PASSIVE COMPONENTS

DATA HANDBOOK

Ceramic Capacitors

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Philips Components

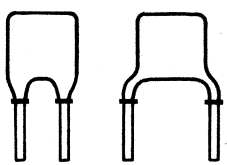
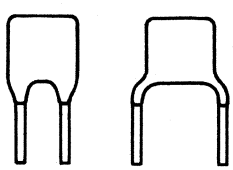
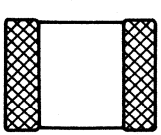
PHILIPS

CERAMIC CAPACITORS

SELECTION GUIDE
INTRODUCTION

SELECTION GUIDE

CERAMIC CAPACITORS

type	class	application	series number 2222 . . .	nominal capacitance pF	rated voltage (U_R) V	page
Plate; leads with flange 		high-frequency circuits	678 to 683 688; 689	0,56 to 560	100	**45**
	1	temperature compensating high stability	652 653 654	0,47 to 270	500	**33**
		space saving	691	0,47 to 270	500	**33**
	2	general purpose coupling/decoupling space saving	629 630 640	1000 to 47 000 180 to 6 800 1000 to 15 000	63 100 100	**23**
			655	100 to 2 700	500	**41**
Plate; non-flanged types 	1	high-frequency circuits temperature compensating high stability space saving	631, 638, 641, 642 650 651	0,56 to 560 0,47 to 270	100 500	**65** **69**
	2	general purpose coupling/decoupling space saving	629 630 640	1000 to 47 000 180 to 6 800 1000 to 15 000	63 100 100	**61**
			655	100 to 2 700	500	**73**
Multilayer; surface mounted 	1	high-frequency circuits, temperature compensating high stability space saving		0,47 to 10 000	50	**79**
	2	general purpose coupling/decoupling space saving		180 to 1 000 000	50	**79**

INTRODUCTION

1. GENERAL

Ceramic capacitors are widely used in electronic circuitry for coupling and 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 very high specific resistance, very good Q and linear temperature dependence (ϵ_r from 6 up to 250). 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 temperature characteristics ($\epsilon_r > 250$). They are used for coupling and decoupling.

2. 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:

$$C = \epsilon_r \epsilon_o \frac{A}{t} (n)$$

The working voltage is dependent on the dielectric strength.

Two constructions are shown in the figures below:

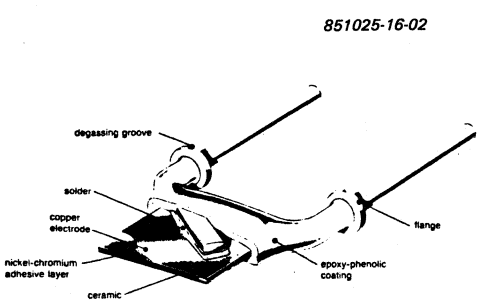


Fig. 1 Plate capacitor.

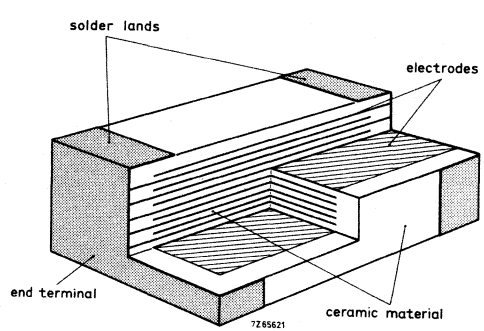


Fig. 2 Cross-section of a multilayer capacitor.

The electrodes are normally silver or some other good electrical conductor. For multilayer capacitors palladium or platinum is used since the electrodes are applied before the ceramic is fired at a temperature where silver would oxidize.

The dielectric material

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 compositions. 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 plate capacitors these sheets are fired in a carefully controlled atmosphere at temperatures between 1200 and 1400 °C. 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.

To prevent silver migration under humid conditions plate capacitors have copper electrodes. The totally in the ceramic enclosed electrodes of a multilayer capacitor guarantee good life test behaviour as well. As an extra precaution to ensure a good behaviour under humid conditions and to protect the electrodes the capacitors are lacquered.

3. EQUIVALENT CIRCUIT

Figure 3 shows the equivalent circuit of a capacitor.

C is the capacitance between the two electrodes, plus the stray capacitances at the edges and between the leads.

R_p is the insulation 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 dielectric material in an alternating electric field.

R_s is the 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 is the 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.

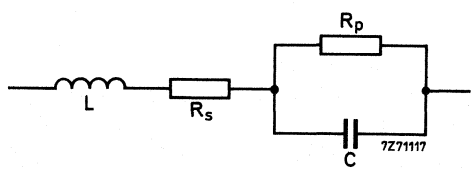


Fig. 3.

4. TANGENT OF THE LOSS ANGLE

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

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

From this formula, tan δ can be derived for different frequency ranges as shown diagrammatically in the graph of Fig. 4.

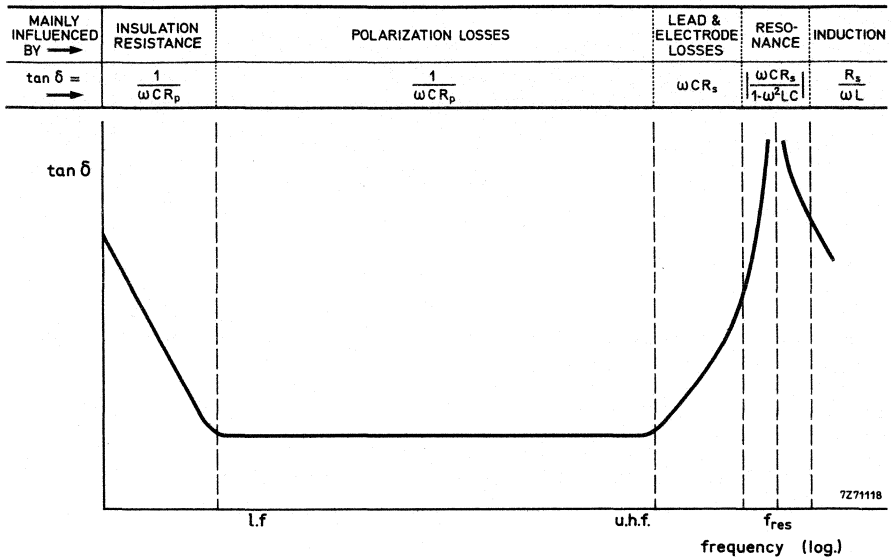


Fig. 4.

5. RELIABILITY

The failure rates shown below have a confidence level of 60% and refer to observations of plate capacitors up to and including 1987.

number of component hours	failure rate		
	catastrophic	degradation	field result
24 790 000	7 FIT	44 FIT	< 0,2 FIT

Notes

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

Catastrophic and degradation failure rates are given under normalized conditions, i.e. at ½ x rated voltage (d.c.) and T_{amb} = 40 °C.

Catastrophic failures include capacitance, tan δ and insulation resistance values, which do not meet the requirements after endurance test.

Degradation failures include capacitance, tan δ and insulation resistance values, which are between initial values as given in the data sheet, and 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.

The field result value has been obtained from measurements in applications with very low environmental stress, at ½ x rated voltage (d.c.), continuous operation, and equipment temperature between 10 and 55 °C.

MINIATURE CERAMIC PLATE CAPACITORS

GENERAL DATA

PACKING

The miniature ceramic plate capacitors are supplied in bulk packing (cardboard boxes) and in tape on reels or ammunition packing. The number of capacitors per box, per reel and per ammunition packing is given below.

size	number of capacitors		
	per box	per reel	per ammunition packing
I, IIA, III	1000	4000	4000
IV, V with wire length $\leq$ 6 mm	1000	–	–
IV, V with wire length $>$ 6 mm	500	4000	4000
IV, V 500 V with wire length $\leq$ 6 mm	1000	–	–
IV, V 500 V with wire length $>$ 6 mm	500	4000	2000

Composition, color coding and marking

The table below shows the composition of the materials used in plate capacitors. Colour coding indicating the temperature coefficient or temperature dependence is also given.

class 1 ϵ_r = 6 up to 250, T.C. types		colour code T.C.-value	body colour
P100 (+100 x 10^{-6}/K)	$MgTiO_3$, Mg_2SiO_4	red-violet	grey
NP0 (0 x 10^{-6}/K)	$MgTiO_3$	black	grey
N075 (–75 x 10^{-6}/K)		red	grey
N150 (–150 x 10^{-6}/K)		orange	grey
N220 (–220 x 10^{-6}/K)	$BaNd_2(Bi_2)Ti_5O_x + TiO_2$	yellow	grey
N330 (–330 x 10^{-6}/K)		green	grey
N470 (–470 x 10^{-6}/K)		blue	grey
N750 (–750 x 10^{-6}/K)	TiO_2 + additions	violet	grey
N1500 (–1500 x 10^{-6}/K)	$CaTiO_3$ + additions	orange/orange	grey
class 2 $\epsilon_r > 250$, high-K types		colour code K-value	body colour
ϵ_r = 2000	$Ba(Bi)TiO_3$	yellow	tan
ϵ_r = 5000	(Ba, Ca) (Ti, Zr) O_3 + add.	blue	tan
ϵ_r = 14000	(Ba, Ca) (Ti, Zr) O_3 + add.	green	tan

The capacitance is marked on the body of the plate capacitors in a three digit code: two numbers corresponding with the numerical capacitance value and one letter indicating the multiplier and the decimal point. For example: 1pO = 1.0 pF, 22n = 22 nF.

Current and maintenance types

Current ceramic plate capacitors have leads provided with a flange. They are available in a wide varierity of executions. The flange ensures excellent solderability and component height definition on the PCB. These capacitors are suitable for both hand mounting and automatic insertion.

Ceramic plate capacitors **without flanged leads** are not for design-in. They are for maintenance purposes only. They are not available on tape.

Note: The electrical properties of capacitors with flanged leads are the same as the electrical properties of capacitors with straight leads.

Capacitors on tape, lead pitch 5,08 mm (0,2 in)

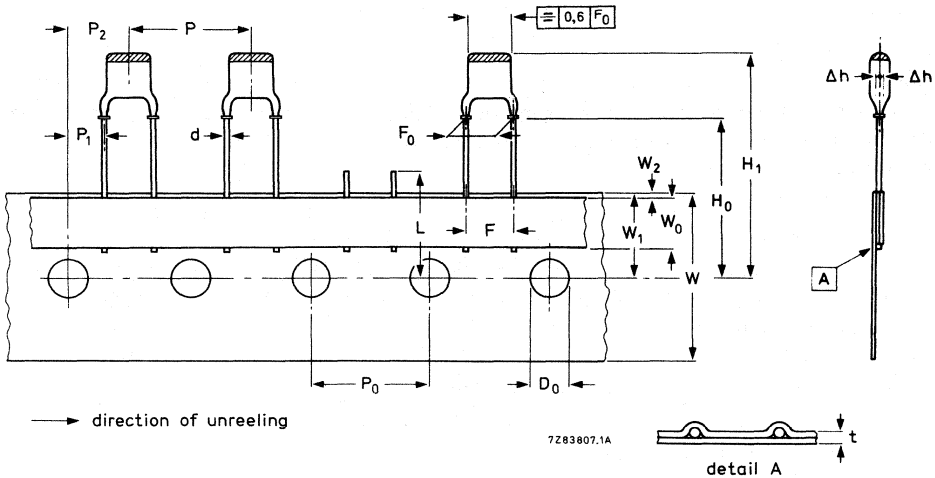


Fig. 1 Capacitors, lead pitch 5,08 mm, on tape; see Table 1 for dimensions.

Table 1

	symbol	dimensions	
		nominal	tolerance
Lead diameter	d	0,6	+0,06/−0,05
Pitch between capacitors	P	12,7	±1,0
Feed-hole pitch	P_0	12,7	±0,2*
Feed-hole centre to lead centre	P_1	3,85	±0,5
Feed hole centre to component centre	P_2	6,35	±1,0
Lead-to-lead distance	F	5,0	+0,6/−0,2
	F_0	5,08	+0,5/−0,1
Component alignment	Δh	0	±1,0
Tape width	W	18,0	−0,5
Hold-down tape width	W_0	6,0	±0,5
Hole position	W_1	9,0	±0,5
Hold-down tape position	W_2	0	+2
Flange to tape centre	H_0	18,25	±0,5
Component height	H_1	31	max.
		22	min.
Length of snipped lead	L	11	max.
Feed-hole diameter	D_0	4,0	±0,2
Total tape thickness	t	0,65	±0,2

* Cumulative pitch error: ± ⩽ 1 mm/20 pitches.

Extraction force for component in the tape plane, vertically to direction of unreeling	min.	5 N
Break force of tape	min.	15 N
Pull-off force main tape – reel	max.	2,5 N

Maximum 0,5% of the total number of capacitors per reel may be missing. A maximum of 3 consecutive vacant positions is followed by at least 6 consecutive components. The tape begins and ends with 5 empty positions.

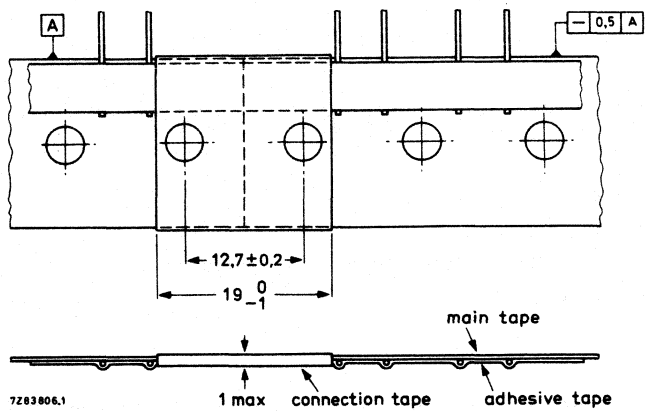


Fig. 2 Connection of tapes, lead pitch 5,08 mm.

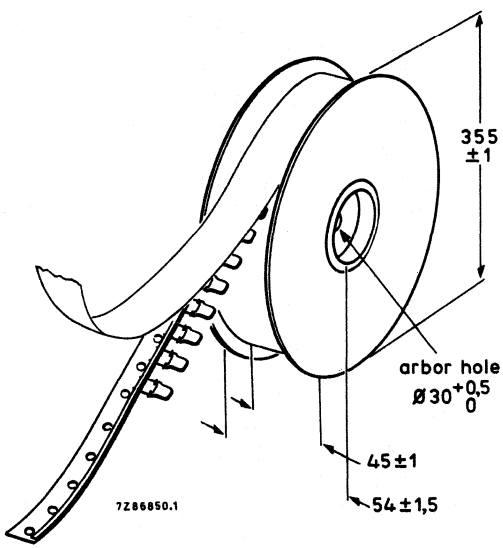


Fig. 3 Reel with capacitors on tape.

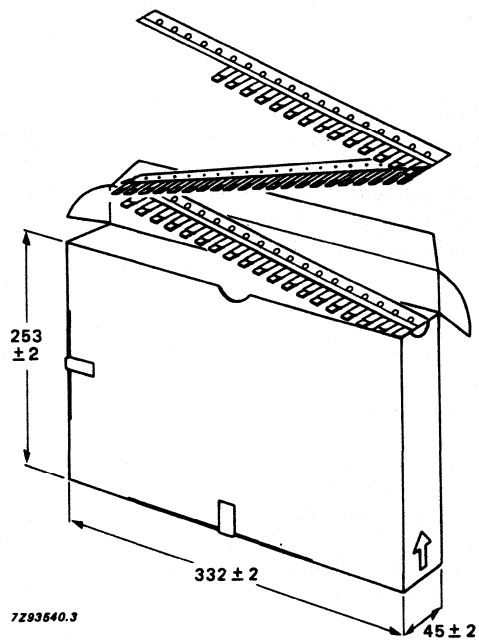


Fig. 4 Ammunition packing with capacitors on tape.

Capacitors on tape, lead pitch 2,54 mm (0,1 in)

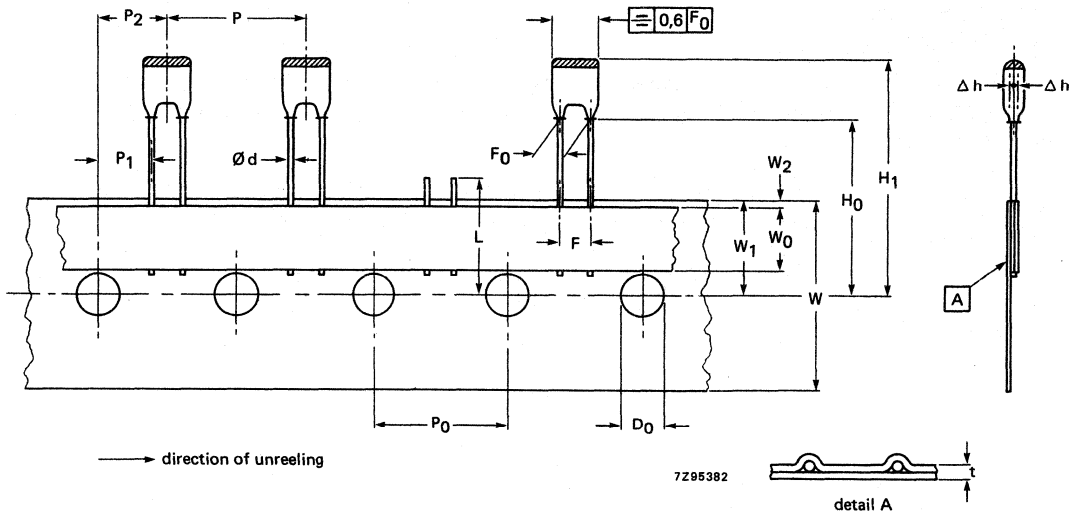


Fig. 5 Capacitors, lead pitch 2,54 mm, on tape; see Table 2 for dimensions.

Table 2

	symbol	dimensions	
		nominal	tolerance
Lead diameter	d	0,6	+ 0,06/−0,05
Pitch between capacitors	P	12,7	± 1,0
Feed-hole pitch	P_0	12,7	± 0,2*
Feed-hole centre to lead centre	P_1	5,1	± 0,5
Feed-hole centre to component centre	P_2	6,35	± 1,0
Lead-to-lead distance	F	2,54	± 0,3
	F_0	2,54	± 0,3
Component alignment	Δh	0	± 1,0
Tape width	W	18,0	−0,5
Hold-down tape width	W_0	6,0	± 0,5
Hole position	W_1	9,0	± 0,5
Hold-down tape position	W_2	0	+ 2
Flange to tape centre	H_0	18,25	± 0,5
Component height	H_1	30	max.
		21	min.
Length of snipped lead	L	11	max.
Feed-hole diameter	D_0	4,0	± 0,2
Total tape thickness	t	0,65	± 0,2

* Cumulative pitch error: ± ⩽ 1 mm/20 pitches.

Extraction force for component in the tape plane, vertically to direction of unreeling	min.	5 N
Break force of tape	min.	15 N
Pull-off force main tape – reel	max.	2,5 N

Maximum 0,5% of the total number of capacitors per reel may be missing. A maximum of 3 consecutive vacant positions is followed by at least 6 consecutive components. The tape begins and ends with 5 empty positions.

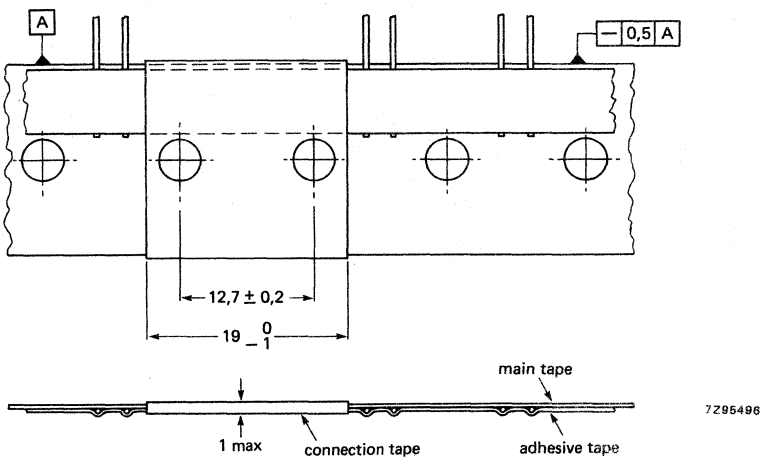


Fig. 6 Connection of tapes, lead pitch 2,54 mm.

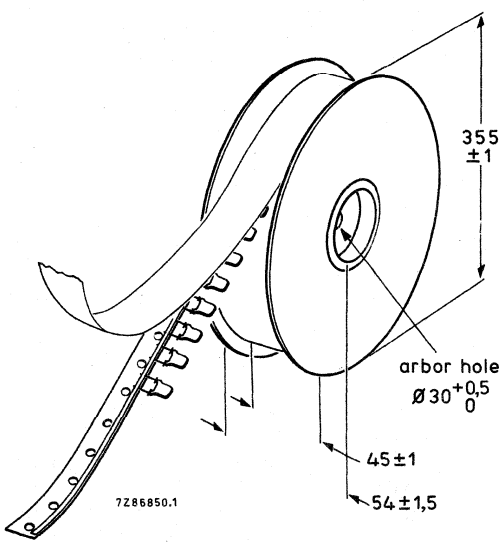


Fig. 7 Reel with capacitors on tape.

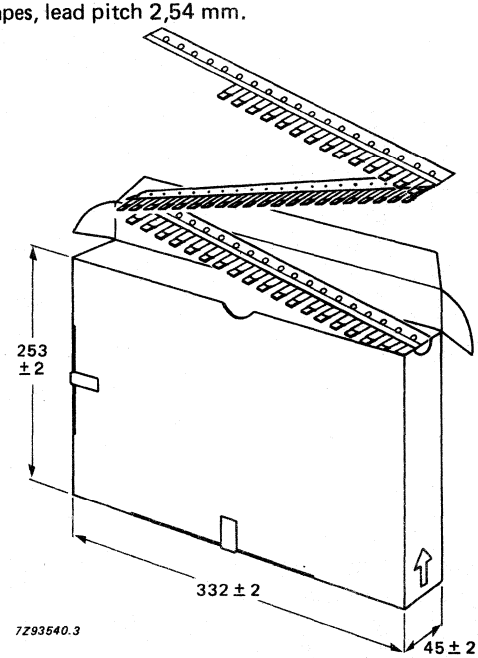
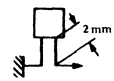


Fig. 8 Ammunition packing with capacitors on tape.

TESTS AND REQUIREMENTS

Class 1 capacitors

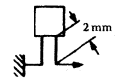
After manufacture, *each* capacitor is checked on capacitance, tan δ and test voltage. Apart from this the following quality checks are carried out by frequent inspections.
Essentially all tests mentioned in the schedule of IEC publication 384-8, category 55/085/21 (temperature range −55/+ 85 °C; damp heat, long term, 21 days) are carried out along the lines of IEC publication 68.

IEC 384-8 clause	IEC 68-2 test method	name of test	procedure	requirements
10.1		Robustness of terminations		
–	–	Pull-off	pull velocity 15 cm/min, load 5 N 	no wire breakage
10.1.1	Ua	Tensile strength	axial force 10 N	no wire breakage
10.1.1	Ub	Bending	load 5 N, 4 x 90°	no wire breakage
10.2		Soldering		
10.2.1	Ta method 1	Solderability (solder bath)	solderability: 2 s 235 °C	good tinning
10.2.2	Tb method 1A	Resistance to soldering heat	260 °C, 10 s	no visible damage $\Delta C/C \pm \leqslant 0{,}5\%$ or 0,5 pF after 1 h to 2 h
10.3	Na	Rapid change of temperature	30 min −55 °C/30 min + 85 °C, 5 cycles	no damage, after 24 h $\Delta C/C \pm \leqslant 0{,}5\%$ or 0,5 pF
10.4	Fc	Vibration	10-55-10 Hz 0,75 mm displacement 3 directions, 6 h	no visible damage
10.5	Eb	Bump	4000 bumps in 2 directions, 40g; pulse time 6 ms	no visible damage
–	–	Inflammability	15 s, 35 mm above bunsen burner with flame-height 40-60 mm	self-extinguishing within 15 s after removal of bunsen burner
9.5	–	Temperature coefficient	between + 20 and −55 °C, and between + 20 and + 85 °C	within tolerance as specified for each particular material

IEC 384-8 clause	IEC 68-2 test method	name of test	procedure	requirements
10.6		Climatic sequence		
10.6.2	B	Dry heat	16 h + 85 °C	no visible damage
10.6.3	Db	Damp heat (accel.) 1st cycle	12 h + 55 °C, 90 to 96% R.H. 12 h + 25 °C, 95 to 100% R.H.	after recovery of 1-2 h immediately followed by cold test
10.6.4	A	Cold	2 h −55 °C	no visible damage
10.6.5	M	Low air pressure	1 h 8,5 kPa, last 2 min rated voltage	no breakdown or flashover
10.6.6	Db	Damp heat (accel.) remaining cycle	12 h + 55 °C, 90 to 96% R.H. 12 h + 25 °C, 95 to 100% R.H.	$\Delta C/C \pm \leqslant 1\%$ or 1 pF tan $\delta \leqslant 2$ x specified tan δ R_{ins} after 1-2 h: $>$ 5000 MΩ for 2222 650 to 654, 691, $>$ 100 MΩ for other types
10.7	Ca	Damp heat, steady state (half number of the lot at rated voltage, other half at zero voltage)	21 days + 40 °C 90 to 95% R.H.	$\Delta C/C \pm \leqslant 1\%$ or 1 pF tan $\delta \leqslant 2$ x specified tan δ R_{ins} after 1-2 h: $>$ 5000 MΩ for 2222 650 to 654, 691, $>$ 100 MΩ for other types
10.8	–	Endurance	1000 h at + 85 °C; 2222 650 to 654, 691: 750 V (d.c.), other types: 150 V (d.c.)	$\Delta C/C \pm \leqslant 1\%$ or 1 pF tan $\delta \leqslant 1,5$ x specified tan δ R_{ins}: $>$ 3000 MΩ for 2222 650 to 654, 691, $>$ 300 MΩ for other types
–	–	Resistance to solvents	3 min ultrasonic washing in trichloroethylene 1 min drying, 30 °C 10 brush strokes	marking and colour code must remain legible and not be discoloured; no mechanical or electrical damage or deterioration of the material

Class 2 capacitors

After manufacturing *each* capacitor is checked on capacitance, tan δ and test voltage. Apart from this the following quality checks are carried out by frequent inspections.
Essentially all tests mentioned in the schedule of IEC publication 384-9, category 55/085/21 (temperature range −55/+85 °C; damp heat, long term, 21 days) are carried out along the lines of IEC publication 68.

IEC 384-9 clause	IEC 68-2 test method	name of test	procedure	requirements
7.3.2		Pre-conditioning	1 hr, +150 °C reference measurements after 24 hr	
		Robustness of terminations		
		Pull-off	pull velocity 15 cm/min, load 5 N 	no wire breakage
10.1	Ua	Tensile strength	axial force 10 N	no wire breakage
10.1	Ub	Bending	load 5 N, 4 x 90°	no wire breakage
10.2		Soldering		
10.2.1	Ta method 1	Solderability (solder bath)	solderability: 2 s at 235 °C	good tinning
10.2.2	Tb method 1A	Resistance to soldering heat	pre-conditioning 260 °C, 10 s	no visible damage, ΔC/C after 24 h, 2222 630: ± ⩽ 10% 2222 629, 2222 640: ± ⩽ 20% 2222 655: ±10%
10.3	Na	Rapid change of temperature	pre-conditioning 2222 630, 2222 640, 2222 655: 30 mins −55 °C/30 mins +85 °C 2222 629: 30 mins −10 °C/30 mins +55 °C 5 cycles	no damage ΔC/C after 24 h, 2222 630, 2222 655: ± ⩽ 10% 2222 629, 2222 640: ± ⩽ 20%

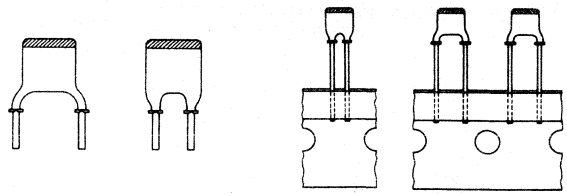
IEC 384-9 clause	IEC 68-2 test method	name of test	procedure	requirements
10.4	Fb	Vibration	10-55-10 Hz 0,75 mm displacement 3 directions, 6 h	no visible damage
10.5	Eb	Bump	4000 bumps in 2 directions, 40g; pulse time 6 ms	no visible damage
–	–	Inflammability	15 s, 35 mm above bunsen burner with flame-height 40-60 mm	self-extinguishing within 15 s after removal of bunsen burner
–	–	Resistance to solvents	3 min ultrasonic washing in trichloroethylene 1 min drying, 30 °C 10 brush strokes	marking and colour coding must remain legible and not discoloured; no mechanical or electrical damage or deterioration of the material
10.6		Climatic sequence		
10.6.1	–	Pre-conditioning	1 hr, + 150 °C	
10.6.2	Ba	Dry heat	16 h + 85 °C and + 55 °C respectively for 630/640/655 and 629	no visible damage
10.6.3	Db	Damp heat (cyclic.) 1st cycle	12 h + 55 °C, 90 to 96% R.H. 12 h + 25 °C, 95 to 100% R.H.	no visible damage; after recovery of 1 - 2 h immediately followed by cold test
10.6.4	Aa	Cold	2222 630/640/655: 2 h –55 °C 2222 629: 2 h –10 °C	no visible damage
10.6.5	M	Low air pressure	1 h at 8,5 kPa last 2 min rated voltage applied	no breakdown or flashover
10.6.6	Db	Damp heat (cyclic.) remaining cycle	12 h + 55 °C, 90 to 96% R.H. 12 h + 25 °C, 95 to 100% R.H.	after 24 h recovery: $\Delta C/C$, 2222 630, 2222 655: $\pm \leqslant 10\%$ 2222 629, 2222 640: $\pm \leqslant 20\%$ $\tan \delta \leqslant 7\%$ R_{ins}, 2222 629/630/640: > 100 MΩ 2222 655: > 1000 MΩ

IEC 384-9 clause	IEC 68-2 test method	name of test	procedure	requirements
10.7	Ca	Damp heat (steady state) half number of samples rated voltage, half number of samples no voltage applied	Pre-conditioning 21 days + 40 °C, 90 to 95% R.H. Pre-conditioning	no visible damage; after 24 h: $\Delta C/C$, 2222 630, 2222 655: $\pm \leqslant 10\%$ 2222 629, 2222 640: $\pm \leqslant 20\%$ tan $\delta \leqslant 7\%$ R_{ins}, 2222 629/630/640: > 100 MΩ 2222 655: > 1000 MΩ
10.9	–	Endurance	Pre-conditioning 1000 h (IEC) Pre-conditioning 2222 630, 2222 640: +85 °C, 150 V (DC) 2222 629: +55 °C, 100 V (DC), 2222 655: +85 °C, 750 V (DC)	after 24 h $\Delta C/C$, 2222 630, 2222 655: $\pm \leqslant 10\%$ 2222 629, 2222 640: $\pm \leqslant 20\%$ tan $\delta \leqslant 5\%$ (2222 629 $\leqslant 6.5\%$) R_{ins}, 2222 629/630/640: > 300 MΩ 2222 655: > 1000 MΩ
9.5	–	Temperature Characteristic	Pre-conditioning minimum and maximum temperature	In accordance with specification

MINIATURE CERAMIC PLATE CAPACITORS

class 2

- General purpose
- Coupling and decoupling
- Space saving



QUICK REFERENCE DATA

	2222 629-series	2222 630-series	2222 640-series
Capacitance range	1000-47000 pF	180-6800 pF	1000-15000 pF
	E3 series	E12 series	E6 series
Rated DC voltage	63 V	100 V	100 V
Tolerance on capacitance	−20/+ 80%	± 10%	−20/+ 50%
Sectional specification	IEC 384-9	IEC 384-9 (2C2)	IEC 384-9 (2E2)
Climatic category (IEC 68)	10/055/21	55/085/21	55/085/21

APPLICATION

In electronic circuits where non-linear change of capacitance with temperature is permissible and low losses are not essential, e.g. coupling and decoupling. Because of their small size, the capacitors are ideal for circuitry with high component density.

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized. The tinned connecting leads are secured by a high melting point solder. The capacitors are encapsulated in epoxy lacquer, which is resistant to all commonly used cleaning solvents. They have small dimensions and narrow tolerances on the lead spacing. The leads are provided with a flange. The flange guarantees that the leads are free of lacquer and its shape allows soldering gasses to escape freely, thus ensuring excellent solderability. This makes the capacitors suitable for hand mounting and automatic insertion.

MECHANICAL DATA

Dimensions in mm

Outlines

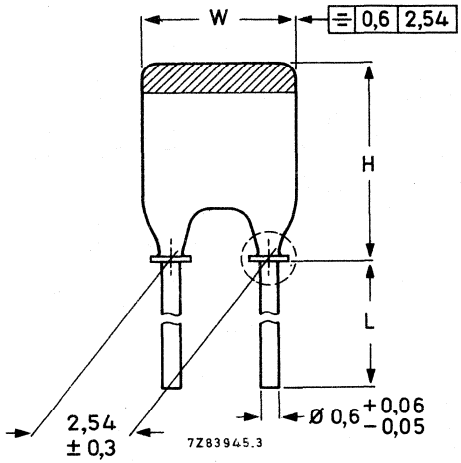


Fig.1 Style 1.

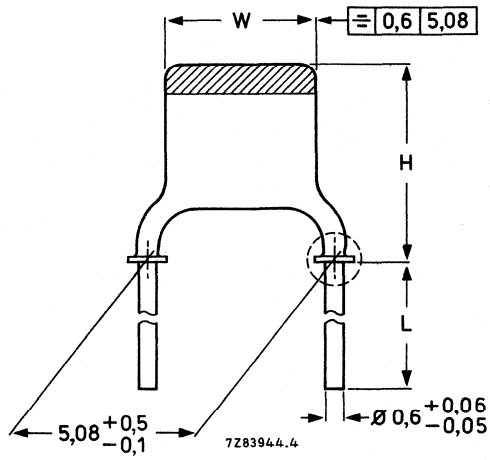


Fig.2 Style 2.

For dimensions H and W see Table 2.
The lead length (L) is shown in Table 1 for bulk packed capacitors; for taped capacitors it can be found in "Packing" section of "General Data on Miniature ceramic plate capacitors".

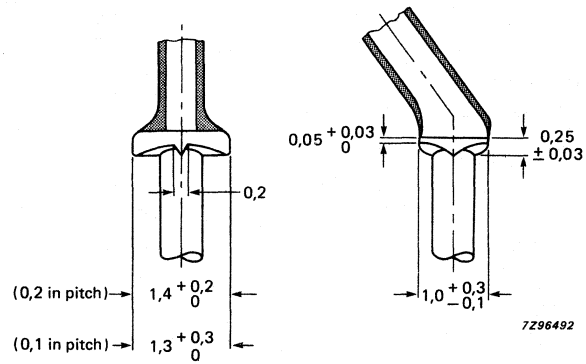


Fig.3 Detail of flange.

Table 1 Ordering information

pitch	lead diameter	Style	catalogue number (see note 1)			
			bulk packed		on tape on reel	on tape in ammopack
			L ⩾ 13 mm	L = 4 ± 0,5 mm		
2.54 mm (0.1 in)	0.6 mm (0.024 in)	1	2222 629 08 . . . 2222 630 08 . . . 2222 640 08 . . .	2222 629 18 . . . 2222 630 18 . . . 2222 640 18 . . .	2222 629 51 . . . 2222 630 51 . . . 2222 640 51 . . .	2222 629 61 . . . 2222 630 61 . . . 2222 640 61 . . .
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2	2222 629 09 . . . 2222 630 09 . . . 2222 640 09 . . .	2222 629 19 . . . 2222 630 19 . . . 2222 640 19 . . .	2222 629 53 . . . 2222 630 53 . . . 2222 640 53 . . .	2222 629 63 . . . 2222 630 63 . . . 2222 640 63 . . .

Note

1. Catalogue number to be completed by adding code for required capacitance, see Tables 3, 4 and 5.

Table 2 Capacitor dimensions

size	W (mm)	H (mm)		approx. mass g
		Fig.1	Fig.2	
I	3.6 (−1.1)	5.0 (−1.5)	6.3 (−1.8)	0.14
II A	3.9 (−1.4)	5.3 (−1.7)	6.7 (−2.0)	0.15
II B	4.5 (−1.8)	6.0 (−2.1)	7.3 (−2.4)	0.15
III	5.1 (−1.8)	6.6 (−2.3)	7.9 (−2.6)	0.17
IV	6.2 (−2.0)	7.7 (−2.4)	9.0 (−2.7)	0.20
V	6.2 (−2.0)	10.3 (−2.8)	11.2 (−3.1)	0.23

Note: Tolerances are given between brackets

Unless otherwise indicated in Tables 3, 4 and 5, the thickness of the capacitors does not exceed 2.3 mm.

Marking

The body of the capacitors is tan coloured. The capacitors have a colour mark on top indicating the temperature dependence of the capacitance; green for type 2222 629, yellow for type 2222 630, and blue for type 2222 640. The capacitance value is indicated by a marking code in a contrasting colour on the body. Refer to Tables 3, 4 and 5 for marking codes.

Mounting

When bending and cutting or flattening the leads, they should be relieved of the applied load by supporting them at the capacitor body.

Soldering conditions 260 °C ± 5 °C, max. 10 s

The capacitors are suitable for mounting on printed-wiring boards (hand mounting or automatic insertion).

PACKING

Refer to the General section for Miniature Ceramic Plate Capacitors.

ELECTRICAL DATA

Capacitors 2222 629 (colour mark green)

The capacitors conform to IEC 384-9.
Unless otherwise specified all electrical values apply at a temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 63 to 67%.

Capacitance values measured at 1 kHz, 1 V	1000–47 000 pF; E3 series (see Table 3)
Tolerance on the capacitance, after 1000 hours	−20 to +80%
Maximum capacitance variation with respect to capacitance value at 20 °C	+20 to −75% (see Fig.5)
Rated DC voltage at 55 °C	63 V
Derated DC voltage at 85 °C	40 V
Test voltage (DC) for 1 min	200 V
Test voltage (DC) of coating for 1 min	200 V
Insulation resistance at 10 V (DC) after 1 min	⩾ 4000 MΩ
Tan δ at 1 kHz, 1 V	⩽ 3.5%
Category temperature range	−10 to +55 °C
Storage temperature range	−55 to +85 °C
Climatic category, IEC 68	10/055/21
Ageing	typ. 5% per time decade

Table 3 Range of values for 2222 629

cap. value (pF)	size see Table 2	marking	code for ordering, see Table 1
1 000	I	1n0	102
2 200	I	2n2	222
4 700	I	4n7	472
10 000	IIB	10n	103
22 000	IV	22n	223
47 000	V	47n	473

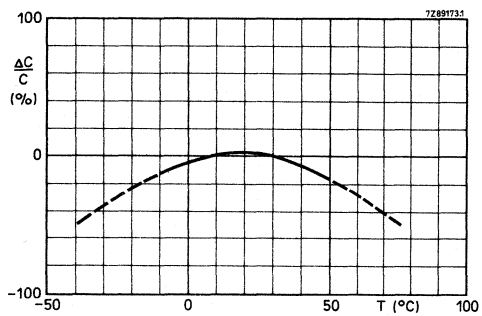


Fig.4 Typical capacitance change as a function of temperature for capacitance value 1000 pF; f = 1 kHz, U = 1 V.
Dotted lines give an indication of the behaviour at higher and lower temperatures.

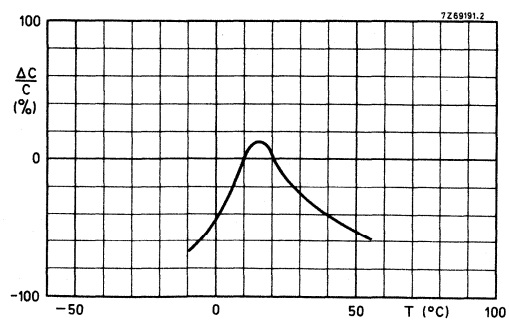


Fig.5 Typical capacitance change as a function of temperature for capacitance values 2200 pF to 47 000 pF; f = 1 kHz, U = 1 V.

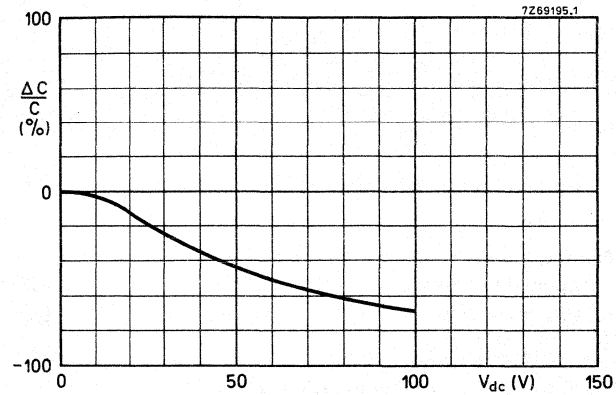


Fig.6 Typical capacitance change with respect to the capacitance value at 0 V, as a function of DC voltage, for capacitance values 2200 to 47 000 pF; f = 1 kHz, U = 1 V, T = 20 °C.

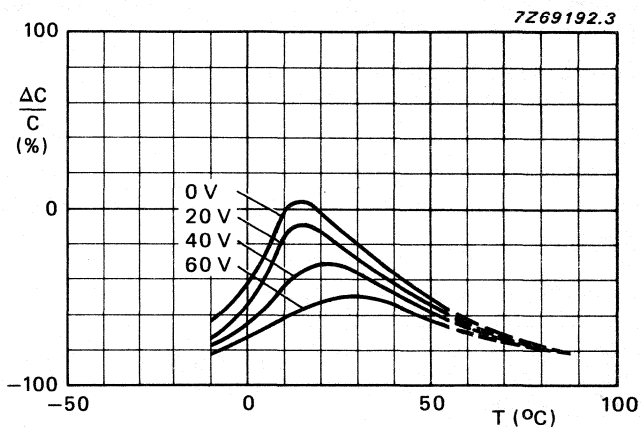


Fig.7 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different DC voltages, for capacitance values 2200 to 47 000 pF; f = 1 kHz, U = 1 V.

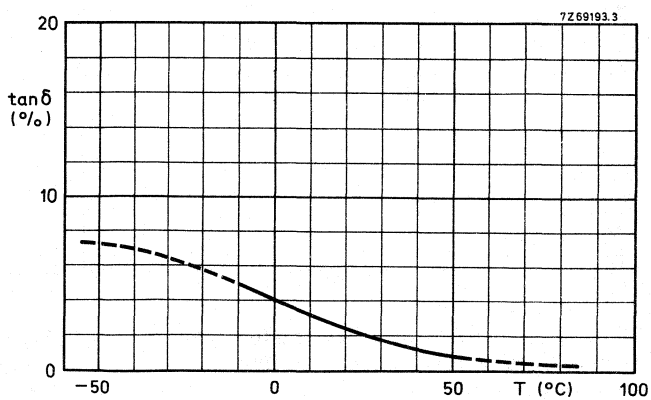


Fig.8 Typical tan δ as a function of temperature, for capacitance values 2200 to 47 000 pF; f = 1 kHz, U = 1 V.

ELECTRICAL DATA (continued)

Capacitors 2222 630 (colour mark yellow)

The capacitors conform to IEC 384-9 (2C2).
Unless otherwise specified all electrical values apply at a temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 63 to 67%.

Capacitance values, measured at 1 kHz, 1 V	180 – 6800 pF, E12 series (see Table 4)
Tolerance on the capacitance, after 1000 hours	± 10%
Maximum capacitance variation with respect to capacitance value at 20 °C	+20 to –20% (see Fig.9)
Rated DC voltage	100 V
Test voltage (DC) for 1 min	300 V
Test voltage (DC) of coating for 1 min	300 V
Insulation resistance at 100 V (DC) after 1 min	⩾ 4000 MΩ
Tan δ at 1 kHz, 1 V	⩽ 3.5%
Maximum voltage dependence of the capacitance between 0 and 40 V	–5%
Category temperature range	–55 to +85 °C
Storage temperature range	–55 to +85 °C
Climatic category (IEC 68)	55/085/21
Ageing	typ. 1.5% per time decade

Table 4 Range of values for 2222 630

cap. value (pF)	size see Table 2	marking	code for ordering see Table 1	cap. value (pF)	size see Table 2	marking	code for ordering see Table 1
180*	I	n18	181	1200	IIA	1n2	122
220	I	n22	221	1500	IIA	1n5	152
270	I	n27	271	1800	IIB	1n8	182
330	I	n33	331	2200	IIB	2n2	222
390	I	n39	391	2700	III	2n7	272
470	I	n47	471	3300	III	3n3	332
560	I	n56	561	3900	IV	3n9	392
680	I	n68	681	4700	IV	4n7	472
820	I	n82	821	5600	V	5n6	562
1000	I	1n0	102	6800	V	6n8	682

* Maximum thickness 2.5 mm.

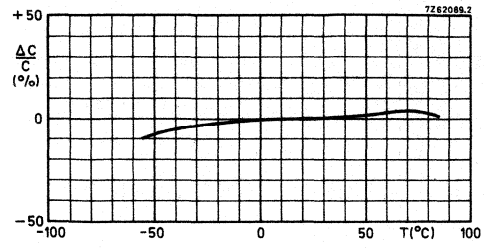


Fig.9 Typical capacitance change with respect to capacitance value as a function of temperature; f = 1 kHz, U = 1 V.

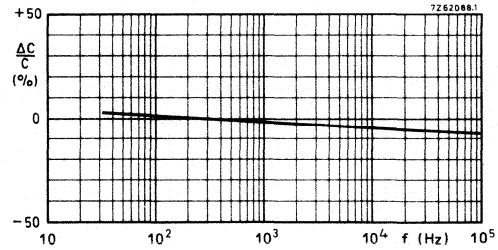


Fig.10 Typical capacitance change with respect to capacitance value at 300 Hz as a function of frequency; U = 1 V.

Fig.11 Typical capacitance change with respect to the capacitance value at 0 V, as a function of DC voltage; f = 1 kHz, U = 1 V, T = 20 °C.

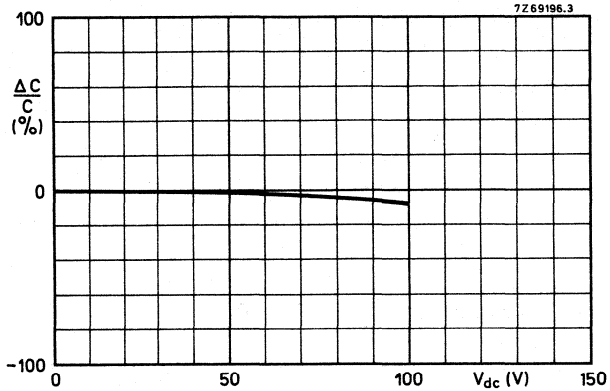
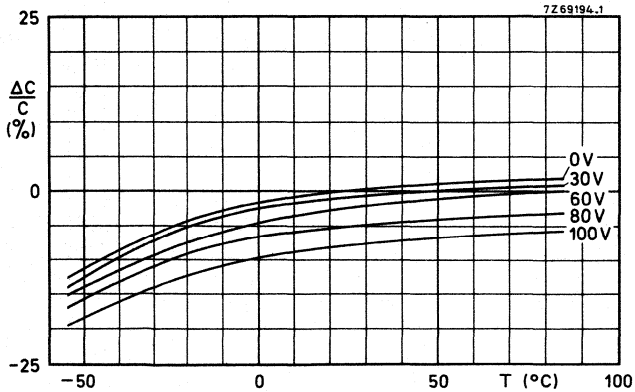


Fig.12 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different DC voltages; f = 1 kHz, U = 1 V.



ELECTRICAL DATA (continued)

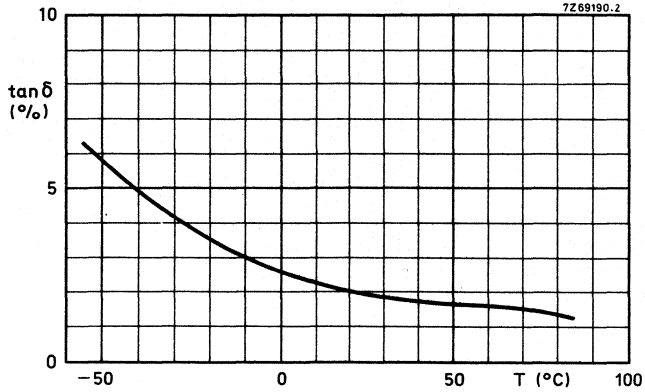


Fig.13 Typical tan δ as a function of temperature; f = 1 kHz, U = 1 V.

Capacitors 2222 640 (colour mark blue)

The capacitors meet the essential requirements of IEC 384-9 (2E2).
Unless otherwise specified all electrical values apply at a temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 63 to 67%.

Capacitance values, measured at 1 kHz, 1 V	1000–15 000 pF; E6 series (see Table 5)
Tolerance on the capacitance, after 1000 hours	−20 to +50%
Maximum capacitance variation with respect to capacitance value at 20 °C	+20 to −55% (see Fig.14)
Rated DC voltage	100 V
Test voltage (DC) for 1 min	300 V
Test voltage (DC) of coating for 1 min	300 V
Insulation resistance at 100 V (DC) after 1 min	⩾ 4000 MΩ
Tan δ at 1 kHz, 1 V	⩽ 3.5%
Category temperature range	−55 to +85 °C
Storage temperature range	−55 to +85 °C
Climatic category (IEC 68)	55/085/21
Ageing	typ. 5% per time decade

Table 5 Range of values for 2222 640

cap. value (pF)	size see Table 2	marking	code for ordering, see Table 1
1000	I	1n0	102
1500	I	1n5	152
2200	I	2n2	222
3300	IIA	3n3	332
4700	IIB	4n7	472
6800	III	6n8	682
10000	IV	10n	103
15000	V	15n	153

ELECTRICAL DATA (continued)

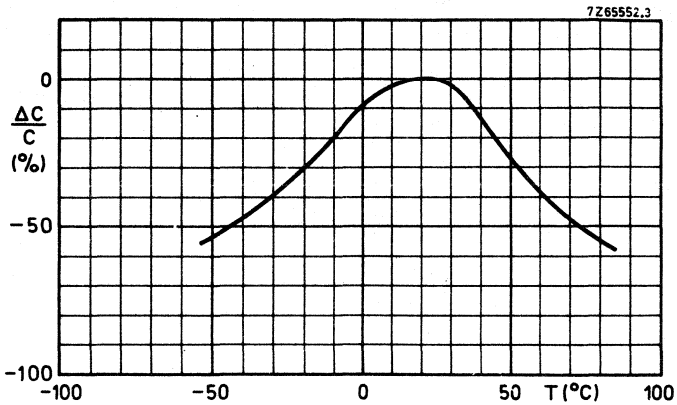


Fig.14 Maximum capacitance variation with respect to capacitance value at 20 °C; f = 1 kHz, U = 1 V.

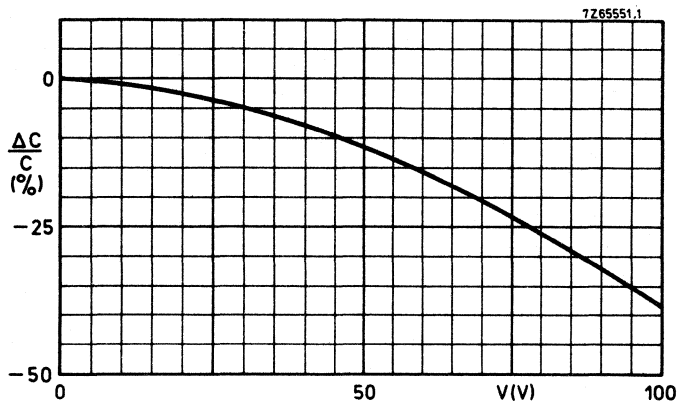


Fig.15 Typical capacitance variation with respect to capacitance value at 20 °C as a function of DC voltage; f = 1 kHz, U = 1 V.

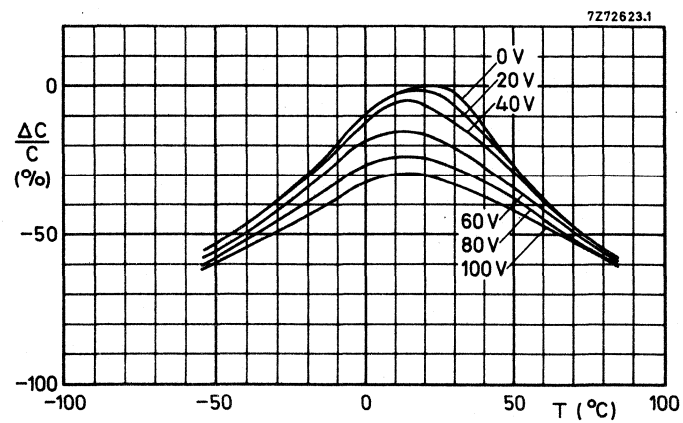
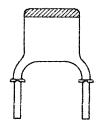


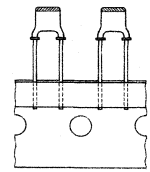
Fig.16 Typical capacitance variation with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different voltages; f = 1 kHz, U = 1 V.

MINIATURE CERAMIC PLATE CAPACITORS

class 1, 500 V (DC)

- High-frequency circuits
- Temperature compensating
- High stability
- Space saving





QUICK REFERENCE DATA

Capacitance range	0.47 to 270 pF (E12 series)
Rated DC voltage	500 V
Tolerance on capacitance	± 2% or ± 0.25 pF
Temperature coefficients	P100, NP0, N150, N750, N1500
Sectional specification	IEC 384-8
Climatic category (IEC 68)	55/085/21

APPLICATION

In a great variety of electronic circuits, e.g. in filters and tuning circuits where high stability and/or temperature compensation are a requirement. Because of their small size the capacitors are suitable for circuitry with high component density.

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized and tinned connecting leads are secured by a high melting point solder. The capacitors are encapsulated in epoxy lacquer, which is resistant to all commonly used cleaning solvents. They have small dimensions and narrow tolerances on the lead spacing. The leads are provided with a flange.
The flange guarantees that the leads are free of lacquer and its shape allows soldering gasses to escape freely ensuring excellent solderability. This makes the capacitors suitable for both hand mounting and automatic insertion. The electrical properties are characterized by low losses, a narrow tolerance on capacitance (± 0.25 pF or 2%), high stability and, owing to the absence of silver, an extremely good DC behaviour.

MECHANICAL DATA

Dimensions in mm

Outlines

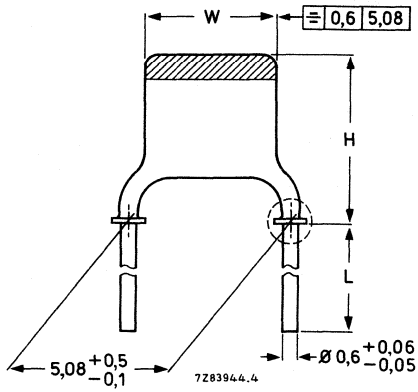


Fig.1 Component outline.

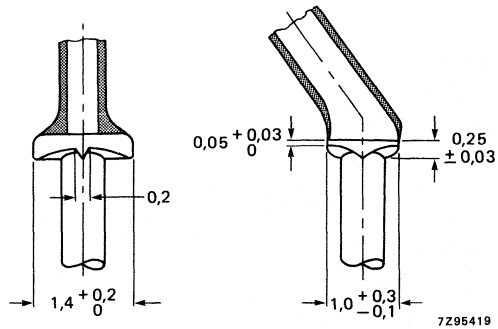


Fig.2 Detail of flange.

For dimensions H and W see Table 2.
The lead length (L) is shown in Table 1 for bulk packed capacitors; for taped capacitors it can be found in "Packing" section of "General Data on Miniature ceramic plate capacitors".

Table 1 Ordering information

pitch	lead diameter	catalogue number (see note 1)			
		bulk packed		on tape on reel	on tape in ammopack
		L ⩾ 13 mm	L = 4 ± 0.5 mm		
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2222 652	2222 653	2222 654	2222 691 . . . . .

Table 2 Component dimensions

size	W (mm)	H (mm)	approx. mass g
I	3.6 (−1.1)	6.3 (−1.8)	0.14
II A	3.9 (−1.4)	6.7 (−2.0)	0.15
II B	4.5 (−1.8)	7.3 (−2.4)	0.15
III	5.1 (−1.8)	7.9 (−2.6)	0.17
IV	6.2 (−2.0)	9.0 (−2.7)	0.20
V	6.2 (−2.0)	11.2 (−3.1)	0.23

Note: Tolerances are given between brackets.

Unless indicated in Tables 3 to 7, the thickness of the capacitors does not exceed 2.3 mm.

Note

1. Catalogue number to be completed by adding code for required capacitance value, see Tables 3 to 7.

Marking

The body of the capacitors is coloured grey. The temperature coefficient is indicated by a colour code as per IEC and EIA recommendations. The capacitance value and the voltage are indicated by a marking code in a contrasting colour on the body. Refer to Tables 3 to 7 for marking codes.

Mounting

When bending, cutting or flattening the leads, they should be relieved of the applied load by supporting them at the capacitor body.

Soldering conditions 260 °C ± 5 °C, max. 10 s

The capacitors are suitable for mounting on printed-wiring boards (hand mounting or automatic insertion).

PACKING

Refer to the General section for Miniature Ceramic Plate Capacitors.

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 384-8. Unless stated otherwise 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%.

Capacitance values* measured at 1 MHz, ≤ 5 V	0.47 to 270 pF, E12 series, see Tables 3 to 7
Rated DC voltage	500 V
Test voltage (DC) for 1 min	1250 V
Test voltage (DC) of coating for 1 min	1250 V
Insulation resistance at 500 V (DC) after 1 min	> 10 000 MΩ
Tan δ* at 1 MHz, ≤ 5 V for C < 50 pF	$\leqslant 15\,(\frac{15}{C} + 0.7).10^{-4}$
for C > 50 pF	$\leqslant 15.10^{-4}$
Category temperature range	−55 to + 85 °C
Storage temperature range	−55 to + 85 °C
Climatic category (IEC 68)	55/085/21

* Including 2 mm per connecting lead.

Capacitors with temperature coefficient P100

Capacitance range	0.47 to 33 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	+ 100 x 10^{-6}/K
Tolerance on the temperature coefficient	± 30 x 10^{-6}/K
Marking colour of the temperature coefficient	red/violet

Table 3 Capacitance range, temperature coefficient P100

capacitance value (pF)	tolerance	size see Table 2	marking		suffix of catalogue number see Table 1
0.47*	± 0.25 pF	I	p47	500	03477
0.56	± 0.25 pF	I	p56	500	03567
0.68	± 0.25 pF	I	p68	500	03687
0.82	± 0.25 pF	I	p82	500	03827
1.0	± 0.25 pF	I	1p0	500	03108
1.2	± 0.25 pF	I	1p2	500	03128
1.5*	± 0.25 pF	I	1p5	500	03158
1.8	± 0.25 pF	I	1p8	500	03188
2.2	± 0.25 pF	I	2p2	500	03228
2.7	± 0.25 pF	I	2p7	500	03278
3.3	± 0.25 pF	I	3p3	500	03338
3.9	± 0.25 pF	I	3p9	500	03398
4.7	± 0.25 pF	IIA	4p7	500	03478
5.6	± 0.25 pF	IIA	5p6	500	03568
6.8	± 0.25 pF	IIB	6p8	500	03688
8.2	± 0.25 pF	IIB	8p2	500	03828
10	± 2%	III	10p	500	04109
12	± 2%	III	12p	500	04129
15	± 2%	III	15p	500	04159
18	± 2%	IV	18p	500	04189
22	± 2%	IV	22p	500	04229
27	± 2%	V	27p	500	04279
33	± 2%	V	33p	500	04339

Other capacitance values and tolerances are available on request.

* Maximum thickness 2.5 mm.

Capacitors with temperature coefficient NP0

Capacitance range	0.82 to 47 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	$0 \times 10^{-6}/K$
Tolerance on the temperature coefficient	$\pm 30 \times 10^{-6}/K$
Marking colour of the temperature coefficient	black

Table 4 Capacitance range, temperature coefficient NP0

capacitance value (pF)	tolerance	size see Table 2	marking		suffix of catalogue number see Table 1
0.82*	± 0.25 pF	I	p82	500	09827
1.0*	± 0.25 pF	I	1p0	500	09108
1.2	± 0.25 pF	I	1p2	500	09128
1.5	± 0.25 pF	I	1p5	500	09158
1.8	± 0.25 pF	I	1p8	500	09188
2.2	± 0.25 pF	I	2p2	500	09228
2.7	± 0.25 pF	I	2p7	500	09278
3.3	± 0.25 pF	I	3p3	500	09338
3.9	± 0.25 pF	I	3p9	500	09398
4.7	± 0.25 pF	I	4p7	500	09478
5.6	± 0.25 pF	I	5p6	500	09568
6.8	± 0.25 pF	IIA	6p8	500	09688
8.2	± 0.25 pF	IIA	8p2	500	09828
10	± 2%	IIB	10p	500	10109
12	± 2%	IIB	12p	500	10129
15	± 2%	IIB	15p	500	10159
18	± 2%	III	18p	500	10189
22	± 2%	III	22p	500	10229
27	± 2%	IV	27p	500	10279
33	± 2%	IV	33p	500	10339
39	± 2%	IV	39p	500	10399
47	± 2%	V	47p	500	10479

Other capacitance values and tolerances are available on request.

* Maximum thickness 2.5 mm.

Capacitors with temperature coefficient N150

Capacitance range	2.2 to 56 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-150×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	orange

Table 5 Capacitance range, temperature coefficient N150

capacitance value (pF)	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
2.2*	± 0.25 pF	I	2p2 500	33228
2.7*	± 0.25 pF	I	2p7 500	33278
3.3	± 0.25 pF	I	3p3 500	33338
3.9	± 0.25 pF	I	3p9 500	33398
4.7	± 0.25 pF	I	4p7 500	33478
5.6	± 0.25 pF	I	5p6 500	33568
6.8	± 0.25 pF	I	6p8 500	33688
8.2	± 0.25 pF	IIA	8p2 500	33828
10	± 2%	IIA	10p 500	34109
12	± 2%	IIB	12p 500	34129
15	± 2%	IIB	15p 500	34159
18	± 2%	IIB	18p 500	34189
22	± 2%	III	22p 500	34229
27	± 2%	III	27p 500	34279
33	± 2%	IV	33p 500	34339
39	± 2%	IV	39p 500	34339
47	± 2%	IV	47p 500	34479
56	± 2%	V	56p 500	34569

Other capacitance values and tolerances are available on request.

* Maximum thickness 2.5 mm.

Capacitors with temperature coefficient N750

Capacitance range	1.8 to 120 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-750×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 120 \times 10^{-6}$/K
Marking colour of the temperature coefficient	violet

Table 6 Capacitance range, temperature coefficient N750

capacitance value (pF)	tolerance	size see Table 2	marking		suffix of catalogue number see Table 1
1.8*	± 0.25 pF	I	1p8	500	57188
2.2**	± 0.25 pF	I	2p2	500	57228
2.7	± 0.25 pF	I	2p7	500	57278
3.3	± 0.25 pF	I	3p3	500	57338
3.9	± 0.25 pF	I	3p9	500	57398
4.7**	± 0.25 pF	I	4p7	500	57478
5.6	± 0.25 pF	I	5p6	500	57568
6.8	± 0.25 pF	I	6p8	500	57688
8.2	± 0.25 pF	I	8p2	500	57828
10	± 2%	I	10p	500	58109
12	± 2%	I	12p	500	58129
15	± 2%	I	15p	500	58159
18	± 2%	IIA	18p	500	58189
22	± 2%	IIA	22p	500	58229
27	± 2%	IIB	27p	500	58279
33	± 2%	IIB	33p	500	58339
39	± 2%	IIB	39p	500	58399
47	± 2%	III	47p	500	58479
56	± 2%	III	56p	500	58569
68	± 2%	IV	68p	500	58689
82	± 2%	IV	82p	500	58829
100	± 2%	IV	n10	500	58101
120	± 2%	V	n12	500	58121

Other capacitance values and tolerances are available on request.

* Maximum thickness 2.7 mm.
** Maximum thickness 2.5 mm.

Capacitors with temperature coefficient N1500

Capacitance range	8.2 to 270 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-1500×10^{-6}/K
Tolerance on the temperature coefficient	$(-0 + 500) \times 10^{-6}$/K
Marking colour of the temperature coefficient	orange/orange

Table 7 Capacitance range, temperature coefficient N1500

capacitance value (pF)	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
8.2*	± 0.25 pF	I	8p2 500	69828
10 **	± 2%	I	10p 500	70109
12 **	± 2%	I	12p 500	70129
15	± 2%	I	15p 500	70159
18	± 2%	I	18p 500	70189
22	± 2%	I	22p 500	70229
27	± 2%	I	27p 500	70279
33	± 2%	IIA	33p 500	70339
39	± 2%	IIA	39p 500	70399
47	± 2%	IIA	47p 500	70479
56	± 2%	IIB	56p 500	70569
68	± 2%	IIB	68p 500	70689
82	± 2%	IIB	82p 500	70829
100	± 2%	III	n10 500	70101
120	± 2%	III	n12 500	70121
150	± 2%	IV	n15 500	70151
180	± 2%	IV	n18 500	70181
220	± 2%	IV	n22 500	70221
270	± 2%	V	n27 500	70271

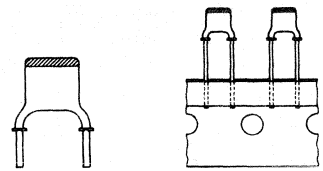
Other capacitance values and tolerances are available on request.

* Maximum thickness 3.0 mm.
** Maximum thickness 2.5 mm.

MINIATURE CERAMIC PLATE CAPACITORS

class 2, 500 V (DC)

- General purpose
- Coupling and decoupling
- Space saving



QUICK REFERENCE DATA

Capacitance range	100 - 2700 pF (E12 series)
Rated DC voltage	500 V
Tolerance on capacitance	± 10%
Sectional specification	IEC 384-9 (2C2)
Climatic category (IEC 68)	55/085/21

APPLICATION

In electronic circuits where non-linear change of capacitance with temperature is permissible and low losses are not essential, e.g. coupling and decoupling. Because of their small size, the capacitors are ideal for circuitry with high component density.

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized. The tinned connecting leads are secured by a high melting point solder. The capacitors are encapsulated in epoxy lacquer, which is resistant to all commonly used cleaning solvents. They have small dimensions and narrow tolerances on the lead spacing. The leads are provided with a flange.
The flange guarantees that the leads are free of lacquer and its shape allows soldering gasses to escape freely thus ensuring excellent solderability. This makes the capacitors suitable for both hand mounting and automatic insertion.

MECHANICAL DATA

Dimensions in mm

Outlines

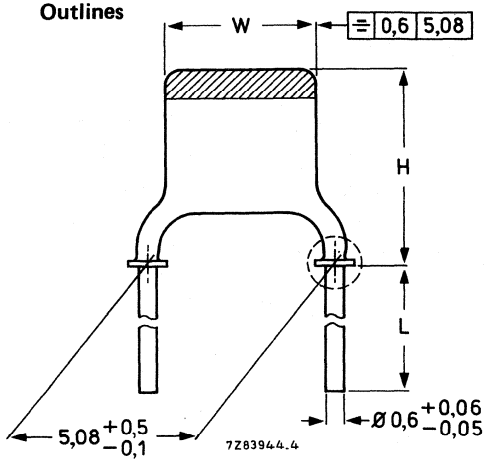


Fig.1 Component outlines.

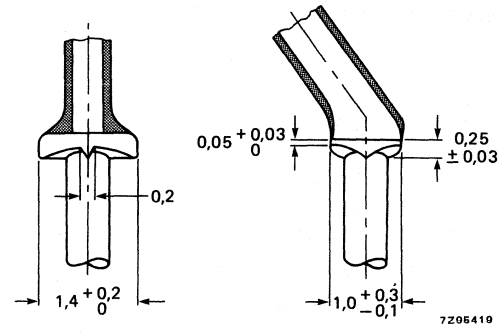


Fig.2 Detail of flange.

For dimensions H and W see Table 2.
The lead length (L) is shown in Table 1 for bulk packed capacitors; for taped capacitors it can be found in "Packing" section of "General Data on Miniature ceramic plate capacitors".

Table 1 Ordering information

pitch	lead diameter	catalogue number (see note 1)			
		bulk packed		on tape on reel	on tape in ammopack
		L ⩾ 13 mm	L = 4 ± 0.5 mm		
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2222 655 09 . . .	2222 655 19 . . .	2222 655 53 . . .	2222 655 63 . . .

Table 2 Capacitor dimensions

size	W (mm)	H (mm)	approx. mass g
I	3.6 (−1.1)	6.3 (−1.8)	0.14
II A	3.9 (−1.4)	6.7 (−2.0)	0.15
II B	4.5 (−1.8)	7.3 (−2.4)	0.15
III	5.1 (−1.8)	7.9 (−2.6)	0.17
IV	6.2 (−2.0)	9.0 (−2.7)	0.20
V	6.2 (−2.0)	11.2 (−3.1)	0.23

Note:
Tolerances are given between brackets.

Unless otherwise indicated in Table 3, the thickness of the capacitors does not exceed 2.3 mm.

Note

1. Catalogue number to be completed by adding code for required capacitance value, see Table 3.

Marking

The body of the capacitors is tan coloured.
The temperature dependence is indicated by a yellow colour cap. Capacitance value and voltage are indicated by a marking code in a contrasting colour on the body. Refer to Table 3 for marking codes.

Mounting

When bending, cutting or flattening the leads, they should be relieved of the applied load by supporting them at the capacitor body.

Soldering conditions max. 260 °C, max. 10 s

The capacitors are suitable for mounting on printed-wiring boards (hand mounting or automatic insertion).

PACKING

Refer to the General section for Miniature Ceramic Plate Capacitors.

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 384-9. Unless stated otherwise 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%.

Capacitance values, measured at 1 kHz, 1 V	100 to 2700 pF, E12 series, see Table 3
Tolerance on the capacitance, after 1000 hours	± 10%
Rated DC voltage	500 V
Test voltage (DC) for 1 min	1250 V
Test voltage (DC) of coating for 1 min	1250 V
Insulation resistance at 500 V (DC) after 1 min	> 4000 MΩ
Tan δ at 1 kHz, 1 V	< 3.5%
Category temperature range	−55 to + 85 °C
Climatic category	55/085/21
Storage temperature range	−55 to + 85 °C
Capacitance change versus temperature	see Fig.3
Capacitance change versus frequency	see Fig.4
Ageing	typ. 1.5% per time decade

Table 3 Range of values

cap. value (pF)	size see Table 2	marking		code for ordering see Table 1
100 *	I	n10	500	101
120 **	I	n12	500	121
150	I	n15	500	151
180	I	n18	500	181
220	I	n22	500	221
270	I	n27	500	271
330	I	n33	500	331
390	IIA	n39	500	391
470	IIA	n47	500	471
560	IIB	n56	500	561
680	IIB	n68	500	681
820	IIB	n82	500	821
1000	III	1n0	500	102
1200	III	1n2	500	122
1500	IV	1n5	500	152
1800	IV	1n8	500	182
2200	IV	2n2	500	222
2700	V	2n7	500	272

* Maximum thickness 2.7 mm. ** Maximum thickness 2.5 mm.

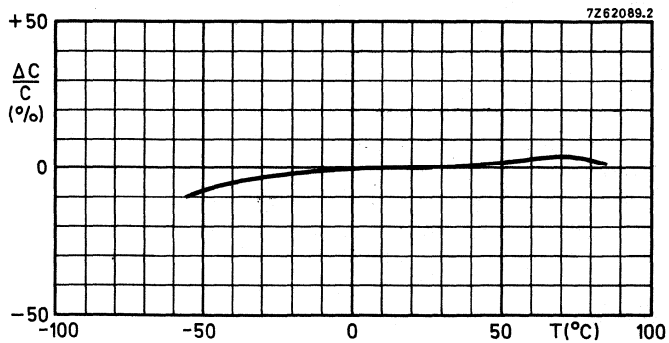


Fig. 3 Typical capacitance change with respect to the capacitance at 20 °C as a function of temperature; f = 1 kHz, U = 1 V.

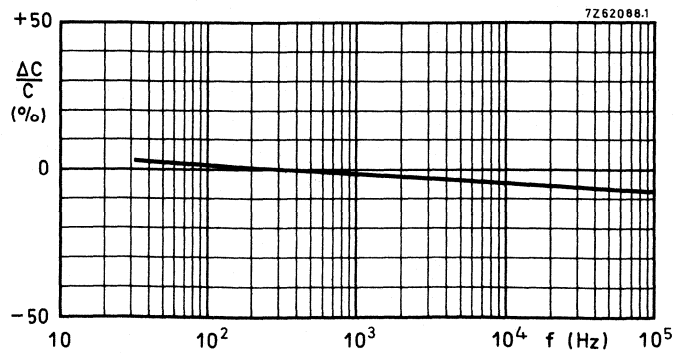
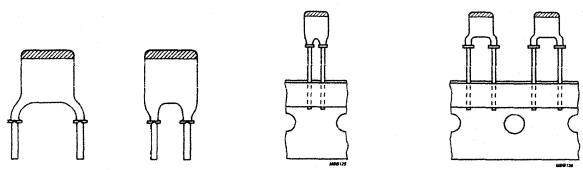


Fig. 4 Typical capacitance change with respect to the capacitance at 300 Hz as a function of frequency; U = 1 V.

MINIATURE CERAMIC PLATE CAPACITORS

class 1

- High-frequency circuits
- Temperature compensating
- High stability
- Space saving



QUICK REFERENCE DATA

Capacitance range	0.56 to 560 pF (E12 series)
Rated DC voltage	100 V
Tolerance on capacitance	± 2% or ± 0.25 pF
Temperature coefficients	P100, NP0, N075, N150, N220 N330, N470, N750, N1500
Sectional specification	IEC 384-8
Climatic category (IEC 68)	55/085/21

APPLICATION

In a great variety of electronic circuits, e.g. in filters and tuning circuits where high stability and/or temperature compensation are a requirement. Because of their small size the capacitors are suitable for circuitry with high component density.

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized and tinned connecting leads are secured by a high melting point solder. The capacitors are encapsulated in epoxy lacquer, which is resistant to all commonly used cleaning solvents. They have small dimensions and narrow tolerances on the lead spacing. The leads are provided with a flange. This makes the capacitors perfectly suited for hand mounting and automatic insertion. The electrical properties are characterized by low losses, a narrow tolerance on capacitance (± 0.25 pF or 2%), high stability and, owing to the absence of silver, an extremely good DC behaviour.

The flange guarantees that the leads are free of lacquer and its shape allows soldering gasses to escape freely, thus ensuring excellent solderability.

MECHANICAL DATA

Dimensions in mm

Outlines

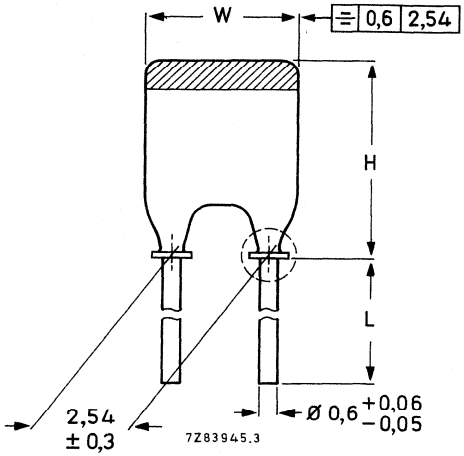


Fig.1 Style 1.

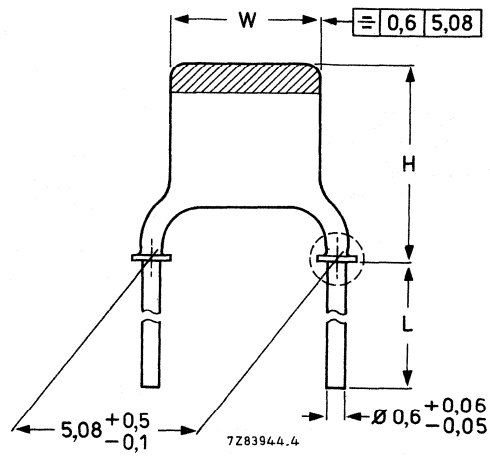


Fig.2 Style 2.

For dimensions H and W see Table 2.
The lead length (L) is shown in Table 1 for bulk packed capacitors; for taped capacitors it can be found in "Packing" section of "General Data" on Miniature ceramic plate capacitors.

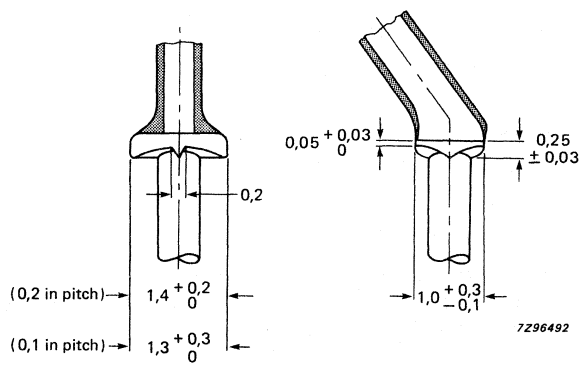


Fig.3 Detail of flange.

Table 1 Ordering information

pitch	lead diameter	Style	catalogue number (see note 1)			
			bulk packed		on tape on reel	on tape in ammopack
			L ⩾ 13 mm	L = 4 ± 0.5 mm		
2.54 mm (0.1 in)	0.6 mm (0.024 in)	1	2222 680	2222 682	2222 678	2222 688 .....
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2	2222 681	2222 683	2222 679	2222 689 .....

Note:

1. Catalog number to be completed by adding code for required capacitance, see tables 3 to 11.

Table 2 Capacitor dimensions

size	W (mm)	H (mm)		approx. mass g
		Fig.1	Fig.2	
I	3.6 (−1.1)	5.0 (−1.5)	6.3 (−1.8)	0.14
II A	3.9 (−1.4)	5.3 (−1.7)	6.7 (−2.0)	0.15
II B	4.5 (−1.8)	6.0 (−2.1)	7.3 (−2.4)	0.15
III	5.1 (−1.8)	6.6 (−2.3)	7.9 (−2.6)	0.17
IV	6.2 (−2.0)	7.7 (−2.4)	9.0 (−2.7)	0.20
V	6.2 (−2.0)	10.3 (−2.8)	11.2 (−3.1)	0.23

Note:

Tolerances are given in brackets.

Unless indicated in tables 3 to 11, the thickness of the capacitors does not exceed 2.3 mm.

Marking

The temperature coefficient is indicated by a colour code as per IEC and EIA recommendations.
The capacitance value is indicated by a marking code in a contrasting colour on the body.

Mounting

When bending, cutting or flattening the leads, they should be relieved of the applied load by supporting them at the capacitor body.

Soldering conditions 260 °C ± 5 °C, max. 10 s

The capacitors are suitable for mounting on printed-wiring boards (hand mounting or automatic insertion). The flange on the leads ensure that soldered connections are free from lacquer. The flange is provided with a degassing groove.

PACKING

Refer to the General Data for Miniature Ceramic Plate Capacitors.

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 384-8. Unless stated otherwise 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%.

Capacitance values* and tolerances, measured at 1 MHz, $\leqslant$ 5 V	see Tables 3 to 11
Rated DC voltage	100 V
Test voltage (DC) for 1 min	300 V
Test voltage (DC) of coating for 1 min	300 V
Insulation resistance after 1 min at 100 V (DC)	$\geqslant$ 10 000 MΩ
Tan δ* at 1 MHz, $\leqslant$ 5 V for C $\leqslant$ 50 pF	$\leqslant 15 \left(\frac{15}{C} + 0{,}7\right) \times 10^{-4}$; max. 55×10^{-4}
for C > 50 pF	$\leqslant 15 \times 10^{-4}$
Category temperature range	−55 to + 85 °C
Storage temperature range	−55 to + 85 °C
Climatic category, IEC 68	55/085/21

* Including 2 mm per connecting lead.

Capacitors with a temperature coefficient P100, rated voltage 100 V (DC)

Capacitance range	0.56 to 47 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	+ 100 x 10^{-6}/K
Tolerance on the temperature coefficient	± 30 x 10^{-6}/K
Marking colour of the temperature coefficient	red/violet

Table 3 Capacitor range, temperature coefficient P100

cap. value (pF)	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
0.56*	± 0.25 pF	I	p56	03567
0.68**	± 0.25 pF	I	p68	03687
0.82***	± 0.25 pF	I	p82	03827
1.0***	± 0.25 pF	I	1p0	03108
1.2	± 0.25 pF	I	1p2	03128
1.5	± 0.25 pF	I	1p5	03158
1.8	± 0.25 pF	I	1p8	03188
2.2	± 0.25 pF	I	2p2	03228
2.7	± 0.25 pF	I	2p7	03278
3.3	± 0.25 pF	I	3p3	03338
3.9	± 0.25 pF	I	3p9	03398
4.7	± 0.25 pF	I	4p7	03478
5.6	± 0.25 pF	I	5p6	03568
6.8	± 0.25 pF	I	6p8	03688
8.2	± 0.25 pF	IIA	8p2	03828
10	± 2%	IIA	10p	04109
12	± 2%	IIB	12p	04129
15	± 2%	IIB	15p	04159
18	± 2%	III	18p	04189
22	± 2%	III	22p	04229
27	± 2%	IV	27p	04279
33	± 2%	IV	33p	04339
39	± 2%	V	39p	04399
47	± 2%	V	47p	04479

Other capacitance values and tolerances are available on request.

* Maximum thickness 3.0 mm.
** Maximum thickness 2.7 mm.
*** Maximum thickness 2.5 mm.

Capacitors with a temperature coefficient NP0, rated voltage 100 V (DC)

Capacitance range	1.8 to 220 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	0×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	black

Table 4 Capacitor range, temperature coefficient NP0

cap. value (pF)	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
1.8	± 0.25 pF	I	1p8	09188
2.2	± 0.25 pF	I	2p2	09228
2.7	± 0.25 pF	I	2p7	09278
3.3	± 0.25 pF	I	3p3	09338
3.9	± 0.25 pF	I	3p9	09398
4.7	± 0.25 pF	I	4p7	09478
5.6	± 0.25 pF	I	5p6	09568
6.8	± 0.25 pF	I	6p8	09688
8.2	± 0.25 pF	I	8p2	09828
10	± 2%	I	10p	10109
12	± 2%	I	12p	10129
15	± 2%	I	15p	10159
18	± 2%	I	18p	10189
22	± 2%	I	22p	10229
27	± 2%	I	27p	10279
33	± 2%	I	33p	10339
39	± 2%	IIA	39p	10399
47	± 2%	IIA	47p	10479
56	± 2%	IIA	56p	10569
68	± 2%	IIB	68p	10689
82	± 2%	IIB	82p	10829
100	± 2%	III	n10	10101
120	± 2%	III	n12	10121
150	± 2%	IV	n15	10151
180	± 2%	IV	n18	10181
220	± 2%	V	n22	10221

Other capacitance values and tolerances are available on request.

Capacitors with a temperature coefficient N075, rated voltage 100 V (DC)

Capacitance range	3.9 to 120 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-75×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	red

Table 5 Capacitor range, temperature coefficient N075

cap. value (pF)	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
3.9	± 0.25 pF	I	3p9	27398
4.7	± 0.25 pF	I	4p7	27478
5.6	± 0.25 pF	I	5p6	27568
6.8	± 0.25 pF	I	6p8	27688
8.2	± 0.25 pF	I	8p2	27828
10	± 2%	I	10p	28109
12	± 2%	I	12p	28129
15	± 2%	I	15p	28159
18	± 2%	I	18p	28189
22	± 2%	IIA	22p	28229
27	± 2%	IIA	27p	28279
33	± 2%	IIB	33p	28339
39	± 2%	IIB	39p	28399
47	± 2%	III	47p	28479
56	± 2%	III	56p	28569
68	± 2%	IV	68p	28689
82	± 2%	IV	82p	28829
100	± 2%	V	n10	28101
120	± 2%	V	n12	28121

Other capacitance values and tolerances are available on request.

Capacitors with a temperature coefficient N150, rated voltage 100 V (DC)

Capacitance range	3.9 to 220 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-150×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	orange

Table 6 Capacitor range, temperature coefficient N150

cap. value (pF)	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
3.9*	± 0.25 pF	I	3p9	33398
4.7	± 0.25 pF	I	4p7	33478
5.6	± 0.25 pF	I	5p6	33568
6.8	± 0.25 pF	I	6p8	33688
8.2	± 0.25 pF	I	8p2	33828
10	± 2%	I	10p	34109
12	± 2%	I	12p	34129
15	± 2%	I	15p	34159
18	± 2%	I	18p	34189
22	± 2%	I	22p	34229
27	± 2%	I	27p	34279
33	± 2%	I	33p	34339
39	± 2%	IIA	39p	34399
47	± 2%	IIA	47p	34479
56	± 2%	IIB	56p	34569
68	± 2%	IIB	68p	34689
82	± 2%	III	82p	34829
100	± 2%	III	n10	34101
120	± 2%	IV	n12	34121
150	± 2%	IV	n15	34151
180	± 2%	IV	n18	34181
220	± 2%	V	n22	34221

Other capacitance values and tolerances are available on request.

* Maximum thickness 2.5 mm.

Capacitors with a temperature coefficient N220, rated voltage 100 V (DC)

Capacitance range	3.9 to 150 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-220×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	yellow

Table 7 Capacitor range, temperature coefficient N220

cap. value (pF)	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
3.9*	± 0.25 pF	I	3p9	39398
4.7	± 0.25 pF	I	4p7	39478
5.6	± 0.25 pF	I	5p6	39568
6.8	± 0.25 pF	I	6p8	39688
8.2	± 0.25 pF	I	8p2	39828
10	± 2%	I	10p	40109
12	± 2%	I	12p	40129
15	± 2%	I	15p	40159
18	± 2%	I	18p	40189
22	± 2%	I	22p	40229
27	± 2%	IIA	27p	40279
33	± 2%	IIA	33p	40339
39	± 2%	IIB	39p	40399
47	± 2%	IIB	47p	40479
56	± 2%	III	56p	40569
68	± 2%	III	68p	40689
82	± 2%	IV	82p	40829
100	± 2%	IV	n10	40101
120	± 2%	V	n12	40121
150	± 2%	V	n15	40151

Other capacitance values and tolerances are available on request.

* Maximum thickness 2.5 mm.

Capacitors with a temperature coefficient N330, rated voltage 100 V (DC)

Capacitance range	4.7 to 180 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-330×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 60 \times 10^{-6}$/K
Marking colour of the temperature coefficient	green

Table 8 Capacitor range, temperature coefficient N330

cap. value (pF)	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
4.7	± 0.25 pF	I	4p7	45478
5.6	± 0.25 pF	I	5p6	45568
6.8	± 0.25 pF	I	6p8	45688
8.2	± 0.25 pF	I	8p2	45828
10	± 2%	I	10p	46109
12	± 2%	I	12p	46129
15	± 2%	I	15p	46159
18	± 2%	I	18p	46189
22	± 2%	I	22p	46229
27	± 2%	I	27p	46279
33	± 2%	IIA	33p	46339
39	± 2%	IIA	39p	46399
47	± 2%	IIB	47p	46479
56	± 2%	IIB	56p	46569
68	± 2%	III	68p	46689
82	± 2%	III	82p	46829
100	± 2%	IV	n10	46101
120	± 2%	IV	n12	46121
150	± 2%	V	n15	46151
180	± 2%	V	n18	46181

Other capacitance values and tolerances are available on request.

Capacitors with a temperature coefficient N470, rated voltage 100 V (DC)

Capacitance range	6.8 to 220 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-470×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 60 \times 10^{-6}$/K
Marking colour of the temperature coefficient	blue

Table 9 Capacitor range, temperature coefficient N470

cap. value (pF)	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
6.8	± 0.25 pF	I	6p8	51688
8.2	± 0.25 pF	I	8p2	51828
10	± 2%	I	10p	52109
12	± 2%	I	12p	52129
15	± 2%	I	15p	52159
18	± 2%	I	18p	52189
22	± 2%	I	22p	52229
27	± 2%	I	27p	52279
33	± 2%	I	33p	52339
39	± 2%	IIA	39p	52399
47	± 2%	IIA	47p	52479
56	± 2%	IIB	56p	52569
68	± 2%	IIB	68p	52689
82	± 2%	III	82p	52829
100	± 2%	III	n10	52101
120	± 2%	IV	n12	52121
150	± 2%	IV	n15	52151
180	± 2%	V	n18	52181
220	± 2%	V	n22	52221

Other capacitance values and tolerances are available on request.

Capacitors with a temperature coefficient N750, rated voltage 100 V (DC)

Capacitance range	3.9 to 330 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-750×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 120 \times 10^{-6}$/K
Marking colour of the temperature coefficient	violet

Table 10 Capacitor range, temperature coefficient N750

cap. value (pF)	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
3.9	± 0.25 pF	I	3p9	57398
4.7	± 0.25 pF	I	4p7	57478
5.6	± 0.25 pF	I	5p6	57568
6.8	± 0.25 pF	I	6p8	57688
8.2	± 0.25 pF	I	8p2	57828
10	± 2%	I	10p	58109
12	± 2%	I	12p	58129
15	± 2%	I	15p	58159
18	± 2%	I	18p	58189
22	± 2%	I	22p	58229
27	± 2%	I	27p	58279
33	± 2%	I	33p	58339
39	± 2%	I	39p	58399
47	± 2%	I	47p	58479
56	± 2%	IIA	56p	58569
68	± 2%	IIA	68p	58689
82	± 2%	IIB	82p	58829
100	± 2%	IIB	n10	58101
120	± 2%	III	n12	58121
150	± 2%	III	n15	58151
180	± 2%	IV	n18	58181
220	± 2%	IV	n22	58221
270	± 2%	V	n27	58271
330	± 2%	V	n33	58331

Other capacitance values and tolerances are available on request.

Capacitors with a temperature coefficient N1500, rated voltage 100 V (DC)

Capacitance range	18 to 560 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	$-1500 \times 10^{-6}/K$
Tolerance on the temperature coefficient	$(0 \text{ to } +500) \times 10^{-6}/K$
Marking colour of the temperature coefficient	orange/orange

Table 11 Capacitor range, temperature coefficient N1500

cap. value (pF)	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
18*	± 2%	I	18p	70189
22	± 2%	I	22p	70229
27	± 2%	I	27p	70279
33	± 2%	I	33p	70339
39	± 2%	I	39p	70399
47	± 2%	I	47p	70479
56	± 2%	I	56p	70569
68	± 2%	I	68p	70689
82	± 2%	I	82p	70829
100	± 2%	IIA	n10	70101
120	± 2%	IIA	n12	70121
150	± 2%	IIB	n15	70151
180	± 2%	IIB	n18	70181
220	± 2%	III	n22	70221
270	± 2%	IV	n27	70271
330	± 2%	IV	n33	70331
390	± 2%	IV	n39	70391
470	± 2%	V	n47	70471
560	± 2%	V	n56	70561

Other capacitance values and tolerances are available on request.

* Maximum thickness 2.5 mm.

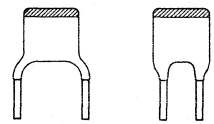
MINIATURE CERAMIC PLATE CAPACITORS
NON-FLANGED TYPES

MINIATURE CERAMIC PLATE CAPACITORS

(NON-FLANGED TYPES)

class 2

- General purpose
- Coupling and decoupling
- Space saving



QUICK REFERENCE DATA

	2222 629-series	2222 630-series	2222 640-series
Capacitance range	1000 - 47000 pF E3 series	180 - 6800 pF E12 series	1000 - 15000 pF E6 series
Rated DC voltage	63 V	100 V	100 V
Tolerance on capacitance	–20/+ 80%	± 10%	–20/+ 50%
Sectional specification	IEC 384-9	IEC 384-9 (2C2)	IEC 384-9 (2E2)
Climatic category (IEC 68)	10/055/21	55/085/21	55/085/21

APPLICATION

Ceramic plate capacitors without flange are not for current design projects. They are recommended for maintenance purposes only. The electrical properties are identical to capacitors with flanged leads.

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized. The tinned connecting leads are secured by a high melting point solder. The capacitors are encapsulated in epoxy lacquer, which is resistant to all commonly used cleaning solvents. They have small dimensions and narrow tolerances on the lead spacing.

MECHANICAL DATA

Dimensions in mm

Outlines

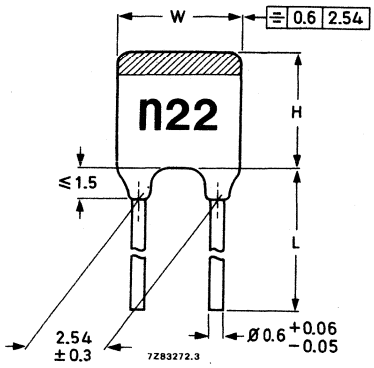


Fig.1 Style 1.

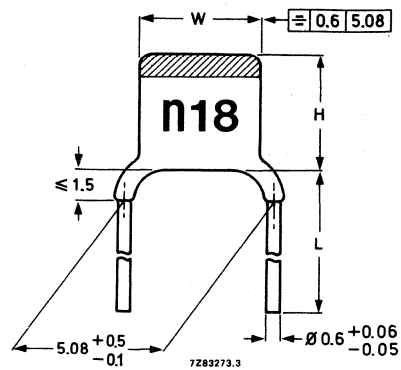


Fig.2 Style 2.

For dimensions H, L and W see Tables 1 and 2.

Table 1 Ordering information

pitch	lead diameter	Style	catalogue number (see note 1)	
			L ⩾ 15 mm	L = 6 $^{+0}_{-2}$
2.54 mm (0.1 in)	0.6 mm (0.024 in)	1	2222 629 01 . . . 2222 630 01 . . . 2222 640 01 . . .	2222 629 05 . . . 2222 630 05 . . . 2222 640 05 . . .
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2	2222 629 03 . . . 2222 630 03 . . . 2222 640 03 . . .	2222 629 06 . . . 2222 630 06 . . . 2222 640 06 . . .

Note

1. Catalog number to be completed by adding code for required capacitance value, see Tables 3, 4 and 5 of 2222 629, 630, 640 with flange.

Table 2 Capacitor dimensions

size	W (mm)	H (mm)	approx. mass g.
I	3.6 (−1.1)	3.7 (−1.2)	0.14
II A	3.9 (−1.4)	4.0 (−1.5)	0.15
II B	4.5 (−1.8)	4.7 (−2.0)	0.16
III	5.1 (−1.8)	5.3 (−2.0)	0.17
IV	6.2 (−2.0)	6.4 (−2.2)	0.20
V	6.2 (−2.0)	8.6 (−2.6)	0.23

Note: Tolerances are given between brackets.

The thickness of the capacitors does not exceed 2.3 mm with the exception of 2222 630 . . 181 (maximum thickness 2.5 mm).

Lacquer on the leads

When the capacitors shown in Figs 1 and 2 are mounted on printed-wiring boards with a thickness of 1.5 mm and with holes of 1.3 mm diameter or on printed-wiring boards with a thickness of 1 mm and with holes of 0.8 mm diameter there will be no lacquer on the leads at the lower side of the board. For capacitors with maximum thickness greater than 2.3 mm and lead pitch of 5.08 mm, the lacquer on the leads extends less than 2 mm.

Marking

The body of the capacitors is tan coloured. The capacitors also have a colour mark on top indicating the temperature dependence of the capacitance; green for type 2222 629, yellow for type 2222 630, and blue for type 2222 640. The capacitance value is indicated by a marking code in a contrasting colour on the body.

Refer to Tables 3, 4 and 5 of 2222 629,630,640 with flange.

Mounting

When bending, cutting or flattening the leads, they should be relieved of the applied load by supporting them at the capacitor body.

Soldering conditions max. 260 °C ± 5 °C, max. 10 s

PACKING

Refer to the General section for Miniature Ceramic Plate Capacitors.

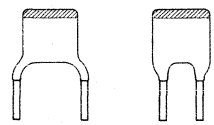
For electrical data, refer to datasheet 2222 629, 630, 640 with flange.

MINIATURE CERAMIC PLATE CAPACITORS

(NON-FLANGED TYPES)

class 1

- High-frequency circuits
- Temperature compensating
- High stability
- Space saving



QUICK REFERENCE DATA

Capacitance range	0.56 to 560 pF (E12 series)
Rated DC voltage	100 V
Tolerance on capacitance	± 2% or ± 0.25 pF
Temperature coefficients	P100, NP0, N075, N150, N220 N330, N470, N750, N1500
Sectional specification	IEC 384-8
Climatic category (IEC 68)	55/085/21

APPLICATION

Ceramic plate capacitors without flange are not for current design projects. They are recommended for maintenance purposes only. The electrical properties are identical to capacitors with flanged leads.

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized. The tinned connecting leads are secured by a high melting point solder. The capacitors are encapsulated in epoxy lacquer, which is resistant to all commonly used cleaning solvents. They have small dimensions and narrow tolerances on the lead spacing.

The electrical properties are characterized by low losses, a narrow tolerance on capacitance (± 0.25 pF of 2%), high stability and, owing to the absence of silver, an extremely good DC behaviour.

MECHANICAL DATA

Dimensions in mm

Outlines

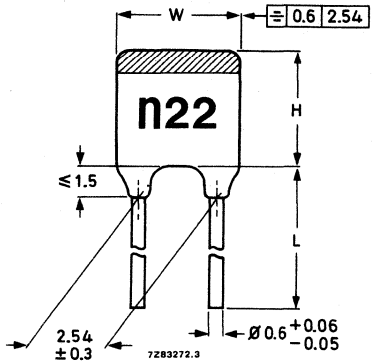


Fig.1 Style 1.

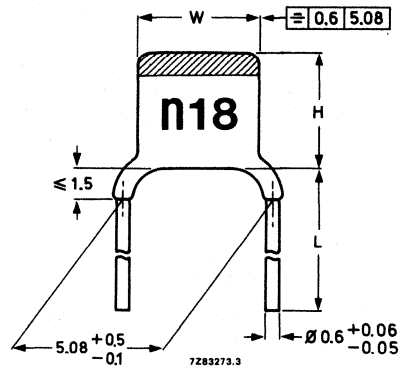


Fig.2 Style 2.

For dimensions H, L and W see Tables 1 and 2.

Table 1 Ordering information

pitch	lead diameter	Style	catalogue number (see note 1)	
			L ⩾ 15 mm	L = 6 $^{+0}_{-2}$
2.54 mm (0.1 in)	0.6 mm (0.024 in)	1	2222 631	2222 641 . . . . .
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2	2222 638	2222 642 . . . . .

Note

1. For catalogue number suffix, see Tables 3 to 11 of data sheet 2222 678 to 683; 2222 688; 689.

Table 2 Capacitor dimensions

size	W (mm)	H (mm)	approx. mass g.
I	3.6 (−1.1)	3.7 (−1.2)	0.14
II A	3.9 (−1.4)	4.0 (−1.5)	0.15
II B	4.5 (−1.8)	4.7 (−2.0)	0.16
III	5.1 (−1.8)	5.3 (−2.0)	0.17
IV	6.2 (−2.0)	6.4 (−2.2)	0.20
V	6.2 (−2.0)	8.6 (−2.6)	0.23

Note: Tolerances are given between brackets.

Unless indicated in tables 3 to 11 of datasheet 2222 678 to 683, 688, 689, the thickness of the capacitors does not exceed 2.3 mm. Capacitors exceeding this thickness also have H_{max} = 4.5 mm.

Lacquer on the leads

When the capacitors shown in Figs 1 and 2 are mounted on printed-wiring boards with a thickness of 1.5 mm and with holes of 1.3 mm diameter or on printed-wiring boards with a thickness of 1 mm and with holes of 0.8 mm diameter there will be no lacquer on the leads at the lower side of the board. For capacitors with maximum thickness greater than 2.3 mm and lead pitch of 5.08 mm, the lacquer on the leads extends less than 2 mm.

Marking

The temperature coefficient is indicated by a colour code as per IEC and EIA recommendations. The capacitance value is indicated by a marking code in a contrasting colour on the body.

Mounting

When bending, cutting or flattening the leads, they should be relieved of the applied load by supporting them at the capacitor body.

Soldering conditions max. 260 °C ± 5 °C, max. 10 s

PACKING

Refer to the General section for Miniature Ceramic Plate Capacitors.

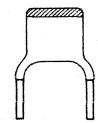
For further detailed information, refer to datasheet 2222 678 to 683, 2222 688; 689.

MINIATURE CERAMIC PLATE CAPACITORS

(NON-FLANGED TYPES)

class 1, 500 V (DC)

- High-frequency circuits
- Temperature compensating
- High stability
- Space saving



QUICK REFERENCE DATA

Capacitance range	0.47 to 270 pF (E12 series)
Rated DC voltage	500 V
Tolerance on capacitance	± 2% or ± 0.25 pF
Temperature coefficients	P100, NP0, N150, N750, N1500
Sectional specification	IEC 384-8
Climatic category (IEC 68)	55/085/21

APPLICATION

Ceramic plate capacitors without flange are not for current design projects. They are recommended for maintenance purposes only. The electrical properties are identical to capacitors with flanged leads.

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized. The tinned connecting leads are secured by a high melting point solder. The capacitors are encapsulated in epoxy lacquer, which is resistant to all commonly used cleaning solvents. They have small dimensions and narrow tolerances on the lead spacing.

The electrical properties are characterized by low losses, a narrow tolerance on capacitance (± 0.25 pF of 2%), high stability and, owing to the absence of silver, an extremely good DC behaviour.

MECHANICAL DATA

Dimensions in mm

Outlines

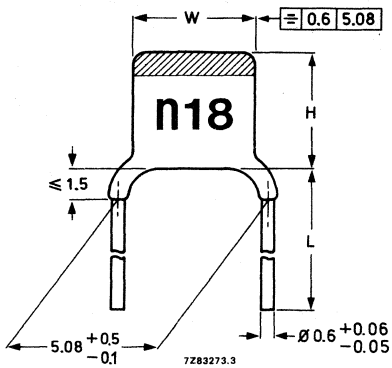


Fig.1 Component outline.

For dimensions H, L and W see Tables 1 and 2.

Table 1 Ordering information

pitch	lead diameter	catalogue number (see note 1)	
		$L \geqslant 15$ mm	$L = 6^{+0}_{-2}$
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2222 650	2222 651 . . . . .

Table 2 Capacitor dimensions

size	W (mm)	H (mm)	approx. mass g.
I	3.6 (−1.1)	3.7 (−1.2)	0.14
II A	3.9 (−1.4)	4.0 (−1.5)	0.15
II B	4.5 (−1.8)	4.7 (−2.0)	0.16
III	5.1 (−1.8)	5.3 (−2.0)	0.17
IV	6.2 (−2.0)	6.4 (−2.2)	0.20
V	6.2 (−2.0)	8.6 (−2.6)	0.23

Note: Tolerances are given between brackets.

Unless indicated in tables 3 to 7 of datasheet 2222 625, 653, 654, the thickness of the capacitors does not exceed 2.3 mm.
The H_{max} of the indicated capacitors is 4.5 mm.

Note

1. Catalog number to be completed by adding code for required capacitance and temperature coefficient, see Tables 3 to 7 of datasheet 2222 652; 2222 653; 2222 654; 2222 691.

Lacquer on the leads

When the capacitors are mounted on printed-wiring boards with a thickness of 1.5 mm and with holes of 1.3 mm diameter or on printed-wiring boards with a thickness of 1 mm and with holes of 0.8 mm diameter there will be no lacquer on the leads at the lower side of the board. For capacitors with maximum thickness greater than 2.3 mm and lead pitch of 5.08 mm, the lacquer on the leads extends less than 2 mm.

Marking

The temperature coefficient is indicated by a colour code as per IEC and EIA recommendations. The capacitance value and the voltage are indicated on the body by figures in a contrasting colour.

Mounting

When bending, cutting or flattening the leads, they should be relieved of the applied load by supporting them at the capacitor body.

Soldering conditions max. 260 °C ± 5 °C, max. 10 s

PACKING

Refer to the General section for Miniature Ceramic Plate Capacitors.

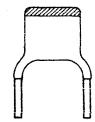
For further detailed information, refer to the datasheet for 2222 652; 2222 653; 2222 654; 2222 691.

MINIATURE CERAMIC PLATE CAPACITORS

(NON-FLANGED TYPE)

class 2, 500 V (DC)

- Coupling and decoupling
- Space saving



QUICK REFERENCE DATA

Capacitance range	100 - 2700 pF (E12 series)
Rated DC voltage	500 V
Tolerance on capacitance	± 10%
Sectional specification	IEC 384-9 (2C2)
Climatic category (IEC 68)	55/085/21

APPLICATION

Ceramic plate capacitors without flange are not for current design projects. They are recommended for maintenance purposes only. The electrical properties are identical to capacitors with flanged leads.

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized. The tinned connecting leads are secured by a high melting point solder. The capacitors are encapsulated in epoxy lacquer, which is resistant to all commonly used cleaning solvents. They have small dimensions and narrow tolerances on the lead spacing.

MECHANICAL DATA

Dimensions in mm

Outlines

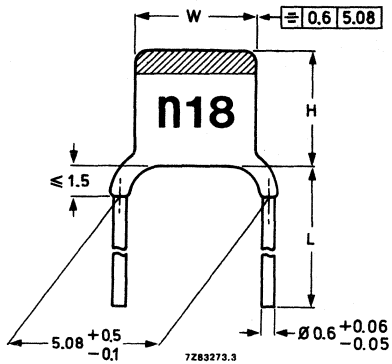


Fig.1.

For dimensions H, L and W see Tables 1 and 2.

Table 1 Ordering information

pitch	lead diameter	catalogue number (see note 1)	
		$L \geqslant 15$ mm	$L = 6^{+0}_{-2}$
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2222 655 03 . . .	2222 655 06 . . .

Table 2 Capacitor dimensions

size	W (mm)	H (mm)	approx. mass g.
I	3.6 (−1.1)	3.7 (−1.2)	0.14
II A	3.9 (−1.4)	4.0 (−1.5)	0.15
II B	4.5 (−1.8)	4.7 (−2.0)	0.16
III	5.1 (−1.8)	5.3 (−2.0)	0.17
IV	6.2 (−2.0)	6.4 (−2.2)	0.20
V	6.2 (−2.0)	8.6 (−2.6)	0.23

Note: Tolerances are given between brackets.

Except for the types indicated in Table 3, the thickness of the capacitor does not exceed 2.3 mm.

Note

1. Catalog number to be completed by adding code for required capacitance value, see Table 3.

Lacquer on the leads

When the capacitors are mounted on printed-wiring boards with a thickness of 1.5 mm and with holes of 1.3 mm diameter or on printed-wiring boards with a thickness of 1 mm and with holes of 0.8 mm diameter there will be no lacquer on the leads at the lower side of the board. For those capacitance values indicated with asterisks in Table 3, the lacquer on the leads is less than 2 mm.

Marking

The body of the capacitors is tan coloured.
The temperature dependence is indicated by a yellow colour cap. Capacitance value and voltage are indicated on the body by figures according to Table 3 in a contrasting colour.

Mounting

When bending, cutting or flattening the leads, they should be relieved of the applied load by supporting them at the capacitor body.

Soldering conditions max. 260 °C ± 5 °C, max. 10 s

PACKING

Refer to the General section for Miniature Ceramic Plate Capacitors.

ELECTRICAL DATA

For electrical data see data sheet 2222 655 with flange.

Table 3

capacitance pF	size see Table 2	marking		code in catalogue number, see Table 1
100 *	I	n10	500	101
120 **	I	n12	500	121
150	I	n15	500	151
180	I	n18	500	181
220	I	n22	500	221
270	I	n27	500	271
330	I	n33	500	331
390	IIA	n39	500	391
470	IIA	n47	500	471
560	IIB	n56	500	561
680	IIB	n68	500	681
820	IIB	n82	500	821
1000	III	1n0	500	102
1200	III	1n2	500	122
1500	IV	1n5	500	152
1800	IV	1n8	500	182
2200	IV	2n2	500	222
2700	V	2n7	500	272

* Maximum thickness 2.7 mm, H_{max} = 4.5 mm.
** Maximum thickness 2.5 mm, H_{max} = 4.5 mm.

CERAMIC MULTILAYER CAPACITORS

SURFACE MOUNTED
CERAMIC MULTILAYER CAPACITORS

This section gives details of the range of ceramic multilayer capacitors.

The product range consists of two parts.

Standard CMC range

These capacitors are produced using standard manufacturing technology and are available with NPO, N220 and N750 dielectrics for class 1 types and X7R and Y5V dielectrics for class 2 types.

The capacitance ranges are

class 1	NPO	0.47 pF to 10 000 pF	E12 series
	N220	2.7 pF to 820 pF	E12 series
	N750	4.7 pF to 1200 pF	E12 series
class 2	X7R	100 pF to 1 μF	E12 series
	Y5V	1000 pF to 100 nF	E6 series

Compact CMC range

Additional to the standard series, the compact series are produced using new manufacturing technology, which gives increased volume efficiency and a dense dielectric. The compact CMC technology is applied to higher capacitance values using NPO and X7R dielectrics.

The capacitance range is

NPO	470 pF to 33 nF
X7R	39 nF to 1 μF

Table 1 provides selection chart for both standard and compact ranges. The survey shows the size, thickness category, dielectric and capacitance values which are available.

For further technical details see the relevant data sheet in the following pages.

Table 1 Selection guide class 1

size	thickness (mm)	product series	specification			
			NPO (100 V)	NPO (63 V)	N220 (63 V)	N750 (63 V)
0603	0.70–0.90	standard		0.47–150 pF	2.7–150 pF	4.7–220 pF
	0.70–0.90	compact		220–390 pF*		
0805	0.51–0.70	standard	10–270 pF	0.47–270 pF	4.7–270 pF	6.8–390 pF
	0.51–0.70	compact		470–1000 pF		
	0.70–1.00	standard	330–560 pF	330–1000 pF		
	0.70–1.00	compact		1200–1800 pF		
	1.00–1.30	standard	680–1000 pF			
	1.00–1.30	compact		2200 pF		
1206	0.51–0.70	standard	10–820 pF	0.47–820 pF	8.2–820 pF	6.8–1200 pF
	0.51–0.70	compact		2200–2700 pF		
	0.70–1.00	standard	1000–1800 pF	1000–1800 pF		
	0.70–1.00	compact		3300–5600 pF		
	1.00–1.30	standard	2200 pF	2200 pF		
	1.00–1.30	standard	2700–3300 pF	2700–3300 pF		
	1.00–1.30	compact		6800 pF		
	1.30–1.60	compact		8200 pF		
1210	0.51–0.70	compact		4700–5600 pF		
	0.51–1.00	standard	47–3300 pF	47–3300 pF		
	0.70–1.00	compact		6800–10000 pF		
	1.00–1.60	standard	3900–4700 pF	3900–4700 pF		
	1.00–1.30	compact		12000–15000 pF		
	1.30–1.60	compact		18000 pF		
1808	0.51–1.00	standard		100–3300 pF		
	1.00–1.60	standard		3300–5600 pF		
1812	0.51–1.00	standard		330–5600 pF		
	0.51–1.00	compact		8200–22000 pF		
	1.00–1.30	compact		27000 pF		
	1.30–1.80	compact		33000 pF		
2220	0.51–1.00	standard		470–10000 pF		
	0.51–1.00	compact		47000 pF*		
	1.00–1.80	compact		56000–100000pF*		

* Values under development.

Class 2

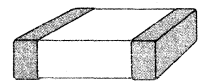
size	thickness (mm)	product series	specification			
			X7R (100 V)	X7R (63 V)	X7R (25 V)	Y5V (63 V)
0603	0.70–0.90	standard		0.10–10 nF		1–10 nF
	0.70–0.90	compact			10–22 nF*	
0805	0.51–0.70	standard	0.18–10 nF	0.18–15 nF		
	0.51–0.70	compact			39–56 nF	
	0.80–1.0	standard		18–33 nF		
	0.70–1.0	compact		39–47 nF	68–100 nF	
	1.0–1.3	compact		56–68 nF	120 nF	
1206	0.51–0.70	compact		100 nF	120–180 nF	
	0.70–1.0	standard	0.68–33 nF	0.68–100 nF		
	0.70–1.0	compact		120–150 nF	220–330 nF	
	1.0–1.3	compact		180–220 nF	390 nF	
1210	0.51–0.70	compact		180 nF	270 nF	
	0.51–1.0	standard	2.2–68 nF	2.2–220 nF		
	0.70–1.0	compact		220–270 nF	330–470 nF	
	1.0–1.3	compact		330–390 nF	560–680 nF	
	1.3–1.6	compact		470 nF	820 nF	
1808	0.51–1.0	standard	2.2–82 nF	2.2–220 nF		
	1.0–1.30	standard		270 nF		
1812	0.51–1.0	standard	4.7–150 nF	4.7–390 nF		
	0.51–1.0	compact		330–560 nF	560–1000 nF*	
	1.0–1.30	standard		470 nF		
	1.0–1.30	compact		680 nF	1200 nF*	
	1.3–1.80	compact		820–1000 nF	1500–1800 nF*	
2220	0.51–1.0	standard		12–820 nF		
	0.51–1.0	compact		1200 nF*	2200 nF*	
	1.0–1.30	standard		1000 nF		
	1.0–1.80	compact		1500–1800 nF*	2700–3900 nF*	

* Value under development.

SURFACE MOUNTED CERAMIC MULTILAYER CAPACITORS

(STANDARD SERIES)

- Seven standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in boxes
- For high frequency applications
- Ag/Pd and Ni/Sn plated end terminations



QUICK REFERENCE DATA

Capacitance range	
class 1, NP0 dielectric	0.47 to 10 000 pF (E-12 series) (note 1)
N220 dielectric	2.7 to 820 pF (E-12 series)
N750 dielectric	4.7 to 1200 pF (E-12 series)
class 2, X7R dielectric	100 pF to 1 μF (E-12 series)
Y5V dielectric	1000 to 100 000 pF (E-6 series)
Rated voltage U_R (DC)	63 V (IEC), 100 V (IEC) (note 3)
Tolerance on capacitance	
NP0, N220, N750 dielectrics	± 10%, ± 5%, ± 2% (note 2); below 10 pF, ± 0.5 or ± 0.25 pF
X7R dielectric	± 20%, ± 10%, ± 5%
Y5V dielectric	−20 to +80%; ± 20%
Sectional specifications	IEC 384-10, second edition 1989-04 CECC 32 100 (note 4)
Detail specification	CECC 32 101 - 801 (note 4)
Climatic category (IEC 68)	
NP0, N220, N750 dielectrics	55/125/56
X7R dielectric	55/125/56
Y5V dielectric	25/085/56

APPLICATION

These surface mounted capacitors have a high capacitance per unit volume, and their small dimensions, performance characteristics (e.g. high Q-factor) and reliability make them suitable for a wide range of applications, especially where high packaging density is a major requirement.

Main areas of application are consumer electronics (e.g. tuners, televisions, video recorders, cameras, pocket calculators etc.), telecommunications and in automotive and data processing equipment.

The capacitors may be supplied in blister tape on reel; this makes them suitable for use with automatic placement epuipment. They may also be supplied in bulk in boxes.

Notes

1. Other values below 10 pF and values other than E12 are available on request.
2. ± 1% available on request.
3. See Tables 2, 4 and 5.
4. CECC approvals in preparation.

DESCRIPTION

The capacitors consist 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 suitably connected to the two terminations - either by silver palladium (Ag/Pd alloy) in a 65:35 ratio; or silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (see Fig.1).

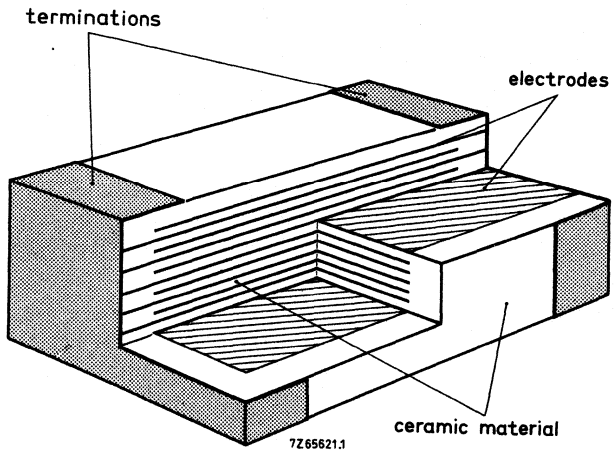


Fig. 1 Construction of Ceramic Multilayer Capacitor.

MECHANICAL DATA

Dimensions in mm

Outline

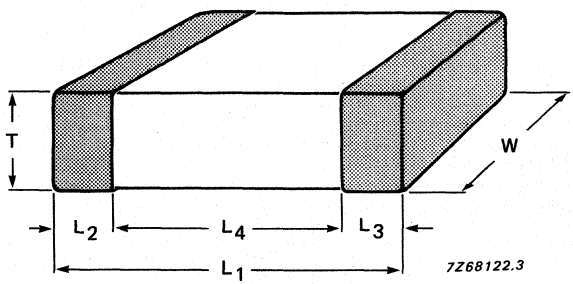


Fig.2 Component outline; see Table 1 for dimensions.

Table 1 Physical dimensions

case size	L_1	W	T min.	T max.	L_2/L_3 min.	L_2/L_3 max.	L_4 min.
0603	1.6 ± 0.10	0.80 ± 0.10	0.70	0.90	0.25	0.65	0.4
0805	2.0 ± 0.10	1.25 ± 0.10	0.51*	1.30*	0.25	0.75	0.55
1206	3.2 ± 0.15	1.6 ± 0.15	0.51*	1.60*	0.25	0.75	1.4
1210	3.2 ± 0.2	2.5 ± 0.2	0.51	1.80	0.25	0.75	1.4
1808**	4.5 ± 0.2	2.0 ± 0.2	0.51	1.80	0.25	0.75	2.2
1812	4.5 ± 0.2	3.2 ± 0.2	0.51	1.80	0.25	0.75	2.2
2220	5.7 ± 0.2	5.0 ± 0.2	0.51	1.80	0.25	0.75	2.9

* Refer also to Tables 2 and 4.

** Non-preferred.

Table 2 Selection chart for class 1 capacitors with AgPd and NiSn plated terminations

MSA195 - 2

C (pF)	NPO										N220			N750		
	63 V							100 V *****			63 V			63 V		
	0603	0805	1206	1210	**** 1808	1812	**** 2220	0805	1206	1210	* 0603	*** 0805	*** 1206	* 0603	*** 0805	*** 1206
0.47																
0.56																
0.68																
0.82																
1.0																
1.2																
1.5																
1.8																
2.2																
2.7																
3.3																
3.9																
4.7																
5.6																
6.8																
8.2																
10																
12																
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820																
1000																
1200																
1500																
1800																
2200																
2700																
3300																
3900																
4700																
5600																
6800																
8200																
10000																

0.7 to 0.9 mm
0.7 to 1.0 mm
0.51 to 0.7 mm
1.0 to 1.30 mm
0.51 to 1.0 mm
1.30 to 1.60 mm

Packing

Sizes 0603, 0805, 1206 and 1210 with thickness $\leqslant$ 1.30 mm are available in 8 mm tape on reel and in bulk, with thickness $>$ 1.30 only available in bulk.
Sizes 1812 and 2220 with thickness $\leqslant$ 1.30 mm are available in 12 mm tape on reel and in bulk, with thickness $>$ 1.30 only available in bulk.
Size 1808 is only available in bulk.

* Size 0603 in N220 and N750 under development.
** NiSn plated terminations for N220 dielectrics under development.
*** Sizes 0805 and 1206 in N220 and N750 usable up to 100 V.
**** NiSn plated terminations for NP0 in sizes 1808 and 2220 under development.
***** 100 V rated voltage products available with AgPd terminations and up to a product thickness $\leqslant$ 1.00 mm with NiSn terminations.

ELECTRICAL DATA

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%.

Class 1 capacitors

Capacitance range (E-12 series) (note 1)	
NP0 dielectric	0.47 to 10 000 pF
N220 dielectric	2.7 to 820 pF
N750 dielectric	4.7 to 1200 pF
Tolerance on capacitance	
$C \geqslant 10$ pF	± 10%, ± 5%, ± 2% (note 2)
5 pF $\leqslant C <$ 10 pF	± 0.5 pF
$C <$ 5 pF	± 0.25 pF
Rated voltage U_R (DC) (note 3)	63 V (IEC), 100 V (IEC)
Test voltage (DC) for 1 minute	2.5 x U_R
Tan δ (note 1)	
$C <$ 5 pF	$\leqslant 30 \times 10^{-4}$
5 pF $\leqslant C <$ 50 pF	$1.5 \times (150 + 7) \times 10^{-4}$, $\frac{}{C}$ (30×10^{-4} maximum)
$C \geqslant$ 50 pF	$\leqslant 10 \times 10^{-4}$
Insulation resistance, after 60 s at U_R (DC)	> 100 GΩ
Climatic category (IEC 68)	55/125/56
Temperature coefficient	see Table 3

Table 3 Temperature coefficient values

capacitance range	dielectric type		
	NP0	N220	N750
0.47 pF $\leqslant C <$ 5 pF	(0 ± 150) x 10^{-6}/K (note 5)	(−220 ± 60) x 10^{-6}/K	
5 pF $\leqslant C <$ 10 pF	(0 ± 150) x 10^{-6}/K (note 5)	(−220 ± 60) x 10^{-6}/K	(−750 ± 250) x 10^{-6}/K
$C \geqslant$ 10 pF	(0 ± 30) x 10^{-6}/K	(−220 ± 60) x 10^{-6}/K	(−750 ± 250) x 10^{-6}/K

Terminations	AgPd or NiSn metallized (note 4)

Notes

1. Measured at 1 V, 1 MHz for $C \leqslant$ 1000 pF, and at 1 V, 1 kHz for $C >$ 1000 pF, using a four gauge method.
2. For $C \geqslant$ 10 pF, ± 1% available to special order.
3. Refer to Table 2 for indication of which products are rated up to 100 V.
4. NiSn plated terminations in NP0 sizes 1808, 2220 and in N220 are under development.
5. For size 0603 in NP0 all capacitance values from 0.47 pF – 150 pF have temperature coefficient of (0 ± 30) x 10^{-6}/K.

Fig. 3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage for NP0, N220 and N750 dielectrics.

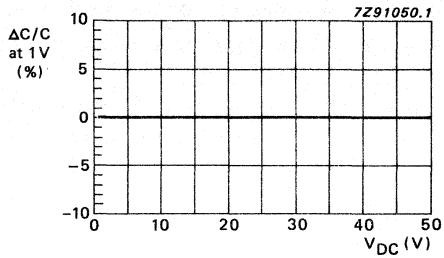


Fig.4 Typical tan δ as a function of temperature for NP0 dielectric.

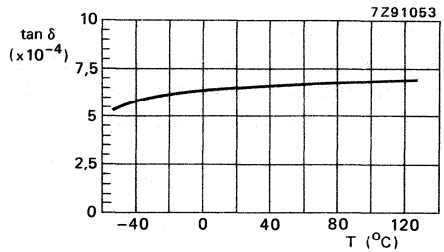
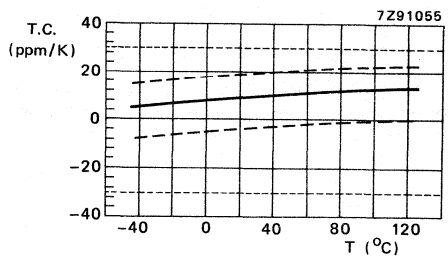


Fig.5 Typical temperature coefficient as a function of temperature for NP0 dielectric; the dashed curves indicate sample limits, dotted lines indicate requirement levels.



High frequency behaviour of Ceramic Multilayer Capacitors

Ceramic Multilayer Capacitors are suitable for use at high frequencies. Fig.6 shows an equivalent series representation.

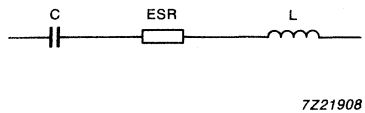


Fig.6 Equivalent series representation of a Ceramic Multilayer Capacitor.

In Fig.6,

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.

In general, the quantities C, ESR and L are frequency dependent. For most applications, C and L can be regarded as frequency independent for frequencies 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 size 0603, 1 nH for sizes 0805, 1206 and 1210, and approximately 1.5 nH for sizes 1808, 1812 and 2220.

  These figures are accurate to within approximately 20%.

Figures 7 and 8 show the series resonance frequency as a function of capacitance, where the series resonant frequency f_r can be represented by the following formula:

$$f_r = \frac{1}{2\pi (LC)^{1/2}}$$

Fig.7 Series resonance frequency as a function of capacitance (pF values).

L = 1 nH ————————

L = 1.5 nH – – – – – – – –

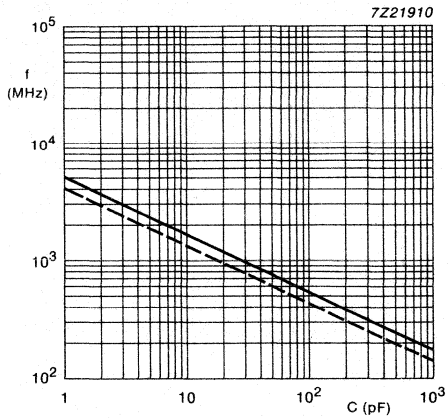
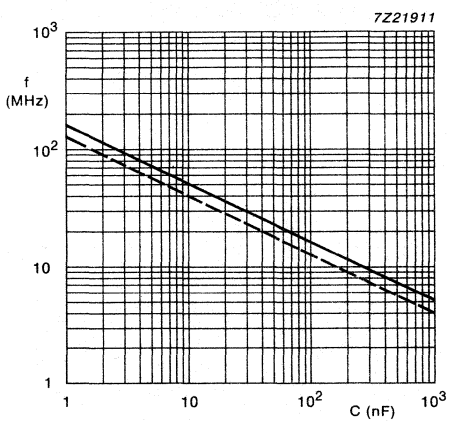


Fig.8 Series resonance frequency as a function of capacitance (nF values).

L = 1 nH ————————

L = 1.5 nH – – – – – – – –



The impedance, Z is given by the formula:

$$Z = \frac{1 - \omega^2 LC}{j\omega C} + ESR$$

where $j^2 = -1$ and $\omega = 2\pi f$.

The typical behaviour of |Z| for products of size 0603, 0805, 1206 and 1210 is shown in Fig.9.

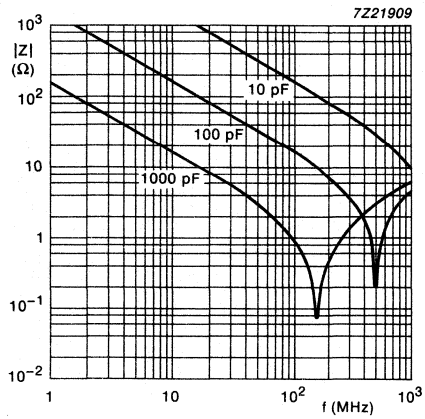


Fig.9 Typical impedance (|Z|) as a function of frequency for class 1 dielectric capacitors, sizes 0603 - 1210.

Figures 10 and 11 show the Equivalent Series Resistance (ESR) as a function of capacitance for class 1 dielectrics, sizes 0603, 0805 and 1206 respectively.

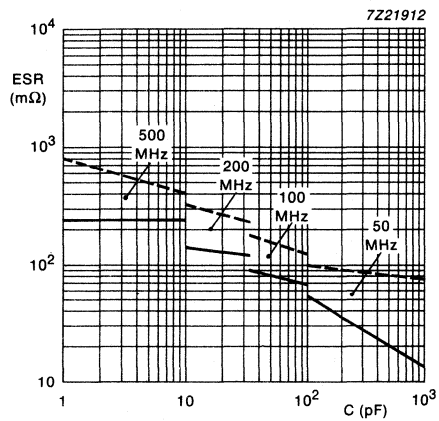


Fig.10 Equivalent Series Resistance (ESR) as a function of capacitance for class 1 dielectric, size 0603 and 0805*.

maximum – – – – – – –

typical ———————

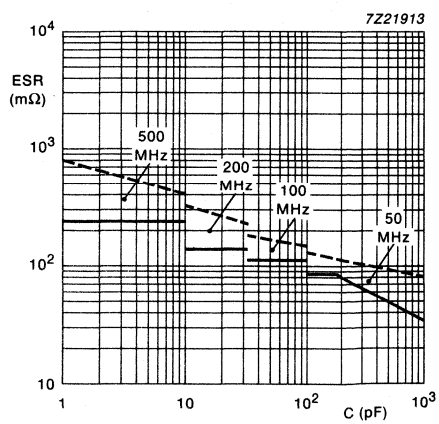


Fig.11 Equivalent Series Resistance (ESR) as a function of capacitance for class 1 dielectric, size 1206*.

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

maximum – – – – – – –

typical ———————

* Measuring equipment HP4191A.

The quality factor Q is given by the formula:

$$Q = \frac{|1 - \omega^2 LC|}{\omega \, ESR \, C}$$

where $\omega = 2 \pi f$.

Figures 12 and 13 show the quality factor (Q) as a function of capacitance for class 1 dielectrics, sizes 0603, 0805 and 1206 respectively.

Fig.12 Quality factor (Q) as a function of capacitance for class 1 dielectrics, sizes 0603 and 0805*.

typical ————————

minimum – – – – – – –

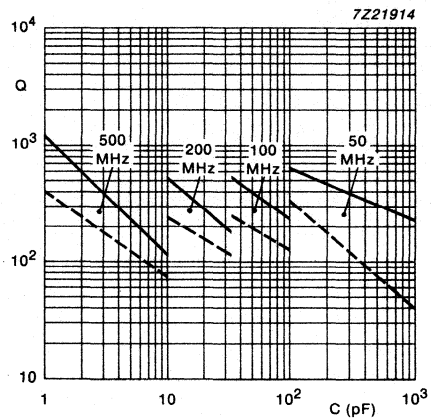
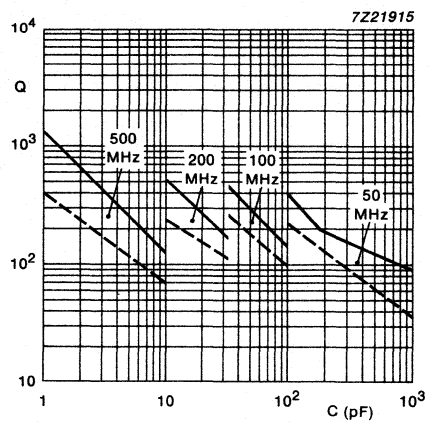


Fig.13 Quality factor (Q) as a function of capacitance for class 1 dielectrics, size 1206*.

For $C > 1$ nF, $Q_{min} = 35$ measured at 50 MHz.

typical ————————

minimum – – – – – – –



* Measuring equipment HP4191A.

Table 4 Selection chart for class 2 capacitors X7R dielectric with AgPd and NiSn terminations.

MSA194 - 2

C (pF)	Dielectric X7R											
	63 V							100 V ***				
	0603 *	0805	1206	1210 ****	1808 **	1812 ****	2220 **	0805	1206	1210	1808	1812
100												
120												
150												
180												
220												
270												
330												
390												
470												
560												
680												
820												
1000												
1200												
1500												
1800												
2200												
2700												
3300												
3900												
4700												
5600												
6800												
8200												
10000												
12000												
15000												
18000												
22000												
27000												
33000												
39000												
47000												
56000												
68000												
82000												
100000												
120000												
150000												
180000												
220000												
270000												
330000												
390000												
470000												
560000												
680000												
820000												
1000000												

0.7 to 0.9 mm
0.7 to 1.0 mm
0.51 to 0.7 mm
1.00 to 1.30 mm
0.51 to 1.0 mm

Packing

Sizes 0603, 0805, 1206 and 1210 with thickness $\leqslant$ 1.30 mm are available in 8 mm tape on reel and in bulk.
Sizes 1812 and 2220 with thickness $\leqslant$ 1.30 mm are available in 12 mm tape on reel and in bulk, with thickness $>$ 1.30 only available in bulk.
Size 1808 is only available in bulk.

* Size 0603 under development, samples available.
** NiSn plated terminations for sizes 1808 and 2220 under development.
*** 100 V rated voltage products only available in AgPd terminations, NiSn under development.
**** Sizes 1210 and 1812 with NiSn endterminations and capacitance value larger than 100 nF are under development.

Class 2, X7R dielectric

Capacitance range (E12 series) (note 1)	100 pF to 1 μF
Tolerance on capacitance after 1000 hours	± 20%, ± 10%, ± 5%
Rated voltage U_R (DC) (note 3)	63 V (IEC), 100 V (IEC) (note 3)
Test voltage (DC) for 1 minute	2.5 x U_R
Tan δ (note 1)	$\leqslant$ 2.5%
Insulation resistance after 1 minute, at U_R (DC)	
$C \leqslant 10\,000$ pF	$R_{INS} > 100$ GΩ
$C > 10\,000$ pF	$R_{INS} \times C > 1000$ s
Climatic category	55/125/56
Maximum capacitance variation as a function of temperature	± 15%, also see Fig.16
Ageing	typically 1% per time decade
Terminations	AgPd or NiSn plated

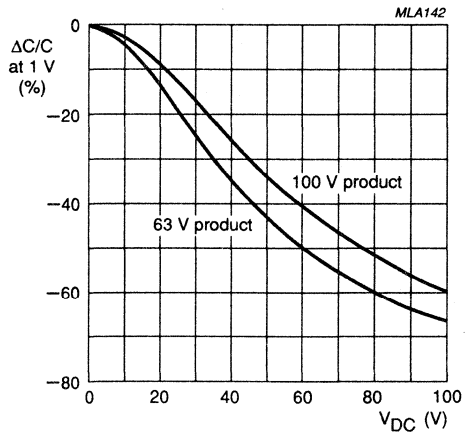


Fig.14 Typical capacitance change with respect to the capacitance value at 1 V as a function of DC voltage, for X7R dielectric at 20 °C.

Notes

1. Measured at 1 V, 1 kHz, using a four gauge method.
2. Refer to Table 4 for indication of which products are rated up to 100 V.
3. NiSn plated terminations in sizes 1808 and 2220 are under development. NiSn plated terminations in sizes 1210 and 1812 > 100 nF are under development.

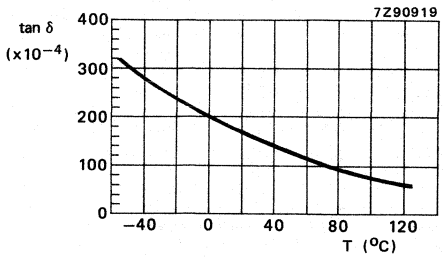


Fig.15 Typical tan δ as a function of temperature, for X7R dielectric.

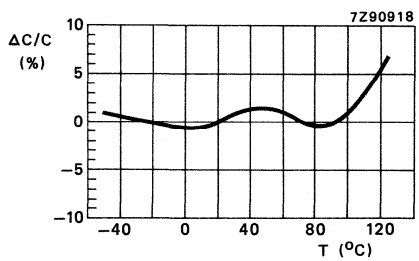
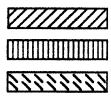


Fig.16 Typical capacitance change as a function of temperature, for X7R dielectric.

Table 5 Selection chart for class 2 capacitors, Y5V dielectric, with AgPd and NiSn terminations.

MSA193 - 1

C (pF)	Dielectric Y5V		
	63 V		
	0603	0805	1206
1000			
1500			
2200			
3300			
4700			
6800			
10000			
15000			
22000			
33000			
47000			
68000			
100000			



Packing

Sizes 0603, 0805 and 1206 with thickness $\leqslant$ 1 mm are available in 8 mm tape on reel and in bulk.

Class 2, Y5V dielectric

Capacitance range (E6 series) (note 1)	1000 pF to 100 nF (values up to 330 nF under development)
Tolerance of capacitance after 1000 hours	−20 to +80%, and ± 20%
Rated voltage U_R (DC)	63 V (IEC)
Test voltage (DC) for 1 minute	2.5 x U_R
Tan δ (note 1)	⩽ 2.5%
Insulation resistance after 1 minute, at U_R (DC)	
C ⩽ 25 nF	R_{INS} > 10 GΩ
C > 25 nF	R_{INS} x C > 100 s
Climatic category (IEC 68)	25/085/56
Maximum capacitance variation with respect to capacitance at 20 °C (IEC)	+30 to −80%, also refer to Fig.17
Ageing	typically 5% per time decade
Terminations	AgPd or NiSn plated

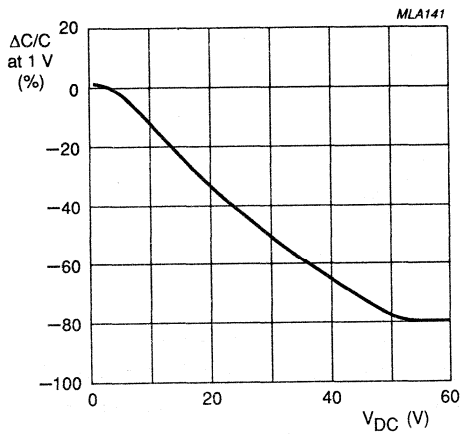


Fig.17 Typical capacitance change with respect to capacitance value at 1 V as a function of DC voltage at 20 °C, for Y5V dielectric.

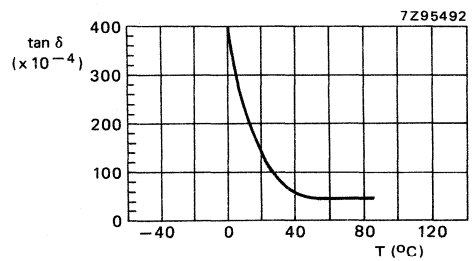


Fig.18 Typical tan δ as a function of temperature for Y5V dielectric.

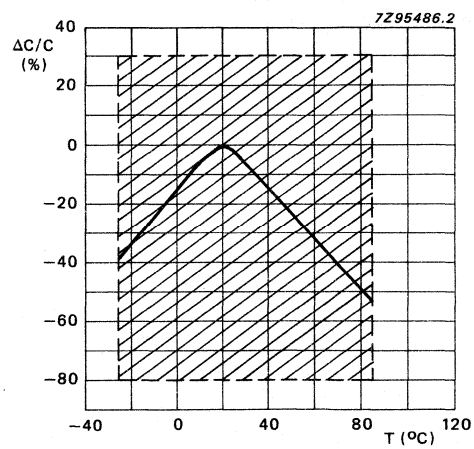


Fig.19 Typical capacitance change as a function of temperature, for Y5V dielectric; hatched area in accordance with IEC 384-10.

Note

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

Test conditions in static solder bath

Solderability
95% covered with smooth and bright solder coating

CECC: 235 ± 5 °C for 2 ± 0.5 s
IEC : 215 ± 3 °C for 3 ± 0.3 s

Resistance to soldering heat
10% of the metallization of the edges of the head face may be missing (inner electrodes not visible)

260 ± 5 °C for 30 ± 1 s

$\frac{\Delta C}{C}$ class 1; 0.5% or 0.5 pF

and

$\frac{\Delta C}{C}$ class 2; $-5\% < X7R \leqslant 10\%$
$-10\% < Y5V \leqslant 20\%$

must not be exceeded

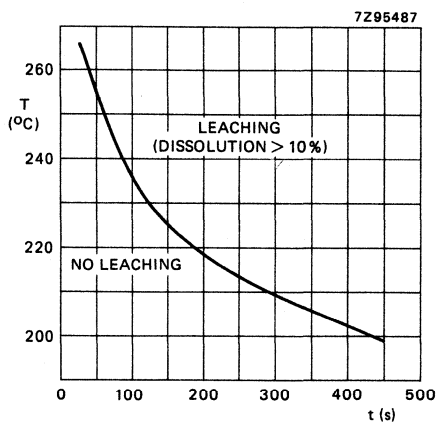


Fig.20 Resistance to leaching of AgPd metallized terminations (in static solder bath) at various temperatures; for NiSn metallized terminations, the leaching resistance is a factor of 10 times better than shown in the graph.

Fig.21 Reflow soldering.

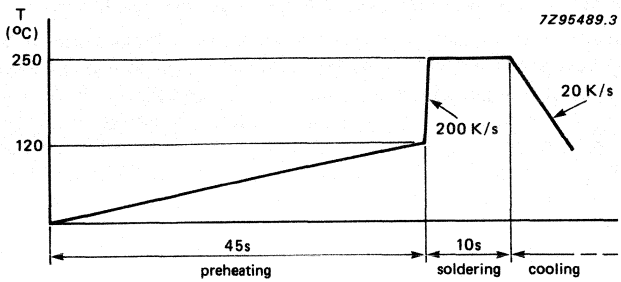


Fig.22 Wave soldering.
The capacitors may be soldered twice in accordance with this method if desired.

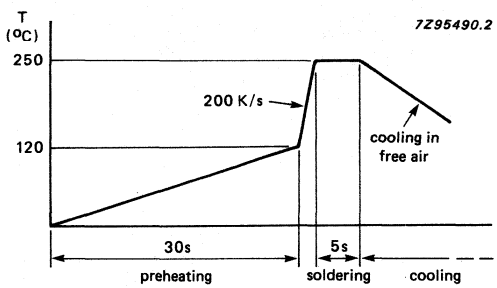
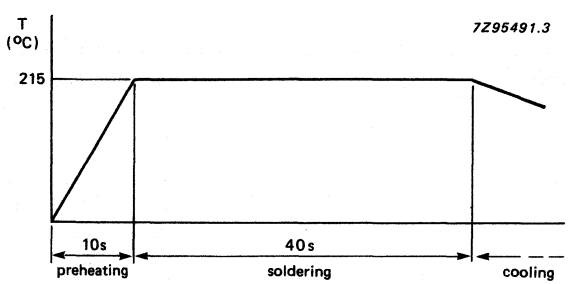


Fig.23 Vapour phase soldering.



METHODS OF MOUNTING AND DIMENSIONS OF SOLDERLANDS

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 (for advised soldering profiles, see figures 21, 22 and 23).
An improper combination of soldering conditions, substrate and chipsize can lead to a damaging of the component. The risk increases with chipsize and with temperature fluctuations ($> 100\ ^{o}C$). Therefore it is advised to use the smallest possible size and follow the recommendations given in the table below, (all dimensions are in mm).

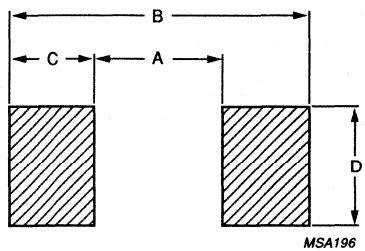


Fig. 24 Recommended dimensions of solderlands.

Reflow soldering					Wave soldering				
Size	A	B	C	D	Size	A	B	C	D
0603	0.9	2.3	0.7	0.8	0603	0.9	2.5	0.8	0.8
0805	0.8	3.4	1.3	1.4	0805	1.2	3.6	1.2	1.2
1206	1.8	4.0	1.1	1.7	1206	2.0	4.8	1.4	1.4
1210	1.8	4.6	1.4	2.6	1210	2.0	4.8	1.4	2.5
1808	2.8	6.2	1.7	2.1	*1808	3.0	6.2	1.6	2.0
1812	2.8	6.2	1.7	3.3	*1812	3.0	6.2	1.6	3.2
2220	4.0	7.4	1.7	5.1	*2220	4.0	7.2	1.6	5.0

* Sizes 1808, 1812, 2220 are recommended to be mounted on ceramic substrate and reflow soldered only.

PACKING (IEC286-3)

Bulk packing

The capacitors are supplied in bulk in cardboard boxes of 1000 pieces.

Tape

Capacitor size 0603 is supplied in 8 mm plastified cardboard tape on reels of 4000 pieces.

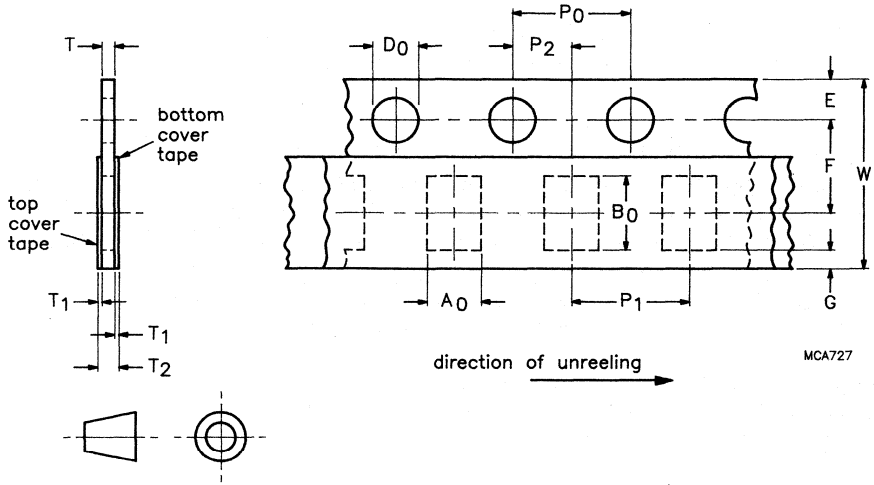
Capacitor sizes 0805, 1206 and 1210, with a thickness $\leqslant$ 1.00 mm are supplied in 8 mm blistertape on reels of 4000 pieces and with a thickness between 1.00 mm and 1.30 mm on reels of 3000 pieces. They may also be supplied in quantities of 10.000 pieces per reel and with a thickness between 1.00 mm and 1.30 mm they can be supplied in quantities of 8000 pieces per reel.

Capacitor sizes 1812 and 2220 with a thickness $\leqslant$ 1.00 mm are supplied in 12 mm blistertape on reels of 2000 pieces. With a thickness between 1.00 mm and 1.30 mm they are supplied in reels of 1500 pieces.
These sizes with a thickness $\leqslant$ 1.00 mm can also be supplied in quantities of 5000 pieces per reel and with a thickness between 1.00 mm and 1.30 mm the capacitors can be supplied in quantities of 4000 pieces per reel.

Capacitors of size 1808 are supplied in bulk packing only.

For all reels: on reel per flat cardboard box.

Packing for 0603



Tape width W = 8.0 ± 0.3 mm
Carrier tape thickness T = 0.9 + 0.1/–0 mm (see Note 1)
Pitch of the sprocket holes P_0 = 4.0 ± 0.1 mm
Pitch tolerance over any 10 pitches = ± 0.2 mm

Fig.25 Cardboard carrier tape; size 0603 only. See table 6 for dimensions.

Table 6 Physical dimensions of cardboard tape

dimensions	tolerance	size 0603
A_0	+ 0.2/–0	1.0
B_0	+ 0.2/–0	1.8
W	± 0.3	8
E	± 0.1	1.75
F	± 0.05	3.5
D_0	+ 0.1/–0	1.5
P_0	± 0.1	4
P_1	± 0.1	4
P_2	± 0.05	2

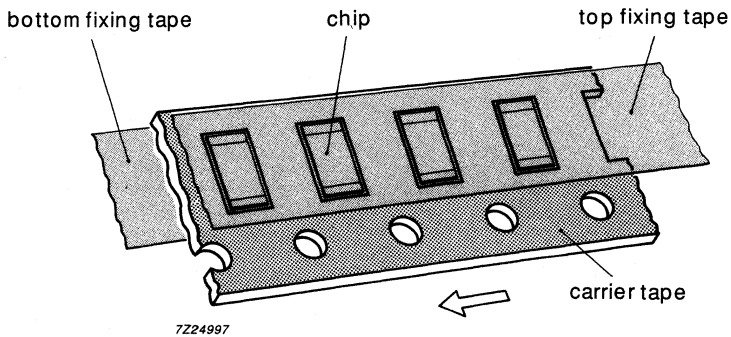
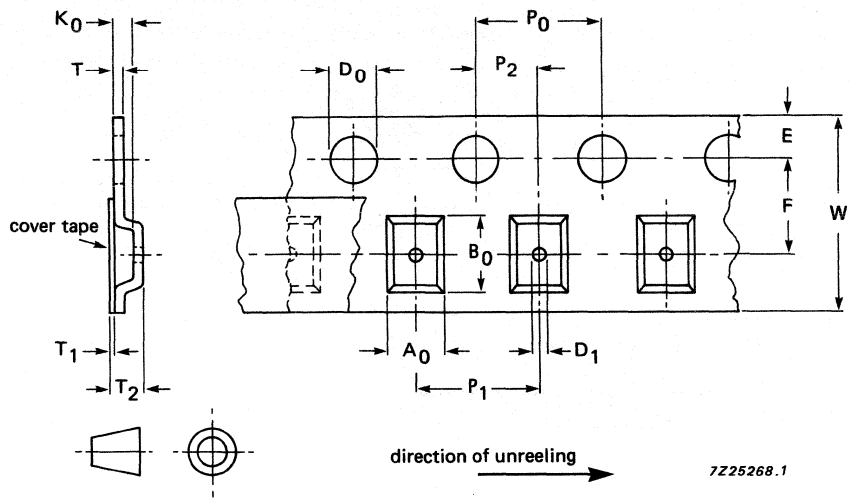


Fig.26 Cardboard tape.

Note

1. The overall tape thickness (T_2) may exceed dimension T due to the additional thickness of the component and/or the cover tapes (T_1).

Packing for 0805 - 2220



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

T – 0.3 ± 0.1 mm.

For W = 8 mm, T_2 = 2.5 mm max.
For W = 12 mm, T_2 = 4.5 mm max.

Fig. 27 Blister tape.

Table 7 Physical dimensions of blister tape

dimension	tolerance	capacitor size					
		0805	1206	1210	1808	1812	2220
A_0	± 0.1	1.55	1.85	2.9	2.4	3.6	5.4
B_0	± 0.1	2.3	3.55	3.55	4.9	4.9	6.1
W	± 0.3	8	8	8	12	12	12
E	± 0.1	1.75	1.75	1.75	1.75	1.75	1.75
F	± 0.05	3.5	3.5	3.5	5.5	5.5	5.5
D_0	± 0.1 – 0	1.5	1.5	1.5	1.5	1.5	1.5
D_1		⩾1	⩾1	⩾1	⩾1.5	⩾1.5	⩾1.5
P_0	± 0.1	4	4	4	4	4	4
P_1	± 0.1	4	4	4	4	8	8
P_2	± 0.05	2	2	2	2	2	2

Note: P_0 pitch tolerance over any 10 pitches is ± 0.2 mm.

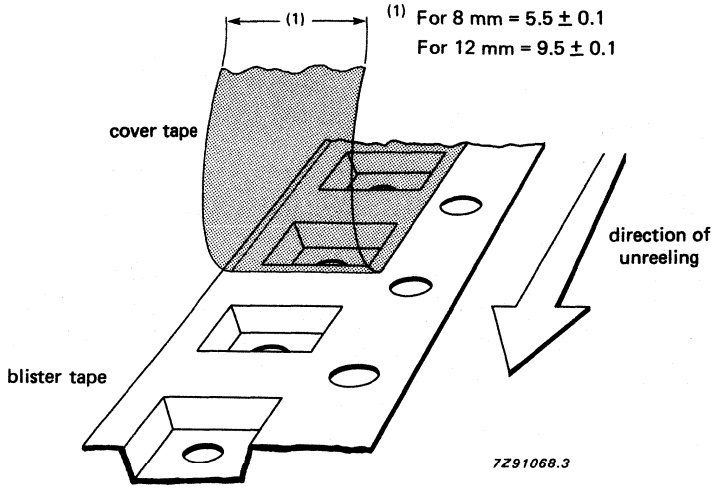


Fig.28 Construction of blister tape.

Note to Fig.28:

The 8 mm and 12 mm blister tapes are provided with an anti-static coating and an anti-static cover tape to prevent the build-up of static charges, which could cause low weighted products to stick to the blister or the cover tape.

A cross-sectional view of the blister tape construction is shown in Fig.29

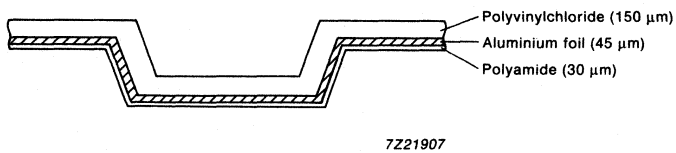


Fig. 29 Cross-sectional construction of 8 mm blister tape.

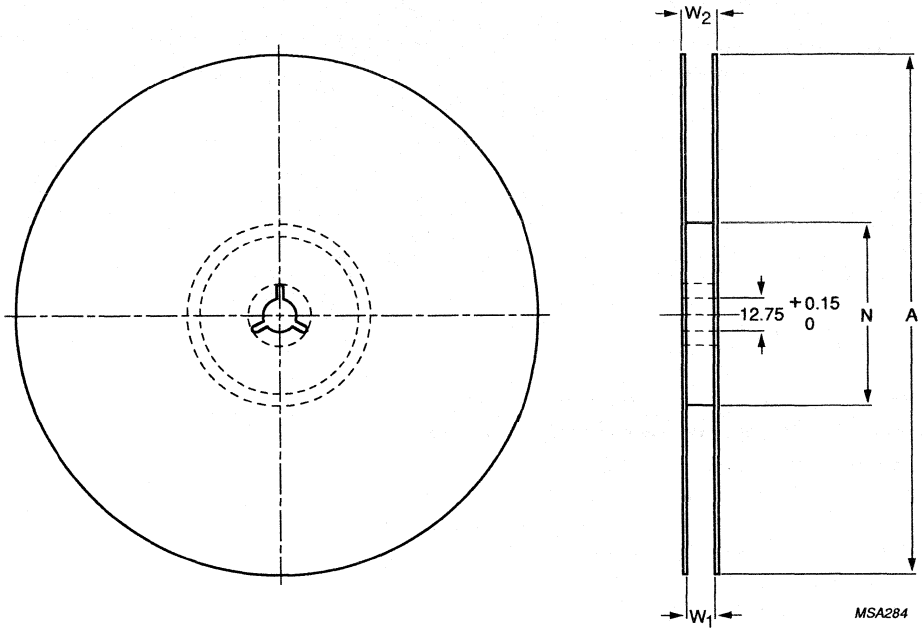
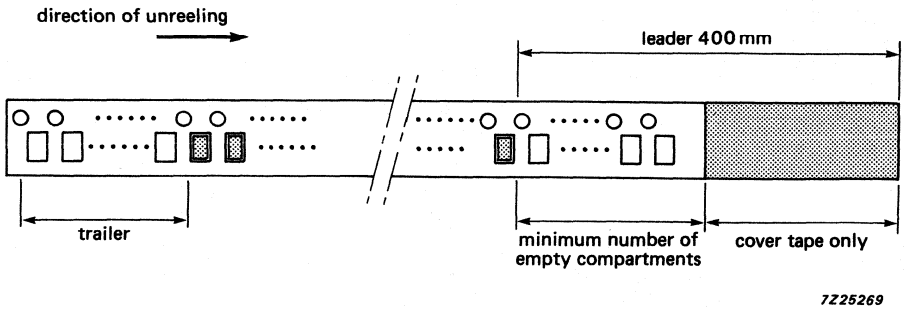


Fig.30 Reel.

Table 8 Reel dimensions

tape width mm	A mm	N mm	W_1 mm	W_{2max} mm
8	180	62 ± 1.5	8.4 + 1.5/–0	14.4
	250	62 ± 1.5	8.4 + 1.5/–0	14.4
	286	62 ± 1.5	8.4 + 1.5/–0	14.4
12	180	62 ± 1.5	12.4 + 2/–0	18.4
	286	62 ± 1.5	12.4 + 2/–0	18.4



Tape data

Minimum number of empty compartments at leader end:

40 compartments for 4 mm pitch (160 mm)
18 compartments for 8 mm pitch (144 mm)

Minimum number of empty compartments at trailer end:

10 compartments for 4 mm pitch (40 mm)
5 compartments for 8 mm pitch (40 mm)

Maximum number of empty compartments at trailer end:

60 compartments for 4 mm pitch (240 mm)
30 compartments for 8 mm pitch (240 mm)

Fig.31 Leader/trailer tape.

Table 9 CECC tests and CECC/Philips requirements

CECC test clause		test	procedure	requirements
CECC 32-100 para.	IEC 68-2 para.			
4.4		mounting	the capacitors may be mounted on printed-circuit boards or ceramic sub-strates by 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 x 10 magnification	in accordance with specification
4.6.1		capacitance	class 1 $C \leqslant 1000$ pF, f = 1 MHz $C > 1000$ pF, f = 1 kHz measuring voltage 1 V at temperature of 20 °C class 2 for all capacitors f = 1 kHz	within specified tolerance; for class 2, measured 1000 hours after date of manufacture
4.6.2.		tan δ	see procedure 4.6.1	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	2.5 U_R 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	X7R and Y5V between minimum and maximum temperature	in accordance with specification
4.8		adhesion	a force of 5 N applied 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	mounting in accordance with para. 4.4 conditions: bending 1 mm at a rate of 1 mm/s	no visible damage $\Delta C/C$ class 1: $\leqslant 1\%$ class 2: $\leqslant 10\%$

Table 9 (continued)

CECC test clause		test	procedure	requirements
CECC 32-100 para.	IEC 68-2 para.			
4.10	Tb	resistance to soldering heat	260 ± 5 °C for 10 ± 0.5 s	the terminations shall be well tinned after recovery ΔC/C requirements class 1 dielectric: ⩽ 0.5% or ± 0.5 pF, whichever is greater X7R dielectric: > −5% and ⩽ 10% Y5V dielectric: > −10% and ⩽ 20%
		resistance to leaching	260 ± 5 °C for 30 ± 1 s in a static solder bath	using visual enlargement of x 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 ± 0.5 s in a solder bath at 235 ± 0.5 °C	the terminations shall be well tinned
4.12	Na	rapid change of temperature	pre-conditioning (class 2 only) for X7R −55/+125 °C 5 cycles for Y5V −25/+85 °C 5 cycles	no visible damage: after 24 hours recovery: class 1, ΔC/C ⩽ 1% or 1 pF X7R, ΔC/C ⩽ 15% Y5V, ΔC/C ⩽ 20%
4.13		climatic sequence	pre-conditioning (class 2 only)	
4.13.3	Ba	dry heat	16 hours at maximum temperature	no visible damage
4.13.4	Db	damp heat accelerated, 1 cycle	24 hours at +55 °C, 100% RH	
4.13.5	Aa	cold	2 hours at minimum temperature	no visible damage

Table 9 (continued)

CECC test clause		test	procedure	requirements
CECC 32-100 para.	IEC 68-2 para.			
4.13.6	Db	damp heat accelerated, remaining cycles	5 cycles of 24 hours duration at + 55 °C, 100% RH	after recovery; class 1, 1 - 2 hours class 2, 24 hours ΔC/C measurements: class 1; ± 2% or 1 pF* X7R; ⩽ 15%, Y5V; ⩽ 20% tan δ measurements: class 1; ⩽ 2 x specified value X7R ⩽ 7%, Y5V ⩽ 7% R_{INS} measurements: class 1; 2500 MΩ or $R_iC_R \geqslant 25$ s** X7R, Y5V ⩾ 1000 MΩ or $R_iC_R \geqslant 25$ s **
4.14	Ca	damp heat, steady state	pre-conditioning (class 2 only), 56 days at 40 °C, 90 - 95% RH, 63 V applied	no visible damage electrical checks shall comply with clause 4.13.6, except ΔC/C for Y5V ⩽ ± 30%
4.15		endurance	pre-conditioning (class 2 only) 1000 hours at maximum temperature at 1.5 x rated voltage	no visible damage after 24 hours recovery; ΔC/C measurements: class 1; ± 2% or 1 pF* X7R; ⩽ 20%, Y5V; ⩽ 30% tan δ measurements: class 1; ⩽ 2 x specified value X7R ⩽ 7%, Y5V ⩽ 7% R_{INS} measurements: class 1; 4000 MΩ or ⩾ 40 s** X7R, Y5V ⩾ 2000 MΩ or $R_iC_R \geqslant 50$ s**
CECC 32101-801		damp heat accelerated, steady state	85 °C 85% RH 500 hours with bias 1.5 V and rated voltage	R_{INS} shall not be less than 10% of the initial requirement

* Whichever is greater.
** Whichever is less.

ORDERING INFORMATION

The capacitors may be ordered by using the 12 NC ordering code. These code numbers can be determined by consulting Appendix 1.

If required, the capacitors may also be ordered by quoting the 15 digit ordering code (see Appendix 2).

Appendix 1

CONVERSION LIST

Capacitor types to 12NC-catalogue numbers.

Examples

A 63 V ceramic multilayer capacitor of 12 pF ± 10% NP0 in size 0805 with AgPd terminations, supplied in tape on reel 4000 pieces has the 12NC 2222 861 13129.

A 100 V ceramic multilayer capacitor of 100 pF ± 2% NP0 in size 0805 with AgPd terminations, supplied in tape on reel 10000 pieces has the 12NC 2222 610 51436.

Composition of the 12 NC ordering code for NP0 dielectric (63 V)

The 12 NC may be constructed using the information given below:

	(A)	(B)	(C)	(D)	(E)
2222	8 x	x	x	x	xxx

A and C. **Packing**

Insert the following digits in accordance with the desired packing method.

1000 pieces, bulk	–A = 5, C = 1
4000 or 3000 pieces, see "Packing" (0603, 0805, 1206, 1210)	–A = 6, C = 1
2000 pieces (1812, 2220) tape on reel	–A = 6, C = 1
10000 pieces (0603, 0805, 1206, 1210)	–A = 6, C = 7
5000 pieces (1812, 2220) tape on reel	–A = 6, C = 7

B. **Capacitor size**

Insert the following digits in accordance with the desired capacitor size.

Size 0805	– 1	remarks:	0.47 pF – 1000 pF
Size 1210	– 2		47 pF – 4700 pF
Size 1206	– 3		0.47 pF – 3300 pF
Size 1808	– 4		100 pF – 5600 pF
Size 1812	– 5		330 pF – 5600 pF
Size 2220	– 6		470 pF – 10000 pF
Size 0603	– 7		0.47 pF – 150 pF

D. **Tolerance on capacitance and terminal composition**

Insert the following digits in accordance with the desired tolerance and terminal composition.

± 0.25 pF for 5.6 pF $\leqslant$ C $\leqslant$ 8.2 pF, ± 2% for C $\geqslant$ 10 pF, AgPd terminations	– 1
± 0.25 pF for 0.47 pF $\leqslant$ C $\leqslant$ 4.7 pF, ± 0.5 pF for 5.6 pF $\leqslant$ C $\leqslant$ 8.2 pF	– 2
± 5% for C $\geqslant$ 10 pF, AgPd terminations	– 2
± 10% for C $\geqslant$ 10 pF, AgPd terminations	– 3
± 0.25 for 5.6 pF $\leqslant$ C $\leqslant$ 8.2 pF, ± 2% for C $\geqslant$ 10 pF, NiSn terminations	– 4
± 0.25 pF for 0.47 pF $\leqslant$ C $\leqslant$ 4.7 pF, ± 0.5 pF for 5.6 pF $\leqslant$ C $\leqslant$ 8.2 pF	– 5
± 5% for C $\geqslant$ 10 pF, NiSn terminations	– 5
± 10% for C $\geqslant$ 10 pF, NiSn terminations	– 6

E. **Capacitance value**

Insert the following digits in accordance with the desired capacitance value:

0.47 pF	–	477	68 pF	–	689
0.56 pF	–	567	82 pF	–	829
0.68 pF	–	687	100 pF	–	101
0.82 pF	–	827	120 pF	–	121
1.0 pF	–	108	150 pF	–	151
1.2 pF	–	128	180 pF	–	181
1.5 pF	–	158	220 pF	–	221
1.8 pF	–	188	270 pF	–	271
2.2 pF	–	228	330 pF	–	331
2.7 pF	–	278	390 pF	–	391
3.3 pF	–	338	470 pF	–	471
3.9 pF	–	398	560 pF	–	561
4.7 pF	–	478	680 pF	–	681
5.6 pF	–	568	820 pF	–	821
6.8 pF	–	688	1000 pF	–	102
8.2 pF	–	828	1200 pF	–	122
10 pF	–	109	1500 pF	–	152
12 pF	–	129	1800 pF	–	182
15 pF	–	159	2200 pF	–	222
18 pF	–	189	2700 pF	–	272
22 pF	–	229	3300 pF	–	332
27 pF	–	279	3900 pF	–	392
33 pF	–	339	4700 pF	–	472
39 pF	–	399	5600 pF	–	562
47 pF	–	479	6800 pF	–	682
56 pF	–	569	8200 pF	–	822
			10000 pF	–	103

– 680, 820, 1000 pF in 0805 with NiSn endterminations under development.

– Only available as bulkproducts: (tape versions under development) 2700, 3300 pF in 1206 with NiSn and AgPd endterminations.
4700 pF in 1210 with NiSn and AgPd endterminations.

– NiSn plated endterminations in sizes 1808 and 2220 under development.

Composition of the 12 NC ordering code for NP0 dielectric (100 V)

The 12 NC may be constructed using the information given below:

	(A)	(B)	(C)	(D)	(E)
2222	xx	x	x 1	x	xx

A. **Rated voltage and termination**

Insert the following digits in accordance with the desired rated voltage and terminal composition.

100 V, NiSn terminations – 60
100 V, AgPd terminations – 61

B. **Size**

Insert the following digit in accordance with the desired case size.

Size 0805 – 0
Size 1206 – 1
Size 1210 – 2

remarks:	available in AgPd	available in NiSn
	10 pF – 1000 pF	10 pF – 560 pF
	10 pF – 3300 pF	10 pF – 1800 pF
	47 pF – 4700 pF	47 pF – 3300 pF

C. **Packing**

Insert the following digit in accordance with the desired packing method (x).

1000 pieces, bulk	– 0
4000 or 3000 pieces, see "Packing" (0603, 0805, 1206, 1210)	– 1
2000 pieces (1812, 2220, 1808), tape on reel	– 1
10000 pieces (0603, 0805, 1206, 1210)	– 5
5000 pieces (1812, 2220), tape on reel	– 5

D. **Tolerance**

Insert the following digit in accordance with the desired tolerance.

± 0.25 pF	– 1
± 0.5 pF	– 2
± 2%	– 4
± 5%	– 5
± 10%	– 6

E. **Capacitance value**

Insert the following digits in accordance with the desired capacitance value:

0.47 pF	–	05	68 pF	–	34
0.56 pF	–	06	82 pF	–	35
0.68 pF	–	07	100 pF	–	36
0.82 pF	–	08	120 pF	–	37
1.0 pF	–	09	150 pF	–	38
1.2 pF	–	11	180 pF	–	39
1.5 pF	–	12	220 pF	–	41
1.8 pF	–	13	270 pF	–	42
2.2 pF	–	14	330 pF	–	43
2.7 pF	–	15	390 pF	–	44
3.3 pF	–	16	470 pF	–	45
3.9 pF	–	17	560 pF	–	46
4.7 pF	–	18	680 pF	–	47
5.6 pF	–	19	820 pF	–	48
6.8 pF	–	21	1000 pF	–	49
8.2 pF	–	22	1200 pF	–	51
10 pF	–	23	1500 pF	–	52
12 pF	–	24	1800 pF	–	53
15 pF	–	25	2200 pF	–	54
18 pF	–	26	2700 pF	–	55
22 pF	–	27	3300 pF	–	56
27 pF	–	28	3900 pF	–	57
33 pF	–	29	4700 pF	–	58
39 pF	–	31			
47 pF	–	32			
56 pF	–	33			

(x) Only available as bulk products: 2700, 3300 pF in 1206.
4700 pF in 1210.

Composition of the 12 NC ordering code for N220 dielectric (63 V)

The 12 NC may be constructed using the information given below:

	(A)	(B)	(C)	(D)
2222	xx	x	x 2	xxx

A. **Rated voltage and termination**

Insert the following digits in accordance with the desired rated voltage and terminal composition.

63 V, NiSn terminations — 58 (x)
63 V, AgPd terminations — 59

B. **Size**

Insert the following digit in accordance with the desired capacitor size.

Size 0805 — 0
Size 1206 — 1
Size 0603 — 6 (xx)

remarks: 4.7 pF — 270 pF
8.2 pF — 820 pF
2.7 pF — 150 pF

C. **Packing**

Insert the following digit in accordance with the desired packing method.

1000 pieces, bulk — 0
4000 pieces, tape on reel — 1
10000 pieces, tape on reel — 5

D. **Tolerance and capacitance**

± 0.25 pF for 2.7 pF ⩽ C ⩽ 4.7 pF
± 0.5 pF for 5.6 pF ⩽ C ⩽ 8.2 pF
± 5% for C ⩾ 10 pF

2.7 pF	–	469	56 pF	–	504
3.3 pF	–	471	68 pF	–	506
3.9 pF	–	473	82 pF	–	508
4.7 pF	–	475	100 pF	–	511
5.6 pF	–	477	120 pF	–	513
6.8 pF	–	479	150 pF	–	515
8.2 pF	–	482	180 pF	–	517
10 pF	–	484	220 pF	–	519
12 pF	–	486	270 pF	–	522
15 pF	–	488	330 pF	–	524
18 pF	–	491	390 pF	–	526
22 pF	–	493	470 pF	–	528
27 pF	–	495	560 pF	–	531
33 pF	–	497	680 pF	–	533
39 pF	–	499	820 pF	–	535
47 pF	–	502			

± 10% for C ⩾ 10 pF

10 pF	–	618	100 pF	–	645
12 pF	–	621	120 pF	–	647
15 pF	–	623	150 pF	–	649
18 pF	–	625	180 pF	–	652
22 pF	–	627	220 pF	–	654
27 pF	–	629	270 pF	–	656
33 pF	–	632	330 pF	–	658
39 pF	–	634	390 pF	–	661
47 pF	–	636	470 pF	–	663
56 pF	–	638	560 pF	–	665
68 pF	–	641	680 pF	–	667
82 pF	–	643	820 pF	–	669

(x) NiSn plated endterminations under development.
(xx) Size 0603 under development, samples available.

Composition of the 12 NC ordering code for N750 dielectric (63 V)

The 12 NC may be constructed using the information given below:

	(A)	(B)	(C)	(D)
2222	xx	x	x 4	xxx

A. **Rated voltage and termination**

Insert the following digits in accordance with the desired rated voltage and terminal composition.

63 V, NiSn terminations — 58 (x)
63 V, AgPd terminations — 59

B. **Size**

Insert the following digit in accordance with the desired capacitor size.

Size 0805 — 0
Size 1206 — 1
Size 0603 — 6

remarks: 4.7 pF — 470 pF
6.8 pF — 1200 pF
4.7 pF — 220 pF

C. **Packing**

Insert the following digit in accordance with the desired packing method.

1000 pieces, bulk — 0
4000 pieces, tape on reel — 1
10000 pieces, tape on reel — 5

D. **Tolerance and capacitance**

± 0.25 pF for C ⩽ 4.7 pF, ± 0.5 pF for 5.6 pF ⩽ C ⩽ 8.2 pF, ± 5% for C ⩾ 10 pF

4.7	pF	–	095	82	pF	–	128
5.6	pF	–	097	100	pF	–	131
6.8	pF	–	099	120	pF	–	133
8.2	pF	–	102	150	pF	–	135
10	pF	–	104	180	pF	–	137
12	pF	–	106	220	pF	–	139
15	pF	–	108	270	pF	–	142
18	pF	–	111	330	pF	–	144
22	pF	–	113	390	pF	–	146
27	pF	–	115	470	pF	–	148
33	pF	–	117	560	pF	–	151
39	pF	–	119	680	pF	–	153
47	pF	–	122	820	pF	–	155
56	pF	–	124	1000	pF	–	157
68	pF	–	126	1200	pF	–	159

± 10% for C ⩾ 10 pF

10	pF	–	238	120	pF	–	267
12	pF	–	241	150	pF	–	269
15	pF	–	243	180	pF	–	272
18	pF	–	245	220	pF	–	274
22	pF	–	247	270	pF	–	276
27	pF	–	249	330	pF	–	278
33	pF	–	252	390	pF	–	281
39	pF	–	254	470	pF	–	283
47	pF	–	256	560	pF	–	285
56	pF	–	258	680	pF	–	287
68	pF	–	261	820	pF	–	289
82	pF	–	263	1000	pF	–	292
100	pF	–	265	1200	pF	–	294

(x) Size 0603 under development, samples available.

Composition of the 12 NC ordering code for X7R dielectric (63 V)

The 12 NC may be constructed using the information given below:

	(A)	(B)	(C)	(D)	(E)
2222	xx	x	x 6	x	xx

A. **Rated voltage and termination**

Insert the following digits in accordance with the desired rated voltage and terminal composition.

63 V, NiSn terminations — 58 (x)
63 V, AgPd terminations — 59

B. **Size**

Insert the following digit in accordance with the desired case size.

Size 0805	—	0	remarks:	180 pF	—	33 nF	
Size 1206	—	1		680 pF	—	100 nF	
Size 1210	—	2		2200 pF	—	220 nF	(xx)
Size 1808	—	3		2200 pF	—	270 nF	
Size 1812	—	4		4700 pF	—	470 nF	(xx)
Size 2220	—	5		12000 pF	—	1000 nF	
Size 0603	—	6		100 pF	—	10 nF	

C. **Packing**

Insert the following digit in accordance with the desired packing method.

1000 pieces, bulk	—0
4000 or 3000 pieces, see "Packing" (0603, 0805, 1206, 1210)	—1
2000 or 1500 pieces, see "Packing" (1808, 1812, 2220), tape on reel	—1
10000 or 8000 pieces, see "Packing" (0603, 0805, 1206, 1210)	—5
5000 or 4000 pieces, see "Packing" (1812, 2220), tape on reel	—5

D. **Tolerance**

Insert the following digit in accordance with the desired tolerance.

± 5% — 5
± 10% — 6
± 20% — 7

E. **Capacitance**

Insert the following digits in accordance with the desired capacitance value

100	pF	–	01	12	nF	–	28
120	pF	–	02	15	nF	–	29
150	pF	–	03	18	nF	–	31
180	pF	–	04	22	nF	–	32
220	pF	–	05	27	nF	–	33
270	pF	–	06	33	nF	–	34
330	pF	–	07	39	nF	–	35
390	pF	–	08	47	nF	–	36
470	pF	–	09	56	nF	–	37
560	pF	–	11	68	nF	–	38
680	pF	–	12	82	nF	–	39
820	pF	–	13	100	nF	–	41
1.0	nF	–	14	120	nF	–	42
1.2	nF	–	15	150	nF	–	43
1.5	nF	–	16	180	nF	–	44
1.8	nF	–	17	220	nF	–	45
2.2	nF	–	18	270	nF	–	46
2.7	nF	–	19	330	nF	–	47
3.3	nF	–	21	390	nF	–	48
3.9	nF	–	22	470	nF	–	49
4.7	nF	–	23	560	nF	–	51
5.6	nF	–	24	680	nF	–	52
6.8	nF	–	25	820	nF	–	53
8.2	nF	–	26	1	μF	–	54
10.0	nF	–	27				

(x) NiSn plated endterminations for sizes 1808 and 2220 under development.

(xx) NiSn endterminations for capacitance values $\leqslant$ 100 nF.

Composition of the 12 NC ordering code for X7R dielectric (100 V)

The 12 NC may be constructed using the information given below:

	(A)	(B)	(C)	(D)	(E)
2222	xx	x	x 6	x	xx

A. **Rated voltage and termination**

Insert the following digits in accordance with the desired rated voltage and terminal composition.

100 V, NiSn terminations – 60 (x)
100 V, AgPd terminations – 61

B. **Size**

Insert the following digit in accordance with the desired case size.

Size 0805	–	0	remarks:	180 pF	–	10 nF
Size 1206	–	1		680 pF	–	33 nF
Size 1210	–	2		2200 pF	–	68 nF
Size 1808	–	3		2200 pF	–	82 nF
Size 1812	–	4		4700 pF	–	150 nF

C. **Packing**

Insert the following digit in accordance with the desired packing method.

1000 pieces, bulk	–0
4000 or 3000 pieces, see "Packing" (0603, 0805, 1206, 1210)	–1
2000 or 1500 pieces, see "Packing" (1808, 1812, 2220), tape on reel	–1
10000 or 8000 pieces, see "Packing" (0603, 0805, 1206, 1210)	–5
5000 or 4000 pieces, see "Packing" (1812, 2220), tape on reel)	–5

D. **Tolerance**

Insert the following digit in accordance with the desired tolerance.

± 5% – 5
± 10% – 6
± 20% – 7

E. **Capacitance**

Insert the following digits in accordance with the desired capacitance value

100	pF	–	09	12	nF	–	37
120	pF	–	11	15	nF	–	38
150	pF	–	12	18	nF	–	39
180	pF	–	13	22	nF	–	41
220	pF	–	14	27	nF	–	42
270	pF	–	15	33	nF	–	43
330	pF	–	16	39	nF	–	44
390	pF	–	17	47	nF	–	45
470	pF	–	18	56	nF	–	46
560	pF	–	19	68	nF	–	47
680	pF	–	21	82	nF	–	48
820	pF	–	22	100	nF	–	49
1.0	nF	–	23	120	nF	–	51
1.2	nF	–	24	150	nF	–	52
1.5	nF	–	25				
1.8	nF	–	26				
2.2	nF	–	27				
2.7	nF	–	28				
3.3	nF	–	29				
3.9	nF	–	31				
4.7	nF	–	32				
5.6	nF	–	33				
6.8	nF	–	34				
8.2	nF	–	35				
10	nF	–	36				

(x) NiSn plated endterminations for U_r = 100 V are under development.

Composition of the 12 NC ordering code for Y5V dielectric (63 V)

The 12 NC may be constructed using the information given below:

	(A)	(B)	(C)	(D)	(E)
2222	xx	x	x 8	x	xx

A. **Rated voltage and termination**

Insert the following digits in accordance with the desired rated voltage and terminal composition.

63 V, NiSn terminations — 58
63 V, AgPd terminations — 59

B. **Size**

Insert the following digit in accordance with the desired capacitor size

Size 0805 — 0
Size 1206 — 1
Size 0603 — 6 (x)

C. **Packing**

Insert the following digit in accordance with the desired packing method.

1000 pieces, bulk — 0
4000 pieces, tape on reel — 1
10000 pieces, tape on reel — 5

D. **Tolerance on capacitance**

Insert the following digits in accordance with the desired tolerance:

± 20% — 7
+ 80%/−20% — 8

E. **Capacitance value**

Insert the following digits in accordance with the desired capacitance value.

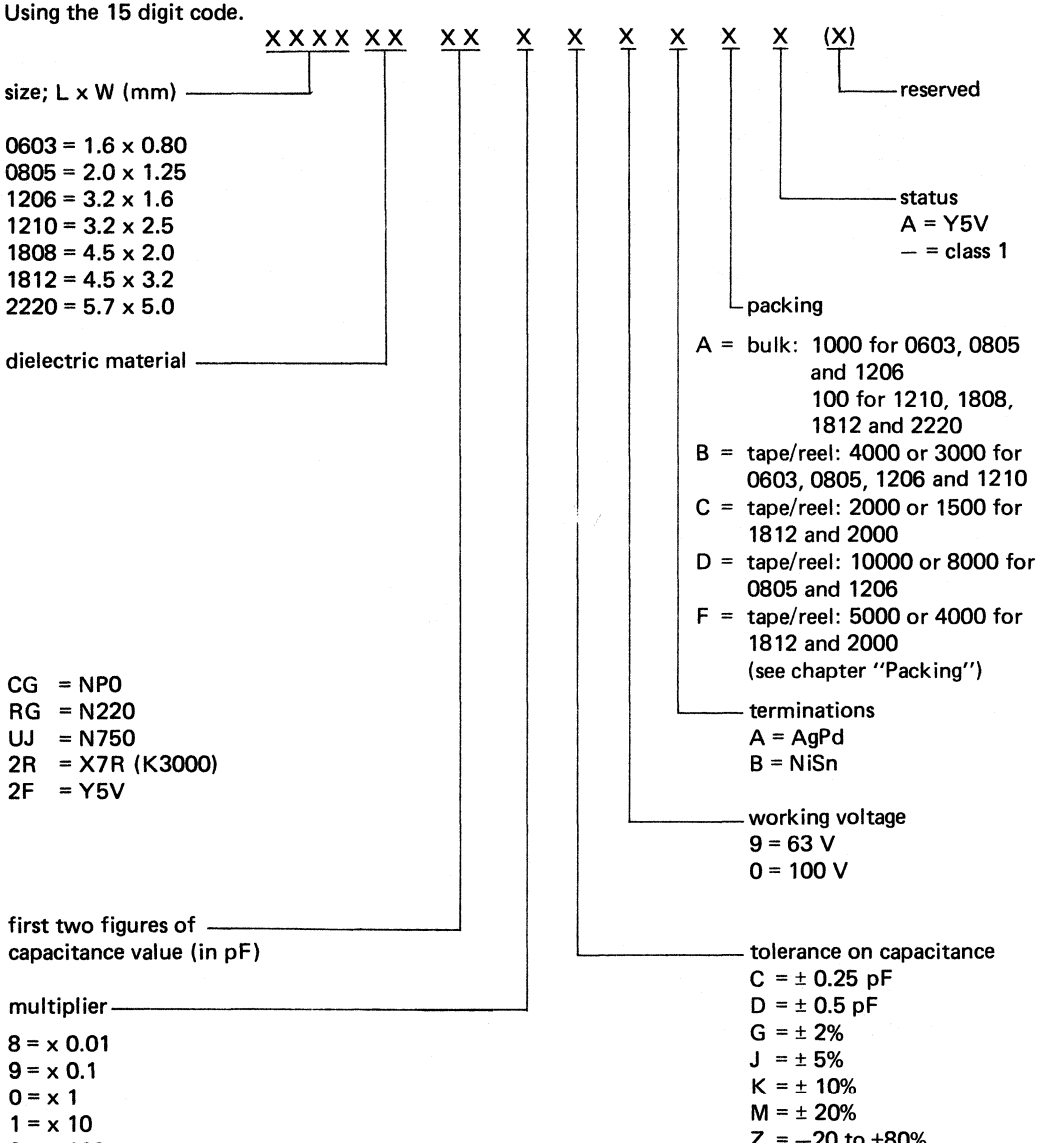
1.0	nF	–	96
1.5	nF	–	98
2.2	nF	–	01
3.3	nF	–	02
4.7	nF	–	03
6.8	nF	–	04
10	nF	–	05
15	nF	–	06
22	nF	–	07
33	nF	–	08
47	nF	–	09
68	nF	–	11
100	nF	–	12

(x) Size 0603 under development.

Appendix 2

ORDERING INFORMATION

Using the 15 digit code.



Example of coding:

8000 capacitors, value 150 pF, tolerance ± 5%, NP0 dielectric, size 1206, on tape, should be ordered as:

8000 x 1206CG151J9AB–

SURFACE MOUNTED CERAMIC MULTILAYER CAPACITORS

(COMPACT SERIES)

- Dense dielectric layers
- Six standard sizes
- Maximum capacitance per unit volume
- Supplied on tape on reel, or in boxes
- Ag/Pd and Ni/Sn plated end terminations

QUICK REFERENCE DATA

Capacitance range (E12 series)	
class 1, NP0 dielectric	220 to 33 000 pF (see note 1)
class 2, X7R dielectric	10 nF to 1 μF (see note 2)
Rated voltage U_R (DC)	
NP0 dielectric	63 V (IEC)
X7R dielectric	25 V, 63 V (IEC)
Tolerance on capacitance	
NP0 dielectric	± 10%; ± 5%; ± 2%
X7R dielectric	± 20%; ± 10%; ± 5%
Sectional specifications	IEC 384-10
Climatic category (IEC 68)	
NP0 dielectric	55/125/56
X7R dielectric	55/125/56

APPLICATION

These surface mounted capacitors have a high capacitance per unit volume, and their small dimensions, performance characteristics (e.g. high Q-factor) and reliability make them suitable for a wide range of applications, especially where a high packing density is a major requirement.

Main areas of application are professional electronics (e.g. telecommunication, telephony and hybrid circuits) automotive equipment, portable equipment and high density consumer electronics (e.g. car radios, video recorders and video cameras).

The capacitors may be supplied in blister tape on reel; this makes them suitable for use with automatic placement equipment. They may also be supplied in bulk in boxes.

Notes.

1. Values up to 100 nF in development.
2. Values up to 3.9 μF in development.

DESCRIPTION

The capacitors consist 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 suitably connected to the two terminations - either by silver palladium (Ag/Pd alloy) in a 65:35 ratio, or silver dipped with a barrier of plated nickel and finally covered with a layer of plated tin (see Fig.1).

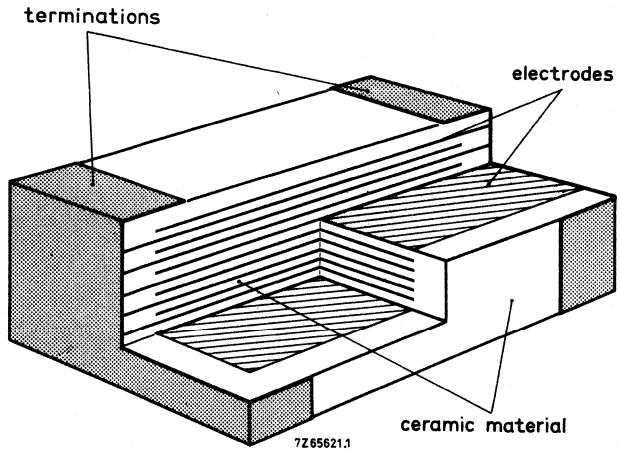


Fig.1 Construction of compact Ceramic Multilayer Capacitor.

MECHANICAL DATA

Dimensions in mm

Outline

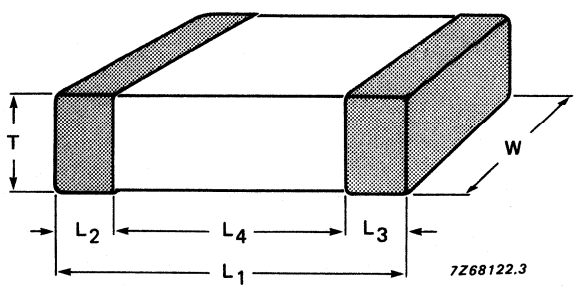


Fig.2 Component outline; see Table 1 for dimensions.

Table 1 Physical dimensions

case size	L_1	W	T min.	T max.	L_2/L_3 min.	L_2/L_3 max.	L_4 min.
0603	1.6 ± 0.10	0.8 ± 0.10	0.70	0.90	0.25	0.65	0.40
0805	2.0 ± 0.10	1.25 ± 0.10	0.51*	1.30*	0.25	0.75	0.55
1206	3.2 ± 0.15	1.60 ± 0.15	0.51*	1.60*	0.25	0.75	1.40
1210	3.2 ± 0.15	2.50 ± 0.15	0.51*	1.80*	0.25	0.75	1.40
1812	4.5 ± 0.20	3.20 ± 0.20	0.51*	1.80*	0.25	0.75	2.20
2220	5.7 ± 0.20	5.00 ± 0.20	0.51	1.80	0.25	0.75	2.90

* Refer to Tables 3 and 4.

ELECTRICAL DATA

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

Class 1 capacitors, NP0 dielectric

Capacitance range (see note 1)	220 to 33 000 pF, E12 series (see note 2)
Tolerance on capacitance	± 10%; ± 5%; ± 2%
Rated voltage U_R (DC)	63 V (IEC)
Test voltage (DC) for 1 minute	2.5 x U_R
Tan δ (see note 1)	$\leqslant 10 \times 10^{-4}$
Insulation resistance	> 100 GΩ
Climatic category (IEC 68)	55/125/56
Temperature coefficient	(0 ± 30) x 10^{-6}/K
Terminations	AgPd or NiSn metallized (see note 3)

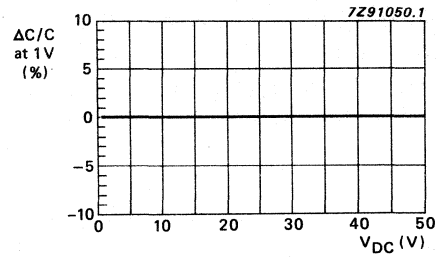


Fig.3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage for NP0 dielectric.

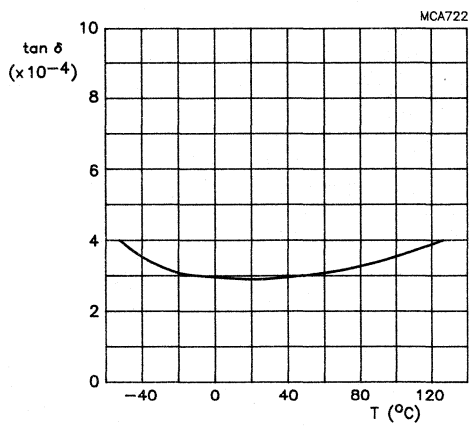


Fig.4 Typical tan δ as a function of temperature for NP0 dielectric.

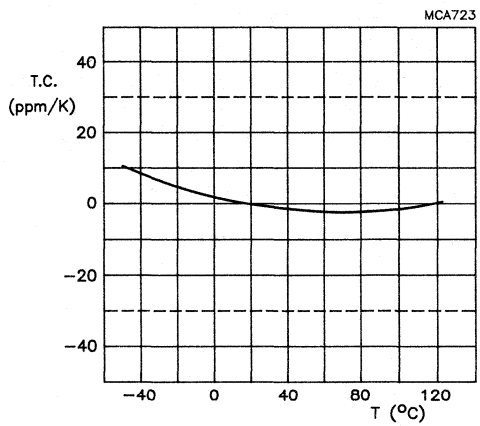


Fig.5 Typical temperature coefficient as a function of temperature for NP0 dielectric; dotted lines indicate requirement levels.

Notes:

1. Measured at 1 V, 1 MHz for C ⩽ 1000 pF, and at 1 V, 1 kHz for C > 1000 pF, using a four gauge method.
2. Values up to 100 nF in development.
3. NiSn: only for sizes 0805, 1206 and 1210.

High frequency behaviour of compact ceramic multilayer capacitors

Compact ceramic multilayer capacitors are suitable for use at high frequencies. Figure 6 shows an equivalent series representation.

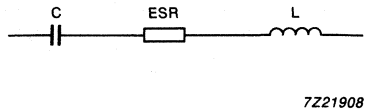


Fig.6 Equivalent series representation of a ceramic multilayer capacitor.

In Fig.6:

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

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

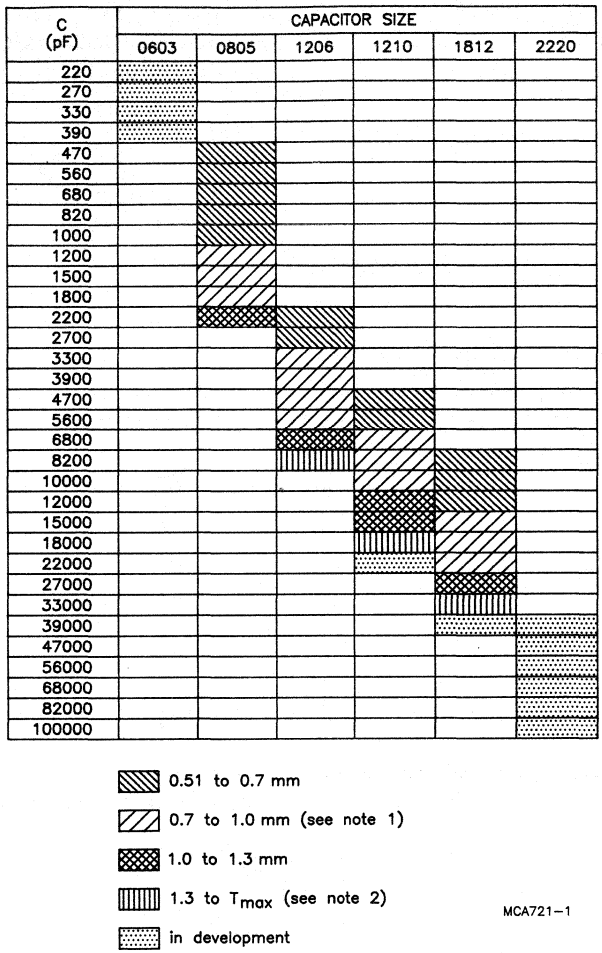
  The value of L is approximately 0.6 nH for size 0603, 1 nH for sizes 0805, 1206 and 1210, and approximately 1.5 nH for sizes 1812 and 2220. These figures are accurate to within approximately 20%.

Table 2 shows maximum Equivalent Series Resistance values for capacitor sizes 0805 and 1206 at frequencies of 50 MHz and 100 MHz. The measurements were taken using equipment type HP 4191A.

Table 2 Maximum Equivalent Series Resistance (ESR) values

size	value range	ESR at 50 MHz	ESR at 100 MHz
0805	470 pF $<$ C $\leqslant$ 2200 pF	80 mΩ	150 mΩ
1206	2200 pF $<$ C $\leqslant$ 8200 pF	80 mΩ	150 mΩ

Table 3 Selection chart for class 1 capacitors with AgPd and NiSn (see note 3) plated terminations; U_R = 63 V



Notes to Table 3

1. Capacitor size 0603; 0.7 to 0.9 mm max.
2. Dimensions for T_{max} — 1206; 1.6 mm
   1210; 1.8 mm
   1812; 1.8 mm
   2220; 1.8 mm
3. NiSn: for sizes 0805, 1206 and 1210.

Class 2, X7R dielectric

Capacitance range (see note 1)	10 nF to 1 μF, E12 series (see note 2)
Tolerance on capacitance after 1000 hours	± 20%; ± 10%; ± 5%
Rated voltage U_R (DC)	25 V, 63 V (IEC)
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Tan δ (see note 1)	⩽ 2.5%
Insulation resistance after 1 minute at 10 V DC	
$C \leqslant 10\,000$ pF	$R_{INS} > 100$ GΩ
$C > 10\,000$ pF	$R_{INS} \times C > 1000$ s
Climatic category	55/125/56
Maximum capacitance variation as a function of temperature	± 15%, also see Fig.7
Terminations	AgPd or NiSn plated (see note 3)

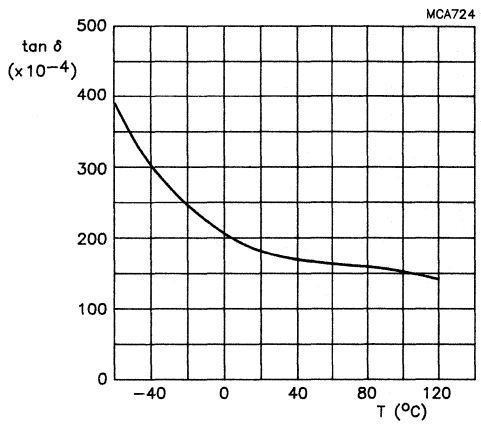


Fig.7 Typical tan δ as a function of temperature.

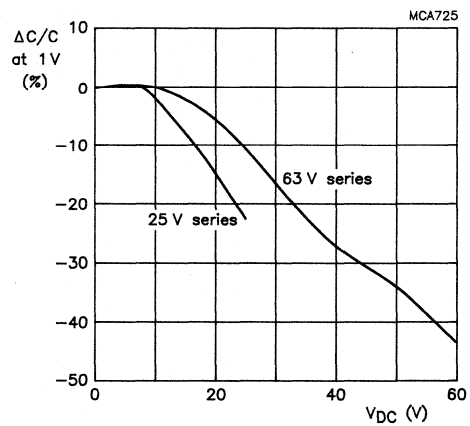


Fig.8 Typical capacitance change with respect to capacitance at 1 V as a function of DC voltage.

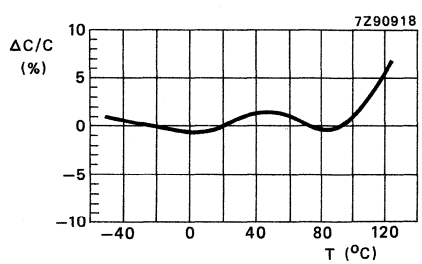


Fig.9 Typical capacitance change as a function of temperature for X7R dielectric.

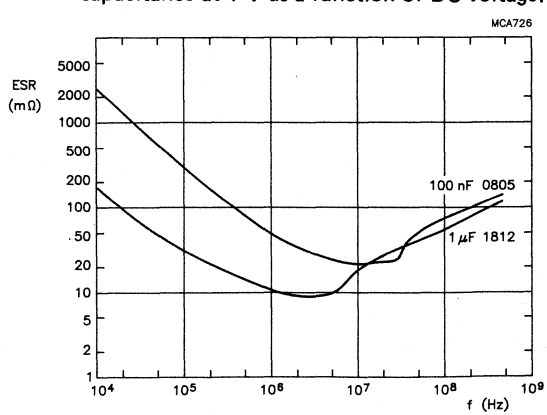


Fig.10 Typical equivalent series resistance (ESR) as a function of frequency. Measured using HP4191A and HP4194A.

Notes

1. Measured at 1 V, 1 kHz, using a four gauge method.
2. Values up to 3.9 μF in development.
3. NiSn: for sizes 0805, 1206 and 1210.

Table 4 Selection chart for class 2 capacitors, X7R dielectric with AgPd and NiSn terminations (see note 3)

C (nF)	CAPACITOR SIZE											
	0603		0805		1206		1210		1812		2220	
	25 V	63 V	25 V	63 V	25 V	63 V	25 V	63 V	25 V	63 V	25 V	63 V
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												

0.51 to 0.7 mm

0.7 to 1.0 mm (see note 1)

1.0 to 1.3 mm

1.3 to T_{max} (see note 2)

in development

MCA720–1

Notes:

1. Capacitor size 0603, 0.7 to 0.9 mm max.
2. Dimensions for T_{max} – 1206; 1.6 mm
   1210; 1.8 mm
   1812; 1.8 mm
   2220; 1.8 mm
3. NiSn: for sizes 0805, 1206 and 1210.

PACKING

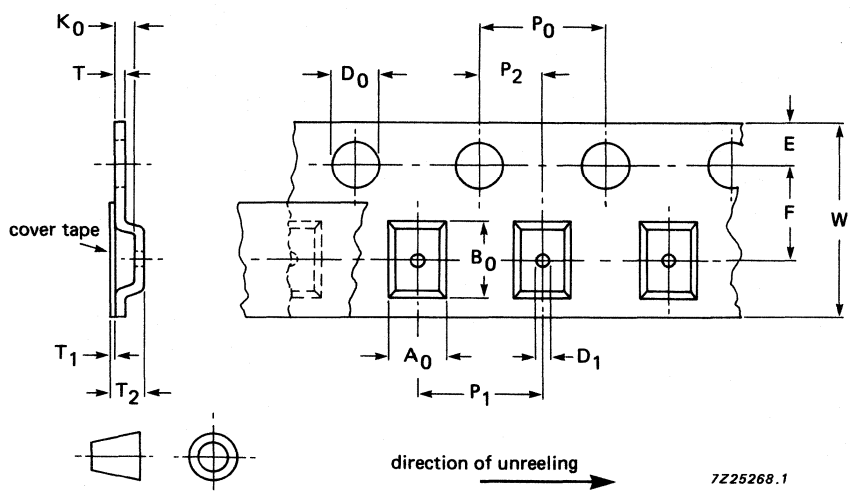
Bulk packing

Capacitor sizes 0603, 0805 and 1206 are supplied in quantities of 1000 pieces per plastic bag in cardboard boxes; sizes 1210, 1812 and 2220 are available in quantities of 100 pieces per plastic bag, with a maximum of 1000 pieces in a cardboard box.

TAPE

Capacitor sizes 0805, 1206 and 1210 are supplied in 8 mm blister tape on reels, the quantity per reel being dependent upon capacitor thickness as follows:
products with a maximum thickness of $\leqslant$ 1 mm; 4000 pieces per reel
products with a thickness of 1.0 - 1.3 mm; 3000 pieces per reel
products with a thickness of 1.3 mm T_{max}; 2000 pieces per reel
For capacitor thickness, please refer to Tables 3 and 4.

Capacitor sizes 1812 and 2220 are available in 12 mm blister tape on reels, the quantity per reel being dependent upon capacitor thickness as follows:
products with a maximum thickness of $\leqslant$ 1 mm; 2000 pieces per reel
products with a thickness of 1.0 - 1.3 mm; 1500 pieces per reel
products with a thickness of 1.3 mm T_{max}; 1000 pieces per reel
Packing quantity per reel (reel diameter 180 mm, see Fig.16)
For capacitor thickness, please refer to Tables 3 and 4.
For all reels: one reel per flat cardboard box.



K_0; so chosen that the orientation of the component cannot change
T; 0.3 ± 0.1 mm
For W = 8 mm, T_2 = 2.5 mm max.
For W = 12 mm, T_2 = 4.5 mm max.

Fig.11 Blister tape.

Table 5 Physical dimensions of blister tape

dimension	tolerance	capacitor size				
		0805	1206	1210	1812	2220
A_0	± 0.1	1.55	1.85	2.9	3.6	5.4
B_0	± 0.1	2.3	3.55	3.55	4.9	6.1
W	± 0.3	8	8	8	12	12
E	± 0.1	1.75	1.75	1.75	1.75	1.75
F	± 0.05	3.5	3.5	3.5	5.5	5.5
D_0	+ 0.1/−0	1.5	1.5	1.5	1.5	1.5
D_1		⩾1	⩾1	⩾1	⩾1.5	⩾1.5
P_0	± 0.1	4	4	4	4	4
P_1	± 0.1	4	4	4	8	8
P_2	± 0.05	2	2	2	2	2

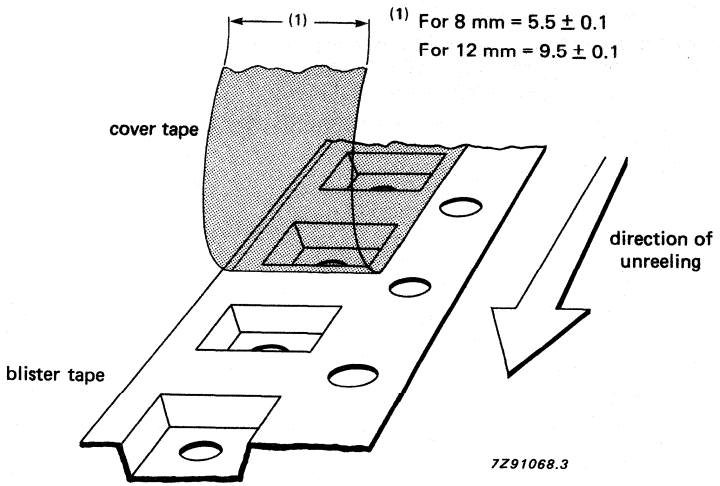


Fig.12 Construction of blister tape.

Note to Fig. 12

The 8 mm and 12 mm blister tapes are provided with an anti-static coating and an anti-static cover tape to prevent the build up of static charges which could cause low weighted products to stick to the blister or cover tape.

A cross sectional view of the blister tape construction is shown in Fig.13.

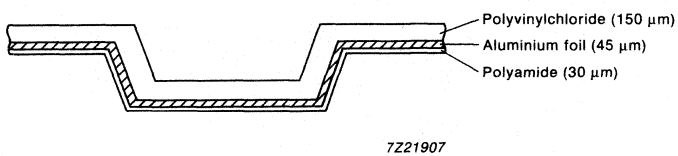
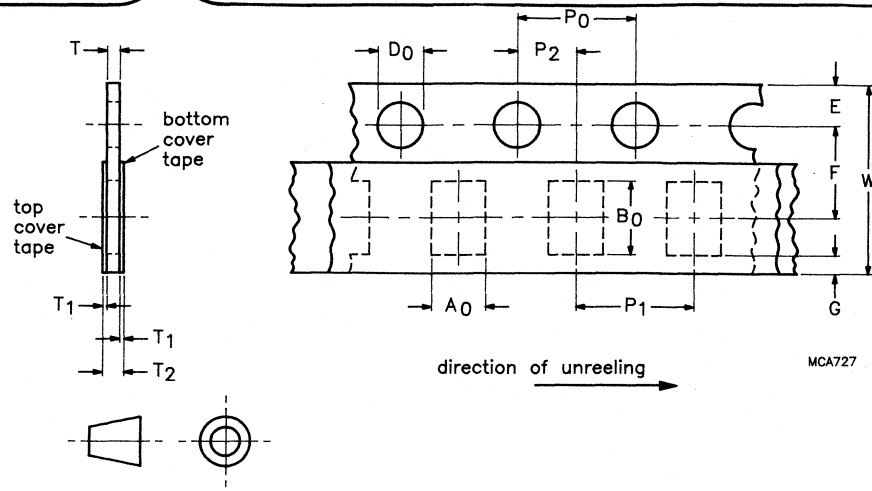


Fig.13 Cross sectional construction of blister tape.



Tape width W = 8.0 ± 0.3 mm
Carrier tape thickness T = 0.9 + 0.1/–0 mm (see Note 1)
Pitch of the sprocket holes P_0 = 4.0 ± 0.1 mm
Pitch tolerance over any 10 pitches = ± 0.2 mm

Fig.14 Cardboard carrier tape; size 0603 only. See Table 6 for dimensions.

Table 6 Physical dimensions of cardboard tape

dimension	tolerance	size 0603
A_0	+0.2/–0	1.10
B_0	+0.2/–0	1.90
W	± 0.3	8
E	± 0.1	1.75
F	± 0.05	3.5
D_0	± 0.1/–0	1.5
P_0	± 0.1	4
P_1	± 0.1	4
P_2	± 0.05	2

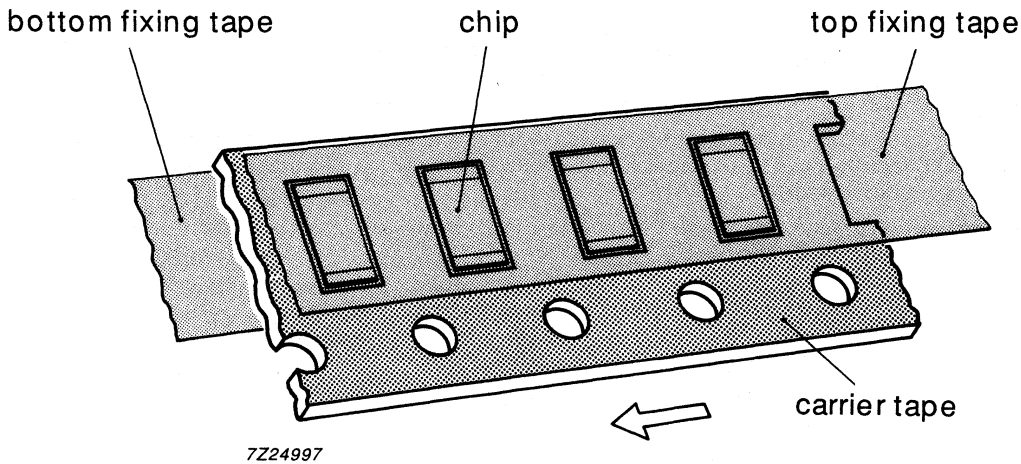


Fig.15 Cardboard tape.

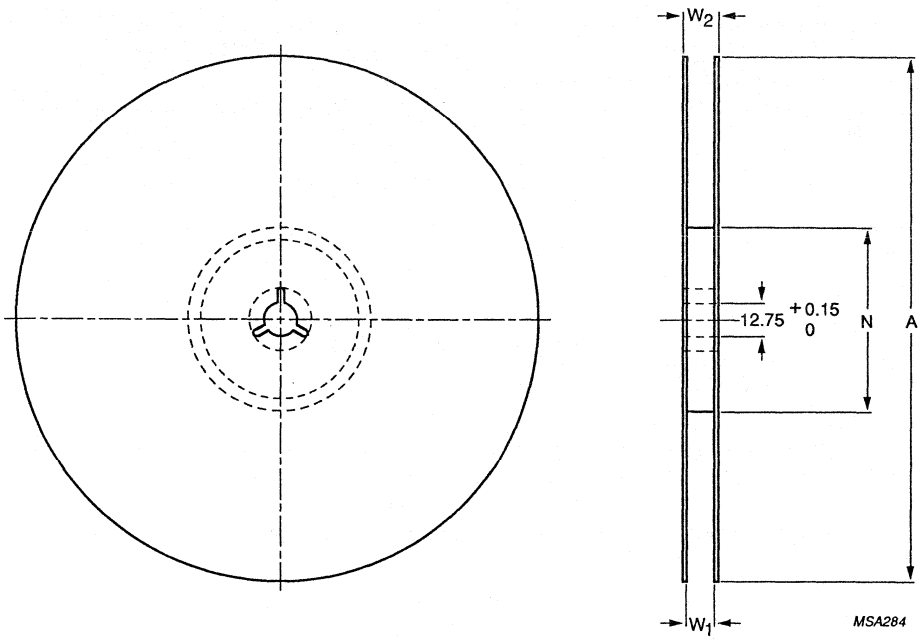


Fig. 16 Reel.

Table 7 Dimensions of reel

tape width (mm)	A (mm)	N (mm)	W_1 (mm)	W_{2max} (mm)
8	180	62 ± 1.5	8.4 +1.5/–0	14.4
	250	62 ± 1.5	8.4 +1.5/–0	14.4
	286	62 ± 1.5	8.4 +1.5/–0	14.4
12	180	62 ± 1.5	12.4 +2/–0	18.4
	286	62 ± 1.5	12.4 +2/–0	18.4

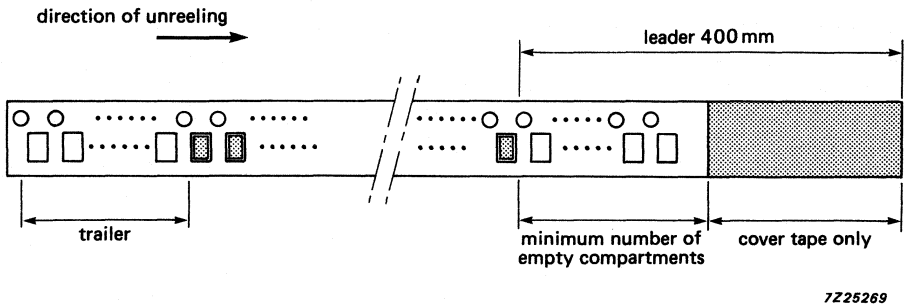


Fig. 17 Leader/trailer tape.

Tape data

Leader end:
Minimum length of 400 mm, including a minimum of 80 mm with empty compartments. The empty compartments are sealed with covertape.

Trailer end:
Minimum length of 160 mm.
The empty compartments are sealed with covertape.

Test conditions in static solder bath

Solderability	
95% covered with smooth and bright solder coating	235 ± 5 °C for 2 ± 0.5 s
Resistance to soldering heat	
10% of the metallization of the edges of the head face may be missing (inner electrodes not visible)	260 ± 5 °C for 30 ± 1 s ($\Delta C/C$ class 1; 0.5% or 0.5 pF), or ($\Delta C/C$ class 2: $-5\% < X7R \leqslant 10\%$, $-20\% < Y5V \leqslant 20\%$) must not be exceeded

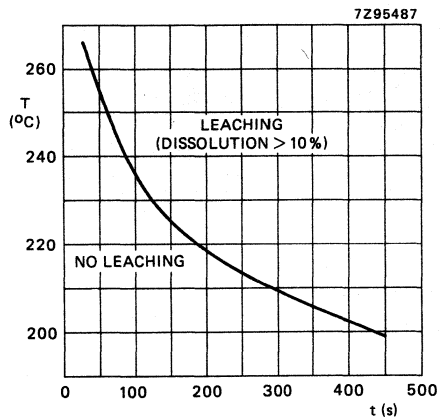


Fig.18 Resistance to leaching of AgPd metallized terminations (in static solder bath) at various temperature; for NiSn metallized terminations, the leaching resistance is a factor of 10 times better than shown in the graph.

METHODS OF MOUNTING AND DIMENSIONS OF SOLDERLANDS

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 (for advised soldering profiles, see figures 20, 21 and 22).
An improper combination of soldering conditions, substrate and chipsize can lead to a damaging of the component. The risk increases with chipsize and with temperature fluctuations (> 100 °C). Therefore it is advised to use the smallest possible size and follow the recommendations given in the table below, (all dimensions are in mm).

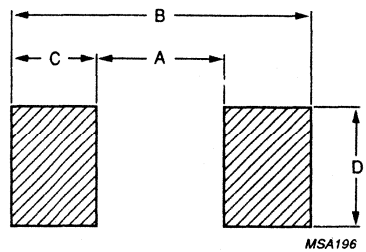


Fig. 19 Recommended dimensions of solderlands.

Reflow soldering

SIZE	A	B	C	D
0603	0.9	2.3	0.7	0.8
0805	0.8	3.4	1.3	1.4
1206	1.8	4.0	1.1	1.7
1210	1.8	4.6	1.4	2.6
1812	2.8	6.2	1.7	3.3
2220	4.0	7.4	1.7	5.1

Wave soldering

SIZE	A	B	C	D
0603	0.9	2.5	0.8	0.8
0805	1.2	3.6	1.2	1.2
1206	2.0	4.8	1.4	1.4
1210	2.0	4.8	1.4	2.5
*1812	3.0	6.2	1.6	3.2
*2220	4.0	7.2	1.6	5.0

* Sizes 1812, 2220 are recommended to be mounted on ceramic substrate and reflow soldered.

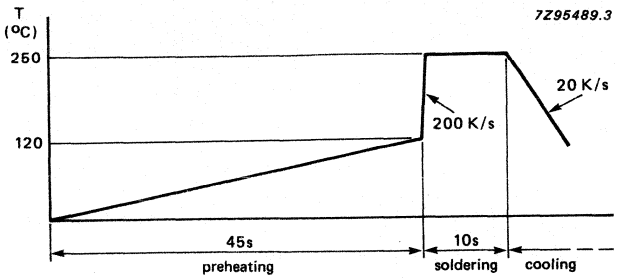


Fig. 20 Reflow soldering.

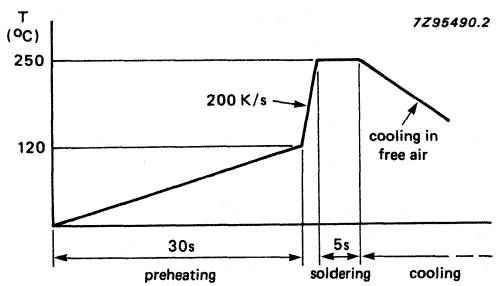


Fig. 21 Wave soldering. The capacitors may be soldered twice in accordance with this method if desired.

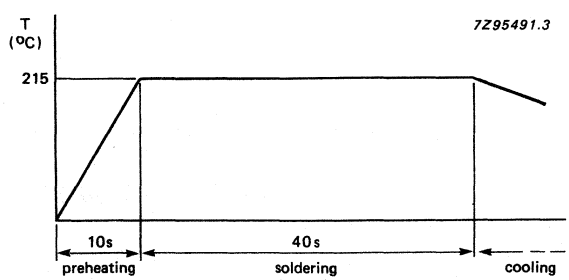


Fig. 22 Vapour phase soldering.

ORDERING INFORMATION FOR COMPACT CMC SERIES CAPACITORS

Composition of the 12 NC prdering code

The 12 NC may be constructed using the information given below:

	(A)	(B)	(C)	(D)	(E)	(F)
2222	xx	x	x	x	x	xx

A: **Rated voltage**

Insert the following digits in accordance with the desired rated voltage.

NiSn terminations, rated voltage 25 V – 87
AgPd terminations, rated voltage 25 V – 88
} X7R dielectric types only

NiSn terminations, rated voltage 63 V – 89
AgPd terminations, rated voltage 63 V – 90

B: **Capacitor size**

Insert the following digits in accordance with the desired capacitor size.

Size 0805 – 0
Size 1206 – 1
Size 1210 – 2
Size 1812 – 4
Size 2220 – 5

C: **Packing**

Insert the following digits in accordance with the desired packing method.

1000 pieces, bulk (see note 1) – 0
Quantity for tape on reel depends on size and thickness of the product (see note 2) – 1
Special series – 9

D: **Dielectric material**

Insert the following digits in accordance with the desired dielectric material.

NP0 dielectric – 0
X7R dielectric – 6

Notes

1. Capacitor sizes 1210, 1812 and 2220 are supplied in a cardboard box in 10 plastic bags, each bag contains 100 pieces.
2. Quantity for tape on (reel diameter 180 mm) reel for capacitor sizes 0805, 1206 and 1210;
   Capacitor thickness $\leqslant$ 1 mm; 4000 pieces per reel.
   Capacitor thickness 1.0 - 1.3 mm; 3000 pieces per reel.
   Capacitor thickness $>$ 1.3 mm; 2000 pieces per reel.
   For capacitor sizes 1812 and 2220;
   Capacitor thickness $\leqslant$ 1 mm; 2000 pieces per reel.
   Capacitor thickness 1.0 - 1.3 mm; 1500 pieces per reel.
   Capacitor thickness $>$ 1.3 mm; 1000 pieces per reel.

E. **Tolerance on capacitance**

Insert the following digits in accordance with the desired tolerance:

± 2% – 4 (NP0 dielectric only)
± 5% – 5
± 10% – 6
± 20% – 7

F. **Capacitance value**

Insert the following digits in accordance with the desired capacitance value:

Class 1, NPO dielectric

220 pF	– 41	3.9 nF	– 57
270 pF	– 42	4.7 nF	– 58
330 pF	– 43	5.6 nF	– 59
390 pF	– 44	6.8 nF	– 61
470 pF	– 45	8.2 nF	– 62
560 pF	– 46	10 nF	– 63
680 pF	– 47	12 nF	– 64
820 pF	– 48	15 nF	– 65
1.0 nF	– 49	18 nF	– 66
1.2 nF	– 51	22 nF	– 67
1.5 nF	– 52	27 nF	– 68
1.8 nF	– 53	33 nF	– 69
2.2 nF	– 54	39 nF	– 71
2.7 nF	– 55	47 nF	– 72
3.3 nF	– 56		

Class 2, X7R dielectric

10 nF	– 36	220 nF	– 54
12 nF	– 37	270 nF	– 55
15 nF	– 38	330 nF	– 56
18 nF	– 39	390 nF	– 57
22 nF	– 41	470 nF	– 58
27 nF	– 42	560 nF	– 59
33 nF	– 43	680 nF	– 61
39 nF	– 44	820 nF	– 62
47 nF	– 45	1 μF	– 63
56 nF	– 46	1.2 μF	– 64
68 nF	– 47	1.5 μF	– 65
82 nF	– 48	1.8 μF	– 66
100 nF	– 49	2.2 μF	– 67
120 nF	– 51	2.7 μF	– 68
150 nF	– 52	3.3 μF	– 69
180 nF	– 53	3.9 μF	– 71

Example: 100 nF, 0805, 10% tolerance, X7R, 25 V with AgPd terminations, packed in 4000 pieces, tape reel has the catalogue number: 2222 880 16649.

Table 10 IEC tests and requirements

IEC test clause		test	procedure	requirements
384-10 para.	68-2 para.			
4.4		mounting	soldering of products to an alumina test substrate using a reflow soldering method (e.g. infra-red, condensation)	no visible damage
4.5		visual inspection and dimension check	any applicable method using x 10 magnification	in accordance with specification
4.6.1		capacitance	$C \leqslant 1000$ pF, f = 1 MHz $C > 1000$ pF, f = 1 kHz measuring voltage 1 V at temperature of 20 °C	within specified tolerance; for class 2, measured 1000 hours after data of manufacture
4.6.2		tan δ	see IEC 384-10, para. 9.2	in accordance with specification
4.6.3		insulation resistance	at 10 V DC for 1 minute	in accordance with specification
4.6.4		voltage proof	2.5 U_R 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	X7R and Y5V between minimum and maximum temperature	in accordance with specification
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 ± 0.5 s in a solder bath at 235 ± 0.5 °C	the terminations shall be well tinned
4.10	Tb	resistance to soldering heat	260 ± 5 °C for 10 ± 0.5 s	the terminations shall be well tinned after recovery $\Delta C/C$ requirements class 1 dielectric: $\leqslant 0.5\%$ or ± 0.5 pF, whichever is greater X7R dielectric: $> -5\%$ and $\leqslant 10\%$ Y5V dielectric: $> -10\%$ and $\leqslant 20\%$

Table 10 (continued)

IEC test clause		test	procedure	requirements
384-10 para.	68-2 para.			
		resistance to leaching	260 ± 5 °C for 30 ± 1 s in a static solder bath	using visual enlargement of x 10, dissolution of the terminations shall not exceed 10%
4.8		adhesion	a force of 5 N applied 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	mounting in accordance with para. 4.4 conditions: bending 1 mm at a rate of 1 mm/s	no visible damage $\Delta C/C \leqslant 10\%$
4.1		pre-conditioning, class 2	X7R and Y5V; 1 hour at 175 °C, then 24 hours recovery	
4.12	Na	rapid change of temperature	pre-conditioning (class 2 only) −55/+125 °C, 5 cycles	no visible damage: after 24 hours recovery: class 1, $\Delta C/C \leqslant 1\%$ or 1 pF X7R, $\Delta C/C \leqslant 10\%$ Y5V, $\Delta C/C \leqslant 20\%$
4.13		climatic sequence	pre-conditioning (class 2 only)	
4.13.3	Ba	dry heat	16 hours at maximum temperature	no visible damage
4.13.4	Db	damp heat accelerated, 1 cycle	24 hours at +55 °C, 100% RH	
4.13.5	Aa	cold	2 hours at minimum temperature	no visible damage

Table 10 (continued)

IEC test clause		test	procedure	requirements
384-10 para.	68-2 para.			
4.13.6	Db	damp heat accelerated, remaining cycles	5 cycles of 24 hours duration at +55 °C, 100% RH	after recovery; class 1, 1 - 2 hours class 2, 24 hours $\Delta C/C$ measurements: class 1; ± 2% or 1 pF* X7R; ⩽ 10%, Y5V; ⩽ 20% tan δ measurements: class 1; ⩽ 2 x specified value X7R ⩽ 5%, Y5V ⩽ 7% R_{INS} measurements: class 1; 2500 MΩ or $R_iC_R \geqslant 25$ s** X7R, Y5V ⩾ 1000 MΩ or $R_iC_R \geqslant 25$ s**
4.14	Ca	damp heat, steady state	pre-conditioning (class 2 only), 56 days at 40 °C, 90 - 95% RH, 1 V applied	no visible damage electrical checks shall comply with clause 4.13.6, except $\Delta C/C$ for Y5V ⩽ ± 30%
4.15		endurance	pre-conditioning (class 2 only) 1000 hours at maximum temperature at 1.5 x rated voltage	no visible damage after 24 hours recovery; $\Delta C/C$ measurements: class 1; ± 2% or 1 pF* X7R; ⩽ 10%, Y5V; ⩽ 30% tan δ measurements: class 1; ⩽ 2 x specified value X7R ⩽ 5%, Y5V ⩽ 7% R_{INS} measurements: class 1; 4000 MΩ or ⩾ 40 s** X7R, Y5V ⩾ 2000 MΩ or $R_iC_R \geqslant 50$ s**

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IC04	**HE4000B logic family** CMOS
IC05	**Advanced Low-power Schottky (ALS) Logic Series**
IC06	**High-speed CMOS; 74HC/HCT/HCU** Logic family
IC07	**Advanced CMOS logic (ACL)**
Supplement to IC07	**Advanced CMOS logic (ACL)**
IC08	**10/100K ECL Logic/Memory/PLD**
IC09	**TTL logic series**
IC10	**Memories** MOS, TTL, ECL
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IC12	**I^2C-bus compatible ICs**
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S4a	**SC05**	**Low-frequency power transistors and hybrid IC power modules**
S4b	**SC06**	**High-voltage and switching power transistors**
S5	**SC07**	**Small-signal field-effect transistors**
S6	**SC08a**	**RF power bipolar transistors**
	SC08b	**RF power MOS transistors**
	SC09	**RF power modules**
S7	**SC10**	**Surface mounted semiconductors**
S8b	**SC12**	**Optocouplers**
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C7	**PA04**	**Variable capacitors**
C22	**PA05***	**Film capacitors**
C15	**PA06**	**Ceramic capacitors**
C9	**PA07***	**Piezoelectric quartz devices**
C13	**PA08**	**Fixed resistors**
	PA11	**Quartz Oscillators**

* Not yet issued with the new code in this series of handbooks.

PROFESSIONAL COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
T3	**PC01**	**High-power klystrons and accessories**
T5	**PC02***	**Cathode-ray tubes**
T6	**PC03***	**Geiger-Müller tubes**
T9	**PC04**	**Photo multipliers**
T10	**PC05**	**Plumbicon camera tubes and accessories**
T11	**PC06**	**Circulators and Isolators**
T12	**PC07**	**Vidicon and Newvicon camera tubes and deflection units**
T13	**PC08**	**Image intensifiers**
T15	**PC09**	**Dry-reed switches**
	PC11	**Solid state image sensors and peripherals integrated circuits**
T9	**PC12***	**Electron multipliers**

* Not yet issued with the new code in this series of handbooks.

MAGNETIC PRODUCTS

This series of data handbooks comprises:

current code	new code	handbook title
C4, C5	MA01	**Soft Ferrites**
C16	MA02	**Permanent magnet materials**
C19	MA03*	**Piezoelectric ceramics**

* Not yet issued with the new code in this series of handbooks.

LIQUID CRYSTAL DISPLAYS

current code	new code	handbook title
S14	**LCD01**	**Liquid Crystal Displays and driver ICs for LCDs**

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