PASSIVE COMPONENTS

DATA HANDBOOK

Ceramic Capacitors

BOOK PA06 1995

Philips Components

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Ceramic Capacitors

CONTENTS

DEFINITIONS

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

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INTRODUCTION

Ceramic Capacitors — Introduction

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 a very high specific resistance, very good Q and linear temperature dependence (ε_r from 6 up to 550). They are used in such applications as oscillators and filters where low losses, capacitance drift compensation and high stability are required.

- Class 2

  These capacitors have higher losses and have non-linear characteristics ($\varepsilon_r > 250$). They are used for coupling and decoupling.

CONSTRUCTION

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

$$C = \varepsilon_r \times \varepsilon_o \times \frac{A}{t} \times n$$

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

Two constructions are shown in Figs 2 and 3.

The electrodes are normally copper, 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.

MANUFACTURING OF CERAMIC CAPACITORS

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

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

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

EQUIVALENT CIRCUIT FOR LEADED CAPACITORS

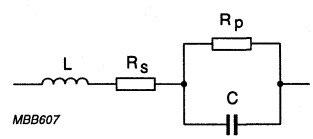


Fig.1 Equivalent circuit.

Definition of symbols (see Fig.1).

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

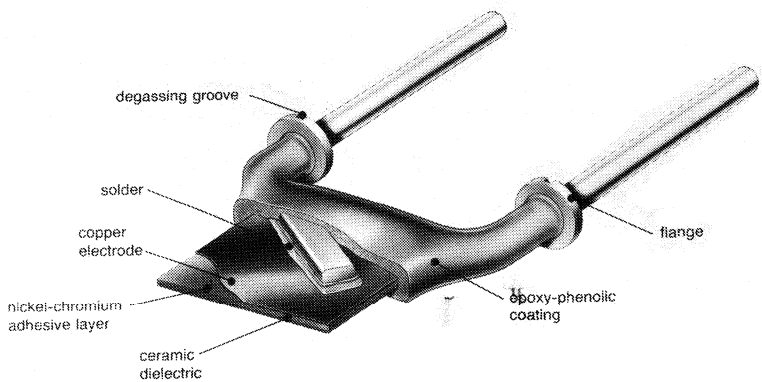


Fig.2 Plate capacitor.

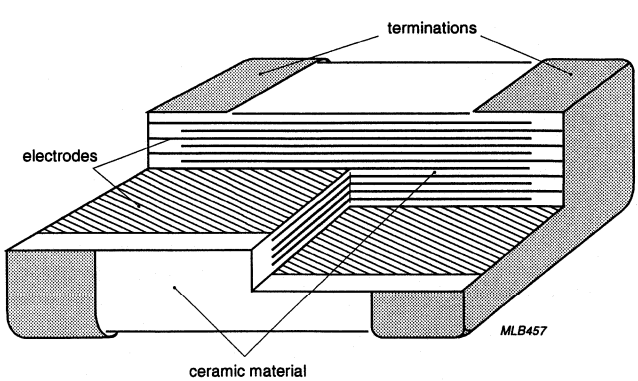


Fig.3 Cross-section of a multilayer capacitor.

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:

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

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

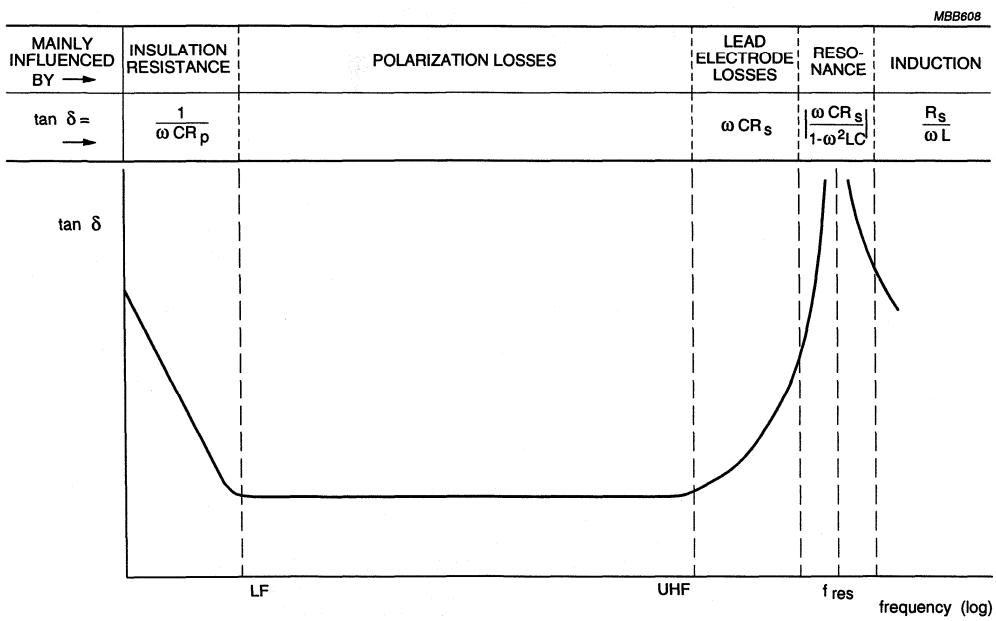


Fig.4 Tan δ as a function of frequency.

RELIABILITY

The failure rates shown in Table 1 have a confidence level of 60% and refer to observations of ceramic multilayer capacitors (CMC) and ceramic plate capacitors (CPC) up to and including 1993.

Table 1 Reliability.

CAPACITOR TYPE	NUMBER OF COMPONENT HOURS	FAILURE RATE AT NORMALIZED CONDITIONS
CMC	25756000	2.4 FIT
CPC	51420000	2.2 FIT

Remarks

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

Failure rates are given under normalized conditions, i.e. at 0.5 × rated DC voltage and T_{amb} = 40 °C.

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

The determination of failure rates is based on the rated conditions as stated in *"MIL-HDBK-217D"*. All the test results should be interpreted as results under rated conditions even if the temperature and voltage exceed the rated values.

SURFACE MOUNTED
CERAMIC MULTILAYER CAPACITORS

PACKAGING AND ORDERING INFORMATION

Tape on reel

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

COVER TAPE (ANTI-STATIC)

- Polyester: 12 μm
- Adhesive: 20 μm
- Sealant: 30 μm (styrene resin).

Table 1 Properties of cover tape.

PARAMETER	TAPE PROPERTIES	
	5.5 ±0.1 mm	**9.5 ±0.1 mm**
Breaking force	≥10.7 N	≥17.6 N
Elongation at break	≥63%	≥63%
Surface resistance	$<10^{10}$ Ω/sq.	$<10^{10}$ Ω/sq.
Softening point	71 ±5 °C	71 ±5 °C

CARRIER TAPE

- Polycarbonate.

Table 2 Properties of carrier tape.

PARAMETER	TAPE PROPERTIES	
	8.1 ±0.2 mm	**12 ±0.2 mm**
Thickness	190 to 280 μm	240 ±20 μm
Tensile strength at break	>60 N/mm^2	>60 N/mm^2
Elongation at break	100 to 150%	100 to 150%
Surface resistance	$>10^{12}$ Ω/sq.	$>10^{12}$ Ω/sq.

General information

For the combination carrier/cover tape no static behaviour is observed (relative humidity ≥30%). The products do not stick to the cover tape and no voltage is measured if the cover tape is separated from the carrier tape.

The technical and thermal properties of polycarbonate tapes are excellent, so there is no change in dimensions as a function of time. The peel off force is very stable as a function of time and temperature, and it is defined as 10 to 70 cN (centi-Newton) at a peel-off speed of 120 mm/minute.

Bulk packaging

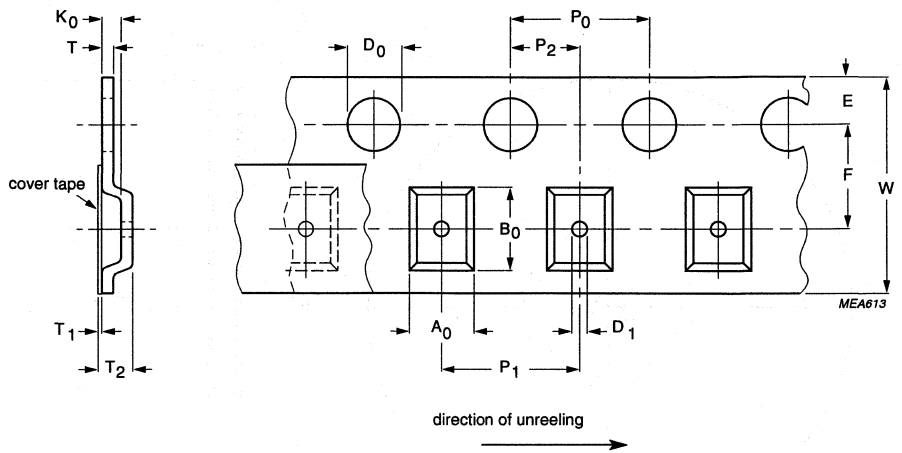
For bulk case; see Fig.4 and Table 6.

Loose in bag is available on request.

Environmental considerations

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

Blister tape specifications



K_0: so chosen that the orientation of the component cannot change.
For W = 8 mm: T_2 = 2.5 mm max.
For W = 12 mm: T_2 = 4.5 mm max.

Fig.1 Blister tape.

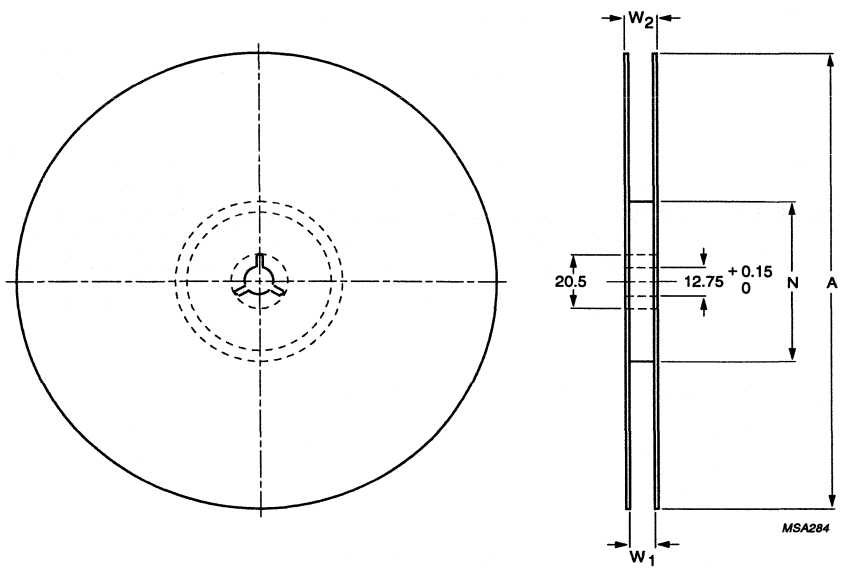
Table 3 Physical dimensions of blister tape (see Fig.1).

DIMENSION	TAPE SIZE (mm)/SIZE CODE/THICKNESS CLASSIFICATION(3)						TOLERANCE (mm)
	0603	0805	1206	1210	1812	2220	
A_0 nominal clearance; note 1	0.15	0.30	0.30	0.30	0.35	0.35	–
B_0 nominal clearance; note 1	0.15	0.20	0.20	0.30	0.40	0.40	–
K_0 minimum clearance; note 1	0.10	0.10	0.10	0.10	0.10	0.10	–
W	8.1	8.1	8.1	8.1	12.0	12.0	±0.2
E	1.75	1.75	1.75	1.75	1.75	1.75	±0.1
F	3.5	3.5	3.5	3.5	5.5	5.5	±0.05
D_0	1.5	1.5	1.5	1.5	1.5	1.5	+0.1/–0.0
D_1	–	≥1	≥1	≥1	1.5	1.5	+0.1/–0.0
P_0; note 2	4	4	4	4	4	4	±0.1
P_1	2	4	4	4	8	8	±0.1
P_2	0/2	2	2	2	2	2	±0.05

Notes

1. Possible capacitor displacement in pocket.
2. P_0 pitch tolerance over any 10 pitches is ±0.2 mm.
3. Refer to selection charts in product data for specific values.

Reel specifications



Dimensions in mm.

Fig.2 Reel.

Table 4 Reel dimensions.

TAPE WIDTH (mm)	A (mm)	N (mm)	W_1 (mm)	W_2 MAX. (mm)
8	180	62 ±1.5	8.4 +1.5/–0.0	14.4
8	286	62 ±1.5	8.4 +1.5/–0.0	14.4
12	180	62 ±1.5	12.4 +2/–0.0	18.4

Leader/trailer tape specification

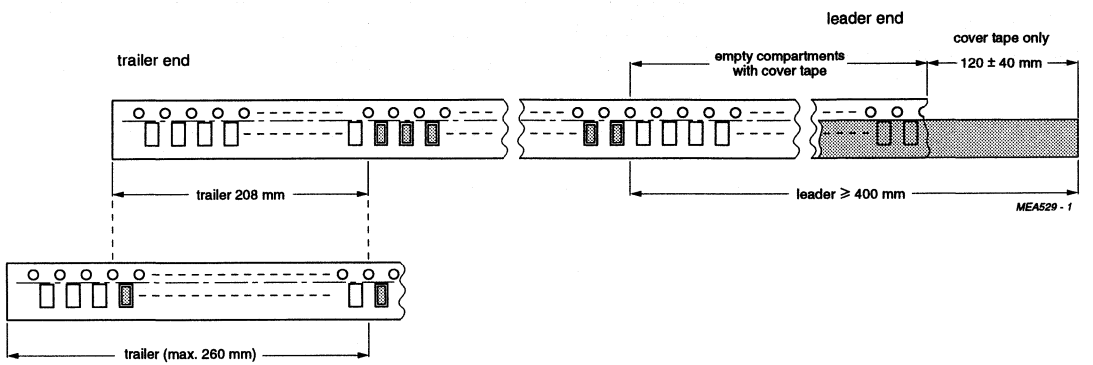


Fig.3 Leader/trailer tape.

Table 5 Leader/trailer tape data.

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

Bulk case specification

Features and benefits:

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

Table 6 Packaging quantities for component size (see note 1).

SIZE CODE	DIMENSIONS OF CAPACITOR (mm)			QUANTITY
	LENGTH	WIDTH	HEIGHT	
0603	1.6	0.8	0.8	15000
0805	2.0	1.25	0.6	10000
0805	2.0	1.25	0.9	8000
0805	2.0	1.25	1.25	5000

Note

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

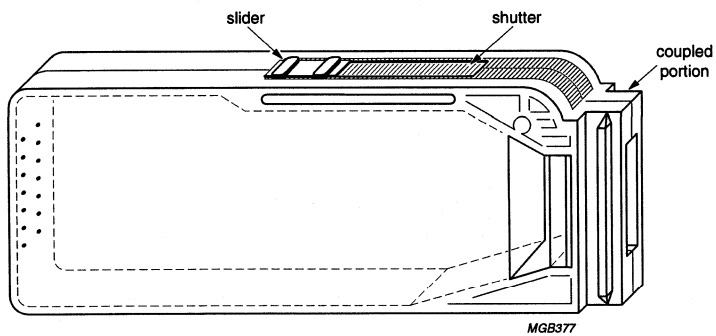


Fig.4 Bulk case outlines.

Multi-pack box specification

Features and benefits:

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

Table 7 Number of reels per box.

REEL SIZE Ø (mm)	TAPE SIZE (mm)	QUANTITY PER BOX	
		MIN.	MAX.
180	8	5	25
	12	5	10
286	8	5	15

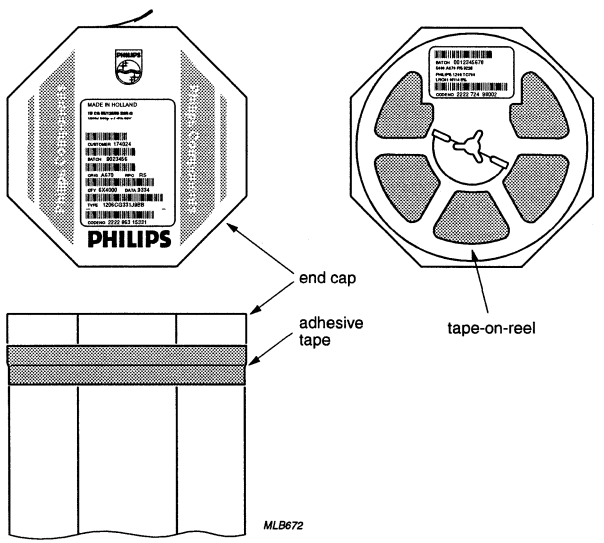
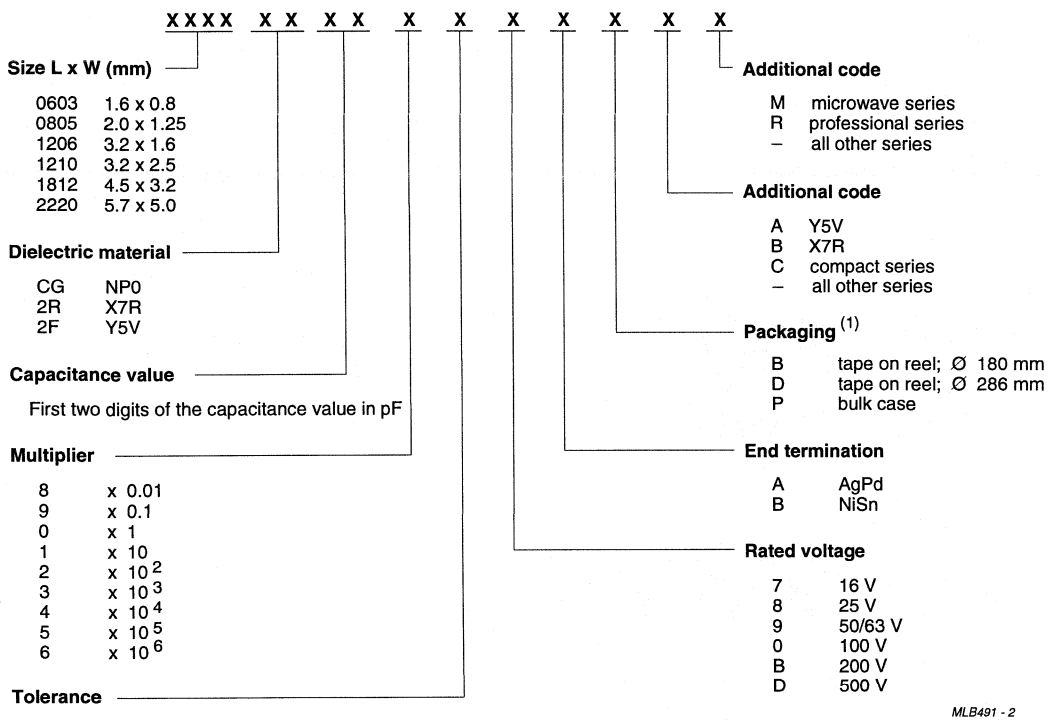


Fig.5 Multi-pack box outline.

COMPOSITION OF THE 15-DIGIT CODE

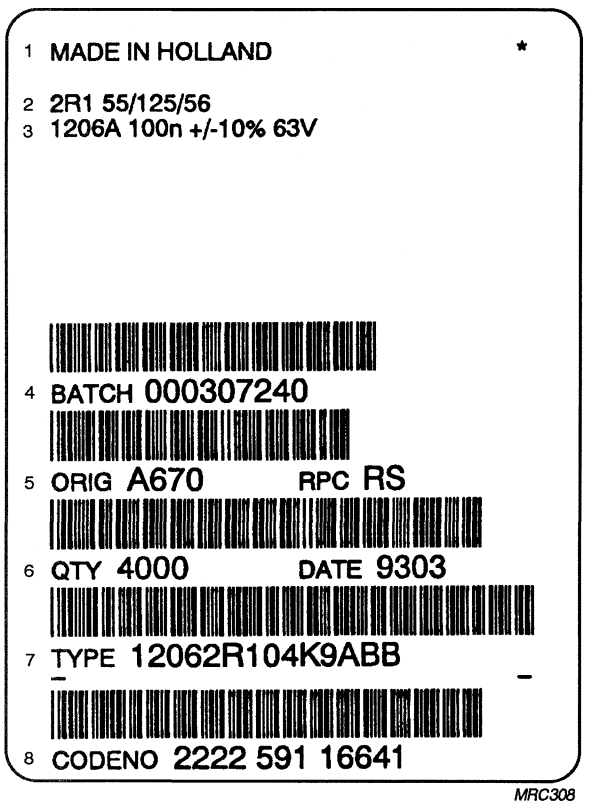


When using this 15-digit code, check the relevant selection chart to ensure that the chosen combination is available.

Fig.6 Composition of the 15 digit code.

LABELLING

Label examples are shown in Figs 7 and 8.



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

Fig.7 Packaging label (example).

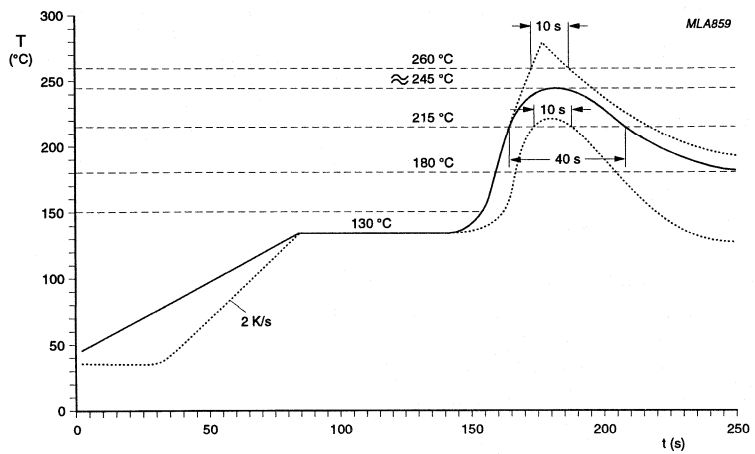
LINE	MARKING EXPLANATION
1.	Unique batch number
2.	Quantity and date code
3.	Material code and climatic category
4.	Size, termination code, value, tolerance and rated voltage
5.	15 digit code
6.	Catalogue number (12NC)

Fig.8 Reel label (example).

METHOD OF MOUNTING AND DIMENSIONS OF SOLDERLANDS

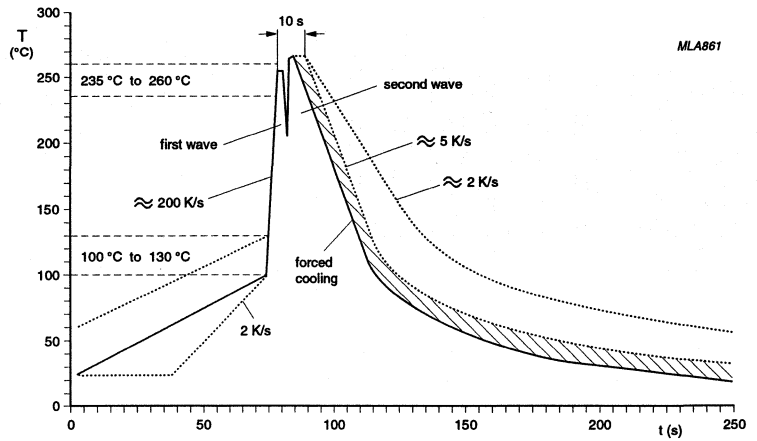
For normal use the capacitors may be mounted on printed-circuit boards or ceramic substrates by applying wave soldering, reflow soldering (including vapour phase soldering) or conductive adhesive in accordance with CECC 00802 classification A. For advised soldering profiles see Figs 9, 10 and 11.

An improper combination of soldering, substrate and chip size can lead to a damaging of the component. The risk increases with the chip size and with temperature fluctuations (>100 °C). Therefore, it is advised to use the smallest possible size and follow the dimensional recommendations given in Tables 8 and 9 for reflow and wave soldering. More detailed information is available on request.



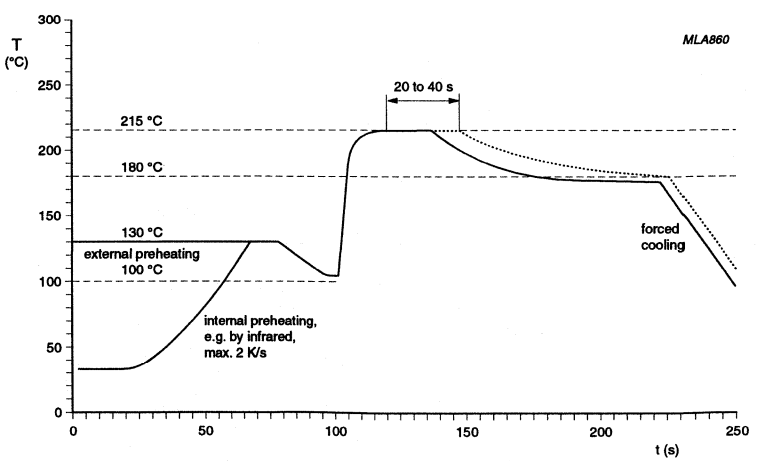
Typical values (solid line).
Process limits (dotted lines).

Fig.9 Reflow soldering.



Typical values (solid line).
Process limits (dotted lines).
The capacitors may be soldered twice in accordance with this method if desired.

Fig.10 Double wave soldering.



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

Fig.11 Vapour phase soldering.

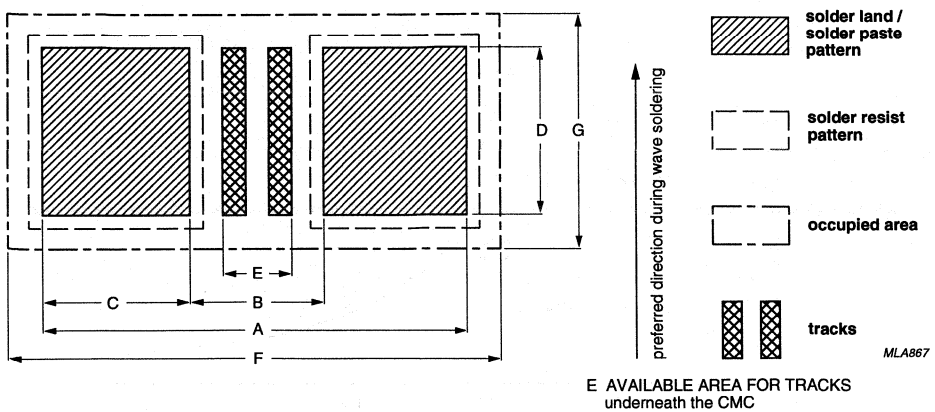


Fig.12 Recommended dimensions of solderlands.

Table 8 Reflow soldering; for dimensions also see Fig.12.

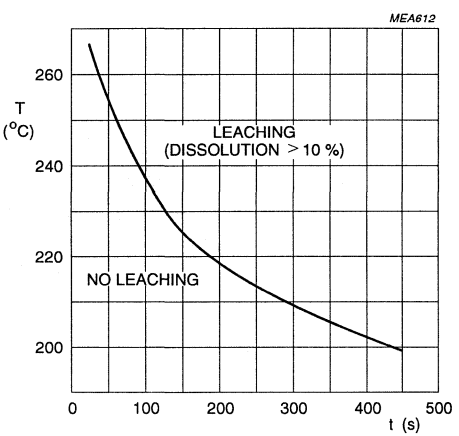
SIZE CODE	FOOTPRINT DIMENSIONS (mm)							PROCESSING REMARKS	PLACEMENT ACCURACY (mm)
	A	B	C	D	E	F	G		
0603	2.3	0.7	0.8	0.9	0.26	2.7	1.5	IR or hot plate soldering	±0.15
0603	2.3	0.5	0.9	0.9	0.0	2.7	1.5		±0.25
0805	2.8	0.9	0.95	1.4	0.45	3.2	2.1		±0.25
1206	4.0	2.0	1.0	1.8	1.4	4.4	2.5		±0.25
1210	4.0	2.0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

Table 9 Wave soldering (no dummy tracks allowed for the high voltage series); for dimensions also see Fig.12.

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

TEST CONDITIONS IN STATIC SOLDER BATH

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



For NiSn metallized terminations, the leaching resistance is a factor of 10 times better than shown in the graph.

Fig.13 Resistance to leaching of AgPd metallized terminations (in static solder bath) at various temperatures.

TESTS AND REQUIREMENTS

CECC/IEC TEST CLAUSE			TEST	PROCEDURE	REQUIREMENTS
IEC 384-10	CECC 32 100	IEC 68-2			
PARAGRAPH					
4.4			mounting	the capacitors may be mounted on printed-circuit boards or ceramic substrates by applying wave soldering, reflow soldering (including vapour phase soldering) or conductive adhesive	no visible damage
4.5			visual inspection and dimension check	any applicable method using × 10 magnification	in accordance with specification
4.6.1			capacitance	class 1: $C \leq 1000$ pF, f = 1 MHz; $C > 1000$ pF, f = 1 kHz; measuring voltage: 1 V at 20 °C	within specified tolerance
				class 2: for all capacitors f = 1 kHz	measured 1000 hours after date of manufacture

4.6.2			tan δ	class 1:
				$C \leq 1000$ pF, f = 1 MHz;
				$C > 1000$ pF, f = 1 kHz;
				measuring voltage:
				1 V at 20 °C
				class 2:
				for all capacitors f = 1 kHz
					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	$2.5 \times U_R$ 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 2X7R, 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	mounted in accordance with CECC 32 100, paragraph 4.4	no visible damage
				conditions: bending 1 mm at a rate of 1 mm/s	ΔC/C: class 1: ≤1% class 2: ≤10%

CECC/IEC TEST CLAUSE			TEST	PROCEDURE	REQUIREMENTS
IEC 384-10	CECC 32 100	IEC 68-2			
PARAGRAPH					
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: class 1: ≤0.5% or ±0.5 pF whichever is greater class 2X7R: >–5% and ≤10%
			resistance to leaching	260 ±5 °C for 30 ±1 s in a static solder bath	using visual enlargement of × 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: –55 to +125 °C; 5 cycles	no visible damage after 48 hours recovery ΔC/C: class 1: ≤1% or 1 pF class 2X7R: ≤15%
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

CECC/IEC TEST CLAUSE			TEST	PROCEDURE	REQUIREMENTS
IEC 384-10	CECC 32 100	IEC 68-2			
PARAGRAPH					

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 to 2 hours
					class 2, 24 hours:
					$\Delta C/C$:
					class 1: ±2% or 1 pF whichever is greater
					class 2X7R: ≤15%
					tan δ:
					class 1: ≤2 × specified value
					class 2X7R: ≤7%
					R_{ins}:
					class 1:
					2500 MΩ or $R_iC_R \geq 25$ s, whichever is less
					class 2X7R:
					1000 MΩ or $R_iC_R \geq 25$ s, whichever is less

4.14		Ca	damp heat, steady state	pre-conditioning, class 2 only: 56 days at 40 °C; 90 to 95% RH; U_r applied	no visible damage; electrical checks shall comply with CECC 32 100, paragraph 4.13.6

4.15			endurance	pre-conditioning:
				1000 hours at maximum temperature at 1.5 × U_R
					no visible damage after 24 hours recovery:
					$\Delta C/C$:
					class 1: ±2% or 1 pF whichever is greater
					class 2X7R: ≤20%
					tan δ:
					class 1: ≤2 × specified value
					class 2X7R: ≤7%
					R_{ins}:
					class 1:
					4000 MΩ or $R_iC_R \geq 40$ s, whichever is less
					class 2X7R:
					2 000 MΩ or $R_iC_R \geq 50$ s, whichever is less

CECC 32101 - 801			damp heat accelerated, steady state	85 °C; 85% RH; 500 hours with bias 1.5 V and U_R	R_{ins} shall not be less than 10% of the initial requirements

PROGRAMME SURVEY

Class 1 capacitors

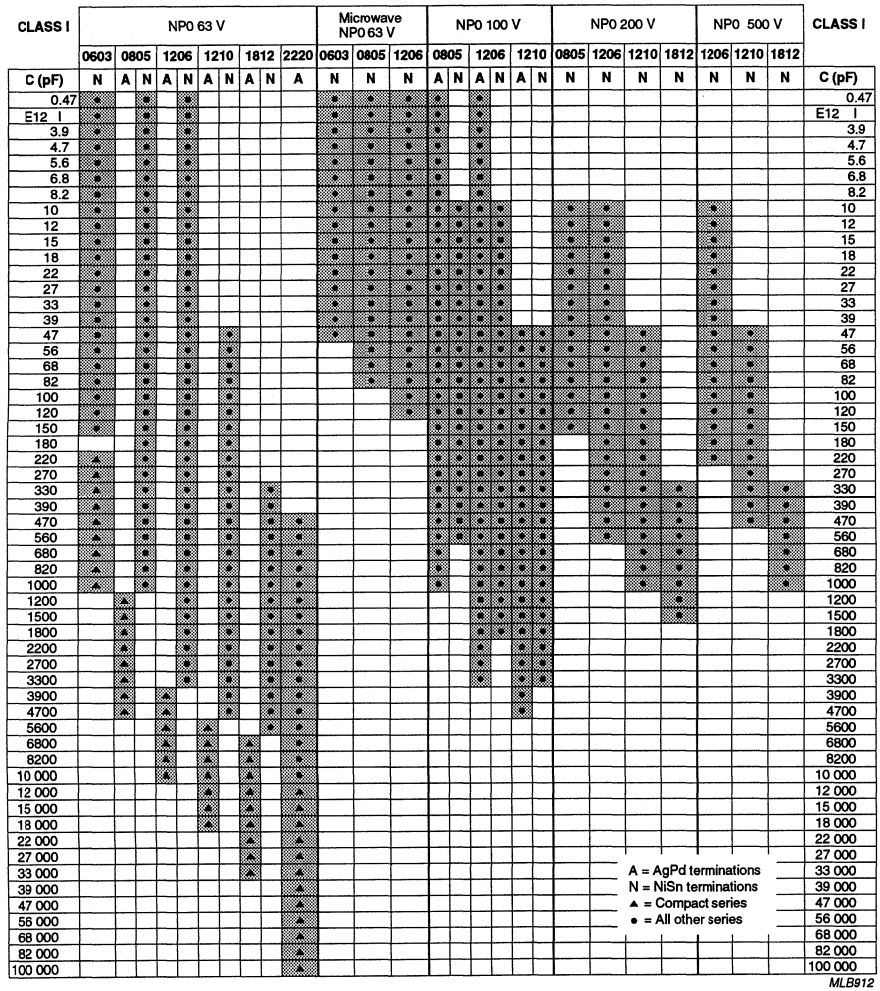


Fig.1 General overview for class 1, Ceramic Multilayer Capacitors.

Class 2 capacitors

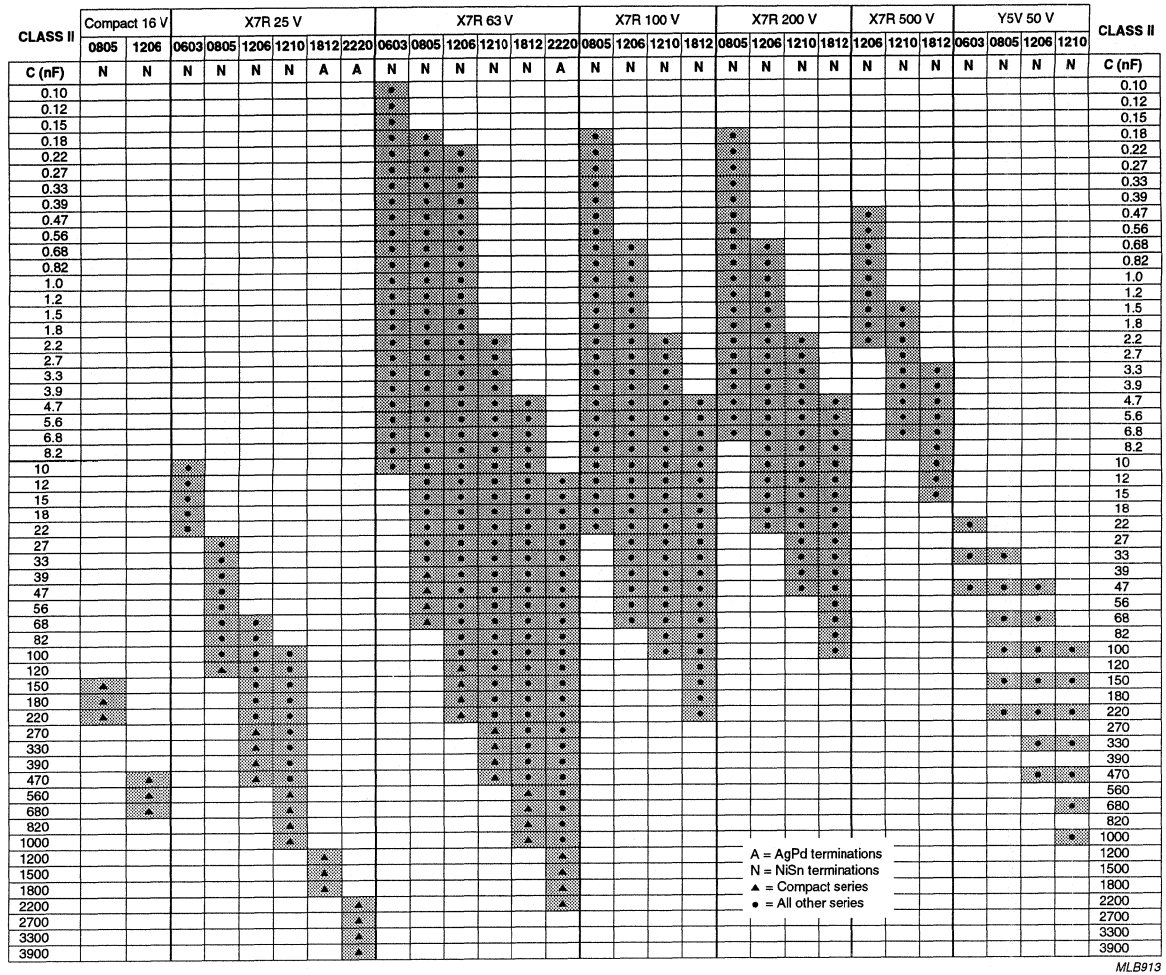


Fig.2 General overview for class 2, Ceramic Multilayer Capacitors.

PRODUCT DATA

Surface mounted ceramic multilayer capacitors

Class 1, NP0 series

FEATURES

- Six standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case (case sizes 0603 and 0805 only); loose in bag available on request
- For high frequency applications
- NiSn terminations (AgPd on request).

APPLICATIONS

- Consumer electronics
- Telecommunications
- Automotive
- Data processing.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	63 V, 100 V, 200 V and 500 V (IEC)
Capacitance range; note 1:	
general purpose; 63 V	0.47 pF to 10000 pF (E12 series)
general purpose; 100 V	0.47 pF to 4700 pF (E12 series)
narrow tolerance; 63 V	0.47 pF to 3300 pF (E12 series)
high voltage; 200 V	10 pF to 1500 pF (E12 series)
high voltage; 500 V	10 pF to 560 pF (E12 series)
Tolerance on capacitance:	
$C \geq 10$ pF	±10%, ±5%, ±2% and ±1%
$C < 10$ pF	±0.5 pF, ±0.25 pF and ±0.1 pF
Sectional specifications	IEC 384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 68)	55/125/56

Note

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

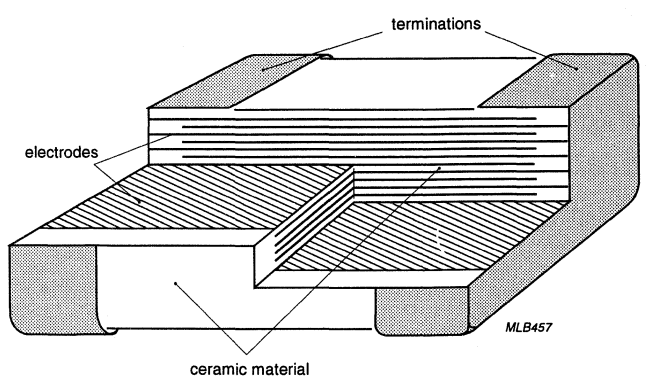
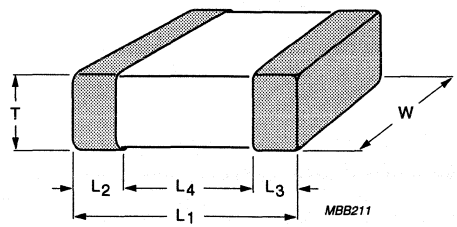


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic multilayer capacitors

Class 1, NP0 series

MECHANICAL DATA



For dimensions see Table 1

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions.

CASE SIZE	L_1 (mm)	W (mm)	T		L_2 and L_3		L_4 MIN. (mm)
			MIN. (mm)	MAX. (mm)	MIN. (mm)	MAX. (mm)	
0603	1.6 ±0.1	0.8 ±0.1	0.7	0.9	0.25	0.65	0.4
0805	2.0 ±0.1	1.25 ±0.1	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.4
1210	3.2 ±0.2	2.5 ±0.2	0.51	1.8	0.25	0.75	1.4
1812	4.5 ±0.2	3.2 ±0.2	0.51	1.8	0.25	0.75	2.2
2220	5.7 ±0.2	5.0 ±0.2	0.51	1.8	0.25	0.75	2.9

SELECTION CHART FOR 63 VOLT GENERAL PURPOSE SERIES

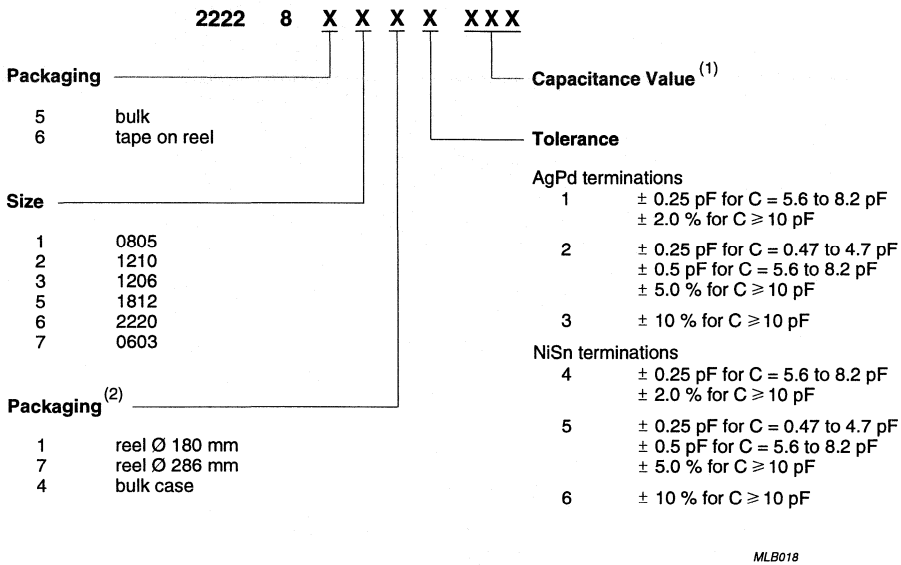
MGA352 - 2

C (pF)	LAST THREE DIGITS OF 12 NC	8 mm TAPE WIDTH				12 mm TAPE WIDTH	
		0603	0805	1206	1210	1812	2220
		NiSn	NiSn	NiSn	NiSn	NiSn	AgPd
0.47	477	4	1	1			
0.56	567	4	1	1			
0.68	687	4	1	1			
0.82	827	4	1	1			
1.0	108	4	1	1			
1.2	128	4	1	1			
1.5	158	4	1	1			
1.8	188	4	1	1			
2.2	228	4	1	1			
2.7	278	4	1	1			
3.3	338	4	1	1			
3.9	398	4	1	1			
4.7	478	4	1	1			
5.6	568	4	1	1			
6.8	688	4	1	1			
8.2	828	4	1	1			
10	109	4	1	1			
12	129	4	1	1			
15	159	4	1	1			
18	189	4	1	1			
22	229	4	1	1			
27	279	4	1	1			
33	339	4	1	1			
39	399	4	1	1			
47	479	4	1	1	3		
56	569	4	1	1	3		
68	689	4	1	1	3		
82	829	4	1	1	3		
100	101	4	1	1	3		
120	121	4	1	1	3		
150	151	4	1	1	3		
180	181		1	1	3		
220	221		1	1	3		
270	271		1	1	3		
330	331		1	1	3	3	
390	391		2	1	3	3	
470	471		2	1	3	3	3
560	561		2	1	3	3	3
680	681		6	1	3	3	3
820	821		6	1	3	3	3
1000	102		6	1	3	3	3
1200	122			2	3	3	3
1500	152			2	3	3	3
1800	182			5	3	3	3
2200	222			5	3	3	3
2700	272			5	3	3	3
3300	332			5	5	3	3
3900	392				5	3	3
4700	472				7	3	3
5600	562					3	3
6800	682						3
8200	822						3
10000	103						3

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL		12 mm TAPE WIDTH AMOUNT PER REEL Ø 180 mm		AMOUNT PER BULK CASE	
	Ø 180 mm	Ø 286 mm	1812	1220	0603	0805
1 = 0.51 to 0.7	4000	10000	–	–	–	10000
2 = 0.8 to 1.0	4000	10000	–	–	–	8000
3 = 0.51 to 1.0	4000	10000	2000	1500	–	–
4 = 0.8 ± 0.1	4000	10000	–	–	15000	–
5 = 0.9 to 1.3	3000	8000	–	–	–	–
6 = 1.25 ± 0.1	3000	8000	–	–	–	5000
7 = 1.2 to 1.75	2500	7000	–	–	–	–

Fig.3 Selection chart for 63 volt general purpose, class 1, NP0 series, with NiSn and AgPd terminations.

ORDERING INFORMATION FOR 63 VOLT GENERAL PURPOSE SERIES



For details of the 15-digit code refer to Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.3).

(2) Amount on reel depends on thickness classification (see Fig.3).

Fig.4 Composition of the 12NC for 63 volt general purpose, class 1, NP0 series.

SELECTION CHART FOR 63 VOLT NARROW TOLERANCE SERIES

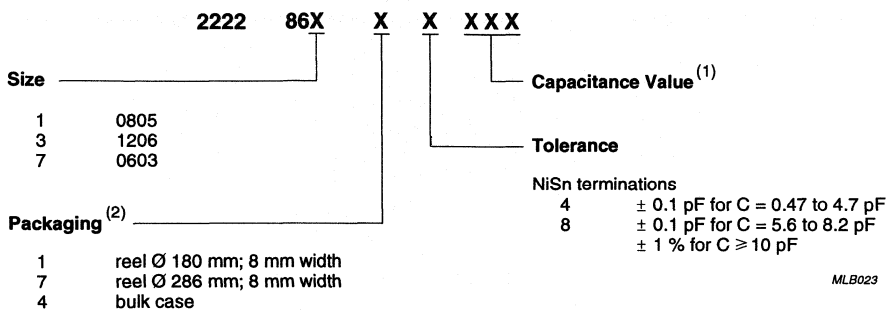
MGA450 - 2

C (pF)	LAST THREE DIGITS OF 12NC	8 mm TAPE WIDTH		
		0603	0805	1206
		NiSn	NiSn	NiSn
0.47	477	4	1	1
0.56	567	4	1	1
0.68	687	4	1	1
0.82	827	4	1	1
1.0	108	4	1	1
1.2	128	4	1	1
1.5	158	4	1	1
1.8	188	4	1	1
2.2	228	4	1	1
2.7	278	4	1	1
3.3	338	4	1	1
3.9	398	4	1	1
4.7	478	4	1	1
5.6	568	4	1	1
6.8	688	4	1	1
8.2	828	4	1	1
10	109	4	1	1
12	129	4	1	1
15	159	4	1	1
18	189	4	1	1
22	229	4	1	1
27	279	4	1	1
33	339	4	1	1
39	399	4	1	1
47	479	4	1	1
56	569	4	1	1
68	689	4	1	1
82	829	4	1	1
100	101	4	1	1
120	121	4	1	1
150	151	4	1	1
180	181		1	1
220	221		1	1
270	271		1	1
330	331		1	1
390	391		2	1
470	471		2	1
560	561		2	1
680	681		6	1
820	821		6	1
1000	102		6	1
1200	122			2
1500	152			2
1800	182			5
2200	222			5
2700	272			5
3300	332			5

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE	
	Ø 180 mm	Ø 286 mm	0603	0805
1 = 0.51 to 0.7	4000	10000	–	10000
2 = 0.8 to 1.0	4000	10000	–	8000
4 = 0.8 ± 0.1	4000	10000	15000	–
5 = 0.9 to 1.3	3000	8000	–	–
6 = 1.25 ± 0.1	3000	8000	–	5000

Fig.5 Selection chart for 63 volt narrow tolerance, class 1, NP0 series, with NiSn terminations.

ORDERING INFORMATION FOR 63 VOLT NARROW TOLERANCE SERIES



For details of the 15-digit code refer to Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.5).

(2) Amount on reel depends on thickness classification (see Fig.5).

Fig.6 Composition of the 12NC for 63 volt narrow tolerance, class 1, NP0 series.

SELECTION CHART FOR 100 VOLT GENERAL PURPOSE SERIES

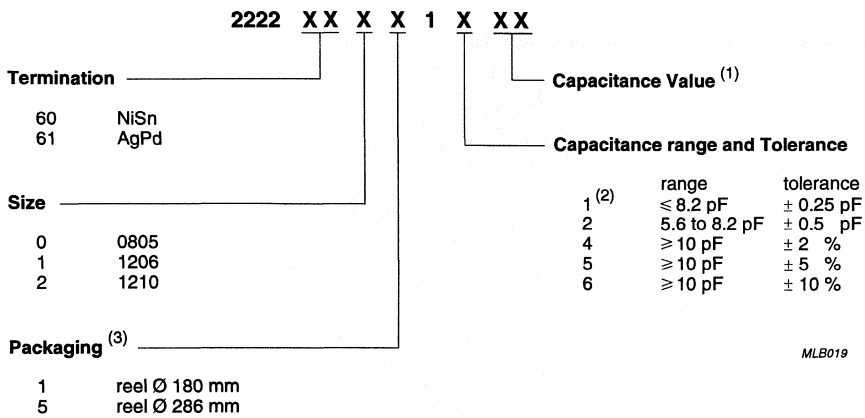
MGA354 - 2

C (pF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH					
		0805		1206		1210	
		AgPd	NiSn	AgPd	NiSn	AgPd	NiSn
0.47	05	1		1			
0.56	06	1		1			
0.68	07	1		1			
0.82	08	1		1			
1.0	09	1		1			
1.2	11	1		1			
1.5	12	1		1			
1.8	13	1		1			
2.2	14	1		1			
2.7	15	1		1			
3.3	16	1		1			
3.9	17	1		1			
4.7	18	1		1			
5.6	19	1		1			
6.8	21	1		1			
8.2	22	1		1			
10	23	1	1	1	1		
12	24	1	1	1	1		
15	25	1	1	1	1		
18	26	1	1	1	1		
22	27	1	1	1	1		
27	28	1	1	1	1		
33	29	1	1	1	1		
39	31	1	1	1	1		
47	32	1	1	1	1	3	3
56	33	1	1	1	1	3	3
68	34	1	1	1	1	3	3
82	35	1	1	1	1	3	3
100	36	1	1	1	1	3	3
120	37	1	1	1	1	3	3
150	38	1	1	1	1	3	3
180	39	1	1	1	1	3	3
220	41	1	1	1	1	3	3
270	42	1	1	1	1	3	3
330	43	1	1	1	1	3	3
390	44	2	2	1	1	3	3
470	45	2	2	1	1	3	3
560	46	2	2	1	1	3	3
680	47	6		1	1	3	3
820	48	6		1	1	3	3
1000	49	6		1	1	3	3
1200	51			2	2	3	3
1500	52			2	2	3	3
1800	53			5	5	3	3
2200	54			5		3	3
2700	55			5		3	3
3300	56			5		5	5
3900	57					5	
4700	58					7	

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL	
	Ø 180 mm	Ø 286 mm
1 = 0.51 to 0.7	4000	10000
2 = 0.8 to 1.0	4000	10000
3 = 0.51 to 1.0	4000	10000
5 = 0.9 to 1.3	3000	8000
6 = 1.25 ± 0.1	3000	8000
7 = 1.2 to 1.75	2500	7000

Fig.7 Selection chart for 100 volt general purpose, class 1, NP0 series, with NiSn and AgPd terminations.

ORDERING INFORMATION FOR 100 VOLT GENERAL PURPOSE SERIES



For details of the 15-digit code refer to the Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.7).

(2) Only available with AgPd terminations.

(3) Amount on reel depends on thickness classification (see Fig.7).

Fig.8 Composition of the 12NC for 100 volt general purpose, class 1, NP0 series.

SELECTION CHART FOR 200 VOLT HIGH VOLTAGE SERIES

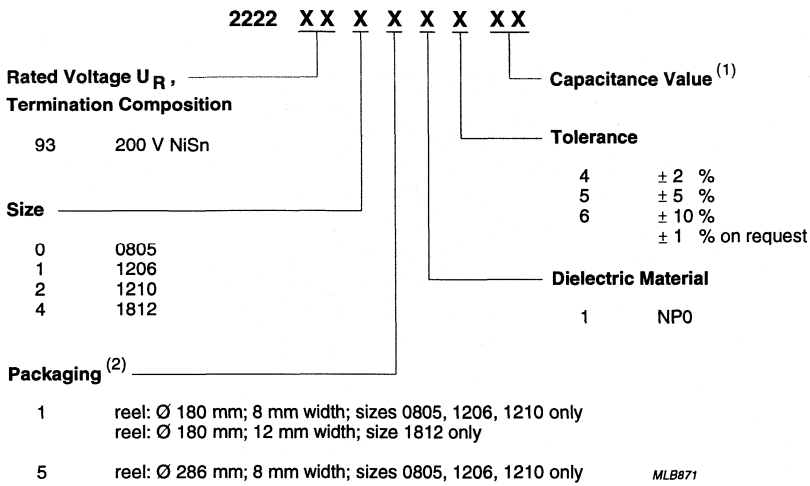
MGA456 - 2

C (pF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH			12 mm TAPE WIDTH
		0805	1206	1210	1812
		NiSn	NiSn	NiSn	NiSn
10	23	2	2		
12	24	2	2		
15	25	2	2		
18	26	2	2		
22	27	2	2		
27	28	2	2		
33	29	2	2		
39	31	2	2		
47	32	2	2	2	
56	33	2	2	2	
68	34	2	2	2	
82	35	6	2	2	
100	36	6	2	2	
120	37	6	2	2	
150	38	6	2	2	
180	39		2	2	
220	41		2	2	
270	42		2	2	
330	43		5	2	2
390	44		5	2	2
470	45		5	5	2
560	46		6	5	2
680	47			5	2
820	48			5	2
1000	49			7	2
1200	51				5
1500	52				5

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL		12 mm TAPE WIDTH AMOUNT PER REEL
	Ø 180 mm	Ø 286 mm	Ø 180 mm
2 = 0.80 to 1.00	4000	10000	2000
5 = 0.90 to 1.30	3000	8000	1500
6 = 1.25 ± 0.10	3000	8000	–
7 = 1.20 to 1.75	2500	7000	–
8 = 1.60 ± 0.15	2500	7000	–

Fig.9 Selection chart for 200 volt high voltage, class 1, NP0 series, with NiSn terminations.

ORDERING INFORMATION FOR 200 VOLT HIGH VOLTAGE SERIES



For details of the 15-digit code refer to the Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.9).

(2) Amount on reel depends on thickness classification (see Fig.9).

Fig.10 Composition of the 12NC for 200 volt high voltage, class 1, NP0 series.

SELECTION CHART FOR 500 VOLT HIGH VOLTAGE SERIES

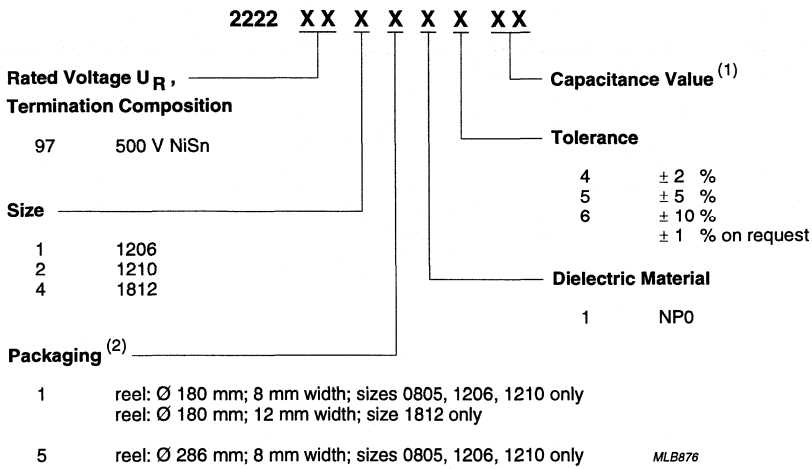
MLB757

C (pF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH		12 mm TAPE WIDTH
		1206	1210	1812
		NiSn	NiSn	NiSn
10	23	2		
12	24	2		
15	25	2		
18	26	2		
22	27	2		
27	28	2		
33	29	2		
39	31	2		
47	32	2	2	
56	33	2	2	
68	34	2	2	
82	35	2	2	
100	36	2	2	
120	37	2	2	
150	38	5	2	
180	39	5	2	
220	41	5	2	
270	42		5	
330	43		5	2
390	44		5	2
470	45		7	2
560	46			2
680	47			5
820	48			5
1000	49			7

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL		12 mm TAPE WIDTH AMOUNT PER REEL
	Ø 180 mm	Ø 286 mm	Ø 180 mm
2 = 0.80 to 1.00	4000	10000	2000
5 = 0.90 to 1.30	3000	8000	1500
7 = 1.20 to 1.75	2500	7000	1200

Fig.11 Selection chart for 500 volt high voltage, class 1, NP0 series, with NiSn terminations.

ORDERING INFORMATION FOR 500 VOLT HIGH VOLTAGE SERIES



For details of the 15-digit code refer to the Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.11).

(2) Amount on reel depends on thickness classification (see Fig.11).

Fig.12 Composition of the 12NC for 500 volt high voltage, class 1, NP0 series.

ELECTRICAL CHARACTERISTICS

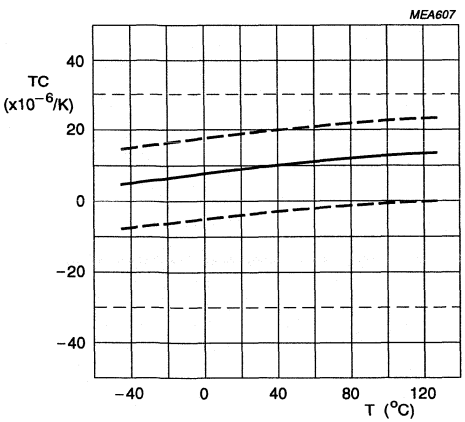
Class 1 capacitors; NP0 dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1:	
general purpose	0.47 pF to 10000 pF
narrow tolerance	0.47 pF to 3300 pF
high voltage	10 pF to 1500 pF
Tolerance on capacitance after 1000 hours:	
$C \geq 10$ pF	±10%, ±5%, ±2%, and ±1%
5 pF ≤ C < 10 pF	±0.5 pF and ±0.1 pF
C < 5 pF	±0.25 pF
Tan δ; note 1:	
C < 10 pF	$\leq 10\left(\frac{3}{C}+0.7\right)\times 10^{-4}$; max. 30×10^{-4}
$C \geq 10$ pF	$\leq 10\times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 100$ GΩ
Temperature coefficient:	
C < 10 pF	$(0 \pm 150)\times 10^{-6}$/K; note 2
$C \geq 10$ pF	$(0 \pm 30)\times 10^{-6}$/K; note 2

Notes

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



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

Fig.13 Typical temperature coefficient as a function of temperature.

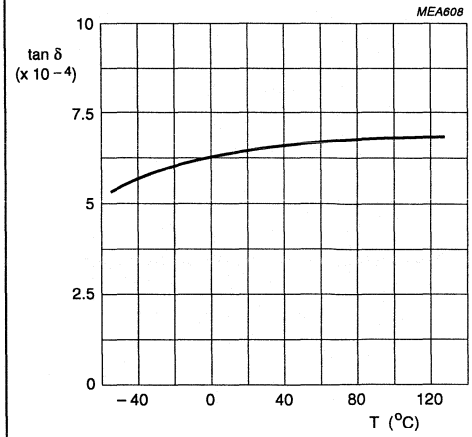


Fig.14 Typical tan δ as a function of temperature.

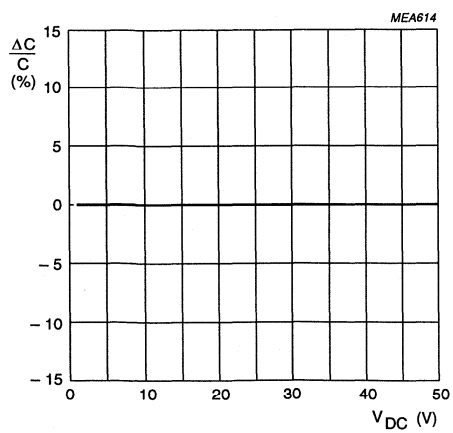
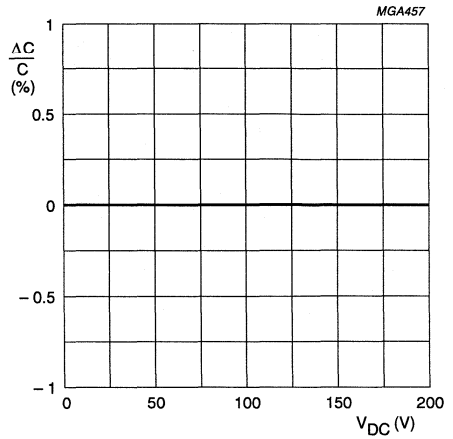
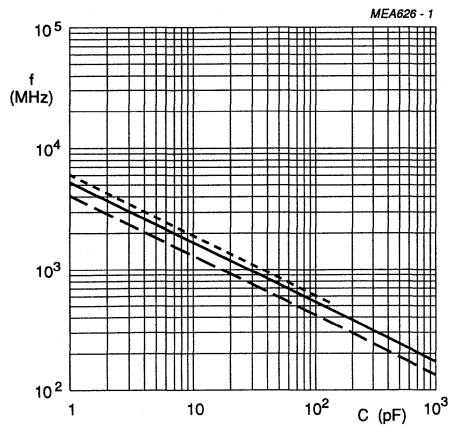


Fig.15 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.



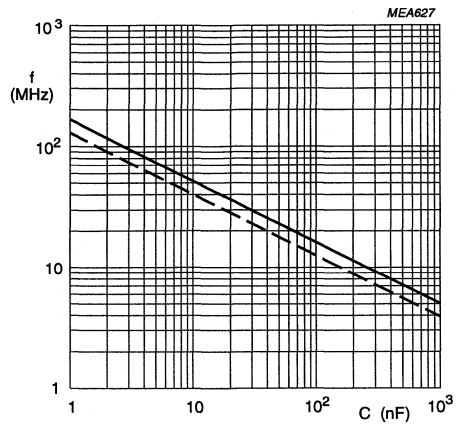
High voltage series.

Fig.16 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.



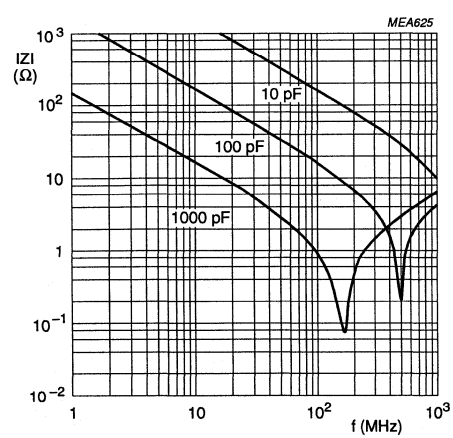
L = 0.6 nH (dotted line).
L = 1 nH (solid line).
L = 1.5 nH (broken line).

Fig.17 Series resonance frequency as a function of capacitance.



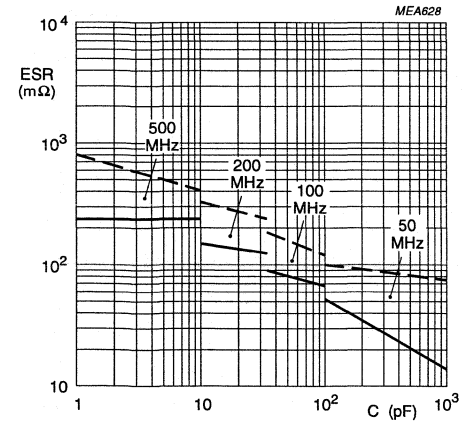
L = 1 nH (solid line).
L = 1.5 nH (broken line).

Fig.18 Series resonance frequency as a function of capacitance.



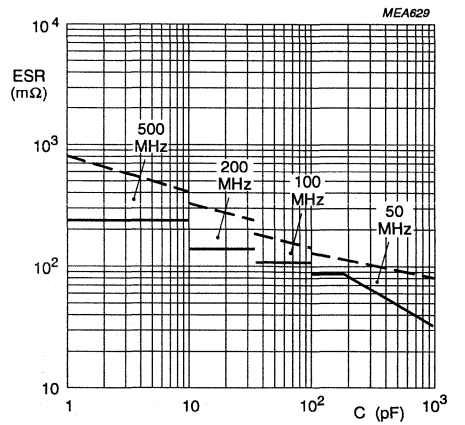
Case sizes **0603** to **1210**.

Fig.19 Typical impedance (|Z|) as a function of frequency.



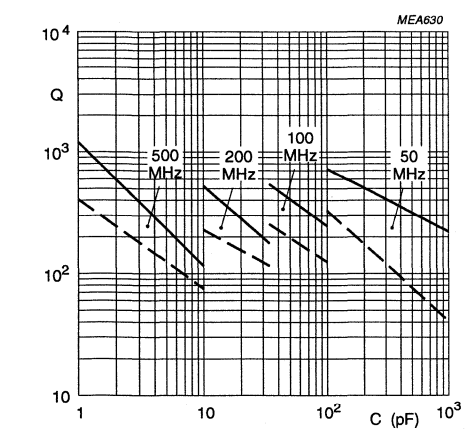
Case sizes **0603** and **0805**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

Fig.20 Equivalent series resistance (ESR) as a function of capacitance.



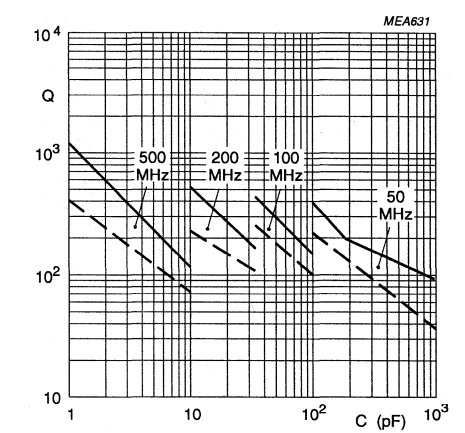
Case size **1206**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.
For C > 1 nF, maximum value of ESR = 80 mΩ measured at 50 MHz.

Fig.21 Equivalent series resistance (ESR) as a function of capacitance.



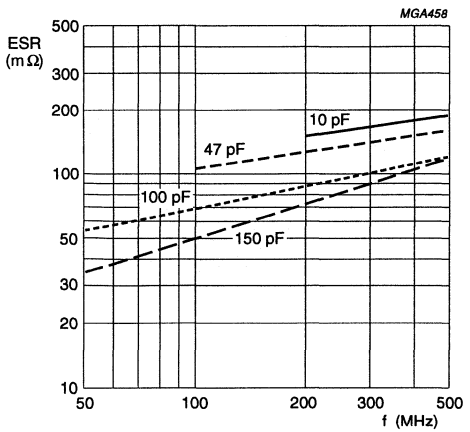
Case sizes **0603** and **0805**.
Typical values (solid lines).
Minimum values (broken lines).
Measuring equipment HP4191A.

Fig.22 Quality factor (Q) as a function of the capacitance.



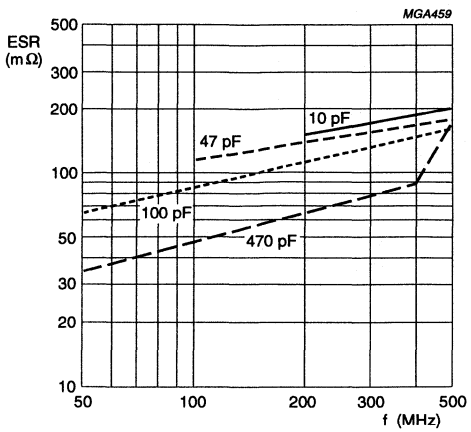
Case size **1206**.
Typical values (solid lines).
Minimum values (broken lines).
Measuring equipment HP4191A.
For C > 1 nF, Q_{min} = 35 measured at 50 MHz.

Fig.23 Quality factor (Q) as a function of the capacitance.



Case size **0805**.
High voltage series.

Fig.24 Typical equivalent series resistance as a function of frequency.



Case size **1206**.
High voltage series.

Fig.25 Typical equivalent series resistance as a function of frequency.

HIGH FREQUENCY BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

Ceramic multilayer capacitors (CMC) are suitable for use at high frequencies. At frequencies below the series resonance frequency, the CMC can be represented by an equivalent circuit as shown in Fig.26

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

The equivalent series self-inductance L is:

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

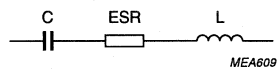
These figures are accurate to within 20%.

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

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

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

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



C = capacitance.
ESR = equivalent series resistance which is determined by the energy dissipation mechanisms (in the dielectric material as well as in the electrodes).
L = equivalent series self-inductance.

Fig.26 Equivalent series representation of a CMC.

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

The impedance (Z) is given by: $Z = \frac{1 - (2\pi f)^2 LC}{2j\pi fC} + ESR$

The quality factor (Q) is given by: $Q = \frac{|1 - (2\pi f)^2 LC|}{2\pi f ESRC}$

Surface mounted ceramic multilayer capacitors

Class 2, X7R series

FEATURES

- Six standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case; loose in bag available on request
- NiSn terminations (AgPd on request; not for case size 0603).

APPLICATIONS

- Consumer electronics
- Telecommunications
- Automotive
- Data processing.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	25 V, 63 V, 100 V, 200 V and 500 V (IEC)
Capacitance range; note 1:	
25 V	10 nF to 470 nF (E12 series)
63 V	100 pF to 1 μF (E12 series)
100 V	180 pF to 220 nF (E12 series)
200 V	180 pF to 100 nF (E12 series)
500 V	470 pF to 15 nF (E12 series)
Tolerance on capacitance	±20%, ±10% and ±5%
Test voltage (DC) for 1 minute:	
25 V, 63 V and 100 V	$2.5 \times U_R$
200 V and 500 V	$3 \times U_R$
Sectional specifications	IEC 384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 68)	55/125/56

Note

1. Non E12 values are available on request.

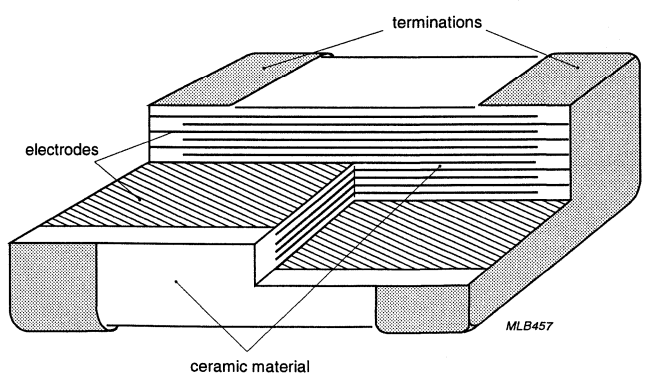
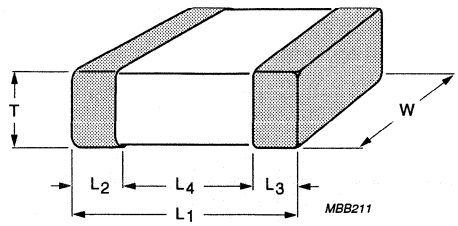


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions.

CASE SIZE	L_1 (mm)	W (mm)	T		L_2 and L_3		L_4 MIN. (mm)
			MIN. (mm)	MAX. (mm)	MIN. (mm)	MAX. (mm)	
0603	1.6 ±0.1	0.8 ±0.1	0.7	0.9	0.25	0.65	0.4
0805	2.0 ±0.1	1.25 ±0.1	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.4
1210	3.2 ±0.2	2.5 ±0.2	0.51	1.8	0.25	0.75	1.4
1812	4.5 ±0.2	3.2 ±0.2	0.51	1.8	0.25	0.75	2.2
2220	5.7 ±0.2	5.0 ±0.2	0.51	1.8	0.25	0.75	2.9

Surface mounted ceramic multilayer capacitors

Class 2, X7R series

SELECTION CHART FOR 25 VOLT SERIES

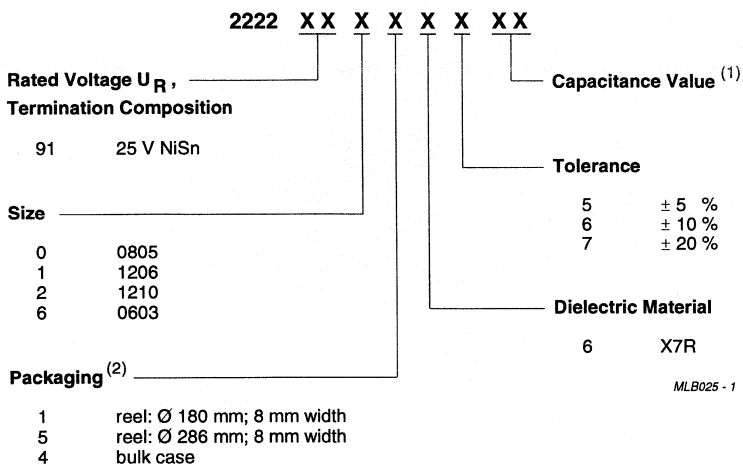
MGA449 - 3

C (nF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH			
		0603	0805	1206	1210
		NiSn	NiSn	NiSn	NiSn
10	36	4			
12	37	4			
15	38	4			
18	39	4			
22	41	4			
27	42		1		
33	43		1		
39	44		2		
47	45		2		
56	46		2		
68	47		2	2a	
82	48		2	2a	
100	49		6	2a	3
120	51			2a	3
150	52			2a	3
180	53			2a	3
220	54			2a	3
270	55				3
330	56				5
390	57				5
470	58				5

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE	
	Ø 180 mm	Ø 286 mm	0603	0805
1 = 0.51 to 0.7	4000	10000	–	10000
2 = 0.8 to 1.0	4000	10000	–	8000
2a = 0.7 to 1.0	4000	10000	–	–
3 = 0.51 to 1.0	4000	10000	–	–
4 = 0.8 ± 0.1	3000	8000	15000	–
5 = 0.9 to 1.3	3000	8000	–	–
6 = 1.25 ± 0.1	3000	8000	–	5000

Fig.3 Selection chart for 25 volt, class 2, X7R series, with NiSn terminations.

ORDERING INFORMATION FOR 25 VOLT SERIES



For details of the 15-digit code refer to Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.3).

(2) Amount on reel depends on thickness classification (see Fig.3).

Fig.4 Composition of the 12NC for 25 volt, class 2, X7R series.

Surface mounted ceramic multilayer capacitors

Class 2, X7R series

SELECTION CHART FOR 63 VOLT SERIES

MGA353 - 3

C (pF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH				12 mm TAPE WIDTH	
		0603	0805	1206	1210	1812	2220
		NiSn	NiSn	NiSn	NiSn	NiSn	AgPd
100	01	4					
120	02	4					
150	03	4					
180	04	4	1				
220	05	4	1	2a			
270	06	4	1	2a			
330	07	4	1	2a			
390	08	4	1	2a			
470	09	4	1	2a			
560	11	4	1	2a			
680	12	4	1	2a			
820	13	4	1	2a			
1000	14	4	1	2a			
1200	15	4	1	2a			
1500	16	4	1	2a			
1800	17	4	1	2a			
2200	18	4	1	2a	3		
2700	19	4	1	2a	3		
3300	21	4	1	2a	3		
3900	22	4	1	2a	3		
4700	23	4	1	2a	3	3	
5600	24	4	1	2a	3	3	
6800	25	4	1	2a	3	3	
8200	26	4	1	2a	3	3	
10000	27	4	1	2a	3	3	
12000	28		1	2a	3	3	3
15000	29		1	2a	3	3	3
18000	31		2	2a	3	3	3
22000	32		2	2a	3	3	3
27000	33		2	2a	3	3	3
33000	34		2	2a	3	3	3
39000	35			2a	3	3	3
47000	36			2a	3	3	3
56000	37			2a	3	3	3
68000	38			2a	3	3	3
82000	39			2a	3	3	3
100000	41			2a	3	3	3
120000	42				3	3	3
150000	43				3	3	3
180000	44				5	3	3
220000	45				5	3	3
270000	46					3	3
330000	47					5	3
390000	48					5	3
470000	49					7	3
560000	51						3
680000	52						3
820000	53						3
1000000	54						5

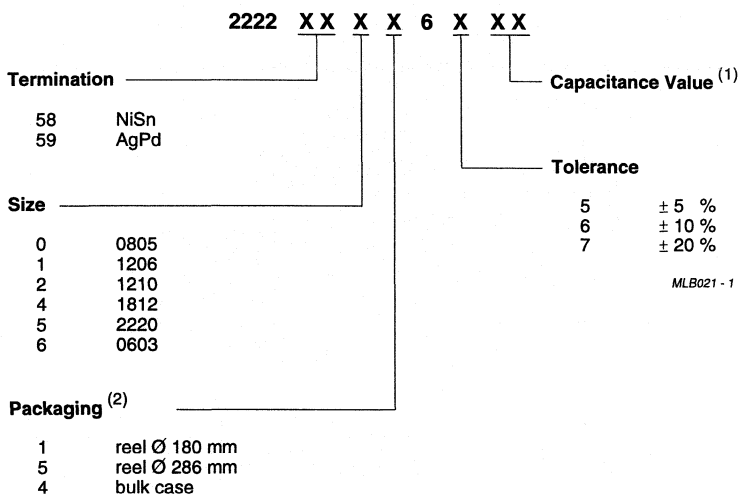
THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL		12 mm TAPE WIDTH AMOUNT PER REEL	AMOUNT PER BULK CASE	
	Ø 180 mm	Ø 286 mm	Ø 180 mm	0603	0805
1 = 0.51 to 0.7	4000	10000	2000	–	10000
2 = 0.6 to 1.0	4000	10000	2000	–	8000
2a = 0.7 to 1.0	4000	10000	2000	–	–
3 = 0.51 to 1.0	4000	10000	2000	–	–
4 = 0.8 ± 0.1	4000	10000	–	15000	–
5 = 0.9 to 1.3	3000	8000	1500	–	–
7 = 1.2 to 1.75	2000	7000	1200	–	–

Fig.5 Selection chart for 63 volt, class 2, X7R series with, NiSn and AgPd terminations.

Surface mounted ceramic multilayer capacitors

Class 2, X7R series

ORDERING INFORMATION FOR 63 VOLT SERIES



For details of the 15-digit code refer to Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.5).

(2) Amount on reel depends on thickness classification (see Fig.5).

Fig.6 Composition of the 12NC for 63 volt, class 2, X7R series.

SELECTION CHART FOR 100 VOLT SERIES

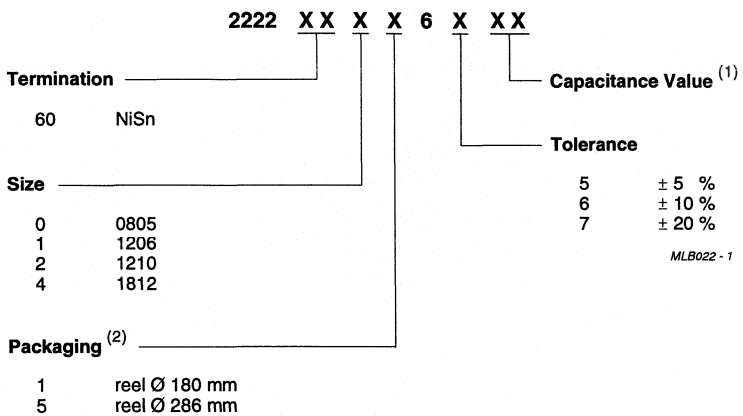
MGA356 - 3

C (pF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH			12 mm TAPE WIDTH
		0805	1206	1210	1812
		NiSn	NiSn	NiSn	NiSn
180	13	1			
220	14	1			
270	15	1			
330	16	1			
390	17	1			
470	18	1			
560	19	1			
680	21	1	2a		
820	22	1	2a		
1000	23	1	2a		
1200	24	1	2a		
1500	25	1	2a		
1800	26	1	2a		
2200	27	1	2a	3	
2700	28	1	2a	3	
3300	29	1	2a	3	
3900	31	1	2a	3	
4700	32	1	2a	3	3
5600	33	1	2a	3	3
6800	34	1	2a	3	3
8200	35	1	2a	3	3
10000	36	1	2a	3	3
12000	37	2	2a	3	3
15000	38	2	2a	3	3
18000	39	6	2a	3	3
22000	41	6	2a	3	3
27000	42		2a	3	3
33000	43		2a	3	3
39000	44		2a	3	3
47000	45		2a	3	3
56000	46		5	3	3
68000	47		5	3	3
82000	48			5	3
100000	49			5	3
120000	51				3
150000	52				3
180000	53				3
220000	54				5

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL		12 mm TAPE WIDTH AMOUNT PER REEL
	Ø 180 mm	Ø 286 mm	Ø 180 mm
1 = 0.51 to 0.7	4000	10000	2000
2 = 0.6 to 1.0	4000	10000	2000
2a = 0.7 to 1.0	4000	10000	2000
3 = 0.51 to 1.0	4000	10000	2000
5 = 0.9 to 1.3	3000	8000	1500
6 = 1.25 ± 0.1	3000	8000	1500

Fig.7 Selection chart for 100 volt, class 2, X7R series, with NiSn terminations.

ORDERING INFORMATION FOR 100 VOLT SERIES



For details of the 15-digit code refer to Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.7).

(2) Amount on reel depends on thickness classification (see Fig.7).

Fig.8 Composition of the 12NC for 100 volt, class 2, X7R series.

SELECTION CHART FOR 200 VOLT SERIES

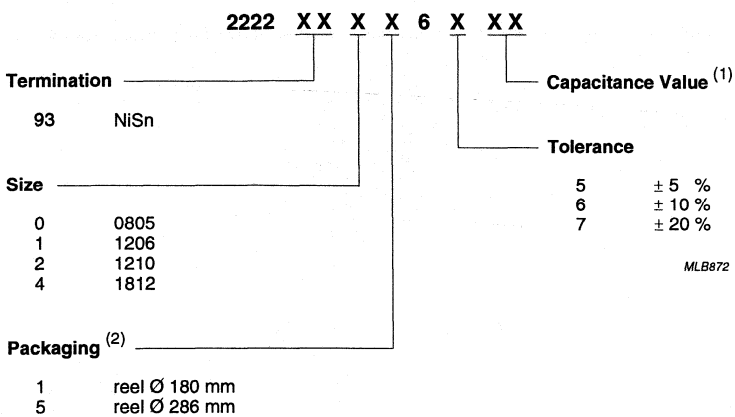
MGA455 - 3

C (pF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH			12 mm TAPE WIDTH
		0805	1206	1210	1812
		NiSn	NiSn	NiSn	NiSn
180	13	2			
220	14	2			
270	15	2			
330	16	2			
390	17	2			
470	18	2			
560	19	2			
680	21	2	2		
820	22	2	2		
1000	23	2	2		
1200	24	2	2		
1500	25	2	2		
1800	26	2	2		
2200	27	2	2	2	
2700	28	2	2	2	
3300	29	2	2	2	
3900	31	2	2	2	
4700	32	6	2	2	2
5600	33	6	2	2	2
6800	34	6	2	2	2
8200	35		2	2	2
10000	36		2	2	2
12000	37		2	2	2
15000	38		2	2	2
18000	39		5	2	2
22000	41		5	2	2
27000	42			2	2
33000	43			5	2
39000	44			5	2
47000	45			7	2
56000	46				2
68000	47				5
82000	48				5
100000	49				5

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL		12 mm TAPE WIDTH AMOUNT PER REEL
	Ø 180 mm	Ø 286 mm	Ø 180 mm
2 = 0.80 to 1.00	4000	10000	2000
5 = 0.90 to 1.30	3000	8000	1500
6 = 1.25 ± 0.10	3000	8000	–
7 = 1.20 to 1.75	2500	7000	–

Fig.9 Selection chart for 200 volt, class 2, X7R series, with NiSn terminations.

ORDERING INFORMATION FOR 200 VOLT SERIES



For details of the 15-digit code refer to Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.9).

(2) Amount on reel depends on thickness classification (see Fig.9).

Fig.10 Composition of the 12NC for 200 volt, class 2, X7R series.

SELECTION CHART FOR 500 VOLT SERIES

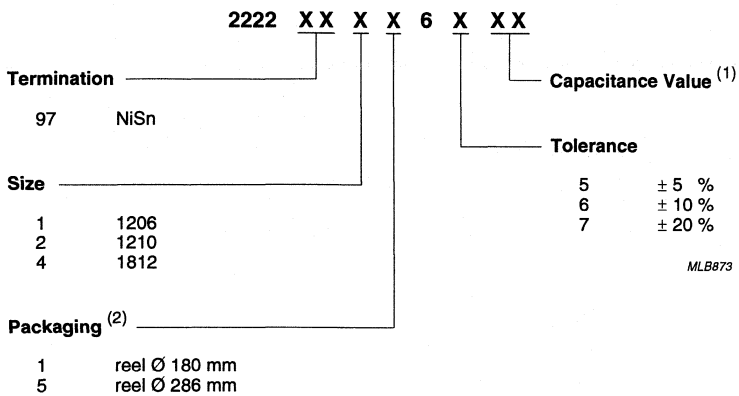
MLB758 - 1

C (pF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH		12 mm TAPE WIDTH
		1206	1210	1812
		NiSn	NiSn	NiSn
470	18	5		
560	19	5		
680	21	5		
820	22	5		
1000	23	5		
1200	24	5		
1500	25	5	5	
1800	26	5	5	
2200	27	5	5	
2700	28		5	
3300	29		5	5
3900	31		5	5
4700	32		5	5
5600	33		7	5
6800	34		7	5
8200	35			5
10000	36			5
12000	37			7
15000	38			7

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL		12 mm TAPE WIDTH AMOUNT PER REEL
	Ø 180 mm	Ø 286 mm	Ø 180 mm
5 = 0.90 to 1.30	3000	8000	1500
7 = 1.20 to 1.75	2500	7000	1200

Fig.11 Selection chart for 500 volt, class 2, X7R series, with NiSn terminations.

ORDERING INFORMATION FOR 500 VOLT SERIES



For details of the 15-digit code refer to Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.11).

(2) Amount on reel depends on thickness classification (see Fig.11).

Fig.12 Composition of the 12NC for 500 volt, class 2, X7R series.

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; X7R dielectric; AgPd and NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	10 nF to 1 µF
Tolerance on capacitance after 1000 hours	±20%, ±10% and ±5%; note 2
Tan δ; note 1	≤2.5%
Insulation resistance after 1 minute at U_R (DC): $C \leq 10$ nF $C > 10$ nF	 $R_{ins} > 100$ GΩ $R_{ins} \times C > 1000$ s
Maximum capacitance change as a function of temperature (for typical values see Fig.13)	±15%
Ageing	typical 1% per time decade

Notes

1. Measured at 1 V, 1 kHz, using a four gauge method.
2. Tolerance of ±1% available on request.

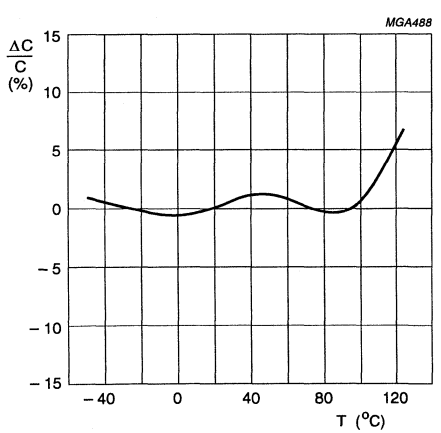


Fig.13 Typical capacitance change as a function of temperature.

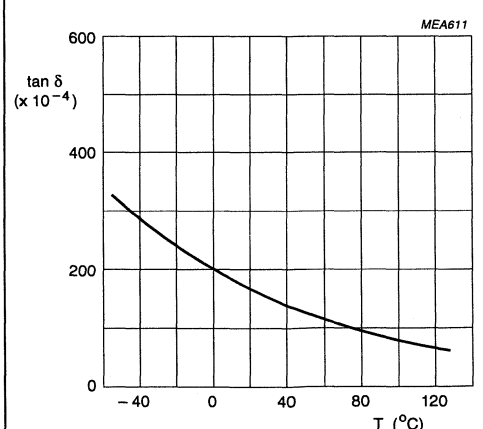
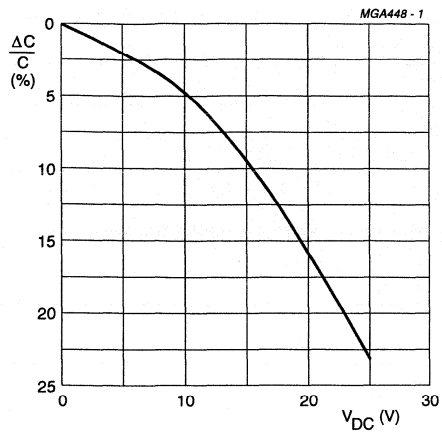
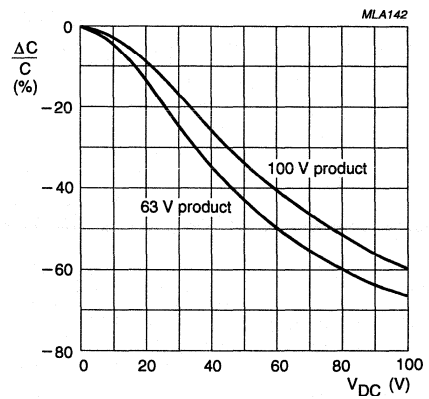


Fig.14 Typical tan δ as a function of temperature.



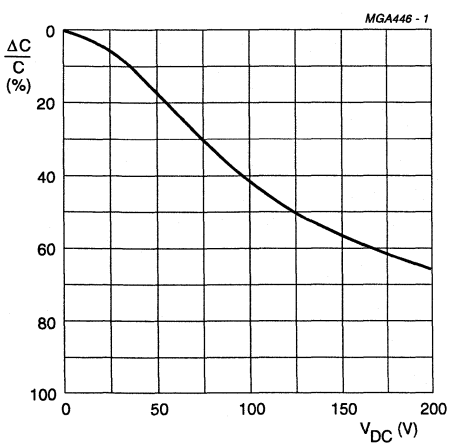
25 volt series.

Fig.15 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.



63 volt and 100 volt series.

Fig.16 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.



200 volt and 500 volt series.

Fig.17 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

Surface mounted ceramic multilayer capacitors

Class 2, Y5V series

FEATURES

- Four standard sizes
- High capacitance per unit volume
- Supplied in blister tape on reel
- NiSn end terminations (AgPd on request).

APPLICATIONS

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

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume. The inner electrodes are connected to the two terminations by silver dipping with a barrier layer of plated nickel and finally covered with a layer of plated tin (NiSn). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V
Capacitance range	22 nF to 1 µF (E6 series)
Tolerance on capacitance	−20% to +80%; ±20%
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
End terminations	NiSn; note 1
Climatic category (IEC 68)	25/085/56

Note

1. AgPd end terminations are available on request.

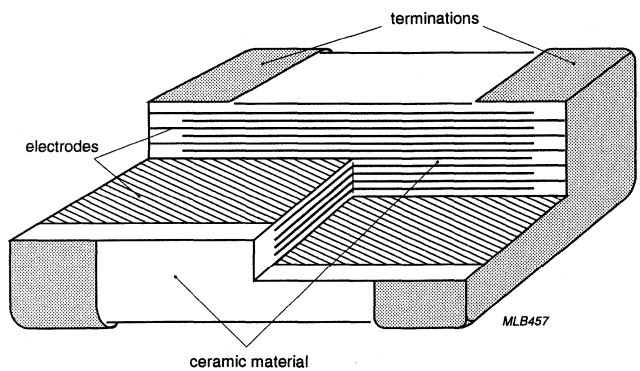
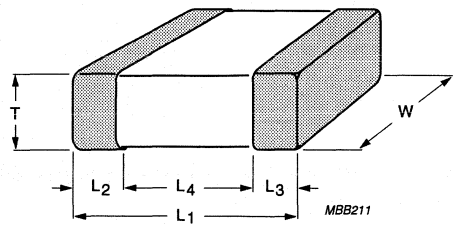


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions.

CASE SIZE	L_1 (mm)	W (mm)	T		L_2 and L_3		L_4 (mm)
			MIN. (mm)	MAX. (mm)	MIN. (mm)	MAX. (mm)	
0603	1.6 ±0.1	0.8 ±0.1	0.7	0.9	0.25	0.65	0.4
0805	2.0 ±0.1	1.25 ±0.1	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.4
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.30	0.25	0.75	1.4

PACKAGING

The capacitors are available on tape on reel and the packaging is in accordance with *"IEC 286-3"*, *"EIA 481-1"* and *"JIS C0806"* industrial standards. For details refer to Chapter *"Surface mounted ceramic multilayer capacitors"*, Section *"General"*.

SELECTION CHART

MBD079 - 1

C (nF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH			
		0603	0805	1206	1210
		NiSn	NiSn	NiSn	NiSn
22	07	4			
33	08	4	1		
47	09	4	1	1	
68	11		1	1	
100	12		1	1	3
150	13		2	1	3
220	14		2	1	3
330	15			1	3
470	16			2	3
680	17				3
1000	18				3

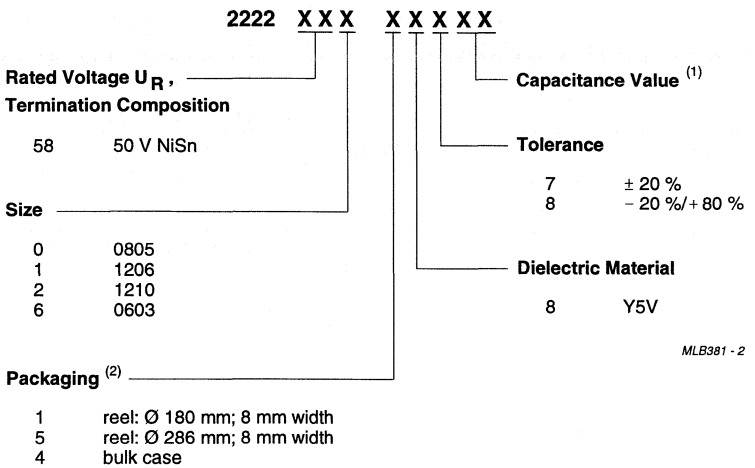
THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE	
	Ø 180 mm	Ø 286 mm	0603	0805
1 = 0.51 to 0.70	4000	10000	–	10000
2 = 0.80 to 1.0	4000	10000	–	8000
3 = 0.51 to 1.0	4000	10000	–	–
4 = 0.8 ± 0.1	4000	10000	15000	–

Fig.3 Selection chart for class 2, Y5V series.

Surface mounted ceramic multilayer capacitors

Class 2, Y5V series

ORDERING INFORMATION



For details of the 15-digit code refer to Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.3).

(2) Amount on reel depends on thickness classification (see Fig.3).

Fig.4 Composition of the 12NC for class 2, Y5V series.

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; Y5V dielectric; NiSn terminations (note 1)

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

DESCRIPTION	VALUE
Capacitance range (E6 series); note 2	22 nF to 1 μF
Tolerance on capacitance after 1000 hours	–20% to +80% and ±20%
Tan δ; note 2	≤5%
Insulation resistance after 1 minute at U_R (DC):	
$C \leq 25$ nF	$R_{ins} > 10$ GΩ
$C > 25$ nF	$R_{ins} \times C > 100$ s
Typical capacitance change as a function of temperature (see Fig.7):	
no voltage applied	+30% to –80%
U_R applied	+30% to –95%
Ageing	typical 1% per time decade

Notes

1. AgPd end terminations are available on request (not for size 1210).
2. Measured at 1 V, 1 kHz using a four gauge method.

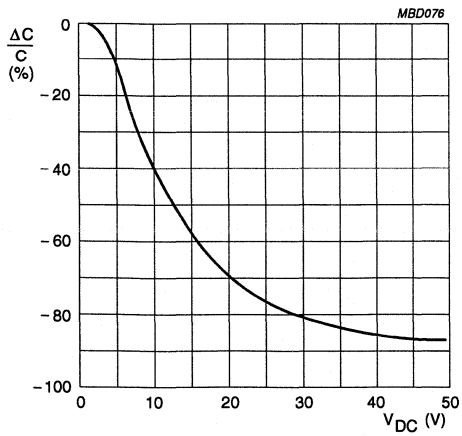


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

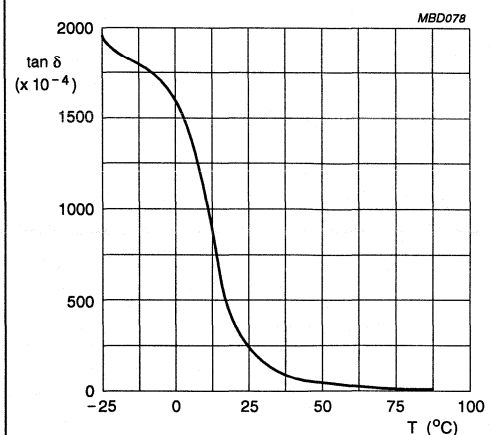


Fig.6 Typical tan δ as a function of temperature.

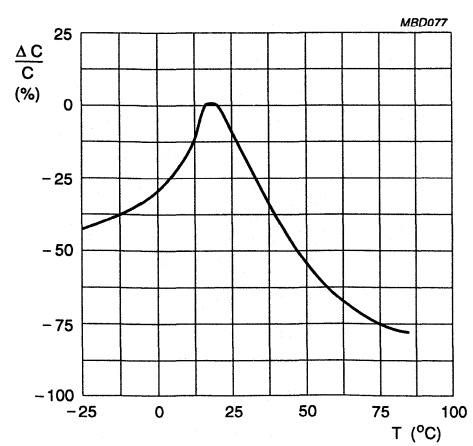


Fig.7 Typical capacitance change as a function of temperature.

Surface mounted ceramic multilayer capacitors

Class 1, Microwave series

FEATURES

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

APPLICATIONS

- Mobile telephones
- Satellite television
- Instrumentation.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	63 V (IEC)
Capacitance range class 1, NP0 dielectric:	
case size 0603	0.47 pF to 47 pF (E12 series); note 1
case size 0805	0.47 pF to 82 pF (E12 series); note 1
case size 1206	0.47 pF to 120 pF (E12 series); note 1
Tolerance on capacitance:	
$C \geq 10$ pF	±10%, ±5%, ±2% and ±1%
5 pF $\leq C <$ 10 pF	±0.5 pF, ±0.25 pF and ±0.1 pF
$C <$ 5 pF	±0.25 pF and ±0.1 pF
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Insulation resistance after 60 s at U_R (DC)	>100 GΩ
Sectional specifications	IEC 384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 68)	55/125/56

Note

1. Non E12 are available on request.

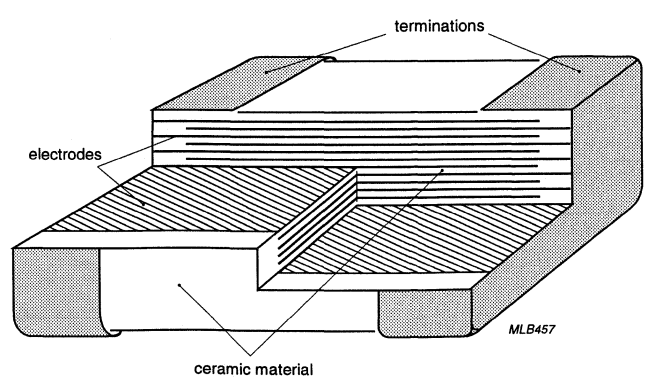
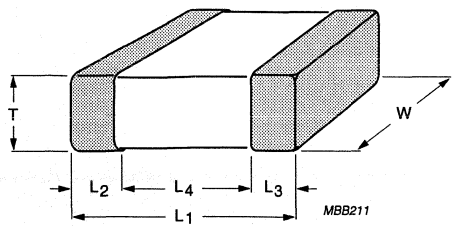


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions.

CASE SIZE	L_1 (mm)	W (mm)	T		L_2 and L_3		L_4 MIN. (mm)
			MIN. (mm)	MAX. (mm)	MIN. (mm)	MAX. (mm)	
0603	1.6 ±0.1	0.8 ±0.1	0.7	0.9	0.25	0.65	0.4
0805	2.0 ±0.1	1.25 ±0.1	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.4

SELECTION CHART

MGA357 - 2

C (pF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH		
		0603	0805	1206
		NiSn	NiSn	NiSn
0.47	05	4	1	1
0.56	06	4	1	1
0.68	07	4	1	1
0.82	08	4	1	1
1.0	09	4	1	1
1.2	11	4	1	1
1.5	12	4	1	1
1.8	13	4	1	1
2.2	14	4	1	1
2.7	15	4	1	1
3.3	16	4	1	1
3.9	17	4	1	1
4.7	18	4	1	1
5.6	19	4	1	1
6.8	21	4	1	1
8.2	22	4	1	1
10	23	4	1	1
12	24	4	1	1
15	25	4	1	1
18	26	4	1	1
22	27	4	1	1
27	28	4	1	1
33	29	4	1	1
39	31	4	1	1
47	32	4	1	1
56	33		1	1
68	34		1	1
82	35		1	1
100	36			1
120	37			1

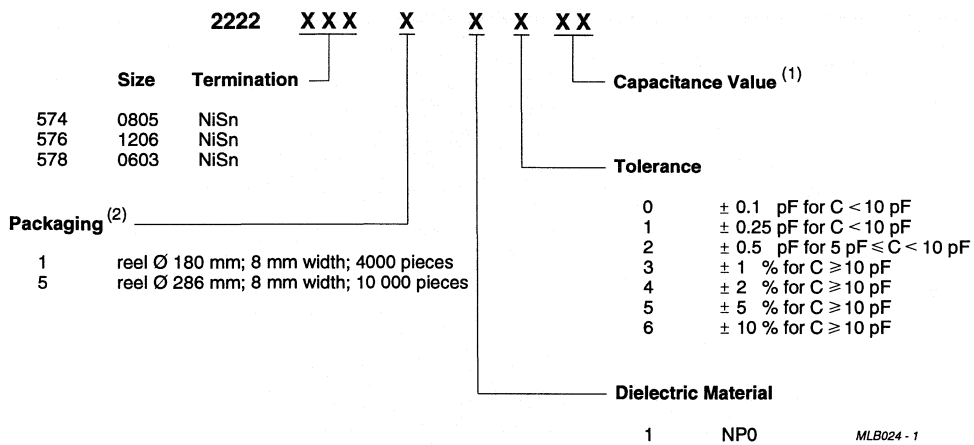
THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL	
	Ø 180 mm	Ø 286 mm
1 = 0.51 to 0.7	4000	10000
4 = 0.8 ± 0.1	4000	10000

Fig.3 Selection chart for microwave series with NiSn terminations.

Surface mounted ceramic multilayer capacitors

Class 1, Microwave series

ORDERING INFORMATION



For details of the 15-digit code refer to Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.3).

(2) Amount on reel depends on thickness classification (see Fig.3).

Fig.4 Composition of the 12NC for microwave series.

ELECTRICAL CHARACTERISTICS

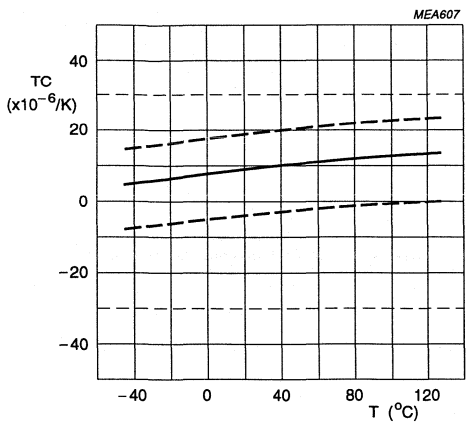
Class 1 capacitors; NP0 dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series) NP0 dielectric; note 1:	
case size 0603	0.47 pF to 47 pF
case size 0805	0.47 pF to 82 pF
case size 1206	0.47 pF to 120 pF
Tolerance on capacitance:	
$C \geq 10$ pF	±10%, ±5%, ±2%, and ±1%
5 pF ≤ C < 10 pF	±0.5 pF, ±0.25 pF and ±0.1 pF
C < 5 pF	±0.25 pF and ±0.1 pF
Tan δ; note 1:	
C < 10 pF	$\leq 10\left(\frac{3}{C}+0.7\right)\times 10^{-4}$; max. 30×10^{-4}
$C \geq 10$ pF	$\leq 10\times 10^{-4}$
Temperature coefficient; note 2:	
0.47 pF ≤ C < 5 pF	$(0 \pm 150)\times 10^{-6}$/K
5 pF ≤ C < 10 pF	$(0 \pm 150)\times 10^{-6}$/K
$C \geq 10$ pF	$(0 \pm 30)\times 10^{-6}$/K
High frequency properties	for ESR values see Figs 9, 10 and 11. The first parallel resonance frequency in the S_{21} and S_{12} scattering parameter lies above 2 GHz and the second resonance frequency above 3 GHz.

Notes

1. Measured at 1 V, 1 MHz using a four gauge method.
2. For size 0603 all capacitance values from 0.47 pF to 150 pF have a temperature coefficient of $(0 \pm 30)\times 10^{-6}$/K.



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

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

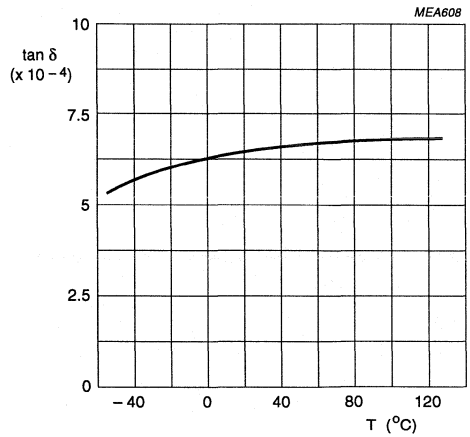


Fig.6 Typical tan δ as a function of temperature.

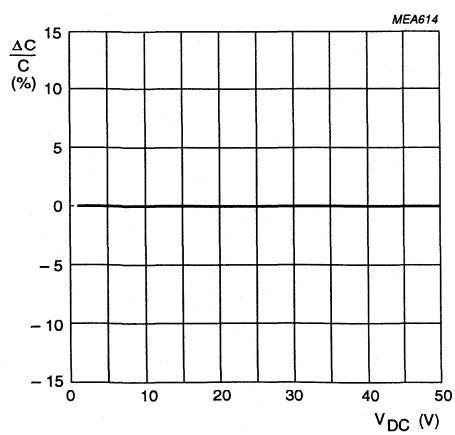
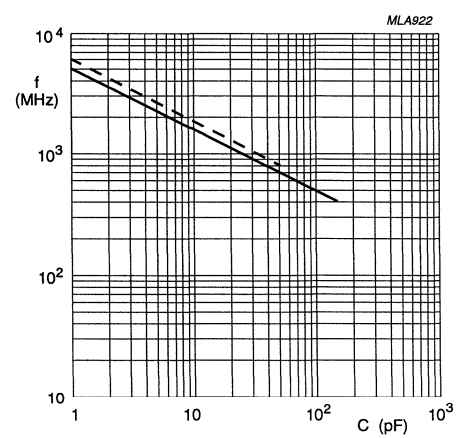
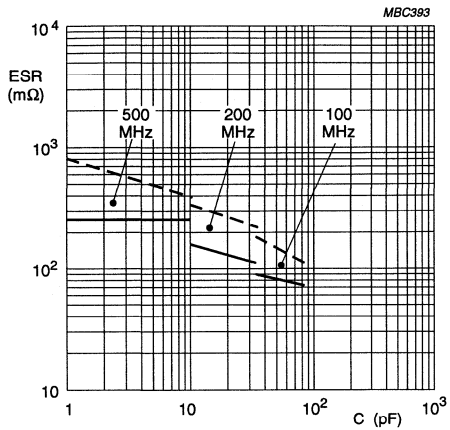


Fig.7 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.



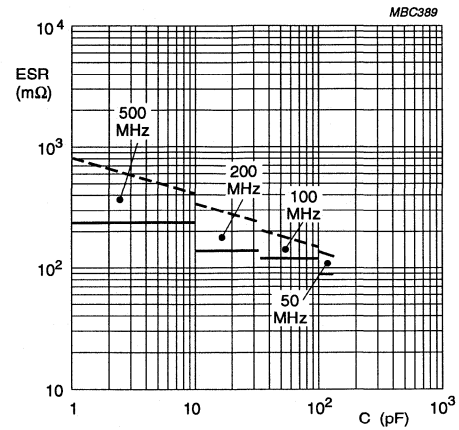
Case sizes **0805** and **1206** (solid line).
Case size **0603** (broken line).

Fig.8 Series resonance frequency as a function of capacitance.



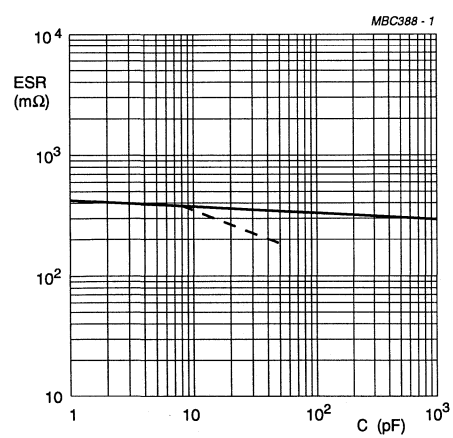
Case sizes **0603** and **0805**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

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



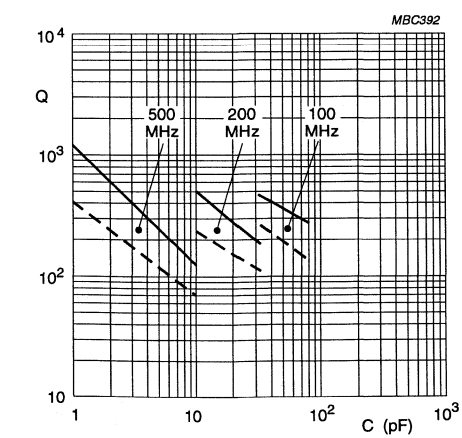
Case size **1206**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

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



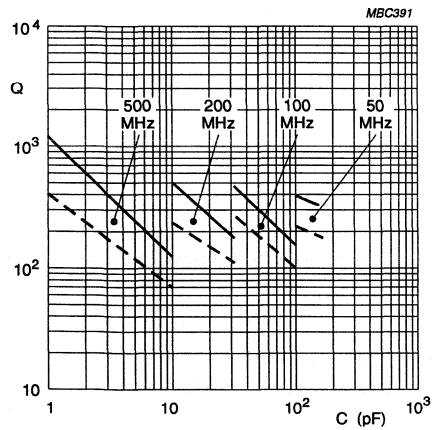
Case sizes **0805** and **1206** (solid line).
Case size **0603** (broken line).
Measuring equipment HP4191A.

Fig.11 Typical ESR values at 1 GHz as a function of the capacitance value.



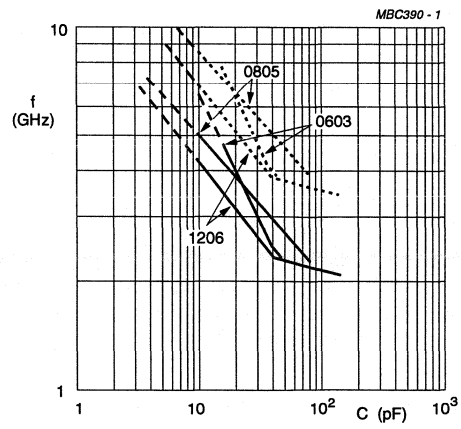
Case sizes **0603** and **0805**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

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



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

Fig.13 Quality factor (Q) as a function of the capacitance.



Case sizes **0603**, **0805** and **1206**.
First resonant frequency (solid lines).
Second resonant frequency (dotted lines).

Fig.14 Typical first and second parallel resonance frequencies as a function of capacitance.

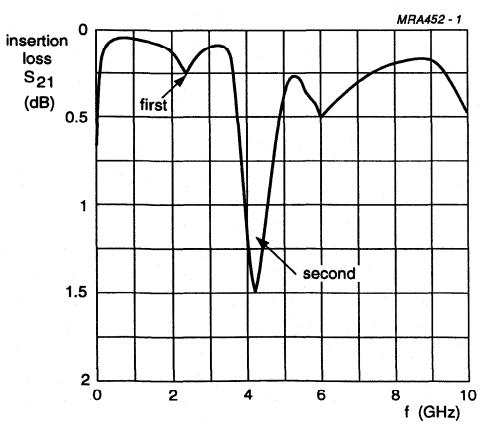


Fig.15 Example of the insertion loss as a function of frequency showing the parallel resonances.

MICROWAVE BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

Ceramic multilayer capacitors (CMC) from the microwave series are suitable for use at high frequencies. At frequencies below the series resonance frequency, the CMC can be represented by an equivalent circuit as shown in Fig.16.

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

The equivalent series self-inductance L is:

- Independent of the dielectric material
- Dependent on the size of the capacitor and is approximately:
  - 0.6 nH for case size 0603
  - 1 nH for case sizes 0805 and 1206 (these figures are accurate to within ±20%).

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

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

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

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

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

C = capacitance.

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

L = equivalent series self-inductance.

Fig.16 Equivalent series representation of a CMC.

The impedance (Z) is given by: $Z = \frac{1-(2\pi f)^2 LC}{2j\pi fC} + ESR$

The quality factor (Q) is given by: $Q = \frac{|1-(2\pi f)^2 LC|}{2\pi f ESRC}$

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

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

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

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

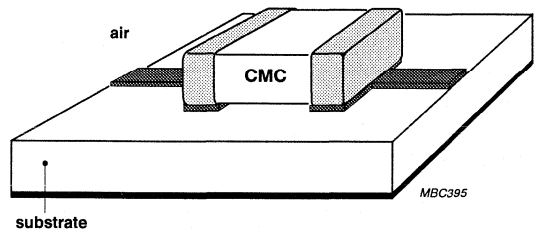
S_{22} is the reflection coefficient at the output port with the input port terminated into a 50 Ω load.

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

The high frequency behaviour of our CMCs is measured in a strip line configuration as shown in Fig.17 using a test fixture with the following features:

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

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



Substrate permittivity: $\varepsilon_r = 9.8$
Substrate thickness = 0.635 mm.

Fig.17 Microwave behaviour measured using a microstrip.

Surface mounted ceramic multilayer capacitors

Compact series

FEATURES

- Six standard sizes
- Dense dielectric layers
- Maximum capacitance per unit volume
- Supplied in tape on reel; bulk available on request
- AgPd end terminations:
  - NP0 and X7R
- NiSn end terminations:
  - X7R.

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC):	
NP0 dielectric	63 V (IEC)
X7R dielectric	16 V, 25 V and 63 V (IEC)
Capacitance range class 1:	
NP0 dielectric	220 pF to 100000 pF (E12 series)
Capacitance range class 2:	
X7R dielectric	22 nF to 3.9 µF (E12 series)
Tolerance on capacitance:	
NP0 dielectric	±10%, ±5% and ±2%; note 1
X7R dielectric	±20%, ±10% and ±5%
Sectional specifications	IEC 384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 68):	
NP0 dielectric	55/125/56
X7R dielectric	55/125/56

Note

1. Capacitors with a tolerance of ±1% are available on request.

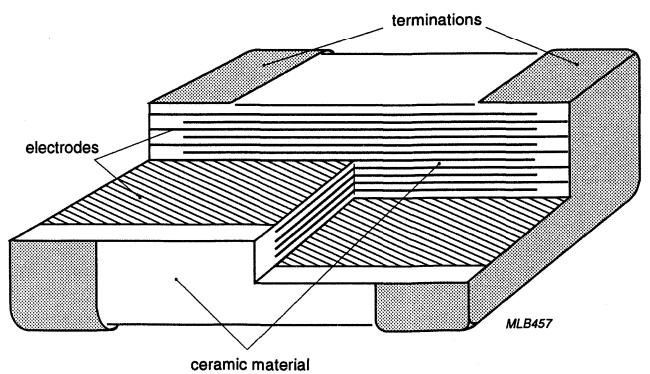
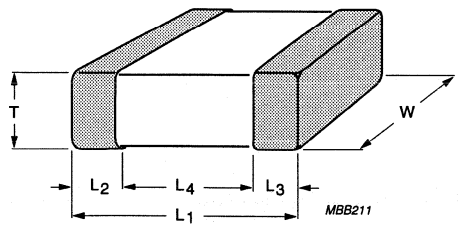


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic multilayer capacitors — Compact series

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions.

CASE SIZE	L_1 (mm)	W (mm)	T		L_2 and L_3		L_4 MIN. (mm)
			MIN. (mm)	MAX. (mm)	MIN. (mm)	MAX. (mm)	
0603	1.6 ±0.1	0.8 ±0.1	0.7	0.9	0.25	0.65	0.4
0805	2.0 ±0.1	1.25 ±0.1	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.4
1210	3.2 ±0.2	2.5 ±0.2	0.51	1.8	0.25	0.75	1.4
1812	4.5 ±0.2	3.2 ±0.2	0.51	1.8	0.25	0.75	2.2
2220	5.7 ±0.2	5.0 ±0.2	0.51	1.8	0.25	0.75	2.9

SELECTION CHART FOR CLASS 1, NP0 DIELECTRIC, 63 VOLT SERIES

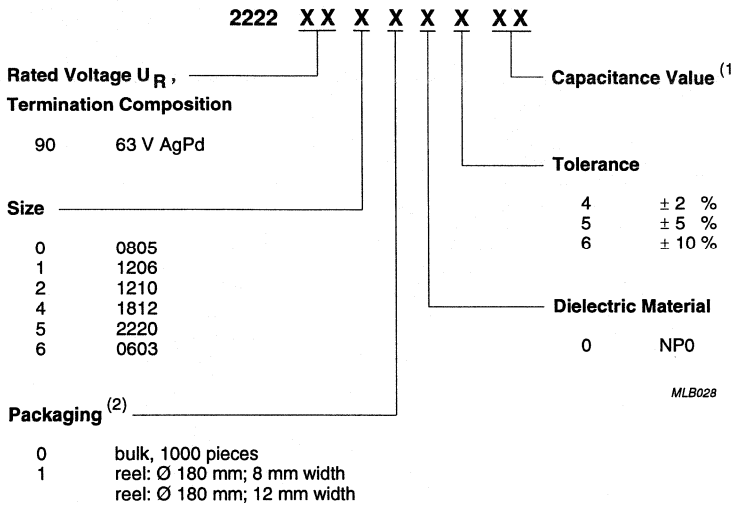
MGA451 - 3

C (pF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH				12 mm TAPE WIDTH	
		0603	0805	1206	1210	1812	2220
		AgPd	AgPd	AgPd	AgPd	AgPd	AgPd
220	41	4					
270	42	4					
330	43	4					
390	44	4					
470	45	4	1				
560	46	4	1				
680	47	4	1				
820	48	4	1				
1000	49	4	1				
1200	51		2a				
1500	52		2a				
1800	53		2a				
2200	54		6	1			
2700	55		2a	1			
3300	56		2a	2a			
3900	57		6	2a			
4700	58		6	2a	1		
5600	59			5	1		
6800	61			6	2a		
8200	62			7	2a	1	
10000	63			5	5	1	
12000	64				5	2a	
15000	65				7	2a	
18000	66				7	2a	
22000	67					5	
27000	68					7	
33000	69					7	
39000	71						2a
47000	72						5
56000	73						5
68000	74						7
82000	75						7
100000	76						7

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL	12 mm TAPE WIDTH AMOUNT PER REEL
	Ø 180 mm	Ø 180 mm
1 = 0.51 to 0.7	4000	2000
2a = 0.7 to 1.0	4000	2000
4 = 0.8 ± 0.1	4000	–
5 = 0.9 to 1.3	3000	1500
6 = 1.25 ± 0.1	3000	–
7 = 1.2 to 1.75	2500	1000

Fig.3 Selection chart for class 1, NP0 dielectric, 63 volt series with AgPd terminations.

ORDERING INFORMATION FOR CLASS 1, NP0 DIELECTRIC, 63 VOLT SERIES



For details of the 15-digit code refer to Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.3).

(2) Amount on reel depends on thickness classification (see Fig.3).

Fig.4 Composition of the 12NC for class 1, NP0 dielectric, 63 volt series.

SELECTION CHART FOR CLASS 2, X7R DIELECTRIC, 16 VOLT, 25 VOLT AND 63 VOLT SERIES

MGA452 - 3

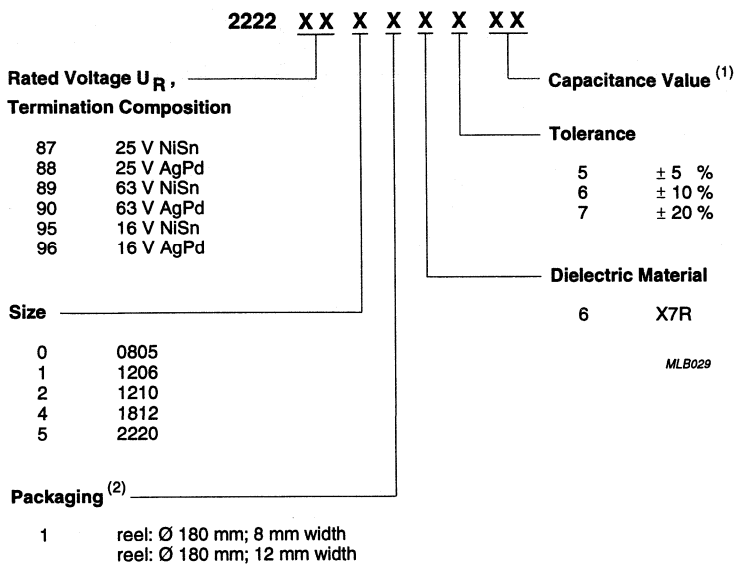
C (nF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH								12 mm TAPE WIDTH			
		0805			1206			1210		1812		2220	
		63 V	25 V	16 V	63 V	25 V	16 V	63 V	25 V	63 V	25 V	63 V	25 V
22	41												
27	42												
33	43												
39	44	2a											
47	45	2a											
56	46	2a											
68	47	6											
82	48												
100	49		2a		1								
120	51		6		2a								
150	52			2a	2a								
180	53			2a	5			2a					
220	54			6	7	2a		2a					
270	55					2a		2a	1				
330	56					5		5	2a	1			
390	57					7		5	2a	2a			
470	58					7	2a	7	2a	2a			
560	59						5		5	2a			
680	61						7		5	5			
820	62								7	7			
1000	63								7	7	5		
1200	64										5	5	
1500	65										7	5	
1800	66										7	7	
2200	67											7	5
2700	68												5
3300	69												7
3900	71												7

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL	12 mm TAPE WIDTH AMOUNT PER REEL
	Ø 180 mm	Ø 180 mm
1 = 0.51 to 0.7	4000	2000
2a = 0.7 to 1.0	4000	2000
5 = 0.9 to 1.3	3000	1500
6 = 1.25 ± 0.1	3000	–
7 = 1.2 to 1.75	2500	1000

d = in development.

Fig.5 Selection chart for class 2, X7R dielectric, 16, 25 and 63 volt with AgPd and NiSn terminations.

ORDERING INFORMATION FOR CLASS 2, X7R DIELECTRIC, 16 VOLT, 25 VOLT AND 63 VOLT SERIES



For details of the 15-digit code refer to Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.5).

(2) Amount on reel depends on thickness classification (see Fig.5).

Fig.6 Composition of the 12NC for class 2, X7R dielectric, 16 volt, 25 volt and 63 volt series.

ELECTRICAL CHARACTERISTICS

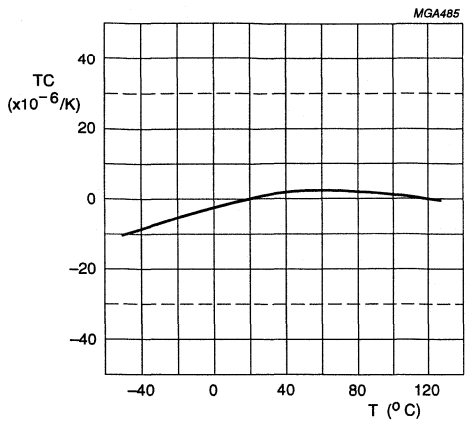
Class 1 capacitors; NP0 dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	220 pF to 100000 pF
Tolerance on capacitance after 1000 hours	±10%, ±5% and ±2%; note 2
Tan δ; note 1	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	>100 GΩ
Temperature coefficient	$(0 \pm 30) \times 10^{-6}$ /K

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. Capacitors with a tolerance of ±1% are available on request.



Sample limits (solid line).
Requirement levels (broken lines).

Fig.7 Typical temperature coefficient as a function of temperature for NP0 dielectric.

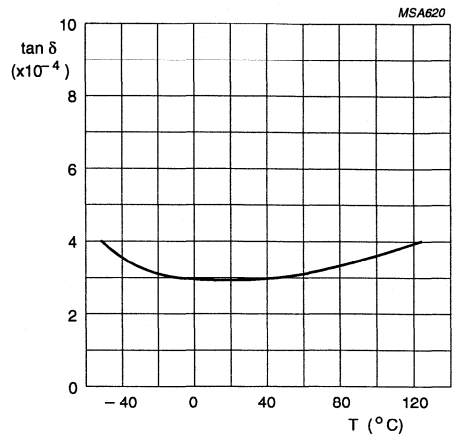


Fig.8 Typical tan δ as a function of temperature for NP0 dielectric.

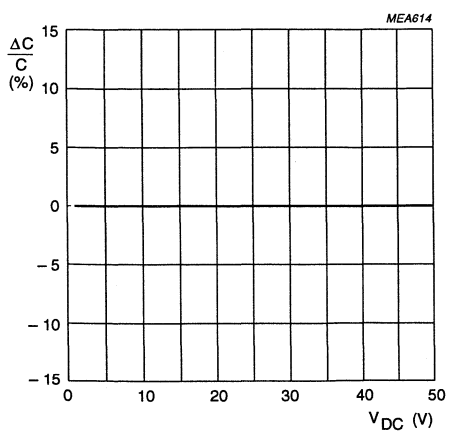


Fig.9 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage for NP0 dielectric.

Class 2 capacitors; X7R dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	22 nF to 3.9 μF
Tolerance on capacitance after 1000 hours	±20%, ±10% and ±5%
Tan δ; note 1	≤2.5%
Insulation resistance after 1 minute at U_R (DC):	
$C \leq 10$ nF	$R_{ins} > 100$ GΩ
$C > 10$ nF	$R_{ins} \times C > 1000$ s
Maximum capacitance change as a function of temperature (for typical values see Fig.12)	±15%

Note

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

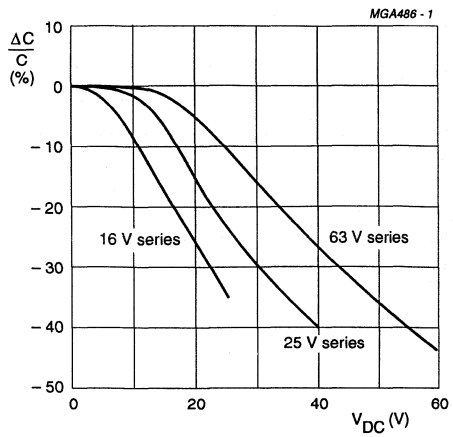


Fig.10 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage for X7R dielectric.

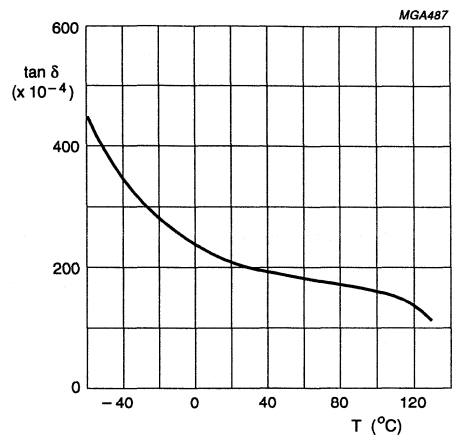
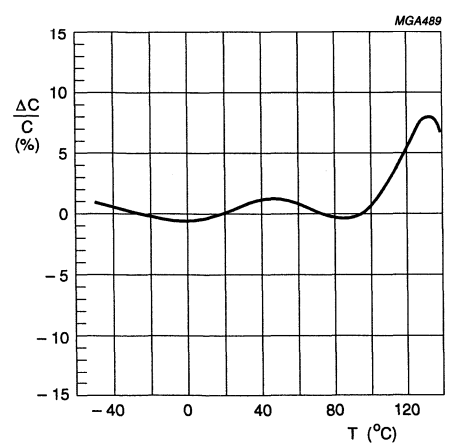
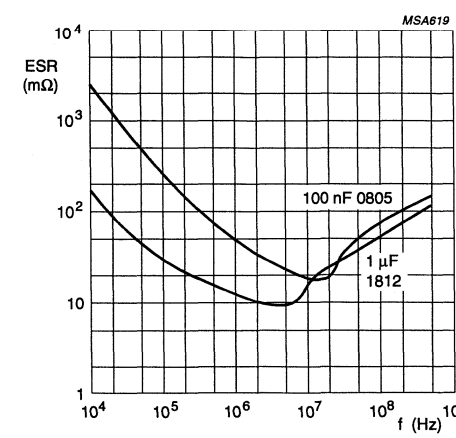


Fig.11 Typical tan δ as a function of temperature for X7R dielectric.



U_{DC} = 0 V.

Fig.12 Typical capacitance change as a function of temperature for X7R dielectric.



Measuring equipment HP4191A and HP4194A.

Fig.13 Typical equivalent series resistance (ESR) as a function of frequency for X7R dielectric.

HIGH FREQUENCY BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

Ceramic multilayer capacitors (CMC) from the high voltage series are suitable for use at high frequencies. At frequencies below the series resonance frequency, the CMC can be represented by an equivalent circuit as shown in Fig.14.

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

The equivalent series self-inductance L is:

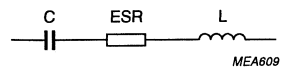
- Independent of the dielectric material
- Dependent on the size of the capacitor, it increases with increasing length and decreases with increasing width or thickness of the product
- The value of L is approximately:
  - 0.6 nH for case size 603
  - 1 nH for case sizes 0805, 1206 and 1210
  - 1.5 nH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

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

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

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

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



C = capacitance.
ESR = equivalent series resistance which is determined by the energy dissipation mechanisms (in the dielectric material as well as in the electrodes).
L = equivalent series self-inductance.

Fig.14 Equivalent series representation of a CMC.

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

The impedance (Z) is given by: $Z = \frac{1-(2\pi f)^2 LC}{2j\pi fC} + ESR$

The quality factor (Q) is given by: $Q = \frac{|1-(2\pi f)^2 LC|}{2\pi f ESRC}$

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

Table 2 Maximum ESR.

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

Surface mounted ceramic multilayer capacitors

Professional series

FEATURES

- Excellent thermal shock and bending behaviour
- High reliability
- Two standard sizes
- High capacitance per unit volume
- Supplied in tape on reel; loose in bag available on request
- NiSn terminations (AgPd on request).

APPLICATIONS

- Consumer electronics
- Telecommunications
- Automotive.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	63 V (IEC)
Capacitance range	33 nF to 150 nF (E12 series); note 1
Tolerance on capacitance	±20%, ±10% and ±5%
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 68)	55/125/56

Note

1. Non E12 values are available on request.

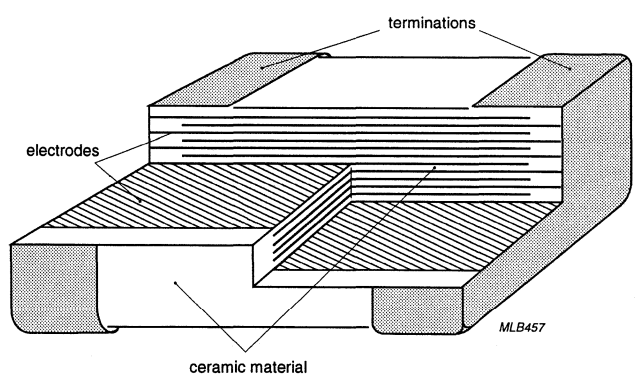
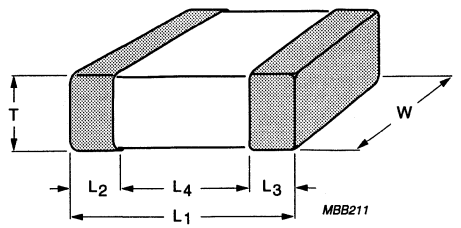


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions.

CASE SIZE	L_1 (mm)	W (mm)	T		L_2 and L_3		L_4 MIN. (mm)
			MIN. (mm)	MAX. (mm)	MIN. (mm)	MAX. (mm	
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.4
1210	3.2 ±0.2	2.5 ±0.2	0.51	1.8	0.25	0.75	1.4

PACKAGING

The capacitors are available on tape on reel and the packaging is in accordance with *"IEC 286-3"*, *"EIA 481-1"* and *"JIS C0806"* industrial standards. For details refer to Chapter *"Surface mounted ceramic multilayer capacitors"*, Section *"General"*.

SELECTION CHART

MLB121 - 2

C (nF)	LAST TWO DIGITS OF 12 NC	8 mm TAPE WIDTH	
		1206	1210
		NiSn	NiSn
33	34	2	
39	35	2	
47	36	2	2
56	37	2	2
68	38	5	2
82	39	5	5
100	41	5	5
120	42		5
150	43		7

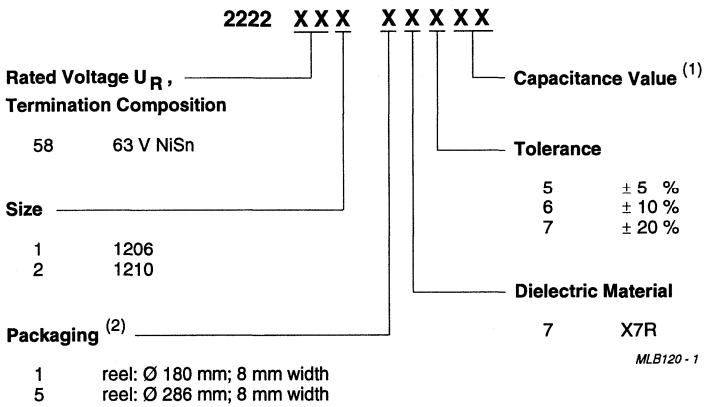
THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL	
	Ø 180 mm	Ø 286 mm
2 = 0.8 to 1.0	4000	10000
5 = 0.9 to 1.3	3000	8000
7 = 1.2 to 1.75	2500	7000

Fig.3 Selection chart for professional series with NiSn terminations.

Surface mounted ceramic multilayer capacitors

Professional series

ORDERING INFORMATION



For details of the 15-digit code refer to Section *"General; Fig.6"*.

(1) Refer to selection chart (see Fig.3).

(2) Amount on reel depends on thickness classification (see Fig.3).

Fig.4 Composition of the 12NC for professional series.

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; X7R dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	33 nF to 150 nF
Tolerance on capacitance after 1000 hours	±20%, ±10% and ±5%
Tan δ; note 1	≤2.5%
Insulation resistance after 1 minute at U_R (DC): C > 10 nF	 $R_{ins} \times C > 1000$ s
Maximum capacitance change as a function of temperature (for typical values see Fig.7)	±15%
Ageing	typical 1% per time decade

Note

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

Surface mounted ceramic multilayer capacitors

Professional series

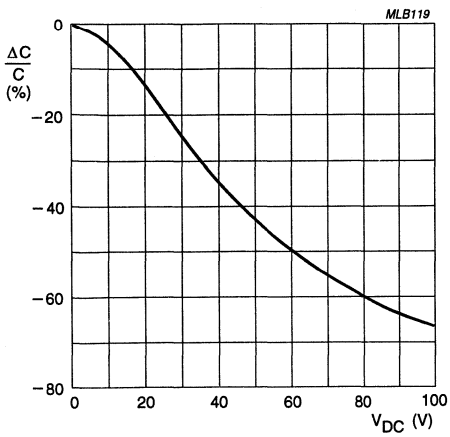


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

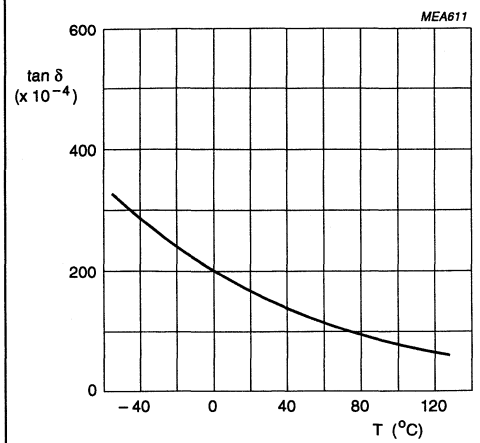


Fig.6 Typical tan δ as a function of temperature.

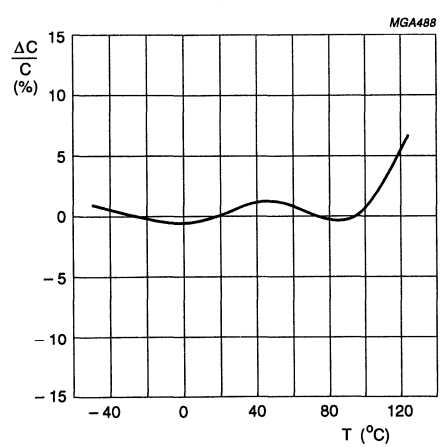


Fig.7 Typical capacitance change as a function of temperature.

LEADED CERAMIC MULTILAYER CAPACITORS

NUMERICAL INDEX FOR LEADED CERAMIC MULTILAYER CAPACITORS

12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	CAP. TOL. (%)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	LEAD SPACING (mm)	LEAD FORM	PACKAGING	PAGE
Radial capacitors												
730	05...	NP0 (C0G)	1	10 to 4700	±5	50	–	≥25	2.54	straight	loose	128
	06...			10 to 4700	±10		–	≥25	2.54	straight	loose	
	09...			10 to 4700	±5		16	–	2.54	outside kink	tape and reel	
	10...			10 to 4700	±10		16	–	2.54	outside kink	tape and reel	
	13...			10 to 4700	±5		16	–	2.54	outside kink	ammopack	
	14...			10 to 4700	±10		16	–	2.54	outside kink	ammopack	
	17...			10 to 22000	±5		–	≥25	5.08	flat bent	loose	
	18...			10 to 22000	±10		–	≥25	5.08	flat bent	loose	
	21...			10 to 22000	±5		≥16	–	5.08	flat bent	tape and reel	
	22...			10 to 22000	±10		≥16	–	5.08	flat bent	tape and reel	
	25...			10 to 22000	±5		≥16	–	5.08	flat bent	ammopack	
	26...			10 to 22000	±10		≥16	–	5.08	flat bent	ammopack	
	37...			10 to 4700	±5	100	–	≥25	2.54	straight	loose	
	38...			10 to 4700	±10		–	≥25	2.54	straight	loose	
	41...			10 to 4700	±5		16	–	2.54	outside kink	tape and reel	
	42...			10 to 4700	±10		16	–	2.54	outside kink	tape and reel	
	45...			10 to 4700	±5		16	–	2.54	outside kink	ammopack	
	46...			10 to 4700	±10		16	–	2.54	outside kink	ammopack	
	49...			10 to 10000	±5		–	≥25	5.08	flat bent	loose	
	50...			10 to 10000	±10		–	≥25	5.08	flat bent	loose	
	53...			10 to 10000	±5		≥16	–	5.08	flat bent	tape and reel	
	54...			10 to 10000	±10		≥16	–	5.08	flat bent	tape and reel	
	57...			10 to 10000	±5		≥16	–	5.08	flat bent	ammopack	
	58...			10 to 10000	±10		≥16	–	5.08	flat bent	ammopack	

12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	CAP. TOL. (%)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	LEAD SPACING (mm)	LEAD FORM	PACKAGING	PAGE
731	06...	2C1 (X7R)	2	220 to 220000	±10	50	–	≥25	2.54	straight	loose	129
	07...			220 to 220000	±20		–	≥25	2.54	straight	loose	
	10...			220 to 220000	±10		16	–	2.54	outside kink	tape and reel	
	11...			220 to 220000	±20		16	–	2.54	outside kink	tape and reel	
	14...			220 to 220000	±10		16	–	2.54	outside kink	ammopack	
	15...			220 to 220000	±20		16	–	2.54	outside kink	ammopack	
	18...			220 to 1000000	±10		–	≥25	5.08	flat bent	loose	
	19...			220 to 1000000	±20		–	≥25	5.08	flat bent	loose	
	22...			220 to 1000000	±10		≥16	–	5.08	flat bent	tape and reel	
	23...			220 to 1000000	±20		≥16	–	5.08	flat bent	tape and reel	
	26...			220 to 1000000	±10		≥16	–	5.08	flat bent	ammopack	
	27...			220 to 1000000	±20		≥16	–	5.08	flat bent	ammopack	
	38...			220 to 100000	±10	100	–	≥25	2.54	straight	loose	
	39...			220 to 100000	±20		–	≥25	2.54	straight	loose	
	42...			220 to 100000	±10		16	–	2.54	outside kink	tape and reel	
	43...			220 to 100000	±20		16	–	2.54	outside kink	tape and reel	
	46...			220 to 100000	±10		16	–	2.54	outside kink	ammopack	
	47...			220 to 100000	±20		16	–	2.54	outside kink	ammopack	
	50...			220 to 330000	±10		–	≥25	5.08	flat bent	loose	
	51...			220 to 330000	±20		–	≥25	5.08	flat bent	loose	
	54...			220 to 330000	±10		≥16	–	5.08	flat bent	tape and reel	
	55...			220 to 330000	±20		≥16	–	5.08	flat bent	tape and reel	
	58...			220 to 330000	±10		≥16	–	5.08	flat bent	ammopack	
	59...			220 to 330000	±20		≥16	–	5.08	flat bent	ammopack	

Numerical index for leaded ceramic multilayer capacitors

12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	CAP. TOL. (%)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	LEAD SPACING (mm)	LEAD FORM	PACKAGING	PAGE
733	06...	Z5U	2	1000 to 330000	±20	50	–	≥25	2.54	straight	loose	131
	07...			1000 to 330000	–20/+80		–	≥25	2.54	straight	loose	
	11...			1000 to 330000	±20		16	–	2.54	outside kink	tape and reel	
	12...			1000 to 330000	–20/+80		16	–	2.54	outside kink	tape and reel	
	15...			1000 to 330000	±20		16	–	2.54	outside kink	ammopack	
	16...			1000 to 330000	–20/+80		16	–	2.54	outside kink	ammopack	
	19...			1000 to 1000000	±20		–	≥25	5.08	flat bent	loose	
	20...			1000 to 1000000	–20/+80		–	≥25	5.08	flat bent	loose	
	23...			1000 to 1000000	±20		≥16	–	5.08	flat bent	tape and reel	
	24...			1000 to 1000000	–20/+80		≥16	–	5.08	flat bent	tape and reel	
	27...			1000 to 1000000	±20		≥16	–	5.08	flat bent	ammopack	
	28...			1000 to 1000000	–20/+80		≥16	–	5.08	flat bent	ammopack	
	39...			1000 to 100000	±20	100	–	≥25	2.54	straight	loose	
	40...			1000 to 100000	–20/+80		–	≥25	2.54	straight	loose	
	43...			1000 to 100000	±20		16	–	2.54	outside kink	tape and reel	
	44...			1000 to 100000	–20/+80		16	–	2.54	outside kink	tape and reel	
	47...			1000 to 100000	±20		16	–	2.54	outside kink	ammopack	
	48...			1000 to 100000	–20/+80		16	–	2.54	outside kink	ammopack	
	51...			1000 to 470000	±20		–	≥25	5.08	flat bent	loose	
	52...			1000 to 470000	–20/+80		–	≥25	5.08	flat bent	loose	
	55...			1000 to 470000	±20		≥16	–	5.08	flat bent	tape and reel	
	56...			1000 to 470000	–20/+80		≥16	–	5.08	flat bent	tape and reel	
	59...			1000 to 470000	±20		≥16	–	5.08	flat bent	ammopack	
	60...			1000 to 470000	–20/+80		≥16	–	5.08	flat bent	ammopack	

Numerical index for leaded ceramic multilayer capacitors

12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	CAP. TOL. (%)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	LEAD SPACING (mm)	LEAD FORM	PACKAGING	PAGE
Axial capacitors												
740	09...	NP0 (C0G)	1	10 to 6800	±5	50	–	52.4 ±1.5	–		tape and reel	119
	10...			10 to 6800	±10	50	–	52.4 ±1.5	–		tape and reel	
	41...			10 to 4700	±5	100	–	52.4 ±1.5	–		tape and reel	
	42...			10 to 4700	±10	100	–	52.4 ±1.5	–		tape and reel	
741	10...	2C1 (X7R)	2	220 to 220000	±10	50	–	52.4 ±1.5	–		tape and reel	120
	11...			220 to 220000	±20	50	–	52.4 ±1.5	–		tape and reel	
	42...			220 to 100000	±10	100	–	52.4 ±1.5	–		tape and reel	
	43...			220 to 100000	±20	100	–	52.4 ±1.5	–		tape and reel	
742	11...	Z5U	2	1000 to 470000	±20	50	–	52.4 ±1.5	–		tape and reel	121
	12...			1000 to 470000	–20/+80	50	–	52.4 ±1.5	–		tape and reel	
	43...			1000 to 100000	±20	100	–	52.4 ±1.5	–		tape and reel	
	44...			1000 to 100000	–20/+80	100	–	52.4 ±1.5	–		tape and reel	

SELECTION GUIDE FOR LEADED CERAMIC MULTILAYER CAPACITORS

STABILITY	TYPICAL CIRCUITS	TARGET APPLICATION	CATALOGUE NUMBERS 2222	CAP. RANGE	CAP. TOL.	TC (or TK)	$U_{R(DC)}$ (V)	CLIMATIC CATEGORY	PAGE
Class 1, radial Mono-kap™ series									
High	high frequency; tuning; temperature compensation; precision clocking	general industrial; high stress circuits; high stress automotive; professional circuits; measuring instruments	730 05...; 730 06...; 730 37...; 730 38...; 730 09...; 730 10...; 730 41...; 730 42...; 730 13...; 730 14...; 730 45...; 730 46...; 730 17...; 730 18...; 730 49...; 730 50...; 730 21...; 730 22...; 730 53...; 730 54...; 730 25...; 730 26...; 730 57...; 730 58...	10 to 22 000 pF	±5% or ±10%	NP0 (C0G)	50 or 100	55/125/21	128
Class 2, radial Mono-kap™ series									
High	coupling/decoupling; filtering	high stress circuits; high stress automotive; professional circuits; measuring instruments	731 06...; 731 07...; 731 38...; 731 39...; 731 10...; 731 11...; 731 42...; 731 43...; 731 14...; 731 15...; 731 46...; 731 47...; 731 18...; 731 19...; 731 50...; 731 51...; 731 22...; 731 23...; 731 54...; 731 55...; 731 26...; 731 27...; 731 58...; 731 59...	220 pF to 1 µF	±10% or ±20%	2C1 (X7R)	50 or 100	55/125/21	129

STABILITY	TYPICAL CIRCUITS	TARGET APPLICATION	CATALOGUE NUMBERS 2222	CAP. RANGE	CAP. TOL.	TC (or TK)	$U_{R(DC)}$ (V)	CLIMATIC CATEGORY	PAGE
Class 2, radial Mono-kap™ series									
Medium	general purpose; coupling/decoupling; filtering	general industrial; consumer	733 07...; 733 08...; 733 39...; 733 40...; 733 11...; 733 12...; 733 43...; 733 44...; 733 15...; 733 16...; 733 47...; 733 48...; 733 19...; 733 20...; 733 51...; 733 52...; 733 23...; 733 24...; 733 55...; 733 56...; 733 27...; 733 28...; 733 59...; 733 60...	1000 pF to 1 µF	±20% or −20/+80%	Z5U	50 or 100	10/085/21	131
Class 1, axial Mono-axial™ series									
High	high frequency; tuning; temperature compensation; precision clocking	general industrial; high stress circuits; high stress automotive; professional circuits; measuring instruments	740 09...; 740 10...; 740 41...; 740 42...	10 to 6800 pF	±5%	NP0 (C0G)	50 or 100	55/125/21	119
Class 2, axial Mono-axial™ series									
High	coupling/decoupling; filtering	high stress circuits; high stress automotive; professional circuits; measuring instruments	741 10...; 741 11...; 741 42...; 741 43...	220 pF to 0.22 µF	±10% or ±20%	2C1 (X7R)	50 or 100	55/125/21	120
Medium	coupling/decoupling; filtering	general industrial; consumer	742 11...; 742 12...; 742 43...; 742 44...	0.01 to 0.47 µF	±20% or −20/+80%	Z5U	50 or 100	10/085/21	121

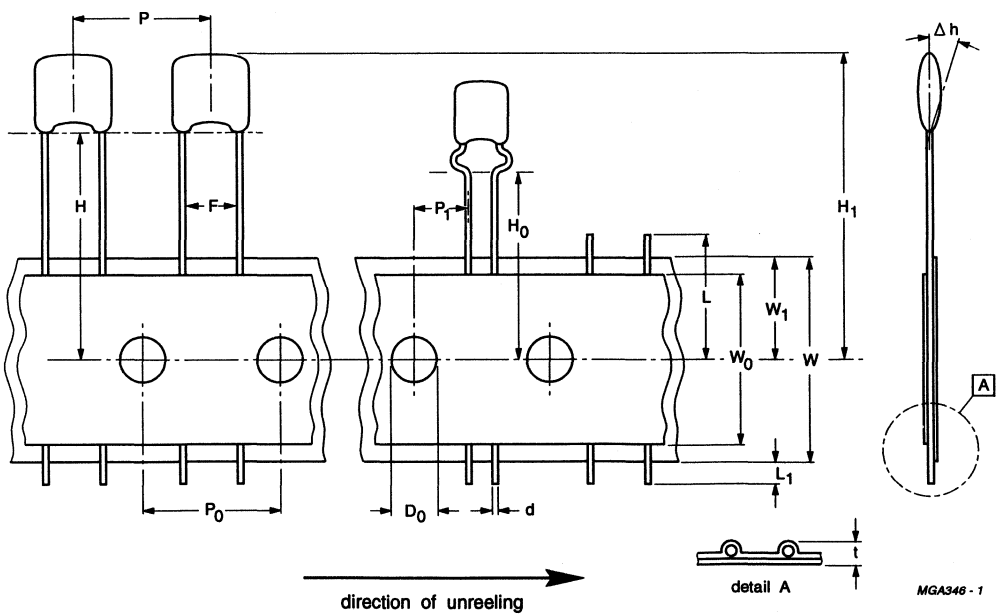
PACKAGING

The monolithic ceramic capacitors are supplied in bulk packaging, in tape on reel or in ammopack (see Table 1).

Table 1 Packaging quantities for capacitors as listed.

PRODUCT TYPE	PACKAGING	FIGURE	SIZE CODE	SMALLEST QUANTITY
Mono-axial™	reel	5	15 and 20	5000
			29	2500
Mono-kap™	bulk	–	all	1000
	reel	4	all	2500
	ammopack	3	15 and 20	2500
			30	2000

CAPACITORS ON TAPE, LEAD PITCH 5.08 AND 2.54 mm



See Table 2 for dimensions.

Maximum 0.1% of the total number of capacitors per reel may be missing. A maximum of 1 consecutive vacant position is followed by 6 consecutive components.

Tape begins and ends with minimum of 60 empty positions (300 mm tape).

Maximum of 5 splices per reel.

Fig.1 Capacitors, with lead pitch 5.08 and 2.54 mm, on tape.

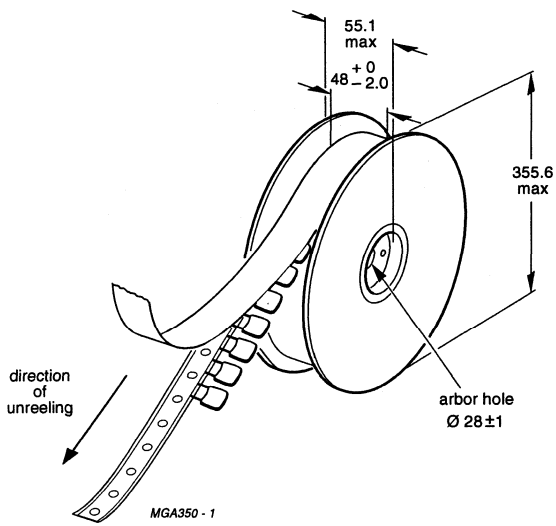
Table 2 Dimensions of tape (see Fig.1).

SYMBOL	PARAMETER	DIMENSIONS	
		mm	inch
L	cut off length	<11	<0.443
L_1	lead end protrusion	<2	<0.079
H	height to seating plane	>16	>0.630
H_0	height to seating plane (formed leads)	16 ±0.5	0.630 ±0.020
H_1	top of component height	<32	<1.260
Δh	body inclination	0.0 ±<1.0	0 ±<0.039
W	carrier tape width	18 +1.0/–0.5	0.709 +0.039/–0.020
W_0	hold down tape width	15 ref.; note 1	0.591 ref.; note 1
W_1	sprocket hole position	9 +0.075/–0.5	0.354 +0.030/–0.020
F	1e lead space; note 2	2.54 +0.6/–0.4	0.100 +0.024/–0.016
	2e lead space; note 2	5.08 +0.6/–0.4	0.200 +0.024/–0.016
P_0	sprocket hole pitch	12.7 ±0.3	0.500 ±0.012
P_1	1e sprocket hole centre to lead centre; note 2	5.08 ±0.7	0.200 ±0.028
	2e sprocket hole centre to lead centre; note 2	3.85 ±0.7	0.151 ±0.028
D_0	sprocket hole diameter	4 ±0.3	0.157 ±0.012
t	overall tape thickness	<0.9	<0.035
d	wire lead diameter	0.5 ±0.05	0.02 ±0.002
P	taping pitch	12.7 ref.	0.500 ref.

Notes

1. Tape width of 6 mm (0.236 inches) permissible.
2. e = 2.54 mm.

Reel and tape data



Dimensions in mm.

Maximum 0.5% of the total number of capacitors per reel may be missing. A maximum of 2 consecutive vacant positions is followed by 6 consecutive components.

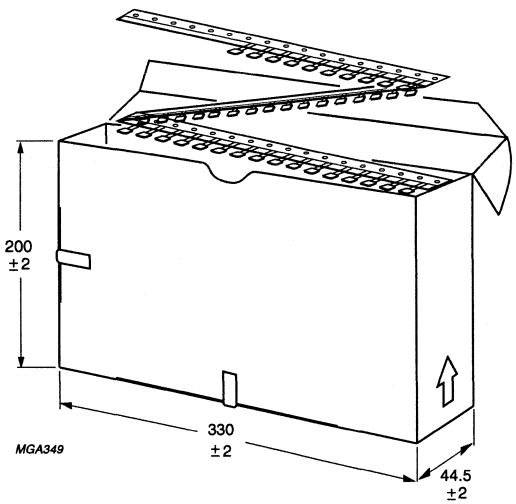
Tape begins and ends with minimum of 24 empty positions (300 mm tape).

Maximum of 5 splices per reel.

Cumulative pitch tolerance over 20 consecutive units not to exceed ±1.0 mm.

Lead space (F) shall be measured at 3.6 ±0.5 mm from the capacitor seating plane.

Fig.2 Reel with capacitors on tape.



Dimensions in mm.

Maximum 0.5% of the total number of capacitors per reel may be missing. A maximum of 2 consecutive vacant positions is followed by 6 consecutive components.

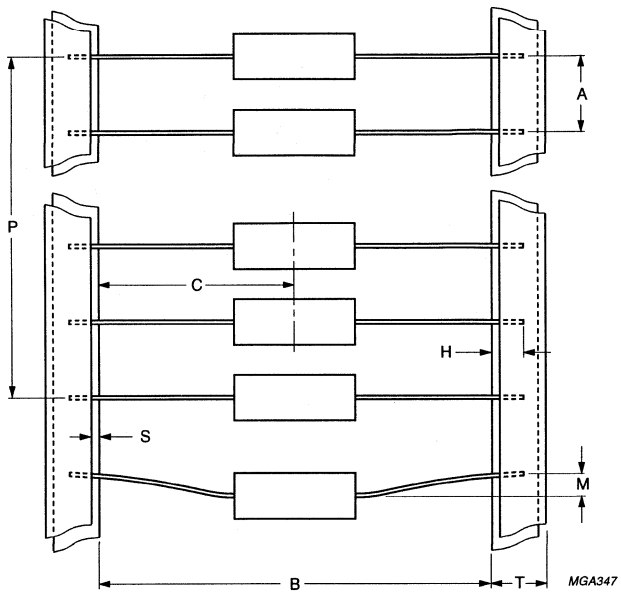
Tape begins and ends with minimum of 24 empty positions (300 mm tape).

Maximum of 5 splices per reel.

Cumulative pitch tolerance over 20 consecutive units not to exceed ±1.0 mm.

Lead space (F) shall be measured at 3.6 ±0.5 mm from the capacitor seating plane.

Fig.3 Ammopack with capacitors on tape.



See Table 3 for dimensions.

Maximum 0.5% of the total number of capacitors per reel may be missing. A maximum of 2 consecutive vacant positions is followed by 6 consecutive components.

Tape begins and ends with minimum of 24 empty positions (300 mm tape).

Maximum of 5 splices per reel.

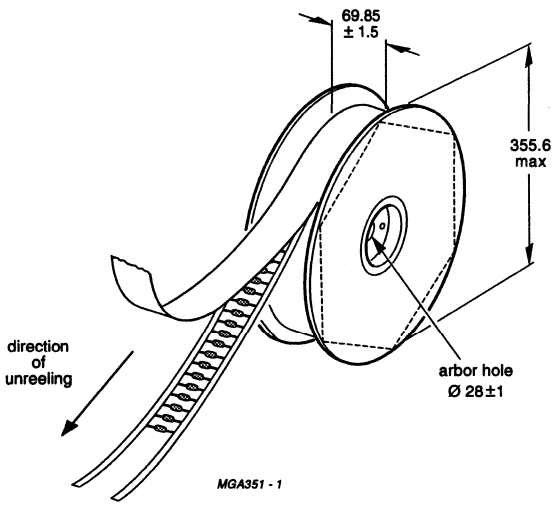
Cumulative pitch tolerance over 20 consecutive units not to exceed ±1.0 mm.

Lead space (F) shall be measured at 3.6 ±0.5 mm from the capacitor seating plane.

Fig.4 Capacitors on bandolier.

Table 3 Dimensions of bandolier (see Fig.4).

SYMBOL	PARAMETER	DIMENSIONS	
		mm	inch
B	inside tape spacing	52.4 ±1.5	2.062 ±0.059
C	centre-to-tape-spacing	±0.8	±0.031
P	cumulative pitch, 6 consecutive components	±1.5	±0.059
A	components pitch	5 ±0.5	0.197 ±0.015
M	lead bend	<1.2	<0.047
S	exposed adhesive	<0.8	<0.031
T	tape width	6.35	0.250
H	lead sandwich	>3.96	>0.156



Dimensions in mm.

Maximum 0.1% of the total number of capacitors per reel may be missing. A maximum of 1 consecutive vacant position is followed by 6 consecutive components.

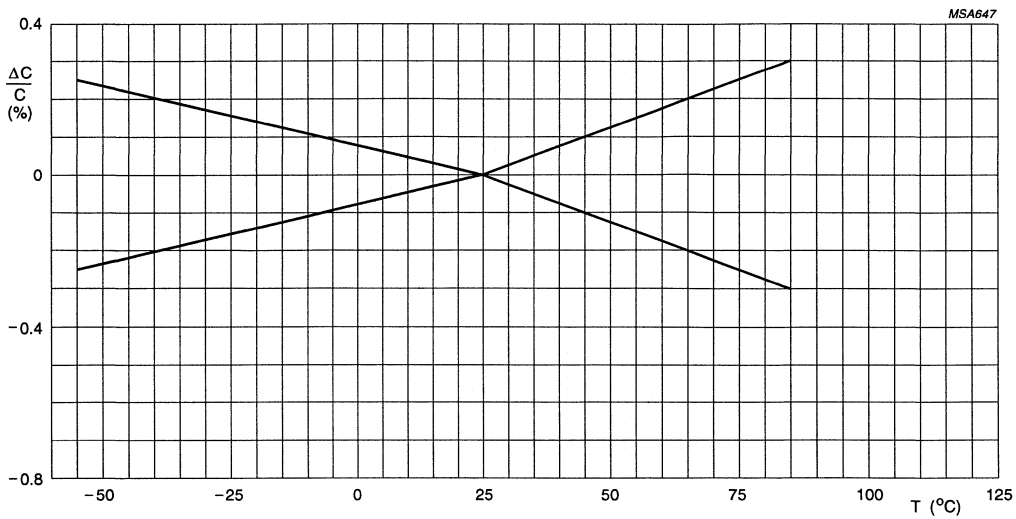
Tape begins and ends with minimum of 60 empty positions (300 mm tape).

Maximum of 5 splices per reel.

For dimensions L and ØD refer to Chapter *"Leaded ceramic multilayer capacitors"*, Section *"Mono-axial™"*, *"Table 1"*, in this handbook.

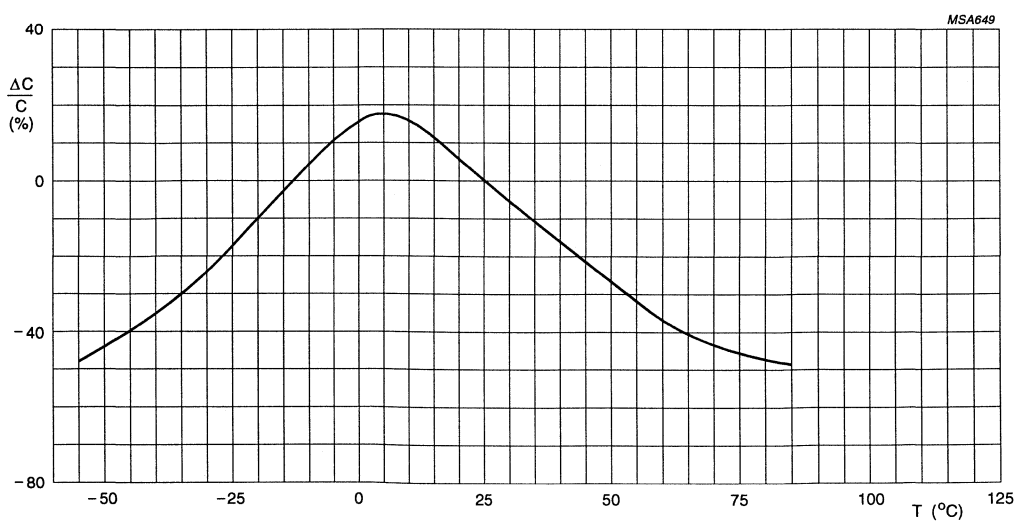
Fig.5 Reel with capacitors on tape.

CHARACTERISTIC CURVES



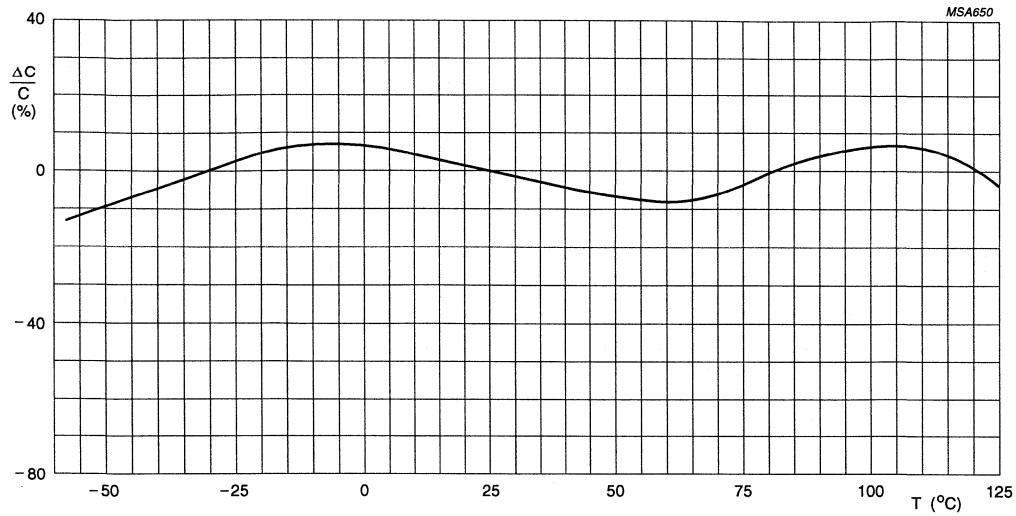
For **NP0/COG**.

Fig.6 Typical capacitance change as a function of temperature.



For **Z5U**.

Fig.7 Typical capacitance change as a function of temperature.



For **X7R**.

Fig.8 Typical capacitance change a a function of temperature.

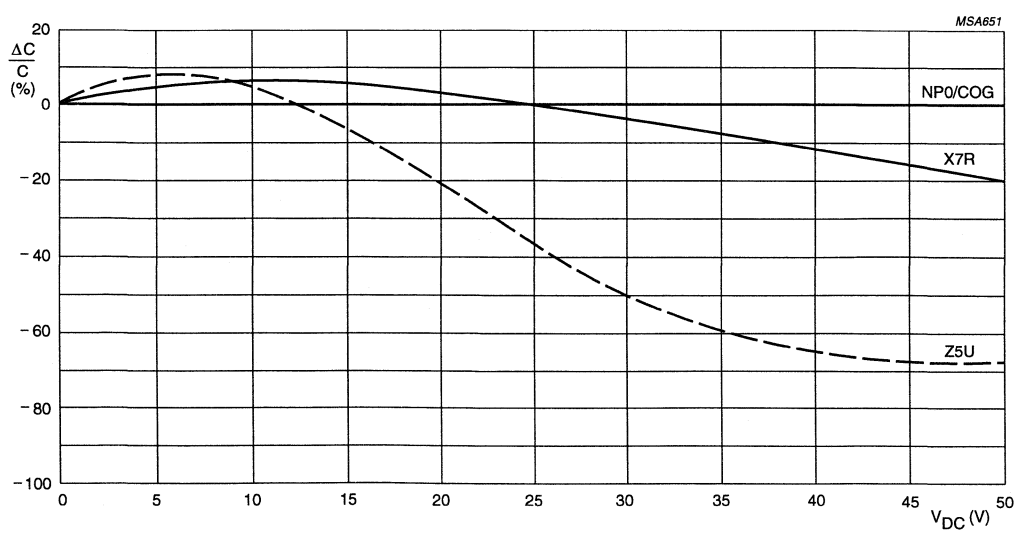


Fig.9 Typical capacitance change as a function of DC voltage.

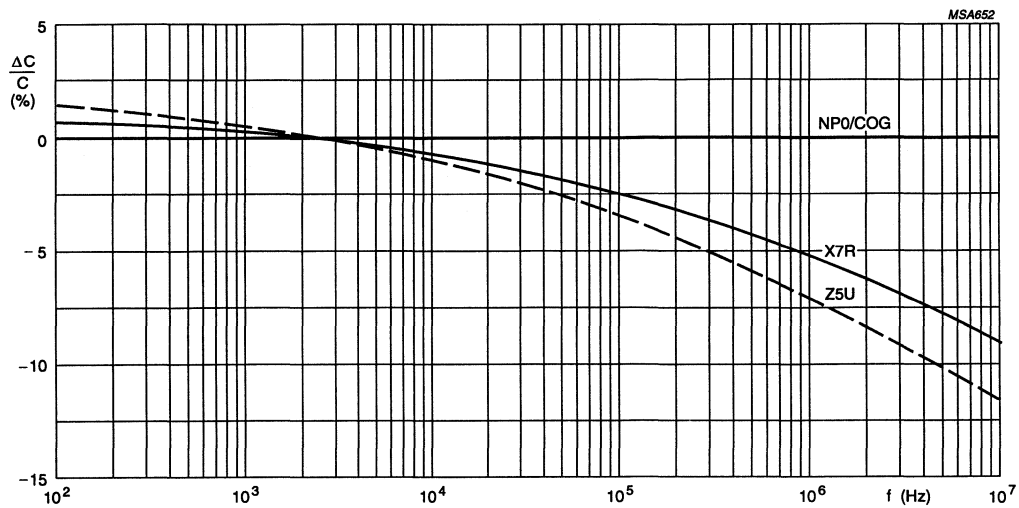


Fig.10 Typical capacitance change as a function of frequency.

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 384-9"*, category 55/125/21 (temperature range –55/+125 °C; damp heat, long term, 21 days) are carried out in accordance with *"IEC publication 68"*.

Table 4

IEC 384-8 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.4		robustness of terminations:		
		pull-off	pull velocity 15 cm/minute; load 5 N	no lead breakage
	Ua_1	tensile strength	axial force 10 N	no lead breakage
	Ub	bending	load 5 N; 4 × 90°	no lead breakage
4.6	Ta method 1	solderability (solder bath)	235 °C; 2 s	good tinning
4.5	Tb method 1A	resistance to soldering heat	260 °C; 10 s	no visible damage ΔC/C: ±≤0.5% or ±0.5 pF after 1 to 2 hours
4.7	Na	rapid change of temperature	30 minutes at –55 °C and 30 minutes at +125 °C; 5 cycles	no damage after 24 hours ΔC/C: ±≤0.5% or ±0.5 pF
4.8	Fc	vibration	10 to 55 to 10 Hz; 0.75 mm displacement; 3 directions; 6 hours	no visible damage
4.9	Eb	bump	4000 bumps in 2 directions; 40 g; pulse time 6 ms	no visible damage
		inflammability	15 s; 35 mm above bunsen burner with flame-height 40 to 60 mm	self-extinguishing within 15 s after removal of bunsen burner
4.3		temperature coefficient	between +20 and –55 °C, and between +20 and +125 °C	within tolerance as specified for each particular material

IEC 384-8 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.11		climatic sequence:		
4.11.2	B	dry heat	16 hours; +125 °C	no visible damage
4.11.3	Db	damp heat (accelerated) 1st cycle	12 hours; +55 °C; 90 to 96% RH 12 hours; +25 °C; 95 to 100% RH	after recovery of 1 to 2 hours immediately followed by cold test
4.11.4	A	cold	2 hours; –55 °C	no visible damage
4.11.5	M	low air pressure	1 hour at 8.5 kPa, last 2 minutes rated voltage	no breakdown or flashover
4.11.6	Db	damp heat (accelerated) remaining cycle	12 hours; +55 °C; 90 to 96% RH 12 hours; +25 °C; 95 to 100% RH	$\Delta C/C$: $\pm \leq 1\%$ or ± 1 pF tan δ: $\leq 2 \times$ specified tan δ R_{ins} after 1 to 2 hours: >5000 MΩ
4.12	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% RH	$\Delta C/C$: $\pm \leq 1\%$ or ± 1 pF tan δ: $\leq 2 \times$ specified tan δ R_{ins} after 1 to 2 hours: >5000 MΩ
4.13		endurance	1000 hours at maximum temperature, at 1.5 × rated voltage	$\Delta C/C$: $\pm \leq 1\%$ or ± 1 pF tan δ: $\leq 1.5 \times$ specified tan δ R_{ins}: >3000 MΩ
		resistance to solvents	3 minutes ultrasonic washing in trichloroethylene; 1 minute 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 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 384-9"*, categories 55/125/21, 10/85/21 and 25/85/21 respectively for X7R-2C1 and Z5U (temperature ranges –55/+125 °C, +10/+85 °C and –25/+85 °C; damp heat, long term, 21 days) are carried out in accordance with *"IEC publication 68"*.

Table 5

IEC 384-9 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.1		pre-conditioning	1 hour; +150 °C; reference measurement after 24 hours	
4.5		robustness of terminations:		
		pull-off	pull velocity 15 cm/minute; load 5 N	no lead breakage
	Ua_1	tensile strength	axial force 10 N	no lead breakage
	Ub	bending	load 5 N; 4 × 90°	no lead breakage
4.7	Ta method 1	solderability (solder bath)	235 °C; 2 s	good tinning
4.6	Tb method 1A	resistance to soldering heat	pre-conditioning: 260 °C; 10 s	no visible damage
4.8	Na	rapid change of temperature	pre-conditioning: for X7R: –55/+125 °C; 5 cycles; for Z5U: +10/+85 °C; 5 cycles	no damage ΔC/C after 24 hours: X7R: ±≤10% Z5U: ±≤20%
4.9	Fb	vibration	10 to 55 to 10 Hz; 0.75 mm displacement; 3 directions; 6 hours	no visible damage
4.10	Eb	bump	4000 bumps in 2 directions; 40 g; pulse time 6 ms	no visible damage
		inflammability	15 s; 35 mm above bunsen burner with flame-height 40 to 60 mm	self-extinguishing within 15 s after removal of bunsen burner
		resistance to solvents	3 minutes ultrasonic washing in trichloroethylene; 1 minute 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

Leaded ceramic multilayer capacitors — General

IEC 384-9 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.12		climatic sequence:		
4.12.1		pre-conditioning	1 hour; +150 °C	
4.12.2	Ba	dry heat	16 hours at maximum temperature	no visible damage
4.12.3	Db	damp heat (accelerated) 1st cycle	12 hours; +55 °C; 90 to 96% RH 12 hours; +25 °C; 95 to 100% RH	no visible damage; after recovery of 1 to 2 hours immediately followed by cold test
4.12.4	Aa	cold	2 hours at minimum temperature	no visible damage
4.12.5	M	low air pressure	1 hour at 8.5 kPa, last 2 minutes rated voltage	no breakdown or flashover
4.12.6	Db	damp heat (accelerated) remaining cycle	12 hours; +55 °C; 90 to 96% RH 12 hours; +25 °C; 95 to 100% RH	after 24 hours recovery: $\Delta C/C$: X7R: $\pm \leq 15\%$ Z5U: $\pm \leq 20\%$ tan δ: $\leq 7\%$ R_{ins}: >1000 MΩ
4.13	Ca	damp heat, steady state (half number of samples at rated voltage, other half of samples no voltage applied)	pre-conditioning: 21 days; +40 °C; 90 to 95% RH	no visible damage after 24 hours: $\Delta C/C$: X7R: $\pm \leq 15\%$ Z5U: $\pm \leq 30\%$ tan δ: $\leq 7\%$ R_{ins}: >1000 MΩ
4.14		endurance	pre-conditioning	after 24 hours: $\Delta C/C$: X7R: $\pm \leq 20\%$ Z5U: $\pm \leq 30\%$ tan δ: $\leq 7\%$ R_{ins}: >2000 MΩ
4.4		temperature characteristic	pre-conditioning: minimum and maximum temperature	in accordance with specification

PRODUCT DATA

Leaded ceramic multilayer capacitors Mono-axial™ series

FEATURES

- High capacitance per unit volume
- Low cost.

APPLICATIONS

These conformally coated radial leaded capacitors are designed for commercial and industrial applications in three dielectrics, NP0 (ultra-stable), X7R (stable) and Z5U (general purpose). Applications include timing, coupling/decoupling, signal comparison and biasing. Mono-axial™ capacitors are suitable for automatic insertion equipment.

DESCRIPTION

The basic capacitor construction consists of ceramic dielectric materials processed into a tape with a typical thickness range from 0.025 to 0.076 mm. Metal electrode patterns are applied using a thick film screening process. Multiple layers are stacked and laminated in such a manner that electrodes are alternately exposed when the pattern is cut into individual chip capacitors. The capacitors are fired through a high temperature profile to mature the ceramic and metal into a homogeneous unit.

Metal end terminations are applied and fired to provide electrical connection between the individual layers. Tinned leads are attached using a solder. Encapsulation consists of a moisture resistant gold colour conformal epoxy coating that meets the flame requirements of *"UL94V-0"*.

QUICK REFERENCE DATA

DESCRIPTION	VALUE		
	2222 740	**2222 741 .....**	**2222 742 .....**
Capacitance range	10 pF to 6800 pF (E12 series)	220 pF to 0.22 µF (E12 series)	1000 pF to 0.47 µF (E12 series)
Rated DC voltage	50 and 100 V	50 and 100 V	50 and 100 V
Tolerance on capacitance	±5%; ±10%	±10%; ±20%	±20%; –20%/+80%
Temperature coefficient	NP0	X7R	Z5U

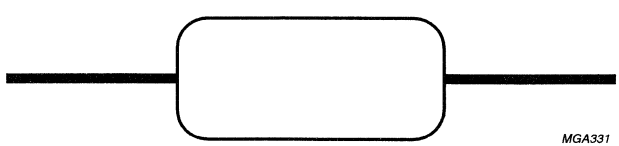
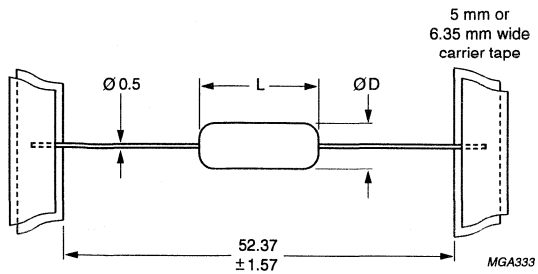


Fig.1 Simplified outline.

MECHANICAL DATA



Dimensions in mm.

Fig.2 Tape carrier.

Marking

Capacitance value (**CCC**T):

10 pF to 99 pF; actual value in pF (2 digits only)

100 pF and above; coded capacitance value (same as used in P/N).

Tolerance (CCC**T**):

Standard EIA tolerance (same as used in P/N).

Material code (**M** V):

Standard EIA TC code

A = COG

C = X7R

E = Z5U.

Voltage code (M **V**):

Standard EIA voltage code

1 = 100 V

5 = 50 V.

Date code (**DDDD**):

Four digit code; first two digits denote year, last two denote week of manufacture.

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE	L_{max}(1) (mm)	$ØD_{max}$(1) (mm)	MASS (g)
15	4.32 (0.150)	2.54 (0.100)	≈0.14
20	5.08 (0.200)	3.05 (0.120)	≈0.14
29	7.37 (0.290)	2.54 (0.150)	≈0.23

Note

1. Dimensions between parentheses are in inches.

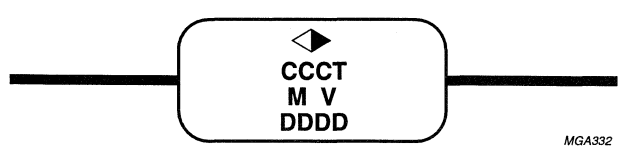


Fig.3 Markings on the body.

PACKAGING

For details refer to the Chapter *"Leaded ceramic multilayer capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

CAPACITANCE TOLERANCE	CATALOGUE NUMBERS(1)					
	2222 740		2222 741		2222 742	
	NP0		X7R		Z5U	
	U_R = 50 V (DC)	U_R = 100 V (DC)	U_R = 50 V (DC)	U_R = 100 V (DC)	U_R = 50 V (DC)	U_R = 100 V (DC)
±5%	09...	41...	–	–	–	–
±10%	10...	42...	10...	42...	–	–
±20%	–	–	11...	43...	11...	43...
–20/+80%	–	–	–	–	12...	44...

Note

1. The first 2 digits of the remaining 5-digit suffix are given here; catalogue number to be completed by adding the 3-digit suffix for required series and capacitance (see Tables 3, 4 and 5).

Table 3 Range of values for **NP0**, 2222 740 .....; see Table 6 for conditions.

CAPACITANCE VALUE (pF)	SIZE (see Table 1)		SUFFIX OF CATALOGUE NUMBER (see Table 2)
	U_R = 50 V (DC)	U_R = 100 V (DC)	
10	15	15	109
12	15	15	129
15	15	15	159
18	15	15	189
22	15	15	229
27	15	15	279
33	15	15	339
39	15	15	399
47	15	15	479
56	15	15	569
68	15	15	689
82	15	15	829
100	15	15	101
120	15	15	121
150	15	15	151
180	15	15	181
220	15	15	221
270	15	15	271
330	15	15	331
390	15	15	391
470	15	15	471
560	15	15	561
680	15	15	681
820	15	15	821
1000	15	20	102
1200	20	20	121
1500	20	20	152
1800	20	20	182
2200	20	20	222
2700	20	29	272
3300	20	29	332
3900	29	29	392
4700	29	29	472
5600	29	–	562
6800	29	–	682

Table 4 Range of values for **X7R**, 2222 741 .....; see Table 6 for conditions.

CAPACITANCE VALUE (pF)	SIZE (see Table 1)		SUFFIX OF CATALOGUE NUMBER (see Table 2)
	U_R = 50 V (DC)	U_R = 100 V (DC)	
220	15	15	221
270	15	15	271
330	15	15	331
390	15	15	391
470	15	15	471
560	15	15	561
680	15	15	681
820	15	15	821
1000	15	15	102
1200	15	15	122
1500	15	15	152
1800	15	15	182
2200	15	15	222
2700	15	15	272
3300	15	15	332
3900	15	15	392
4700	15	15	472
5600	15	15	562
6800	15	15	682
8200	15	15	822
10000	15	15	103
12000	15	20	123
15000	15	20	153
18000	15	20	183
22000	15	20	223
27000	15	20	273
33000	15	20	333
39000	20	20	393
47000	20	20	473
56000	20	29	563
68000	20	29	683
82000	20	29	823
100000	20	29	104
120000	29	29	124
150000	29	–	154
180000	29	–	184
220000	29	–	224

Table 5 Range of values for **Z5U**, 2222 742 .....; see Table 6 for conditions.

CAPACITANCE VALUE (pF)	SIZE (see Table 1)		SUFFIX OF CATALOGUE NUMBER (see Table 2)
	U_R = 50 V (DC)	U_R = 100 V (DC)	
1000	15	15	102
1200	15	15	122
1500	15	15	152
1800	15	15	182
2200	15	15	222
2700	15	15	272
3300	15	15	332
3900	15	15	392
4700	15	15	472
5600	15	15	562
6800	15	15	682
8200	15	15	822
10000	15	15	103
12000	15	20	123
15000	15	20	153
18000	15	20	183
22000	15	20	223
27000	15	20	273
33000	15	20	333
39000	15	29	393
47000	15	29	473
56000	15	29	563
68000	15	29	683
82000	15	29	823
100000	15	29	104
120000	20	–	124
150000	20	–	154
180000	20	–	184
220000	20	–	224
270000	29	–	274
330000	29	–	334
390000	29	–	394
470000	29	–	474

ELECTRICAL CHARACTERISTICS

Table 6 Electrical data for NP0, X7R and Z5U; conditions for the Tables 3, 4 and 5.

The capacitors meet the essential requirements of *"EIA-198"*. Unless stated otherwise all electrical values apply at an ambient temperature of 25 ±3 °C, at barometric pressures of 650 to 800 mm of mercury, and relative humidity not to exceed 75%.

DESCRIPTION	VALUE
Capacitors with temperature coefficient NP0	
Capacitance range: at 1 MHz, 1 V; where C ≤ 1000 pF at 1 kHz, 1 V; where C > 1000 pF	 10 to 1000 pF 1200 to 6800 pF
Tolerance on the capacitance	±5%, ±10%
Rated DC voltage	50 and 100 V
DC test voltage; duration 1 minute	250% of rated voltage
Insulation resistance at rated voltage	100 GΩ or 1000 MΩ × μF, whichever is less at 25 °C
Temperature coefficient of the capacitance	0×10^{-6}
Tolerance on the temperature coefficient	$\pm 30 \times 10^{-6}$
Dissipation factor: at 1 MHz, 1 V; where C ≤ 1000 pF at 1 kHz, 1 V; where C > 1000 pF	 $<15 \times 10^{-4}$ $<15 \times 10^{-4}$
Operating temperature range	−55 to +125 °C
Storage temperature range	−55 to +85 °C
Capacitors with temperature coefficient X7R	
Capacitance range at 1 kHz, 1 V	220 pF to 0.22 μF
Tolerance on the capacitance	±10%, ±20%
Maximum capacitance change with respect to capacitance value at 25 °C	±15%
Rated DC voltage	50 and 100 V
DC test voltage; duration 1 minute	250% of rated voltage
Insulation resistance at rated voltage	100 GΩ or 1000 MΩ × μF, whichever is less at 25 °C
Dissipation factor at 1 kHz, 1 V	≤2.5%
Operating temperature range	−55 to +125 °C
Storage temperature range	−55 to +85 °C
Ageing	typical 1% per time decade

Leaded ceramic multilayer capacitors Mono-axial™ series

DESCRIPTION	VALUE
Capacitors with temperature coefficient Z5U	
Capacitance range at 1 kHz, 0.5 V	0.01 µF to 0.47 µF
Tolerance on the capacitance	±20%, –20/+80%
Maximum capacitance change with respect to capacitance value at 25 °C	–56%/+22%
Rated DC voltage	50 and 100 V
DC test voltage; duration 1 minute	250% of rated voltage
Insulation resistance at rated voltage	100 GΩ or 1000 MΩ × µF, whichever is less at 25 °C
Dissipation factor at 1 kHz, 0.5 V	≤4%
Operating temperature range	10 to 85 °C
Storage temperature range	–55 to +85 °C
Ageing	typical 6% per time decade

Leaded ceramic multilayer capacitors Mono-kap™ series

FEATURES

- Very high capacitance per unit volume
- Low cost.

APPLICATIONS

These conformally coated radial leaded capacitors are designed for commercial and industrial applications in three dielectrics, NP0 (ultra-stable), X7R (stable) and Z5U (general purpose). Applications include timing, coupling/decoupling, signal comparison and biasing. Mono-kap™ capacitors are suitable for automatic insertion equipment.

DESCRIPTION

The basic capacitor construction consists of ceramic dielectric materials processed into a tape with a typical thickness range from 0.025 to 0.076 mm. Metal electrode patterns are applied using a thick film screening process. Multiple layers are stacked and laminated in such a manner that electrodes are alternately exposed when the pattern is cut into individual chip capacitors. The capacitors are fired through a high temperature profile to mature the ceramic and metal into a homogeneous unit.

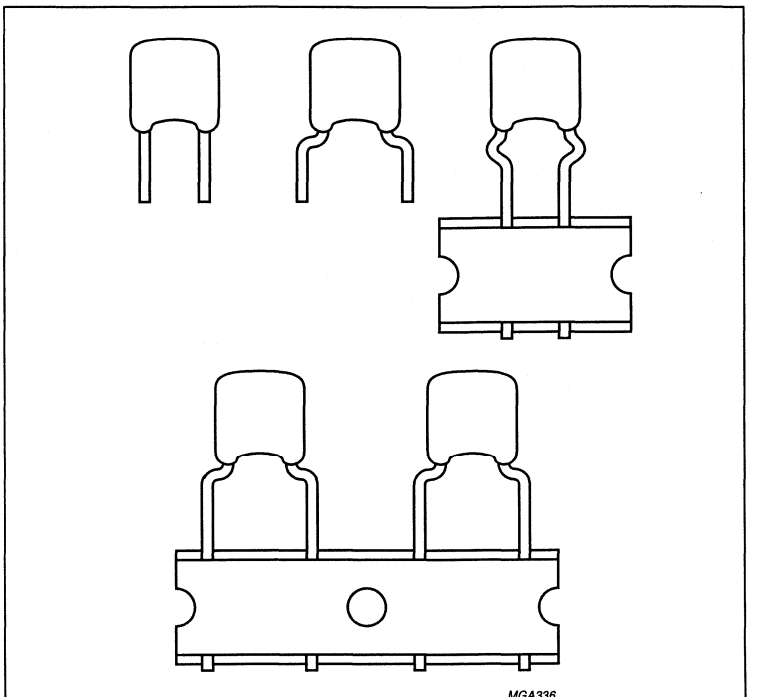


Fig.1 Component outlines.

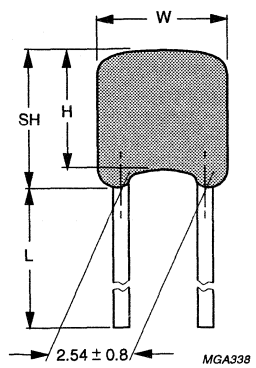
Metal end terminations are applied and fired to provide electrical connection between the individual layers. Tinned leads are attached using a solder.

Encapsulation consists of a moisture-resistant gold colour conformal epoxy coating that meets the flame requirements of *"UL94V-0"*.

QUICK REFERENCE DATA

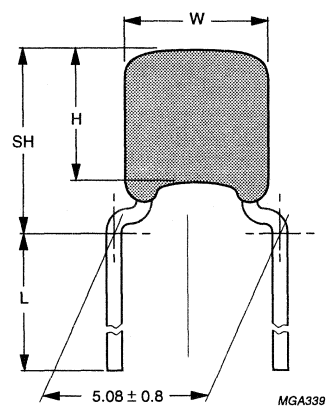
DESCRIPTION	VALUE		
	2222 730	2222 731	2222 733 .....
Capacitance range	10 pF to 0.022 µF (E12 series)	220 pF to 1.0 µF (E12 series)	1000 pF to 1.0 µF (E12 series)
Rated DC voltage	50 and 100 V	50 and 100 V	50 and 100 V
Tolerance on capacitance	±5%; ±10%	±10%; ±20%	±20%; −20%/+80%
Temperature coefficient	NP0 (COG)	X7R	Z5U

MECHANICAL DATA



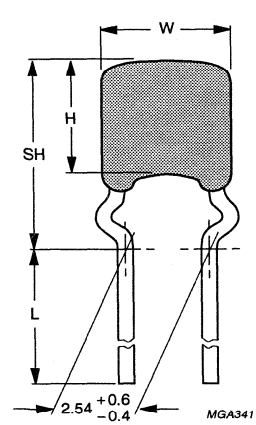
Dimensions in mm.

Fig.2 Component outline for pitch 2.54 ±0.8 mm (straight wires).



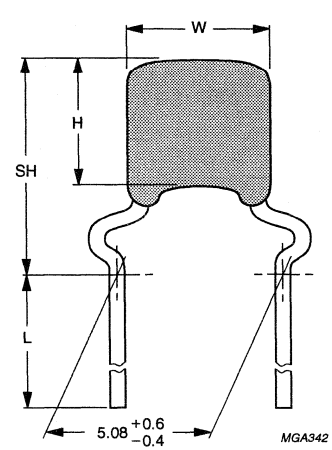
Dimensions in mm.

Fig.3 Component outline for pitch 5.08 ±0.8 mm (flat bent wires).



Dimensions in mm.

Fig.4 Component outline for pitch 2.54 +0.6/–0.4 mm (outside kink wires).



Dimensions in mm.
Lead style available on request.

Fig.5 Component outline for pitch 5.08 +0.6/–0.4 mm (outside kink wires).

Physical dimensions.

Table 1 Capacitor dimensions and mass; notes 1 and 2.

SIZE	W_{max} (mm)	H_{max} (mm)	T_{max}(3) (mm)	MAX. SEATING HEIGHT (SH) (mm)				MASS (g)
				Fig.2	Fig.3	Fig.4	Fig.5	
15	3.81 (0.150)	3.81 (0.150)	2.54 (0.100)	5.38 (0.212)	6.35 (0.250)	6.99 (0.275)	6.99 (0.275)	≈0.15
20	5.08 (0.200)	5.08 (0.200)	3.18 0.125)	6.65 (0.262)	7.62 (0.300)	8.26 (0.325)	8.26 (0.325)	≈0.16
30	7.62 (0.300)	7.62 (0.300)	3.81 (0.150)	–	10.16 (0.400)	–	10.80 (0.425)	≈0.42

Notes

1. Bulk packed products have a standard lead length L ≥ 25.4 mm.
2. Dimensions between the parentheses are in inches.
3. Thickness defined as T.

Marking(1) (see Fig.6)

Capacitance value (**CCC**T):

10 pF to 99 pF; actual value in pF (2 digits only)

100 pF and above; coded capacitance value (same as used in P/N).

Tolerance (CCC**T**):

Standard EIA tolerance.

Material code (**M** V):

Standard EIA TC code

A = NP0 (COG)

C = X7R

E = Z5U.

Voltage code (M **V**):

Standard EIA voltage code

1 = 100 V

5 = 50 V.

(1) Sizes 15 and 20 are marked with capacitance value only.

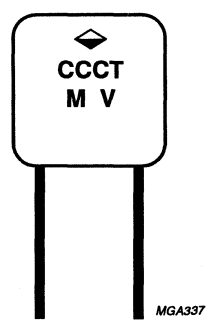


Fig.6 Markings on the body.

PACKAGING

For details refer to Chapter *"Leaded ceramic multilayer capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

CAP. TOL.	PITCH[2] P (mm)	LEAD[2] DIA. d (mm)	CATALOGUE NUMBER 2222 73. .....[1]								
			BULK PACKED			ON TAPE ON REEL			ON TAPE IN AMMOPACK		
			U_R (DC)		Fig.	U_R (DC)		Fig.	U_R (DC)		Fig.
			50 V	100 V		50 V	100 V		50 V	100 V	
±5%	2.54 (0.1); note 3	0.5 (0.020)	05...	37...	2	09...	41...	4	13...	45...	4
±10%			06...	38...	2	10...	42...	4	14...	46...	4
±20%			07...	39...	2	11...	43...	4	15...	47...	4
−20/+80%			08...	40...	2	12...	44...	4	16...	48...	4
±5%	5.08 (0.2)	0.5 (0.020)	17...	49...	3	21...	53...	3	25...	57...	3
±10%			18...	50...	3	22...	54...	3	26...	58...	3
±20%			19...	51...	3	23...	55...	3	27...	59...	3
−20/+80%			20...	52...	3	24...	56...	3	28...	60...	3

Notes

1. Catalogue number to be completed by adding the 7th digit for the required dielectric and the last 3 digits for the required series and capacitance (see Tables 3, 4 and 5).
2. Dimensions between the parentheses are in inches.
3. Sizes 15 and 20 only.

Table 3 Range of values for **NP0 (COG)**, 2222 730 .....; see Table 6 for conditions.

CAPACITANCE VALUE (pF)	SIZE (see Table 1)		SUFFIX OF CATALOGUE NUMBER (see Table 2)
	U_R = 50 V (DC)	U_R = 100 V (DC)	
10 to 82	15	15	..109 to ..829
100 to 820	15	15	..101 to ..821
1000	15	20	..102
1200 to 4700	20	20	..122 to ..472
5600 to 10000	30	30	..562 to ..103
12000 to 22000	30	–	..123 to ..223

Table 4 Range of values for **X7R**, 2222 731 .....; see Table 6 for conditions.

CAPACITANCE VALUE (pF)	SIZE (see Table 1)		SUFFIX OF CATALOGUE NUMBER (see Table 2)
	U_R = 50 V (DC)	U_R = 100 V (DC)	
220	15	15	..221
270	15	15	..271
330	15	15	..331
390	15	15	..391
470	15	15	..471
560	15	15	..561
680	15	15	..681
820	15	15	..821
1000	15	15	..102
1200	15	15	..122
1500	15	15	..152
1800	15	15	..182
2200	15	15	..222
2700	15	15	..272
3300	15	15	..332
3900	15	15	..392
4700	15	15	..472
5600	15	15	..562
6800	15	15	..682
8200	15	15	..822
10000	15	15	..103
12000	15	20	..123
15000	15	20	...153
18000	15	20	..183
22000	15	20	..223
27000	15	20	..273
33000	15	20	..333
39000	15	20	..393
47000	20	20	..473
56000	20	20	..563
68000	20	20	..683
82000	20	20	..823
100000	20	20	..104
120000	20	30	..124
150000	20	30	..154
180000	20	30	..184
220000	20	30	..224
270000	30	30	..274

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CAPACITANCE VALUE (pF)	SIZE (see Table 1)		SUFFIX OF CATALOGUE NUMBER (see Table 2)
	U_R = 50 V (DC)	U_R = 100 V (DC)	
330000	30	30	..334
390000	30	–	..394
470000	30	–	..474
560000	30	–	..564
680000	30	–	..684
820000	30	–	..824
1000000	30	–	..105

Table 5 Range of values for **Z5U**, 2222 733 .....; see Table 6 for conditions.

CAPACITANCE VALUE (pF)	SIZE (see Table 1)		SUFFIX OF CATALOGUE NUMBER (see Table 2)
	U_R = 50 V (DC)	U_R = 100 V (DC)	
1000	15	15	..102
1200	15	15	..122
1500	15	15	..152
1800	15	15	..182
2200	15	15	..222
2700	15	15	..272
3300	15	15	..332
3900	15	15	..392
4700	15	15	..472
5600	15	15	..562
6800	15	15	..682
8200	15	15	..822
10000	15	15	..103
12000	15	20	..123
15000	15	20	..153
18000	15	20	..183
22000	15	20	..223
27000	15	20	..273
33000	15	20	..333
39000	15	20	..393
47000	15	20	..473
56000	15	20	..563
68000	15	20	..683
82000	15	20	..823
100000	15	20	..104
120000	20	30	..124
150000	20	30	..154
180000	20	30	..184
220000	20	30	..224
270000	20	30	..274
330000	20	30	..334
390000	30	30	..394
470000	30	30	..474
560000	30	–	..564
680000	30	–	..684
820000	30	–	..824
1000000	30	–	..105

ELECTRICAL CHARACTERISTICS

Table 6 Electrical data for NP0, X7R and Z5U; conditions for Tables 3, 4 and 5.

The capacitors meet the essential requirements of *"EIA-198"*. Unless stated otherwise all electrical values apply at an ambient temperature of 25 ±3 °C, at barometric pressures of 650 to 800 mm of mercury, and relative humidity not to exceed 75%.

DESCRIPTION	VALUE
Capacitors with temperature coefficient NP0	
Capacitance range: at 1 MHz, 1 V; where C ≤ 1000 pF at 1 kHz, 1 V; where C > 1000 pF	 10 pF to 0.022 µF 10 pF to 0.022 µF
Tolerance on the capacitance	±5%, ±10%
Rated DC voltage	50 and 100 V
DC test voltage; duration 1 minute	250% of rated voltage
Insulation resistance at rated voltage	100 GΩ or 1000 MΩ × µF, whichever is less at 25 °C
Temperature coefficient of the capacitance	0×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 30 \times 10^{-6}$/K
Dissipation factor: at 1 MHz, 1 V; where C ≤ 1000 pF at 1 kHz, 1 V; where C > 1000 pF	 $<15 \times 10^{-4}$ $<15 \times 10^{-4}$
Operating temperature range	−55 to +125 °C
Storage temperature range	−55 to +85 °C
Capacitors with temperature coefficient X7R	
Capacitance range at 1 kHz, 1 V	220 pF to 1.0 µF
Tolerance on the capacitance	±10%, ±20%
Maximum capacitance variation with respect to capacitance value at 25 °C	±15%
Rated DC voltage	50 and 100 V
DC test voltage; duration 1 minute	250% of rated voltage
Insulation resistance at rated voltage	100 GΩ or 1000 MΩ × µF, whichever is less at 25 °C
Dissipation factor at 1 kHz, 1 V	≤2.5%
Operating temperature range	−55 to +125 °C
Storage temperature range	−55 to +85 °C
Ageing	typical 1% per time decade

Leaded ceramic multilayer capacitors Mono-kap™ series

DESCRIPTION	VALUE
Capacitors with temperature coefficient Z5U	
Capacitance range at 1 kHz, 0.5 V	1000 pF to 1.0 μF
Tolerance on the capacitance	±20%, −20/+80%
Maximum capacitance variation with respect to capacitance value at 25 °C	−56/+22%
Rated DC voltage	50 and 100 V
DC test voltage; duration 1 minute	250% of rated voltage
Insulation resistance at rated voltage	100 GΩ or 1000 MΩ × μF, whichever is less at 25 °C
Dissipation factor at 1 kHz, 0.5 V	≤4%
Operating temperature range	10 to 85 °C
Storage temperature range	−55 to +85 °C
Ageing	typical 6% per time decade

Leaded ceramic multilayer capacitors

Cross reference selection guide

Table 1 Mono-kap™ conformal radials, **NP0 (COG)**, 5% and 10% tolerance, **50 V**.

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CN 15 C 100 J	K 100 J 15 COG F VB	2222 730 05109	2.54
CN 15 C 100 K	K 100 K 15 COG F VB	2222 730 06109	2.54
CN 15 C 120 J	K 120 J 15 COG F VB	2222 730 05129	2.54
CN 15 C 120 K	K 120 K 15 COG F VB	2222 730 06129	2.54
CN 15 C 150 J	K 150 J 15 COG F VB	2222 730 05159	2.54
CN 15 C 150 K	K 150 K 15 COG F VB	2222 730 06159	2.54
CN 15 C 180 J	K 180 J 15 COG F VB	2222 730 05189	2.54
CN 15 C 180 K	K 180 K 15 COG F VB	2222 730 06189	2.54
CN 15 C 220 J	K 220 J 15 COG F VB	2222 730 05229	2.54
CN 15 C 220 K	K 220 K 15 COG F VB	2222 730 06229	2.54
CN 15 C 270 J	K 270 J 15 COG F VB	2222 730 05279	2.54
CN 15 C 270 K	K 270 K 15 COG F VB	2222 730 06279	2.54
CN 15 C 330 J	K 330 J 15 COG F VB	2222 730 05339	2.54
CN 15 C 330 K	K 330 K 15 COG F VB	2222 730 06339	2.54
CN 15 C 390 J	K 390 J 15 COG F VB	2222 730 05399	2.54
CN 15 C 390 K	K 390 K 15 COG F VB	2222 730 06399	2.54
CN 15 C 470 J	K 470 J 15 COG F VB	2222 730 05479	2.54
CN 15 C 470 K	K 470 K 15 COG F VB	2222 730 06479	2.54
CN 15 C 560 J	K 560 J 15 COG F VB	2222 730 05569	2.54
CN 15 C 560 K	K 560 K 15 COG F VB	2222 730 06569	2.54
CN 15 C 680 J	K 680 J 15 COG F VB	2222 730 05689	2.54
CN 15 C 680 K	K 680 K 15 COG F VB	2222 730 06689	2.54
CN 15 C 820 J	K 820 J 15 COG F VB	2222 730 05829	2.54
CN 15 C 820 K	K 820 K 15 COG F VB	2222 730 06829	2.54
CN 15 C 101 J	K 101 J 15 COG F VB	2222 730 05101	2.54
CN 15 C 101 K	K 101 K 15 COG F VB	2222 730 06101	2.54
CN 15 C 121 J	K 121 J 15 COG F VB	2222 730 05121	2.54
CN 15 C 121 K	K 121 K 15 COG F VB	2222 730 06121	2.54
CN 15 C 151 J	K 151 J 15 COG F VB	2222 730 05151	2.54
CN 15 C 151 K	K 151 K 15 COG F VB	2222 730 06151	2.54
CN 15 C 181 J	K 181 J 15 COG F VB	2222 730 05181	2.54
CN 15 C 181 K	K 181 K 15 COG F VB	2222 730 06181	2.54
CN 15 C 221 J	K 221 J 15 COG F VB	2222 730 05221	2.54
CN 15 C 221 K	K 221 K 15 COG F VB	2222 730 06221	2.54
CN 15 C 271 J	K 271 J 15 COG F VB	2222 730 05271	2.54
CN 15 C 271 K	K 271 K 15 COG F VB	2222 730 06271	2.54
CN 15 C 331 J	K 331 J 15 COG F VB	2222 730 05331	2.54
CN 15 C 331 K	K 331 K 15 COG F VB	2222 730 06331	2.54

Leaded ceramic multilayer capacitors

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DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CN 15 C 391 J	K 391 J 15 COG F VB	2222 730 05391	2.54
CN 15 C 391 K	K 391 K 15 COG F VB	2222 730 06391	2.54
CN 15 C 471 J	K 471 J 15 COG F VB	2222 730 05471	2.54
CN 15 C 471 K	K 471 K 15 COG F VB	2222 730 06471	2.54
CN 15 C 561 J	K 561 J 15 COG F VB	2222 730 05561	2.54
CN 15 C 561 K	K 561 K 15 COG F VB	2222 730 06561	2.54
CN 20 C 681 J	K 681 J 15 COG F VB	2222 730 05681	2.54
CN 20 C 681 K	K 681 K 15 COG F VB	2222 730 06681	2.54
CN 20 C 821 J	K 821 J 15 COG F VB	2222 730 05821	2.54
CN 20 C 821 K	K 821 K 15 COG F VB	2222 730 06821	2.54
CN 20 C 102 J	K 102 J 15 COG F VB	2222 730 05102	2.54
CN 20 C 102 K	K 102 K 15 COG F VB	2222 730 06102	2.54
CN 20 C 122 J	K 122 J 20 COG F VB	2222 730 05122	2.54
CN 20 C 122 K	K 122 K 20 COG F VB	2222 730 06122	2.54
CN 20 C 152 J	K 152 J 20 COG F VB	2222 730 05152	2.54
CN 20 C 152 K	K 152 K 20 COG F VB	2222 730 06152	2.54
CN 20 C 182 J	K 182 J 20 COG F VB	2222 730 05182	2.54
CN 20 C 182 K	K 182 K 20 COG F VB	2222 730 06182	2.54
CN 20 C 222 J	K 222 J 20 COG F VB	2222 730 05222	2.54
CN 20 C 222 K	K 222 K 20 COG F VB	2222 730 06222	2.54
CN 20 C 272 J	K 272 J 20 COG F VB	2222 730 05272	2.54
CN 20 C 272 K	K 272 K 20 COG F VB	2222 730 06272	2.54
CN 20 C 332 J	K 332 J 20 COG F VB	2222 730 05332	2.54
CN 20 C 332 K	K 332 K 20 COG F VB	2222 730 06332	2.54
CN 30 C 392 J	K 392 J 20 COG F VC	2222 730 17392	5.08
CN 30 C 392 K	K 392 K 20 COG F VC	2222 730 18392	5.08
CN 30 C 472 J	K 472 J 20 COG F VC	2222 730 17472	5.08
CN 30 C 472 K	K 472 K 20 COG F VC	2222 730 18472	5.08
CN 30 C 562 J	K 562 J 30 COG F VC	2222 730 17562	5.08
CN 30 C 562 K	K 562 K 30 COG F VC	2222 730 18562	5.08
CN 30 C 682 J	K 682 J 30 COG F VC	2222 730 17682	5.08
CN 30 C 682 K	K 682 K 30 COG F VC	2222 730 18682	5.08
CN 30 C 822 K	K 822 K 30 COG F VC	2222 730 18822	5.08
CN 30 C 103 J	K 103 J 30 COG F VC	2222 730 17103	5.08
CN 30 C 103 K	K 103 K 30 COG F VC	2222 730 18103	5.08
CN 40 C 153 J	K 153 J 30 COG F VC	2222 730 17153	5.08
CN 40 C 153 K	K 153 K 30 COG F VC	2222 730 18153	5.08
CN 40 C 223 J	K 223 J 30 COG F VC	2222 730 17223	5.08
CN 40 C 223 K	K 223 K 30 COG F VC	2222 730 18223	5.08
CN 15 C 100 J DRM	K 100 J 15 COG F TT	2222 730 21109	5.08

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DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CN 15 C 100 K DRM	K 100 K 15 COG F TT	2222 730 22109	5.08
CN 15 C 120 J DRM	K 120 J 15 COG F TT	2222 730 21129	5.08
CN 15 C 120 K DRM	K 120 K 15 COG F TT	2222 730 22129	5.08
CN 15 C 150 J DRM	K 150 J 15 COG F TT	2222 730 21159	5.08
CN 15 C 150 K DRM	K 150 K 15 COG F TT	2222 730 22159	5.08
CN 15 C 180 J DRM	K 180 J 15 COG F TT	2222 730 21189	5.08
CN 15 C 180 K DRM	K 180 K 15 COG F TT	2222 730 22189	5.08
CN 15 C 220 J DRM	K 220 J 15 COG F TT	2222 730 21229	5.08
CN 15 C 220 K DRM	K 220 K 15 COG F TT	2222 730 22229	5.08
CN 15 C 270 J DRM	K 270 J 15 COG F TT	2222 730 21279	5.08
CN 15 C 270 K DRM	K 270 K 15 COG F TT	2222 730 22279	5.08
CN 15 C 330 J DRM	K 330 J 15 COG F TT	2222 730 21339	5.08
CN 15 C 330 K DRM	K 330 K 15 COG F TT	2222 730 22339	5.08
CN 15 C 390 J DRM	K 390 J 15 COG F TT	2222 730 21399	5.08
CN 15 C 390 K DRM	K 390 K 15 COG F TT	2222 730 22399	5.08
CN 15 C 470 J DRM	K 470 J 15 COG F TT	2222 730 21479	5.08
CN 15 C 470 K DRM	K 470 K 15 COG F TT	2222 730 22479	5.08
CN 15 C 560 J DRM	K 560 J 15 COG F TT	2222 730 21569	5.08
CN 15 C 560 K DRM	K 560 K 15 COG F TT	2222 730 22569	5.08
CN 15 C 680 J DRM	K 680 J 15 COG F TT	2222 730 21689	5.08
CN 15 C 680 K DRM	K 680 K 15 COG F TT	2222 730 22689	5.08
CN 15 C 820 J DRM	K 820 J 15 COG F TT	2222 730 21829	5.08
CN 15 C 820 K DRM	K 820 K 15 COG F TT	2222 730 22829	5.08
CN 15 C 101 J DRM	K 101 J 15 COG F TT	2222 730 21101	5.08
CN 15 C 101 K DRM	K 101 K 15 COG F TT	2222 730 22101	5.08
CN 15 C 121 J DRM	K 121 J 15 COG F TT	2222 730 21121	5.08
CN 15 C 121 K DRM	K 121 K 15 COG F TT	2222 730 22121	5.08
CN 15 C 151 J DRM	K 151 J 15 COG F TT	2222 730 21151	5.08
CN 15 C 151 K DRM	K 151 K 15 COG F TT	2222 730 22151	5.08
CN 15 C 181 J DRM	K 181 J 15 COG F TT	2222 730 21181	5.08
CN 15 C 181 K DRM	K 181 K 15 COG F TT	2222 730 22181	5.08
CN 15 C 221 J DRM	K 221 J 15 COG F TT	2222 730 21221	5.08
CN 15 C 221 K DRM	K 221 K 15 COG F TT	2222 730 22221	5.08
CN 15 C 271 J DRM	K 271 J 15 COG F TT	2222 730 21271	5.08
CN 15 C 271 K DRM	K 271 K 15 COG F TT	2222 730 22271	5.08
CN 15 C 331 J DRM	K 331 J 15 COG F TT	2222 730 21331	5.08
CN 15 C 331 K DRM	K 331 K 15 COG F TT	2222 730 22331	5.08
CN 15 C 391 J DRM	K 391 J 15 COG F TT	2222 730 21391	5.08
CN 15 C 391 K DRM	K 391 K 15 COG F TT	2222 730 22391	5.08
CN 15 C 471 J DRM	K 471 J 15 COG F TT	2222 730 21471	5.08

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DISTRIBUTION PART NUMBER	15 DIGIT CODE[1]	12NC CODE	PITCH
CN 15 C 471 K DRM	K 471 K 15 COG F TT	2222 730 22471	5.08
CN 15 C 561 J DRM	K 561 J 15 COG F TT	2222 730 21561	5.08
CN 15 C 561 K DRM	K 561 K 15 COG F TT	2222 730 22561	5.08
CN 20 C 681 J DRM	K 681 J 15 COG F TT	2222 730 21681	5.08
CN 20 C 681 K DRM	K 681 K 15 COG F TT	2222 730 22681	5.08
CN 20 C 821 J DRM	K 821 J 15 COG F TT	2222 730 21821	5.08
CN 20 C 821 K DRM	K 821 K 15 COG F TT	2222 730 22821	5.08
CN 20 C 102 J DRM	K 102 J 15 COG F TT	2222 730 21102	5.08
CN 20 C 102 K DRM	K 102 K 15 COG F TT	2222 730 22102	5.08
CN 20 C 122 J DRM	K 122 J 20 COG F TT	2222 730 21122	5.08
CN 20 C 122 K DRM	K 122 K 20 COG F TT	2222 730 22122	5.08
CN 20 C 152 J DRM	K 152 J 20 COG F TT	2222 730 21152	5.08
CN 20 C 152 K DRM	K 152 K 20 COG F TT	2222 730 22152	5.08
CN 20 C 182 J DRM	K 182 J 20 COG F TT	2222 730 21182	5.08
CN 20 C 182 K DRM	K 182 K 20 COG F TT	2222 730 22182	5.08
CN 20 C 222 J DRM	K 222 J 20 COG F TT	2222 730 21222	5.08
CN 20 C 222 K DRM	K 222 K 20 COG F TT	2222 730 22222	5.08
CN 20 C 272 J DRM	K 272 J 20 COG F TT	2222 730 21272	5.08
CN 20 C 272 K DRM	K 272 K 20 COG F TT	2222 730 22272	5.08
CN 20 C 332 J DRM	K 332 J 20 COG F TT	2222 730 21332	5.08
CN 20 C 332 K DRM	K 332 K 20 COG F TT	2222 730 22332	5.08
CN 30 C 392 J DRM	K 392 J 20 COG F TT	2222 730 21392	5.08
CN 30 C 392 K DRM	K 392 K 20 COG F TT	2222 730 22392	5.08
CN 30 C 472 J DRM	K 472 J 20 COG F TT	2222 730 21472	5.08
CN 30 C 472 K DRM	K 472 K 20 COG F TT	2222 730 22472	5.08
CN 30 C 562 J DRM	K 562 J 30 COG F TT	2222 730 21562	5.08
CN 30 C 562 K DRM	K 562 K 30 COG F TT	2222 730 22562	5.08
CN 30 C 682 J DRM	K 682 J 30 COG F TT	2222 730 21682	5.08
CN 30 C 682 K DRM	K 682 K 30 COG F TT	2222 730 22682	5.08
CN 30 C 822 K DRM	K 822 K 30 COG F TT	2222 730 22822	5.08
CN 30 C 103 J DRM	K 103 J 30 COG F TT	2222 730 21103	5.08
CN 30 C 103 K DRM	K 103 K 30 COG F TT	2222 730 22103	5.08
CN 40 C 153 J DRM	K 153 J 30 COG F TT	2222 730 21153	5.08
CN 40 C 153 K DRM	K 153 K 30 COG F TT	2222 730 22153	5.08
CN 40 C 223 J DRM	K 223 J 30 COG F TT	2222 730 21223	5.08
CN 40 C 223 K DRM	K 223 K 30 COG F TT	2222 730 22223	5.08

Note to Table 1

1. Only the first 13 digits of the 15-digit code are significant for cross reference purposes.

Table 2 Mono-kap™ conformal radials, **NP0 (COG)**, 5% and 10% tolerance, **100 V**.

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CN 15 A 100 J	K 100 J 15 COG H VB	2222 730 37109	2.54
CN 15 A 100 K	K 100 K 15 COG H VB	2222 730 38109	2.54
CN 15 A 120 J	K 120 J 15 COG H VB	2222 730 37129	2.54
CN 15 A 120 K	K 120 K 15 COG H VB	2222 730 38129	2.54
CN 15 A 150 J	K 150 J 15 COG H VB	2222 730 37159	2.54
CN 15 A 150 K	K 150 K 15 COG H VB	2222 730 38159	2.54
CN 15 A 180 J	K 180 J 15 COG H VB	2222 730 37189	2.54
CN 15 A 180 K	K 180 K 15 COG H VB	2222 730 38189	2.54
CN 15 A 220 J	K 220 J 15 COG H VB	2222 730 37229	2.54
CN 15 A 220 K	K 220 K 15 COG H VB	2222 730 38229	2.54
CN 15 A 270 J	K 270 J 15 COG H VB	2222 730 37279	2.54
CN 15 A 270 K	K 270 K 15 COG H VB	2222 730 38279	2.54
CN 15 A 330 J	K 330 J 15 COG H VB	2222 730 37339	2.54
CN 15 A 330 K	K 330 K 15 COG H VB	2222 730 38339	2.54
CN 15 A 390 J	K 390 J 15 COG H VB	2222 730 37399	2.54
CN 15 A 390 K	K 390 K 15 COG H VB	2222 730 38399	2.54
CN 15 A 470 J	K 470 J 15 COG H VB	2222 730 37479	2.54
CN 15 A 470 K	K 470 K 15 COG H VB	2222 730 38479	2.54
CN 15 A 560 J	K 560 J 15 COG H VB	2222 730 37569	2.54
CN 15 A 560 K	K 560 K 15 COG H VB	2222 730 38569	2.54
CN 15 A 680 J	K 680 J 15 COG H VB	2222 730 37689	2.54
CN 15 A 680 K	K 680 K 15 COG H VB	2222 730 38689	2.54
CN 15 A 820 J	K 820 J 15 COG H VB	2222 730 37829	2.54
CN 15 A 820 K	K 820 K 15 COG H VB	2222 730 38829	2.54
CN 15 A 101 J	K 101 J 15 COG H VB	2222 730 37101	2.54
CN 15 A 101 K	K 101 K 15 COG H VB	2222 730 38101	2.54
CN 15 A 121 J	K 121 J 15 COG H VB	2222 730 37121	2.54
CN 15 A 121 K	K 121 K 15 COG H VB	2222 730 38121	2.54
CN 15 A 151 J	K 151 J 15 COG H VB	2222 730 37151	2.54
CN 15 A 151 K	K 151 K 15 COG H VB	2222 730 38151	2.54
CN 15 A 181 J	K 181 J 15 COG H VB	2222 730 37181	2.54
CN 15 A 181 K	K 181 K 15 COG H VB	2222 730 38181	2.54
CN 15 A 221 J	K 221 J 15 COG H VB	2222 730 37221	2.54
CN 15 A 221 K	K 221 K 15 COG H VB	2222 730 38221	2.54
CN 15 A 271 J	K 271 J 15 COG H VB	2222 730 37271	2.54
CN 15 A 271 K	K 271 K 15 COG H VB	2222 730 38271	2.54
CN 15 A 331 J	K 331 J 15 COG H VB	2222 730 37331	2.54
CN 15 A 331 K	K 331 K 15 COG H VB	2222 730 38331	2.54
CN 15 A 391 J	K 391 J 15 COG H VB	2222 730 37391	2.54

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DISTRIBUTION PART NUMBER	15 DIGIT CODE[1]	12NC CODE	PITCH
CN 15 A 391 K	K 391 K 15 COG H VB	2222 730 38391	2.54
CN 20 A 471 J	K 471 J 15 COG H VB	2222 730 37471	2.54
CN 20 A 471 K	K 471 K 15 COG H VB	2222 730 38471	2.54
CN 20 A 561 J	K 561 J 15 COG H VB	2222 730 37561	2.54
CN 20 A 561 K	K 561 K 15 COG H VB	2222 730 38561	2.54
CN 20 A 681 J	K 681 J 15 COG H VB	2222 730 37681	2.54
CN 20 A 681 K	K 681 K 15 COG H VB	2222 730 38681	2.54
CN 20 A 821 J	K 821 J 15 COG H VB	2222 730 37821	2.54
CN 20 A 821 K	K 821 K 15 COG H VB	2222 730 38821	2.54
CN 20 A 102 J	K 102 J 20 COG H VB	2222 730 37102	2.54
CN 20 A 102 K	K 102 K 20 COG H VB	2222 730 38102	2.54
CN 20 A 122 J	K 122 J 20 COG H VB	2222 730 37122	2.54
CN 20 A 152 J	K 152 J 20 COG H VB	2222 730 37152	2.54
CN 20 A 152 K	K 152 K 20 COG H VB	2222 730 38152	2.54
CN 30 A 182 J	K 182 J 20 COG H VC	2222 730 49182	5.08
CN 30 A 182 K	K 182 K 20 COG H VC	2222 730 50182	5.08
CN 30 A 222 J	K 222 J 20 COG H VC	2222 730 49222	5.08
CN 30 A 222 K	K 222 K 20 COG H VC	2222 730 50222	5.08
CN 30 A 272 J	K 272 J 20 COG H VC	2222 730 49272	5.08
CN 30 A 272 K	K 272 K 20 COG H VC	2222 730 50272	5.08
CN 30 A 332 J	K 332 J 20 COG H VC	2222 730 49332	5.08
CN 30 A 332 K	K 332 K 20 COG H VC	2222 730 50332	5.08
CN 30 A 392 J	K 392 J 20 COG H VC	2222 730 49392	5.08
CN 30 A 472 J	K 472 J 20 COG H VC	2222 730 49472	5.08
CN 30 A 472 K	K 472 K 20 COG H VC	2222 730 50472	5.08
CN 30 A 682 J	K 682 J 30 COG H VC	2222 730 49682	5.08
CN 30 A 103 J	K 103 J 30 COG H VC	2222 730 49103	5.08
CN 30 A 103 K	K 103 K 30 COG H VC	2222 730 50103	5.08
CN 15 A 100 J DRM	K 100 J 15 COG H TT	2222 730 53109	5.08
CN 15 A 100 K DRM	K 100 K 15 COG H TT	2222 730 54109	5.08
CN 15 A 120 J DRM	K 120 J 15 COG H TT	2222 730 53129	5.08
CN 15 A 120 K DRM	K 120 K 15 COG H TT	2222 730 54129	5.08
CN 15 A 150 J DRM	K 150 J 15 COG H TT	2222 730 53159	5.08
CN 15 A 150 K DRM	K 150 K 15 COG H TT	2222 730 54159	5.08
CN 15 A 180 J DRM	K 180 J 15 COG H TT	2222 730 53189	5.08
CN 15 A 180 K DRM	K 180 K 15 COG H TT	2222 730 54189	5.08
CN 15 A 220 J DRM	K 220 J 15 COG H TT	2222 730 53229	5.08
CN 15 A 220 K DRM	K 220 K 15 COG H TT	2222 730 54229	5.08
CN 15 A 270 J DRM	K 270 J 15 COG H TT	2222 730 53279	5.08
CN 15 A 270 K DRM	K 270 K 15 COG H TT	2222 730 54279	5.08

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DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CN 15 A 330 J DRM	K 330 J 15 COG H TT	2222 730 53339	5.08
CN 15 A 330 K DRM	K 330 K 15 COG H TT	2222 730 54339	5.08
CN 15 A 390 J DRM	K 390 J 15 COG H TT	2222 730 53399	5.08
CN 15 A 390 K DRM	K 390 K 15 COG H TT	2222 730 54399	5.08
CN 15 A 470 J DRM	K 470 J 15 COG H TT	2222 730 53479	5.08
CN 15 A 470 K DRM	K 470 K 15 COG H TT	2222 730 54479	5.08
CN 15 A 560 J DRM	K 560 J 15 COG H TT	2222 730 53569	5.08
CN 15 A 560 K DRM	K 560 K 15 COG H TT	2222 730 54569	5.08
CN 15 A 680 J DRM	K 680 J 15 COG H TT	2222 730 53689	5.08
CN 15 A 680 K DRM	K 680 K 15 COG H TT	2222 730 54689	5.08
CN 15 A 820 J DRM	K 820 J 15 COG H TT	2222 730 53829	5.08
CN 15 A 820 K DRM	K 820 K 15 COG H TT	2222 730 54829	5.08
CN 15 A 101 J DRM	K 101 J 15 COG H TT	2222 730 53101	5.08
CN 15 A 101 K DRM	K 101 K 15 COG H TT	2222 730 54101	5.08
CN 15 A 121 J DRM	K 121 J 15 COG H TT	2222 730 53121	5.08
CN 15 A 121 K DRM	K 121 K 15 COG H TT	2222 730 54121	5.08
CN 15 A 151 J DRM	K 151 J 15 COG H TT	2222 730 53151	5.08
CN 15 A 151 K DRM	K 151 K 15 COG H TT	2222 730 54151	5.08
CN 15 A 181 J DRM	K 181 J 15 COG H TT	2222 730 53181	5.08
CN 15 A 181 K DRM	K 181 K 15 COG H TT	2222 730 54181	5.08
CN 15 A 221 J DRM	K 221 J 15 COG H TT	2222 730 53221	5.08
CN 15 A 221 K DRM	K 221 K 15 COG H TT	2222 730 54221	5.08
CN 15 A 271 J DRM	K 271 J 15 COG H TT	2222 730 53271	5.08
CN 15 A 271 K DRM	K 271 K 15 COG H TT	2222 730 54271	5.08
CN 15 A 331 J DRM	K 331 J 15 COG H TT	2222 730 53331	5.08
CN 15 A 331 K DRM	K 331 K 15 COG H TT	2222 730 54331	5.08
CN 15 A 391 J DRM	K 391 J 15 COG H TT	2222 730 53391	5.08
CN 15 A 391 K DRM	K 391 K 15 COG H TT	2222 730 54391	5.08
CN 20 A 471 J DRM	K 471 J 15 COG H TT	2222 730 53471	5.08
CN 20 A 471 K DRM	K 471 K 15 COG H TT	2222 730 54471	5.08
CN 20 A 561 J DRM	K 561 J 15 COG H TT	2222 730 53561	5.08
CN 20 A 561 K DRM	K 561 K 15 COG H TT	2222 730 54561	5.08
CN 20 A 681 J DRM	K 681 J 15 COG H TT	2222 730 53681	5.08
CN 20 A 681 K DRM	K 681 K 15 COG H TT	2222 730 54681	5.08
CN 20 A 821 J DRM	K 821 J 15 COG H TT	2222 730 53821	5.08
CN 20 A 821 K DRM	K 821 K 15 COG H TT	2222 730 54821	5.08
CN 20 A 102 J DRM	K 102 J 20 COG H TT	2222 730 53102	5.08
CN 20 A 102 K DRM	K 102 K 20 COG H TT	2222 730 54102	5.08
CN 20 A 122 J DRM	K 122 J 20 COG H TT	2222 730 53122	5.08
CN 20 A 152 J DRM	K 152 J 20 COG H TT	2222 730 53152	5.08

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CN 20 A 152 K DRM	K 152 K 20 COG H TT	2222 730 54152	5.08
CN 30 A 182 J DRM	K 182 J 20 COG H TT	2222 730 53182	5.08
CN 30 A 182 K DRM	K 182 K 20 COG H TT	2222 730 54182	5.08
CN 30 A 222 J DRM	K 222 J 20 COG H TT	2222 730 53222	5.08
CN 30 A 222 K DRM	K 222 K 20 COG H TT	2222 730 54222	5.08
CN 30 A 272 J DRM	K 272 J 20 COG H TT	2222 730 53272	5.08
CN 30 A 272 K DRM	K 272 K 20 COG H TT	2222 730 54272	5.08
CN 30 A 332 J DRM	K 332 J 20 COG H TT	2222 730 53332	5.08
CN 30 A 332 K DRM	K 332 K 20 COG H TT	2222 730 54332	5.08
CN 30 A 392 J DRM	K 392 J 30 COG H TT	2222 730 53392	5.08
CN 30 A 472 J DRM	K 472 J 30 COG H TT	2222 730 53472	5.08
CN 30 A 472 K DRM	K 472 K 30 COG H TT	2222 730 54472	5.08
CN 30 A 682 J DRM	K 682 J 30 COG H TT	2222 730 53682	5.08
CN 30 A 103 J DRM	K 103 J 30 COG H TT	2222 730 53103	5.08
CN 30 A 103 K DRM	K 103 K 30 COG H TT	2222 730 54103	5.08

Note to Table 2

1. Only the first 13 digits of the 15-digit code are significant for cross reference purposes.

Table 3 Mono-kap™ conformal radials **X7R**, 10% and 20% tolerance, **50 V**.

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CW 15 C 151 K	K 151 K 15 X7R F VB	2222 731 06151	2.54
CW 15 C 181 K	K 181 K 15 X7R F VB	2222 731 06181	2.54
CW 15 C 181 M	K 181 M 15 X7R F VB	2222 731 07181	2.54
CW 15 C 221 K	K 221 K 15 X7R F VB	2222 731 06221	2.54
CW 15 C 271 K	K 271 K 15 X7R F VB	2222 731 06271	2.54
CW 15 C 271 M	K 271 M 15 X7R F VB	2222 731 07271	2.54
CW 15 C 331 K	K 331 K 15 X7R F VB	2222 731 06331	2.54
CW 15 C 331 M	K 331 M 15 X7R F VB	2222 731 07331	2.54
CW 15 C 391 K	K 391 K 15 X7R F VB	2222 731 06391	2.54
CW 15 C 391 M	K 391 M 15 X7R F VB	2222 731 07391	2.54
CW 15 C 471 K	K 471 K 15 X7R F VB	2222 731 06471	2.54
CW 15 C 471 M	K 471 M 15 X7R F VB	2222 731 07471	2.54
CW 15 C 561 K	K 561 K 15 X7R F VB	2222 731 06561	2.54
CW 15 C 681 K	K 681 K 15 X7R F VB	2222 731 06681	2.54
CW 15 C 681 M	K 681 M 15 X7R F VB	2222 731 07681	2.54
CW 15 C 821 K	K 821 K 15 X7R F VB	2222 731 06821	2.54
CW 15 C 821 M	K 821 M 15 X7R F VB	2222 731 07821	2.54
CW 15 C 102 K	K 102 K 15 X7R F VB	2222 731 06102	2.54
CW 15 C 102 M	K 102 M 15 X7R F VB	2222 731 07102	2.54

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DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CW 15 C 122 K	K 122 K 15 X7R F VB	2222 731 06122	2.54
CW 15 C 152 K	K 152 K 15 X7R F VB	2222 731 06152	2.54
CW 15 C 182 K	K 182 K 15 X7R F VB	2222 731 06182	2.54
CW 15 C 222 K	K 222 K 15 X7R F VB	2222 731 06222	2.54
CW 15 C 222 M	K 222 M 15 X7R F VB	2222 731 07222	2.54
CW 15 C 272 K	K 272 K 15 X7R F VB	2222 731 06272	2.54
CW 15 C 272 M	K 272 M 15 X7R F VB	2222 731 07272	2.54
CW 15 C 332 K	K 332 K 15 X7R F VB	2222 731 06332	2.54
CW 15 C 332 M	K 332 M 15 X7R F VB	2222 731 07332	2.54
CW 15 C 392 K	K 392 K 15 X7R F VB	2222 731 06392	2.54
CW 15 C 472 K	K 472 K 15 X7R F VB	2222 731 06472	2.54
CW 15 C 472 M	K 472 M 15 X7R F VB	2222 731 07472	2.54
CW 15 C 562 K	K 562 K 15 X7R F VB	2222 731 06562	2.54
CW 15 C 562 M	K 562 M 15 X7R F VB	2222 731 07562	2.54
CW 15 C 682 K	K 682 K 15 X7R F VB	2222 731 06682	2.54
CW 15 C 682 M	K 682 M 15 X7R F VB	2222 731 07682	2.54
CW 15 C 822 K	K 822 K 15 X7R F VB	2222 731 06822	2.54
CW 15 C 822 M	K 822 M 15 X7R F VB	2222 731 07822	2.54
CW 15 C 103 K	K 103 K 15 X7R F VB	2222 731 06103	2.54
CW 15 C 103 M	K 103 M 15 X7R F VB	2222 731 07103	2.54
CW 15 C 153 K	K 153 K 15 X7R F VB	2222 731 06153	2.54
CW 15 C 153 M	K 153 M 15 X7R F VB	2222 731 07153	2.54
CW 20 C 183 K	K 183 K 15 X7R F VB	2222 731 06183	2.54
CW 20 C 183 M	K 183 M 15 X7R F VB	2222 731 07183	2.54
CW 20 C 223 K	K 223 K 15 X7R F VB	2222 731 06223	2.54
CW 20 C 223 M	K 223 M 15 X7R F VB	2222 731 07223	2.54
CW 20 C 273 K	K 273 K 15 X7R F VB	2222 731 06273	2.54
CW 20 C 273 M	K 273 M 15 X7R F VB	2222 731 07273	2.54
CW 20 C 333 K	K 333 K 15 X7R F VB	2222 731 06333	2.54
CW 20 C 333 M	K 333 M 15 X7R F VB	2222 731 07333	2.54
CW 20 C 393 K	K 393 K 20 X7R F VB	2222 731 06393	2.54
CW 20 C 473 K	K 473 K 20 X7R F VB	2222 731 06473	2.54
CW 20 C 473 M	K 473 M 20 X7R F VB	2222 731 07473	2.54
CW 20 C 563 K	K 563 K 20 X7R F VB	2222 731 06563	2.54
CW 20 C 563 M	K 563 M 20 X7R F VB	2222 731 07563	2.54
CW 20 C 683 K	K 683 K 20 X7R F VB	2222 731 06683	2.54
CW 20 C 683 M	K 683 M 20 X7R F VB	2222 731 07683	2.54
CW 20 C 823 K	K 823 K 20 X7R F VB	2222 731 06823	2.54
CW 20 C 104 K	K 104 K 20 X7R F VB	2222 731 06104	2.54
CW 20 C 104 M	K 104 M 20 X7R F VB	2222 731 07104	2.54

Leaded ceramic multilayer capacitors

Cross reference selection guide

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CW 30 C 124 K	K 124 K 20 X7R F VC	2222 731 18124	5.08
CW 30 C 124 M	K 124 M 20 X7R F VC	2222 731 19124	5.08
CW 30 C 154 K	K 154 K 20 X7R F VC	2222 731 18154	5.08
CW 30 C 154 M	K 154 M 20 X7R F VC	2222 731 19154	5.08
CW 30 C 184 K	K 184 K 20 X7R F VC	2222 731 18184	5.08
CW 30 C 184 M	K 184 M 20 X7R F VC	2222 731 19184	5.08
CW 30 C 224 K	K 224 K 20 X7R F VC	2222 731 18224	5.08
CW 30 C 224 M	K 224 M 20 X7R F VC	2222 731 19224	5.08
CW 30 C 274 K	K 274 K 30 X7R F VC	2222 731 18274	5.08
CW 30 C 274 M	K 274 M 30 X7R F VC	2222 731 19274	5.08
CW 30 C 334 K	K 334 K 30 X7R F VC	2222 731 18334	5.08
CW 30 C 334 M	K 334 M 30 X7R F VC	2222 731 19334	5.08
CW 30 C 394 K	K 394 K 30 X7R F VC	2222 731 18394	5.08
CW 30 C 474 K	K 474 K 30 X7R F VC	2222 731 18474	5.08
CW 30 C 474 M	K 474 M 30 X7R F VC	2222 731 19474	5.08
CW 40 C 564 M	K 564 M 30 X7R F VC	2222 731 19564	5.08
CW 40 C 684 K	K 684 K 30 X7R F VC	2222 731 18684	5.08
CW 40 C 824 M	K 824 M 30 X7R F VC	2222 731 19824	5.08
CW 40 C 105 K	K 105 K 30 X7R F VC	2222 731 18105	5.08
CW 40 C 105 M	K 105 M 30 X7R F VC	2222 731 19105	5.08
CW 15 C 151 K DRM	K 151 K 15 X7R F TT	2222 731 22151	5.08
CW 15 C 181 K DRM	K 181 K 15 X7R F TT	2222 731 22181	5.08
CW 15 C 181 M DRM	K 181 M 15 X7R F TT	2222 731 23181	5.08
CW 15 C 221 K DRM	K 221 K 15 X7R F TT	2222 731 22221	5.08
CW 15 C 271 K DRM	K 271 K 15 X7R F TT	2222 731 22271	5.08
CW 15 C 271 M DRM	K 271 M 15 X7R F TT	2222 731 23271	5.08
CW 15 C 331 K DRM	K 331 K 15 X7R F TT	2222 731 22331	5.08
CW 15 C 331 M DRM	K 331 M 15 X7R F TT	2222 731 23331	5.08
CW 15 C 391 K DRM	K 391 K 15 X7R F TT	2222 731 22391	5.08
CW 15 C 391 M DRM	K 391 M 15 X7R F TT	2222 731 23391	5.08
CW 15 C 471 K DRM	K 471 K 15 X7R F TT	2222 731 22471	5.08
CW 15 C 471 M DRM	K 471 M 15 X7R F TT	2222 731 23471	5.08
CW 15 C 561 K DRM	K 561 K 15 X7R F TT	2222 731 22561	5.08
CW 15 C 681 K DRM	K 681 K 15 X7R F TT	2222 731 22681	5.08
CW 15 C 681 M DRM	K 681 M 15 X7R F TT	2222 731 23681	5.08
CW 15 C 821 K DRM	K 821 K 15 X7R F TT	2222 731 22821	5.08
CW 15 C 821 M DRM	K 821 M 15 X7R F TT	2222 731 23821	5.08
CW 15 C 102 K DRM	K 102 K 15 X7R F TT	2222 731 22102	5.08
CW 15 C 102 M DRM	K 102 M 15 X7R F TT	2222 731 23102	5.08
CW 15 C 122 K DRM	K 122 K 15 X7R F TT	2222 731 22122	5.08

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DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CW 15 C 152 K DRM	K 152 K 15 X7R F TT	2222 731 22152	5.08
CW 15 C 182 K DRM	K 182 K 15 X7R F TT	2222 731 22182	5.08
CW 15 C 222 K DRM	K 222 K 15 X7R F TT	2222 731 22222	5.08
CW 15 C 222 M DRM	K 222 M 15 X7R F TT	2222 731 23222	5.08
CW 15 C 272 K DRM	K 272 K 15 X7R F TT	2222 731 22272	5.08
CW 15 C 272 M DRM	K 272 M 15 X7R F TT	2222 731 23272	5.08
CW 15 C 332 K DRM	K 332 K 15 X7R F TT	2222 731 22332	5.08
CW 15 C 332 M DRM	K 332 M 15 X7R F TT	2222 731 23332	5.08
CW 15 C 392 K DRM	K 392 K 15 X7R F TT	2222 731 22392	5.08
CW 15 C 472 K DRM	K 472 K 15 X7R F TT	2222 731 22472	5.08
CW 15 C 472 M DRM	K 472 M 15 X7R F TT	2222 731 23472	5.08
CW 15 C 562 K DRM	K 562 K 15 X7R F TT	2222 731 22562	5.08
CW 15 C 562 M DRM	K 562 M 15 X7R F TT	2222 731 23562	5.08
CW 15 C 682 K DRM	K 682 K 15 X7R F TT	2222 731 22682	5.08
CW 15 C 682 M DRM	K 682 M 15 X7R F TT	2222 731 23682	5.08
CW 15 C 822 K DRM	K 822 K 15 X7R F TT	2222 731 22822	5.08
CW 15 C 822 M DRM	K 822 M 15 X7R F TT	2222 731 23822	5.08
CW 15 C 103 K DRM	K 103 K 15 X7R F TT	2222 731 22103	5.08
CW 15 C 103 M DRM	K 103 M 15 X7R F TT	2222 731 23103	5.08
CW 15 C 153 K DRM	K 153 K 15 X7R F TT	2222 731 22153	5.08
CW 15 C 153 M DRM	K 153 M 15 X7R F TT	2222 731 23153	5.08
CW 20 C 183 K DRM	K 183 K 15 X7R F TT	2222 731 22183	5.08
CW 20 C 183 M DRM	K 183 M 15 X7R F TT	2222 731 23183	5.08
CW 20 C 223 K DRM	K 223 K 15 X7R F TT	2222 731 22223	5.08
CW 20 C 223 M DRM	K 223 M 15 X7R F TT	2222 731 23223	5.08
CW 20 C 273 K DRM	K 273 K 15 X7R F TT	2222 731 22273	5.08
CW 20 C 273 M DRM	K 273 M 15 X7R F TT	2222 731 23273	5.08
CW 20 C 333 K DRM	K 333 K 15 X7R F TT	2222 731 22333	5.08
CW 20 C 333 M DRM	K 333 M 15 X7R F TT	2222 731 23333	5.08
CW 20 C 393 K DRM	K 393 K 20 X7R F TT	2222 731 22393	5.08
CW 20 C 473 K DRM	K 473 K 20 X7R F TT	2222 731 22473	5.08
CW 20 C 473 M DRM	K 473 M 20 X7R F TT	2222 731 23473	5.08
CW 20 C 563 K DRM	K 563 K 20 X7R F TT	2222 731 22563	5.08
CW 20 C 563 M DRM	K 563 M 20 X7R F TT	2222 731 23563	5.08
CW 20 C 683 K DRM	K 683 K 20 X7R F TT	2222 731 22683	5.08
CW 20 C 683 M DRM	K 683 M 20 X7R F TT	2222 731 23683	5.08
CW 20 C 823 K DRM	K 823 K 20 X7R F TT	2222 731 22823	5.08
CW 20 C 104 K DRM	K 104 K 20 X7R F TT	2222 731 22104	5.08
CW 20 C 104 M DRM	K 104 M 20 X7R F TT	2222 731 23104	5.08
CW 30 C 124 K DRM	K 124 K 20 X7R F TT	2222 731 22124	5.08

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CW 30 C 124 M DRM	K 124 M 20 X7R F TT	2222 731 23124	5.08
CW 30 C 154 K DRM	K 154 K 20 X7R F TT	2222 731 22154	5.08
CW 30 C 154 M DRM	K 154 M 20 X7R F TT	2222 731 23154	5.08
CW 30 C 184 K DRM	K 184 K 20 X7R F TT	2222 731 22184	5.08
CW 30 C 184 M DRM	K 184 M 20 X7R F TT	2222 731 23184	5.08
CW 30 C 224 K DRM	K 224 K 20 X7R F TT	2222 731 22224	5.08
CW 30 C 224 M DRM	K 224 M 20 X7R F TT	2222 731 23224	5.08
CW 30 C 274 K DRM	K 274 K 30 X7R F TT	2222 731 22274	5.08
CW 30 C 274 M DRM	K 274 M 30 X7R F TT	2222 731 23274	5.08
CW 30 C 334 K DRM	K 334 K 30 X7R F TT	2222 731 22334	5.08
CW 30 C 334 M DRM	K 334 M 30 X7R F TT	2222 731 23334	5.08
CW 30 C 394 K DRM	K 394 K 30 X7R F TT	2222 731 22394	5.08
CW 30 C 474 K DRM	K 474 K 30 X7R F TT	2222 731 22474	5.08
CW 30 C 474 M DRM	K 474 M 30 X7R F TT	2222 731 23474	5.08
CW 40 C 564 M DRM	K 564 M 30 X7R F TT	2222 731 23564	5.08
CW 40 C 684 K DRM	K 684 K 30 X7R F TT	2222 731 22684	5.08
CW 40 C 824 M DRM	K 824 M 30 X7R F TT	2222 731 23824	5.08
CW 40 C 105 K DRM	K 105 K 30 X7R F TT	2222 731 22105	5.08
CW 40 C 105 M DRM	K 105 M 30 X7R F TT	2222 731 23105	5.08

Note to Table 3

1. Only the first 13 digits of the 15-digit code are significant for cross reference purposes.

Table 4 Mono-kap™ conformal radials **X7R**, 10% and 20% tolerance, **100 V**.

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CW 15 A 151 K	K 151 K 15 X7R H VB	2222 731 38151	2.54
CW 15 A 151 M	K 151 M 15 X7R H VB	2222 731 39151	2.54
CW 15 A 181 K	K 181 K 15 X7R H VB	2222 731 38181	2.54
CW 15 A 221 K	K 221 K 15 X7R H VB	2222 731 38221	2.54
CW 15 A 221 M	K 221 M 15 X7R H VB	2222 731 39221	2.54
CW 15 A 271 K	K 271 K 15 X7R H VB	2222 731 38271	2.54
CW 15 A 331 K	K 331 K 15 X7R H VB	2222 731 38331	2.54
CW 15 A 331 M	K 331 M 15 X7R H VB	2222 731 39331	2.54
CW 15 A 391 K	K 391 K 15 X7R H VB	2222 731 38391	2.54
CW 15 A 391 M	K 391 M 15 X7R H VB	2222 731 39391	2.54
CW 15 A 471 K	K 471 K 15 X7R H VB	2222 731 38471	2.54
CW 15 A 471 M	K 471 M 15 X7R H VB	2222 731 39471	2.54
CW 15 A 561 K	K 561 K 15 X7R H VB	2222 731 38561	2.54
CW 15 A 561 M	K 561 M 15 X7R H VB	2222 731 39561	2.54
CW 15 A 681 K	K 681 K 15 X7R H VB	2222 731 38681	2.54

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DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CW 15 A 821 K	K 821 K 15 X7R H VB	2222 731 38821	2.54
CW 15 A 102 K	K 102 K 15 X7R H VB	2222 731 38102	2.54
CW 15 A 102 M	K 102 M 15 X7R H VB	2222 731 39102	2.54
CW 15 A 122 K	K 122 K 15 X7R H VB	2222 731 38122	2.54
CW 15 A 122 M	K 122 M 15 X7R H VB	2222 731 39122	2.54
CW 15 A 152 K	K 152 K 15 X7R H VB	2222 731 38152	2.54
CW 15 A 182 K	K 182 K 15 X7R H VB	2222 731 38182	2.54
CW 15 A 222 K	K 222 K 15 X7R H VB	2222 731 38222	2.54
CW 15 A 222 M	K 222 M 15 X7R H VB	2222 731 39222	2.54
CW 15 A 272 K	K 272 K 15 X7R H VB	2222 731 38272	2.54
CW 15 A 332 K	K 332 K 15 X7R H VB	2222 731 38332	2.54
CW 15 A 332 M	K 332 M 15 X7R H VB	2222 731 39332	2.54
CW 15 A 392 K	K 392 K 15 X7R H VB	2222 731 38392	2.54
CW 15 A 472 K	K 472 K 15 X7R H VB	2222 731 38472	2.54
CW 15 A 472 M	K 472 M 15 X7R H VB	2222 731 39472	2.54
CW 15 A 562 K	K 562 K 15 X7R H VB	2222 731 38562	2.54
CW 15 A 682 K	K 682 K 15 X7R H VB	2222 731 38682	2.54
CW 15 A 682 M	K 682 M 15 X7R H VB	2222 731 39682	2.54
CW 15 A 822 K	K 822 K 15 X7R H VB	2222 731 38822	2.54
CW 15 A 103 K	K 103 K 15 X7R H VB	2222 731 38103	2.54
CW 15 A 103 M	K 103 M 15 X7R H VB	2222 731 39103	2.54
CW 15 A 123 K	K 123 K 15 X7R H VB	2222 731 38123	2.54
CW 20 A 153 K	K 153 K 20 X7R H VB	2222 731 38153	2.54
CW 20 A 153 M	K 153 M 20 X7R H VB	2222 731 39153	2.54
CW 20 A 183 K	K 183 K 20 X7R H VB	2222 731 38183	2.54
CW 20 A 223 K	K 223 K 20 X7R H VB	2222 731 38223	2.54
CW 20 A 223 M	K 223 M 20 X7R H VB	2222 731 39223	2.54
CW 20 A 273 K	K 273 K 20 X7R H VB	2222 731 38273	2.54
CW 20 A 273 M	K 273 M 20 X7R H VB	2222 731 39273	2.54
CW 20 A 333 K	K 333 K 20 X7R H VB	2222 731 38333	2.54
CW 20 A 333 M	K 333 M 20 X7R H VB	2222 731 39333	2.54
CW 20 A 393 M	K 393 M 20 X7R H VB	2222 731 39393	2.54
CW 20 A 473 K	K 473 K 20 X7R H VB	2222 731 38473	2.54
CW 20 A 473 M	K 473 M 20 X7R H VB	2222 731 39473	2.54
CW 20 A 563 K	K 563 K 20 X7R H VB	2222 731 38563	2.54
CW 20 A 683 K	K 683 K 20 X7R H VB	2222 731 38683	2.54
CW 20 A 683 M	K 683 M 20 X7R H VB	2222 731 39683	2.54
CW 20 A 823 M	K 823 M 20 X7R H VB	2222 731 39823	2.54
CW 20 A 104 K	K 104 K 20 X7R H VB	2222 731 38104	2.54
CW 20 A 104 M	K 104 M 20 X7R H VB	2222 731 39104	2.54

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DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CW 30 A 124 K	K 124 K 30 X7R H VC	2222 731 50124	5.08
CW 30 A 124 M	K 124 M 30 X7R H VC	2222 731 51124	5.08
CW 30 A 224 K	K 224 K 30 X7R H VC	2222 731 50224	5.08
CW 30 A 224 M	K 224 M 30 X7R H VC	2222 731 51224	5.08
CW 30 A 334 K	K 334 K 30 X7R H VC	2222 731 50334	5.08
CW 15 A 151 K DRM	K 151 K 15 X7R H TT	2222 731 54151	5.08
CW 15 A 151 M DRM	K 151 M 15 X7R H TT	2222 731 55151	5.08
CW 15 A 181 K DRM	K 181 K 15 X7R H TT	2222 731 54181	5.08
CW 15 A 221 K DRM	K 221 K 15 X7R H TT	2222 731 54221	5.08
CW 15 A 221 M DRM	K 221 M 15 X7R H TT	2222 731 55221	5.08
CW 15 A 271 K DRM	K 271 K 15 X7R H TT	2222 731 54271	5.08
CW 15 A 331 K DRM	K 331 K 15 X7R H TT	2222 731 54331	5.08
CW 15 A 331 M DRM	K 331 M 15 X7R H TT	2222 731 55331	5.08
CW 15 A 391 K DRM	K 391 K 15 X7R H TT	2222 731 54391	5.08
CW 15 A 391 M DRM	K 391 M 15 X7R H TT	2222 731 55391	5.08
CW 15 A 471 K DRM	K 471 K 15 X7R H TT	2222 731 54471	5.08
CW 15 A 471 M DRM	K 471 M 15 X7R H TT	2222 731 55471	5.08
CW 15 A 561 K DRM	K 561 K 15 X7R H TT	2222 731 54561	5.08
CW 15 A 561 M DRM	K 561 M 15 X7R H TT	2222 731 55561	5.08
CW 15 A 681 K DRM	K 681 K 15 X7R H TT	2222 731 54681	5.08
CW 15 A 821 K DRM	K 821 K 15 X7R H TT	2222 731 54821	5.08
CW 15 A 102 K DRM	K 102 K 15 X7R H TT	2222 731 54102	5.08
CW 15 A 102 M DRM	K 102 M 15 X7R H TT	2222 731 55102	5.08
CW 15 A 122 K DRM	K 122 K 15 X7R H TT	2222 731 54122	5.08
CW 15 A 122 M DRM	K 122 M 15 X7R H TT	2222 731 55122	5.08
CW 15 A 152 K DRM	K 152 K 15 X7R H TT	2222 731 54152	5.08
CW 15 A 182 K DRM	K 182 K 15 X7R H TT	2222 731 54182	5.08
CW 15 A 222 K DRM	K 222 K 15 X7R H TT	2222 731 54222	5.08
CW 15 A 222 M DRM	K 222 M 15 X7R H TT	2222 731 55222	5.08
CW 15 A 272 K DRM	K 272 K 15 X7R H TT	2222 731 54272	5.08
CW 15 A 332 K DRM	K 332 K 15 X7R H TT	2222 731 54332	5.08
CW 15 A 332 M DRM	K 332 M 15 X7R H TT	2222 731 55332	5.08
CW 15 A 392 K DRM	K 392 K 15 X7R H TT	2222 731 54392	5.08
CW 15 A 472 K DRM	K 472 K 15 X7R H TT	2222 731 54472	5.08
CW 15 A 472 M DRM	K 472 M 15 X7R H TT	2222 731 55472	5.08
CW 15 A 562 K DRM	K 562 K 15 X7R H TT	2222 731 54562	5.08
CW 15 A 682 K DRM	K 682 K 15 X7R H TT	2222 731 54682	5.08
CW 15 A 682 M DRM	K 682 M 15 X7R H TT	2222 731 55682	5.08
CW 15 A 822 K DRM	K 822 K 15 X7R H TT	2222 731 54822	5.08
CW 15 A 103 K DRM	K 103 K 15 X7R H TT	2222 731 54103	5.08

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CW 15 A 103 M DRM	K 103 M 15 X7R H TT	2222 731 55103	5.08
CW 15 A 123 K DRM	K 123 K 15 X7R H TT	2222 731 54123	5.08
CW 20 A 153 K DRM	K 153 K 15 X7R H TT	2222 731 54153	5.08
CW 20 A 153 M DRM	K 153 M 15 X7R H TT	2222 731 55153	5.08
CW 20 A 183 K DRM	K 183 K 20 X7R H TT	2222 731 54183	5.08
CW 20 A 223 K DRM	K 223 K 20 X7R H TT	2222 731 54223	5.08
CW 20 A 223 M DRM	K 223 M 20 X7R H TT	2222 731 55223	5.08
CW 20 A 273 K DRM	K 273 K 20 X7R H TT	2222 731 54273	5.08
CW 20 A 273 M DRM	K 273 M 20 X7R H TT	2222 731 55273	5.08
CW 20 A 333 K DRM	K 333 K 20 X7R H TT	2222 731 54333	5.08
CW 20 A 333 M DRM	K 333 M 20 X7R H TT	2222 731 55333	5.08
CW 20 A 393 M DRM	K 393 M 20 X7R H TT	2222 731 55393	5.08
CW 20 A 473 K DRM	K 473 K 20 X7R H TT	2222 731 54473	5.08
CW 20 A 473 M DRM	K 473 M 20 X7R H TT	2222 731 55473	5.08
CW 20 A 563 K DRM	K 563 K 20 X7R H TT	2222 731 54563	5.08
CW 20 A 683 K DRM	K 683 K 20 X7R H TT	2222 731 54683	5.08
CW 20 A 683 M DRM	K 683 M 20 X7R H TT	2222 731 55683	5.08
CW 20 A 823 M DRM	K 823 M 20 X7R H TT	2222 731 55823	5.08
CW 20 A 104 K DRM	K 104 K 20 X7R H TT	2222 731 54104	5.08
CW 20 A 104 M DRM	K 104 M 20 X7R H TT	2222 731 55104	5.08
CW 30 A 124 K DRM	K 124 K 30 X7R H TT	2222 731 54124	5.08
CW 30 A 124 M DRM	K 124 M 30 X7R H TT	2222 731 55124	5.08
CW 30 A 224 K DRM	K 224 K 30 X7R H TT	2222 731 54224	5.08
CW 30 A 224 M DRM	K 224 M 30 X7R H TT	2222 731 55224	5.08
CW 30 A 334 K DRM	K 334 K 30 X7R H TT	2222 731 54334	5.08

Note to Table 4

1. Only the first 13 digits of the 15-digit code are significant for cross reference purposes.

Table 5 Mono-kap™ conformal radials **Z5U**, ±20%; −20%/+80% tolerance, **50 V**.

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CZ 15 C 102 M	K 102 M 15 Z5U F VB	2222 733 07102	2.54
CZ 15 C 152 M	K 152 M 15 Z5U F VB	2222 733 07152	2.54
CZ 15 C 182 Z	K 182 Z 15 Z5U F VB	2222 733 08182	2.54
CZ 15 C 222 M	K 222 M 15 Z5U F VB	2222 733 07222	2.54
CZ 15 C 332 Z	K 332 Z 15 Z5U F VB	2222 733 08332	2.54
CZ 15 C 392 M	K 392 M 15 Z5U F VB	2222 733 07392	2.54
CZ 15 C 472 Z	K 472 Z 15 Z5U F VB	2222 733 08472	2.54
CZ 15 C 682 M	K 682 M 15 Z5U F VB	2222 733 07682	2.54
CZ 15 C 682 Z	K 682 Z 15 Z5U F VB	2222 733 08682	2.54

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DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CZ 15 C 822 M	K 822 M 15 Z5U F VB	2222 733 07822	2.54
CZ 15 C 103 M	K 103 M 15 Z5U F VB	2222 733 07103	2.54
CZ 15 C 103 Z	K 103 Z 15 Z5U F VB	2222 733 08103	2.54
CZ 15 C 123 M	K 123 M 15 Z5U F VB	2222 733 07123	2.54
CZ 15 C 123 Z	K 123 Z 15 Z5U F VB	2222 733 08123	2.54
CZ 15 C 183 M	K 183 M 15 Z5U F VB	2222 733 07183	2.54
CZ 15 C 223 M	K 223 M 15 Z5U F VB	2222 733 07223	2.54
CZ 15 C 223 Z	K 223 Z 15 Z5U F VB	2222 733 08223	2.54
CZ 15 C 273 M	K 273 M 15 Z5U F VB	2222 733 07273	2.54
CZ 15 C 333 M	K 333 M 15 Z5U F VB	2222 733 08333	2.54
CZ 15 C 333 Z	K 333 Z 15 Z5U F VB	2222 733 07333	2.54
CZ 20 C 473 M	K 473 M 15 Z5U F VB	2222 733 07473	2.54
CZ 20 C 473 Z	K 473 Z 15 Z5U F VB	2222 733 08473	2.54
CZ 20 C 683 M	K 683 M 15 Z5U F VB	2222 733 07683	2.54
CZ 20 C 683 Z	K 683 Z 15 Z5U F VB	2222 733 08683	2.54
CZ 20 C 104 M	K 104 M 15 Z5U F VB	2222 733 07104	2.54
CZ 20 C 104 Z	K 104 Z 15 Z5U F VB	2222 733 08104	2.54
CZ 20 C 124 M	K 124 M 20 Z5U F VB	2222 733 07124	2.54
CZ 20 C 154 M	K 154 M 20 Z5U F VB	2222 733 07154	2.54
CZ 20 C 154 Z	K 154 Z 20 Z5U F VB	2222 733 08154	2.54
CZ 20 C 184 M	K 184 M 20 Z5U F VB	2222 733 07184	2.54
CZ 20 C 224 M	K 224 M 20 Z5U F VB	2222 733 07224	2.54
CZ 20 C 224 Z	K 224 Z 20 Z5U F VB	2222 733 08224	2.54
CZ 20 C 334 M	K 334 M 20 Z5U F VB	2222 733 07334	2.54
CZ 30 C 474 M	K 474 M 30 Z5U F VC	2222 733 19474	5.08
CZ 30 C 474 Z	K 474 Z 30 Z5U F VC	2222 733 20474	5.08
CZ 30 C 684 M	K 684 M 30 Z5U F VC	2222 733 19684	5.08
CZ 30 C 824 M	K 824 M 30 Z5U F VC	2222 733 19824	5.08
CZ 30 C 105 M	K 105 M 30 Z5U F VC	2222 733 19105	5.08
CZ 30 C 105 Z	K 105 Z 30 Z5U F VC	2222 733 20105	5.08
CZ 15 C 102 M DRM	K 102 M 15 Z5U F TT	2222 733 23102	5.08
CZ 15 C 152 M DRM	K 152 M 15 Z5U F TT	2222 733 23152	5.08
CZ 15 C 182 Z DRM	K 182 Z 15 Z5U F TT	2222 733 24182	5.08
CZ 15 C 222 M DRM	K 222 M 15 Z5U F TT	2222 733 23222	5.08
CZ 15 C 332 Z DRM	K 332 Z 15 Z5U F TT	2222 733 24332	5.08
CZ 15 C 392 M DRM	K 392 M 15 Z5U F TT	2222 733 23392	5.08
CZ 15 C 472 Z DRM	K 472 Z 15 Z5U F TT	2222 733 24472	5.08
CZ 15 C 682 M DRM	K 682 M 15 Z5U F TT	2222 733 23682	5.08
CZ 15 C 682 Z DRM	K 682 Z 15 Z5U F TT	2222 733 24682	5.08
CZ 15 C 822 M DRM	K 822 M 15 Z5U F TT	2222 733 23822	5.08

Leaded ceramic multilayer capacitors

Cross reference selection guide

DISTRIBUTION PART NUMBER	15 DIGIT CODE[1]	12NC CODE	PITCH
CZ 15 C 103 M DRM	K 103 M 15 Z5U F TT	2222 733 23103	5.08
CZ 15 C 103 Z DRM	K 103 Z 15 Z5U F TT	2222 733 24103	5.08
CZ 15 C 123 M DRM	K 123 M 15 Z5U F TT	2222 733 23123	5.08
CZ 15 C 123 Z DRM	K 123 Z 15 Z5U F TT	2222 733 24123	5.08
CZ 15 C 183 M DRM	K 183 M 15 Z5U F TT	2222 733 23183	5.08
CZ 15 C 223 M DRM	K 223 M 15 Z5U F TT	2222 733 23223	5.08
CZ 15 C 223 Z DRM	K 223 Z 15 Z5U F TT	2222 733 24223	5.08
CZ 15 C 273 M DRM	K 273 M 15 Z5U F TT	2222 733 23273	5.08
CZ 15 C 333 M DRM	K 333 M 15 Z5U F TT	2222 733 23333	5.08
CZ 15 C 333 Z DRM	K 333 Z 15 Z5U F TT	2222 733 24333	5.08
CZ 20 C 473 M DRM	K 473 M 15 Z5U F TT	2222 733 23473	5.08
CZ 20 C 473 Z DRM	K 473 Z 15 Z5U F TT	2222 733 24473	5.08
CZ 20 C 683 M DRM	K 683 M 15 Z5U F TT	2222 733 23683	5.08
CZ 20 C 683 Z DRM	K 683 Z 15 Z5U F TT	2222 733 24683	5.08
CZ 20 C 104 M DRM	K 104 M 15 Z5U F TT	2222 733 23104	5.08
CZ 20 C 104 Z DRM	K 104 Z 15 Z5U F TT	2222 733 24104	5.08
CZ 20 C 124 M DRM	K 124 M 20 Z5U F TT	2222 733 23124	5.08
CZ 20 C 154 M DRM	K 154 M 20 Z5U F TT	2222 733 23154	5.08
CZ 20 C 154 Z DRM	K 154 Z 20 Z5U F TT	2222 733 24154	5.08
CZ 20 C 184 M DRM	K 184 M 20 Z5U F TT	2222 733 23184	5.08
CZ 20 C 224 M DRM	K 224 M 20 Z5U F TT	2222 733 23224	5.08
CZ 20 C 224 Z DRM	K 224 Z 20 Z5U F TT	2222 733 24224	5.08
CZ 20 C 334 M DRM	K 334 M 20 Z5U F TT	2222 733 23334	5.08
CZ 30 C 474 M DRM	K 474 M 30 Z5U F TT	2222 733 23474	5.08
CZ 30 C 474 Z DRM	K 474 Z 30 Z5U F TT	2222 733 24474	5.08
CZ 30 C 684 M DRM	K 684 M 30 Z5U F TT	2222 733 23684	5.08
CZ 30 C 824 M DRM	K 824 M 30 Z5U F TT	2222 733 23824	5.08
CZ 30 C 105 M DRM	K 105 M 30 Z5U F TT	2222 733 23105	5.08
CZ 30 C 105 Z DRM	K 105 Z 30 Z5U F TT	2222 733 24105	5.08

Note to Table 5

1. Only the first 13 digits of the 15-digit code are significant for cross reference purposes.

Table 6 Mono-kap™ conformal radials **Z5U**, ±20%; –20%/+80% tolerance, **100 V**.

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CZ 15 A 102 M	K 102 M 15 Z5U H VB	2222 733 39102	2.54
CZ 15 A 102 Z	K 102 Z 15 Z5U H VB	2222 733 40102	2.54
CZ 15 A 222 M	K 222 M 15 Z5U H VB	2222 733 39222	2.54
CZ 15 A 332 Z	K 332 Z 15 Z5U H VB	2222 733 40332	2.54
CZ 15 A 392 M	K 392 M 15 Z5U H VB	2222 733 39392	2.54
CZ 15 A 472 M	K 472 M 15 Z5U H VB	2222 733 39472	2.54
CZ 15 A 472 Z	K 472 Z 15 Z5U H VB	2222 733 40472	2.54
CZ 15 A 822 M	K 822 M 15 Z5U H VB	2222 733 39822	2.54
CZ 15 A 103 M	K 103 M 15 Z5U H VB	2222 733 39103	2.54
CZ 15 A 103 Z	K 103 Z 15 Z5U H VB	2222 733 40103	2.54
CZ 15 A 123 M	K 123 M 15 Z5U H VB	2222 733 39123	2.54
CZ 20 A 223 M	K 223 M 20 Z5U H VB	2222 733 39223	2.54
CZ 20 A 223 Z	K 223 Z 20 Z5U H VB	2222 733 40223	2.54
CZ 20 A 333 M	K 333 M 20 Z5U H VB	2222 733 39333	2.54
CZ 20 A 393 M	K 393 M 20 Z5U H VB	2222 733 39393	2.54
CZ 20 A 473 M	K 473 M 20 Z5U H VB	2222 733 39473	2.54
CZ 20 A 683 M	K 683 M 20 Z5U H VB	2222 733 39683	2.54
CZ 20 A 104 M	K 104 M 20 Z5U H VB	2222 733 39104	2.54
CZ 30 A 224 M	K 224 M 30 Z5U H VC	2222 733 51224	5.08
CZ 30 A 334 M	K 334 M 30 Z5U H VC	2222 733 51334	5.08
CZ 30 A 474 M	K 474 M 30 Z5U H VC	2222 733 51474	5.08
CZ 30 A 474 Z	K 474 Z 30 Z5U H VC	2222 733 52474	5.08
CZ 15 A 102 M DRM	K 102 M 15 Z5U H TT	2222 733 55102	5.08
CZ 15 A 102 Z DRM	K 102 Z 15 Z5U H TT	2222 733 56102	5.08
CZ 15 A 222 M DRM	K 222 M 15 Z5U H TT	2222 733 55222	5.08
CZ 15 A 332 Z DRM	K 332 Z 15 Z5U H TT	2222 733 56332	5.08
CZ 15 A 392 M DRM	K 392 M 15 Z5U H TT	2222 733 55392	5.08
CZ 15 A 472 M DRM	K 472 M 15 Z5U H TT	2222 733 55472	5.08
CZ 15 A 472 Z DRM	K 472 Z 15 Z5U H TT	2222 733 56472	5.08
CZ 15 A 822 M DRM	K 822 M 15 Z5U H TT	2222 733 55822	5.08
CZ 15 A 103 M DRM	K 103 M 15 Z5U H TT	2222 733 55103	5.08
CZ 15 A 103 Z DRM	K 103 Z 15 Z5U H TT	2222 733 56103	5.08
CZ 15 A 123 M DRM	K 123 M 15 Z5U H TT	2222 733 55123	5.08
CZ 20 A 223 M DRM	K 223 M 20 Z5U H TT	2222 733 55223	5.08
CZ 20 A 223 Z DRM	K 223 Z 20 Z5U H TT	2222 733 56223	5.08
CZ 20 A 333 M DRM	K 333 M 20 Z5U H TT	2222 733 55333	5.08
CZ 20 A 393 M DRM	K 393 M 20 Z5U H TT	2222 733 55393	5.08
CZ 20 A 473 M DRM	K 473 M 20 Z5U H TT	2222 733 55473	5.08
CZ 20 A 683 M DRM	K 683 M 20 Z5U H TT	2222 733 55683	5.08

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE	PITCH
CZ 20 A 104 M DRM	K 104 M 20 Z5U H TT	2222 733 55104	5.08
CZ 20 A 104 Z DRM	K 104 Z 20 Z5U H TT	2222 733 56104	5.08
CZ 20 A 124 M DRM	K 124 M 20 Z5U H TT	2222 733 55124	5.08
CZ 20 A 154 M DRM	K 154 M 30 Z5U H TT	2222 733 55154	5.08
CZ 30 A 224 M DRM	K 224 M 30 Z5U H TT	2222 733 55224	5.08
CZ 30 A 334 M DRM	K 334 M 30 Z5U H TT	2222 733 55334	5.08
CZ 30 A 474 M DRM	K 474 M 30 Z5U H TT	2222 733 55474	5.08
CZ 30 A 474 Z DRM	K 474 Z 30 Z5U H TT	2222 733 56474	5.08

Note to Table 6

1. Only the first 13 digits of the 15-digit code are significant for cross reference purposes.

Table 7 Mono-axial™ conformal axials **NP0 (COG)**, 5% tolerance, **50 V**.

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE
A 40 C 101 J DRM	A 101 J 15 COG F VV	2222 740 09101
A 40 C 151 J DRM	A 151 J 15COG F VV	2222 740 09151
A 40 C 181 J DRM	A 181 J 15 COG F VV	2222 740 09181
A 40 C 221 J DRM	A 221 J 15 COG F VV	2222 740 09221
A 40 C 331 J DRM	A 331 J 15 COG F VV	2222 740 09331
A 40 C 391 J DRM	A 391 J 15 COG F VV	2222 740 09391
A 40 C 471 J DRM	A 471 J 15 COG F VV	2222 740 09471
A 40 C 561 J DRM	A 561 J 15 COG F VV	2222 740 09561
A 40 C 681 J DRM	A 681 J 15 COG F VV	2222 740 09681
A 40 C 102 J DRM	A 102 J 15 COG F VV	2222 740 09102

Note

1. Only the first 13 digits of the 15-digit code are significant for cross reference purposes.

Table 8 Mono-axial™ conformal axials **NP0 (COG)**, 5% tolerance, **100 V**.

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE
A 40 A 100 J DRM	A 100 J 15 COG H VV	2222 740 41109
A 40 A 150 J DRM	A 150 J 15 COG H VV	2222 740 41159
A 40 A 180 J DRM	A 180 J 15 COG H VV	2222 740 41189
A 40 A 220 J DRM	A 220 J 15 COG H VV	2222 740 41229
A 40 A 270 J DRM	A 270 J 15 COG H VV	2222 740 41279
A 40 A 330 J DRM	A 330 J 15 COG H VV	2222 740 41339
A 40 A 470 J DRM	A 470 J 15 COG H VV	2222 740 41479
A 40 A 680 J DRM	A 680 J 15 COG H VV	2222 740 41689
A 40 A 820 J DRM	A 820 J 15 COG H VV	2222 740 41829

Note

1. Only the first 13 digits of the 15-digit code are significant for cross reference purposes.

Table 9 Mono-axial™ conformal axials **X7R**, 10% tolerance, **50 V**.

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE
A 41 C 332 K DRM	A 332 K 15 X7R F VV	2222 741 10332
A 41 C 472 K DRM	A 472 K 15 X7R F VV	2222 741 10472
A 41 C 103 K DRM	A 103 K 15 X7R F VV	2222 741 10103
A 41 C 153 K DRM	A 153 K 15 X7R F VV	2222 741 10153
A 41 C 223 K DRM	A 223 K 15 X7R F VV	2222 741 10223
A 41 C 333 K DRM	A 333 K 15 X7R F VV	2222 741 10333
A 41 C 473 K DRM	A 473 K 20 X7R F VV	2222 741 10473
A 41 C 563 K DRM	A 563 K 20 X7R F VV	2222 741 10563
A 41 C 104 K DRM	A 104 K 20 X7R F VV	2222 741 10104

Note

1. Only the first 13 digits of the 15-digit code are significant for cross reference purposes.

Table 10 Mono-axial™ conformal axials **X7R**, 10% tolerance, **100 V**.

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE
A 41 A 221 K DRM	A 221 K 15 X7R H VV	2222 741 42221
A 41 A 271 K DRM	A 271 K 15 X7R H VV	2222 741 42271
A 41 A 331 K DRM	A 331 K 15 X7R H VV	2222 741 42331
A 41 A 471 K DRM	A 471 K 15 X7R H VV	2222 741 42471
A 41 A 681 K DRM	A 681 K 15 X7R H VV	2222 741 42681
A 41 A 821 K DRM	A 821 K 15 X7R H VV	2222 741 42821
A 41 A 102 K DRM	A 102 K 15 X7R H VV	2222 741 42102
A 41 A 122 K DRM	A 122 K 15 X7R H VV	2222 741 42122
A 41 A 152 K DRM	A 152 K 15 X7R H VV	2222 741 42152
A 41 A 222 K DRM	A 222 K 15 X7R H VV	2222 741 42222

Note

1. Only the first 13 digits of the 15-digit code are significant for cross reference purposes.

Table 11 Mono-axial™ conformal axials **Z5U, M and Z** tolerance codes, **50 V**.

DISTRIBUTION PART NUMBER	15 DIGIT CODE(1)	12NC CODE
A 43 C 103 M DRM	A 103 M 15 Z5U F VV	2222 742 11103
A 43 C 103 Z DRM	A 103 Z 15 Z5U F VV	2222 742 12103
A 43 C 223 M DRM	A 223 M 15 Z5U F VV	2222 742 11223
A 43 C 333 M DRM	A 333 M 15 Z5U F VV	2222 742 11333
A 43 C 473 M DRM	A 473 M 15 Z5U F VV	2222 742 11473
A 43 C 473 Z DRM	A 473 Z 15 Z5U F VV	2222 742 12473
A 43 C 104 M DRM	A 104 M 15 Z5U F VV	2222 742 11104
A 43 C 104 Z DRM	A 104 Z 15 Z5U F VV	2222 742 12104
A 43 C 224 M DRM	A 224 M 20 Z5U F VV	2222 742 11224
A 43 C 224 Z DRM	A 224 Z 20 Z5U F VV	2222 742 12224
A 43 C 274 Z DRM	A 274 Z 30 Z5U F VV	2222 742 12274
A 43 C 334 M DRM	A 334 M 30 Z5U F VV	2222 742 11334
A 43 C 334 Z DRM	A 334 Z 30 Z5U F VV	2222 742 12334
A 43 C 474 Z DRM	A 474 Z 30 Z5U F VV	2222 742 12474

Note

1. Only the first 13 digits of the 15-digit code are significant for cross reference purposes.

MINIATURE CERAMIC PLATE CAPACITORS

NUMERICAL INDEX FOR MINIATURE CERAMIC PLATE CAPACITORS

Preferred types in **bold**.

12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	PITCH	LEAD FORM	PACKAGING	PAGE
629	01...	2F6 (K14000)	2	1000 to 47000	63	–	>15	1e	non-flanged	loose	227
	03...					–	>15	2e	non-flanged	loose	
	05...					–	6 +0/–2	1e	non-flanged	loose	
	06...					–	6 +0/–2	2e	non-flanged	loose	
	08...					–	>13	1e	**flanged**	loose	211
	09...					–	>13	2e	**flanged**	loose	
	18...					–	4 ±0.5	1e	**flanged**	loose	
	19...					–	4 ±0.5	2e	**flanged**	loose	
	51...					18.25	–	1e	**flanged**	tape and reel	
	53...					18.25	–	2e	**flanged**	tape and reel	
	61...					18.25	–	1e	**flanged**	ammopack	
	62...					16	–	1e	**flanged**	ammopack	
	63...					18.25	–	2e	**flanged**	ammopack	
	64...					16	–	2e	**flanged**	ammopack	
630	01...	2C2-2E1 (K2000)	2	180 to 6800	100	–	>15	1e	non-flanged	loose	227
	03...					–	>15	2e	non-flanged	loose	
	05...					–	6 +0/–2	1e	non-flanged	loose	
	06...					–	6 +0/–2	2e	non-flanged	loose	
	08...					–	>13	1e	**flanged**	loose	210
	09...					–	>13	2e	**flanged**	loose	
	18...					–	4 ±0.5	1e	**flanged**	loose	
	19...					–	4 ±0.5	2e	**flanged**	loose	
	51...					18.25	–	1e	**flanged**	tape and reel	
	53...					18.25	–	2e	**flanged**	tape and reel	
	61...					18.25	–	1e	**flanged**	ammopack	
	62...					16	–	1e	**flanged**	ammopack	
	63...					18.25	–	2e	**flanged**	ammopack	
	64...					16	–	2e	**flanged**	ammopack	

Numerical index for miniature ceramic plate capacitors

12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	PITCH	LEAD FORM	PACKAGING	PAGE
631	03/04...	P100	1	0.56 to 47	100	–	>15	1e	non-flanged	loose	224
	09/10...	NP0		1.8 to 220							
	27/28...	N075		3.9 to 120							
	33/34...	N150		3.9 to 220							
	39/40...	N220		3.9 to 150							
	45/46...	N330		4.7 to 180							
	51/52...	N470		6.8 to 220							
	57/58...	N750		3.9 to 330							
	70...	N1500		18 to 560							
638	03/04...	P100	1	0.56 to 47	100	–	>15	2e	non-flanged	loose	224
	09/10...	NP0		1.8 to 220							
	27/28...	N075		3.9 to 120							
	33/34...	N150		3.9 to 220							
	39/40...	N220		3.9 to 150							
	45/46...	N330		4.7 to 180							
	51/52...	N470		6.8 to 220							
	57/58...	N750		3.9 to 330							
	70....	N1500		18 to 560							

Numerical index for miniature ceramic plate capacitors

12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	PITCH	LEAD FORM	PACKAGING	PAGE
640	01...	2E2 (K5000)	2	1000 to 15000	100	–	>15	1e	non-flanged	loose	227
	03...					–	>15	2e	non-flanged	loose	
	05...					–	6 +0/–2	1e	non-flanged	loose	
	06...					–	6 +0/–2	2e	non-flanged	loose	
	08...					–	>13	1e	**flanged**	loose	211
	09...					–	>13	2e	**flanged**	loose	
	18...					–	4 ±0.5	1e	**flanged**	loose	
	19...					–	4 ±0.5	2e	**flanged**	loose	
	51...					18.25	–	1e	**flanged**	tape and reel	
	53...					18.25	–	2e	**flanged**	tape and reel	
	61...					18.25	–	1e	**flanged**	ammopack	
	62...					16	–	1e	**flanged**	ammopack	
	63...					18.25	–	2e	**flanged**	ammopack	
	64...					16	–	2e	**flanged**	ammopack	
641	03/04...	P100	1	0.56 to 47	100	–	6 +0/–2	1e	non-flanged	loose	224
	09/10...	NP0		1.8 to 220							
	27/28...	N075		3.9 to 120							
	33/34...	N150		3.9 to 220							
	39/40...	N220		3.9 to 150							
	45/46...	N330		4.7 to 180							
	51/52...	N470		6.8 to 220							
	57/58...	N750		3.9 to 330							
	70...	N1500		18 to 560							

Numerical index for miniature ceramic plate capacitors

12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	PITCH	LEAD FORM	PACKAGING	PAGE
642	03/04...	P100	1	0.56 to 47	100	–	6 +0/–2	2e	non-flanged	loose	224
	09/10...	NP0		1.8 to 220							
	27/28...	N075		3.9 to 120							
	33/34...	N150		3.9 to 220							
	39/40...	N220		3.9 to 150							
	45/46...	N330		4.7 to 180							
	51/52...	N470		6.8 to 220							
	57/58...	N750		3.9 to 330							
	70...	N1500		18 to 560							
650	03/04...	P100	1	0.47 to 33	500	–	>15	2e	non-flanged	loose	252
	09/10...	NP0		0.82 to 150							
	33/34...	N150		2.2 to 150							
	57/58...	N750		1.8 to 150							
	69/70...	N1500		8.2 to 330							
651	03/04...	P100	1	0.47 to 33	500	–	6 +0/–2	2e	non-flanged	loose	252
	09/10...	NP0		0.82 to 150							
	33/34...	N150		2.2 to 150							
	57/58...	N750		1.8 to 150							
	69/70...	N1500		8.2 to 330							
652	**03/04...**	P100	1	0.47 to 33	500	–	>13	2e	**flanged**	loose	231 to 237
	09/10...	NP0		0.82 to 150							
	33/34...	N150		2.2 to 150							
	57/58...	N750		1.8 to 150							
	69/70...	N1500		8.2 to 330							
653	**03/04...**	P100	1	0.47 to 33	500	–	4 ±0.5	2e	**flanged**	loose	231 to 237
	09/10...	NP0		0.82 to 150							
	33/34...	N150		2.2 to 150							
	57/58...	N750		1.8 to 150							
	69/70...	N1500		8.2 to 330							

Numerical index for miniature ceramic plate capacitors

12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	PITCH	LEAD FORM	PACKAGING	PAGE
654	**03/04...**	P100	1	0.47 to 33	500	18.25	–	2e	**flanged**	tape and reel	231 to 237
	09/10...	NP0		0.82 to 150							
	33/34...	N150		2.2 to 150							
	57/58...	N750		1.8 to 150							
	69/70...	N1500		8.2 to 330							
655	03...	2C2-2E1 (K2000)	2	100 to 4700	500	–	>15	2e	non-flanged	loose	255
	06...					–	6 +0/–2		non-flanged	loose	
	09...					–	>13		**flanged**	loose	242
	19...					–	4 ±0.5		**flanged**	loose	
	53...					18.25	–		**flanged**	tape and reel	
	63...					18.25	–		**flanged**	ammopack	
	64...					16	–		**flanged**	ammopack	
678	**03/04...**	P100	1	0.56 to 47	100	18.25	–	1e	**flanged**	tape and reel	197 to 205
	09/10...	NP0		1.8 to 220					**flanged**		
	27/28...	N075		3.9 to 120					flanged		
	33/34...	N150		3.9 to 220					**flanged**		
	39/40...	N220		3.9 to 150					flanged		
	45/46...	N330		4.7 to 180					flanged		
	51/52...	N470		6.8 to 220					flanged		
	57/58...	N750		3.9 to 330					**flanged**		
	70...	N1500		18 to 560					**flanged**		189
	90...	NP0		1 to 240					**flanged**		

12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	PITCH	LEAD FORM	PACKAGING	PAGE
679	**03/04...**	P100	1	0.56 to 47	100	18.25	–	2e	**flanged**	tape and reel	197 to 205
	09/10...	NP0		1.8 to 220					**flanged**		
	27/28...	N075		3.9 to 120					flanged		
	33/34...	N150		3.9 to 220					**flanged**		
	39/40...	N220		3.9 to 150					flanged		
	45/46...	N330		4.7 to 180					flanged		
	51/52...	N470		6.8 to 220					flanged		
	57/58...	N750		3.9 to 330					**flanged**		
	70...	N1500		18 to 560					**flanged**		
	90...	NP0		1 to 240					**flanged**		189
680	**03/04...**	P100	1	0.56 to 47	100	–	>13	1e	**flanged**	loose	197 to 205
	09/10...	NP0		1.8 to 220					**flanged**		
	27/28...	N075		3.9 to 120					flanged		
	33/34...	N150		3.9 to 220					**flanged**		
	39/40...	N220		3.9 to 150					flanged		
	45/46...	N330		4.7 to 180					flanged		
	51/52...	N470		6.8 to 220					flanged		
	57/58...	N750		3.9 to 330					**flanged**		
	70...	N1500		18 to 560					**flanged**		
	90...	NP0		1 to 240					**flanged**		189
681	**03/04...**	P100	1	0.56 to 47	100	–	>13	2e	**flanged**	loose	197 to 205
	09/10...	NP0		1.8 to 220					**flanged**		
	27/28...	N075		3.9 to 120					flanged		
	33/34...	N150		3.9 to 220					**flanged**		
	39/40...	N220		3.9 to 150					flanged		
	45/46...	N330		4.7 to 180					flanged		
	51/52...	N470		6.8 to 220					flanged		
	57/58...	N750		3.9 to 330					**flanged**		
	70...	N1500		18 to 560					**flanged**		
	90...	NP0		1 to 240					**flanged**		189

Numerical index for miniature ceramic plate capacitors

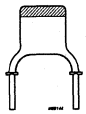
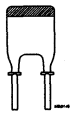
12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	PITCH	LEAD FORM	PACKAGING	PAGE
682	**03/04...**	P100	1	0.56 to 47	100	–	4 ±0.5	1e	**flanged**	loose	197 to 205
	09/10...	NP0		1.8 to 220					**flanged**		
	27/28...	N075		3.9 to 120					flanged		
	33/34...	N150		3.9 to 220					**flanged**		
	39/40...	N220		3.9 to 150					flanged		
	45/46...	N330		4.7 to 180					flanged		
	51/52...	N470		6.8 to 220					flanged		
	57/58...	N750		3.9 to 330					**flanged**		
	70...	N1500		18 to 560					**flanged**		
	90...	NP0		1 to 240					**flanged**		189
683	**03/04...**	P100	1	0.56 to 47	100	–	4 ±0.5	2e	**flanged**	loose	197 to 205
	09/10...	NP0		1.8 to 220					**flanged**		
	27/28...	N075		3.9 to 120					flanged		
	33/34...	N150		3.9 to 220					**flanged**		
	39/40...	N220		3.9 to 150					flanged		
	45/46...	N330		4.7 to 180					flanged		
	51/52...	N470		6.8 to 220					flanged		
	57/58...	N750		3.9 to 330					**flanged**		
	70...	N1500		18 to 560					**flanged**		
	90...	NP0		1 to 240					**flanged**		189
686	**03/04...**	P100	1	0.56 to 47	100	16	–	1e	**flanged**	ammopack	197 to 205
	09/10...	NP0		1.8 to 220					**flanged**		
	27/28...	N075		3.9 to 120					flanged		
	33/34...	N150		3.9 to 220					**flanged**		
	39/40...	N220		3.9 to 150					flanged		
	45/46...	N330		4.7 to 180					flanged		
	51/52...	N470		6.8 to 220					flanged		
	57/58...	N750		3.9 to 330					**flanged**		
	70...	N1500		18 to 560					**flanged**		
	90...	NP0		1 to 240					**flanged**		189

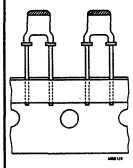
12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	PITCH	LEAD FORM	PACKAGING	PAGE
687	**03/04...**	P100	1	0.56 to 47	100	16	–	2e	**flanged**	ammopack	197 to 205
	09/10...	NP0		1.8 to 220					**flanged**		
	27/28...	N075		3.9 to 120					flanged		
	33/34...	N150		3.9 to 220					**flanged**		
	39/40...	N220		3.9 to 150					flanged		
	45/46...	N330		4.7 to 180					flanged		
	51/52...	N470		6.8 to 220					flanged		
	57/58...	N750		3.9 to 330					**flanged**		
	70...	N1500		18 to 560					**flanged**		
	90...	NP0		1 to 240					**flanged**		189
688	**03/04...**	P100	1	0.56 to 47	100	18.25	–	1e	**flanged**	ammopack	197 to 205
	09/10...	NP0		1.8 to 220					**flanged**		
	27/28...	N075		3.9 to 120					flanged		
	33/34...	N150		3.9 to 220					**flanged**		
	39/40...	N220		3.9 to 150					flanged		
	45/46...	N330		4.7 to 180					flanged		
	51/52...	N470		6.8 to 220					flanged		
	57/58...	N750		3.9 to 330					**flanged**		
	70...	N1500		18 to 560					**flanged**		
	90...	NP0		1 to 240					**flanged**		189
689	**03/04...**	P100	1	0.56 to 47	100	18.25	–	2e	**flanged**	ammopack	197 to 205
	09/10...	NP0		1.8 to 220					**flanged**		
	27/28...	N075		3.9 to 120					flanged		
	33/34...	N150		3.9 to 220					**flanged**		
	39/40...	N220		3.9 to 150					flanged		
	45/46...	N330		4.7 to 180					flanged		
	51/52...	N470		6.8 to 220					flanged		
	57/58...	N750		3.9 to 330					**flanged**		
	70...	N1500		18 to 560					**flanged**		
	90...	NP0		1 to 240					**flanged**		189

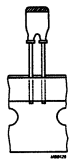
Numerical index for miniature ceramic plate capacitors

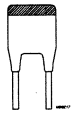
12 NC 2222		TC (or TK)	CLASS	CAPACITANCE RANGE (pF)	$U_{R(DC)}$ (V)	H_0 (mm)	LEAD LENGTH (mm)	PITCH	LEAD FORM	PACKAGING	PAGE
691	03/04...	P100	1	0.47 to 33	500	18.25	–	2e	flanged	ammopack	231 to 237
	09/10...	NP0		0.82 to 150							
	33/34...	N150		2.2 to 150							
	57/58...	N750		1.8 to 150							
	69/70...	N1500		8.2 to 330							
692	03/04...	P100	1	0.47 to 33	500	16	–	2e	flanged	ammopack	231 to 237
	09/10...	NP0		0.82 to 150							
	33/34...	N150		2.2 to 150							
	57/58...	N750		1.8 to 150							
	69/70...	N1500		8.2 to 330							
693	09...	2C2-2E1 (K2000)	2	100 to 1200	1000	–	>13	2e	flanged	loose	265
	19...					–	4 ±0.5			loose	
	53...					18.25	–			tape and reel	
	63...					18.25	–			ammopack	
	64...					16	–			ammopack	
694	09...	SL	1	0.47 to 120	1000	–	>13	2e	flanged	loose	248
	19...					–	4 ±0.5			loose	
	53...					18.25	–			tape and reel	
	63...					18.25	–			ammopack	
	64...					16	–			ammopack	
695	09...	2E2 (K5000)	2	270 to 3300	1000	–	>13	2e	flanged	loose	260
	19...					–	4 ±0.5			loose	
	53...					18.25	–			tape and reel	
	63...					18.25	–			ammopack	
	64...					16	–			ammopack	

SELECTION GUIDE FOR MINIATURE CERAMIC PLATE CAPACITORS

PACKAGE OUTLINE	TYPICAL CIRCUITS	TARGET APPLICATION	CATALOGUE NUMBERS 2222 ,...	CAP. RANGE (pF)	CAP. TOL.	TC (or TK)	$U_{R(DC)}$ (V)	CLIMATIC CATEGORY	PAGE
Class 1, standard types, leads with flanges									
	high frequency; tuning; temperature compensation; precision clocking; high stability	general industrial; consumer; automotive	678 ..... to 683 .....; 688 .....; 689	0.56 to 560	±0.25 pF ±2%	P100; NP0; N075; N150; N220; N330; N470; N750; N1500	100	55/085/21	197 to 205; 189
	high frequency; SMPS; power supplies; temperature compensation; precision clocking; high stability	general industrial; consumer; automotive	652 ..... to 654 .....; 691 .....; 692	0.47 to 330	±0.25 pF ±2%	P100; NP0; N150; N750; N1500	500	55/085/21	231 to 237
	SMPS; HV systems; HV power supplies; high stability	high stress circuits; high stress automotive; professional circuits; measuring instruments	694 09...; 694 19...; 694 53...; 694 63...; 694 64...	0.47 to 120	±0.25 pF ±5%	SL	1000	55/085/21	248
Class 1, precision types, leads with flanges									
	high frequency; tuning; precision clocking; high stability	high stress circuits; high stress automotive	678 ..... to 683 .....; 688 .....; 689 .....; 678 ..... to 683 90...; 688 90...; 689 90...	0.82 to 240	±0.1 pF ±1%	NP0	100	55/125/56	197 to 205; 189
	SMPS; power supplies; high frequency; tuning; high stability	high stress circuits; high stress automotive	652 ..... to 654 90...; 691 90...; 692 90...; note 1	0.82 to 150	±0.1 pF ±1%	NP0	500	55/125/56	231 to 237

PACKAGE OUTLINE	TYPICAL CIRCUITS	TARGET APPLICATION	CATALOGUE NUMBERS 2222	CAP. RANGE (pF)	CAP. TOL.	TC (or TK)	$U_{R(DC)}$ (V)	CLIMATIC CATEGORY	PAGE
Class 2, leads with flanges									
	coupling/decoupling; filtering; high stability	high stress circuits; high stress automotive; professional circuits; measuring instruments	630 08...; 630 18...; 630 09...; 630 19...; 630 51...; 630 61...; 630 53...; 630 63...; 630 62...; 630 64...	180 to 6800	±10%	2C2-2E1 (K2000)	100	55/085/21; 55/125/56	210
	coupling/decoupling; filtering; medium stability	high stress circuits; high stress automotive; professional circuits; measuring instruments	640 08...; 640 18...; 640 09...; 640 19...; 640 51...; 640 61...; 640 53...; 640 63...; 640 62...; 640 64...	1000 to 15000	–20/+50%	2E2 (K5000)	100	55/085/21	211
	general purpose; coupling/decoupling; filtering; low stability	general industrial; consumer	629 08...; 629 18...; 629 09...; 629 19...; 629 51...; 629 61...; 629 53...; 629 63...; 629 62...; 629 64...	1000 to 47000	–20/+80%	2F6 (K14000)	63	10/055/21	211
	SMPS; HV systems; HV power supplies; coupling/decoupling; filtering; high stability	high stress circuits; high stress automotive; professional circuits; measuring instruments	655 09...; 655 19...; 655 53...; 655 63...; 655 64...	100 to 4700	±10%	2C2-2E1 (K2000)	500	55/085/21; 55/125/56	242

PACKAGE OUTLINE	TYPICAL CIRCUITS	TARGET APPLICATION	CATALOGUE NUMBERS 2222	CAP. RANGE (pF)	CAP. TOL.	TC (or TK)	$U_{R(DC)}$ (V)	CLIMATIC CATEGORY	PAGE
	SMPS; HV systems; HV power supplies; coupling/decoupling; filtering; high stability	high stress circuits; high stress automotive; professional circuits; measuring instruments	693 09...; 693 19...; 693 53...; 693 63...; 693 64...	100 to 1200	±10%	2C2-2E1 (K2000)	1000	55/085/21; 55/125/56	265
	SMPS; HV systems; HV power supplies; coupling/decoupling; filtering; medium stability	high stress circuits; high stress automotive; professional circuits; measuring instruments	695 09...; 695 19...; 695 53...; 695 63...; 695 64...	270 to 3300	±20%	2E2 (K5000)	1000	55/085/21	260
Class 1, standard types, leads without flanges									
	high frequency; tuning; temperature compensation; precision clocking; high stability	general industrial; consumer; automotive	631 .....; 638 .....; 641 .....; 642	0.56 to 560	±0.25 pF ±2%	P100; NP0; N075; N150; N220; N330; N470; N750; N1500	100	55/085/21	224
	high frequency; SMPS; power supplies; temperature compensation; precision clocking; high stability	general industrial; consumer; automotive	650 .....; 651	0.47 to 330	±0.25 pF ±2%	P100; NP0; N150; N750; N1500	500	55/085/21	252

PACKAGE OUTLINE	TYPICAL CIRCUITS	TARGET APPLICATION	CATALOGUE NUMBERS 2222	CAP. RANGE (pF)	CAP. TOL.	TC (or TK)	$U_{R(DC)}$ (V)	CLIMATIC CATEGORY	PAGE
Class 2, standard types, leads without flanges									
	coupling/decoupling; filtering; high stability	high stress circuits; high stress automotive; professional circuits; measuring instruments	630 01...; 630 05...; 630 03...; 630 06...	180 to 6800	±10%	2C2-2E1 (K2000)	100	55/085/21; 55/125/56	227
	coupling/decoupling; filtering; medium stability	high stress circuits; high stress automotive; professional circuits; measuring instruments	640 01...; 640 05...; 640 03...; 640 06...	1000 to 15000	–20/+50%	2E2 (K5000)	100	55/085/21	227
	general purpose; coupling/decoupling; filtering; low stability	general industrial; consumer	629 01...; 629 05...; 629 03...; 629 06...	1000 to 47000	–20/+80%	2F6 (K14000)	63	10/055/21	227
	SMPS; HV systems; HV power supplies; coupling/decoupling filtering; high stability	high stress circuits; high stress automotive; professional circuits; measuring instruments	655 03...; 655 06...	100 to 4700	±10%	2C2-2E1 (K2000)	500	55/085/21; 55/125/56	255

Note

1. Available on request.

Miniature ceramic plate capacitors — General

CURRENT AND MAINTENANCE TYPES

Current ceramic plate capacitors have leads provided with a flange. They are available in a wide variety of executions. The flange ensures excellent solderability and component height definition on the printed-circuit boards. 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.

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

COMPOSITION, COLOUR CODING AND MARKING

Tables 1 and 2 show the composition of the materials used in ceramic plate capacitors. Colour coding indicating the temperature coefficient or temperature dependency is given.

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: 1p0 = 1.0 pF, 22n = 22 nF.

Table 1 Class 1: ε_r = 6 up to 250; TC types.

TC TYPES		MATERIAL	COLOUR CODES	
CODE	VALUE		TC	BODY
P100	$+100 \times 10^{-6}$/K	$MgTiO_3$, Mg_2SiO_4	red-violet	grey
NP0	0×10^{-6}/K	$MgTiO_3$	black	
N075	-75×10^{-6}/K	$BaNd_2(Bi_2)Ti_5O_x + TiO_2$	red	
N150	-150×10^{-6}/K	$BaNd_2(Bi_2)Ti_5O_x + TiO_2$	orange	
N220	-220×10^{-6}/K	$BaNd_2(Bi_2)Ti_5O_x + TiO_2$	yellow	
N330	-330×10^{-6}/K	$BaNd_2(Bi_2)Ti_5O_x + TiO_2$	green	
N470	-470×10^{-6}/K	$BaNd_2(Bi_2)Ti_5O_x + TiO_2$	blue	
N750	-750×10^{-6}/K	TiO_2 + additions	violet	
N1500	-1500×10^{-6}/K	$CaTiO_3$ + additions	orange/orange	

Table 2 Class 2: ε_r > 250; high-K types.

ε_r VALUE	MATERIAL	COLOUR CODES	
		K-VALUE	BODY
ε_r = 2000	$Ba(Bi)TiO_3$	yellow	tan
ε_r = 5000	(Ba, Ca) (Ti, Zr) O_3 + additions	blue	
ε_r = 14000	(Ba, Ca) (Ti, Zr) O_3 + additions	green	

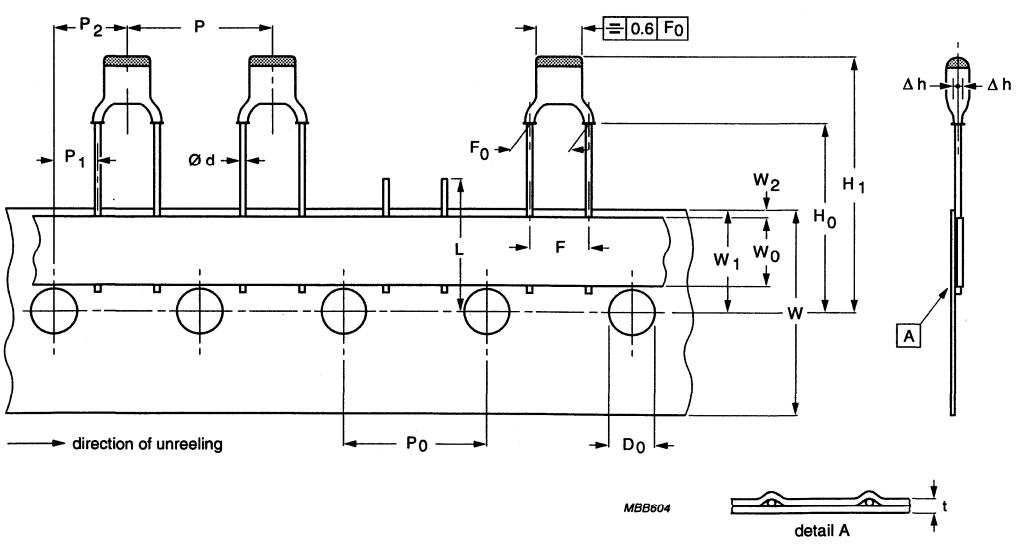
PACKAGING

The miniature ceramic plate capacitors are supplied in bulk packaging (cardboard boxes), in tape on reel or in ammopack (see Table 3).

Table 3 Packaging quantities.

SIZE CODE	QUANTITIES		
	BOX	REEL	AMMOPACK
I, IIA, IIB	1000	4000	4000
III, IV, V (with lead length ≤6 mm)	1000	–	–
III, IV, V (with lead length >6 mm)	500	4000	4000
III (500 V with lead length >6 mm)	500	4000	4000
IV, V (500 V with lead length >6 mm)	500	4000	2000
I, IIA, IIB, III, IV, V (1000 V with lead length >6 mm)	500	2000	2000
I, IIA, IIB, III, IV (1000 V with lead length ≤6 mm)	1000	–	–
V (1000 V with lead length ≤6 mm)	500	–	–

CAPACITORS ON TAPE, LEAD PITCH 5.08 mm (0.2 inch)



See Table 4 for dimensions.

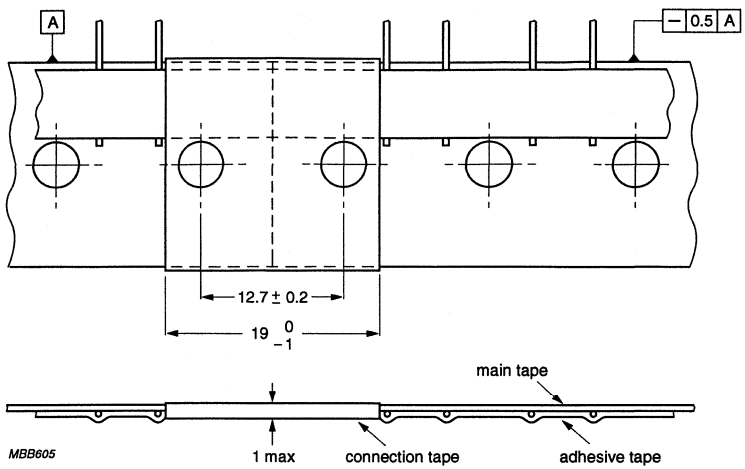
Fig.1 Capacitors, lead pitch 5.08 mm, on tape.

Table 4 Dimensions of tape (see Fig.1).

SYMBOL	PARAMETER	DIMENSIONS (mm)	
		NOMINAL	TOLERANCE
d	lead diameter	0.6	+0.6 −0.05
P	pitch between capacitors	12.7	±1.0
P_0	feed-hole pitch	12.7	±0.2; note 1
P_1	feed-hole centre to lead centre	3.85	±0.5; note 2
P_2	feed-hole centre to component centre	6.35	±1.0; note 2
F	lead-to-lead	5.0	+0.6 −0.2
F_0	lead-to-lead	5.08	+0.5 −0.1
Δh	component alignment	0	±1.0
W	tape width	18.0	±0.5
W_0	hold-down tape width	6.0	±0.5
W_1	hole position	9.0	±0.5
W_2	hold-down tape position	0	±2
H_0	flange to tape centre	18.25 (16.0); note 3	±0.5
H_1	maximum component height	31 (28.75); note 4	–
	minimum component height	22 (18.75); note 4	–
L	maximum length of snipped lead	11	–
D_0	feed-hole diameter	4.0	±0.2
t	total tape thickness	0.65	±0.2

Notes

1. Cumulative pitch error: ±≤1 mm/20 pitches.
2. Obliquity maximum 3°.
3. H_0 = 16 mm also available.
4. Values between parentheses are referred to component height when H_0 = 16 mm.



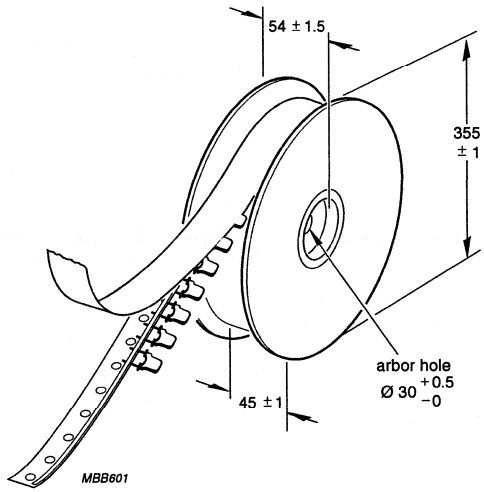
Dimensions in mm.

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.

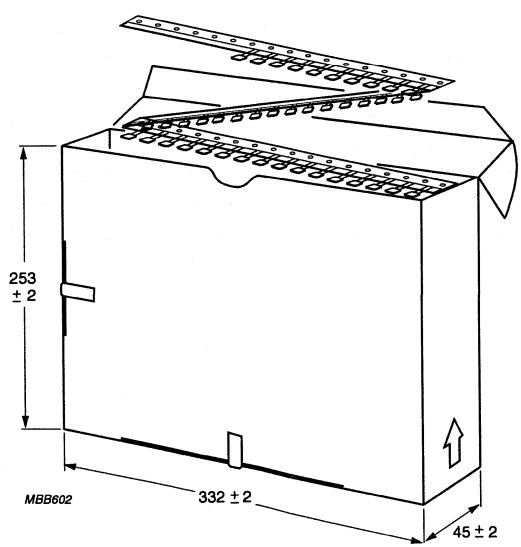
Table 5 Properties of the tape.

PARAMETER	TAPE PROPERTIES		
	MIN.	MAX.	UNIT
Extraction force for component in the tape plane, vertically to direction of unreeling	5	–	N
Break force of tape	15	–	N
Pull-off force main tape - reel	–	2.5	N



Dimensions in mm.

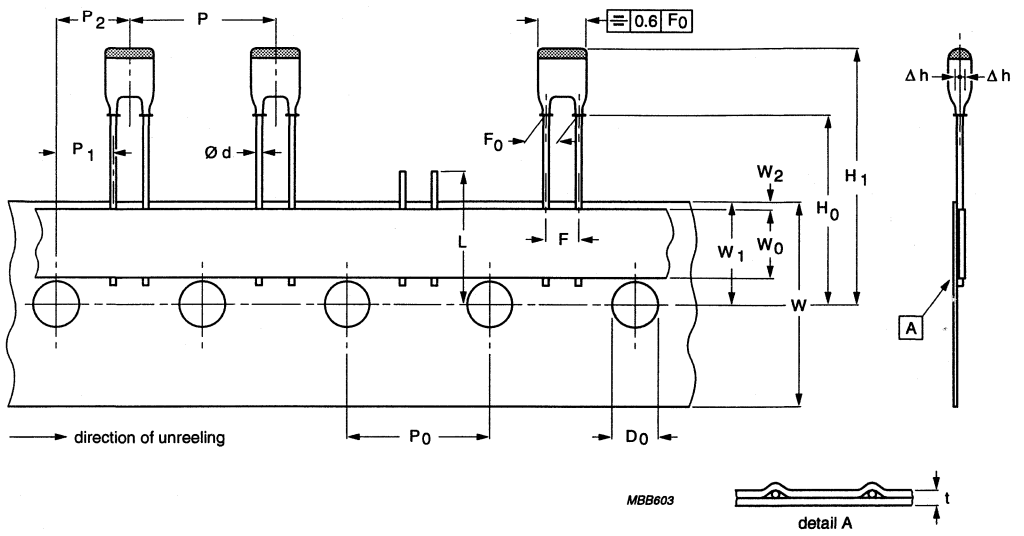
Fig.3 Reel with capacitors on tape.



Dimensions in mm.

Fig.4 Ammopack with capacitors on tape.

CAPACITORS ON TAPE, LEAD PITCH 2.54 mm (0.1 inch)



See Table 6 for dimensions.

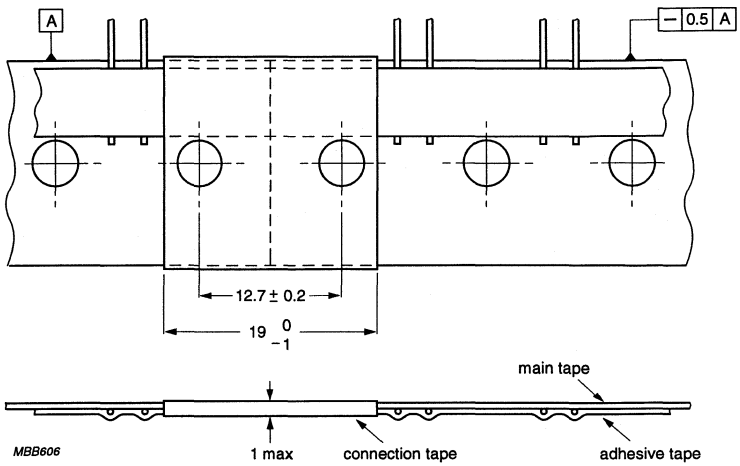
Fig.5 Capacitors, lead pitch 2.54 mm, on tape.

Table 6 Dimensions of tape (see Fig.5).

SYMBOL	PARAMETER	DIMENSIONS (mm)	
		NOMINAL	TOLERANCE
d	lead diameter	0.6	+0.6 −0.05
P	pitch between capacitors	12.7	±1.0
P_0	feed-hole pitch	12.7	±0.2; note 1
P_1	feed-hole centre to lead centre	5.1	±0.5; note 2
P_2	feed-hole centre to component centre	6.35	±1.0; note 2
F	lead-to-lead	2.54	±0.3
F_0	lead-to-lead	2.54	±0.3
Δh	component alignment	0	±1.0
W	tape width	18.0	±0.5
W_0	hold-down tape width	6.0	±0.5
W_1	hole position	9.0	±0.5
W_2	hold-down tape position	0	±2
H_0	flange to tape centre	18.25 (16.0); note 3	±0.5
H_1	maximum component height	30 (27.75); note 4	–
	minimum component height	21 (18.75); note 4	–
L	maximum length of snipped lead	11	–
D_0	feed-hole diameter	4.0	±0.2
t	total tape thickness	0.65	±0.2

Notes

1. Cumulative pitch error: ±≤1 mm/20 pitches.
2. Obliquity maximum 3°.
3. H_0 = 16 mm also available.
4. Values between parentheses are referred to component height when H_0 = 16 mm.



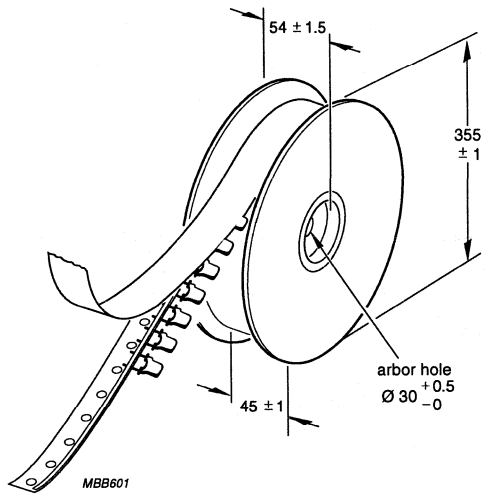
Dimensions in mm.

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.

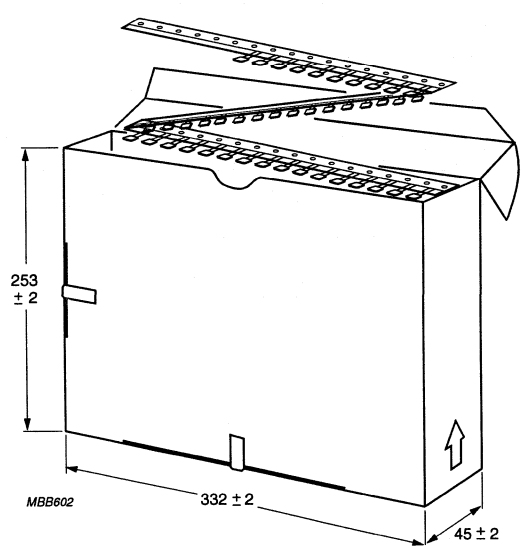
Table 7 Properties of the tape.

PARAMETER	TAPE PROPERTIES		
	MIN.	MAX.	UNIT
Extraction force for component in the tape plane, vertically to direction of unreeling	5	–	N
Break force of tape	15	–	N
Pull-off force main tape - reel	–	2.5	N



Dimensions in mm.

Fig.7 Reel with capacitors on tape.



Dimensions in mm.

Fig.8 Ammopack 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 in accordance with *"IEC publication 68"*.

Table 8

IEC 384-8 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.4		robustness of terminations:		
		pull-off	pull velocity 15 cm/minute; load 5 N	no lead breakage
	Ua_1	tensile strength	axial force 10 N	no lead breakage
	Ub	bending	load 5 N; 4 × 90°	no lead breakage
4.6	Ta method 1	solderability (solder bath)	235 °C; 2 s	good tinning
4.5	Tb method 1A	resistance to soldering heat	260 °C; 10 s	no visible damage ΔC/C: ±≤0.5% or ±0.5 pF after 1 to 2 hours
4.7	Na	rapid change of temperature	30 minutes at –55 °C and 30 minutes at +85 °C; 5 cycles	no damage, after 24 hours ΔC/C: ±≤0.5% or ±0.5 pF
4.8	Fc	vibration	10 to 55 to 10 Hz; 0.75 mm displacement; 3 directions; 6 hours	no visible damage
4.9	Eb	bump	4000 bumps in 2 directions; 40 g; pulse time 6 ms	no visible damage
		inflammability	15 s; 35 mm above bunsen burner with flame height 40 to 60 mm	self-extinguishing within 15 seconds after removal of bunsen burner
4.3		temperature coefficient	between +20 and –55 °C and between +20 and +85 °C	within tolerance as specified for each particular material

Miniature ceramic plate capacitors — General

IEC 384-8 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.11		climatic sequence:		
4.11.2	B	dry heat	16 hours; +85 °C	no visible damage
4.11.3	Db	damp heat (accelerated) 1st cycle	12 hours; +55 °C; 90 to 96% RH 12 hours; +25 °C; 95 to 100% RH	no visible damage; after recovery of 1 to 2 hours immediately followed by cold test
4.11.4	A	cold	2 hours; –55 °C	no visible damage
4.11.5	M	low air pressure	1 hour; 8.5 kPa, last 2 minutes rated voltage	no breakdown or flashover
4.11.6	Db	damp heat (accelerated) remaining cycle	12 hours; +55 °C; 90 to 96% RH 12 hours; +25 °C; 95 to 100% RH	$\Delta C/C$: $\pm \leq 1\%$ or ± 1 pF tan δ: $\leq 2 \times$ specified tan δ R_{ins} after 1 to 2 hours: >5000 MΩ for 2222 650 to 654; 691/692/694 >100 MΩ for other types
4.12	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% RH	$\Delta C/C$: $\pm \leq 1\%$ or ± 1 pF tan δ: $\leq 2 \times$ specified tan δ R_{ins} after 1 to 2 hours: >5000 MΩ for 2222 650 to 654/691/692/694 >100 MΩ for other types
4.13		endurance	1000 hours at +85 °C; 2222 694: 1500 V (DC) 2222 650 to 654/691/692: 750 V (DC) other types: 150 V (DC)	$\Delta C/C$: $\pm \leq 1\%$ or ± 1 pF tan δ: $\leq 1.5 \times$ specified tan δ R_{ins}: >3000 MΩ for 2222 650 to 654/691/692/694 >300 MΩ for other types
		resistance to solvents	3 minutes ultrasonic washing in trichloroethylene; 1 minute 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 1 precision capacitors NP0

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 55/125/56 (temperature range –55/+125 °C; damp heat, long term, 56 days) are carried out in accordance with *"IEC publication 68"*.

Table 9

IEC 384-8 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.4		robustness of terminations:		
		pull-off	pull velocity 15 cm/minute; load 5 N	no lead breakage
	Ua_1	tensile strength	axial force 10 N	no lead breakage
	Ub	bending	load 5 N; 4 × 90°	no lead breakage
4.6	Ta method 1	solderability (solder bath)	235 °C; 2 s	good tinning
4.5	Tb method 1A	resistance to soldering heat	260 °C; 10 s	no visible damage ΔC/C: ±≤0.5% or ±0.5 pF after 1 to 2 hours
4.7	Na	rapid change of temperature	30 minutes at –55 °C and 30 minutes at +125 °C; 5 cycles	no damage, after 24 hours ΔC/C: ±≤0.5% or ±0.5 pF
4.8	Fc	vibration	10 to 55 to 10 Hz; 0.75 mm displacement; 3 directions; 6 hours	no visible damage
4.9	Eb	bump	4000 bumps in 2 directions; 40 g; pulse time 6 ms	no visible damage
		inflammability	15 s; 35 mm above bunsen burner with flame height 40 to 60 mm	self-extinguishing within 15 seconds after removal of bunsen burner
4.3		temperature coefficient	between +20 and –55 °C and between +20 and +125 °C	within tolerance as specified

IEC 384-8 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.11		climatic sequence:		
4.11.2	B	dry heat	16 hours; +125 °C	no visible damage
4.11.3	Db	damp heat (accelerated) 1st cycle	12 hours; +55 °C; 90 to 96% RH 12 hours; +25 °C; 95 to 100% RH	no visible damage; after recovery of 1 to 2 hours immediately followed by cold test
4.11.4	A	cold	2 hours; −55 °C	no visible damage
4.11.5	M	low air pressure	1 hour; 8.5 kPa, last 2 minutes rated voltage	no breakdown or flashover
4.11.6	Db	damp heat (accelerated) remaining cycle	12 hours; +55 °C; 90 to 96% RH 12 hours; +25 °C; 95 to 100% RH	$\Delta C/C$: $\pm \leq 1\%$ or ± 1 pF whichever is greater tan δ: $\leq 2 \times$ specified tan δ R_{ins} after 1 to 2 hours: >1 000 MΩ
4.12	Ca	damp heat, steady state (half number of the lot at rated voltage, other half at zero voltage)	56 days; +40 °C; 90 to 95% RH	$\Delta C/C$: $\pm \leq 1\%$ or ± 1 pF whichever is greater tan δ: $\leq 2 \times$ specified tan δ R_{ins} after 1 to 2 hours: >1 000 MΩ
4.13		endurance	1 000 hours at +125 °C; 150 V (DC)	$\Delta C/C$: $\pm \leq 1\%$ or ± 1 pF whichever is greater tan δ: $\leq 1.5 \times$ specified tan δ R_{ins}: >3000 MΩ
		resistance to solvents	3 minutes ultrasonic washing in trichloroethylene; 1 minute 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 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 384-9"*, category as specified for each product family, are carried out in accordance with *"IEC publication 68"*.

Table 10

IEC 384-9 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.1		pre-conditioning	1 hour; +150 °C; reference measurement after 24 hours	
4.5		robustness of terminations:		
		pull-off	pull velocity 15 cm/minute; load 5 N	no lead breakage
	Ua_1	tensile strength	axial force 10 N	no lead breakage
	Ub	bending	load 5 N; 4 × 90°	no lead breakage
4.7	Ta method 1	solderability (solder bath)	235 °C; 2 s	good tinning
4.6	Tb method 1A	resistance to soldering heat	pre-conditioning: 260 °C; 10 s	no visible damage ΔC/C after 24 hours: 2222 630: ±≤10% 2222 629/640/695: ±≤20% 2222 655/693: ±10%
4.8	Na	rapid change of temperature	pre-conditioning: 2222 630/655/693/695: 30 minutes at –55 °C and 30 minutes at +85 °C (+125 °C for 630/655/693); 2222 629: 30 minutes at –10 °C and 30 minutes at +55 °C; 5 cycles	no damage ΔC/C after 24 hours: 2222 630/655/693: ±≤10% 2222 629/640/695: ±≤20%
4.9	Fb	vibration	10 to 55 to 10 Hz; 0.75 mm displacement; 3 directions; 6 hours	no visible damage
4.10	Eb	bump	4000 bumps in 2 directions; 40 g; pulse time 6 ms	no visible damage
		inflammability	15 s; 35 mm above bunsen burner with flame height 40 to 60 mm	self-extinguishing within 15 s after removal of bunsen burner
		resistance to solvents	3 minutes ultrasonic washing in trichloroethylene; 1 minute 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

IEC 384-9 CLAUSE	IEC 68-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.12		climatic sequence:		
4.12.1		pre-conditioning	1 hour; +150 °C	
4.12.2	Ba	dry heat	16 hours at +125 °C, +85 °C and +55 °C respectively for 2222 630/655/693; 640/695 and 629	no visible damage
4.12.3	Db	damp heat (accelerated) 1st cycle	12 hours; +55 °C; 90 to 96% RH 12 hours; +25 °C; 95 to 100% RH	no visible damage; after recovery of 1 to 2 hours immediately followed by cold test
4.12.4	Aa	cold	2222 630/640/655/693/695: 2 hours; −55 °C; 2222 629: 2 hours; −10 °C	no visible damage
4.12.5	M	low air pressure	1 hour at 8.5 kPa, last 2 minutes rated voltage	no breakdown or flashover
4.12.6	Db	damp heat (accelerated) remaining cycle	12 hours; +55 °C; 90 to 96% RH 12 hours; +25 °C; 95 to 100% RH	after 24 hours recovery: $\Delta C/C$: 2222 630/655/693: $\pm \leq 10\%$ 2222 629/640/695: $\pm \leq 20\%$ tan δ: $\leq 7\%$ R_{ins}: 2222 629/630/640: >100 MΩ 2222 655/693/695: >1000 MΩ
4.13	Ca	damp heat, steady state (half number of samples at rated voltage, other half of samples no voltage applied)	pre-conditioning: 21 days; +40 °C; 90 to 95% RH	no visible damage after 24 hours: $\Delta C/C$: 2222 630/655/693: $\pm \leq 10\%$ 2222 629/640/695: $\pm \leq 20\%$ tan δ: $\leq 7\%$ R_{ins}: 2222 629/630/640: >100 MΩ 2222 655/693/695: >1000 MΩ
4.14		endurance	pre-conditioning: 1000 hours (IEC) pre-conditioning: 2222 630: +125 °C; 150 V (DC) 2222 640: +85 °C; 150 V (DC 2222 629: +55 °C; 100 V (DC) 2222 655: +125 °C; 750 V (DC) 2222 693: +125 °C; 1500 V (DC) 2222 695: +85 °C; 1500 V (DC)	after 24 hours: $\Delta C/C$: 2222 630/655/693: $\pm \leq 10\%$ 2222 629/640/695: $\pm \leq 20\%$ tan δ: $\leq 5\%$ (2222 629: $\leq 6.5\%$) R_{ins}: 2222 629/630/640: >300 MΩ 2222 655/693/695: >1000 MΩ
4.4		temperature characteristic	pre-conditioning minimum and maximum temperature	in accordance with specification

PRODUCT DATA

Miniature ceramic plate capacitors Precision capacitors NP0

FEATURES

- High-frequency circuits
- High reliability
- High stability
- Space saving.

APPLICATIONS

In a great variety of electronic circuits, e.g. in filters, tuning circuits and other professional applications where high stability, precision, reliability and low losses are a requirement. Because of their small size the capacitors are suitable for use in circuitry with high component density. The high reliability even in most demanding environmental conditions make the product suitable for automotive, telecommunications and other electronic circuits used at high temperatures.

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized, and tinned connecting leads are secured using 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, which 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 very narrow tolerance on capacitance (±0.1 pF or 1%), high stability and, owing to the absence of silver, an extremely good DC behaviour.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Capacitance range	1 pF to 240 pF (E24 series)
Rated DC voltage	100 V; note 1
Tolerance on capacitance	$C \leq 10$ pF: ±0.1 pF $C > 10$ pF: ±1%
Sectional specification	IEC 384-8
Climatic category (IEC 68)	55/125/56

Note

1. 500 V available on request.

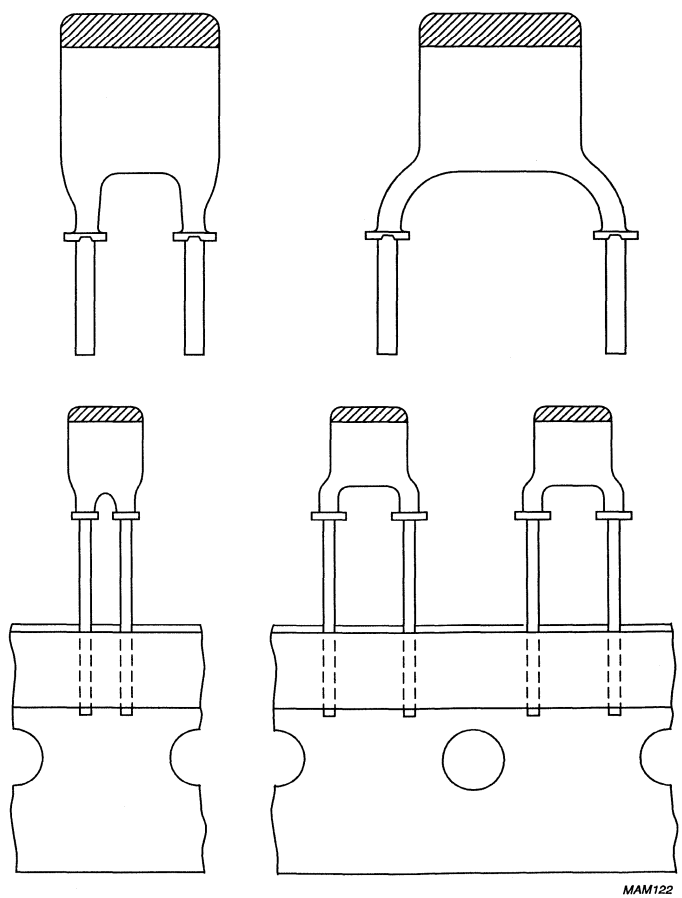
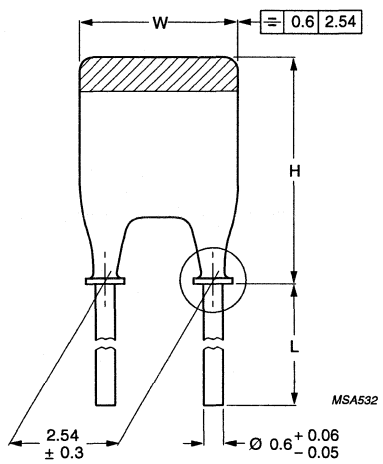


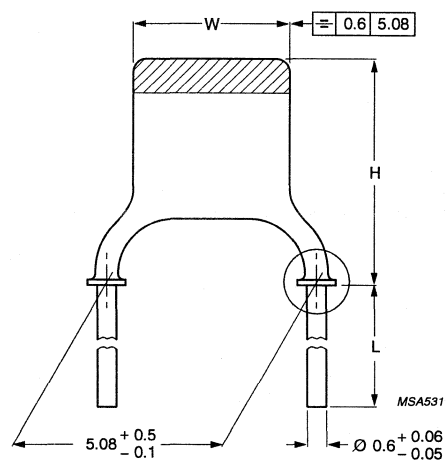
Fig.1 Outlines.

MECHANICAL DATA



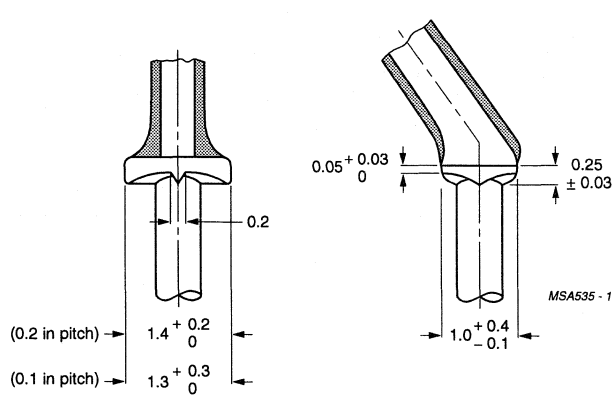
Dimensions in mm.
For dimensions H, L and W see Tables 1 and 2.

Fig.2 Component outline style 1.



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

Fig.3 Component outline style 2.



Dimensions in mm.

Fig.4 Detail of flange.

Marking

The temperature coefficient is indicated by a colour code in accordance with IEC and EIA recommendations. Capacitance value is indicated by a marking code in a contrasting colour on the body. Refer to Table 4, for marking codes.

Mounting

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

Soldering conditions:

max. 265 °C, max. 10 s.

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

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE[1]	W[2] (mm)	H[2] (mm)		MASS (g)
		STYLE 1	STYLE 2	
I	3.6 (–1.1)	5.0 (–1.5)	6.3 (–1.8)	≈0.14
IIA	3.9 (–1.4)	5.3 (–1.7)	6.7 (–2.0)	≈0.15
IIB	4.5 (–1.8)	6.0 (–2.1)	7.3 (–2.4)	≈0.15
III	5.3 (–1.8)	6.8 (–2.3)	8.1 (–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

Notes

1. Unless indicated in Table 4, the thickness of the capacitors does not exceed 2.3 mm.
2. Tolerances are given between parentheses.

PACKAGING

For details refer to the Chapter *"Miniature ceramic plate capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

PITCH P	LEAD DIAMETER d	STYLE	CATALOGUE NUMBERS[1]				
			BULK PACKED		ON TAPE[3] (REEL)	ON TAPE[2] (AMMOPACK)	ON TAPE[3] (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 686	2222 688 .....
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2	2222 681	2222 683	2222 679	2222 687	2222 689 .....

Notes

1. Catalogue number to be completed by adding the last 5 digits for required capacitance value, see Table 4.
2. H_0 = 16 mm.
3. H_0 = 18.25 mm.

Table 3 Conditions for Table 4; precision capacitors with temperature coefficient NP0, rated voltage 100 V (DC).

DESCRIPTION	VALUE
Capacitance range	1 to 240 pF (E24 series)
Temperature coefficient of the capacitance $\left(\frac{\Delta C}{C\Delta T}\right)$	0×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	black

Table 4 Precision capacitance range, temperature coefficient NP0.

CAPACITANCE VALUE[1] (pF)	TOLERANCE[1]	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
1.0	±0.1 pF	I[2]	1p0	90108
1.1	±0.1 pF	I	1p1	90118
1.2	±0.1 pF	I	1p2	90128
1.3	±0.1 pF	I	1p3	90138
1.5	±0.1 pF	I	1p5	90158
1.6	±0.1 pF	I	1p6	90168
1.8	±0.1 pF	I	1p8	90188
2.0	±0.1 pF	I	2p0	90208
2.2	±0.1 pF	I	2p2	90228
2.4	±0.1 pF	I	2p4	90248
2.7	±0.1 pF	I	2p7	90278
3.0	±0.1 pF	I	3p0	90308
3.3	±0.1 pF	I	3p3	90338
3.6	±0.1 pF	I	3p6	90368
3.9	±0.1 pF	I	3p9	90398
4.3	±0.1 pF	I	4p3	90438
4.7	±0.1 pF	I	4p7	90478
5.1	±0.1 pF	I	5p1	90518
5.6	±0.1 pF	I	5p6	90568
6.2	±0.1 pF	I	6p2	90628
6.8	±0.1 pF	I	6p8	90688
7.5	±0.1 pF	I	7p5	90758
8.2	±0.1 pF	I	8p2	90828
10	±0.1 pF	I	10p	90109
11	±1%	I	11p	90119
12	±1%	I	12p	90129
13	±1%	I	13p	90139
15	±1%	I	15p	90159
16	±1%	I	16p	90169

Miniature ceramic plate capacitors Precision capacitors NP0

CAPACITANCE VALUE[1] (pF)	TOLERANCE[1]	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
18	±1%	I	18p	90189
20	±1%	I	20p	90209
22	±1%	I	22p	90229
24	±1%	I	24p	90249
27	±1%	I	27p	90279
30	±1%	I	30p	90309
33	±1%	I	33p	90339
36	±1%	IIA	36p	90369
39	±1%	IIA	39p	90399
43	±1%	IIA	43p	90439
47	±1%	IIA	47p	90479
51	±1%	IIA	51p	90519
56	±1%	IIA	56p	90569
62	±1%	IIB	62p	90629
68	±1%	IIB	68p	90689
75	±1%	IIB	75p	90759
82	±1%	IIB	82p	90829
100	±1%	III	n10	90101
110	±1%	III	n11	90111
120	±1%	III	n12	90121
130	±1%	IV	n13	90131
150	±1%	IV	n15	90151
160	±1%	IV	n16	90161
180	±1%	IV	n18	90181
200	±1%	V	n20	90201
220	±1%	V	n22	90221
240	±1%	V	n24	90241

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 2.5 mm.

ELECTRICAL CHARACTERISTICS

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%.

DESCRIPTION	VALUE
Capacitance values (note 1) measured at 1 MHz, ≤5 V	see Table 4
Rated DC voltage	100 V
DC test voltage; duration 1 minute	300 V
DC test voltage of coating; duration 1 minute	300 V
Insulation resistance at 100 V (DC) after 1 minute	≥10000 MΩ
Tan δ (note 1) measured at 1 MHz, ≤5 V:	
$C \leq 50$ pF	$\leq 10\left(\frac{15}{C}+0.7\right)\times 10^{-4}$; $<20\times 10^{-4}$
$C > 50$ pF	$\leq 10\times 10^{-4}$
Category temperature range	−55 to +125 °C
Climatic category (IEC 68)	55/125/56

Note

1. Including 2 mm per connecting lead.

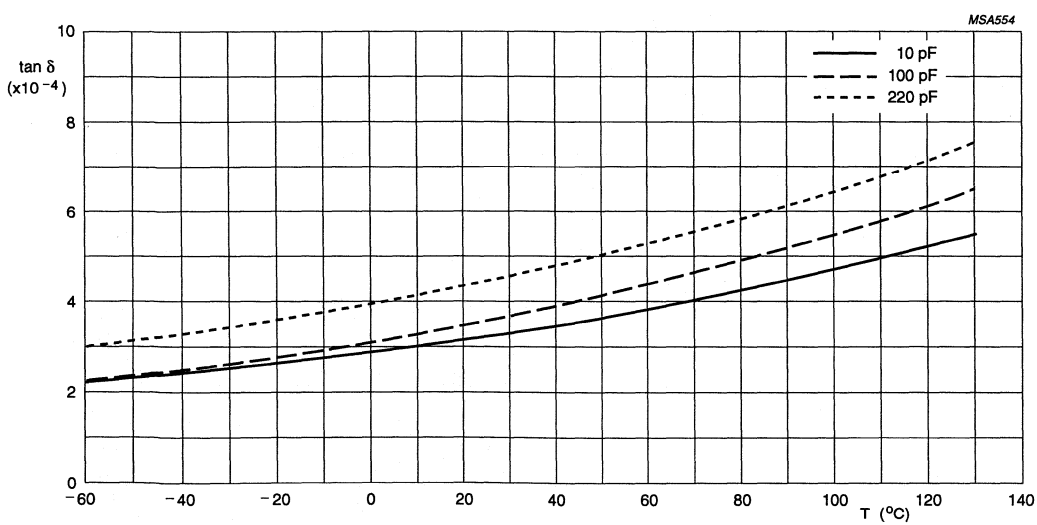
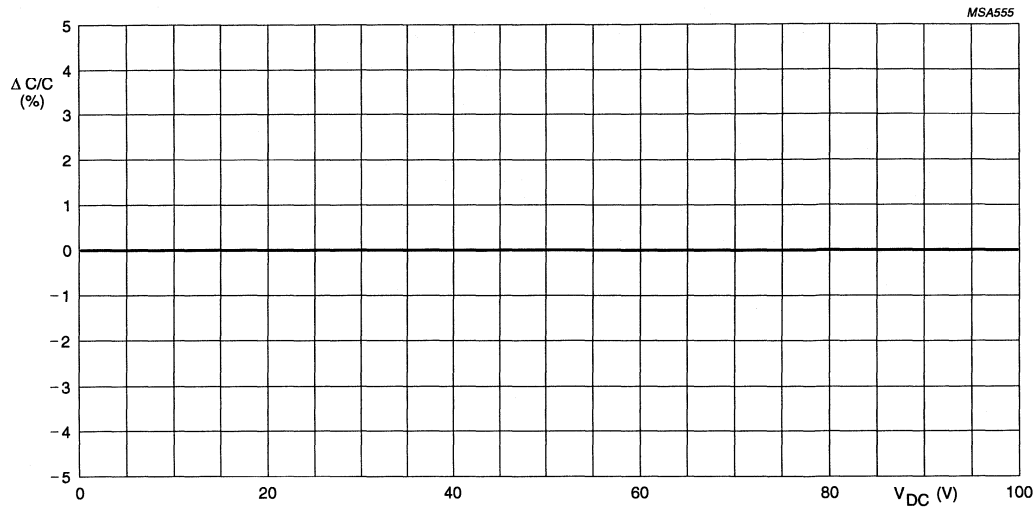


Fig.5 Typical tan δ as a function of temperature.



Reference values at 1 MHz.
Measurements made at 1 V, including 2 mm per connecting lead.

Fig.6 Typical capacitance change as function of DC voltage.

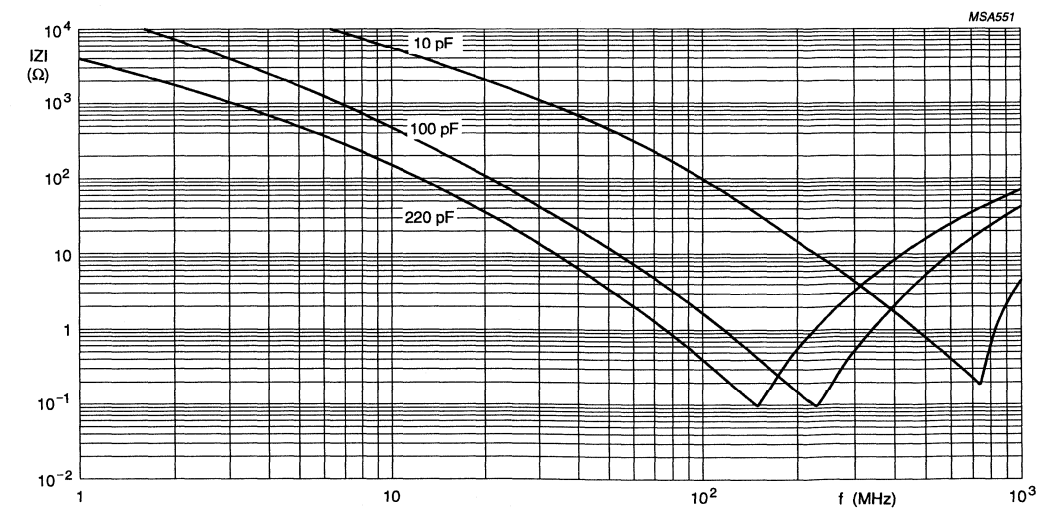
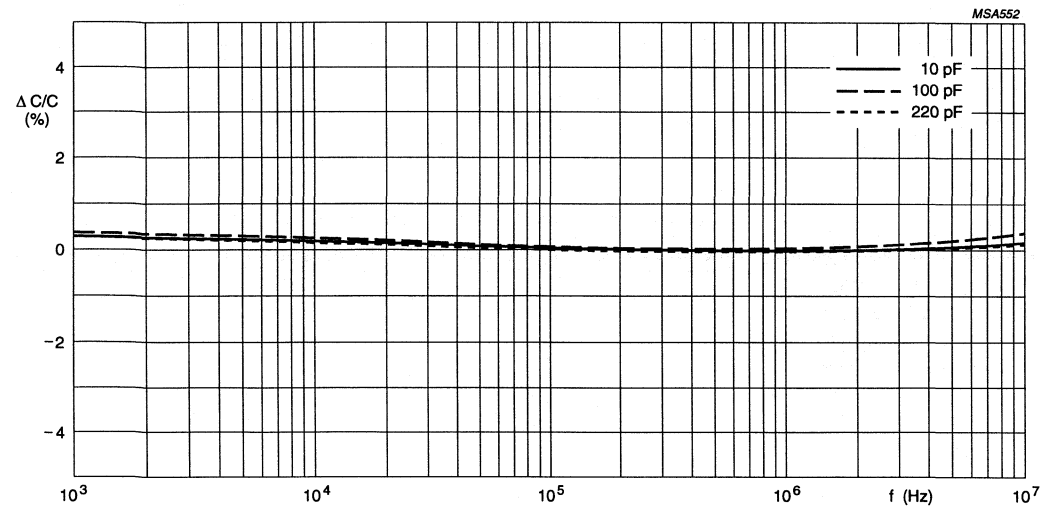


Fig.7 Typical impedance |Z| as a function of frequency.



Reference values at 1 MHz.
Measurements made at 1 V, including 2 mm per connecting lead.

Fig.8 Typical capacitance change as function of frequency.

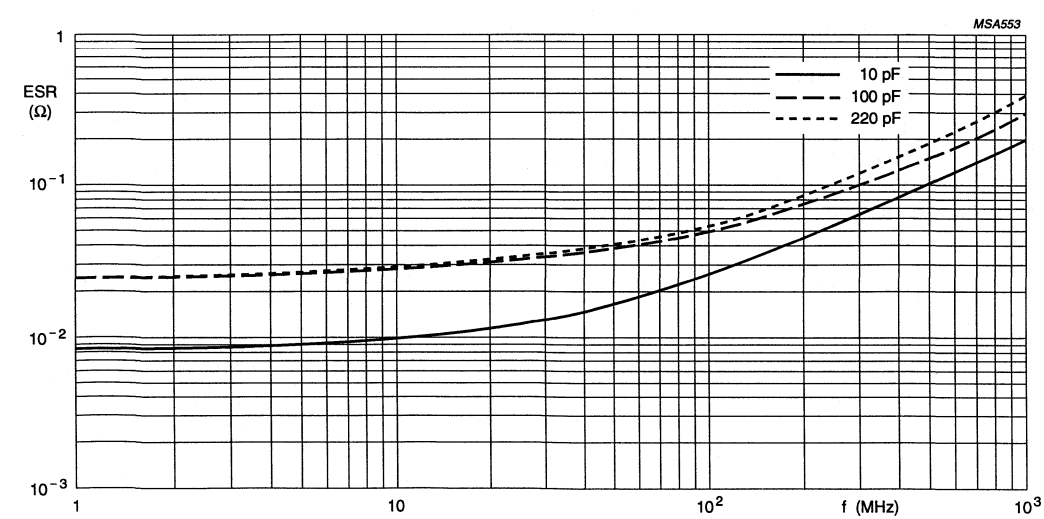


Fig.9 Equivalent series resistance (ESR) as a function of frequency.

Miniature ceramic plate capacitors Class 1 (flanged types)

FEATURES

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

APPLICATIONS

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 use in 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 using 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, which 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.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
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 and N1500
Sectional specification	IEC 384-8
Climatic category (IEC 68)	55/085/21

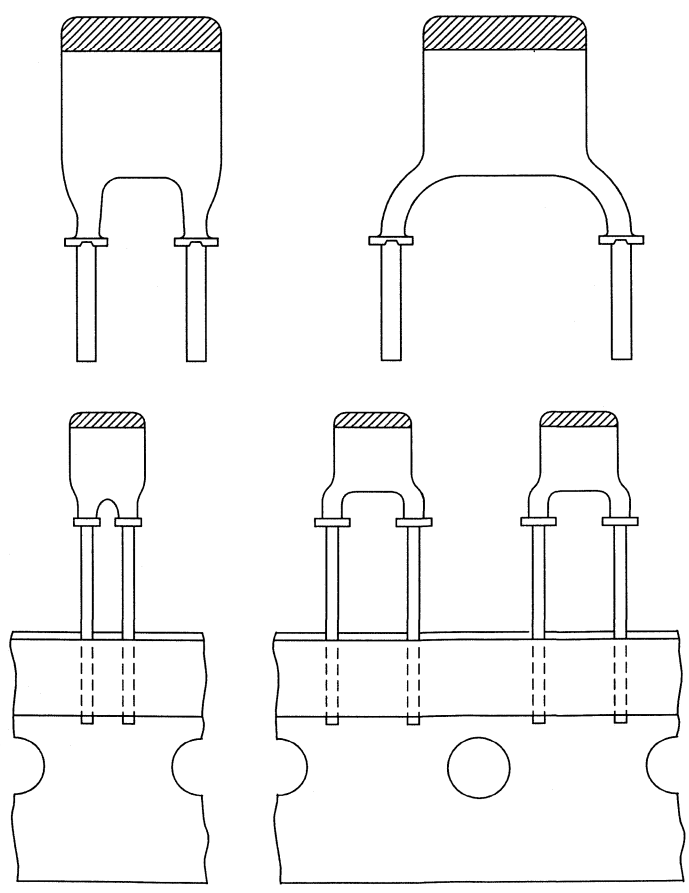
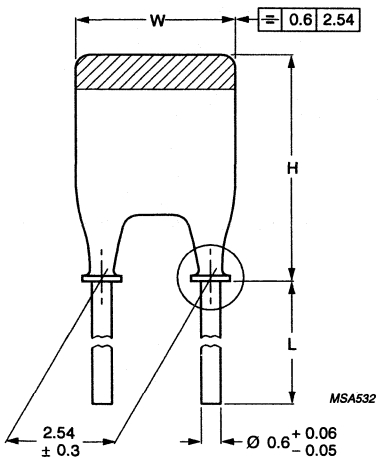


Fig.1 Outlines.

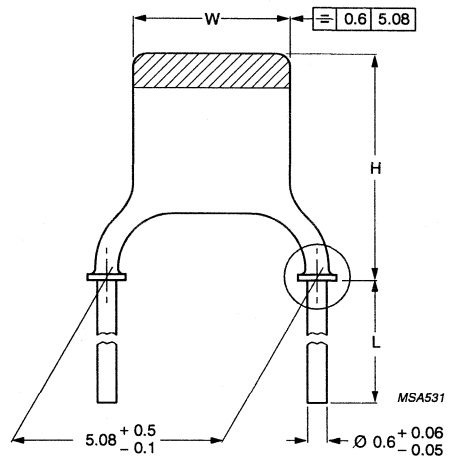
Miniature ceramic plate capacitors Class 1 (flanged types)

MECHANICAL DATA



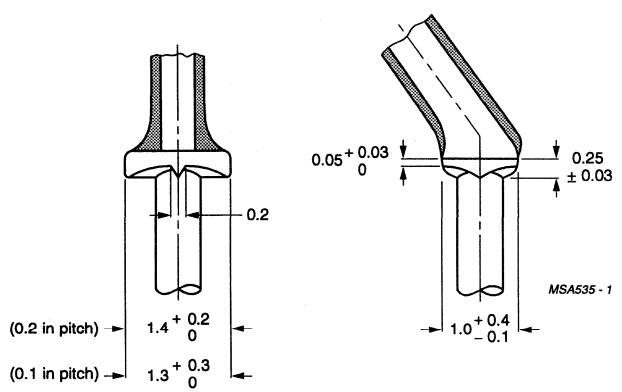
Dimensions in mm.
For dimensions H, L and W see Tables 1 and 2.

Fig.2 Component outline style 1.



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

Fig.3 Component outline style 2.



Dimensions in mm.

Fig.4 Detail of flange.

Miniature ceramic plate capacitors Class 1 (flanged types)

Marking

The temperature coefficient is indicated by a colour code in accordance with IEC and EIA recommendations. Capacitance value is indicated by a marking code in a contrasting colour on the body. Refer to Tables 3 to 20, for colour and marking codes.

Mounting

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

Soldering conditions:

max. 265 °C, max. 10 s.

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

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE[1]	W[2] (mm)	H[2] (mm)		MASS (g)
		STYLE 1	STYLE 2	
I	3.6 (–1.1)	5.0 (–1.5)	6.3 (–1.8)	≈0.14
IIA	3.9 (–1.4)	5.3 (–1.7)	6.7 (–2.0)	≈0.15
IIB	4.5 (–1.8)	6.0 (–2.1)	7.3 (–2.4)	≈0.15
III	5.3 (–1.8)	6.8 (–2.3)	8.1 (–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

Notes

1. Unless indicated in Tables 4 to 20, the thickness of the capacitors does not exceed 2.3 mm.
2. Tolerances are given between parentheses.

PACKAGING

For details refer to Chapter *"Miniature ceramic plate capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

PITCH P	LEAD DIAMETER d	STYLE	CATALOGUE NUMBERS[1]				
			BULK PACKED		ON TAPE[3] (REEL)	ON TAPE[2] (AMMOPACK)	ON TAPE[3] (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 686	2222 688 .....
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2	2222 681	2222 683	2222 679	2222 687	2222 689 .....

Notes

1. Catalogue number to be completed by adding the last 5-digit suffix for required capacitance value, see Tables 4 to 20.
2. H_0 = 16 mm.
3. H_0 = 18.25 mm.

Table 3 Conditions for Table 4; capacitors with temperature coefficient **P100**, rated voltage 100 V (DC).

DESCRIPTION	VALUE
Capacitance range	0.56 to 47 pF (E12 series)
Temperature coefficient of the capacitance $\left(\frac{\Delta C}{C\Delta T}\right)$	100×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	red/violet

Table 4 **Preferred** capacitance range, temperature coefficient **P100**.

CAPACITANCE VALUE[1] (pF)	TOLERANCE	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
0.56	±0.25 pF	I[2]	p56	03567
0.68	±0.25 pF	I[2]	p68	03687
0.82	±0.25 pF	I[2]	p82	03827
1.0	±0.25 pF	I[3]	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

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 2.7 mm.
3. Maximum thickness 2.5 mm.

Table 5 Conditions for Table 6; capacitors with temperature coefficient **NP0**, rated voltage 100 V (DC).

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

Table 6 **Preferred** capacitance range, temperature coefficient **NP0**.

CAPACITANCE VALUE[1] (pF)	TOLERANCE	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
1.8	±0.25 pF	I[2]	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

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 2.5 mm.

Table 7 Conditions for Table 8; capacitors with temperature coefficient **N075**, rated voltage 100 V (DC).

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

Table 8 **Non-preferred** capacitance range, temperature coefficient **N075**.

CAPACITANCE VALUE[1] (pF)	TOLERANCE	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
3.9	±0.25 pF	I[2]	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

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 2.5 mm.

Table 9 Conditions for Table 10; capacitors with temperature coefficient **N150**, rated voltage 100 V (DC).

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

Table 10 Preferred capacitance range, temperature coefficient **N150**.

CAPACITANCE VALUE[1] (pF)	TOLERANCE	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
3.9	±0.25 pF	I[2]	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

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 2.5 mm.

Table 11 Conditions for Table 12; capacitors with temperature coefficient **N220**, rated voltage 100 V (DC).

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

Table 12 Non-preferred capacitance range, temperature coefficient **N220**.

CAPACITANCE VALUE[1] (pF)	TOLERANCE	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
3.9	±0.25 pF	I[2]	3p9	39398
4.7	±0.25 pF	I[2]	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

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 2.5 mm.

Table 13 Conditions for Table 14; capacitors with temperature coefficient **N330**, rated voltage 100 V (DC).

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

Table 14 Non-preferred capacitance range, temperature coefficient **N330**.

CAPACITANCE VALUE(1) (pF)	TOLERANCE	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
4.7	±0.25 pF	I(2)	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

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 2.5 mm.

Table 15 Conditions for Table 16; capacitors with temperature coefficient **N470**, rated voltage 100 V (DC).

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

Table 16 Non-preferred capacitance range, temperature coefficient **N470**.

CAPACITANCE VALUE(1) (pF)	TOLERANCE	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
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

Note

1. Other capacitance values and tolerances are available on request.

Table 17 Conditions for Table 18; capacitors with temperature coefficient **N750**, rated voltage 100 V (DC).

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

Table 18 Preferred capacitance range, temperature coefficient **N750**.

CAPACITANCE VALUE[1] (pF)	TOLERANCE	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
3.9	±0.25 pF	I[2]	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

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 2.5 mm.

Table 19 Conditions for Table 20; capacitors with temperature coefficient **N1500**, rated voltage 100 V (DC).

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

Table 20 Preferred capacitance range, temperature coefficient **N1500**.

CAPACITANCE VALUE[1] (pF)	TOLERANCE	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
18	±2%	I[2]	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

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 2.5 mm.

ELECTRICAL CHARACTERISTICS

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%.

DESCRIPTION	VALUE
Capacitance values (note 1) measured at 1 MHz, ≤5 V	see Tables 4 to 20
Rated DC voltage	100 V
DC test voltage; duration 1 minute	300 V
DC test voltage of coating; duration 1 minute	300 V
Insulation resistance at 100 V (DC) after 1 minute	≥10000 MΩ
Tan δ (note 1) measured at 1 MHz, ≤5 V	
$C \leq 50$ pF	$\leq 15\left(\frac{15}{C}+0.7\right)\times 10^{-4}$; $<55\times 10^{-4}$
$C > 50$ pF	$\leq 15\times 10^{-4}$
Category temperature range	–55 to +85 °C
Storage temperature range	–55 to +85 °C
Climatic category (IEC 68)	55/085/21

Note

1. Including 2 mm per connecting lead.

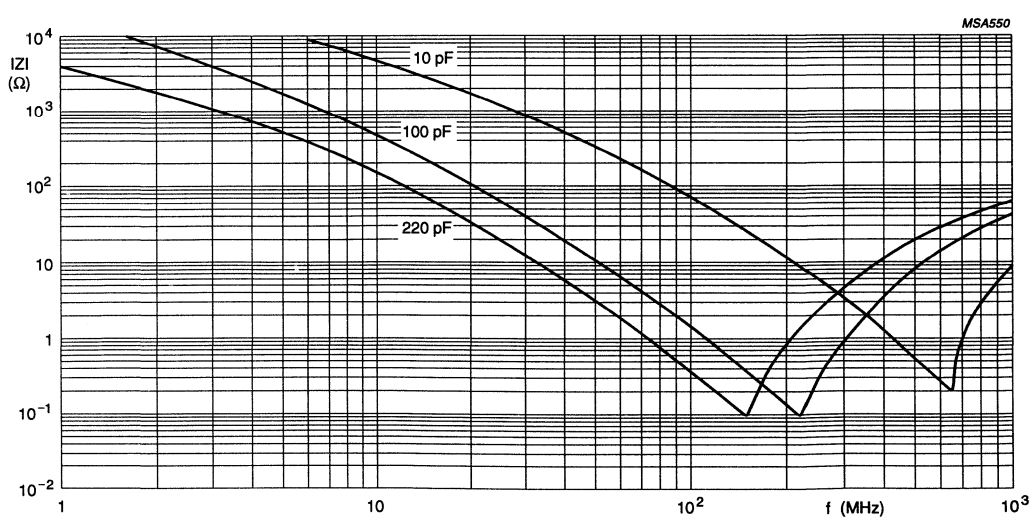


Fig.5 Typical impedance |Z| as a function of frequency.

Miniature ceramic plate capacitors Class 2 (flanged types)

FEATURES

- General purpose
- Coupling and decoupling
- Space saving.

APPLICATIONS

In electronic circuits where non-linear change of capacitance with temperature is permissible and low losses are not essential, i.e. coupling and decoupling. Because of their small size the capacitors are suitable for use in 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 using 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, which 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.

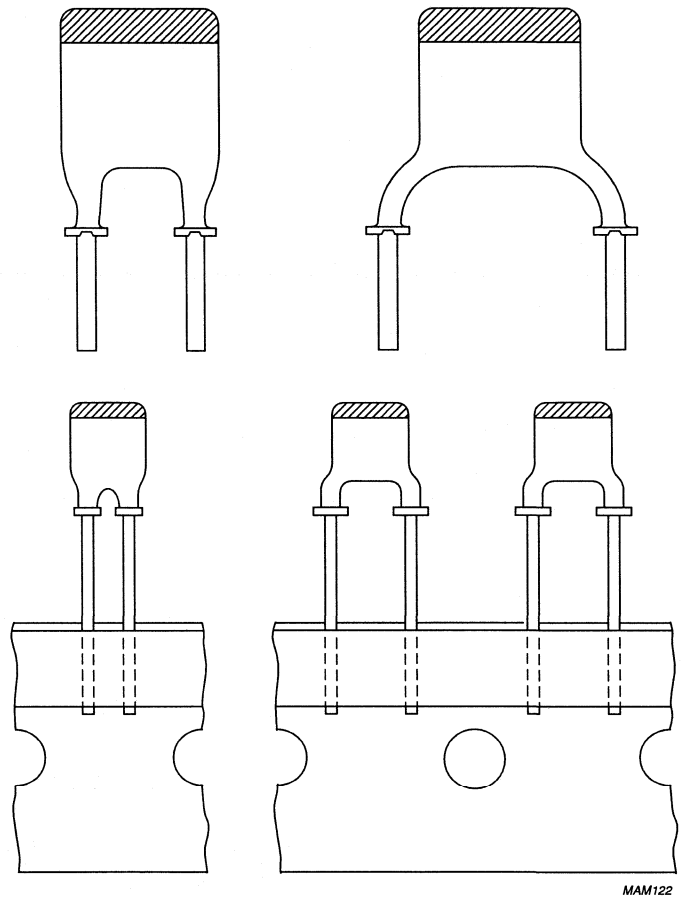
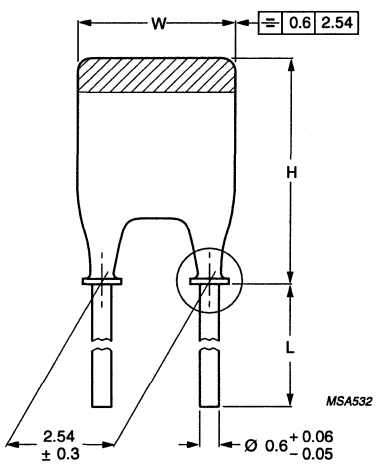


Fig.1 Outlines.

QUICK REFERENCE DATA

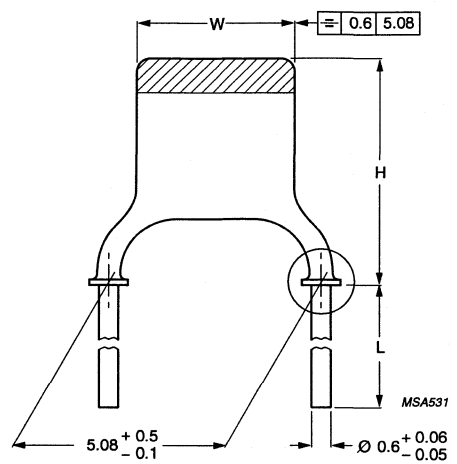
DESCRIPTION	VALUE		
	2222 630	2222 640	2222 629 .....
Capacitance range	180 to 6800 pF (E12 series)	1000 to 15000 pF (E6 series)	1000 to 47000 pF (E3 series)
Dielectric material	K2000	K5000	K14000
Rated DC voltage	100 V	100 V	63 V
Tolerance on capacitance	±10%	–20/+50%	–20/+80%
Sectional specification	IEC 384-9 (2C2 and 2E1)	IEC 384-9 (2E2)	IEC 384-9
Climatic category (IEC 68)	55/125/56	55/085/21	10/055/21

MECHANICAL DATA



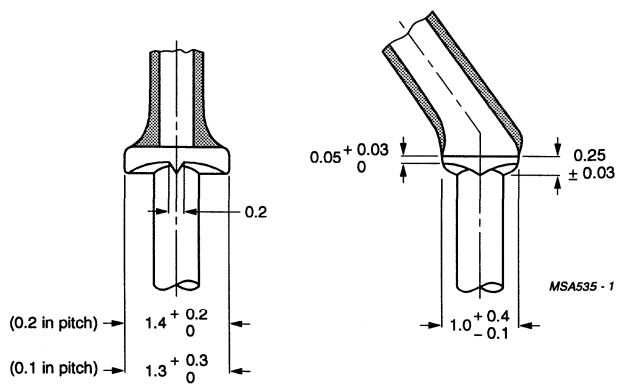
Dimensions in mm.
For dimensions H, L and W see Tables 1 and 2.

Fig.2 Component outline style 1.



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

Fig.3 Component outline style 2.



Dimensions in mm.

Fig.4 Detail of flange.

Miniature ceramic plate capacitors Class 2 (flanged types)

Marking

The body of the capacitor is tan coloured. The capacitors also have a colour mark on top indicating the temperature dependency of the capacitance:

yellow for type 2222 630 .....

blue for type 2222 640 .....

green for type 2222 629 .....

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

Soldering conditions:

max. 265 °C, max. 10 s.

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

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE[1]	W[2] (mm)	H[2] (mm)		MASS (g)
		STYLE 1	STYLE 2	
I	3.6 (–1.1)	5.0 (–1.5)	6.3 (–1.8)	≈0.14
IIA	3.9 (–1.4)	5.3 (–1.7)	6.7 (–2.0)	≈0.15
IIB	4.5 (–1.8)	6.0 (–2.1)	7.3 (–2.4)	≈0.15
III	5.3 (–1.8)	6.8 (–2.3)	8.1 (–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

Notes

1. Unless indicated in Tables 3, 4 and 5, the thickness of the capacitors does not exceed 2.3 mm.
2. Tolerances are given between parentheses.

PACKAGING

For details refer to the Chapter *"Miniature ceramic plate capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

PITCH P	LEAD DIAMETER d	STYLE	CATALOGUE NUMBERS[1]				
			BULK PACKED		ON TAPE[3] (REEL)	ON TAPE[2] (AMMOPACK)	ON TAPE[3] (AMMOPACK)
			L ≥ 13 mm	L = ±0.5 mm			
2.54 mm (0.1 in)	0.6 mm (0.024 in)	1	2222 630 08...	2222 630 18...	2222 630 51...	2222 630 62...	2222 630 61...
			2222 640 08...	2222 640 18...	2222 640 51...	2222 640 62...	2222 640 61...
			2222 629 08...	2222 629 18...	2222 629 51...	2222 629 62...	2222 629 61...
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2	2222 630 09...	2222 630 19...	2222 630 53...	2222 630 64...	2222 630 63...
			2222 640 09...	2222 640 19...	2222 640 53...	2222 640 64...	2222 640 63...
			2222 629 09...	2222 629 19...	2222 629 53...	2222 629 64...	2222 629 63...

Notes

1. Catalogue number to be completed by adding the 3-digit suffix for required capacitance value, see Tables 3, 4 and 5.
2. H_0 = 16 mm.
3. H_0 = 18.25 mm.

Table 3 Preferred capacitance range for **2222 630 .....**

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

Note

1. Maximum thickness 2.5 mm.

Table 4 **Preferred** capacitance range for **2222 640 .....**

CAPACITANCE VALUE (pF)	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
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

Table 5 **Preferred** capacitance range for **2222 629 .....**

CAPACITANCE VALUE (pF)	SIZE (see Table 1)	MARKING	SUFFIX OF CATALOGUE NUMBER (see Table 2)
1000	I	1n0	102
2200	I	2n2	222
4700	I	4n7	472
10000	IIB	10n	103
22000	IV	22n	223
47000	V	47n	473

ELECTRICAL CHARACTERISTICS

Capacitors 2222 630 (colour mark yellow)

The capacitors meet the essential requirements of *"IEC 384-8"* (2C2 and 2E1). 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%.

DESCRIPTION	VALUE
Capacitance values measured at 1 kHz, 1 V	180 to 6800 pF; E12 series (see Table 3)
Dielectric material	K2000
Tolerance on capacitance, after 1000 hours	±10%
Maximum capacitance change with respect to capacitance value at 20 °C	+20 to –20% (see Fig.5) from –55 to +85 °C; +20 to –56% from –55 to +125 °C
Rated DC voltage	100 V
DC test voltage; duration 1 minute	300 V
DC test voltage of coating; duration 1 minute	300 V
Insulation resistance at 100 V (DC) after 1 minute	≥4 000 MΩ
Tan δ measured at 1 kHz, 1 V	≤3.5%
Maximum voltage dependency of the capacitance between 0 and 40 V	–5%
Category temperature range	–55 to +85 °C (2C2) and –55 to +125 °C (2E1)
Storage temperature range	–55 to +85 °C
Ageing	typical 1.5% per time decade
Climatic category (IEC 68)	55/125/56

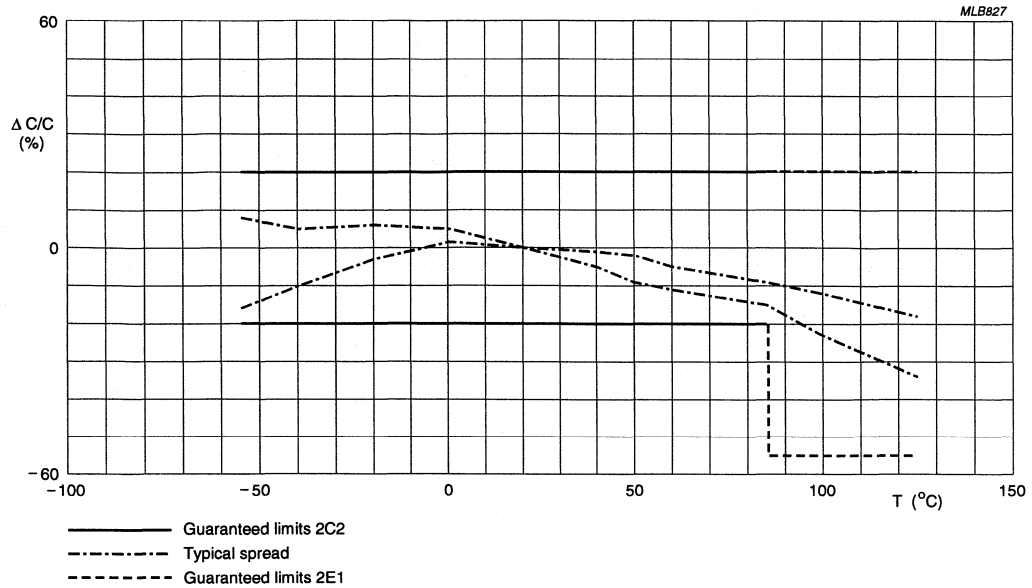
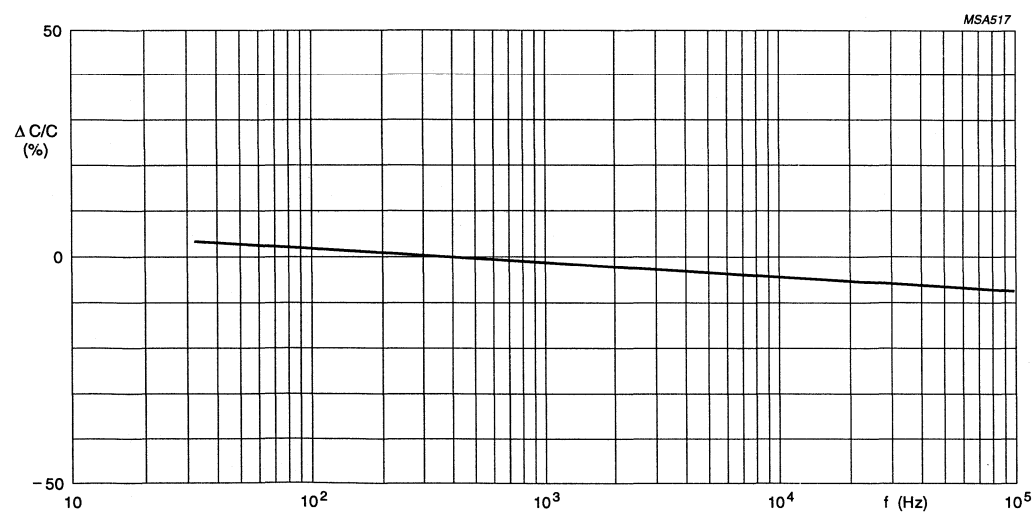
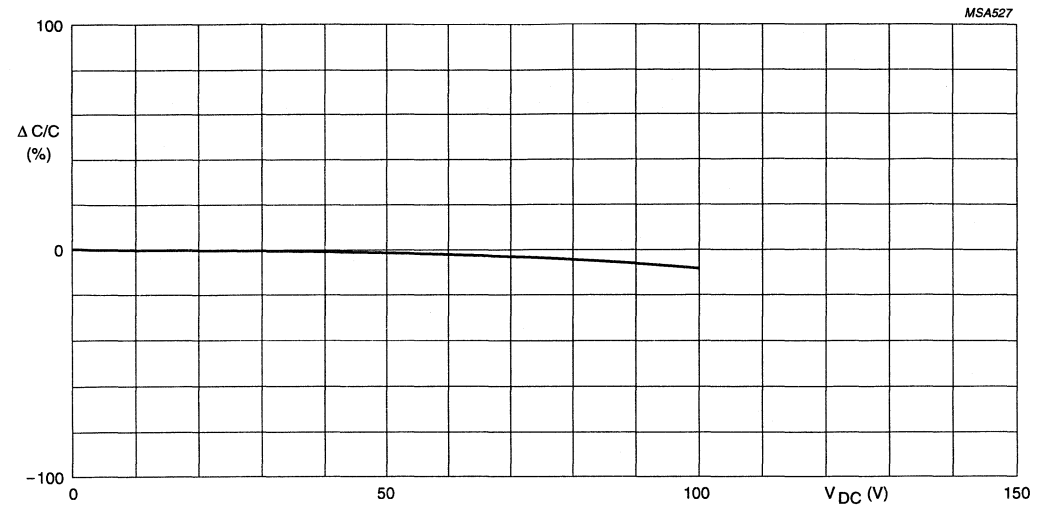


Fig.5 Typical capacitance change with respect to capacitance value at 20 °C as a function of temperature.



U = 1 V.

Fig.6 Typical capacitance change with respect to the capacitance value at 300 Hz as a function of frequency.



f = 1 kHz.
U = 1 V.
T = 20 °C.

Fig.7 Typical capacitance change with respect to the capacitance value at 0 V as a function of DC voltage.

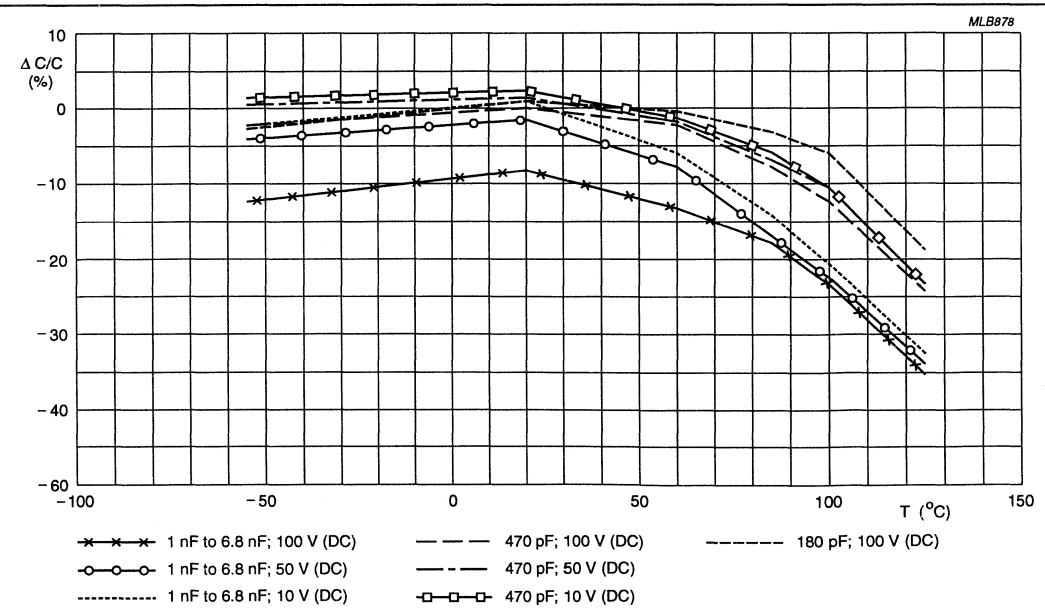
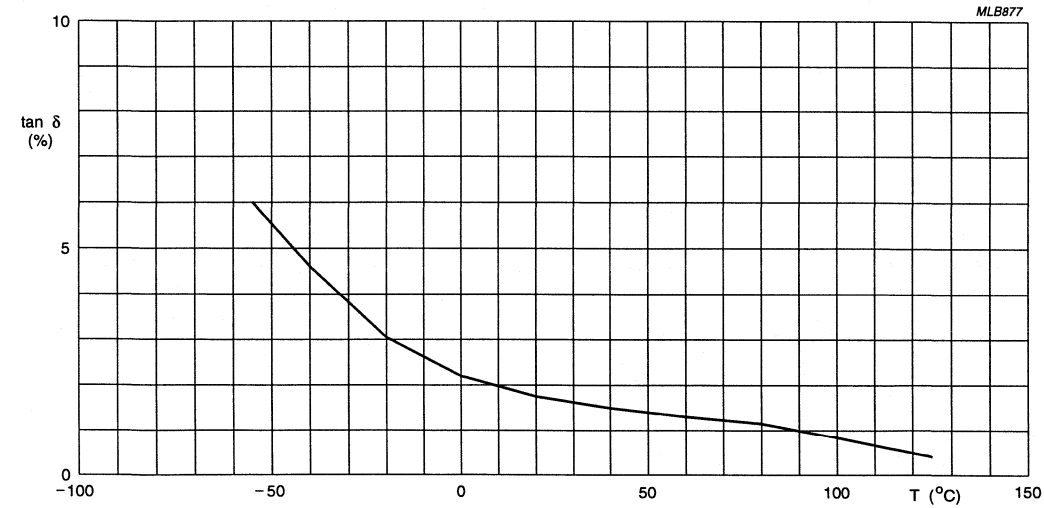


Fig.8 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C as a function of temperature at different DC voltages.



f = 1 kHz.
U = 1 V.

Fig.9 Typical tan δ as a function of temperature.

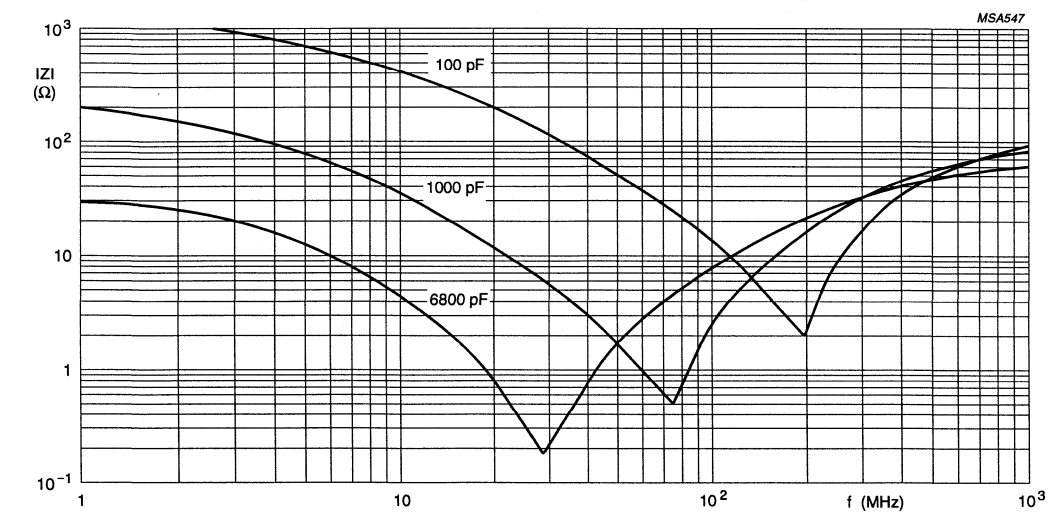
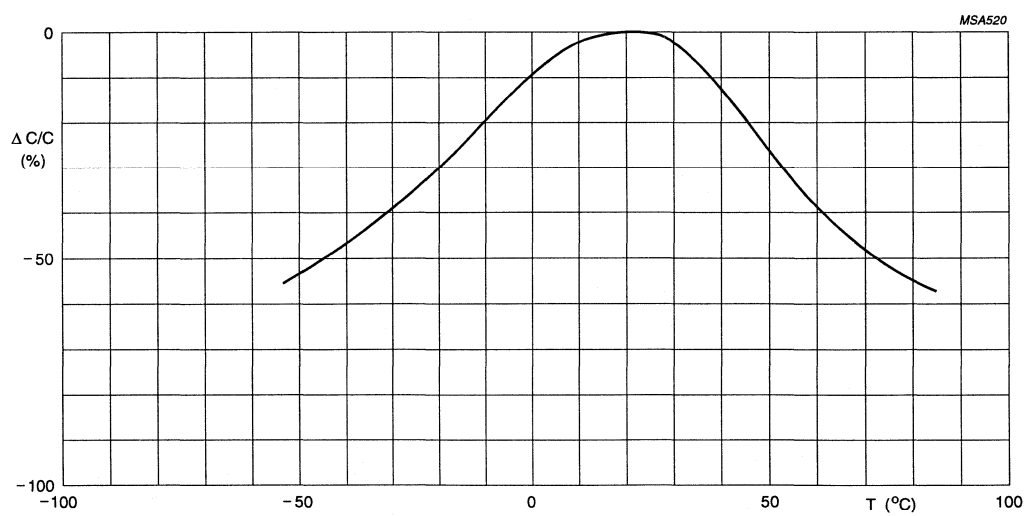


Fig.10 Typical impedance |Z| as a function of frequency.

Capacitors 2222 640 (colour mark blue)

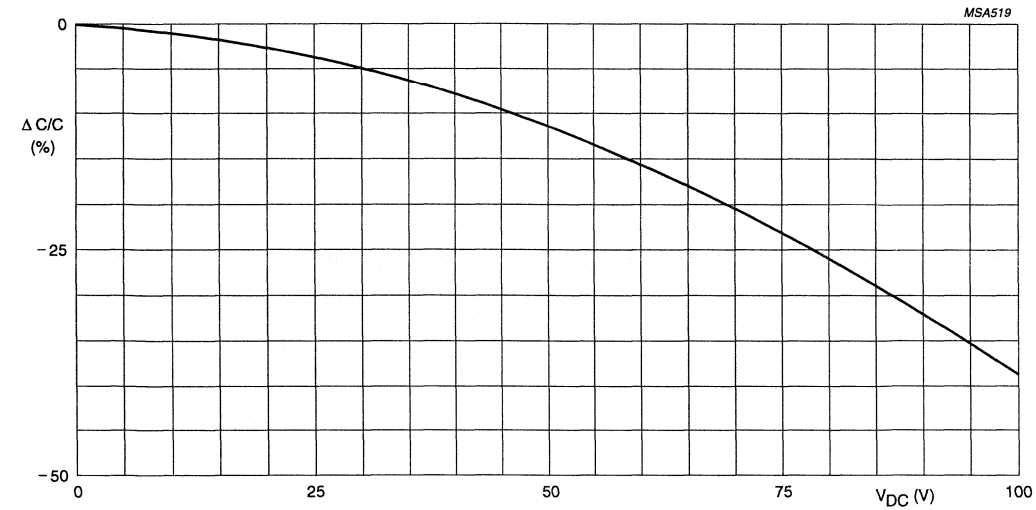
The capacitors meet the essential requirements of *"IEC 384-9"* (2E2). Unless stated otherwise all electrical values apply at an ambient temperature of 20 ±1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance values measured at 1 kHz, 1 V	1000 to 15000 pF; E6 series (see Table 4)
Tolerance on capacitance, after 1000 hours	–20 to +50%
Dielectric material	K5000
Maximum capacitance change with respect to capacitance value at 20 °C	+20 to –55% (see Fig.11)
Rated DC voltage	100 V
DC test voltage; duration 1 minute	300 V
DC test voltage of coating; duration 1 minute	300 V
Insulation resistance at 100 V (DC) after 1 minute	≥4000 MΩ
Tan δ measured at 1 kHz, 1 V	≤3.5%
Category temperature range	–55 to +85 °C
Storage temperature range	–55 to +85 °C
Ageing	typical 5% per time decade
Climatic category (IEC 68)	55/085/21



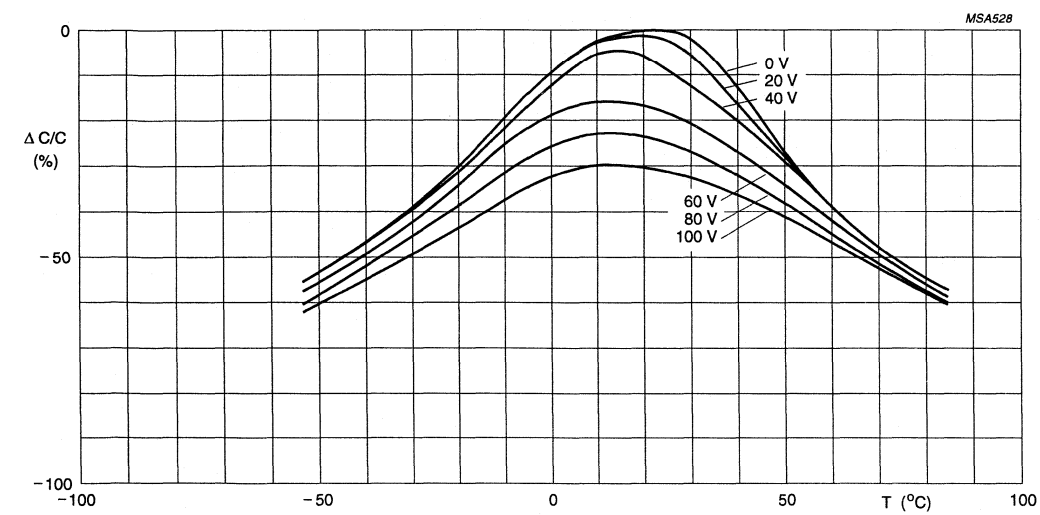
f = 1 kHz.
U = 1 V.

Fig.11 Maximum capacitance change with respect to capacitance value at 20 °C as a function of temperature.



f = 1 kHz.
U = 1 V.

Fig.12 Typical capacitance change with respect to capacitance value at 20 °C as a function of DC voltage.



f = 1 kHz.
U = 1 V.

Fig.13 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C as a function of temperature at different DC voltages.

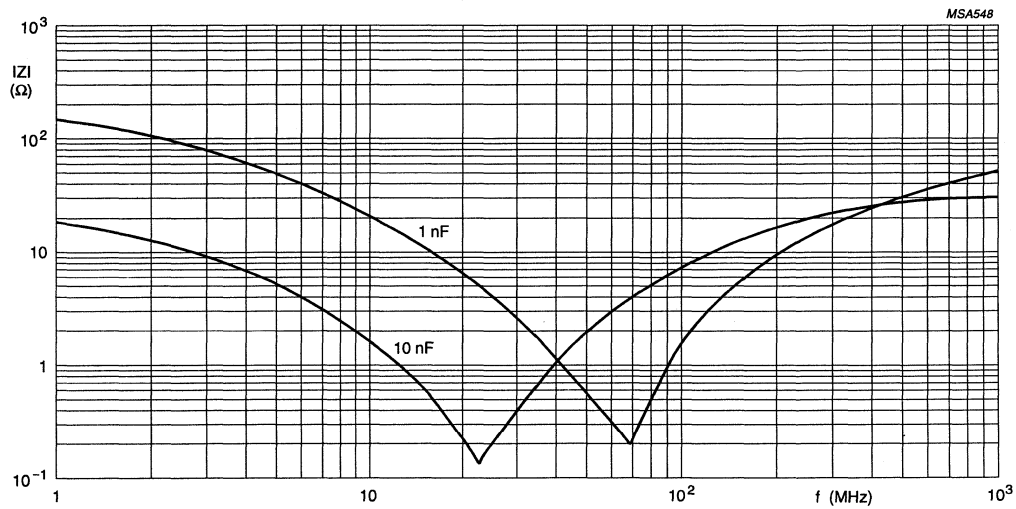
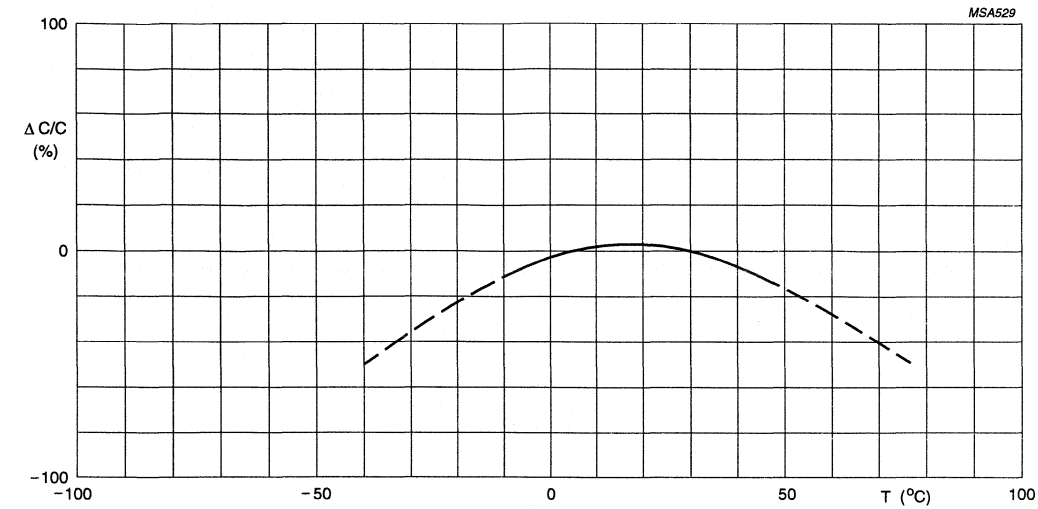


Fig.14 Typical impedance |Z| as a function of frequency.

Capacitors 2222 629 (colour mark green)

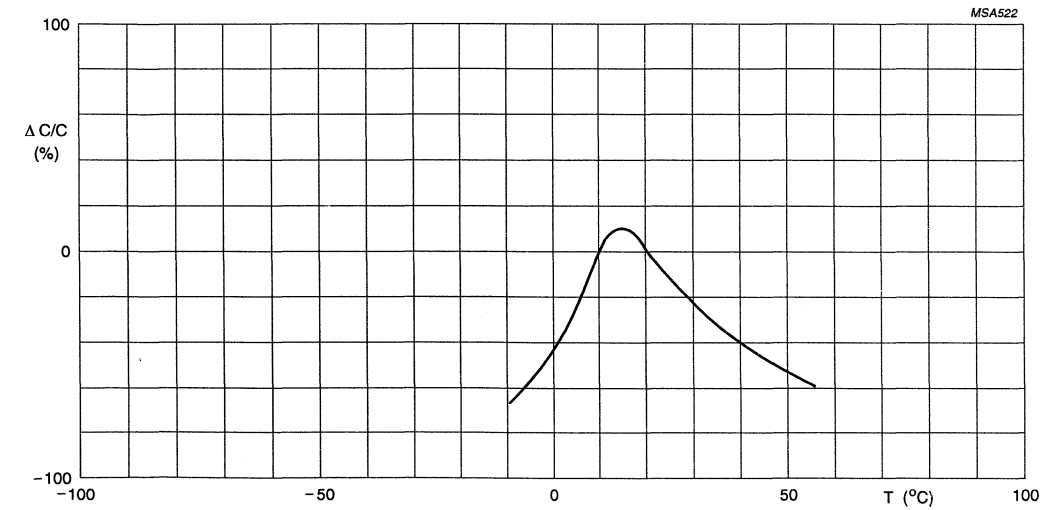
The capacitors meet the essential requirements of *"IEC 384-9"*. Unless stated otherwise all electrical values apply at an ambient temperature of 20 ±1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance values measured at 1 kHz, 1 V	1000 to 47000 pF; E3 series (see Table 5)
Tolerance on capacitance, after 1000 hours	–20 to +80%
Dielectric material	K14000
Maximum capacitance change with respect to capacitance value at 20 °C	+20 to –75% (see Figs 15 and 16)
Rated DC voltage at 55 °C	63 V
Derated DC voltage at 85 °C	40 V
DC test voltage; duration 1 minute	200 V
DC test voltage of coating; duration 1 minute	200 V
Insulation resistance at 100 V (DC) after 1 minute	≥4000 MΩ
Tan δ measured at 1 kHz, 1 V	≤3.5%
Category temperature range	–10 to +55 °C
Storage temperature range	–55 to +85 °C
Ageing	typical 5% per time decade
Climatic category (IEC 68)	10/055/21



f = 1 kHz.
U = 1 V.

Fig.15 Maximum capacitance change with respect to capacitance value at 20 °C as a function of temperature for capacitance value 1000 pF.



f = 1 kHz.
U = 1 V.

Fig.16 Maximum capacitance change with respect to capacitance value at 20 °C as a function of temperature for capacitance values 2200 pF to 47000 pF.

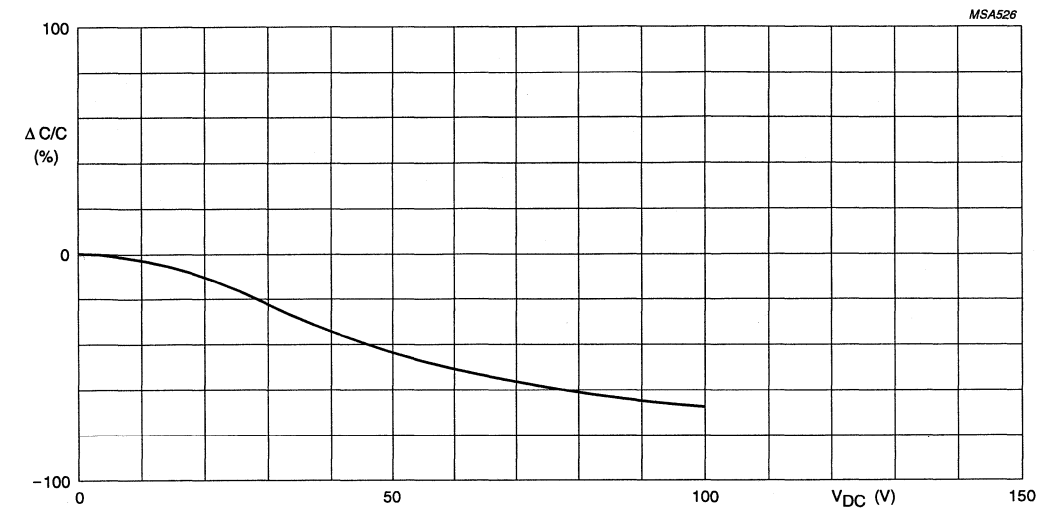


Fig.17 Typical capacitance change with respect to the capacitance value at 0 V as a function of DC voltage for capacitance values 2200 to 47000 pF.

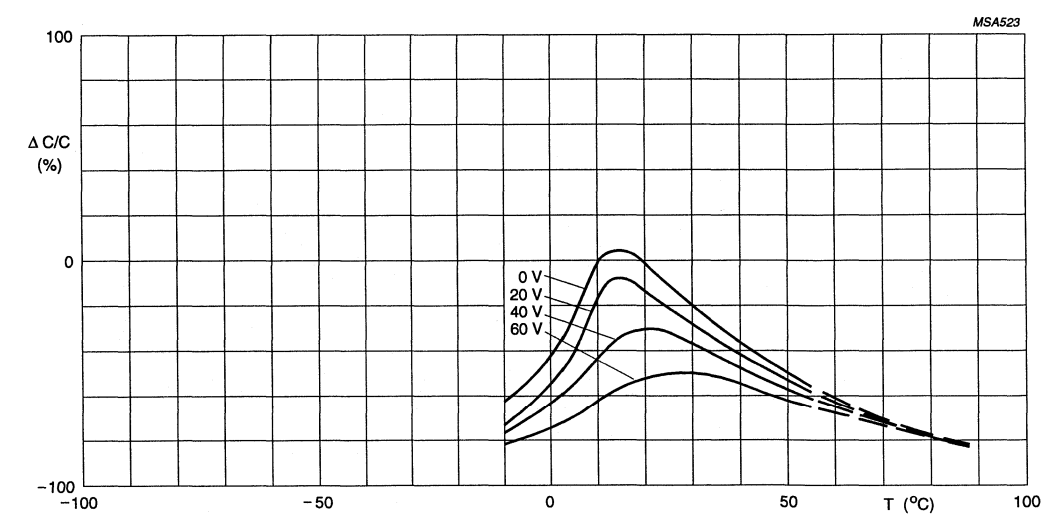
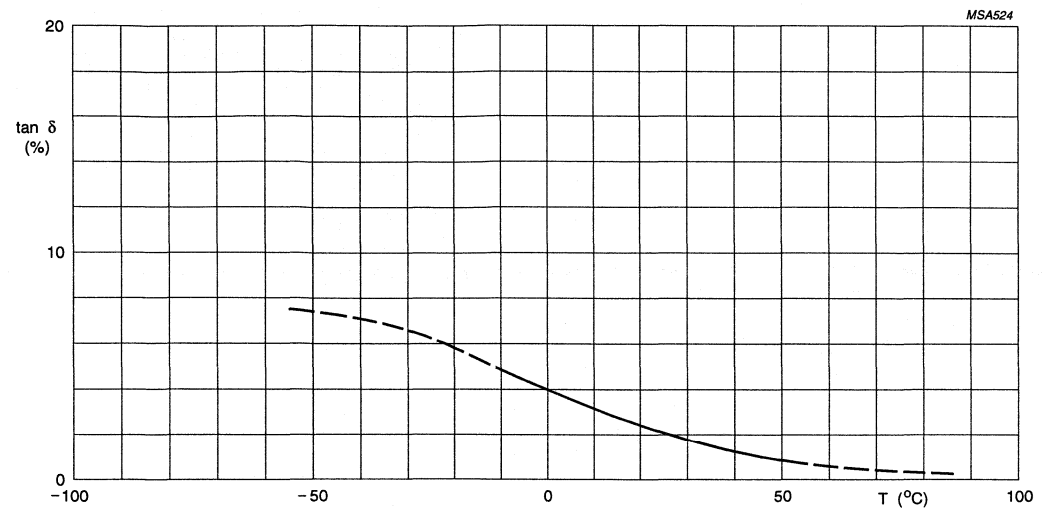


Fig.18 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C as a function of temperature at different DC voltages for capacitance values 2200 to 47000 pF.



f = 1 kHz.
U = 1 V.

Fig.19 Typical tan δ as a function of temperature for capacitance values 2200 to 47000 pF.

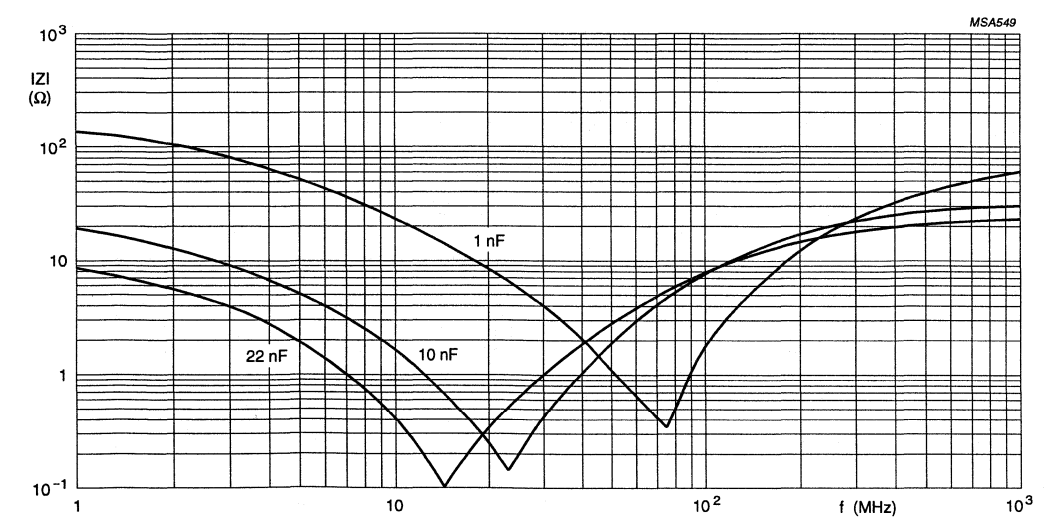


Fig.20 Typical impedance |Z| as a function of frequency.

Miniature ceramic plate capacitors Class 1 (non-flanged types)

FEATURES

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

APPLICATIONS

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 using 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 or 2%), high stability and, owing to the absence of silver, an extremely good DC behaviour.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
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 and N1500
Sectional specification	IEC 384-8
Climatic category (IEC 68)	55/085/21

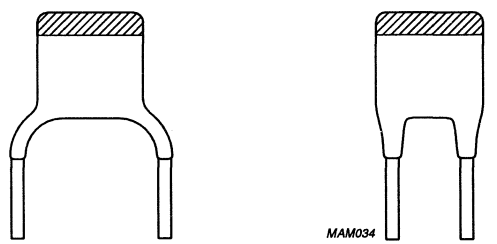
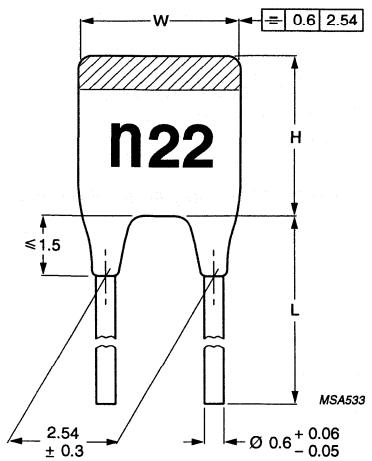


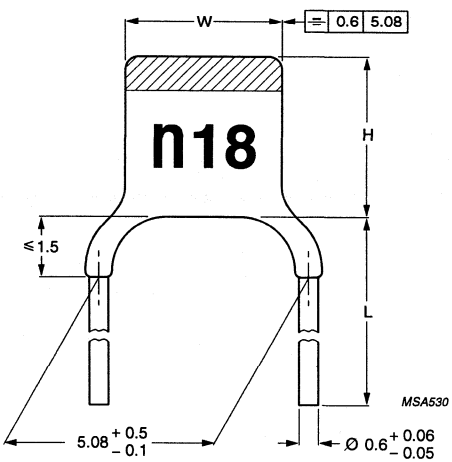
Fig.1 Outlines.

MECHANICAL DATA



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

Fig.2 Component outline style 1.



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

Fig.3 Component outline style 2.

Marking

The temperature coefficient is indicated by a colour code in accordance with IEC and EIA recommendations. Capacitance value and voltage are indicated by a marking code in a contrasting colour on the body. Refer to the Tables of data sheet *"Class 1 (flanged types)"* for marking codes and colours.

Mounting

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

Soldering conditions:

max. 265 °C, max. 10 s.

Lacquer on the leads

When the capacitors shown in Figs 2 and 3 are mounted on printed-circuit boards with a thickness of 1.5 mm and with holes of 1.3 mm diameter or on printed-circuit 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.

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE(1)	W(2) (mm)	H(2) (mm)	MASS (g)
I	3.6 (–1.1)	3.7 (–1.2)	≈0.14
IIA	3.9 (–1.4)	4.0 (–1.5)	≈0.15
IIB	4.5 (–1.8)	4.7 (–2.0)	≈0.16
III	5.3 (–1.8)	5.5 (–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

Notes

1. Unless indicated in the Tables of data sheet *"Class 1 (flanged types)"* the thickness of the capacitors does not exceed 2.3 mm. Capacitors exceeding this thickness have H_{max} = 4.5 mm.
2. Tolerances are given between parentheses.

PACKAGING

For details refer to Chapter *"Miniature ceramic plate capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

PITCH P	LEAD DIAMETER d	STYLE	CATALOGUE NUMBERS(1)	
			L ≥ 15 mm	L = 6 $^{+0}/_{-2}$ mm
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. Catalogue number to be completed by adding the 5-digit suffix for required capacitance value. Refer to the Tables of data sheet *"Class 1 (flanged types)"* for catalogue numbers.

Miniature ceramic plate capacitors Class 2 (non-flanged types)

FEATURES

- General purpose
- Coupling and decoupling
- Space saving.

APPLICATIONS

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 using 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.

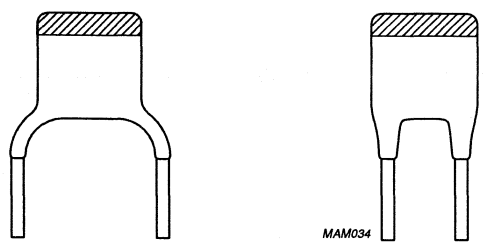
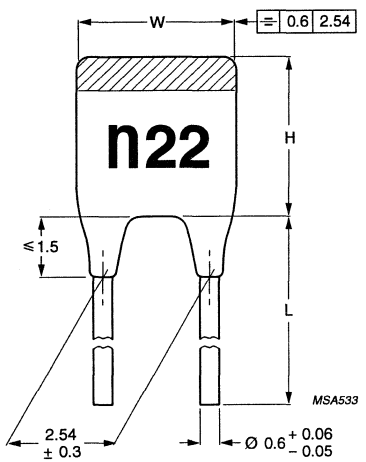


Fig.1 Outlines.

QUICK REFERENCE DATA

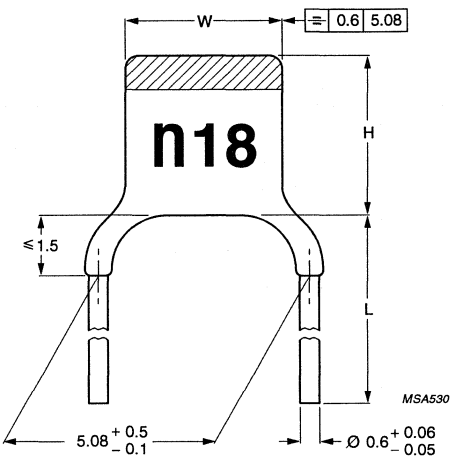
DESCRIPTION	VALUE		
	2222 630	2222 640	2222 629 .....
Capacitance range	180 to 6800 pF (E12 series)	1000 to 15000 pF (E6 series)	1000 to 47000 pF (E3 series)
Dielectric material	K2000	K5000	K14000
Rated DC voltage	100 V	100 V	63 V
Tolerance on capacitance	±10%	–20/+50%	–20/+80%
Sectional specification	IEC 384-9 (2C2 and 2E1)	IEC 384-9 (2E2)	IEC 384-9
Climatic category (IEC 68)	55/125/56	55/085/21	10/055/21

MECHANICAL DATA



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

Fig.2 Component outline style 1.



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

Fig.3 Component outline style 2.

Marking

The body of the capacitors is tan coloured. The capacitors also have a colour mark on top indicating the temperature dependency of the capacitance:

yellow for type 2222 630 .....

blue for type 2222 640 .....

green for type 2222 629 .....

The capacitance value is indicated by a marking code in a contrasting colour on the body.

Refer to the Tables of data sheet *"Class 2 (flanged type)"* for marking codes.

Mounting

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

Soldering conditions:

max. 265 °C, max. 10 s.

Lacquer on the leads

When the capacitors shown in Figs 2 and 3 are mounted on printed-circuit boards with a thickness of 1.5 mm and with holes of 1.3 mm diameter or on printed-circuit 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 a maximum thickness greater than 2.3 mm and lead pitch of 5.08 mm, the lacquer on the leads extends less than 2 mm.

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE(1)	W(2) (mm)	H(2) (mm)	MASS (g)
I	3.6 (–1.1)	3.7 (–1.2)	≈0.14
IIA	3.9 (–1.4)	4.0 (–1.5)	≈0.15
IIB	4.5 (–1.8)	4.7 (–2.0)	≈0.16
III	5.3 (–1.8)	5.5 (–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

Notes

1. The thickness of the capacitors does not exceed 2.3 mm with the exception of 2222 630 ..181 and 2222 630 ..221 (maximum thickness 2.5 mm).
2. Tolerances are given between parentheses.

PACKAGING

For details refer to Chapter *"Miniature ceramic plate capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

PITCH P	LEAD DIAMETER d	STYLE	CATALOGUE NUMBERS(1)	
			L ≥ 15 mm	L = 6 $^{+0}/_{-2}$ mm
2.54 mm (0.1 in)	0.6 mm (0.024 in)	1	2222 630 01...	2222 630 05...
			2222 640 01...	2222 640 05...
			2222 629 01...	2222 629 05...
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2	2222 630 03...	2222 630 06...
			2222 640 03...	2222 640 06...
			2222 629 03...	2222 629 06...

Note

1. Catalogue number to be completed by adding the 3-digit suffix for required capacitance values. Refer to the Tables of data sheet *"Class 2 (flanged type)"*.

Miniature ceramic plate capacitors

Class 1, 500 V (DC) (flanged types)

FEATURES

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

APPLICATIONS

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 use in 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 using 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, which 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.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Capacitance range	0.47 to 330 pF (E12 series)
Rated DC voltage	500 V
Tolerance on capacitance	±2% or ±0.25 pF
Temperature coefficients	P100, NP0, N150, N750 and N1500
Sectional specification	IEC 384-8
Climatic category (IEC 68)	55/085/21

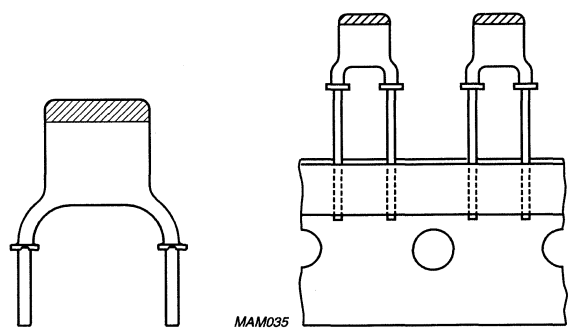
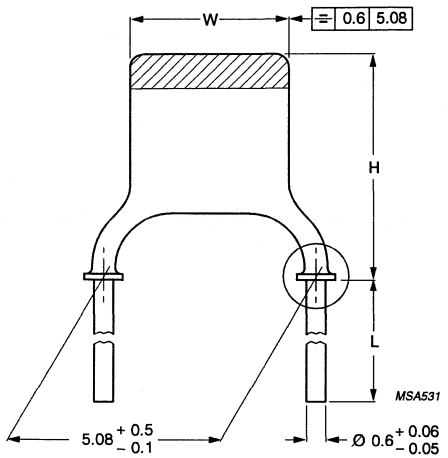


Fig.1 Outlines.

Miniature ceramic plate capacitors

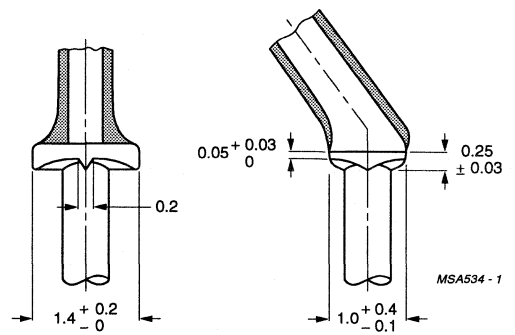
Class 1, 500 V (DC) (flanged types)

MECHANICAL DATA



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

Fig.2 Component outline.



Dimensions in mm.

Fig.3 Detail of flange.

Marking

The body of the capacitors is coloured grey. The temperature coefficient is indicated by a colour code in accordance with IEC and EIA recommendations. Capacitance value and voltage are indicated by a marking code in a contrasting colour on the body. Refer to Tables 3 to 12, for marking codes and colours.

Mounting

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

Soldering conditions:

max. 265 °C, max. 10 s.

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

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE(1)	W(2) (mm)	H(2) (mm)	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	5.3 (–1.8)	8.1 (–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

Notes

1. Unless indicated in Tables 4 to 12, the thickness of the capacitors does not exceed 2.3 mm.
2. Tolerances are given between parentheses.

PACKAGING

For details refer to Chapter *"Miniature ceramic plate capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

PITCH P	LEAD DIAMETER d	CATALOGUE NUMBERS(1)				
		BULK PACKED		ON TAPE (REEL)	ON TAPE(2) (AMMOPACK)	ON TAPE(3) (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 692	2222 691 .....

Notes

1. Catalogue numbers to be completed by adding the 5-digit suffix for required capacitance value, see Tables 4 to 12.
2. H_0 = 16 mm.
3. H_0 = 18.25 mm.

Table 3 Conditions for Table 4; capacitors with temperature coefficient **P100**.

DESCRIPTION	VALUE
Capacitance range	0.47 to 33 pF (E12 series)
Temperature coefficient of the capacitance $\left(\frac{\Delta C}{C\Delta T}\right)$	100×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	red/violet

Table 4 **Preferred** capacitance range, temperature coefficient **P100**.

CAPACITANCE VALUE[1] (pF)	TOLERANCE	SIZE (see Table 1)	MARKING CODE		SUFFIX OF CATALOGUE NUMBER (see Table 2)
			VALUE	VOLTAGE[3]	
0.47	±0.25 pF	I[2]	p47	500	03477
0.56	±0.25 pF	I[2]	p56	500	03567
0.68	±0.25 pF	I[2]	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[2]	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

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 2.5 mm.
3. The voltage code may be marked on the front or rear side of the capacitor.

Table 5 Conditions for Table 6; capacitors with temperature coefficient **NP0**.

DESCRIPTION	VALUE
Capacitance range	0.82 to 150 pF (E12 series)
Temperature coefficient of the capacitance $\left(\frac{\Delta C}{C \Delta T}\right)$	0×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	black

Table 6 **Preferred** capacitance range, temperature coefficient **NP0**.

CAPACITANCE VALUE[1] (pF)	TOLERANCE	SIZE (see Table 1)	MARKING CODE		SUFFIX OF CATALOGUE NUMBER (see Table 2)
			VALUE	VOLTAGE[4]	
0.82	±0.25 pF	I[2]	p82	500	09827
1.0	±0.25 pF	I[3]	1p0	500	09108
1.2	±0.25 pF	I[3]	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	I	6p8	500	09688
8.2	±0.25 pF	I	8p2	500	09828
10	±2%	I	10p	500	10109
12	±2%	I	12p	500	10129
15	±2%	IIA	15p	500	10159
18	±2%	IIA	18p	500	10189
22	±2%	IIA	22p	500	10229
27	±2%	IIB	27p	500	10279
33	±2%	IIB	33p	500	10339
39	±2%	IIB	39p	500	10399
47	±2%	III	47p	500	10479
56	±2%	III	56p	500	10569
68	±2%	IV	68p	500	10689
82	±2%	IV	82p	500	10829
100	±2%	IV	n10	500	10101
120	±2%	V	n12	500	10121
150	±2%	V	n15	500	10151

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 2.7 mm.
3. Maximum thickness 2.5 mm.
4. The voltage code may be marked on the front or rear side of the capacitor.

Table 7 Conditions for Table 8; capacitors with temperature coefficient **N150**.

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

Table 8 **Preferred** capacitance range, temperature coefficient **N150**.

CAPACITANCE VALUE(1) (pF)	TOLERANCE	SIZE (see Table 1)	MARKING CODE		SUFFIX OF CATALOGUE NUMBER (see Table 2)
			VALUE	VOLTAGE(3)	
2.2	±0.25 pF	I(2)	2p2	500	33228
2.7	±0.25 pF	I(2)	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	I	8p2	500	33828
10	±2%	I	10p	500	34109
12	±2%	I	12p	500	34129
15	±2%	IIA	15p	500	34159
18	±2%	IIA	18p	500	34189
22	±2%	IIA	22p	500	34229
27	±2%	IIB	27p	500	34279
33	±2%	IIB	33p	500	34339
39	±2%	IIB	39p	500	34399
47	±2%	III	47p	500	34479
56	±2%	III	56p	500	34569
68	±2%	IV	68p	500	34689
82	±2%	IV	82p	500	34829
100	±2%	IV	n10	500	34101
120	±2%	V	n12	500	34121
150	±2%	V	n15	500	34151

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 2.5 mm.
3. The voltage code may be marked on the front or rear side of the capacitor.

Table 9 Conditions for Table 10; capacitors with temperature coefficient **N750**.

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

Table 10 Preferred capacitance range, temperature coefficient **N750.**

CAPACITANCE VALUE[1] (pF)	TOLERANCE	SIZE (see Table 1)	MARKING CODE		SUFFIX OF CATALOGUE NUMBER (see Table 2)
			VALUE	VOLTAGE[5]	
1.8	±0.25 pF	I[2]	1p8	500	57188
2.2	±0.25 pF	I[3]	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[4]	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
150	±2%	V	n15	500	58151

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 3.0 mm.
3. Maximum thickness 2.5 mm.
4. Maximum thickness 2.7 mm.
5. The voltage code may be marked on the front or rear side of the capacitor.

Table 11 Conditions for Table 12; capacitors with temperature coefficient **N1500**.

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

Table 12 Preferred capacitance range, temperature coefficient **N1500**.

CAPACITANCE VALUE[1] (pF)	TOLERANCE	SIZE (see Table 1)	MARKING CODE		SUFFIX OF CATALOGUE NUMBER (see Table 2)
			VALUE	VOLTAGE[4]	
8.2	±0.25 pF	I[2]	8p2	500	69828
10	±2%	I[3]	10p	500	70109
12	±2%	I[3]	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
330	±2%	V	n33	500	70331

Notes

1. Other capacitance values and tolerances are available on request.
2. Maximum thickness 3.0 mm.
3. Maximum thickness 2.5 mm.
4. The voltage code may be marked on the front or rear side of the capacitor.

ELECTRICAL CHARACTERISTICS

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%.

DESCRIPTION	VALUE
Capacitance values (note 1) measured at 1 MHz, ≤5 V	see Tables 4 to 12
Rated DC voltage	500 V
DC test voltage; duration 1 minute	1250 V
DC test voltage of coating; duration 1 minute	1250 V
Insulation resistance at 500 V (DC) after 1 minute	>10000 MΩ
Tan δ (note 1) measured at 1 MHz, ≤5 V:	
$C \leq 50$ pF	$\leq 15 \left(\frac{15}{C} + 0.7\right) \times 10^{-4}$
$C > 50$ pF	$\leq 15 \times 10^{-4}$
Category temperature range	−55 to +85 °C
Storage temperature range	−55 to +85 °C
Climatic category (IEC 68)	55/085/21

Note

1. Including 2 mm per connecting lead.

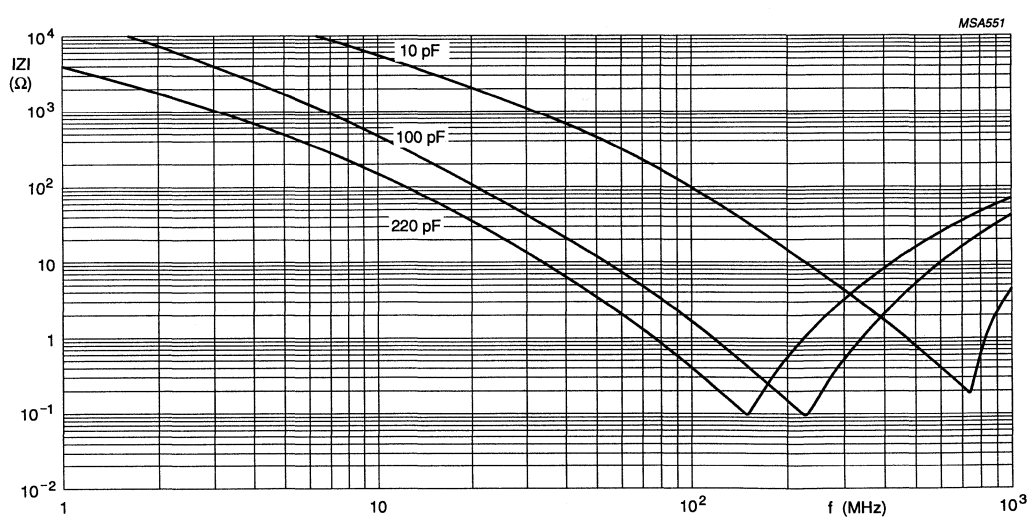


Fig.4 Typical impedance |Z| as a function of frequency.

Miniature ceramic plate capacitors

Class 2, 500 V (DC) (flanged types)

FEATURES

- General purpose
- Coupling and decoupling
- Space saving.

APPLICATIONS

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 using 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.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Capacitance range	100 to 4700 pF (E12 series)
Dielectric material	K2000
Rated DC voltage	500 V
Tolerance on capacitance	±10%
Sectional specification	IEC 384-9 (2C2 and 2E1)
Climatic category (IEC 68)	55/125/56

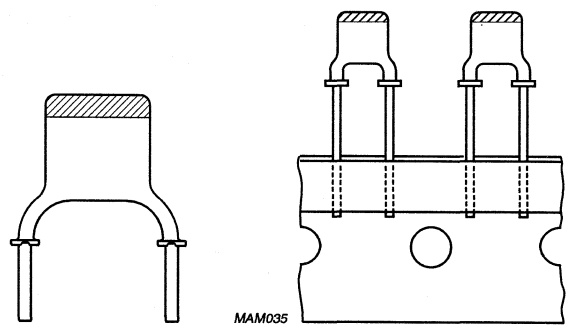
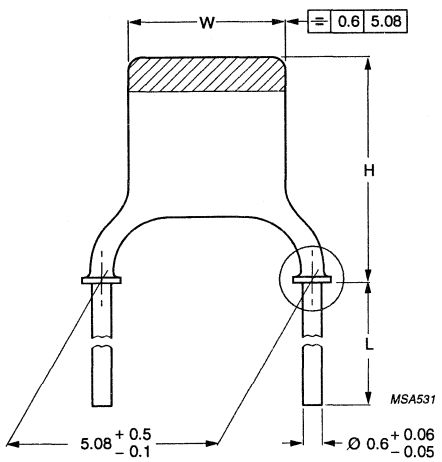


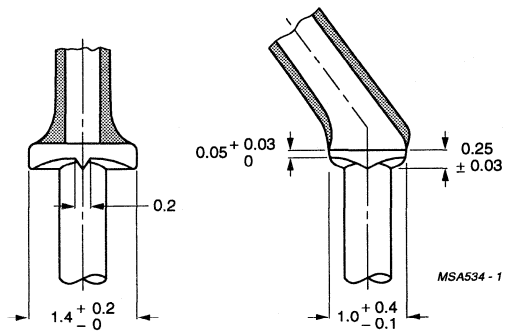
Fig.1 Outline.

MECHANICAL DATA



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

Fig.2 Component outline.



Dimensions in mm.

Fig.3 Detail of flange.

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 should be relieved of the applied load by supporting them at the capacitor body.

Soldering conditions:

max. 265 °C, max. 10 s.

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

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE(1)	W(2) (mm)	H(2) (mm)	MASS (g)
I	3.6 (–1.1)	6.3 (–1.8)	≈0.14
IIA	3.9 (–1.4)	6.7 (–2.0)	≈0.15
IIB	4.5 (–1.8)	7.3 (–2.4)	≈0.15
III	5.3 (–1.8)	8.1 (–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

Notes

1. Unless indicated in Table 3, the thickness of the capacitors does not exceed 2.3 mm.
2. Tolerances are given between parentheses.

PACKAGING

For details refer to Chapter *"Miniature ceramic plate capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

PITCH P	LEAD DIAMETER d	CATALOGUE NUMBERS(1)				
		BULK PACKED		ON TAPE (REEL)	ON TAPE(2) (AMMOPACK)	ON TAPE(3) (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 64...	2222 655 63...

Notes

1. Catalogue numbers to be completed by adding the last 3-digit suffix for required capacitance value, see Table 3.
2. H_0 = 16 mm.
3. H_0 = 18.25 mm.

Table 3 Preferred range of values.

CAPACITANCE VALUE (pF)	SIZE (see Table 1)	MARKING CODE		SUFFIX OF CATALOGUE NUMBERS (see Table 2)
		VALUE	VOLTAGE[3]	
100	I[1]	n10	500 V	101
120	I[2]	n12	500 V	121
150	I	n15	500 V	151
180	I	n18	500 V	181
220	I	n22	500 V	221
270	I	n27	500 V	271
330	I	n33	500 V	331
390	I	n39	500 V	391
470	IIA	n47	500 V	471
560	IIA	n56	500 V	561
680	IIB	n68	500 V	681
820	IIB	n82	500 V	821
1000	IIB	1n0	500 V	102
1200	IIB	1n2	500 V	122
1500	III	1n5	500 V	152
1800	III	1n8	500 V	182
2200	IV	2n2	500 V	222
2700	IV	2n7	500 V	272
3300	V	3n3	500 V	332
3900	V	3n9	500 V	392
4700	V	4n7	500 V	472

Notes

1. Maximum thickness 2.7 mm.
2. Maximum thickness 2.5 mm.
3. The voltage code may be marked on the front or rear side of the capacitor.

ELECTRICAL CHARACTERISTICS

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%.

DESCRIPTION	VALUE
Capacitance values measured at 1 kHz, 1 V	100 to 4700 pF (E12 series)
Tolerance on the capacitance, after 1000 hours	±10%
Dielectric material	K2000
Rated DC voltage	500 V
DC test voltage; duration 1 minute	1250 V
DC test voltage of coating; duration 1 minute	1250 V
Insulation resistance at 500 V (DC) after 1 minute	>4000 MΩ
Tan δ measured at 1 kHz, 1 V	<3.5%
Category temperature range	−55 to +85 °C (2C2) and −55 to +125 °C (2E1)
Storage temperature range	−55 to +85 °C
Capacitance change as a function of temperature	see Fig.4
Capacitance change as a function of frequency	see Fig.5
Climatic category (IEC 68)	55/125/56
Ageing	typical 1.5% per time decade

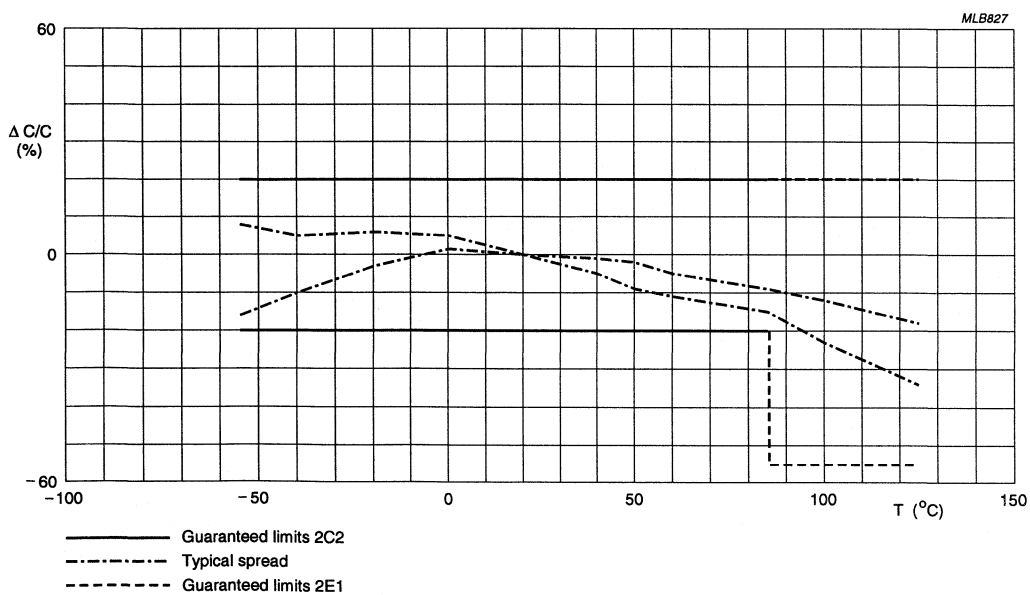
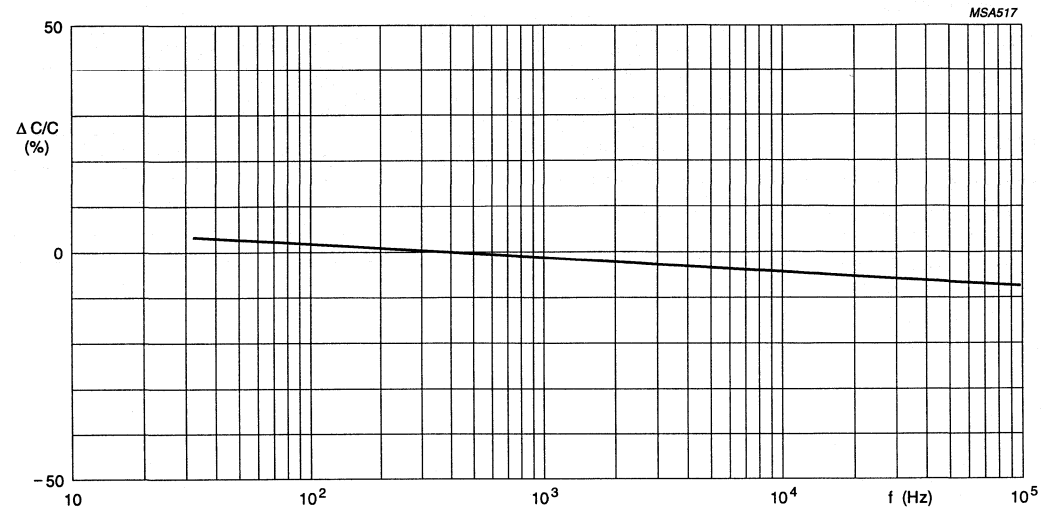


Fig.4 Typical capacitance change with respect to the capacitance at 20 °C as a function of temperature.



U = 1 V (DC).

Fig.5 Typical capacitance change with respect to the capacitance at 300 Hz as a function of frequency.

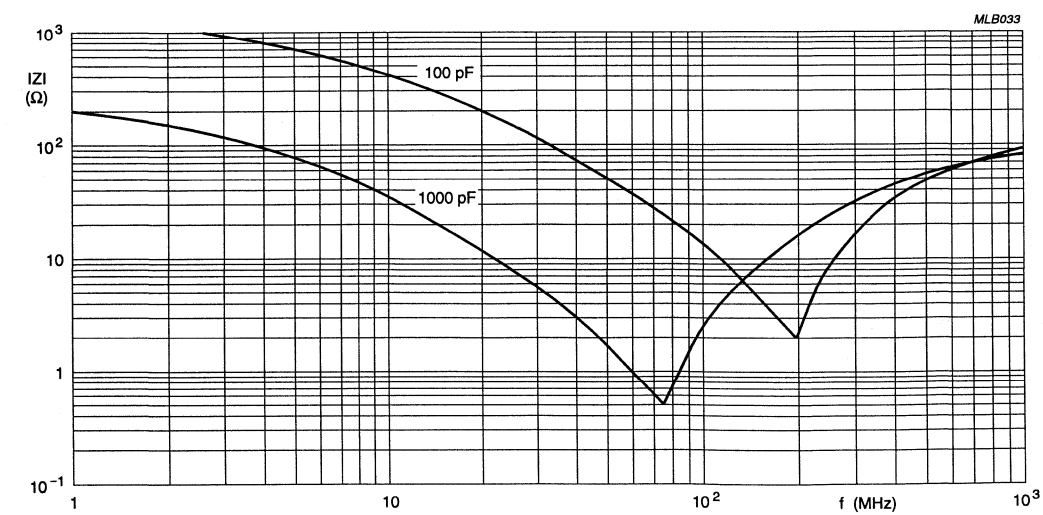


Fig.6 Typical impedance |Z| as a function of frequency.

Miniature ceramic plate capacitors

Class 1, 1000 V (DC) (flanged types)

FEATURES

- High-frequency circuits
- High stability
- Space saving.

APPLICATIONS

In a great variety of electronic circuits, e.g. in filters and tuning circuits where stability and low losses are a requirement. Because of their small size the capacitors are suitable for use in circuitry with high component density such as SMPS.

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized, and tinned connecting leads are secured using 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, which 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 5%), high stability and, owing to the absence of silver, an extremely good DC behaviour.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Capacitance range	0.47 to 120 pF (E12 series)
Rated DC voltage	1000 V
Tolerance on capacitance	±5% or ±0.25 pF
Temperature coefficients	SL (+150 to -1500×10^{-6}/K)
Sectional specification	IEC 384-8
Climatic category (IEC 68)	55/085/21

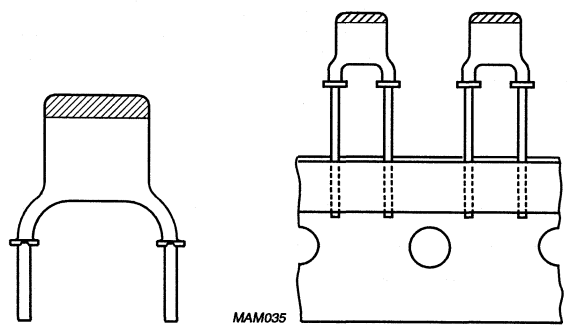
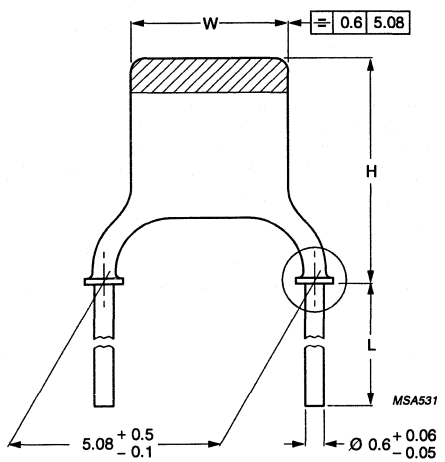


Fig.1 Outlines.

Miniature ceramic plate capacitors

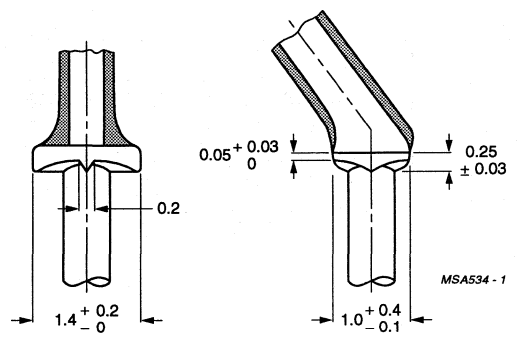
Class 1, 1000 V (DC) (flanged types)

MECHANICAL DATA



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

Fig.2 Component outline.



Dimensions in mm.

Fig.3 Detail of flange.

Marking

The body of the capacitors is coloured tan. Capacitance value and voltage are indicated by a marking code in a contrasting colour on the body. Refer to Tables 3 and 4 for colour and marking codes.

Mounting

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

Soldering conditions:

max. 265 °C, max. 10 s.

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

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE(1)	W(2) (mm)	H(2) (mm)	MASS (g)
I	3.6 (–1.1)	6.3 (–1.8)	≈0.14
IIA	3.9 (–1.4)	6.7 (–2.0)	≈0.15
IIB	4.5 (–1.8)	7.3 (–2.4)	≈0.15
III	5.3 (–1.8)	8.1 (–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

Notes

1. Unless indicated in Table 4, the thickness of the capacitors does not exceed 3 mm.
2. Tolerances are given between parentheses.

PACKAGING

For details refer to Chapter *"Miniature ceramic plate capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

PITCH P	LEAD DIAMETER d	CATALOGUE NUMBERS(1)				
		BULK PACKED		ON TAPE (REEL)	ON TAPE(2) (AMMOPACK)	ON TAPE(3) (AMMOPACK)
		L ≥ 13 mm	L = 4 ±0.5 mm			
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2222 694 09...	2222 694 19...	2222 694 53...	2222 694 64...	2222 694 63...

Notes

1. Catalogue numbers to be completed by adding the last 3-digit suffix for required capacitance value, see Table 4.
2. H_0 = 16 mm.
3. H_0 = 18.25 mm.

Table 3 Conditions for Table 4; capacitors with temperature coefficient **SL**.

DESCRIPTION	VALUE
Capacitance range	0.47 to 120 pF (E12 series)
Temperature coefficient of the capacitance $\left(\frac{\Delta C}{C \Delta T}\right)$	$+150 \times 10^{-6}$/K to -1500×10^{-6}/K
Marking colour of the temperature coefficient	none

Table 4 Preferred capacitance range, temperature coefficient **SL**.

CAPACITANCE VALUE[1] (pF)	TOLERANCE	SIZE (see Table 1)	MARKING CODE		SUFFIX OF CATALOGUE NUMBER (see Table 2)
			VALUE	VOLTAGE[2]	
0.47	±0.25 pF	I	p47	1 kV	477
0.56	±0.25 pF	I	p56	1 kV	567
0.68	±0.25 pF	I	p68	1 kV	687
0.82	±0.25 pF	I	p82	1 kV	827
1.0	±0.25 pF	I	1p0	1 kV	108
1.2	±0.25 pF	I	1p2	1 kV	128
1.5	±0.25 pF	I	1p5	1 kV	158
1.8	±0.25 pF	I	1p8	1 kV	188
2.2	±0.25 pF	I	2p2	1 kV	228
2.7	±0.25 pF	I	2p7	1 kV	278
3.3	±0.25 pF	I	3p3	1 kV	338
3.9	±0.25 pF	I	3p9	1 kV	398
4.7	±0.25 pF	I	4p7	1 kV	478
5.6	±0.25 pF	I	5p6	1 kV	568
6.8	±0.25 pF	I	6p8	1 kV	688
8.2	±0.25 pF	I	8p2	1 kV	828
10	±5%	I	10p	1 kV	109
12	±5%	I	12p	1 kV	129
15	±5%	IIA	15p	1 kV	159
18	±5%	IIA	18p	1 kV	189
22	±5%	IIB	22p	1 kV	229
27	±5%	IIB	27p	1 kV	279
33	±5%	III	33p	1 kV	339
39	±5%	III	39p	1 kV	399
47	±5%	III	47p	1 kV	479
56	±5%	IV	56p	1 kV	569
68	±5%	IV	68p	1 kV	689
82	±5%	V	82p	1 kV	829
100	±5%	V	n10	1 kV	101
120	±5%	V	n12	1 kV	121

Notes

1. Other capacitance values and tolerances are available on request.
2. The voltage code may be marked on the front or rear side of the capacitor.

ELECTRICAL CHARACTERISTICS

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%.

DESCRIPTION	VALUE
Capacitance values (note 1) measured at 1 MHz, ≤5 V	see Table 4
Rated DC voltage	1000 V
DC test voltage; duration 1 minute	2000 V
DC test voltage of coating; duration 1 minute	2000 V
Insulation resistance at 500 V (DC) after 1 minute	>10 000 MΩ
Tan δ (note 1) measured at 1 MHz, ≤5 V:	
$C \leq 50$ pF	$\leq 15 \left(\frac{15}{C} + 0.7\right) \times 10^{-4}$
$C > 50$ pF	$\leq 15 \times 10^{-4}$
Category temperature range	−55 to +85 °C
Storage temperature range	−55 to +85 °C
Climatic category (IEC 68)	55/085/21

Note

1. Including 2 mm per connecting lead.

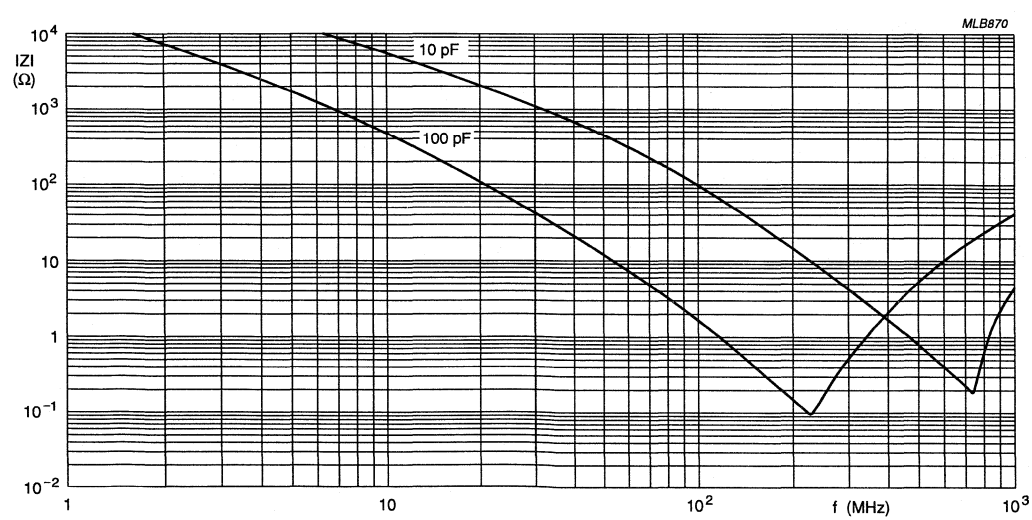


Fig.4 Typical impedance |Z| as a function of frequency.

Miniature ceramic plate capacitors

Class 1, 500 V (DC) (non-flanged types)

FEATURES

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

APPLICATIONS

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 using 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 or 2%), high stability and, owing to the absence of silver, an extremely good DC behaviour.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Capacitance range	0.47 to 330 pF (E12 series)
Rated DC voltage	500 V
Tolerance on capacitance	±2% or ±0.25 pF
Temperature coefficients	P100, NP0, N150, N750 and N1500
Sectional specification	IEC 384-8
Climatic category (IEC 68)	55/085/21

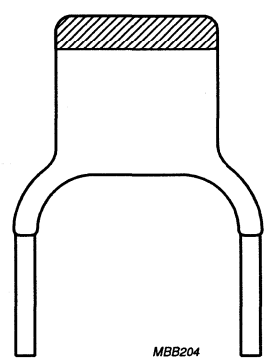


Fig.1 Outline.

Miniature ceramic plate capacitors

Class 1, 500 V (DC) (non-flanged types)

MECHANICAL DATA

Marking

The temperature coefficient is indicated by a colour code in accordance with IEC and EIA recommendations. Capacitance value and voltage are indicated by a marking code in a contrasting colour on the body. Refer to the Tables of data sheet *"Class 1, 500 V (DC) (flanged types)"* for marking codes and colour.

Mounting

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

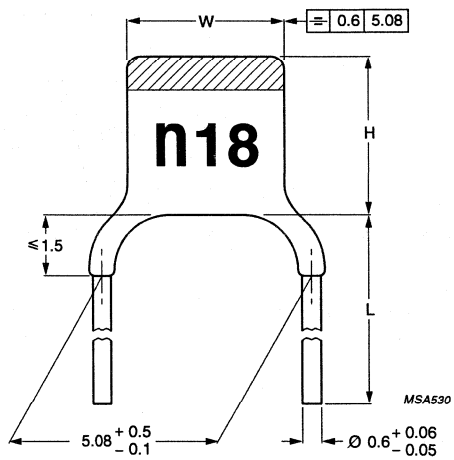
Soldering conditions:

max. 265 °C, max. 10 s.

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

Lacquer on the leads

When the capacitors are mounted on printed-circuit boards with a thickness of 1.5 mm and with holes of 1.3 mm diameter or on printed-circuit 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.



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

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE(1)	W(2) (mm)	H(2) (mm)	MASS (g)
I	3.6 (–1.1)	3.7 (–1.2)	≈0.14
IIA	3.9 (–1.4)	4.0 (–1.5)	≈0.15
IIB	4.5 (–1.8)	4.7 (–2.0)	≈0.16
III	5.3 (–1.8)	5.5 (–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

Notes

1. Unless indicated in the Tables of data sheet *"Class 1, 500 V (DC) (flanged types)"* the thickness of the capacitors does not exceed 2.3 mm.
2. Tolerances are given between parentheses. The H_{max} of capacitors with thickness exceeding 2.3 mm is 4.5 mm.

Miniature ceramic plate capacitors

Class 1, 500 V (DC) (non-flanged types)

PACKAGING

For details refer to Chapter *"Miniature ceramic plate capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

PITCH P	LEAD DIAMETER d	CATALOGUE NUMBERS(1)	
		L ≥ 15 mm	L = 6 $^{+0}/_{-2}$ mm
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2222 650	2222 651 .....

Note

1. Catalogue number to be completed by adding the 5-digit suffix for required capacitance value. Refer to the Tables of data sheet *"Class 1, 500 V (DC) (flanged types)"* for catalogue numbers.

Miniature ceramic plate capacitors

Class 2, 500 V (DC) (non-flanged types)

FEATURES

- Coupling and decoupling
- Space saving.

APPLICATIONS

Ceramic plate capacitors without flanges are not intended 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 using 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.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Capacitance range	100 to 4700 pF (E12 series)
Tolerance on capacitance	±10%
Dielectric material	K2000
Rated DC voltage	500 V
Sectional specification	IEC 384-9 (2C2 and 2E1)
Climatic category (IEC 68)	55/125/56

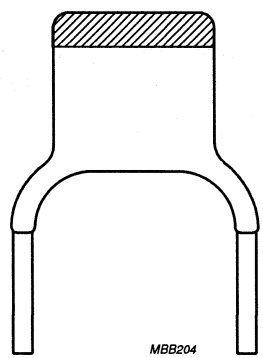


Fig.1 Outline.

MECHANICAL DATA

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

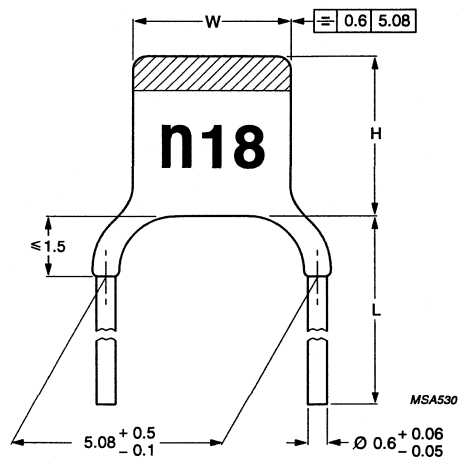
When bending, cutting or flattening, the leads should be relieved of the applied load by supporting them at the capacitor body.

Soldering conditions:

max. 265 °C, max. 10 s.

Lacquer on the leads

When the capacitors are mounted on printed-circuit boards with a thickness of 1.5 mm and with holes of 1.3 mm diameter or on printed-circuit 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 the capacitance value indicated by note 1 in Table 3, the lacquer on the leads is less than 2 mm.



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

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE(1)	W(2) (mm)	H(2) (mm)	MASS (g)
I	3.6 (–1.1)	3.7 (–1.2)	≈0.14
IIA	3.9 (–1.4)	4.0 (–1.5)	≈0.15
IIB	4.5 (–1.8)	4.7 (–2.0)	≈0.16
III	5.3 (–1.8)	5.5 (–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

Notes

1. Unless indicated in the Table 3, the thickness of the capacitors does not exceed 2.3 mm.
2. Tolerances are given between parentheses. The H_{max} of capacitors with thickness exceeding 2.3 mm is 4.5 mm.

PACKAGING

For details refer to Chapter *"Miniature ceramic plate capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

PITCH P	LEAD DIAMETER d	CATALOGUE NUMBERS(1)	
		L ≥ 15 mm	L = 6 $^{+0}/_{-2}$ mm
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2222 655 03...	2222 655 06...

Note

1. Catalogue numbers to be completed by adding the last 3-digit suffix for required capacitance value, see Table 3.

Table 3 Range of values.

CAPACITANCE VALUE (pF)	SIZE (see Table 1)	MARKING CODE		SUFFIX OF CATALOGUE NUMBERS (see Table 2)
		VALUE	VOLTAGE(3)	
100	I(1)	n10	500 V	101
120	I(2)	n12	500 V	121
150	I	n15	500 V	151
180	I	n18	500 V	181
220	I	n22	500 V	221
270	I	n27	500 V	271
330	I	n33	500 V	331
390	I	n39	500 V	391
470	IIA	n47	500 V	471
560	IIA	n56	500 V	561
680	IIB	n68	500 V	681
820	IIB	n82	500 V	821
1000	IIB	1n0	500 V	102
1200	IIB	1n2	500 V	122
1500	III	1n5	500 V	152
1800	III	1n8	500 V	182
2200	IV	2n2	500 V	222
2700	IV	2n7	500 V	272
3300	V	3n3	500 V	332
3900	V	3n9	500 V	392
4700	V	4n7	500 V	472

Notes

1. Maximum thickness 2.7 mm.
2. Maximum thickness 2.5 mm.
3. The voltage code may be marked on the front or side of the capacitor.

ELECTRICAL CHARACTERISTICS

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%.

DESCRIPTION	VALUE
Capacitance values measured at 1 kHz, 1 V	see Table 3
Tolerance on the capacitance, after 1000 h	±10%
Dielectric material	K2000
Rated DC voltage	500 V
DC test voltage; duration 1 minute	1250 V
DC test voltage of coating; duration 1 minute	1250 V
Insulation resistance at 500 V (DC) after 1 minute	>4000 MΩ
Tan δ measured at 1 kHz, 1 V	<3.5%
Category temperature range	–55 to +85 °C (2C2) and –55 to +125 °C (2E1)
Storage temperature range	–55 to +85 °C
Capacitance change as a function of temperature	see Fig.3
Capacitance change as a function of frequency	see Fig.4
Climatic category (IEC 68)	55/125/56
Ageing	typical 1.5% per time decade

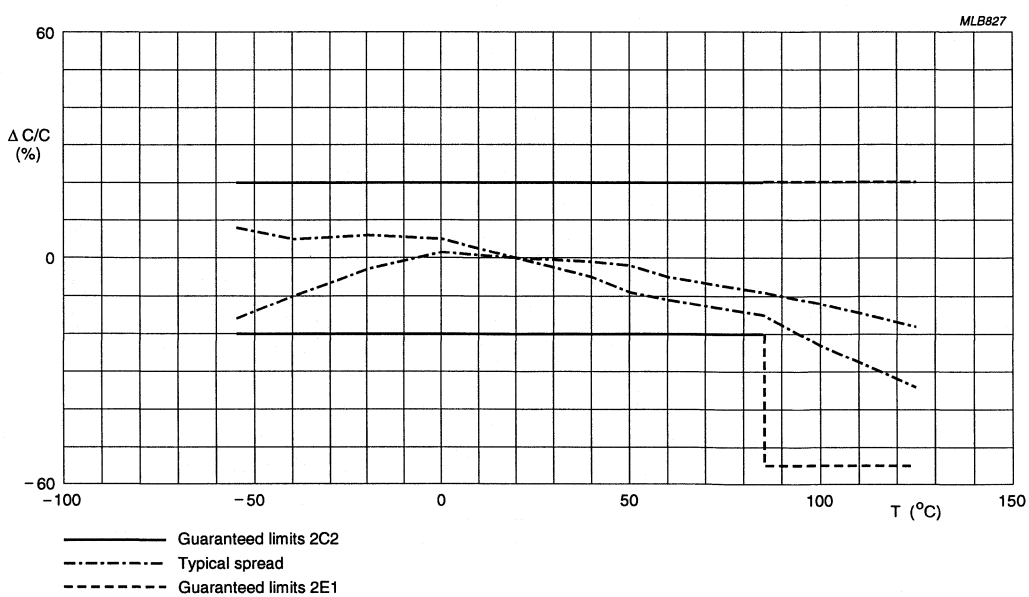
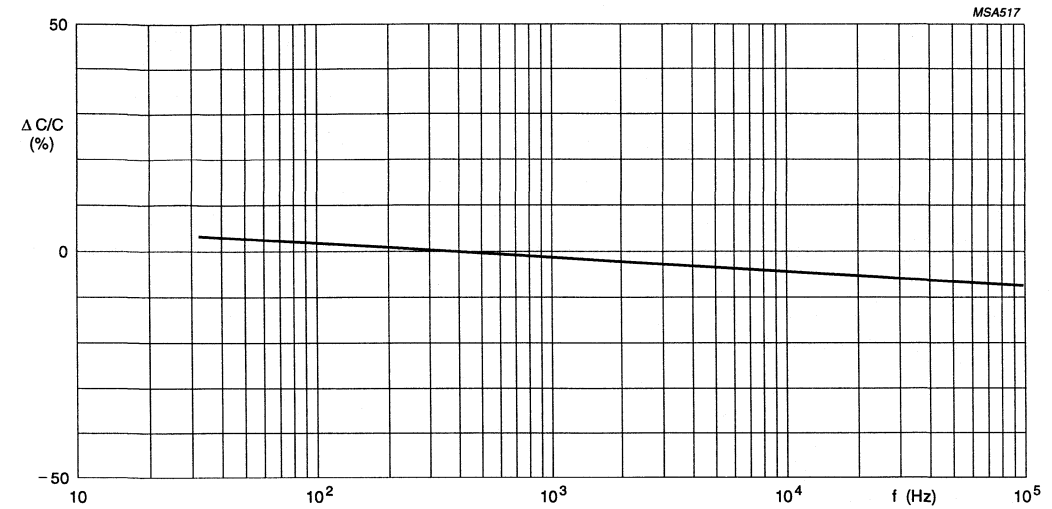


Fig.3 Typical capacitance change with respect to the capacitance at 20 °C as a function of temperature.



U = 1 V.

Fig.4 Typical capacitance change with respect to the capacitance at 300 Hz as a function of frequency.

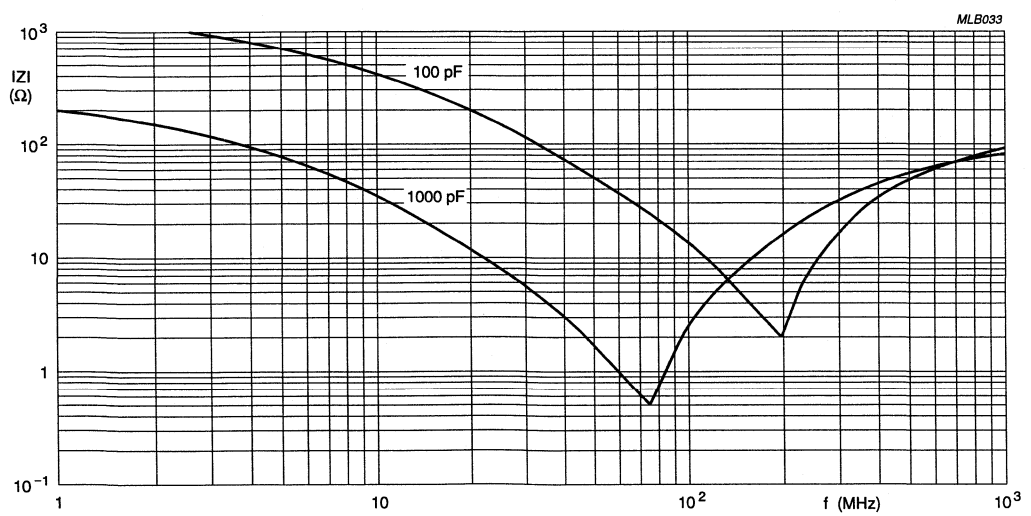


Fig.5 Typical impedance |Z| as a function of frequency.

Miniature ceramic plate capacitors

Class 2, 1000 V (DC) (2E2 flanged types)

FEATURES

- General purpose
- Coupling and decoupling
- Space saving.

APPLICATIONS

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 using 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.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Capacitance range	270 to 3300 pF (E12 series)
Rated DC voltage	1000 V
Tolerance on capacitance	±20%
Sectional specification	IEC 384-9 (2E2)
Climatic category (IEC 68)	55/085/21

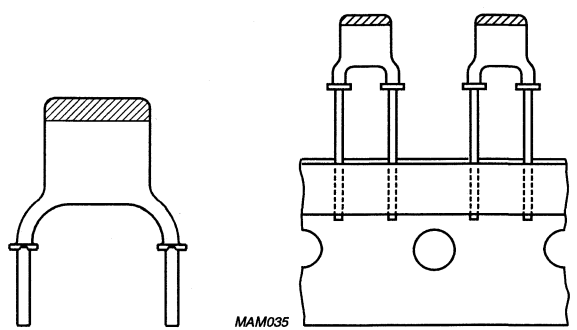
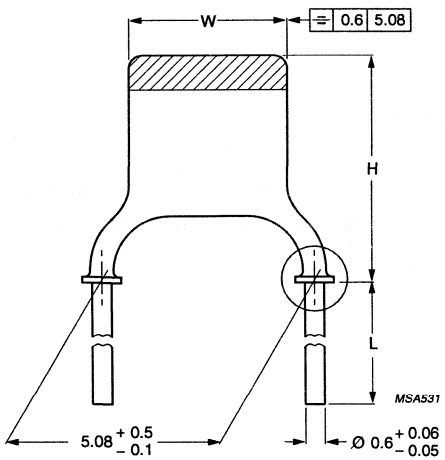


Fig.1 Outline.

Miniature ceramic plate capacitors

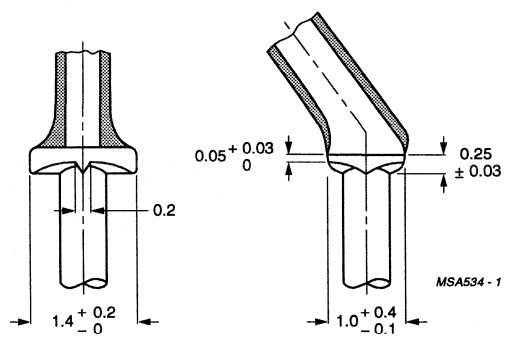
Class 2, 1000 V (DC) (2E2 flanged types)

MECHANICAL DATA



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

Fig.2 Component outline.



Dimensions in mm.

Fig.3 Detail of flange.

Marking

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

Mounting

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

Soldering conditions:

max. 265 °C, max. 10 s.

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

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE(1)	W(2) (mm)	H(2) (mm)	MASS (g)
I	3.6 (–1.1)	6.3 (–1.8)	≈0.15
IIA	3.9 (–1.4)	6.7 (–2.0)	≈0.15
IIB	4.5 (–1.8)	7.3 (–2.4)	≈0.18
III	5.3 (–1.8)	8.1 (–2.6)	≈0.22
IV	6.2 (–2.0)	9.0 (–2.7)	≈0.33
V	6.2 (–2.0)	11.2 (–3.1)	≈0.47

Notes

1. Unless indicated in Table 3, the thickness of the capacitors does not exceed 3.0 mm.
2. Tolerances are given between parentheses.

Miniature ceramic plate capacitors

Class 2, 1000 V (DC) (2E2 flanged types)

PACKAGING

For details refer to Chapter *'Miniature ceramic plate capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

PITCH P	LEAD DIAMETER d	CATALOGUE NUMBERS(1)				
		BULK PACKED		ON TAPE(3) (REEL)	ON TAPE(2) (AMMOPACK)	ON TAPE(3) (AMMOPACK)
		L ≥ 13 mm	L = 4 ±0.5 mm			
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2222 695 09...	2222 695 19...	2222 695 53...	2222 695 64...	2222 695 63...

Notes

1. Catalogue numbers to be completed by adding the 3-digit suffix for required capacitance value, see Table 3.
2. H_0 = 16 mm.
3. H_0 = 18.25 mm.

Table 3 Preferred range of values.

CAPACITANCE VALUE (pF)	SIZE (see Table 1)	MARKING CODE		SUFFIX OF CATALOGUE NUMBERS (see Table 2)
		VALUE	VOLTAGE(1)	
270	I	n27	1 kV	271
330	I	n33	1 kV	331
390	IIA	n39	1 kV	391
470	IIA	n47	1 kV	471
560	IIA	n56	1 kV	561
680	IIB	n68	1 kV	681
820	IIB	n82	1 kV	821
1000	III	1n0	1 kV	102
1200	III	1n2	1 kV	122
1500	III	1n5	1 kV	152
1800	IV	1n8	1 kV	182
2200	IV	2n2	1 kV	222
2700	V	2n7	1 kV	272
3300	V	3n3	1 kV	332

Note

1. The voltage code may be marked on the front or rear side of the capacitor.

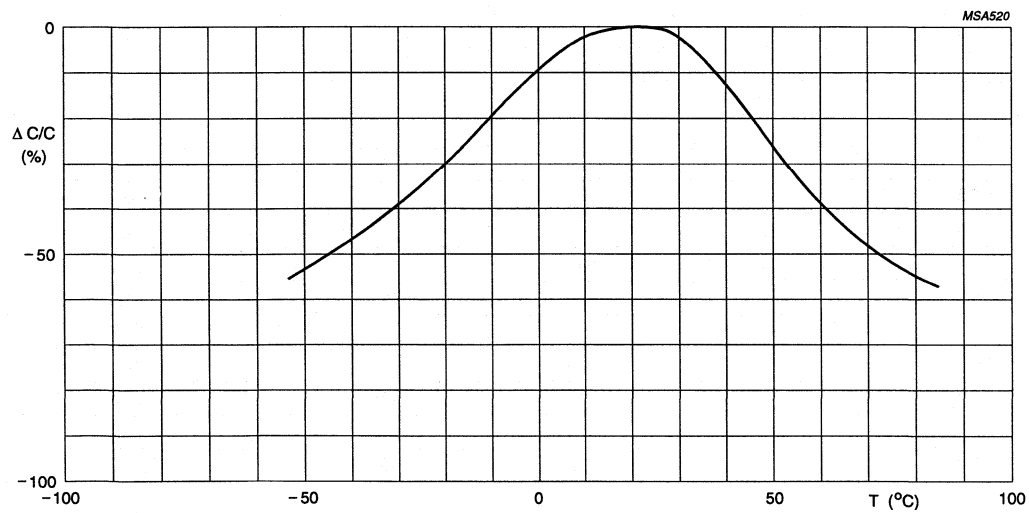
Miniature ceramic plate capacitors

Class 2, 1000 V (DC) (2E2 flanged types)

ELECTRICAL CHARACTERISTICS

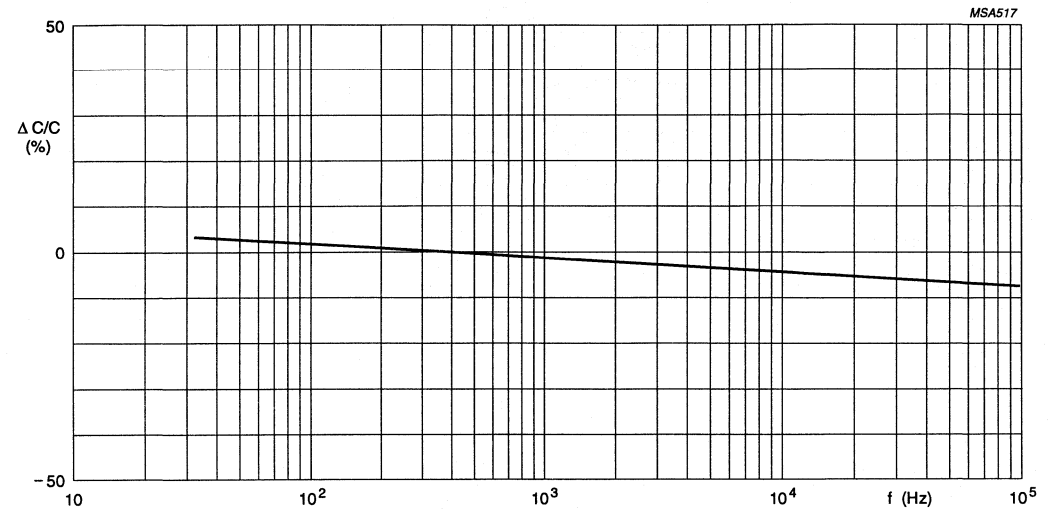
The capacitors meet the essential requirements of *"IEC 384-9"*. Unless stated otherwise all electrical values apply at an ambient temperature of 20 ±1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance values measured at 1 kHz, 1 V	see Table 3
Tolerance on the capacitance, after 1000 hours	±20%
Rated DC voltage	1000 V
DC test voltage; duration 1 minute	2000 V
DC test voltage of coating; duration 1 minute	2000 V
Insulation resistance at 500 V (DC) after 1 minute	>6000 MΩ
Tan δ measured at 1 kHz, 1 V	<3.5%
Category temperature range	–55 to +85 °C (2E2)
Storage temperature range	–55 to +85 °C
Capacitance change as a function of temperature	see Fig.4
Capacitance change as a function of frequency	see Fig.5
Climatic category (IEC 68)	55/085/21
Ageing	typical 5% per time decade



f = 1 kHz.
U = 1 V (DC).

Fig.4 Typical capacitance change with respect to the capacitance at 20 °C as a function of temperature.



U = 1 V (DC).

Fig.5 Typical capacitance change with respect to the capacitance at 300 Hz as a function of frequency.

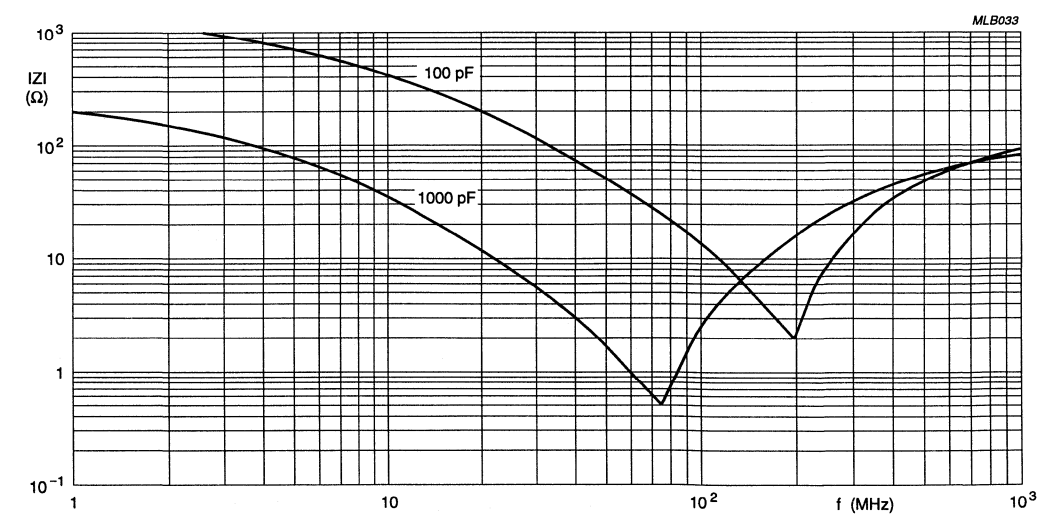


Fig.6 Typical impedance |Z| as a function of frequency.

Miniature ceramic plate capacitors

Class 2, 1000 V (DC) (2C2 and 2E1 flanged types)

FEATURES

- General purpose
- Coupling and decoupling
- Space saving.

APPLICATIONS

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 using 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.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Capacitance range	100 to 1200 pF (E12 series)
Dielectric material	K2000
Rated DC voltage	1000 V
Tolerance on capacitance	±10%
Sectional specification	IEC 384-9 (2C2 and 2E1)
Climatic category (IEC 68)	55/125/56

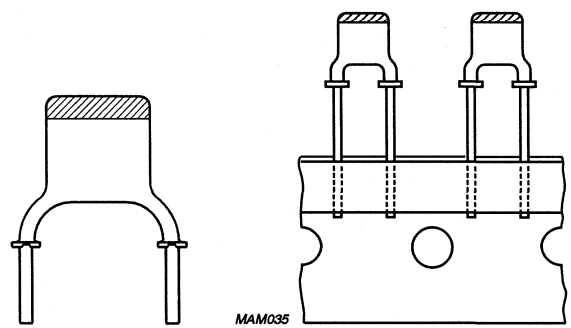
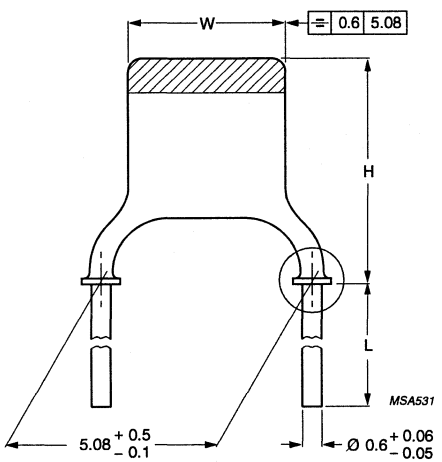


Fig.1 Outline.

Miniature ceramic plate capacitors

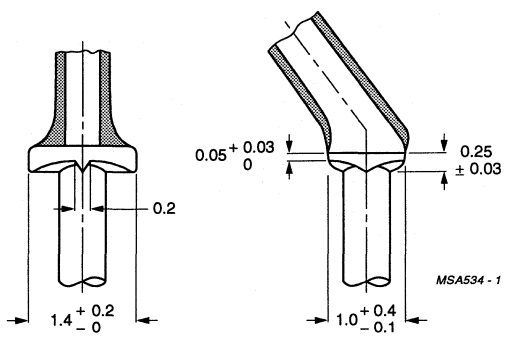
Class 2, 1000 V (DC) (2C2 and 2E1 flanged types)

MECHANICAL DATA



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

Fig.2 Component outline.



Dimensions in mm.

Fig.3 Detail of flange.

Marking

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

Mounting

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

Soldering conditions:

max. 265 °C, max. 10 s.

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

Physical dimensions

Table 1 Capacitor dimensions and mass.

SIZE(1)	W(2) (mm)	H(2) (mm)	MASS (g)
I	3.6 (–1.1)	6.3 (–1.8)	≈0.14
IIA	3.9 (–1.4)	6.7 (–2.0)	≈0.15
IIB	4.5 (–1.8)	7.3 (–2.4)	≈0.15
III	5.3 (–1.8)	8.1 (–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

Notes

1. Unless indicated in Table 3, the thickness of the capacitors does not exceed 3.0 mm.
2. Tolerances are given between parentheses.

PACKAGING

For details refer to Chapter *"Miniature ceramic plate capacitors"*, Section *"General data"*.

ORDERING INFORMATION

Table 2 Catalogue numbers.

PITCH P	LEAD DIAMETER d	CATALOGUE NUMBERS(1)				
		BULK PACKED		ON TAPE(3) (REEL)	ON TAPE(2) (AMMOPACK)	ON TAPE(3) (AMMOPACK)
		L ≥ 13 mm	L = 4 ±0.5 mm			
5.08 mm (0.2 in)	0.6 mm (0.024 in)	2222 693 09...	2222 693 19...	2222 693 53...	2222 693 64...	2222 693 63...

Notes

1. Catalogue numbers to be completed by adding the 3-digit suffix for required capacitance value, see Table 3.
2. H_0 = 16 mm.
3. H_0 = 18.25 mm.

Table 3 Preferred range of values.

CAPACITANCE VALUE (pF)	SIZE (see Table 1)	MARKING CODE		SUFFIX OF CATALOGUE NUMBERS (see Table 2)
		VALUE	VOLTAGE(1)	
100	I	n10	1 kV	101
120	I	n12	1 kV	121
150	IIA	n15	1 kV	151
180	IIA	n18	1 kV	181
220	IIB	n22	1 kV	221
270	IIB	n27	1 kV	271
330	IIB	n33	1 kV	331
390	III	n39	1 kV	391
470	III	n47	1 kV	471
560	IV	n56	1 kV	561
680	IV	n68	1 kV	681
820	IV	n82	1 kV	821
1000	V	1n0	1 kV	102
1200	V	1n2	1 kV	122

Note

1. The voltage code may be marked on the front or rear side of the capacitor.

ELECTRICAL CHARACTERISTICS

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%.

DESCRIPTION	VALUE
Capacitance values measured at 1 kHz, 1 V	see Table 3
Tolerance on the capacitance, after 1000 hours	±10%
Rated DC voltage	1000 V
DC test voltage; duration 1 minute	2000 V
DC test voltage of coating; duration 1 minute	2000 V
Insulation resistance at 500 V (DC) after 1 minute	>6000 MΩ
Tan δ measured at 1 kHz, 1 V	<3.5%
Category temperature range	–55 to +85 °C (2C2) and –55 to +125 °C (2E1)
Storage temperature range	–55 to +85 °C
Capacitance change as a function of temperature	see Fig.4
Capacitance change as a function of frequency	see Fig.5
Climatic category (IEC 68)	55/125/56
Ageing	typical 1.5% per time decade

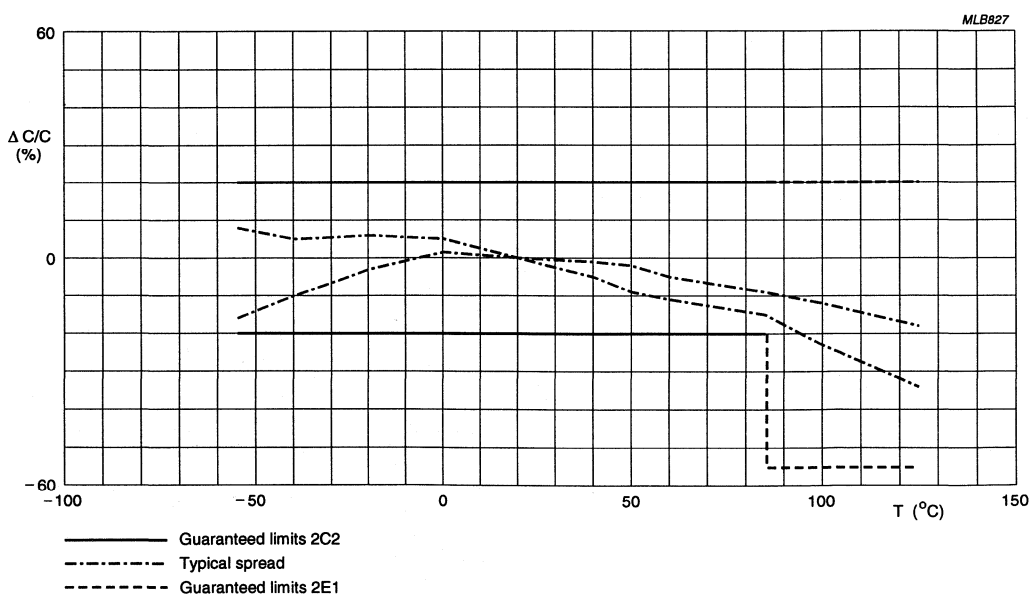
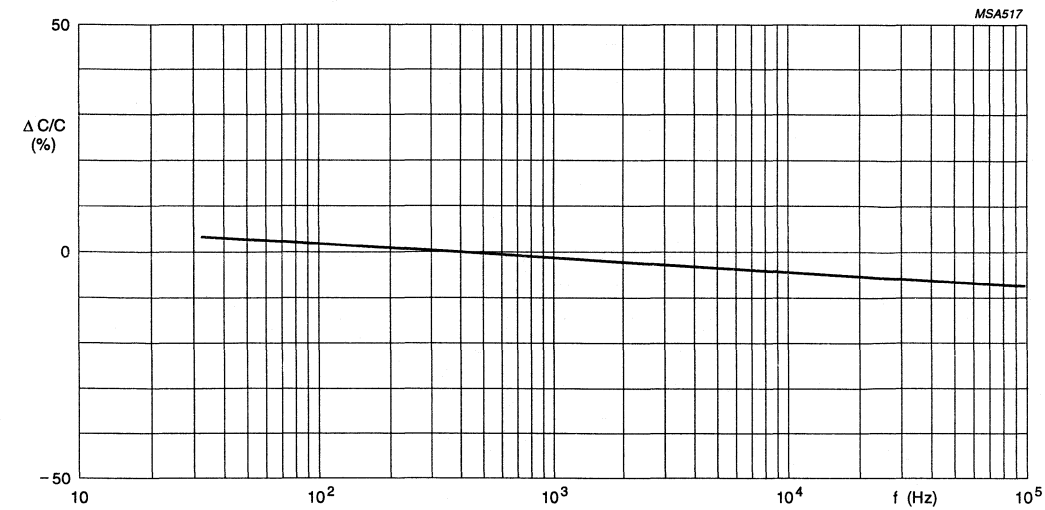


Fig.4 Typical capacitance change with respect to the capacitance at 20 °C as a function of temperature.



U = 1 V.

Fig.5 Typical capacitance change with respect to the capacitance at 300 Hz as a function of frequency.

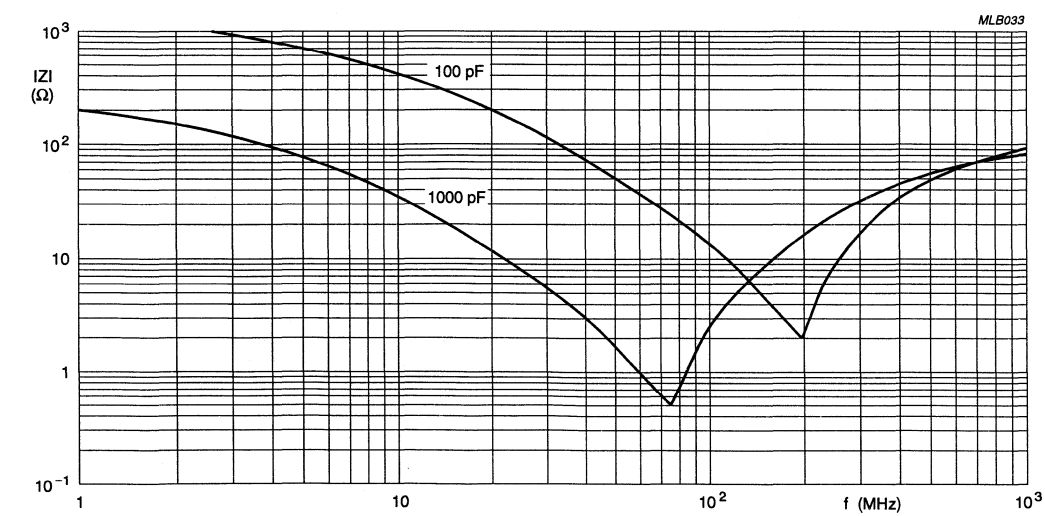


Fig.6 Typical impedance |Z| as a function of frequency.

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Data handbook system

DATA HANDBOOK SYSTEM

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DC03	Television Tuners, Coaxial Aerial Input Assemblies
DC05	Flyback Transformers, Mains Transformers and General-purpose FXC Assemblies

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MA03	Piezoelectric Ceramics and Specialty Ferrites
MA04	Dry-reed Switches

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