DATE 9716

7. TYPE 12062R104K9BB00

8. CODENO 2222 581 16641

CCA601

LINE	MARKING EXPLANATION
1.	Country of origin
2.	Material code and climatic category
3.	Size, termination code, value, tolerance and rated voltage
4.	Unique batch number
5.	Country of origin in code: A670 is Holland
6.	Quantity and production period, year and week code
7.	15-digit code
8.	Catalogue number (12NC)

Fig.7 Packaging label (example).

1. BATCH 6490251 PHILIPS *

2. 4000 A670 RS 9716

3. 2R1 55/125/56

4. 1206J 100n +/-10% 50V

5. 12062R104K9BB00

6. CODENO 2222 581 16641

CCA602

LINE	MARKING EXPLANATION
1.	Unique batch number
2.	Quantity and date code
3.	Material code and climatic category
4.	Size, termination code, value, tolerance and rated voltage
5.	15-digit code
6.	Catalogue number (12NC)

Fig.8 Reel label (example).

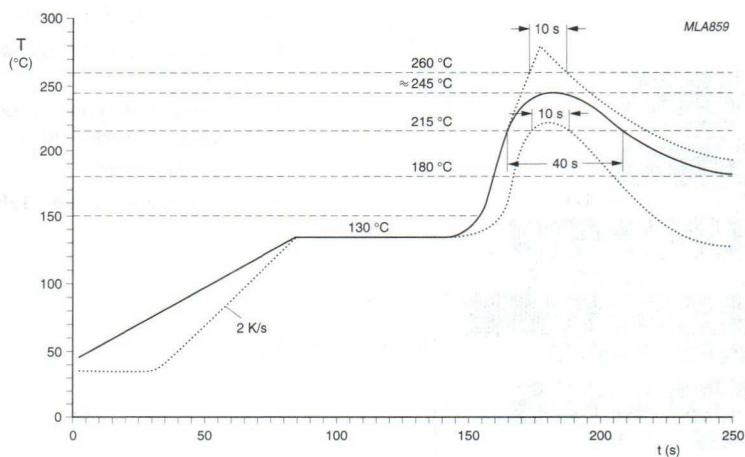
Surface mounted ceramic multilayer capacitors

General data

METHOD OF MOUNTING AND DIMENSIONS OF SOLDER LANDS

For normal use the capacitors may be mounted on printed-circuit boards or ceramic substrates by applying wave soldering, reflow soldering (including vapour phase soldering) or conductive adhesive in accordance with CECC 00802 classification A. For advised soldering profiles see Figs 9, 10 and 11.

An improper combination of soldering, substrate and chip size can lead to a damaging of the component. The risk increases with the chip size and with temperature fluctuations ($>100\text{ }^{\circ}\text{C}$). Therefore, it is advised to use the smallest possible size and follow the dimensional recommendations given in Tables 9 and 10 for reflow and wave soldering. More detailed information is available on request.



Typical values (solid line).
Process limits (dotted lines).

Fig.9 Reflow soldering.

Surface mounted ceramic multilayer capacitors

General data

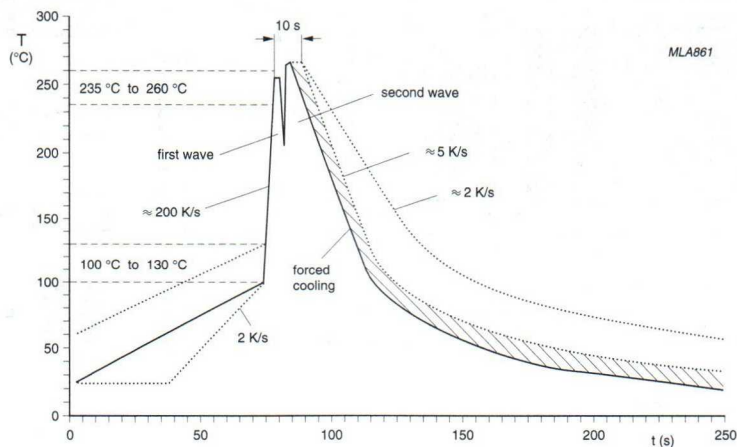


Fig.10 Double wave soldering.

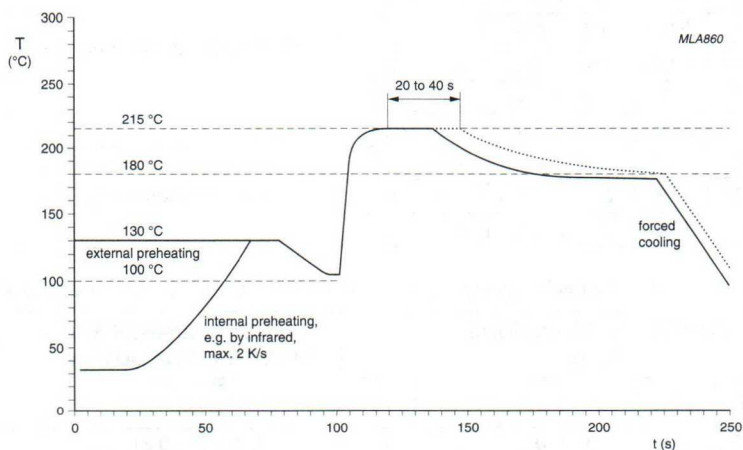


Fig.11 Vapour phase soldering.

Surface mounted ceramic
multilayer capacitors

General data

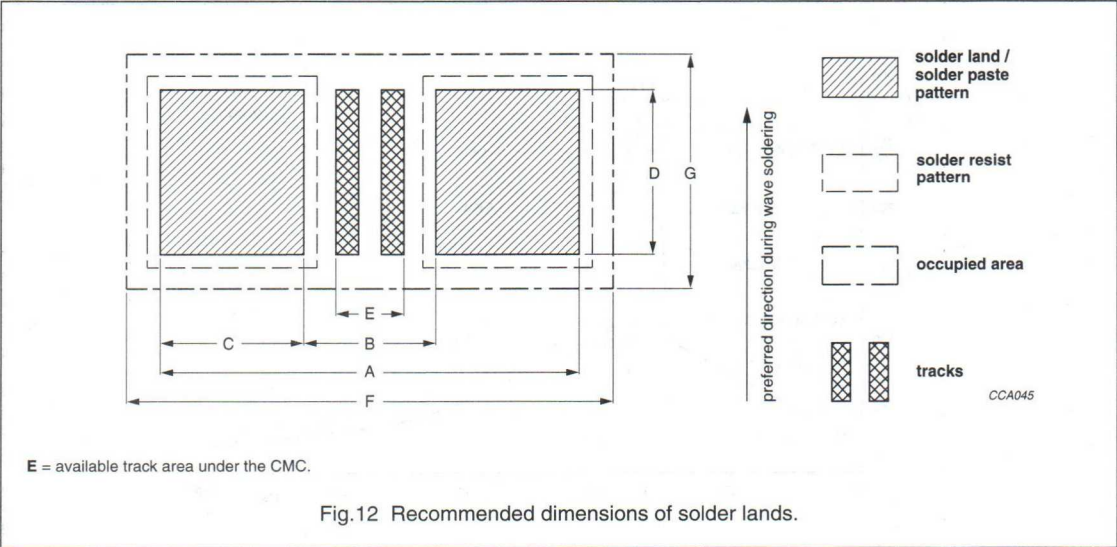


Table 9 Reflow soldering; for dimensions also see Fig.12

SIZE CODE	FOOTPRINT DIMENSIONS (mm)							PROCESSING REMARKS	PLACEMENT ACCURACY (mm)
	A	B	C	D	E	F	G		
0402	1.5	0.5	0.5	0.5	0.10	1.75	0.95	IR or hot plate soldering	±0.15
0603	2.3	0.7	0.8	0.9	0.26	2.7	1.5		±0.15
0603	2.3	0.5	0.9	0.9	0.0	2.7	1.5		±0.25
0805	2.8	0.9	0.95	1.4	0.45	3.2	2.1		±0.25
1206	4.0	2.0	1.0	1.8	1.4	4.4	2.5		±0.25
1210	4.0	2.0	1.0	2.7	1.4	4.4	3.4		±0.25
1808	5.4	3.3	1.05	2.3	2.7	5.8	2.9	ceramic substrate only	±0.25
1812	5.4	3.3	1.05	3.5	2.7	5.8	4.1		±0.25
2220	6.6	4.5	1.05	5.3	3.9	7.0	5.9		±0.25

Table 10 Wave soldering (no dummy tracks allowed for the high voltage series); for dimensions also see Fig.12

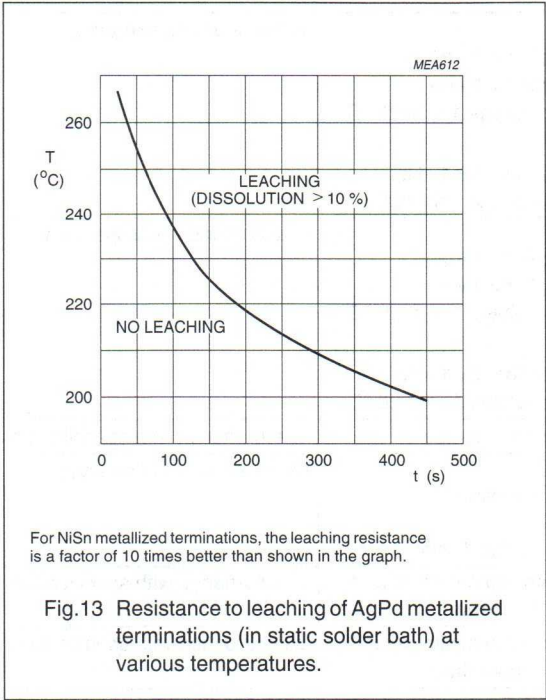
SIZE CODE	FOOTPRINT DIMENSIONS (mm)							PROPOSED NUMBER AND DIMENSIONS OF DUMMY TRACKS (mm)	PLACEMENT ACCURACY (mm)
	A	B	C	D	E	F	G		
0603	2.4	1.0	0.7	0.8	0.2	3.0	1.9	1 × (0.2 × 0.8)	±0.10
0603	2.7	0.9	0.9	0.8	0.0	3.2	2.1	1 × (0.3 × 0.8)	±0.25
0805	3.2	1.4	0.9	1.3	0.36	4.1	2.5	1 × (0.3 × 1.3)	±0.15
0805	3.4	1.3	1.05	1.3	0.2	4.3	2.7	1 × (0.2 × 1.3)	±0.25
1206	4.8	2.3	1.25	1.7	1.25	5.9	3.2	3 × (0.25 × 1.7)	±0.25
1210	5.3	2.3	1.5	2.6	1.25	6.3	4.2	3 × (0.25 × 2.6)	±0.25

Surface mounted ceramic
multilayer capacitors

General data

TEST CONDITIONS IN STATIC SOLDER BATH

PARAMETER	DESCRIPTION
Solderability	
95% covered with smooth and bright solder coating	CECC requirement: 235 ±5 °C for 2 ±0.5 s
	IEC requirement: 215 ±3 °C for 3 ±0.3 s
Resistance to leaching	
10% of the metallization of the edges of the head face may be missing (inner electrodes are not visible) ΔC/C class 1: 0.5% or 0.5 pF and ΔC/C class 2: >-5% and ≤10%	260 ±5 °C for 30 ±1 s



Surface mounted ceramic multilayer capacitors

General data

TESTS AND REQUIREMENTS

Table 11 Test procedures and requirements

IEC 384-10/ CECC 32 100 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.4		mounting	the capacitors may be mounted on printed-circuit boards or ceramic substrates by applying wave soldering, reflow soldering (including vapour phase soldering) or conductive adhesive	no visible damage
4.5		visual inspection and dimension check	any applicable method using $\times 10$ magnification	in accordance with specification
4.6.1		capacitance	class 1: $C \leq 1000 \text{ pF}$, $f = 1 \text{ MHz}$; $C > 1000 \text{ pF}$, $f = 1 \text{ kHz}$; measuring voltage 1 V at 20°C class 2: for all capacitors $f = 1 \text{ kHz}$; measuring voltage 1 V at 20°C	within specified tolerance
4.6.2		$\tan \delta$	class 1: $C \leq 1000 \text{ pF}$, $f = 1 \text{ MHz}$; $C > 1000 \text{ pF}$, $f = 1 \text{ kHz}$; measuring voltage 1 V at 20°C class 2: for all capacitors $f = 1 \text{ kHz}$; measuring voltage 1 V at 20°C	in accordance with specification
4.6.3		insulation resistance	at U_R (DC) for 1 minute	in accordance with specification
4.6.4		voltage proof	$U_R \leq 100 \text{ V}$; $2.5 \times U_R$ for 1 minute; $U_R > 100 \text{ V}$; $1.5 \times U_R + 100$ for 1 minute	no breakdown or flashover
4.7.1		temperature coefficient	class 1: between minimum and maximum temperature	in accordance with specification
4.7.2		temperature characteristic	class 2: between minimum and maximum temperature	in accordance with specification
4.8		adhesion	a force of 5 N applied for 10 s to the line joining the terminations and in a plane parallel to the substrate	no visible damage
4.9		bond strength of plating on end face	mounted in accordance with CECC 32 100, paragraph 4.4	no visible damage
			conditions: bending 1 mm at a rate of 1 mm/s , radius jig. 340 mm	$\Delta C/C$: class 1: $\leq 1\%$ class 2, X7R: $\leq 10\%$ class 2, Y5V: $\leq 20\%$

Surface mounted ceramic multilayer capacitors

General data

IEC 384-10/ CECC 32 100 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.10	Tb	resistance to soldering heat	260 $\pm$ 5 °C for 10 $\pm$ 0.5 s in a static solder bath	the terminations shall be well tinned after recovery $\Delta C/C$: class 1: $\leq$ 0.5% or 0.5 pF whichever is greater class 2, X7R: > -5% and $\leq$ 10% class 2, Y5V: > -10% and $\leq$ 20%
		resistance to leaching	260 $\pm$ 5 °C for 30 $\pm$ 1 s in a static solder bath	using visual enlargement of $\times 10$, dissolution of the terminations shall not exceed 10%
4.11	Ta	solderability	zero hour test, and test after storage (20 to 24 months) in original packing in normal atmosphere; unmounted chips completely immersed for 2 $\pm$ 0.5 s in a solder bath at 235 $\pm$ 5 °C	the terminations shall be well tinned
4.12	Na	rapid change of temperature	preconditioning, class 2 only: NP0/X7R: -55 to +125 °C; 5 cycles Y5V: -25 to +85 °C; 5 cycles	no visible damage after 24 hours recovery $\Delta C/C$: class 1: $\leq$ 1% or 1 pF class 2, X7R: $\leq$ 15% class 2, Y5V: $\leq$ 20%

Surface mounted ceramic multilayer capacitors

General data

IEC 384-10/ CECC 32 100 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.14	Ca	damp heat, steady state	preconditioning, class 2 only: 56 days at 40 °C; 90 to 95% RH; U_R applied	no visual damage after recovery class 1: 1 to 2 hours class 2: 24 hours $\Delta C/C$: class 1: 2% or 1 pF, whichever is greater class 2, X7R: $\leq 15\%$ class 2, Y5V: $\leq 30\%$ $\tan \delta$: class 1: $\leq 2 \times$ specified value class 2: $\leq 7\%$ R_{ins} : class 1: 2500 M Ω or $R_i C_R \geq 25$ s, whichever is less class 2: 1000 M Ω or $R_i C_R \geq 25$ s, whichever is less
4.15		endurance	preconditioning, class 2 only: 1000 hours at upper category temperature at: $2 \times U_R$ for $U_R = 50$ V; $1.5 \times U_R$ for other rated voltages	no visible damage after 24 hours recovery: $\Delta C/C$: class 1: 2% or 1 pF, whichever is greater class 2, X7R: $\leq 20\%$ class 2, Y5V: $\leq 30\%$ $\tan \delta$: class 1: $\leq 2 \times$ specified value class 2: $\leq 7\%$ R_{ins} : class 1: 4000 M Ω or $R_i C_R \geq 40$ s, whichever is less class 2: 2000 M Ω or $R_i C_R \geq 50$ s, whichever is less
CECC 32101 - 801		damp heat accelerated, steady state	85 °C; 85% RH; 500 hours with bias 1.5 V and U_R	R_{ins} shall not be less than 10% of the initial requirements

Surface mounted ceramic multilayer capacitors

Product overview

PROGRAMME SURVEY

Product overview

Class 1	NP0 25 V	NP0 50 V (note)						NP0 100 V						NP0 200 V						NP0 500 V						NP0 1 kV	NP0 3 kV	Class 1
Capacitance (pF)	0402040206030805120612101812222006030805120612101812222008051206121018121206121018121812222018061812																											Capacitance (pF)
0.47		*	*	*	*			*	*	*	*																	0.47
↑ E12		*	*	*	*			*	*	*	*																	↑ E12
3.9		*	*	*	*			*	*	*	*																	3.9
4.7		*	*	*	*			*	*	*	*																	4.7
5.6		*	*	*	*			*	*	*	*																	5.6
6.8		*	*	*	*			*	*	*	*																	6.8
8.2		*	*	*	*			*	*	*	*																	8.2
10		*	*	*	*			*	*	*	*			*	*		*				*	*			*	*		10
12		*	*	*	*			*	*	*	*			*	*		*				*	*			*	*		12
15		*	*	*	*			*	*	*	*			*	*		*				*	*			*	*		15
18		*	*	*	*			*	*	*	*			*	*		*				*	*			*	*		18
22		*	*	*	*			*	*	*	*			*	*		*				*	*			*	*		22
27		*	*	*	*			*	*	*	*			*	*		*				*	*			*	*		27
33		*	*	*	*			*	*	*	*			*	*		*				*	*			*	*		33
39		*	*	*	*			*	*	*	*			*	*		*				*	*			*	*		39
47		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	47
56		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	56
68		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	68
82		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	82
100		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	100
120		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	120
150		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	150
180		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	180
220	▲	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	220
270		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	270
330	▲	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	330
390		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	390
470		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	470
560		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	560
680		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	680
820		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	820
1 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1 000
1 200		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1 200
1 500		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1 500
1 800		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1 800
2 200		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2 200
2 700		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2 700
3 300		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	3 300
3 900		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	3 900
4 700		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	4 700
5 600		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5 600
6 800		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	6 800
8 200		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	8 200
10 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	10 000
12 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	12 000
15 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	15 000
18 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	18 000
22 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	22 000
27 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	27 000
33 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	33 000
39 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	39 000
47 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	47 000
56 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	56 000
68 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	68 000
82 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	82 000
100 000		▲	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	100 000

• = Standard technology,
noble metal electrode type
▲ = Compact technology,
noble metal electrode type
note: Compact series meet IEC 63 V

CCA598

Fig.1 Class 1, NP0 general purpose and high voltage.

Surface mounted ceramic multilayer capacitors

Product overview

Class 2															Class 2														

Surface mounted ceramic
multilayer capacitors

Product overview

Class 2		Y5V 16 V				Y5V 25 V				Y5V 50 V				Z5U 50 V				Class 2	
Capacitance (μF)		0603	0805	1206		0603	0805	1206		0603	0805	1206		0805	1206			Capacitance (nF)	
0.010						■	■	■	■	■	■	■	■	■	■			10	
0.012						■	■	■	■	■	■	■	■	■	■			12	
0.015						■	■	■	■	■	■	■	■	■	■			15	
0.018						■	■	■	■	■	■	■	■	■	■			18	
0.022						■	■	■	■	■	■	■	■	■	■			22	
0.027						■	■	■	■	■	■	■	■	■	■			27	
0.033						■	■	■	■	■	■	■	■	■	■			33	
0.039						■	■	■	■	■	■	■	■	■	■			39	
0.047						■	■	■	■	■	■	■	■	■	■			47	
0.056						■	■	■	■	■	■	■	■	■	■			56	
0.068						■	■	■	■	■	■	■	■	■	■			68	
0.082						■	■	■	■	■	■	■	■	■	■			82	
0.10						■	■	■	■	■	■	■	■	■	■			100	
0.12						■	■	■	■	■	■	■	■	■	■			120	
0.15		■				■	■	■	■	■	■	■	■	■	■			150	
0.18		■				■	■	■	■	■	■	■	■	■	■			180	
0.22		■				■	■	■	■	■	■	■	■	■	■			220	
0.27		■				■	■	■	■	■	■	■	■	■	■			270	
0.33		■				■	■	■	■	■	■	■	■	■	■			330	
0.39		■				■	■	■	■	■	■	■	■	■	■			390	
0.47		■				■	■	■	■	■	■	■	■	■	■			470	
0.56		■				■	■	■	■	■	■	■	■	■	■			560	
0.68		■				■	■	■	■	■	■	■	■	■	■			680	
0.82		■				■	■	■	■	■	■	■	■	■	■			820	
1.0		■	■			■	■	■	■	■	■	■	■	■	■			1000	
1.2		■				■	■	■	■	■	■	■	■	■	■			1200	
1.5		■				■	■	■	■	■	■	■	■	■	■			1500	
1.8		■				■	■	■	■	■	■	■	■	■	■			1800	
2.2		■				■	■	■	■	■	■	■	■	■	■			2200	
2.7		■				■	■	■	■	■	■	■	■	■	■			2700	
3.3		■				■	■	■	■	■	■	■	■	■	■			3300	
3.9		■				■	■	■	■	■	■	■	■	■	■			3900	

CCA600

Fig.3 Class 2, Y5V and Z5U Base Metal Electrode.

Class 1		NP0 50 V			
Capacitance (pF)		0402	0603	0805	1206
0.47	■	■	■	■	■
1 E12	■	■	■	■	■
3.9	■	■	■	■	■
4.7	■	■	■	■	■
5.6	■	■	■	■	■
6.8	■	■	■	■	■
8.2	■	■	■	■	■
10	■	■	■	■	■
12	■	■	■	■	■
15	■	■	■	■	■
18	■	■	■	■	■
22	■	■	■	■	■
27	■	■	■	■	■
33	■	■	■	■	■
39	■	■	■	■	■
47	■	■	■	■	■
56	■	■	■	■	■
68	■	■	■	■	■
82	■	■	■	■	■
100	■	■	■	■	■
120	■	■	■	■	■
150	■	■	■	■	■
180	■	■	■	■	■
220	■	■	■	■	■
270	■	■	■	■	■
330	■	■	■	■	■
390	■	■	■	■	■
470	■	■	■	■	■
560	■	■	■	■	■
680	■	■	■	■	■
820	■	■	■	■	■
1000	■	■	■	■	■
1200	■	■	■	■	■
1500	■	■	■	■	■
1800	■	■	■	■	■
2200	■	■	■	■	■
2700	■	■	■	■	■
3300	■	■	■	■	■
3900	■	■	■	■	■
4700	■	■	■	■	■
5600	■	■	■	■	■
6800	■	■	■	■	■

CCA713

Fig.4 Class 1, NP0 narrow tolerance.

Class 1		NP0 50 V			
Capacitance (pF)		0603	0805	1206	
0.47	■	■	■	■	
1 E12	■	■	■	■	
3.9	■	■	■	■	
4.7	■	■	■	■	
5.6	■	■	■	■	
6.8	■	■	■	■	
8.2	■	■	■	■	
10	■	■	■	■	
12	■	■	■	■	
15	■	■	■	■	
18	■	■	■	■	
22	■	■	■	■	
27	■	■	■	■	
33	■	■	■	■	
39	■	■	■	■	
47	■	■	■	■	
56	■	■	■	■	
68	■	■	■	■	
82	■	■	■	■	
100	■	■	■	■	
120	■	■	■	■	

CCA714

Fig.5 Class 1, NP0 microwave.

Class 1		NP0 50/63 V	
Capacitance (pF)		4 × 0603	
39	■	■	
47	■	■	
56	■	■	
68	■	■	
82	■	■	
100	■	■	
120	■	■	
150	■	■	
180	■	■	
220	■	■	
270	■	■	
330	■	■	
390	■	■	
470	■	■	
560	■	■	
680	■	■	
820	■	■	
1000	■	■	

CCA715

Fig.6 C-Array Class 1, NP0.

Class 2		X7R 16 V		X7R 25 V	
Capacitance (nF)		4 × 0603		4 × 0603	
10	■	■		■	
12	■	■		■	
15	■	■		■	
18	■	■		■	
22	■	■		■	
27	■	■		■	
33	■	■		■	
39	■	■		■	
47	■	■		■	
56	■	■		■	
68	■	■		■	
82	■	■		■	
100	■	■		■	
120	■	■		■	
150	■	■		■	

CCA805

Fig.7 C-Array Class 2, X7R.

Surface mounted ceramic multilayer capacitors

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NUMERICAL INDEX

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2222 97..1	ceramic chip capacitor, NP0 500 V	Ni-barrier	44
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2238 57	ceramic chip capacitor, NP0 50 V, Microwave	Ni-barrier	64
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2238 58..9	ceramic chip capacitor, Y5V 50 V, BME type	Ni-barrier	102
2238 60..1	ceramic chip capacitor, NP0 100 V	Ni-barrier	40
2238 60	ceramic chip capacitor, X7R 100 V	Ni-barrier	86
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Surface mounted ceramic multilayer capacitors

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2238 87	ceramic chip capacitor, X7R 25 V, Compact	Ni-barrier	116
2238 877	ceramic chip capacitor, NP0 25 V, Compact, size 0402	Ni-barrier	114
2238 89..0	ceramic chip capacitor, NP0 50 V/63 V, Compact	Ni-barrier	114
2238 89..6	ceramic chip capacitor, X7R 50 V/63 V, Compact	Ni-barrier	118
2238 91..5	ceramic chip capacitor, X7R 25 V, BME type	Ni-barrier	92
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2238 91..9	ceramic chip capacitor, Y5V 25 V, BME type	Ni-barrier	102
2238 93..1	ceramic chip capacitor, NP0 200 V	Ni-barrier	44
2238 93..6	ceramic chip capacitor, X7R 200 V	Ni-barrier	86
2238 95	ceramic chip capacitor, X7R 16 V, Compact	Ni-barrier	116
2238 97..1	ceramic chip capacitor, NP0 500 V	Ni-barrier	44
2238 97..6	ceramic chip capacitor, X7R 500 V	Ni-barrier	86
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2250 01..1	ceramic chip capacitor, NP0 1 kV	AgPd	74
2250 04..1	ceramic chip capacitor, NP0 3 kV	Ni-barrier	78
2250 10..6	ceramic chip capacitor, C-Array X7R 16 V	Ni-barrier	132
2250 11..6	ceramic chip capacitor, C-Array X7R 16 V	AgPd	132
2250 12..6	ceramic chip capacitor, C-Array X7R 25 V	Ni-barrier	132
2250 13..6	ceramic chip capacitor, C-Array X7R 25 V	AgPd	132
2250 14..1	ceramic chip capacitor, C-Array NP0 50/63 V	Ni-barrier	128
2250 15..1	ceramic chip capacitor, C-Array NP0 50/63 V	AgPd	128
2254 550	ceramic chip capacitor, X7R 16 V, Compact	Ni-barrier	116
2254 57	ceramic chip capacitor, NP0 50 V, Microwave	Ni-barrier	64
2254 58..5	ceramic chip capacitor, X7R 50 V, BME type	Ni-barrier	92
2254 58..6	ceramic chip capacitor, X7R 50 V	Ni-barrier	84
2254 58..9	ceramic chip capacitor, Y5V 50 V, BME type	Ni-barrier	102
2254 60..1	ceramic chip capacitor, NP0 100 V	Ni-barrier	40
2254 60..6	ceramic chip capacitor, X7R 100 V	Ni-barrier	86
2254 62	ceramic chip capacitor, Z5U 50 V, BME type	Ni-barrier	108
2254 78..6	ceramic chip capacitor, X7R 16 V	Ni-barrier	82
2254 78..9	ceramic chip capacitor, Y5V 16 V, BME type	Ni-barrier	102
2254 86	ceramic chip capacitor, NP0 50 V	Ni-barrier	36
2254 87	ceramic chip capacitor, X7R 25 V, Compact	Ni-barrier	116
2254 877	ceramic chip capacitor, X7R 25 V, Compact, size 0402	Ni-barrier	116
2254 89..0	ceramic chip capacitor, NP0 50 V/63 V, Compact	Ni-barrier	114
2254 89..6	ceramic chip capacitor, X7R 50 V/63 V, Compact	Ni-barrier	118
2254 91..5	ceramic chip capacitor, X7R 25 V, BME type	Ni-barrier	92
2254 91..6	ceramic chip capacitor, X7R 25 V	Ni-barrier	82

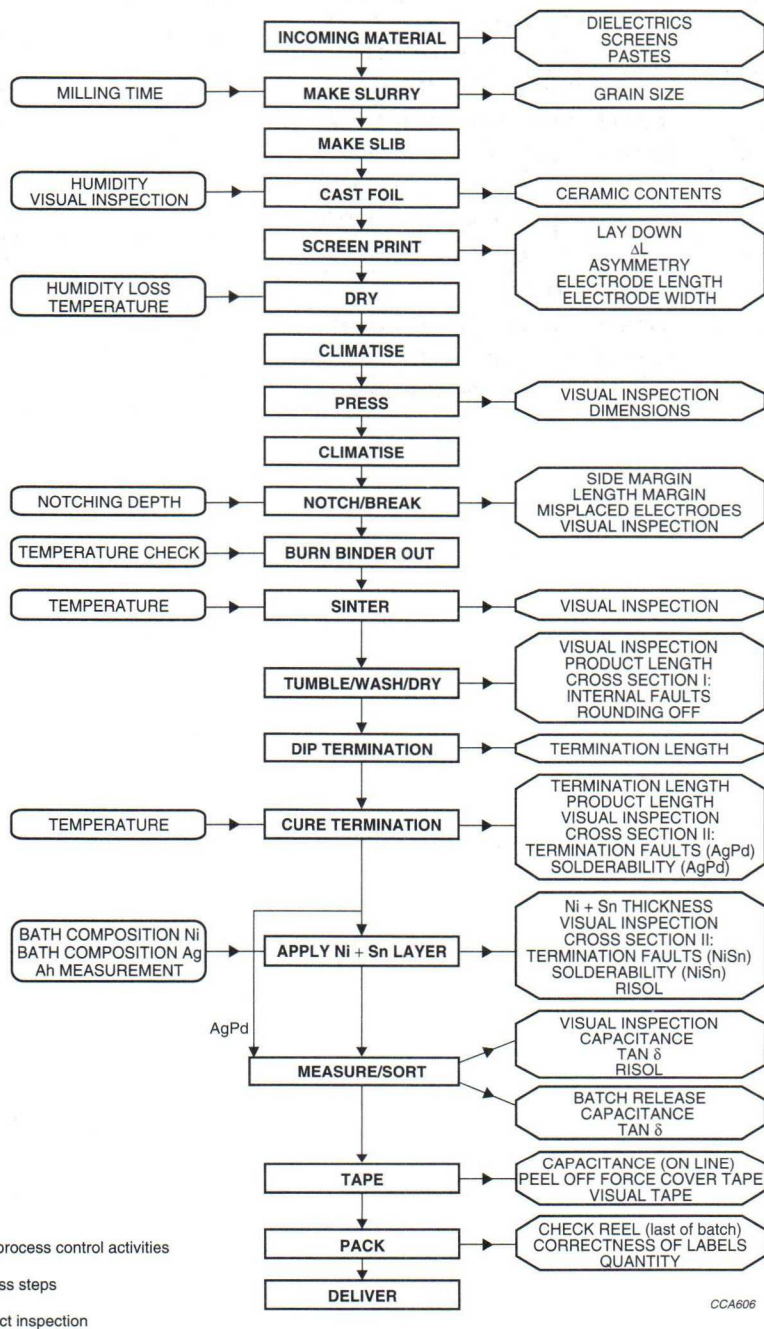
**Surface mounted ceramic
multilayer capacitors**

Numerical index

SERIES	DESCRIPTION	TERMINATION	PAGE
2254 91..9	ceramic chip capacitor, Y5V 25 V, BME type	Ni-barrier	102
2254 93..1	ceramic chip capacitor, NP0 200 V	Ni-barrier	44
2254 93..6	ceramic chip capacitor, X7R 200 V	Ni-barrier	86
2254 95	ceramic chip capacitor, X7R 16 V, Compact	Ni-barrier	116
2255 10..6	ceramic chip capacitor, C-Array X7R 16 V	Ni-barrier	132
2255 11..6	ceramic chip capacitor, C-Array X7R 16 V	AgPd	132
2255 12..6	ceramic chip capacitor, C-Array X7R 25 V	Ni-barrier	132
2255 13..6	ceramic chip capacitor, C-Array X7R 25 V	AgPd	132
2255 14..6	ceramic chip capacitor, C-Array NP0 50/63 V	Ni-barrier	128
2255 15..6	ceramic chip capacitor, C-Array NP0 50/63 V	AgPd	128
2256 04..1	ceramic chip capacitor, NP0 3 kV	Ni-barrier	78
2256 00..6	ceramic chip capacitor, X7R 1 kV	Ni-barrier	98

Surface mounted ceramic multilayer capacitors

Quality flow chart



CCA606

PRODUCT DATA

	Page
Class 1, NP0 general purpose	34
Class 1, NP0 narrow tolerance	52
Class 1, NP0 Microwave	62
Class 1, NP0 1 kV high voltage	72
Class 1, NP0 3 kV high voltage	76
Class 2, X7R general purpose	80
Class 2, X7R Base Metal Electrode	90
Class 2, X7R 1 kV high voltage	96
Class 2, Y5V Base Metal Electrode	100
Class 2, Z5U Base Metal Electrode	106
Compact series NP0 and X7R	112
C-Arrays NP0 and X7R	126

Surface mounted ceramic multilayer capacitors

Class 1, NP0

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 47000 pF 0.47 pF to 47000 pF 10 pF to 5600 pF 10 pF to 3300 pF
Tolerance on capacitance: $C \geq 10$ pF $C < 10$ pF	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$ and $\pm 1\%$ ± 0.5 pF, ± 0.25 pF and ± 0.1 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 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

Notes

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

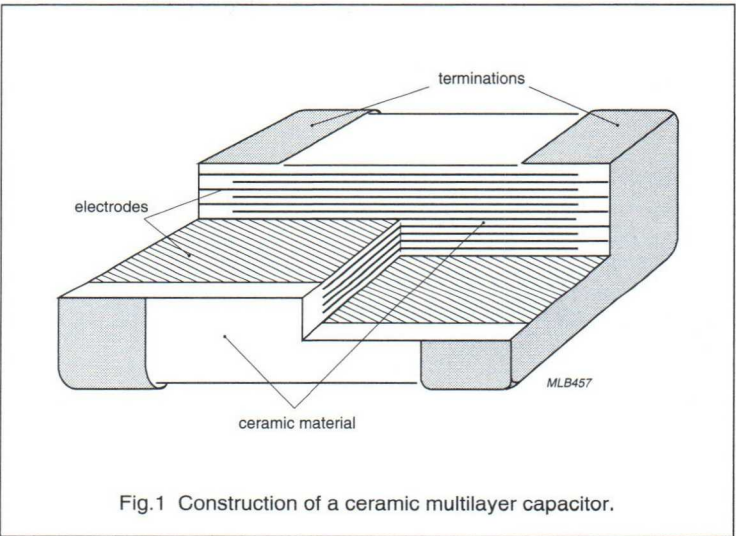
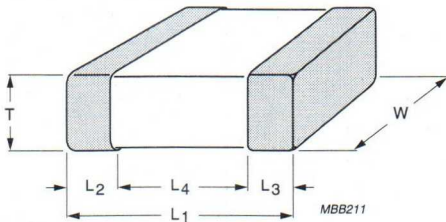


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic
multilayer capacitors

Class 1, NP0

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	0.51	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
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.80	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	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

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V general purpose series

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							
560	561							
680	681					0.5 to 1.0		
820	821							
1000	102							
1200	122							
1500	152			0.85 ±0.1				
1800	182						0.5 to 1.0	
2200	222			1.25 ±0.1				
2700	272							0.5 to 1.0
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							
12000	123							

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V general purpose series

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	4000	20000	10000	—	—	—	—	10000
0.85 ±0.1	4000	4000	15000	10000	—	—	—	—	8000
0.5 to 1.0	—	4000	—	10000	1500	1500	—	—	—
0.8 ±0.07	4000	4000	15000	15000	—	—	—	15000	—
0.9 to 1.3	—	3000	—	10000	1500	—	—	—	—
1.15 ±0.1	—	3000	—	10000	—	—	—	—	—
1.25 ±0.1	—	3000	—	10000	—	—	—	—	5000

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V general purpose series

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 0603 0805 1206 1210 1812 2220 (AgPd only)	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	C ± 0.25 pF D ± 0.5 pF F $\pm 1\%$ G $\pm 2\%$ J $\pm 5\%$ K $\pm 10\%$	9 = 50 V	B = Ni-barrier A = AgPd (2220 only)	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	_____		Capacitance value⁽¹⁾	_____
22 blister				
38 paper				
54 bulk				
Size	_____		Tolerance	
9 0402			NiSn terminations	
7 0603			4 ± 0.25 pF for C = 5.6 to 8.2 pF	
1 0805			$\pm 2\%$ for C ≥ 10 pF	
3 1206			5 ± 0.25 pF for C = 0.47 to 4.7 pF	
2 1210			± 0.5 pF for C = 5.6 to 8.2 pF	
5 1812			$\pm 5\%$ for C ≥ 10 pF	
6 2220 (AgPd only)			6 $\pm 10\%$ for C ≥ 10 pF	
Packaging⁽²⁾	_____		AgPd terminations	
1 reel: $\varnothing 180$ mm; 7"			1 ± 0.25 pF for C = 5.6 to 8.2 pF	
7 reel: $\varnothing 330$ mm; 13"			$\pm 2\%$ for C ≥ 10 pF	
4 bulk case			2 ± 0.25 pF for C = 0.47 to 4.7 pF	
			± 0.5 pF for C = 5.6 to 8.2 pF	
			$\pm 5\%$ for C ≥ 10 pF	
			3 $\pm 10\%$ 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".

Surface mounted ceramic multilayer capacitors

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Surface mounted ceramic multilayer capacitors

Class 1, NP0 100 V general purpose series

SELECTION CHART FOR 100 V

C (pF)	LAST TWO DIGITS OF 12NC	100 V					
		0603	0805	1206	1210	1812	2220
0.47	05						
0.56	06						
0.68	07						
0.82	08						
1.0	09						
1.2	11						
1.5	12						
1.8	13						
2.2	14						
2.7	15						
3.3	16						
3.9	17						
4.7	18						
5.6	19						
6.8	21						
8.2	22						
10	23						
12	24						
15	25						
18	26						
22	27	0.8 ±0.07					
27	28		0.6 ±0.1				
33	29			0.6 ±0.1			
39	31						
47	32						
56	33						
68	34						
82	35						
100	36						
120	37						
150	38						
180	39						
220	41						
270	42						
330	43						
390	44						
470	45						
560	46						
680	47				0.5 to 1.0		
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		0.5 to 1.0	
4700	58						
5600	59			1.15 ±0.1			0.5 to 1.0
6800	61						
8200	62	Values in shaded cells indicate thickness classification.					
10000	63						
12000	64						

Surface mounted ceramic multilayer capacitors

Class 1, NP0 100 V general purpose series

C (pF)	LAST TWO DIGITS OF 12NC	100 V					
		0603	0805	1206	1210	1812	2220
15000	65					0.5 to 1.0	
18000	66					0.9 to 1.3	
22000	67						0.5 to 1.0
27000	68						
33000	69						
39000	71						
47000	72						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	0603	0805
0.6 ±0.1	4000	4000	20000	10000	—	—	—	10000
0.85 ±0.1	4000	4000	15000	10000	—	—	—	8000
0.5 to 1.0	—	4000	—	10000	1500	1500	—	—
0.8 ±0.07	4000	4000	15000	15000	—	—	15000	—
0.9 to 1.3	—	3000	—	10000	1500	—	—	—
1.15 ±0.1	—	3000	—	10000	—	—	—	—
1.25 ±0.1	—	3000	—	10000	—	—	—	5000

Surface mounted ceramic multilayer capacitors

Class 1, NP0 100 V general purpose series

ORDERING INFORMATION FOR 100 V

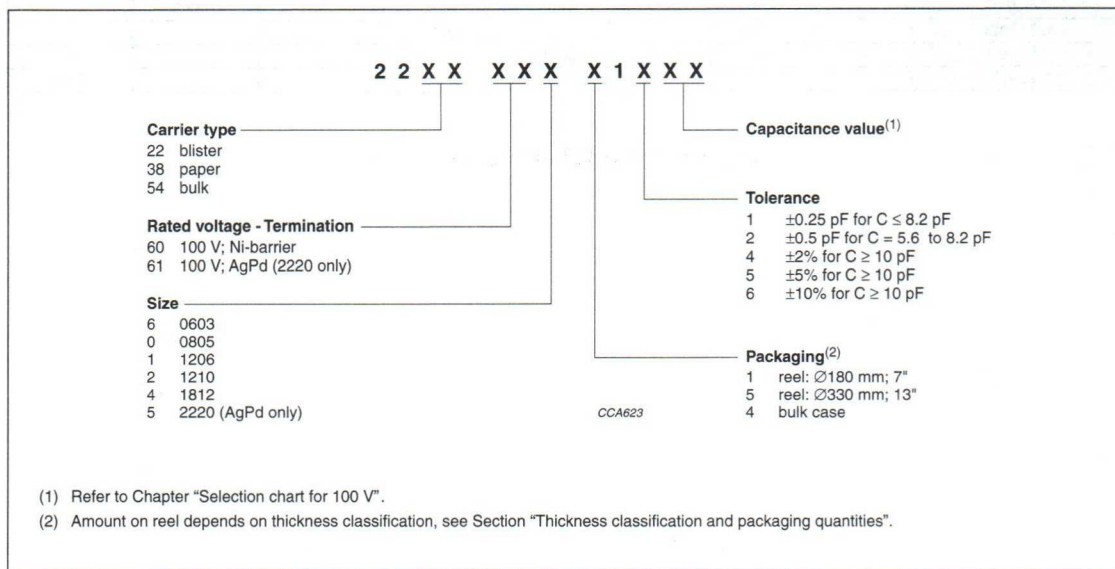
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

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 number of zeros	C ± 0.25 pF	0 = 100 V	B = Ni-barrier	2 = 180 mm; 7" paper	0 = no marking	0 = conv. ceramic
0805			D ± 0.5 pF		A = AgPd (2220 only)	3 = 330 mm; 13" paper	2 = 2-character marking in North America only	
1206			G $\pm 2\%$			B = 180 mm; 7" blister		
1210			J $\pm 5\%$			F = 330 mm; 13" blister		
1812			K $\pm 10\%$			P = bulk case		
2220 (AgPd only)								

Ordering code 12NC



Surface mounted ceramic multilayer capacitors

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Surface mounted ceramic multilayer capacitors

Class 1, NP0 200 V and 500 V general purpose series

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
0.47	05							
0.56	06							
0.68	07							
0.82	08							
1.0	09							
1.2	11							
1.5	12							
1.8	13							
2.2	14							
2.7	15							
3.3	16							
3.9	17							
4.7	18							
5.6	19							
6.8	21							
8.2	22							
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		0.8 to 1.0				
390	44							
470	45							
560	46	1.25 ±0.1				0.85 ±0.1		
680	47							
820	48					1.15 ±0.1		0.8 to 1.0
1000	49		0.85 ±0.1		0.8 to 1.0			
1200	51						0.9 to 1.3	
1500	52		1.15 ±0.1					
1800	53						1.2 to 1.75	
2200	54							
2700	55			0.9 to 1.3				0.9 to 1.3
3300	56							
3900	57							
4700	58				0.9 to 1.3			
5600	59							
6800	61	Values in shaded cells indicate thickness classification.						
8200	62							
10000	63							

Surface mounted ceramic
multilayer capacitors

Class 1, NP0 200 V and 500 V
general purpose series

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	4000	20000	10000	—	10000
0.85 ±0.1	4000	4000	15000	10000	—	8000
0.8 to 1.0	—	4000	—	10000	1500	—
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	—

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 number of zeros	G ±2% J ±5% K ±10%	B = 200 V D = 500 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 X X X X X 1 X X X

Carrier type

22 blister

38 paper

54 bulk

Rated voltage - Termination

93 200 V; Ni-barrier

97 500 V; Ni-barrier

Size

0 0805

1 1206

2 1210

4 1812

Capacitance value⁽¹⁾

Tolerance

4 ±2%

5 ±5%

6 ±10%

±1% on request

Packaging⁽²⁾

1 reel: Ø180 mm; 7"

5 reel: Ø330 mm; 13"

4 bulk case

CCA624

(1) Refer to Chapter "Selection chart for 200 V and 500 V".

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

1997 May 29

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Surface mounted ceramic multilayer capacitors

Class 1, NP0

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%.

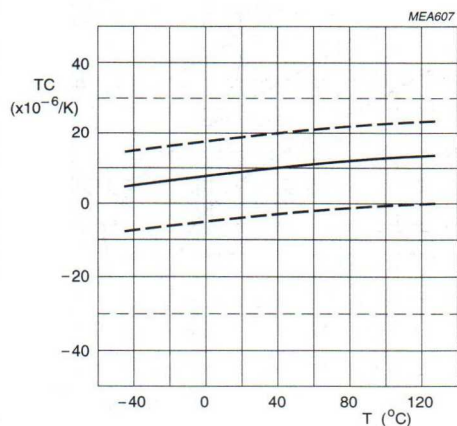
DESCRIPTION	VALUE
Capacitance range (E12 series); note 1:	
50 V	0.47 pF to 47 000 pF
100 V	0.47 pF to 47 000 pF
200 V	10 pF to 5600 pF
500 V	10 pF to 3300 pF
Tolerance on capacitance after 1000 hours:	
$C \geq 10$ pF	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$ and $\pm 1\%$
$5 \text{ pF} \leq C < 10$ pF	± 0.5 pF, ± 0.25 pF and ± 0.1 pF
$C < 5$ pF	± 0.25 pF and ± 0.1 pF
Tan δ ; note 1:	
$C < 10$ pF	$\leq 10 \left(\frac{3}{C} + 0.7 \right) \times 10^{-4}$ or 30×10^{-4} , whichever is smallest
$C \geq 10$ pF	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{\text{ins}} > 100 \text{ G}\Omega$
Temperature coefficient:	
$C < 10$ pF	$(0 \pm 150) \times 10^{-6}/\text{K}$; note 2
$C \geq 10$ pF	$(0 \pm 30) \times 10^{-6}/\text{K}$; 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 $(0 \pm 30) \times 10^{-6}/\text{K}$.

Surface mounted ceramic multilayer capacitors

Class 1, NP0



Sample limits (broken lines).
Requirement levels (dotted lines).

Fig.3 Typical temperature coefficient as a function of temperature.

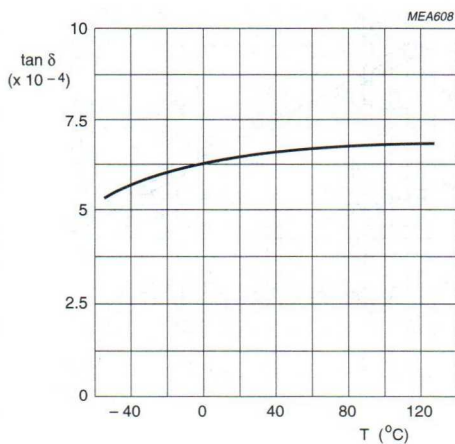


Fig.4 Typical $\tan \delta$ as a function of temperature.

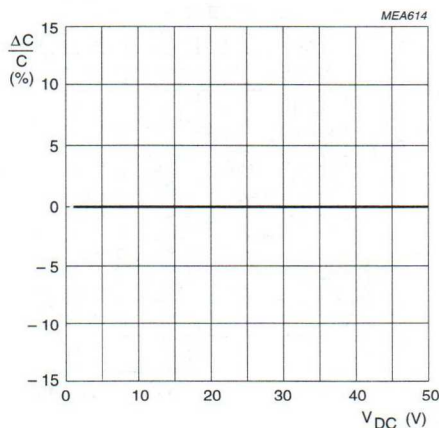
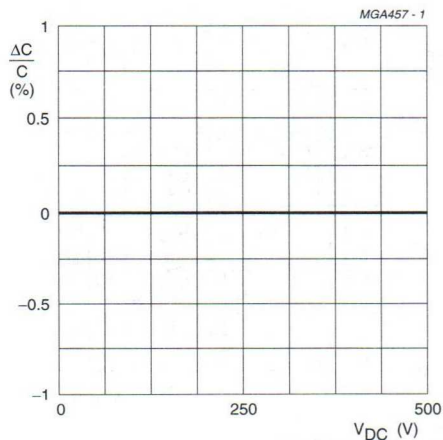


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

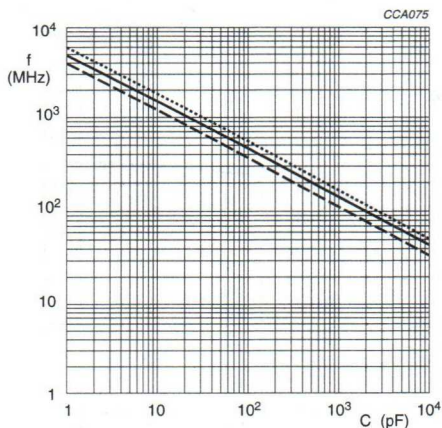


High voltage series.

Fig.6 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

Surface mounted ceramic multilayer capacitors

Class 1, NP0

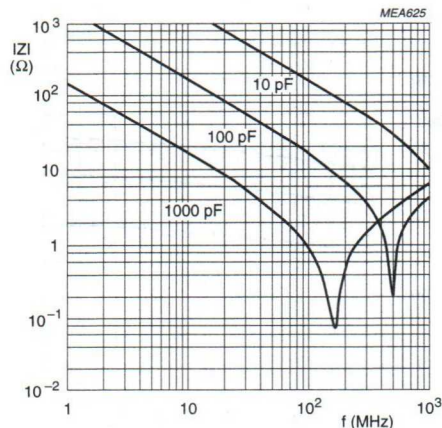


Case size **0603**: $L = 0.6$ nH (dotted line).

Case sizes **0805**, **1206** and **1210**: $L = 1$ nH (solid line).

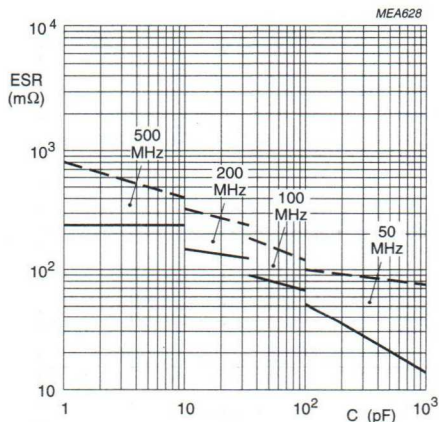
Case sizes **1812** and **2220**: $L = 1.5$ nH (broken line).

Fig. 7 Series resonance frequency as a function of capacitance.



Case sizes **0603** to **1210**.

Fig. 8 Typical impedance ($|Z|$) as a function of frequency.



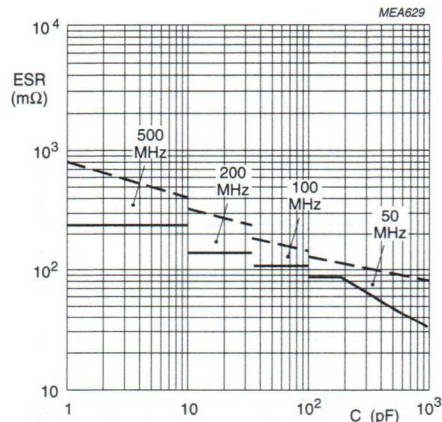
Case sizes **0603** and **0805**.

Typical values (solid lines).

Maximum values (broken lines).

Measuring equipment HP4191A.

Fig. 9 Equivalent series resistance (ESR) as a function of capacitance.



Case size **1206**.

Typical values (solid lines).

Maximum values (broken lines).

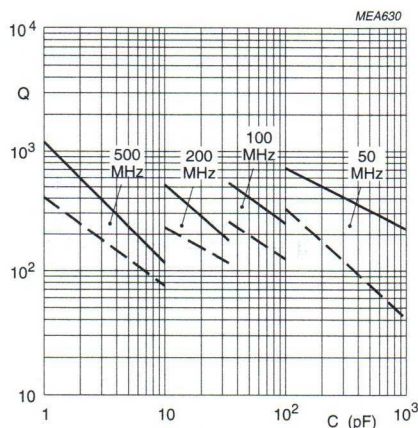
Measuring equipment HP4191A.

For $C > 1$ nF, maximum value of ESR = 80 mΩ measured at 50 MHz.

Fig. 10 Equivalent series resistance (ESR) as a function of capacitance.

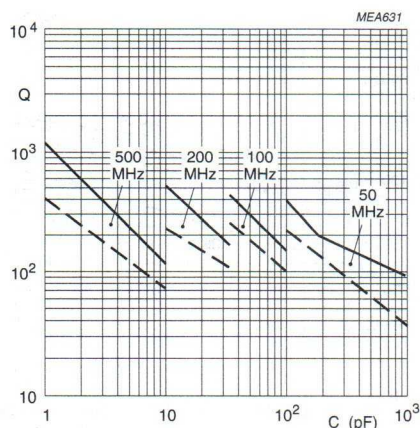
Surface mounted ceramic multilayer capacitors

Class 1, NP0



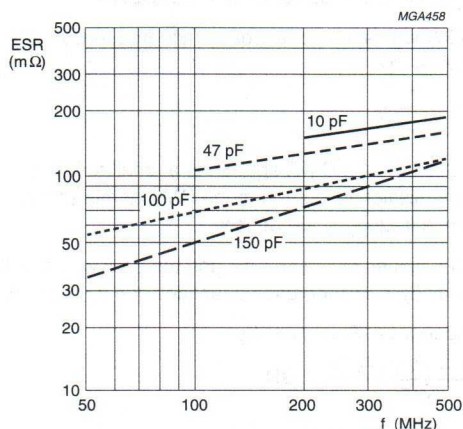
Case sizes **0603** and **0805**.
Typical values (solid lines).
Minimum values (broken lines).
Measuring equipment HP4191A.

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



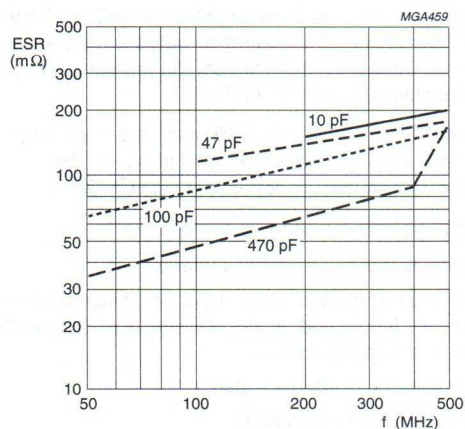
Case size **1206**.
Typical values (solid lines).
Minimum values (broken lines).
Measuring equipment HP4191A.
For $C > 1$ nF, $Q_{\min} = 35$ measured at 50 MHz.

Fig. 12 Quality factor (Q) as a function of the capacitance.



Case size **0805**.
High voltage 200 V.

Fig. 13 Typical equivalent series resistance as a function of frequency.

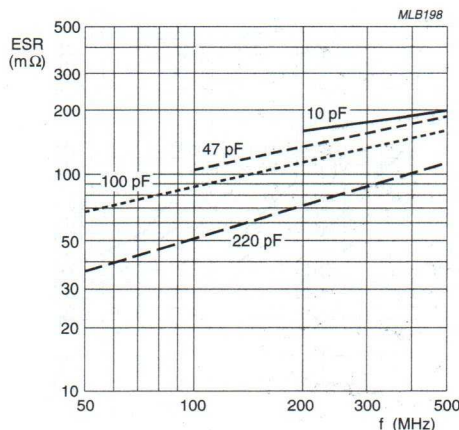


Case size **1206**.
High voltage 200 V.

Fig. 14 Typical equivalent series resistance as a function of frequency.

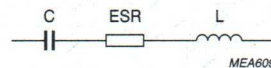
Surface mounted ceramic multilayer capacitors

Class 1, NP0



Case size 1206.
High voltage 500 V.

Fig.15 Typical equivalent series resistance as a function of frequency.



C = capacitance.

ESR = equivalent series resistance which is determined by the energy dissipation mechanisms (in the dielectric material as well as in the electrodes).

L = equivalent series self-inductance.

Fig.16 Equivalent series representation of a CMC.

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:

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

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	$\pm 1\%$ ± 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.

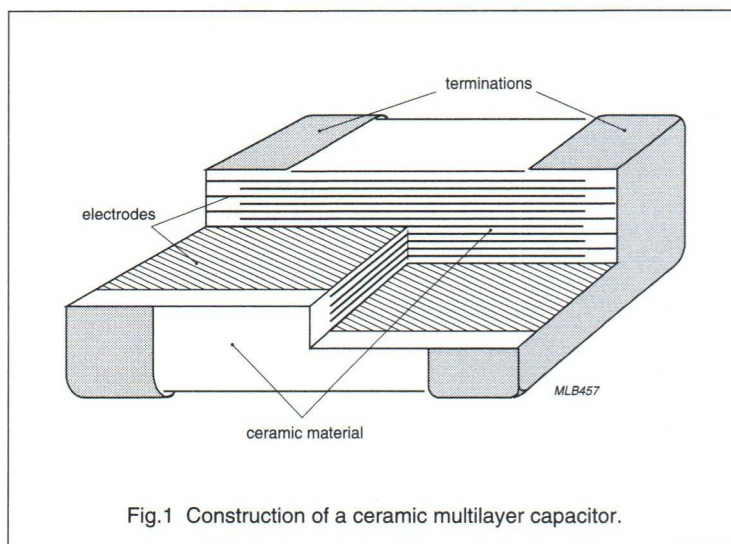
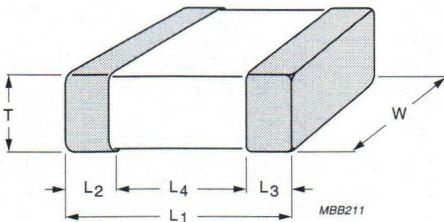


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic
multilayer capacitors

Class 1, NP0 50 V
narrow tolerance series

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	0.51	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
Dimensions in inches							
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

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V narrow tolerance series

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				1.15 ±0.1

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V narrow tolerance series

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"				
	PAPER	BLISTER	PAPER	BLISTER	0402	0603	0805
0.5 ±0.05	10000	—	50000	—	50000	—	—
0.6 ±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⁽¹⁾

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⁽²⁾

- 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".

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V narrow tolerance series

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%.

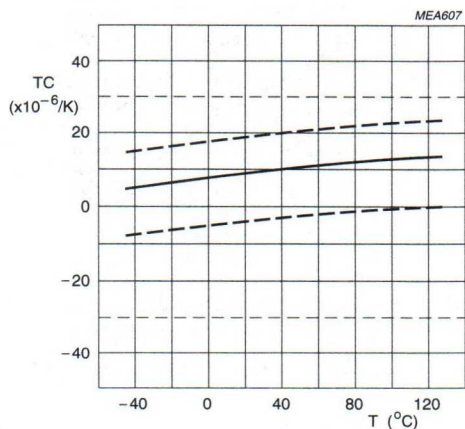
DESCRIPTION	VALUE
Capacitance range (E12 series); note 1: narrow tolerance; 50 V	0.47 pF to 3300 pF
Tolerance on capacitance after 1000 hours: C ≥ 10 pF 5 pF ≤ C < 10 pF	±1% ±0.1 pF
Tan δ; note 1: C < 10 pF C ≥ 10 pF	$\leq 10 \left(\frac{3}{C} + 0.7 \right) \times 10^{-4}$ or 30×10^{-4} , whichever is smallest $\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U _R (DC)	R _{ins} > 100 GΩ
Temperature coefficient: C < 10 pF C ≥ 10 pF	(0 ±150) × 10 ⁻⁶ /K; note 2 (0 ±30) × 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 ±30) × 10⁻⁶/K.

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V narrow tolerance series



Sample limits (broken lines).
Requirement levels (dotted lines).

Fig.3 Typical temperature coefficient as a function of temperature.

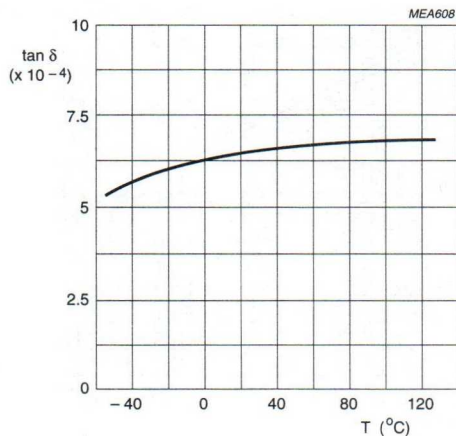


Fig.4 Typical $\tan \delta$ as a function of temperature.

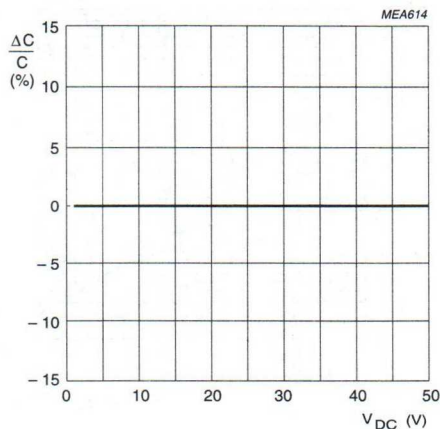
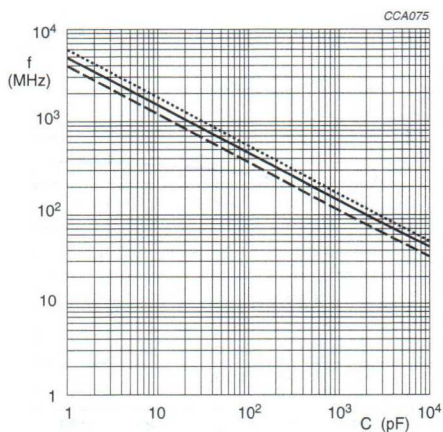


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

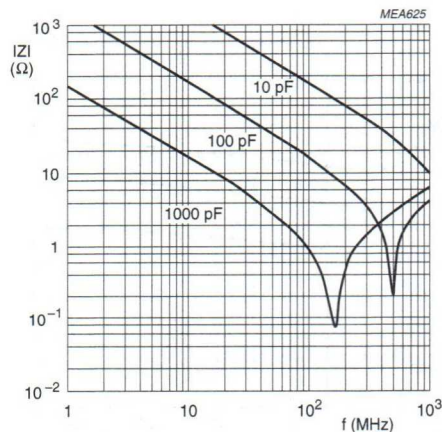
Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V narrow tolerance series



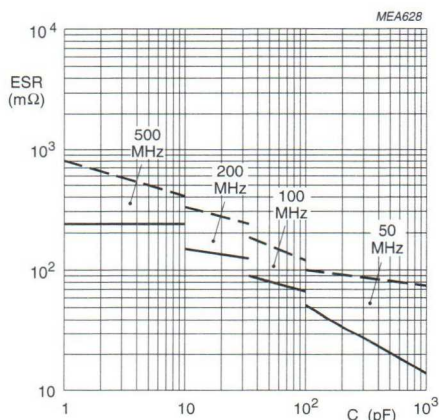
Case size **0603**: $L = 0.6$ nH (dotted line).
Case sizes **0805** and **1206**: $L = 1$ nH (solid line).

Fig. 6 Series resonance frequency as a function of capacitance.



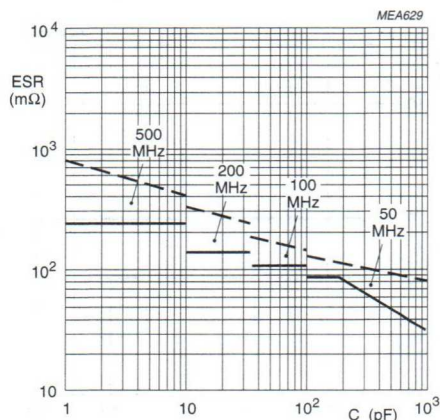
Case sizes **0603** to **1206**.

Fig. 7 Typical impedance ($|Z|$) as a function of frequency.



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

Fig. 8 Equivalent series resistance (ESR) as a function of capacitance.

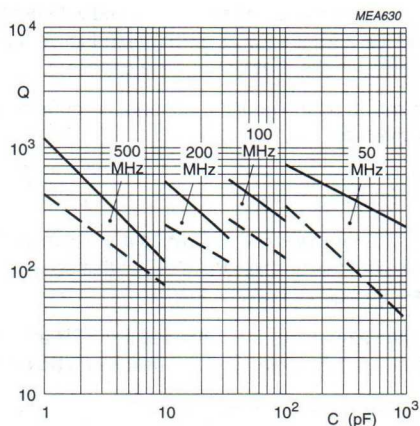


Case size **1206**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.
For $C > 1$ nF, maximum value of ESR = 80 mΩ measured at 50 MHz.

Fig. 9 Equivalent series resistance (ESR) as a function of capacitance.

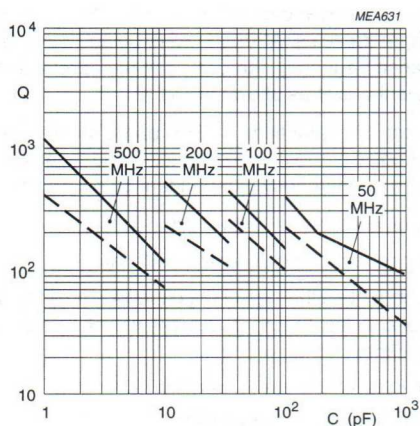
Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V narrow tolerance series



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.

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V narrow tolerance series

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:

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

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:

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



C = capacitance.

ESR = equivalent series resistance which is determined by the energy dissipation mechanisms (in the dielectric material as well as in the electrodes).

L = equivalent series self-inductance.

Fig.12 Equivalent series representation of a CMC.

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V microwave series

FEATURES

- Low insertion loss/ESR up to 3 GHz:
 - 1st parallel resonance above 2 GHz
 - 2nd parallel resonance above 3 GHz
- Small dimensions; sizes 0603, 0805 and 1206 available
- High reliability
- Standard tolerance on capacitance: $\pm 10\%$, $\pm 5\%$, $\pm 2\%$ and $\pm 1\%$
- Suitable for reflow and wave soldering
- s-parameter data available on floppy disk
- NiSn terminations (AgPd on request).

APPLICATIONS

- Mobile telephones
- Satellite television
- Instrumentation.

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 (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V (IEC); note 1
Capacitance range (E12 series), NP0 dielectric; note 2:	
case size 0603	0.47 pF to 47 pF
case size 0805	0.47 pF to 82 pF
case size 1206	0.47 pF to 120 pF
Tolerance on capacitance:	
$C \geq 10$ pF	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$ and $\pm 1\%$
$5 \text{ pF} \leq C < 10 \text{ pF}$	$\pm 0.5 \text{ pF}$, $\pm 0.25 \text{ pF}$ and $\pm 0.1 \text{ pF}$
$C < 5 \text{ pF}$	$\pm 0.25 \text{ pF}$ and $\pm 0.1 \text{ pF}$
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Insulation resistance after 60 s at U_R (DC)	$> 100 \text{ G}\Omega$
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

Notes

1. Also applicable for applications up to 63 V.
2. Non E12 values are available on request.

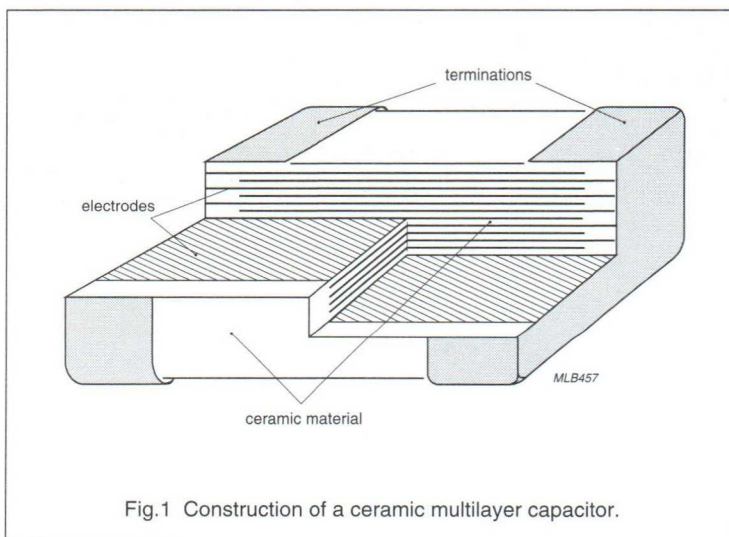
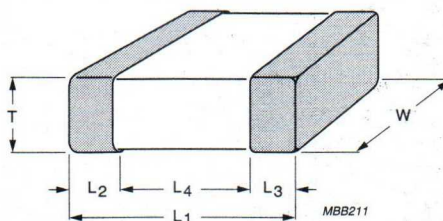


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V microwave series

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							
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
Dimensions in inches							
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

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V microwave series

SELECTION CHART

C (pF)	LAST TWO DIGITS OF 12NC	50 V		
		0603	0805	1206
0.47	05			
0.56	06			
0.68	07			
0.82	08			
1.0	09			
1.2	11			
1.5	12			
1.8	13			
2.2	14			
2.7	15			
3.3	16			
3.9	17			
4.7	18	0.8 ±0.07		
5.6	19			
6.8	21		0.6 ±0.1	
8.2	22			
10	23			0.6 ±0.1
12	24			
15	25			
18	26			
22	27			
27	28			
33	29			
39	31			
47	32			
56	33			
68	34			
82	35			
100	36	Values in shaded cells indicate thickness classification.		
120	37			

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"		0603	0805
	PAPER	BLISTER	PAPER	BLISTER		
0.6 ±0.1	4000	4000	20000	10000	—	10000
0.8 ±0.07	4000	4000	15000	15000	15000	—

Surface mounted ceramic
multilayer capacitors

Class 1, NP0 50 V
microwave series

ORDERING INFORMATION

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

Clear text code

EXAMPLE: 0805CG100G9BB0M

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206	CG = NP0	100 = 10 pF; the third digit signifies the number of zeros	B ± 0.1 pF C ± 0.25 pF D ± 0.5 pF F $\pm 1\%$ G $\pm 2\%$ J $\pm 5\%$ K $\pm 10\%$	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	M = microwave

Ordering code 12NC

2 2 X X X X X X 1 X X X

Carrier type

22 blister
38 paper
54 bulk

Size - Termination

578 0603 Ni-barrier
574 0805 Ni-barrier
576 1206 Ni-barrier

Packaging⁽²⁾

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

Capacitance value⁽¹⁾

Tolerance

0 ±0.1 pF for C < 10 pF
1 ±0.25 pF for C < 10 pF
2 ±0.5 pF for 5 pF ≤ C < 10 pF
3 ±1% for C ≥ 10 pF
4 ±2% for C ≥ 10 pF
5 ±5% for C ≥ 10 pF
6 ±10% for C ≥ 10 pF

CCA616

(1) Refer to Chapter "Selection chart".

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

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V microwave series

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%.

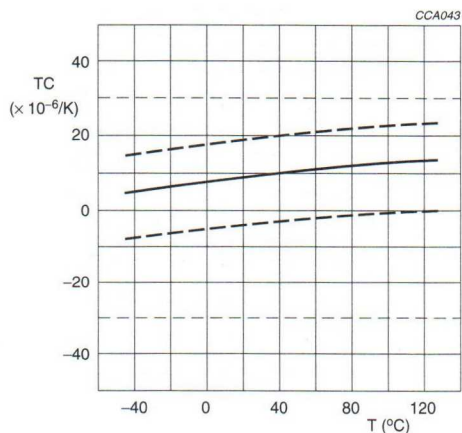
DESCRIPTION	VALUE
Capacitance range (E12 series), NP0 dielectric; note 1: case size 0603 case size 0805 case size 1206	 0.47 pF to 47 pF 0.47 pF to 82 pF 0.47 pF to 120 pF
Tolerance on capacitance: C ≥ 10 pF 5 pF ≤ C < 10 pF C < 5 pF	 ±10%, ±5%, ±2% and ±1% ±0.5 pF, ±0.25 pF and ±0.1 pF ±0.25 pF and ±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 30×10^{-4} , whichever is the smallest $\leq 10 \times 10^{-4}$
Temperature coefficient; note 2: 0.47 pF ≤ C < 5 pF 5 pF ≤ C < 10 pF C ≥ 10 pF	 $(0 \pm 150) \times 10^{-6}/K$ $(0 \pm 150) \times 10^{-6}/K$ $(0 \pm 30) \times 10^{-6}/K$
High frequency properties	for ESR values see Figs 7, 8 and 9. The first parallel resonance frequency in the s_{21} and s_{12} scattering parameters lies above 2 GHz and the second resonance frequency above 3 GHz.

Notes

1. Measured at 1 V, 1 MHz, using a four-gauge method.
2. For size 0603 all capacitance values from 0.47 pF to 47 pF have a temperature coefficient of $(0 \pm 30) \times 10^{-6}/K$.

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V microwave series



Sample limits (broken lines).
Requirement levels (dotted lines).

Fig.3 Typical temperature coefficient as a function of temperature.

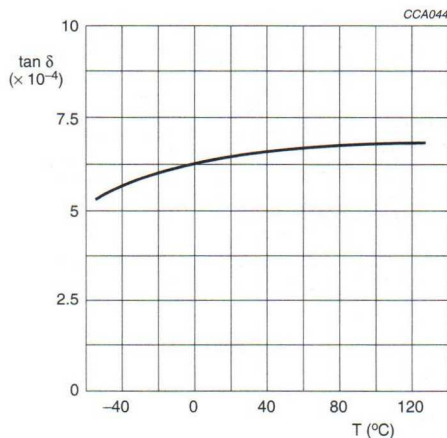


Fig.4 Typical $\tan \delta$ as a function of temperature.

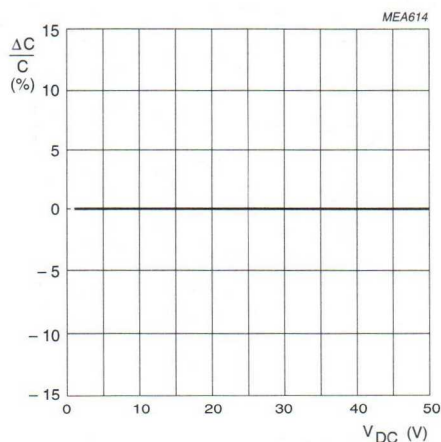
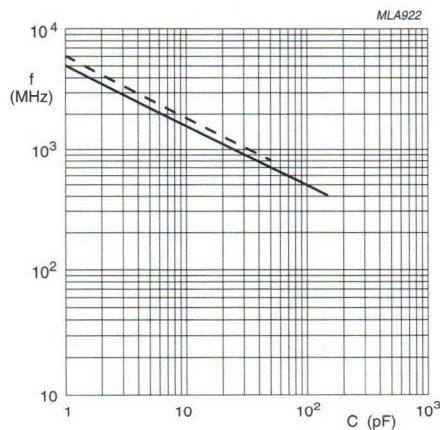


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

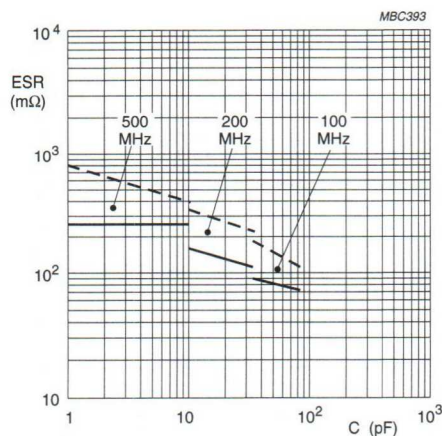


Case sizes **0805** and **1206** (solid line).
Case size **0603** (broken line).

Fig.6 Series resonance frequency as a function of capacitance.

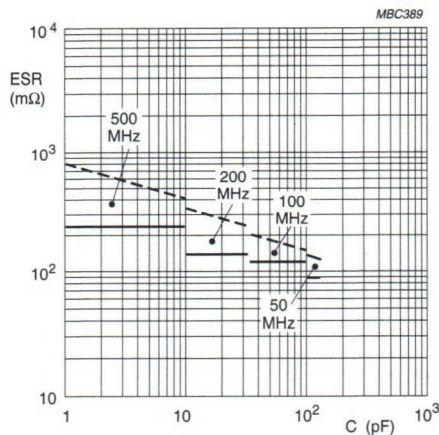
Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V microwave series



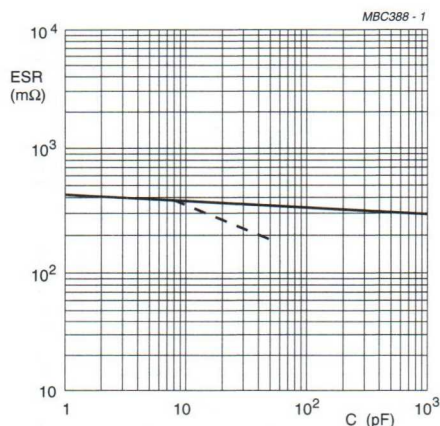
Case sizes **0603** and **0805**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

Fig.7 Equivalent series resistance (ESR)
as a function of capacitance.



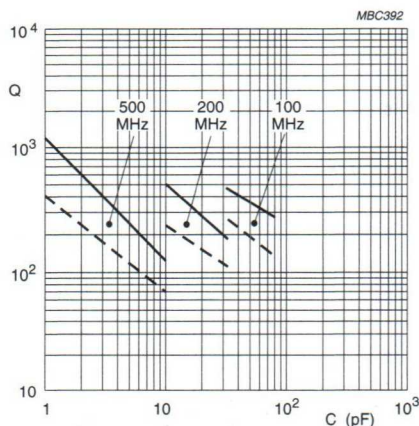
Case size **1206**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

Fig.8 Equivalent series resistance (ESR)
as a function of capacitance.



Case sizes **0805** and **1206** (solid line).
Case size **0603** (broken line).
Measuring equipment HP4191A.

Fig.9 Typical ESR values at 1 GHz as a function
of the capacitance value.

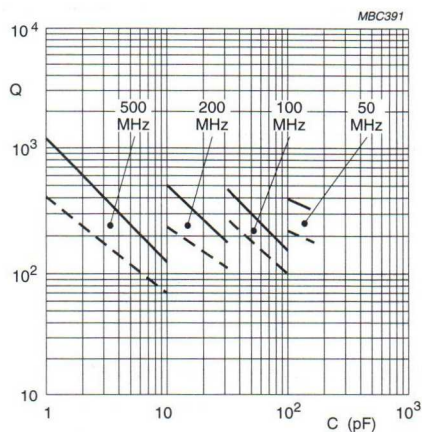


Case sizes **0603** and **0805**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

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

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V microwave series



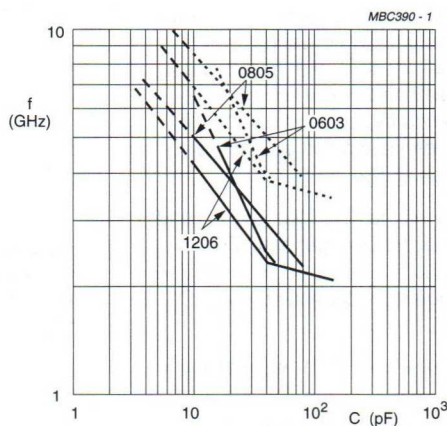
Case size 1206.

Typical values (solid lines).

Maximum values (broken lines).

Measuring equipment HP4191A.

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



Case sizes 0603, 0805 and 1206.

First resonant frequency (solid lines).

Second resonant frequency (dotted lines).

Fig.12 Typical first and second parallel resonance frequencies as a function of capacitance.

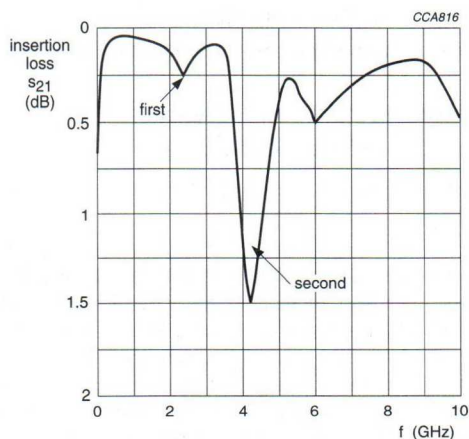


Fig.13 Example of the insertion loss as a function of frequency showing the parallel resonances.

Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V microwave series

MICROWAVE BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

Ceramic multilayer capacitors (CMC) from the microwave series 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.14.

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 and is approximately:
 - 0.6 nH for case size 0603
 - 1 nH for case sizes 0805 and 1206 (these figures are accurate to within $\pm 20\%$).

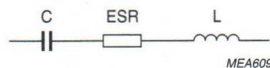
Because of the inductance L, associated with the CMC, there will be a frequency at which the inductive reactance will be equal to the reactance of the capacitor.

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.



C = capacitance.

ESR = equivalent series resistance which is determined by the energy dissipation mechanisms (in the dielectric material as well as in the electrodes).

L = equivalent series self-inductance.

Fig.14 Equivalent series representation of a CMC.

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

The frequency region above the SRF is difficult to model using lumped elements and should be described in terms of a network of transmission lines. The behaviour of the CMC in this frequency region can be best described in terms of scattering or 's' parameters. Knowing these parameters, one can predict the response of a network accurately. There are four scattering parameters for a two-port network: s_{11} , s_{12} , s_{21} and s_{22} :

s_{11} is the reflection coefficient at the input port with the output port terminated in a 50 Ω load.

s_{12} is the reverse transmission coefficient in a 50 Ω system.

s_{21} is the forward transmission coefficient in a 50 Ω system.

s_{22} is the reflection coefficient at the output port with the input port terminated into a 50 Ω load.

When comparing the insertion loss (i.e. s_{21}) of a CMC at high frequencies with that of an ideal capacitor, parallel resonances above the SRF are observed. In series or shunt connections parallel resonances are usually detrimental to the operation of the circuit. They may be the cause of unacceptable insertion loss or parasitic oscillations of amplifiers. For the microwave series, we specify that the first parallel resonance frequency lies above 2 GHz and the second above 3 GHz. It is found that the typical insertion loss at the first resonance frequency is more than a factor 5 smaller than at the second resonance frequency.

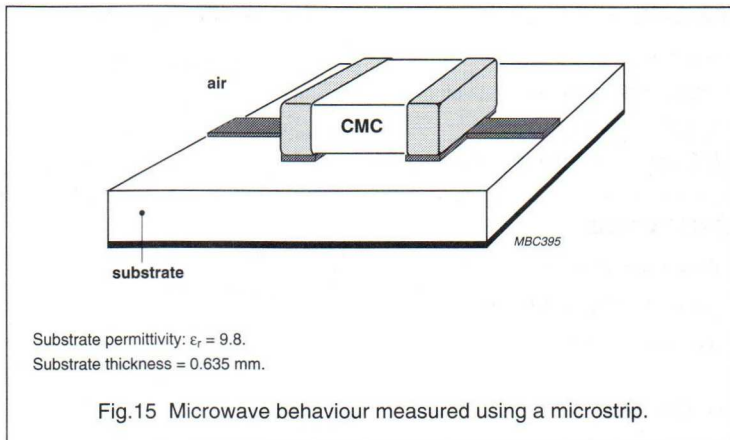
Surface mounted ceramic multilayer capacitors

Class 1, NP0 50 V microwave series

The high frequency behaviour of our CMCs is measured in a strip line configuration as shown in Fig.15 using a test fixture with the following features:

- Microstrip structure (dielectric: Al_2O_3 ; thickness: 0.635 mm)
- Suitable for the TRL calibration method
- De-embedding for the low-frequency range (up to 3 GHz).

The measurements are carried out using the HP 8510B network analyser.



Surface mounted ceramic multilayer capacitors

Class 1, NP0 1 kV high voltage series

FEATURES

- Sizes 1812 and 2220
- High capacitance per unit volume
- Supplied in tape on reel
- NiSn and AgPd terminations.

APPLICATIONS

- Power supplies
- Voltage multiplier circuits
- Surge protection.

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, 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)	1 kV (IEC)
Capacitance range (E12 series); note 1	100 pF to 3300 pF
Tolerance on capacitance at $T_{amb} = 20\text{ }^{\circ}\text{C}$	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$; note 2
Test voltage (DC) for 1 minute	$2 \times U_R$
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

Notes

1. Other values and non E12 series are available on request.
2. $\pm 1\%$ tolerance on capacitance is available on request.

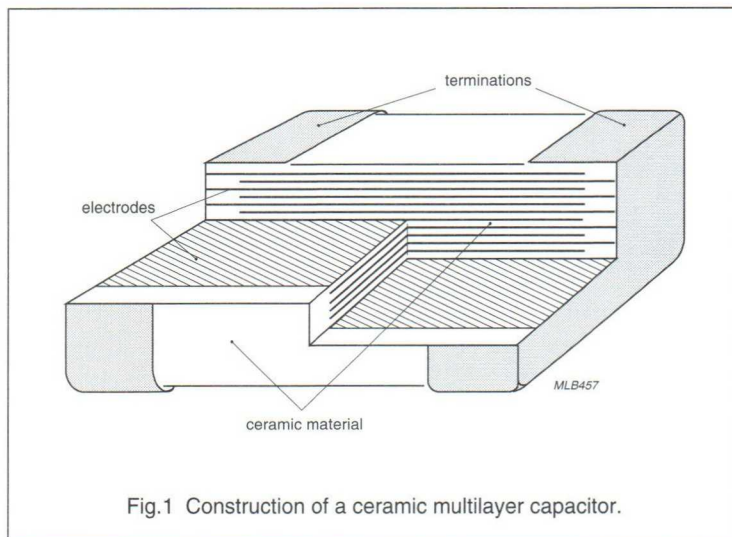
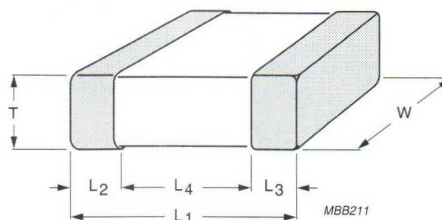


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic multilayer capacitors

Class 1, NP0 1 kV high voltage series

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							
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.30	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	1.30	0.25	0.75	2.90
Dimensions in inches							
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

Surface mounted ceramic
multilayer capacitors

Class 1, NP0 1 kV
high voltage series

SELECTION CHART

C (pF)	LAST TWO DIGITS OF 12NC	1 kV	
		1812	2220
100	36		
120	37		
150	38		
180	39		
220	41		
270	42		
330	43	0.5 to 1.0	
390	44		
470	45		
560	46		0.5 to 1.0
680	47		
820	48		
1000	49		
1200	51	0.9 to 1.3	
1500	52		
1800	53	Values in shaded cells indicate thickness classification.	
2200	54		
2700	55		0.9 to 1.3
3300	56		

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	12 mm TAPE WIDTH AMOUNT PER REEL	
	Ø180 mm; 7" BLISTER	
	1812	2220
0.5 to 1.0	2000	1500
0.9 to 1.3	1500	1500

ORDERING INFORMATION

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

Clear text code

Example: 1812CG102JEBB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
1812 2220	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	G ±2% J ±5% K ±10%	E = 1 kV	A = AgPd B = Ni-barrier	B = 180 mm; 7" blister	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

2 2 X X X X X X 1 X X X

Carrier type

50 blister

55 paper

Termination

14 NiSn

15 AgPd

Size

6 0612 (4 × 0603)

Capacitance value⁽¹⁾

Tolerance

5 ±5%

6 ±10%

7 ±20%

Packaging⁽²⁾

1 reel: Ø180 mm; 7" reel

CCA682

(1) Refer to Chapter "Selection chart".

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

Surface mounted ceramic
multilayer capacitors

Class 1, NP0 1 kV
high voltage series

ELECTRICAL CHARACTERISTICS

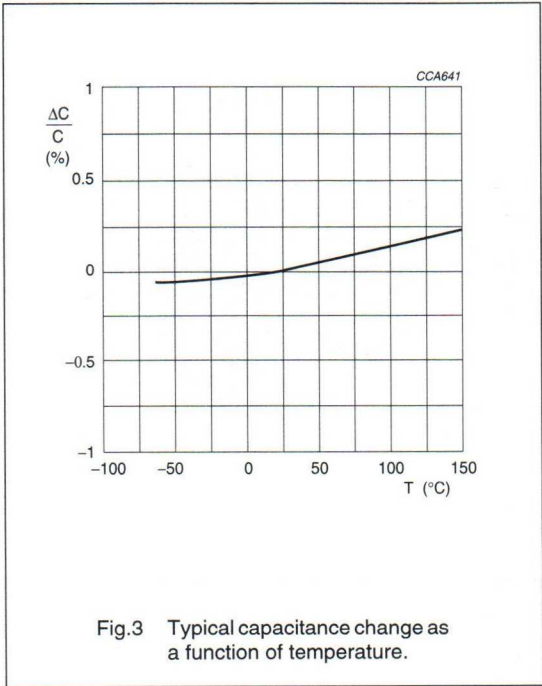
Class 1 capacitors; NP0 dielectric; NiSn terminations

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	100 pF to 3300 pF
Tolerance on capacitance after 1000 hours	±10%, ±5%, ±2%; note 1
Rated voltage U _R (DC)	1 kV (IEC)
Test voltage (DC) for 1 minute	2 × U _R
Tan δ	≤10 × 10 ⁻⁴
Insulation resistance after 1 minute at U _R (DC)	R _{ins} > 100 GΩ
Temperature coefficient	(0 ±30) × 10 ⁻⁶ /K
Ageing	not applicable

Note

- 1. Products with a tolerance of 1% are available on request.



Surface mounted ceramic multilayer capacitors

Class 1, NP0 3 kV high voltage series

FEATURES

- Sizes 1808 and 1812
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case
- NiSn and AgPd terminations.

APPLICATIONS

These surface mounted high voltage capacitors were developed specifically for circuits requiring voltage up to 1 to 3 kV. Typical applications are:

- Inverter circuits for the backlights of liquid crystal displays
- Snubber circuits of power supplies
- Voltage multiplier circuits
- Surge protection.

Due to high voltage across the terminations, circuit applications of 1 to 3 kV or higher may need a coating on the surface to prevent external arcing. This is especially true under humid conditions.

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, 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)	3 kV (IEC)
Capacitance range (E12 series); note 1	10 pF to 100 pF
Tolerance on capacitance at $T_{amb} = 20\text{ }^{\circ}\text{C}$	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$; note 2
Test voltage (DC) for 1 minute	$1.2 \times U_R$
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

Notes

1. Other values below 10 pF and non E12 series are available on request.
2. Special tolerance on capacitance is available on request.

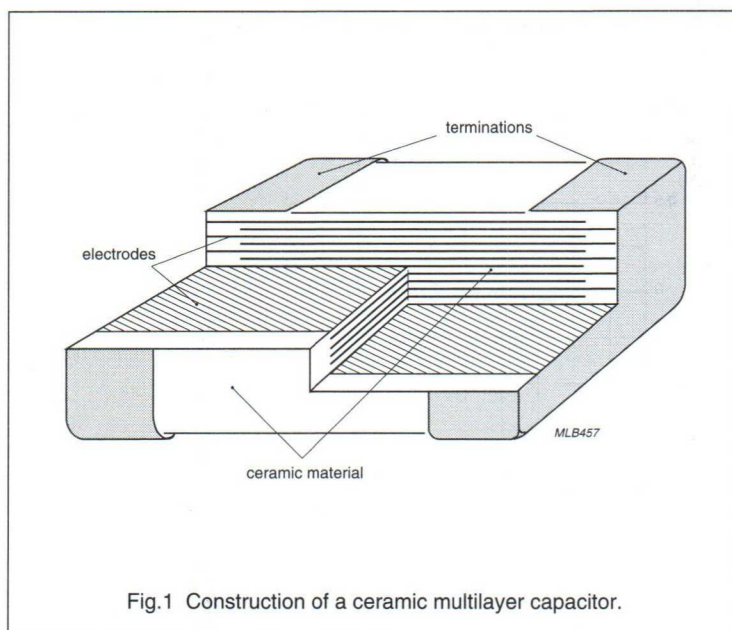
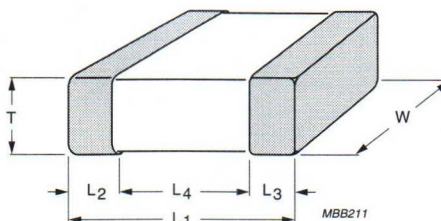


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic multilayer capacitors

Class 1, NP0 3 kV high voltage series

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T MAX.	L ₂ and L ₃ MAX.	L ₄ MIN.
Dimensions in millimetres					
1808	4.5 ±0.20	2.0 ±0.20	1.30	0.75	2.20
1812	4.5 ±0.20	3.2 ±0.20	1.30	0.75	2.20
Dimensions in inches					
1808	0.177 ±0.008	0.079 ±0.008	0.072	0.030	0.088
1812	0.177 ±0.008	0.126 ±0.008	0.072	0.030	0.088

Surface mounted ceramic multilayer capacitors

Class 1, NP0 3 kV high voltage series

SELECTION CHART

C (pF)	LAST TWO DIGITS OF 12NC	3 kV	
		1808	1812
10	23		
12	24		
15	25		
18	26		
22	27	1.2 to 1.75	1.2 to 1.75
27	28		
33	29		
39	31		
47	32		
56	33		
68	34		1.6 to 2.2
82	35		
100	36		

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	12 mm TAPE WIDTH AMOUNT PER REEL	
	Ø180 mm; 7" BLISTER	
	1808	1812
1.2 to 1.75	1000	1000
1.6 to 2.2	1000	1000

ORDERING INFORMATION

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

Clear text code

Example: 1808CG270JGBB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
1808 1812	CG = NP0	27 = 27 pF; the third digit signifies the number of zeros	G ±2% J ±5% K ±10%	G = 3 kV	B = Ni-barrier	B = 180 mm; 7" 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 0 4 X X 1 X X X

Carrier type

50 blister
56 bulk

Size

3 1808
4 1812

Packaging⁽²⁾

1 reel: Ø180 mm; 7" reel
12 mm blister tape

Capacitance value⁽¹⁾

Tolerance

4 ±2%
5 ±5%
6 ±10%

CCA684

(1) Refer to Chapter "Selection chart".

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

Surface mounted ceramic
multilayer capacitors

Class 1, NP0 3 kV
high voltage series

ELECTRICAL CHARACTERISTICS

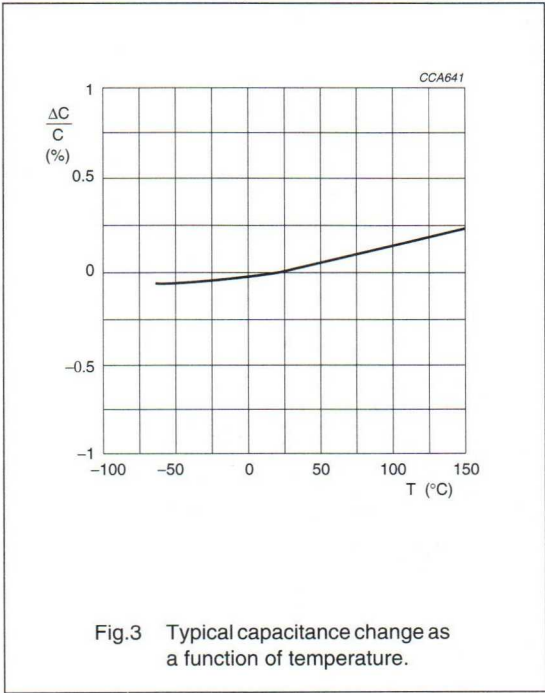
Class 1 capacitors; NP0 dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	10 pF to 100 pF
Tolerance on capacitance after 1000 hours:	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$; note 1
Rated voltage U_R (DC)	3 kV (IEC)
Test voltage (DC) for 1 minute	$1.2 \times U_R$
$\tan \delta$	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 100\text{ G}\Omega$
Temperature coefficient	$(0 \pm 30) \times 10^{-6}/\text{K}$
Ageing	not applicable

Note

1. Products with a tolerance of 1% are available on request.



Surface mounted ceramic multilayer capacitors

Class 2, X7R

FEATURES

- Seven standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case
- NiSn terminations (AgPd on request).

APPLICATIONS

- Consumer electronics, for example:
 - Tuners
 - Television receivers
 - Video recorders
 - All types of cameras
- 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)	16 V, 25 V, 50 V, 100 V, 200 V and 500 V (IEC)
Capacitance range (E12 series); note 1:	
16 V	4.7 nF to 1 μ F
25 V	3.3 nF to 470 nF
50 V; note 2	100 pF to 1 μ F
100 V	180 pF to 330 nF
200 V	180 pF to 120 nF
500 V	470 pF to 15 nF
Tolerance on capacitance	$\pm 20\%$, $\pm 10\%$, $\pm 5\%$
Test voltage (DC) for 1 minute:	
16 V, 25 V, 50 V and 100 V	$2.5 \times U_R$
200 V	$3 \times U_R$
500 V	$2 \times U_R$
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

Notes

1. Non E12 values are available on request.
2. Also applicable for applications up to 63 V.

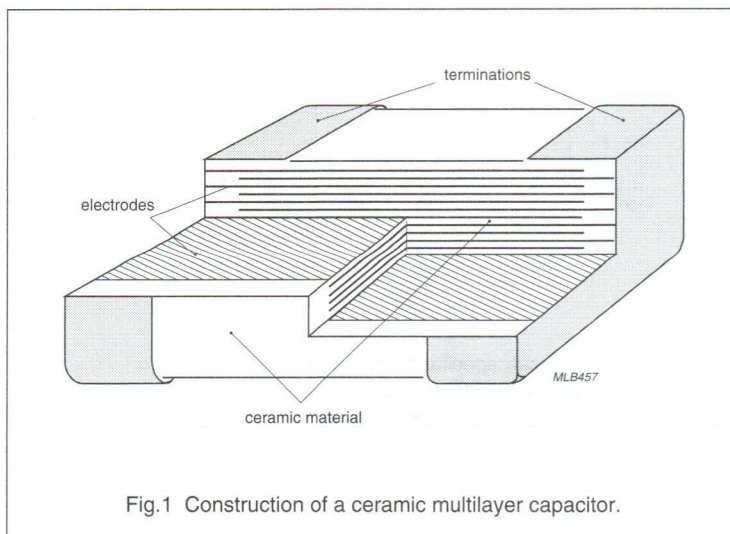
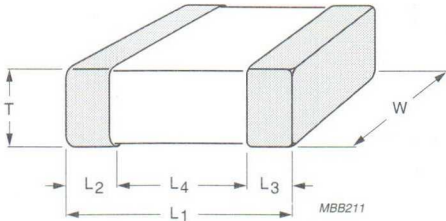


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic
multilayer capacitors

Class 2, X7R

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	0.51	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
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.80	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	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

Surface mounted ceramic multilayer capacitors

Class 2, X7R 16 V and 25 V general purpose series

SELECTION CHART FOR 16 V AND 25 V

C (nF)	LAST TWO DIGITS OF 12NC	16 V				25 V				
		0402	0603	0805	1206	0402	0603	0805	1206	1210
3.3	29									
3.9	31					0.5 ±0.05				
4.7	32									
5.6	33									
6.8	34									
8.2	35									
10	36	0.5 ±0.05								
12	37									
15	38						0.8 ±0.07			
18	39							0.6 ±0.1		
22	41									
27	42									
33	43									
39	44									
47	45		0.8 ±0.07							
56	46			0.6 ±0.1				0.85 ±0.1		
68	47									
82	48									
100	49								0.85 ±0.1	
120	51									
150	52			0.85 ±0.1						
180	53									0.5 to 1.0
220	54									
270	55				0.85 ±0.1				1.15 ±0.1	
330	56									
390	57			1.25 ±0.1						
470	58									0.9 to 1.3
560	59									
680	61				1.15 ±0.1	Values in shaded cells indicate thickness classification.				
820	62									
1000	63									

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"				
	PAPER	BLISTER	PAPER	BLISTER	0402	0603	0805
0.5 ±0.05	10000	—	50000	—	50000	—	—
0.6 ±0.1	4000	4000	20000	10000	—	—	10000
0.85 ±0.1	4000	4000	15000	10000	—	—	8000
0.5 to 1.0	—	4000	—	10000	—	—	—
0.8 ±0.07	4000	4000	15000	15000	—	15000	—
0.9 to 1.3	—	3000	—	10000	—	—	—
1.15 ±0.1	—	3000	—	10000	—	—	—
1.25 ±0.1	—	3000	—	10000	—	—	5000

Surface mounted ceramic
multilayer capacitors

Class 2, X7R 16 V and 25 V
general purpose series

ORDERING INFORMATION FOR 16 V AND 25 V

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

Clear text code

Example: 08052R104K8BB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402	2R = X7R	104 = 100000 pF; the third digit signifies the number of zeros	J $\pm 5\%$ K $\pm 10\%$ M $\pm 20\%$	7 = 16 V 8 = 25 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm; 7" paper	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic
0603						3 = 330 mm; 13" paper		
0805						B = 180 mm; 7" blister		
1206						F = 330 mm; 13" blister		
1210						P = bulk case		

Ordering code 12NC

2 2 X X X X X X 6 X X X

Carrier type

22 blister
38 paper
54 bulk

Rated voltage - Termination

78 16 V; Ni-barrier
91 25 V; Ni-barrier

Size

7 0402
6 0603
0 0805
1 1206
2 1210

Capacitance value⁽¹⁾

Tolerance

5 $\pm 5\%$
6 $\pm 10\%$
7 $\pm 20\%$

Packaging⁽²⁾

1 reel: $\varnothing$ 180 mm; 7"
5 reel: $\varnothing$ 330 mm; 13"
4 bulk case

CCA611

(1) Refer to Chapter "Selection chart for 16 V and 25 V".

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

1997 Jun 06

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Surface mounted ceramic multilayer capacitors

Class 2, X7R 50 V general purpose series

SELECTION CHART FOR 50 V

C (pF)	LAST TWO DIGITS OF 12NC	50 V						
		0402	0603	0805	1206	1210	1812	2220
100	01							
120	02							
150	03							
180	04							
220	05							
270	06							
330	07							
390	08							
470	09							
560	11	0.5 ±0.05						
680	12							
820	13							
1000	14							
1200	15		0.8 ±0.07					
1500	16							
1800	17			0.6 ±0.1				
2200	18							
2700	19							
3300	21							
3900	22							
4700	23							
5600	24							
6800	25				0.85 ±0.1			
8200	26							
10000	27							
12000	28							
15000	29							
18000	31							
22000	32					0.5 to 1.0		
27000	33							
33000	34							
39000	35			0.85 ±0.1				
47000	36						0.5 to 1.0	
56000	37							
68000	38							
82000	39			1.25 ±0.1				
100000	41							0.5 to 1.0
120000	42							
150000	43							
180000	44				1.15 ±0.1	0.9 to 1.3		
220000	45							
270000	46							
330000	47							
390000	48							
470000	49						0.9 to 1.3	
560000	51							
680000	52							
820000	53							
1000000	54							0.9 to 1.3

Values in shaded cells indicate thickness classification.

Surface mounted ceramic
multilayer capacitors

Class 2, X7R 50 V
general purpose series

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	4000	20000	10000	—	—	—	—	10000
0.85 ±0.1	4000	4000	15000	10000	—	—	—	—	8000
0.5 to 1.0	—	4000	—	10000	1500	1500	—	—	—
0.8 ±0.07	4000	4000	15000	15000	—	—	—	15000	—
0.9 to 1.3	—	3000	—	10000	1500	1500	—	—	—
1.15 ±0.1	—	3000	—	10000	—	—	—	—	—
1.25 ±0.1	—	3000	—	10000	—	—	—	—	5000
1.2 to 1.75	—	—	—	—	1200	—	—	—	—

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: 08052R104K9BB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402 0603 0805 1206 1210 1812 2220	2R = X7R	104 = 100000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	9 = 50 V	B = Ni-barrier A = AgPd (2220 only)	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

X

X

X

X

6

X

X

X

Carrier type

22 blister

38 paper

54 bulk

Rated voltage - Termination

58 50 V; Ni-barrier

59 50 V; AgPd (2220 only)

Size

7 0402

6 0603

0 0805

1 1206

2 1210

4 1812

5 2220

Capacitance value⁽¹⁾

Tolerance

5 ±5%

6 ±10%

7 ±20%

Packaging⁽²⁾

1 reel: Ø180 mm; 7"

5 reel: Ø330 mm; 13"

4 bulk case

CCA612

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

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

Surface mounted ceramic multilayer capacitors

Class 2, X7R 100 V, 200 V and 500 V general purpose series

SELECTION CHART FOR 100 V, 200 V AND 500 V

C (pF)	LAST TWO DIGITS OF 12NC	100 V				200 V				500 V		
		0805	1206	1210	1812	0805	1206	1210	1812	1206	1210	1812
180	13											
220	14											
270	15											
330	16											
390	17											
470	18											
560	19											
680	21											
820	22											
1000	23					0.85 ±0.1				1.15 ±0.1		
1200	24											
1500	25	0.6 ±0.1										
1800	26											
2200	27											
2700	28										0.9 to 1.3	
3300	29		0.85 ±0.1				0.85 ±0.1					
3900	31											
4700	32											
5600	33											
6800	34					1.25 ±0.1					1.2 to 1.75	0.9 to 1.3
8200	35							0.8 to 1.0				
10000	36											
12000	37											
15000	38			0.5 to 1.0								
18000	39	0.85 ±0.1							0.8 to 1.0			
22000	41				0.5 to 1.0		1.15 ±0.1					
27000	42											
33000	43											
39000	44											
47000	45							0.9 to 1.3				
56000	46											
68000	47											
82000	48		1.15 ±0.1									
100000	49								0.9 to 1.3			
120000	51			0.9 to 1.3								
150000	52											
180000	53											
220000	54											
270000	55				0.9 to 1.3	Values in shaded cells indicate thickness classification.						
330000	56											

Surface mounted ceramic multilayer capacitors

Class 2, X7R 100 V, 200 V and 500 V general purpose series

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	4000	20000	10000	—	10000
0.85 ±0.1	4000	4000	15000	10000	—	8000
0.8 to 1.0	—	4000	—	10000	—	—
0.5 to 1.0	—	4000	—	10000	1500	—
0.8 ±0.07	4000	4000	15000	15000	—	—
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	—	10000	—	—

ORDERING INFORMATION FOR 100 V, 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: 18122R103KBBB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0805 1206 1210 1812	2R = X7R	103 = 10000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	0 = 100 V B = 200 V D = 500 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

Carrier type 22 blister 38 paper 54 bulk Rated voltage - Termination 60 100 V; Ni-barrier 93 200 V; Ni-barrier 97 500 V; Ni-barrier Size 0 0805 1 1206 2 1210 4 1812		Capacitance value⁽¹⁾ Tolerance 5 ±5% 6 ±10% 7 ±20% Packaging⁽²⁾ 1 reel: Ø180 mm; 7" 5 reel: Ø330 mm; 13" 4 bulk case	
2 2 X X X X X X 6 X X X		CCA613	

(1) Refer to Chapter "Selection chart for 100 V, 200 V and 500 V".

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

Surface mounted ceramic multilayer capacitors

Class 2, X7R

ELECTRICAL CHARACTERISTICS

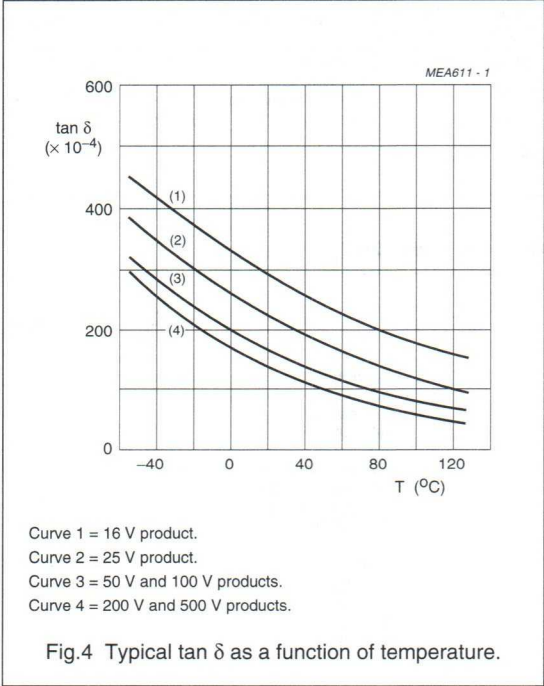
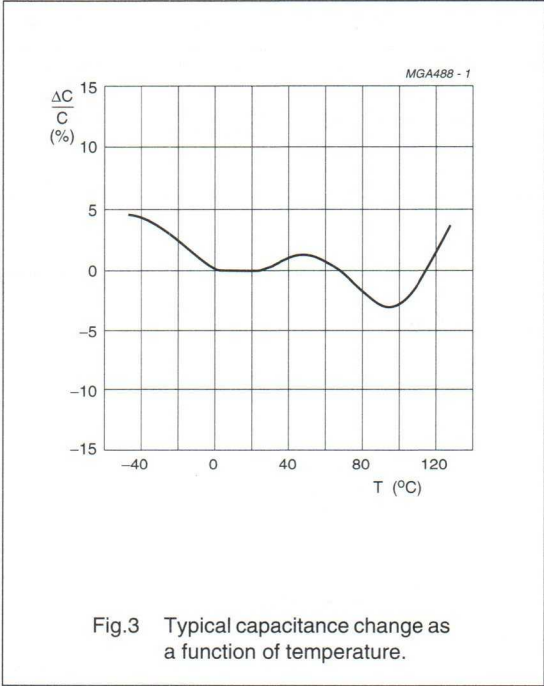
Class 2 capacitors; X7R dielectric; AgPd and NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	100 pF to 1 μF
Tolerance on capacitance after 1000 hours	$\pm 20\%$, $\pm 10\%$, $\pm 5\%$; note 2
Tan δ ; note 1	$\leq 2.5\%$; 16 V range $\leq 3.5\%$
Insulation resistance after 1 minute at U_R (DC): C $\leq 10 \text{ nF}$ C $> 10 \text{ nF}$	$R_{\text{ins}} > 100 \text{ G}\Omega$ $R_{\text{ins}} \times C > 1000 \text{ seconds}$
Maximum capacitance change as a function of temperature (for typical values see Fig.3)	$\pm 15\%$
Ageing	typical 1% per time decade

Notes

1. Measured at 1 V, 1 kHz, using a four-gauge method.
2. Tolerance of $\pm 1\%$ available on request.



Surface mounted ceramic multilayer capacitors

Class 2, X7R

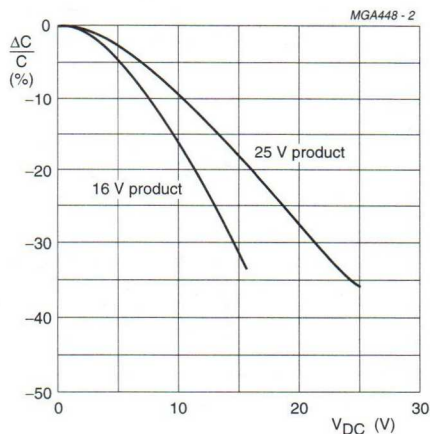


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

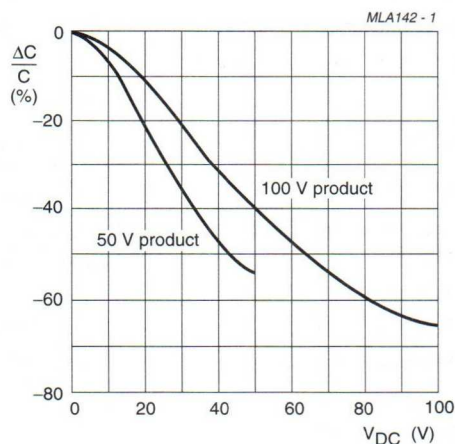


Fig.6 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

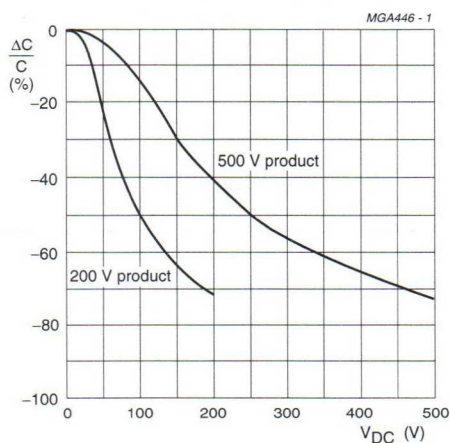


Fig.7 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

Surface mounted ceramic multilayer capacitors

Class 2, X7R 25 V and 50 V Base Metal Electrode

FEATURES

- Two standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case
- NiSn terminations.

APPLICATIONS

- Consumer electronics, for example:
 - Tuners
 - Television receivers
 - Video recorders
 - All types of cameras
- Telecommunications
- Automotive
- Data processing.

DESCRIPTION

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

The inner electrodes are connected to the two terminations by a copper-dipped layer and finally covered with a layer of plated nickel/tin (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	25 V and 50 V (IEC)
Capacitance range (E12 series):	
25 V	82 nF to 330 nF
50 V	10 nF to 150 nF
Tolerance on capacitance	$\pm 20\%$, $\pm 10\%$, $\pm 5\%$
Test voltage (DC) for 1 minute:	
25 V and 50 V	$2.5 \times U_R$
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

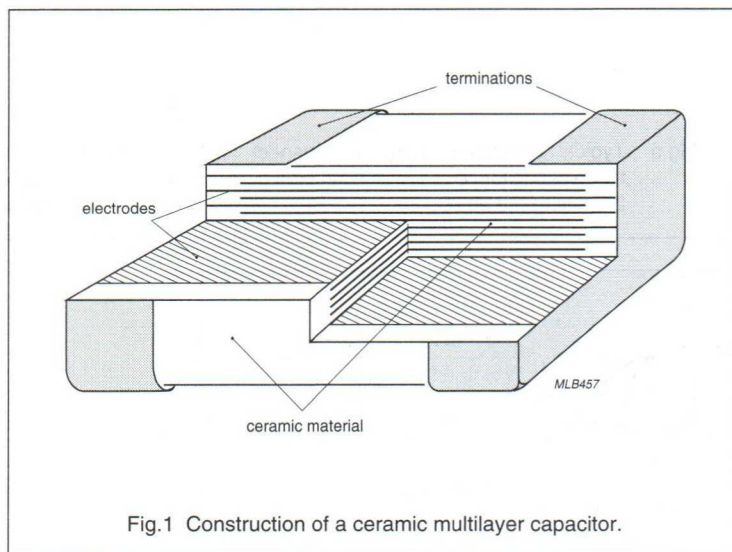
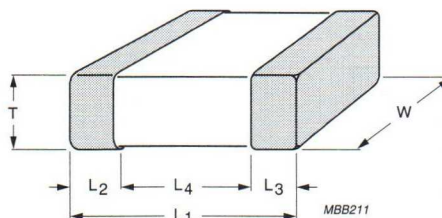


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic multilayer capacitors

Class 2, X7R 25 V and 50 V Base Metal Electrode

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							
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
Dimensions in inches							
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

Surface mounted ceramic multilayer capacitors

Class 2, X7R 25 V and 50 V Base Metal Electrode

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	25 V		50 V	
		0805	1206	0805	1206
10	36				
12	37				
15	38			0.6 ±0.1	
18	39				
22	41				
27	42				
33	43			0.85 ±0.1	
39	44				
47	45				
56	46			1.25 ±0.1	
68	47				0.85 ±0.1
82	48	0.85 ±0.1			
100	49				
120	51		Values in shaded cells indicate thickness classification.		1.15 ±0.1
150	52				
180	53		0.85 ±0.1		
220	54				
270	55		1.15 ±0.1		
330	56				

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"		
	PAPER	BLISTER	PAPER	BLISTER	0805
0.6 ±0.1	4000	4000	20000	10000	10000
0.85 0.1	4000	4000	15000	10000	8000
1.15 ±0.1	-	3000	-	10000	—
1.25 ±0.1	-	3000	-	10000	5000

Surface mounted ceramic
multilayer capacitors

Class 2, X7R 25 V and 50 V
Base Metal Electrode

ORDERING INFORMATION

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

Clear text code

Example: 12062R104K9B20D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0805 1206	2R = X7R	104 = 100000 pF; the third digit signifies the number of zeros	J $\pm 5\%$ K $\pm 10\%$ M $\pm 20\%$	8 = 25 V 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	D = BME

Ordering code 12NC

2 2 X X X X X X 5 X X X

Carrier type

22 blister
38 paper
54 bulk

Rated voltage - Termination

91 25 V; Ni-barrier
58 50 V; Ni-barrier

Size

0 0805
1 1206

Capacitance value⁽¹⁾

Tolerance

5 $\pm 5\%$
6 $\pm 10\%$
7 $\pm 20\%$

Packaging⁽²⁾

1 reel: $\varnothing$ 180 mm; 7"
5 reel: $\varnothing$ 330 mm; 13"
4 bulk case

CCA614

(1) Refer to Chapter "Selection chart".

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

**Surface mounted ceramic
multilayer capacitors**

**Class 2, X7R 25 V and 50 V
Base Metal Electrode**

ELECTRICAL CHARACTERISTICS**Class 2 capacitors; X7R 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	10 nF to 330 nF
Tolerance on capacitance after 1000 hours	$\pm 20\%$, $\pm 10\%$, $\pm 5\%$
Tan δ ; note 1	$\leq 2.5\%$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} \times C > 500$ seconds
Maximum capacitance change as a function of temperature; see Fig.3	$\pm 15\%$
Ageing	typical 1% per time decade

Note

1. Measured at 1 V, 1 kHz, using a four-gauge method.

Surface mounted ceramic multilayer capacitors

Class 2, X7R 25 V and 50 V Base Metal Electrode

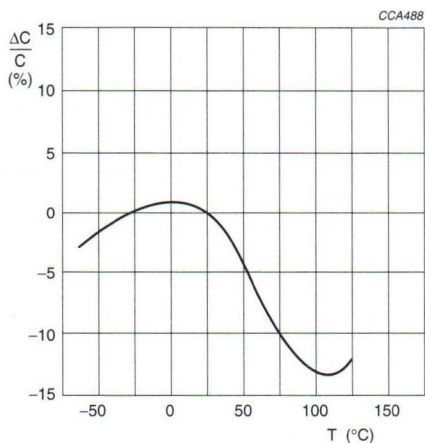
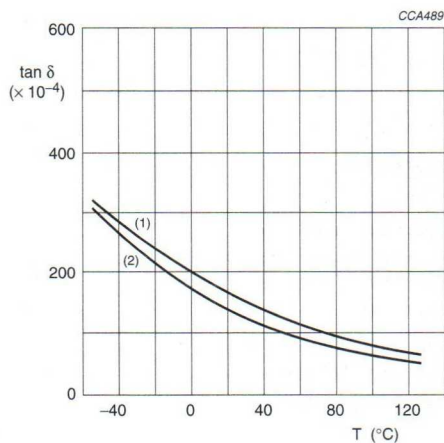


Fig.3 Typical capacitance change as a function of temperature.



Curve 1 = 25 V product.
Curve 2 = 50 V product.

Fig.4 Typical $\tan \delta$ as a function of temperature.

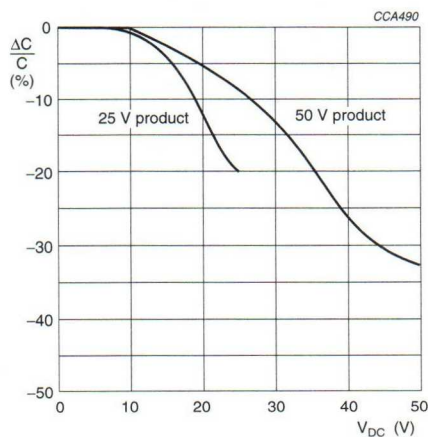


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

Surface mounted ceramic multilayer capacitors

Class 2, X7R 1 kV high voltage series

FEATURES

- Sizes 1808 and 1812
- High capacitance per unit volume
- Supplied in tape on reel
- NiSn terminations.

APPLICATIONS

These surface mounted high voltage capacitors were developed specifically for circuits requiring voltage up to 1 kV. Typical applications are:

- Inverter circuits for the backlights of liquid crystal displays
- Snubber circuits of power supplies
- Voltage multiplier circuits and circuits where surge protection is required.

Due to high voltage across the terminations, circuit applications of 1 kV or higher may need a coating on the surface to prevent external arcing. This is especially true under humid conditions.

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, 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)	1 kV (IEC)
Capacitance range (E12 series); note 1	1 nF to 10 nF
Tolerance on capacitance at $T_{amb} = 20\text{ }^{\circ}\text{C}$	$\pm 20\%$, $\pm 10\%$, $\pm 5\%$; note 2
Test voltage (DC) for 1 minute	$1.5 \times U_R$
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

Notes

1. Other values are available on request.
2. Special tolerance on capacitance is available on request.

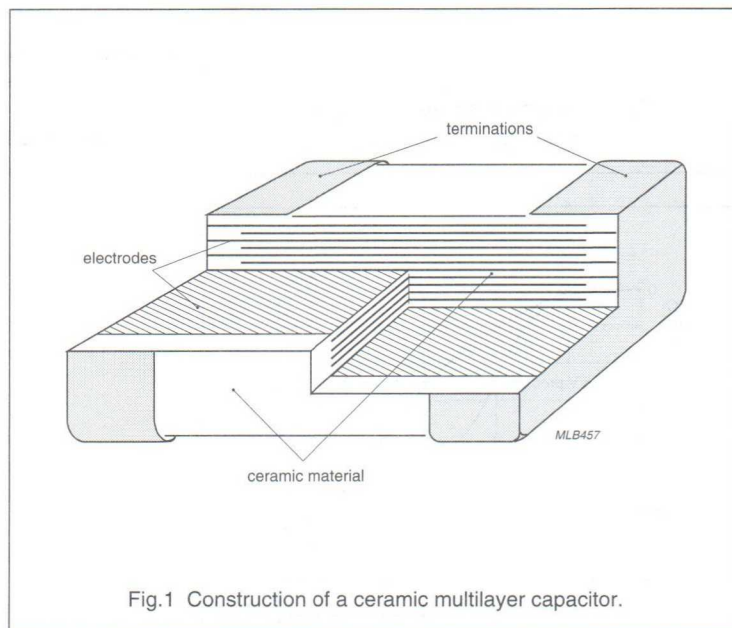
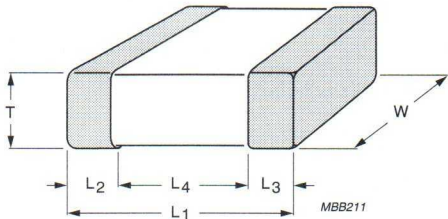


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic
multilayer capacitors

Class 2, X7R 1 kV
high voltage series

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T MAX.	L ₂ and L ₃ MAX.	L ₄ MIN.
Dimensions in millimetres					
1808	4.5 ±0.20	2.0 ±0.20	2.0	0.75	2.20
1812	4.5 ±0.20	3.2 ±0.20	2.5	0.75	2.20
Dimensions in inches					
1808	0.177 ±0.008	0.079 ±0.008	0.028	0.030	0.088
1812	0.177 ±0.008	0.126 ±0.008	0.072	0.030	0.088

Surface mounted ceramic
multilayer capacitors

Class 2, X7R 1 kV
high voltage series

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	1 kV	
		1808	1812
1.0	23		
1.2	24		
1.5	25		
1.8	26	1.2 to 1.75	
2.2	27		
2.7	28		1.2 to 1.75
3.3	29		
3.9	31		
4.7	32		
5.6	33		
6.8	34		
8.2	35		
10	36		

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	12 mm TAPE WIDTH AMOUNT PER REEL	
	Ø180 mm; 7" BLISTER	
	1808	1812
1.2 to 1.75	1000	1000

ORDERING INFORMATION

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

Clear text code

Example: 18082R102KEBB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
1808 1812	2R = X7R	102 = 1000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	E = 1 kV	B = Ni-barrier	B = 180 mm; 7" blister	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

2 2 X X 0 0 X X 6 X X X

Carrier type

50 blister

56 bulk

Size

3 1808

4 1812

Packaging⁽²⁾

1 reel: Ø180 mm; 7" reel

12 mm blister tape

Capacitance value⁽¹⁾

Tolerance

5 ±5%

6 ±10%

7 ±20%

CCA685

(1) Refer to Chapter "Selection chart".

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

Surface mounted ceramic
multilayer capacitors

Class 2, X7R 1 kV
high voltage series

ELECTRICAL CHARACTERISTICS

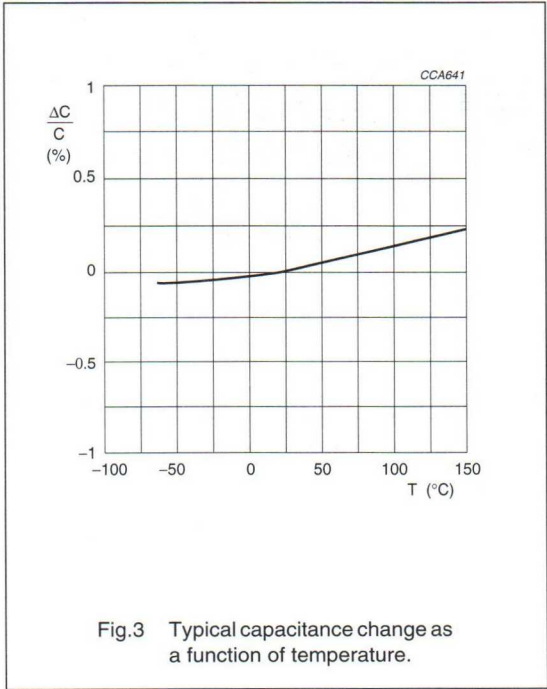
Class 2 capacitors; X7R dielectric; NiSn terminations

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	1 nF to 10 nF
Tolerance on capacitance	±20%, ±10%, ±5%; note 2
Tan δ; note 1	≤2.5%
Insulation resistance after 1 minute at U _R (DC): C ≤ 10 nF C > 10 nF	R _{ins} > 100 GΩ R _{ins} × C > 1000 seconds
Typical capacitance change as a function of temperature; see Fig.3	±15%
Ageing	typical 1% per time decade

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. Special tolerance available on request.



Surface mounted ceramic
multilayer capacitors

Class 2, Y5V 16 V, 25 V and 50 V
Base Metal Electrode

FEATURES

- Four standard sizes
- High capacitance per unit volume
- Supplied in tape on reel
- Nickel-barrier end terminations.

APPLICATIONS

Consumer electronics, for example:

- Tuners
- Television receivers
- Video recorders
- All types of cameras.

DESCRIPTION

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

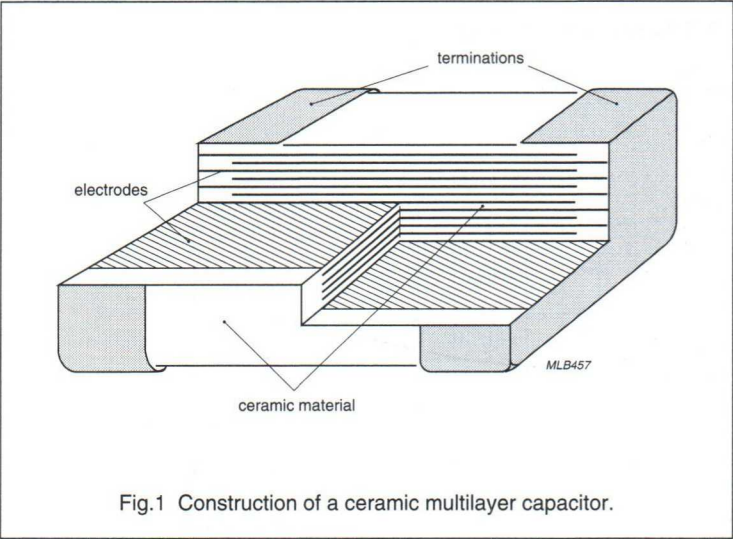
The inner electrodes are connected to the two terminations and finally covered with a layer of plated tin (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	16 V, 25 V, 50 V
Capacitance range (E6 series)	10 nF to 2.2 μ F; note 1
Tolerance on capacitance after 1000 hours	$\pm 20\%$ (M); -20% to $+80\%$ (Z)
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
End terminations	NiSn
Climatic category (IEC 68)	25/085/56

Note

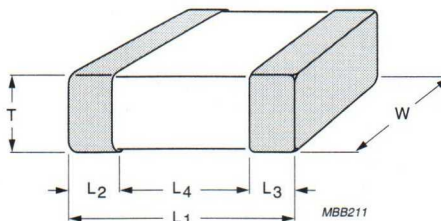
1. Measured at 25 °C, 1 V and 1 kHz, using a four-gauge method.



Surface mounted ceramic multilayer capacitors

Class 2, Y5V 16 V, 25 V and 50 V Base Metal Electrode

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	0.50 ±0.05	0.45	0.55	0.15	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
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

Surface mounted ceramic multilayer capacitors

Class 2, Y5V 16 V, 25 V and 50 V Base Metal Electrode

SELECTION CHART FOR 16 V AND 25 V

C (nF)	LAST TWO DIGITS OF 12NC	16 V				25 V			
		0402	0603	0805	1206	0603	0805	1206	
10	36								
15	38								
22	41								
33	43	0.5 ±0.05				0.8 ±0.07	0.6 ±0.1	0.6 ±0.1	
47	45								
68	47								
100	49								
150	52		Values in shaded cells indicate thickness classification.				0.85 ±0.1		
220	54								
330	56		0.8 ±0.07						
470	58			0.85 ±0.1				0.85 ±0.1	
680	61								
1000	63			1.25 ±0.1	0.85 ±0.1			1.15 ±0.1	
1500	65								
2200	67				1.15 ±0.1				

SELECTION CHART FOR 50 V

C (nF)	LAST TWO DIGITS OF 12NC	50 V		
		0603	0805	1206
10	05			
15	06			
22	07			
33	08	0.8 ±0.07	0.6 ±0.1	0.6 ±0.1
47	09			
68	11			
100	12			
150	13		0.85 ±0.1	
220	14			
330	15		1.25 ±0.1	
470	16			0.85 ±0.1
680	17	Values in shaded cells indicate thickness classification.		1.15 ±0.1
1000	18			

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	—	10000
0.6 ±0.1	4000	4000	10000	10000	—	—	10000
0.85 ±0.1	4000	4000	10000	10000	—	—	8000
0.8 ±0.07	4000	4000	15000	15000	—	15000	—
1.25 ±0.1	—	3000	—	10000	—	—	5000
1.15 ±0.1	—	3000	—	10000	—	—	—

Surface mounted ceramic
multilayer capacitors

Class 2, Y5V 16 V, 25 V and 50 V
Base Metal Electrode

ORDERING INFORMATION

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

Clear text code

Example: 12062F105M8BB0D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402	2F = Y5V	105 = 1000000 pF; the third digit signifies the number of zeros	M $\pm$ 20% Z -20%/+80%	7 = 16 V	B = Ni-barrier	2 = 180 mm; 7" paper	0 = no marking 2 = 2-character marking in North America only	D = BME
0603				8 = 25 V		3 = 330 mm; 13" paper		
0805				9 = 50 V		B = 180 mm; 7" blister		
1206						F = 330 mm; 13" blister P = bulk case		

Ordering code 12NC

2 2 X X X X X X 9 X X X

Carrier type

22 blister
38 paper
54 bulk

Rated voltage - Termination

78 16 V; Ni-barrier
91 25 V; Ni-barrier
58 50 V; Ni-barrier

Size

7 0402
6 0603
0 0805
1 1206

Capacitance value⁽¹⁾

Tolerance

7 $\pm$ 20%
8 -20/+80%

Packaging⁽²⁾

1 reel: $\varnothing$ 180 mm; 7"
8 reel: $\varnothing$ 330 mm; 13"
4 bulk case

CCA620

(1) Refer to Chapters "Selection chart for 16 V and 25 V" and "Selection chart for 50 V".

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

Surface mounted ceramic multilayer capacitors

Class 2, Y5V 16 V, 25 V and 50 V Base Metal Electrode

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; Y5V base metal electrode dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 25 ± 1 °C, an atmospheric pressure of 86 to 105 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1	100 to 1000 nF
Tolerance on capacitance after 1000 hours	-20% (M); -20% to +80% (Z)
Tan δ ; note 1: all types (except 1206 and 1 μ F; 0603 and 100 nF) sizes 1206 and 1 μ F; 0603 and 100 nF	$\leq 5\%$ $\leq 7\%$
Insulation resistance after 1 minute at U_R (DC)	$I_R \times C > 100$ seconds
Maximum capacitance change with respect to capacitance at 25 °C (for typical values see Fig.5)	+22% to -82%
Ageing	typical 7% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

1. Measured at 25 °C, 1 V and 1 kHz, using a four-gauge method.

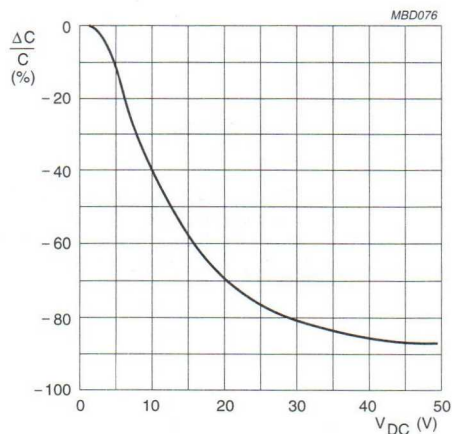
Surface mounted ceramic
multilayer capacitorsClass 2, Y5V 16 V, 25 V and 50 V
Base Metal Electrode

Fig.3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 25 °C.

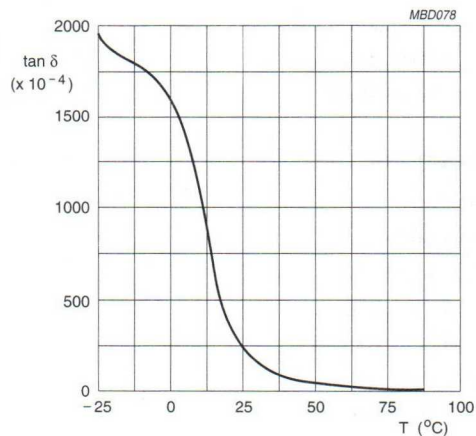


Fig.4 Typical $\tan \delta$ as a function of temperature.

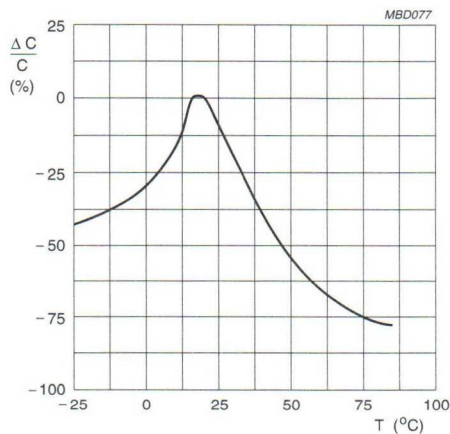


Fig.5 Typical capacitance change as a function of temperature.

Surface mounted ceramic multilayer capacitors

Class 2, Z5U 50 V Base Metal Electrode

FEATURES

- Two standard sizes
- For high frequency applications
- Supplied in tape on reel
- Nickel-barrier end terminations.

APPLICATIONS

- Tuners
- Television receivers
- Video recorders
- All types of cameras
- Telecommunications
- Automotive
- Data processing.

DESCRIPTION

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

The inner electrodes are connected to the two terminations and finally covered with a layer of plated tin (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V
Capacitance range (E12 series)	10 nF to 330 nF
Tolerance on capacitance after 1000 hours	$\pm 20\%$ (M); -20% to $+80\%$ (Z)
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)	10/085/21

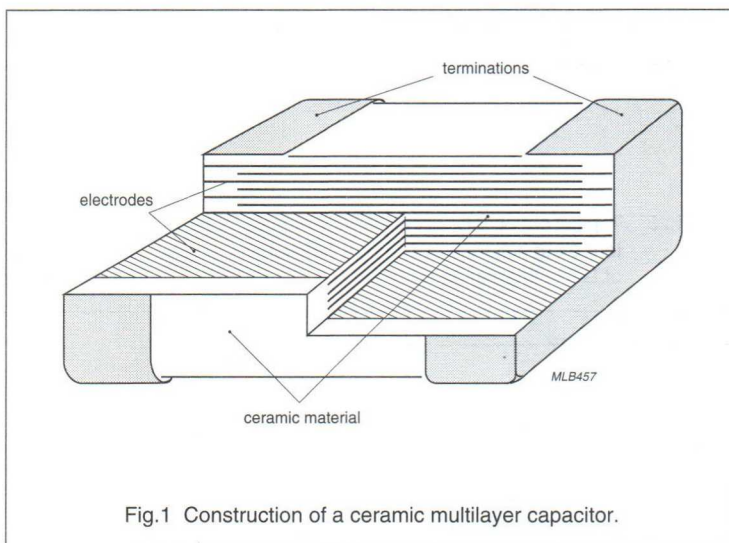
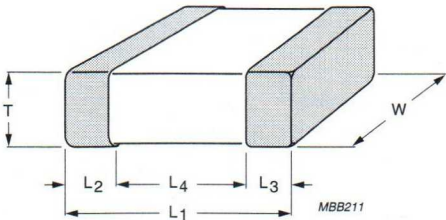


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic
multilayer capacitors

Class 2, Z5U 50 V
Base Metal Electrode

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							
0805	2.0 ±0.1	1.25 ±0.1	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
Dimensions in inches							
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

Surface mounted ceramic multilayer capacitors

Class 2, Z5U 50 V Base Metal Electrode

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	50 V	
		0805	1206
10	36		
12	37		
15	38		
18	39		
22	41		
27	42		
33	43	0.60 ±0.1	
39	44		
47	45		
56	46		0.85 ±0.1
68	47		
82	48		
100	49		
120	51		
150	52		
180	53		
220	54		
270	55		
330	56		

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"	0805
	PAPER	PAPER	
0.60 ±0.1	4000	10000	10000
0.85 ±0.1	4000	10000	10000

Surface mounted ceramic
multilayer capacitors

Class 2, Z5U 50 V
Base Metal Electrode

ORDERING INFORMATION

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

Clear text code

Example: 12062E104Z9B20D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0805 1206	2E = Z5U	104 = 100000 pF; the third digit signifies the number of zeros	M ±20% Z -20%/+80%	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	D = BME

Ordering code 12NC

2 2 X X 6 2 X X 9 X X X

Carrier type

22 blister
38 paper
54 bulk

Capacitance value⁽¹⁾

Tolerance

7 ±20%
8 -20%/+80%

Size

0 0805
1 1206

Packaging⁽²⁾

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

CCA621

(1) Refer to Chapter "Selection chart".

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

Surface mounted ceramic multilayer capacitors

Class 2, Z5U 50 V Base Metal Electrode

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; Z5U base metal electrode dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 25 ± 1 °C, an atmospheric pressure of 86 to 105 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	10 nF to 330 nF
Tolerance on capacitance after 1000 hours	$\pm 20\%$ (M); -20% to $+80\%$ (Z)
Tan δ ; note 1	$\leq 4\%$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 10\,000\,000 \Omega$ or $R_{ins} \times C > 1\,000$ seconds, whichever is smaller
Maximum capacitance change with respect to capacitance at 25 °C (for typical values see Fig.5)	$+22\%$ to -56% at 10 to 85 °C
Ageing	typical 3% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

1. Measured at 25 °C, 0.5 V_{rms} and 1 kHz, using a four-gauge method.

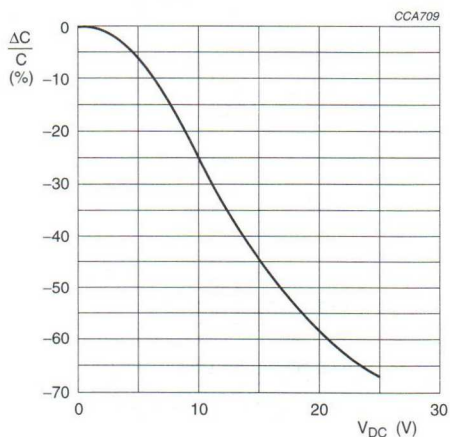
Surface mounted ceramic
multilayer capacitorsClass 2, Z5U 50 V
Base Metal Electrode

Fig.3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 25 °C.

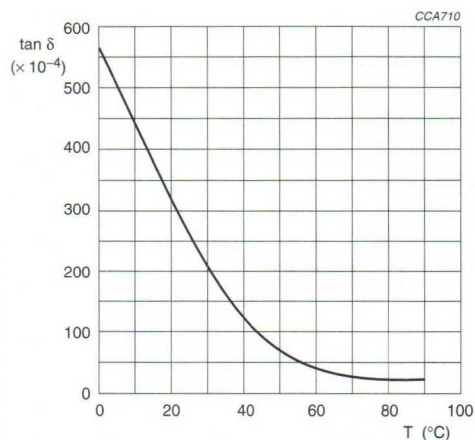


Fig.4 Typical $\tan \delta$ as a function of temperature.

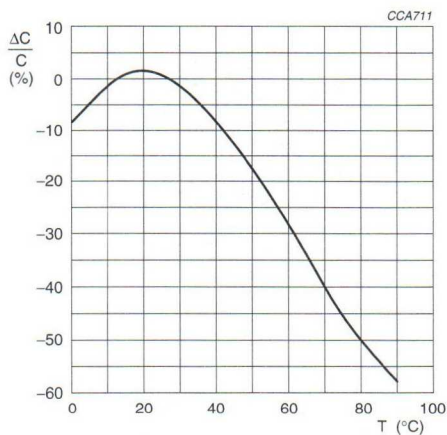


Fig.5 Typical capacitance change as a function of temperature.

Surface mounted ceramic multilayer capacitors

Compact series

FEATURES

- Seven standard sizes
- Dense dielectric layers
- Maximum capacitance per unit volume
- Supplied in tape on reel.

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

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 (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC):	
NP0 dielectric	25 V, 50 V and 63 V (IEC)
X7R dielectric	10 V, 16 V, 25 V and 63 V (IEC)
Capacitance range (E12 series):	
class 1, NP0 dielectric	270 pF to 100000 pF
class 2, X7R dielectric	12 nF to 4.7 μ F
Tolerance on capacitance:	
class 1, NP0 dielectric	$\pm 10\%$, $\pm 5\%$ and $\pm 2\%$; note 1
class 2, X7R dielectric	$\pm 20\%$, $\pm 10\%$ and $\pm 5\%$
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):	
class 1, NP0 dielectric	55/125/56
class 2, X7R dielectric	55/125/56

Note

1. Capacitors with a tolerance of $\pm 1\%$ are available on request.

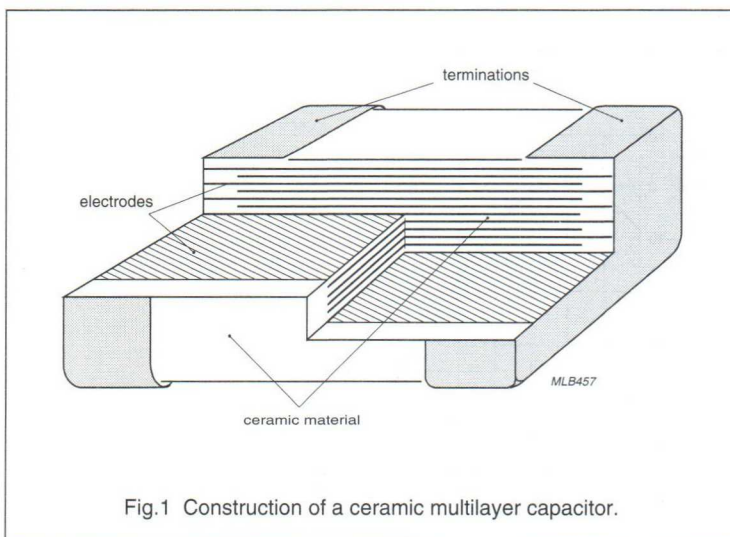
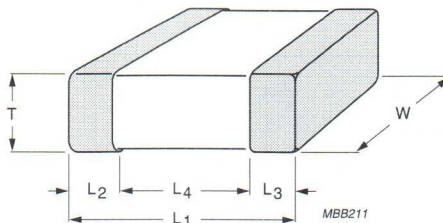


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic multilayer capacitors

Compact series

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	0.51	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
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.80	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	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

Surface mounted ceramic multilayer capacitors

Class 1, NP0 25 V, 50 V and 63 V compact series

SELECTION CHART FOR NP0

C (pF)	LAST TWO DIGITS OF 12NC	25 V	50 V AND 63 V					
		0402	0603	0805	1206	1210	1812	2220
150	38							
180	39							
220	41							
270	42	0.5 ±0.05						
330	43							
390	44							
470	45		0.8 ±0.07					
560	46							
680	47			0.6 ±0.1				
820	48							
1000	49							
1200	51							
1500	52							
1800	53			0.85 ±0.1				
2200	54				0.6 ±0.1			
2700	55							
3300	56							
3900	57					0.6 ±0.1		
4700	58			1.25 ±0.1	0.85 ±0.1			
5600	59							
6800	61					0.85 ±0.1	0.6 ±0.1	
8200	62							
10000	63					0.9 to 1.3		
12000	64				0.9 to 1.3			
15000	65					1.2 to 1.75	0.85 ±0.1	
18000	66					1.6 to 2.2		0.85 ±0.1
22000	67						0.9 to 1.3	
27000	68						1.2 to 1.75	
33000	69							
39000	71							0.9 to 1.3
47000	72							
56000	73							1.2 to 1.75
68000	74							
82000	75							
100000	76							1.6 to 2.2
Values in shaded cells indicate thickness classification.								

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
0.6 ±0.1	4000	4000	10000	10000	2000	—	—	—	10000
0.5 ±0.05	10000	—	50000	—	—	—	50000	—	—
0.85 ±0.1	4000	4000	10000	10000	—	—	—	—	8000
0.8 ±0.07	4000	4000	15000	15000	—	—	—	15000	—
0.9 to 1.3	—	3000	—	8000	15000	15000	—	—	—
1.25 ±0.1	—	3000	—	8000	—	—	—	—	5000
1.2 to 1.75	—	2500	—	7000	1000	1000	—	—	—
1.6 to 2.2	—	—	—	—	1000	1000	—	—	—

Surface mounted ceramic
multilayer capacitors

Class 1, NP0 25 V, 50 V and 63 V
compact series

ORDERING INFORMATION FOR NP0

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

Clear text code

EXAMPLE: 0603CG102G9B20C

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	F ±1%	8 = 25 V	B = Ni-barrier	2 = 180 mm; 7" paper	0 = no marking	C = compact
0603			G ±2%	9 = 50 V/63 V	A = AgPd (1812 and 2220 only)	3 = 330 mm; 13" paper	2 = 2-character marking in North America only	
0805			J ±5%			B = 180 mm; 7" blister		
1206			K ±10%			F = 330 mm; 13" blister		
1210						P = bulk case		
1812 (AgPd only)								
2220 (AgPd only)								

Ordering code 12NC

2 2 X X X X X X 0 X X X

Carrier type

22 blister

38 paper

54 bulk

Rated voltage - Termination

87 25 V; Ni-barrier

89 50 V; 63 V; Ni-barrier

90 50 V; 63 V; AgPd⁽²⁾

Size

7 0402

6 0603

0 0805

1 1206

2 1210

4 1812⁽²⁾

5 2220⁽²⁾

Capacitance value⁽¹⁾

Tolerance

3 ±1%

4 ±2%

5 ±5%

6 ±10%

Packaging⁽³⁾

1 reel: Ø180 mm; 7"

8 reel: Ø330 mm; 13"

4 bulk case

CCA619

(1) Refer to Chapter "Selection chart for NP0".

(2) AgPd for case sizes 1812 and 2220 only.

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

Surface mounted ceramic multilayer capacitors

Class 2, X7R 10 V, 16 V and 25 V compact series

SELECTION CHART FOR X7R 10 V, 16 V AND 25 V

C (nF)	LAST TWO DIGITS OF 12NC	10 V	16 V				25 V				
		0805	0402	0805	1206	1812	0805	1206	1210	1812	2220
12	37										
15	38		0.5 ±0.05								
18	39										
22	41										
27	42										
33	43										
39	44						0.6 ±0.1				
47	45										
56	46										
68	47						0.85 ±0.1				
82	48										
100	49						1.25 ±0.1	0.6 ±0.1			
120	51										
150	52			0.85 ±0.1							
180	53										
220	54			1.25 ±0.1				0.85 ±0.1	0.6 ±0.1		
270	55										
330	56							0.9 to 1.3			
390	57								0.85 ±0.1		
470	58				0.85 ±0.1			1.2 to 1.75			
560	59								0.9 to 1.3		
680	61										
820	62								1.2 to 1.75		
1000	63	1.25 ±0.1			0.9 to 1.3			1.6 to 2.2	0.9 to 1.3		
1200	64										
1500	65				1.2 to 1.75						
1800	66									1.2 to 1.75	
2200	67										0.9 to 1.3
2700	68										1.2 to 1.75
3300	69					1.6 to 2.2					
3900	71										1.6 to 2.2
4700	72										

Values in shaded cells indicate thickness classification.

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
0.6 ±0.1	4000	4000	10000	10000	2000	—	—	—	10000
0.5 ±0.05	10000	—	50000	—	—	—	15000	—	—
0.85 ±0.1	4000	4000	10000	10000	—	—	—	—	8000
0.9 to 1.3	—	3000	—	8000	15000	15000	—	—	—
1.25 ±0.1	—	3000	—	8000	—	—	—	—	5000
1.2 to 1.75	—	2500	—	7000	1000	1000	—	—	—
1.6 to 2.2	—	—	—	—	1000	1000	—	—	—

Surface mounted ceramic multilayer capacitors

Class 2, X7R 10 V, 16 V and 25 V compact series

ORDERING INFORMATION FOR X7R 10 V, 16 V AND 25 V

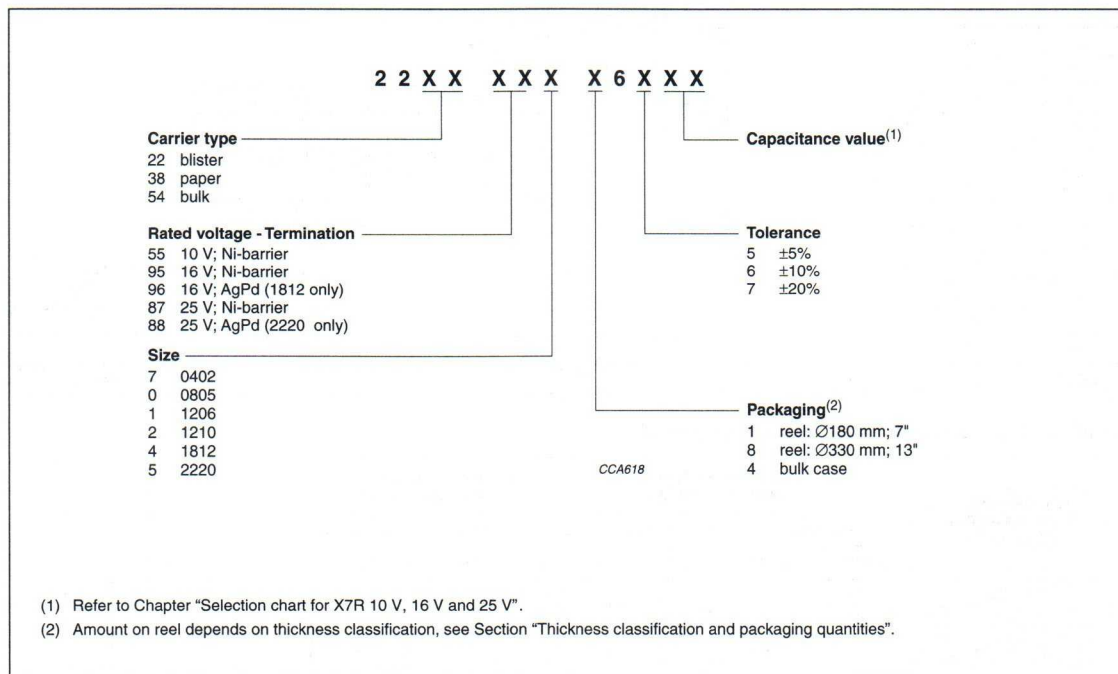
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 12062R104K8BB0C

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402	2R = X7R	104 = 100 000 pF; the third digit signifies the number of zeros	J $\pm 5\%$ K $\pm 10\%$ M $\pm 20\%$	6 = 10 V	B = Ni-barrier	2 = 180 mm; 7" paper	0 = no marking 2 = 2-character marking in North America only	C = compact
0805				7 = 16 V	A = AgPd (2220 only)	3 = 330 mm; 13" paper		
1206				8 = 25 V		B = 180 mm; 7" blister		
1210						F = 330 mm; 13" blister		
1812						P = bulk case		
2220 (AgPd only)								

Ordering code 12NC



Surface mounted ceramic multilayer capacitors

Class 2, X7R 50 V and 63 V compact series

SELECTION CHART FOR X7R 50 V AND 63 V

C (nF)	LAST TWO DIGITS OF 12NC	50 V AND 63 V				
		0805	1206	1210	1812	2220
12	37					
15	38					
18	39					
22	41					
27	42					
33	43					
39	44					
47	45	0.85 ±0.1				
56	46					
68	47	1.25 ±0.1				
82	48					
100	49		0.6 ±0.1			
120	51		0.85 ±0.1			
150	52					
180	53		0.9 to 1.3			
220	54			0.85 ±0.1		
270	55		1.2 to 1.75			
330	56			0.9 to 1.3	0.6 ±0.1	
390	57					
470	58			1.2 to 1.75	0.85 ±0.1	
560	59					
680	61				0.9 to 1.3	
820	62					
1000	63				1.2 to 1.75	0.9 to 1.3
1200	64					
1500	65					1.2 to 1.75
1800	66					
2200	67					1.6 to 2.2

Values in shaded cells indicate thickness classification.

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
0.6 ±0.1	4000	4000	10000	10000	2000	—	—	—	10000
0.85 ±0.1	4000	4000	10000	10000	—	—	—	—	8000
0.9 to 1.3	—	3000	—	8000	15000	15000	—	—	—
1.25 ±0.1	—	3000	—	8000	—	—	—	—	5000
1.2 to 1.75	—	2500	—	7000	1000	1000	—	—	—
1.6 to 2.2	—	—	—	—	1000	1000	—	—	—

Surface mounted ceramic
multilayer capacitors

Class 2, X7R 50 V and 63 V
compact series

ORDERING INFORMATION FOR X7R 50 V AND 63 V

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

Clear text code

EXAMPLE: 18122R105K9BB0C

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATIO N	PACKAGING	MARKING	SERIES
0805 1206 1210 1812 2220 (AgPd only)	2R = X7R	105 = 1000000 p.; the third digit signifies the number of zeros	J $\pm 5\%$ K $\pm 10\%$ M $\pm 20\%$	9 = 50 V/63 V	B = Ni-barrier A = AgPd (2220 only)	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	C = compact

Ordering code 12NC

2

2

X

X

X

X

X

X

6

X

X

X

Carrier type

22 blister

38 paper

54 bulk

Rated voltage - Termination

89 50 V; 63 V; Ni-barrier

90 50 V; 63 V; AgPd (2220 only)

Size

0 0805

1 1206

2 1210

4 1812

5 2220

Capacitance value⁽¹⁾

Tolerance

5 $\pm 5\%$

6 $\pm 10\%$

7 $\pm 20\%$

Packaging⁽²⁾

1 reel: $\varnothing$ 180 mm; 7"

8 reel: $\varnothing$ 330 mm; 13"

4 bulk case

CCA617

(1) Refer to Chapter "Selection chart for X7R 50 V and 63 V".

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

Surface mounted ceramic multilayer capacitors

Class 1, NP0 25 V, 50 V and 63 V compact series

ELECTRICAL CHARACTERISTICS FOR CLASS 1, CAPACITORS

Class 1 capacitors; NP0 dielectric; NiSn and AgPd 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%.

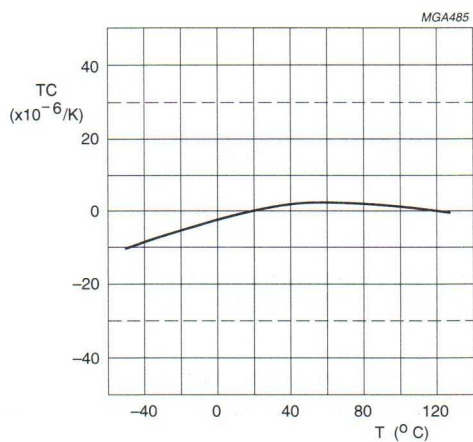
DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	270 pF to 100000 pF
Tolerance on capacitance after 1000 hours	$\pm 10\%$, $\pm 5\%$ and $\pm 2\%$; note 2
Tan δ ; note 1	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$> 100000 \text{ M}\Omega$
Temperature coefficient	$(0 \pm 30) \times 10^{-6}/\text{K}$

Notes

1. Measured at 1 V, 1 MHz for $C \leq 1000 \text{ pF}$ and at 1 V, 1 kHz for $C > 1000 \text{ pF}$, using a four-gauge method.
2. Capacitors with a tolerance of $\pm 1\%$ are available on request.

Surface mounted ceramic multilayer capacitors

Class 1, NP0 25 V, 50 V and 63 V compact series



Typical values (solid line).
Requirement levels (broken lines).

Fig.3 Typical temperature coefficient as a function of temperature for NP0 dielectric.

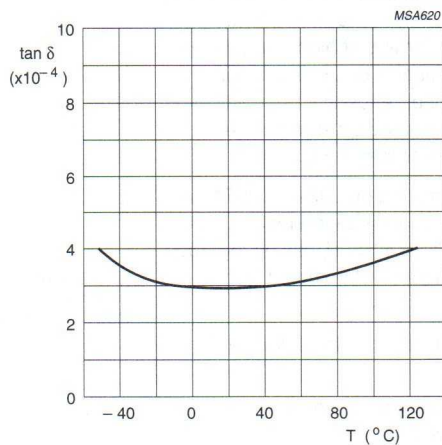


Fig.4 Typical $\tan \delta$ as a function of temperature for NP0 dielectric.

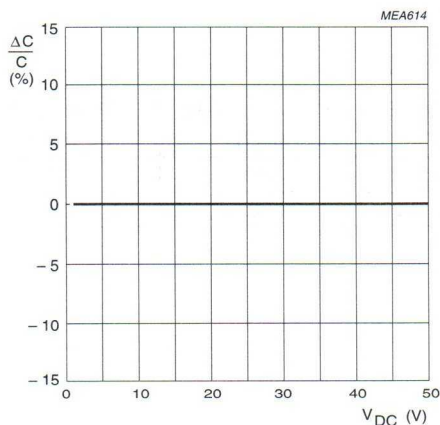


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage for NP0 dielectric.

Surface mounted ceramic multilayer capacitors

Class 1, NP0 25 V, 50 V and 63 V compact series

HIGH FREQUENCY BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

Ceramic multilayer capacitors (CMC) from the high voltage series 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.6.

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:

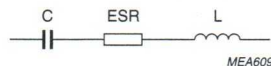
- Independent of the dielectric material.
- Dependent on the size of the capacitor, it increases with increasing length and decreases with increasing width or thickness of the product.
- The value of L is approximately:
 - 0.6 nH for case size 603
 - 1 nH for case sizes 0805, 1206 and 1210
 - 1.5 nH for case sizes 1812 and 2220.

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.



C = capacitance.

ESR = equivalent series resistance which is determined by the energy dissipation mechanisms (in the dielectric material as well as in the electrodes).

L = equivalent series self-inductance.

Fig.6 Equivalent series representation of a CMC.

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

Table 2 shows maximum Equivalent Series Resistance (ESR) for case sizes 0805 and 1206 at frequencies of 50 MHz and 100 MHz. The measurements were taken using equipment type HP4191A.

Table 2 Maximum ESR for NP0

CASE SIZE	CAPACITANCE (pF)	ESR at 50 MHz (mΩ)	ESR at 100 MHz (mΩ)
0805	470 < C ≤ 2200	80	150
1206	2200 < C ≤ 8200	80	150

**Surface mounted ceramic
multilayer capacitors****Class 2, X7R 10 V, 16 V, 25 V, 50 V and 63 V
compact series****ELECTRICAL CHARACTERISTICS FOR CLASS 2, CAPACITORS****Class 2 capacitors; X7R dielectric; NiSn and AgPd 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	12 nF to 4.7 μ F
Tolerance on capacitance after 1000 hours	$\pm 20\%$, $\pm 10\%$ and $\pm 5\%$
Tan δ ; note 1	$\leq 2.5\%$
Insulation resistance after 1 minute at U_R (DC): C $\leq$ 10 nF C $>$ 10 nF	$R_{ins} > 100000 \text{ M}\Omega$ $R_{ins} \times C > 1000 \text{ seconds}$
Maximum capacitance change as a function of temperature (for typical values see Fig.9)	$\pm 15\%$

Note

1. Measured at 1 V, 1 kHz, using a four-gauge method.

Surface mounted ceramic multilayer capacitors

Class 2, X7R 10 V, 16 V, 25 V, 50 V and 63 V compact series

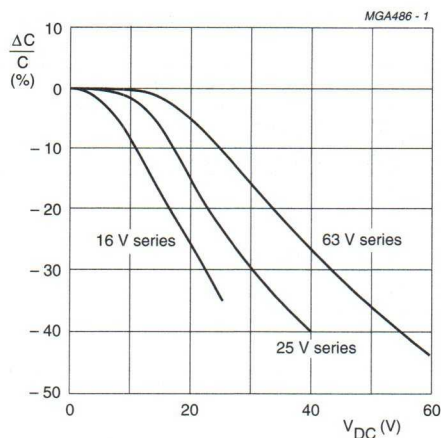


Fig.7 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage for X7R dielectric.

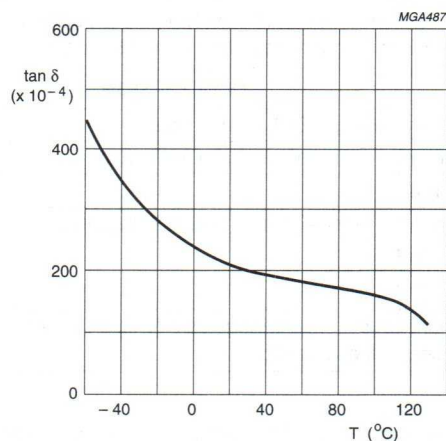
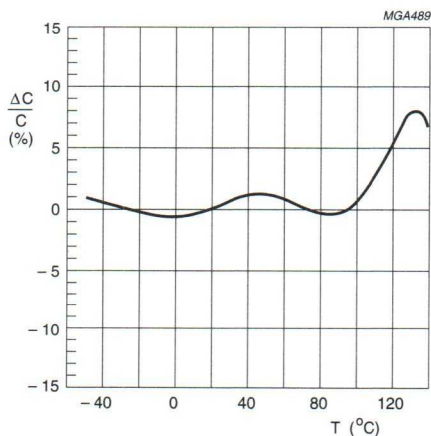
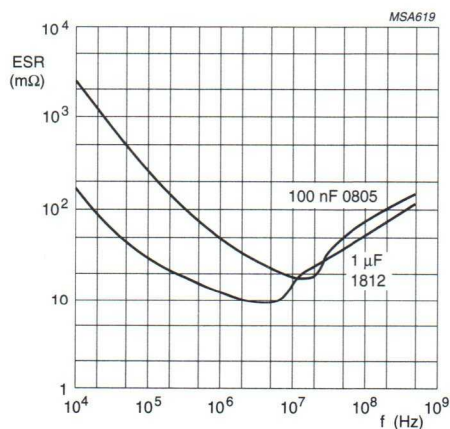


Fig.8 Typical $\tan \delta$ as a function of temperature for X7R dielectric.



$U_{DC} = 0 \text{ V}$.

Fig.9 Typical capacitance change as a function of temperature for X7R dielectric.



Measuring equipment HP4191A and HP4194A.

Fig.10 Typical equivalent series resistance (ESR) as a function of frequency for X7R dielectric.

**Surface mounted ceramic
multilayer capacitors**

C-Array: Class 1, NP0 50/63 V
C-Array: Class 2, X7R 16/25 V

FEATURES

- 4 × capacitors (of the same capacitance value) per array
- Less than 50% board space of an equivalent discrete component
- High volumetric efficiency
- Dense dielectric layers
- Supplied in tape on reel or loose in bag
- Increased throughput, by time saved in mounting
- Cost savings on manufacturing time.

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

DESCRIPTION

Each capacitor element 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 (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC): NP0 dielectric X7R dielectric	50 V and 63 V (IEC) 16 V and 25 V (IEC)
Capacitance range (E12 series): class 1, NP0 dielectric class 2, X7R dielectric: 16 V 25 V	22 pF to 1 nF 1 nF to 150 nF 1 nF to 68 nF
Tolerance on capacitance: NP0 dielectric X7R dielectric	±5%, ±10% ±10%, ±20%
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

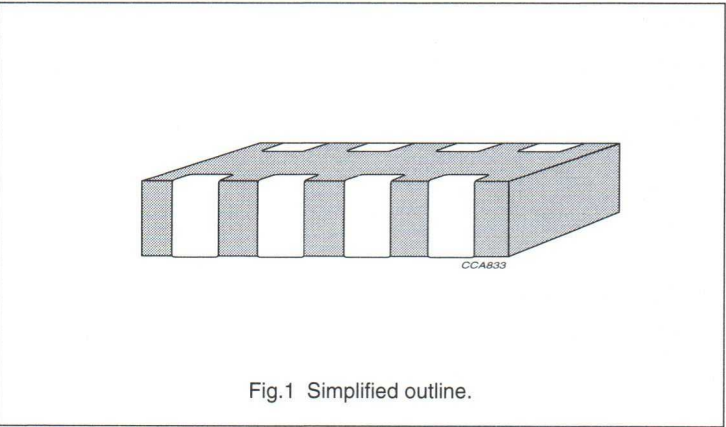
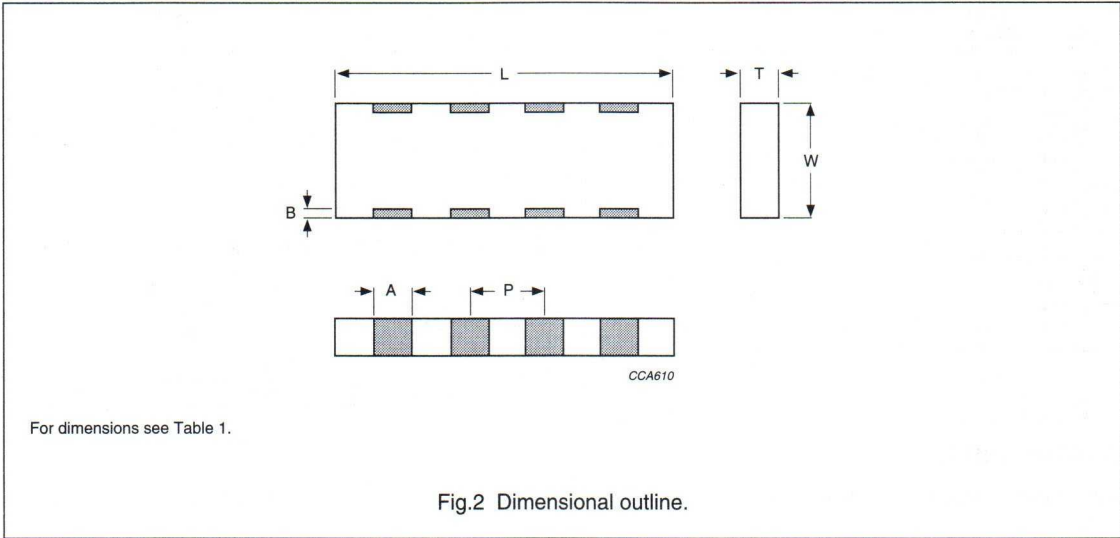


Fig.1 Simplified outline.

Surface mounted ceramic multilayer capacitors	C-Array: Class 1, NP0 50/63 V C-Array: Class 2, X7R 16/25 V
--	--

MECHANICAL DATA



Physical dimensions

Table 1 Capacitor dimensions for product size 0612 (4 × 0603)

CASE SIZE	L	W	T		A	B	P
			MIN.	MAX.			
Dimensions in millimetres							
0612 (4 × 0603)	3.20 ±0.15	1.60 ±0.15	0.80	1.20	0.45 ±0.15	0.30 ±0.15	0.80 ±0.15
Dimensions in inches							
0612 (4 × 0603)	0.125 ±0.006	0.063 ±0.006	0.031	0.047	0.018 ±0.006	0.012 ±0.006	0.031 ±0.004

Surface mounted ceramic multilayer capacitors

C-Array: Class 1, NP0 50/63 V

SELECTION CHART FOR NP0

C (pF)	LAST TWO DIGITS OF 12NC	50/63 V
		0612 (4 × 0603)
22	37	0.8 ±0.1
27	28	
33	29	
39	31	
47	32	
56	33	
68	34	
82	35	
100	36	
120	37	
150	38	
180	39	
220	41	
270	42	
330	43	

C (pF)	LAST TWO DIGITS OF 12NC	50/63 V
		0612 (4 × 0603)
390	44	0.8 ±0.1
470	45	
560	46	
680	47	
820	48	
1000	49	

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL	
	Ø180 mm; 7"	
	PAPER	BLISTER
0.8 ±0.1	4000	4000

ORDERING INFORMATION

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

Clear text code

EXAMPLE: 0612CG102J9B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0612 (4 × 0603)	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	J ±5% K ±10%	9 = 50 /63 V	B = Ni-barrier A = AgPd	2 = 180 mm; 7" paper B = 180 mm; 7" blister	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

2 2 X X X X X X 1 X X X

Carrier type

50 blister
55 paper

Termination

14 NiSn
15 AgPd

Size

6 0612 (4 × 0603)

Capacitance value⁽¹⁾

Tolerance

5 ±5%
6 ±10%
7 ±20%

Packaging⁽²⁾

1 reel: Ø180 mm; 7" reel

CCA682

(1) Refer to Chapter "Selection chart for NP0".

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

Surface mounted ceramic multilayer capacitors

C-Array: Class 1, NP0 50/63 V

ELECTRICAL CHARACTERISTICS FOR CLASS 1, CAPACITORS

Class 1 capacitors; NP0 dielectric; NiSn and AgPd 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	22 pF to 1 nF
Tolerance on capacitance after 1000 hours	$\pm 5\%$, $\pm 10\%$
Tan δ ; note 1	$\leq 0.1\%$
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Insulation resistance after 1 minute at U_R (DC)	$> 100000 \text{ M}\Omega$
Temperature coefficient	$(0 \pm 30) \times 10^{-6}/\text{K}$

Note

1. Measured at 1 V, 1 MHz for $C \leq 1000 \text{ pF}$ and at 1 V, 1 kHz for $C > 1000 \text{ pF}$, using a four-gauge method.

Surface mounted ceramic multilayer capacitors

C-Array: Class 1, NP0 50/63 V

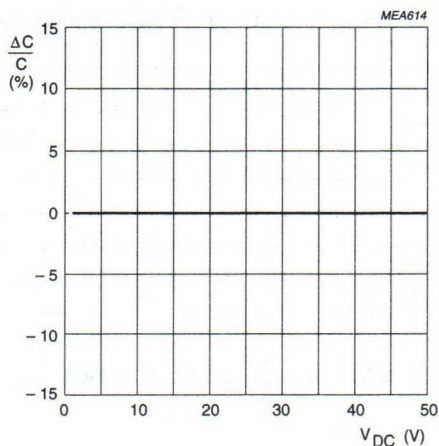


Fig.3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

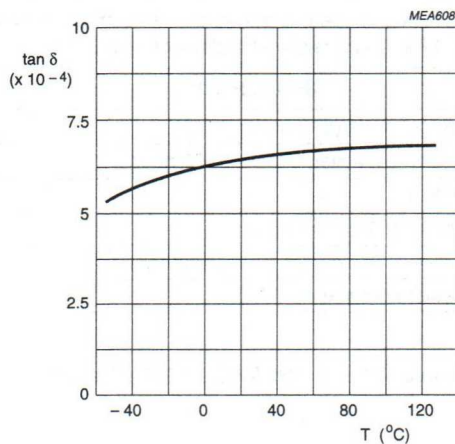


Fig.4 Typical $\tan \delta$ as a function of temperature.

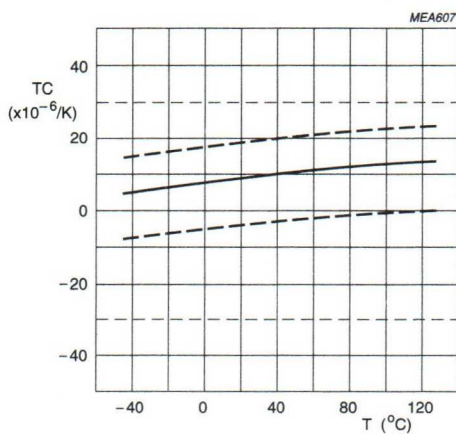
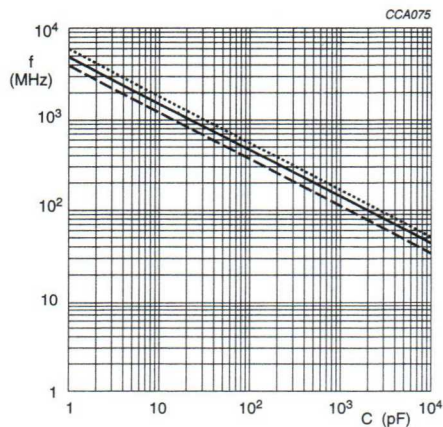


Fig.5 Typical temperature coefficient as a function of temperature.



$L = 0.6$ nH (dotted line).
 $L = 1$ nH (solid line).
 $L = 1.5$ nH (broken line).

Fig.6 Series resonance frequency as a function of capacitance.

Surface mounted ceramic multilayer capacitors

C-Array: Class 1, NP0 50/63 V

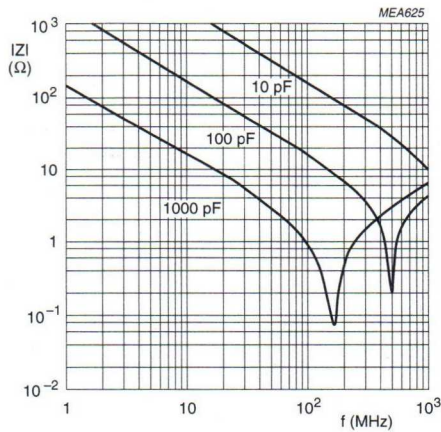
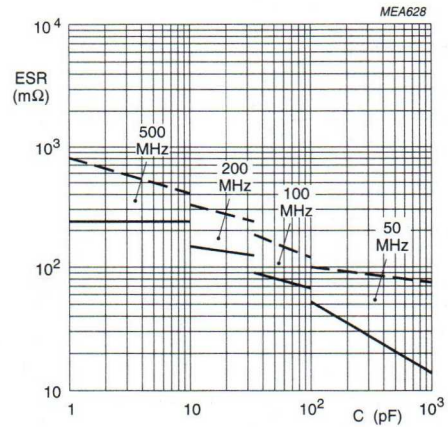
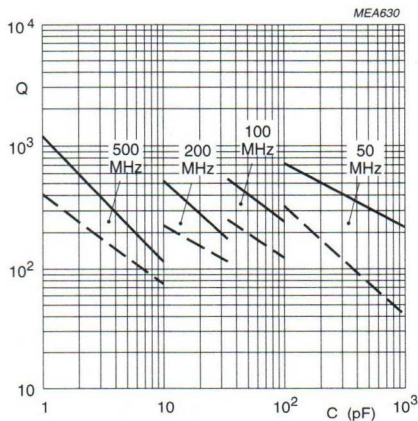


Fig.7 Typical impedance ($|Z|$) as a function of frequency.



Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

Fig.8 Equivalent series resistance (ESR) as a function of capacitance.



Typical values (solid lines).
Minimum values (broken lines).
Measuring equipment HP4191A.

Fig.9 Quality factor (Q) as a function of the capacitance.

Surface mounted ceramic multilayer capacitors

C-Array: Class 2, X7R 16/25 V

SELECTION CHART FOR X7R

C (nF)	LAST TWO DIGITS OF 12NC	16 V	25 V
		0612 (4 × 0603)	
1	23		
1.2	24		
1.5	25		
1.8	26		
2.2	27		
2.7	28		
3.3	29		
3.9	31		
4.7	32		
5.6	33		
6.8	34		
8.2	35		0.8 ±0.1
10	36		
12	37	0.8 ±0.1	
15	38		
18	39		
22	41		
27	42		
33	43		
39	44		
47	45		
56	46		1.2 ±0.1
68	47		
82	48		
100	49		
120	51		
150	52		

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL	
	Ø180 mm; 7"	
	PAPER	BLISTER
0.8 ±0.1	4000	4000
1.2 ±0.1	—	3000

Surface mounted ceramic
multilayer capacitors

C-Array: Class 2, X7R 16/25 V

ORDERING INFORMATION

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

Clear text code

EXAMPLE: 06122R102J8B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0612 (4 × 0603)	2R = X7R	102 = 1000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	7 = 16 V 8 = 25 V	B = Ni-barrier A = AgPd	2 = 180 mm; 7" paper B = 180 mm; 7" blister	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

2 2 X X X X X

Carrier type

50 blister
55 paper

Rated voltage - Termination

10 16 V; Ni-barrier
11 16 V; AgPd
12 25 V; Ni-barrier
13 25 V; AgPd

Size

6 0612 (4 × 0603)

X 6 X X X

Capacitance value⁽¹⁾

Tolerance

5 ±5%
6 ±10%
7 ±20%

Packaging⁽²⁾

1 reel: Ø180 mm; 7" reel

CCA683

(1) Refer to Chapter "Selection chart for X7R".

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

Surface mounted ceramic multilayer capacitors

C-Array: Class 2, X7R 16/25 V

ELECTRICAL CHARACTERISTICS FOR CLASS 2, CAPACITORS

Class 2 capacitors; X7R dielectric; NiSn and AgPd 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: 16 V 25 V	1 nF to 150 nF 1 nF to 68 nF
Tolerance on capacitance after 1000 hours	$\pm 10\%$, $\pm 20\%$
Tan δ ; note 1: 16 V 25 V	$\leq 3.5\%$ $\leq 2.5\%$
Insulation resistance after 1 minute at U_R (DC): $C \leq 10$ nF $C > 10$ nF	$R_{ins} > 100\,000$ M Ω $R_{ins} \times C > 1\,000$ seconds
Ageing	typical 1% per time decade

Note

1. Measured at 1 V, 1 MHz for $C \leq 1000$ pF and at 1 V, 1 kHz for $C > 1000$ pF, using a four-gauge method.

Surface mounted ceramic multilayer capacitors

C-Array: Class 2, X7R 16/25 V

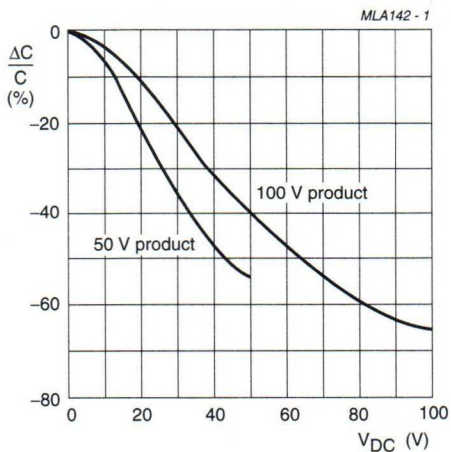


Fig.10 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

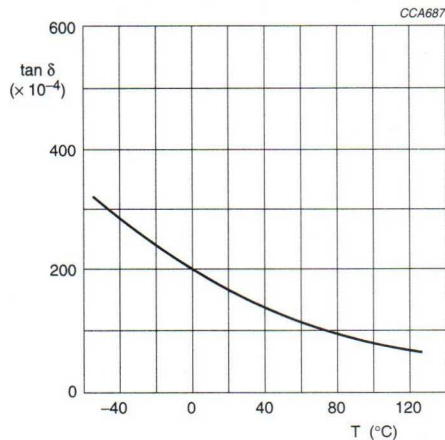
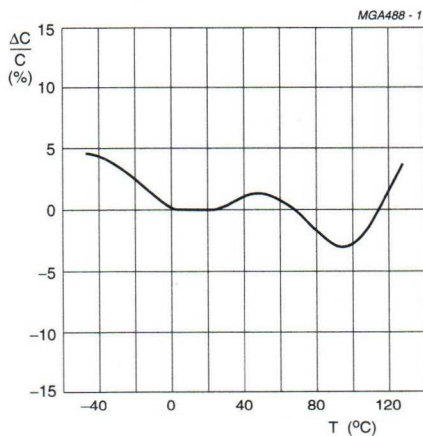


Fig.11 Typical $\tan \delta$ as a function of temperature.



$U_{DC} = 0$ V.

Fig.12 Typical capacitance change as a function of temperature.

The first part of the paper discusses the importance of the study of the history of the United States. It is argued that a knowledge of the past is essential for a full understanding of the present. The author then proceeds to discuss the various factors that have shaped the development of the United States, including geography, economics, and politics.

The second part of the paper is a detailed analysis of the American Revolution. It begins with a discussion of the causes of the revolution, including the growing dissatisfaction with British rule and the desire for independence. The author then describes the events of the revolution, from the first battles to the signing of the Declaration of Independence. Finally, the author discusses the significance of the revolution for the United States and the world.

The third part of the paper is a discussion of the American Civil War. It begins with a discussion of the causes of the war, including the issue of slavery and the growing tensions between the North and the South. The author then describes the events of the war, from the first battles to the final victory of the Union. Finally, the author discusses the significance of the war for the United States and the world.

The fourth part of the paper is a discussion of the American West. It begins with a discussion of the early exploration of the West and the settlement of the frontier. The author then discusses the various factors that have shaped the development of the West, including geography, economics, and politics. Finally, the author discusses the significance of the West for the United States and the world.

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E192	E96	E48	E192	E96	E48	E192	E96	E48	E192	E96	E48	E24	E12	E6	E3
100	100	100	178	178	178	316	316	316	562	562	562	10	10	10	10
101			180			320			569			11			
102	102		182	182		324	324		576	576		12	12		
104			184			328			583			13			
105	105	105	187	187	187	332	332	332	590	590	590	15	15	15	
106			189			336			597			16			
107	107		191	191		340	340		604	604		18	18		
109			193			344			612			20			
110	110	110	196	196	196	348	348	348	619	619	619	22	22	22	22
111			198			352			626			24			
113	113		200	200		357	357		634	634		27	27		
114			203			361			642			30			
115	115	115	205	205	205	365	365	365	649	649	649	33	33	33	
117			208			370			657			36			
118	118		210	210		374	374		665	665		39	39		
120			213			379			673			43			
121	121	121	215	215	215	383	383	383	681	681	681	47	47	47	47
123			218			388			690			51			
124	124		221	221		392	392		698	698		56	56		
126			223			397			706			62			
127	127	127	226	226	226	402	402	402	715	715	715	68	68	68	
129			229			407			723			75			
130	130		232	232		412	412		732	732		82	82		
132			234			417			741			91			
133	133	133	237	237	237	422	422	422	750	750	750				
135			240			427			759						
137	137		243	243		432	432		768	768					
138			246			437			777						
140	140	140	249	249	249	442	442	442	787	787	787				
142			252			448			796						
143	143		255	255		453	453		806	806					
145			258			459			816						
147	147	147	261	261	261	464	464	464	825	825	825				
149			264			470			835						
150	150		267	267		475	475		845	845					
152			271			481			856						
154	154	154	274	274	274	487	487	487	866	866	866				
156			277			493			876						
158	158		280	280		499	499		887	887					
160			284			505			898						
162	162	162	287	287	287	511	511	511	909	909	909				
164			291			517			920						
165	165		294	294		523	523		931	931					
167			298			530			942						
169	169	169	301	301	301	536	536	536	953	953	953				
172			305			542			965						
174	174		309	309		549	549		976	976					
176			312			556			988						

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