PHILIPS

Data handbook

Electronic components and materials

Components and materials

Book C15 1986

Ceramic capacitors

CERAMIC CAPACITORS

DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of four series of handbooks:

ELECTRON TUBES	BLUE
SEMICONDUCTORS	RED
INTEGRATED CIRCUITS	PURPLE
COMPONENTS AND MATERIALS	GREEN

The contents of each series are listed on pages iv to viii.

The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

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The blue series of data handbooks comprises:

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T2a **Transmitting tubes for communications, glass types**

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T3 **Klystrons**

T4 **Magnetrons for microwave heating**

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T6 **Geiger-Müller tubes**

T8 **Colour display systems**
Colour TV picture tubes, colour data graphic display tube assemblies, deflection units

T9 **Photo and electron multipliers**

T10 **Plumbicon camera tubes and accessories**

T11 **Microwave semiconductors and components**

T12 **Vidicon and Newvicon camera tubes**

T13 **Image intensifiers and infrared detectors**

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S1 **Diodes**
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S3 **Small-signal transistors**

S4a **Low-frequency power transistors and hybrid modules**

S4b **High-voltage and switching power transistors**

S5 **Field-effect transistors**

S6 **R.F. power transistors and modules**

S7 **Surface mounted semiconductors**

S8 **Devices for optoelectronics**
Photosensitive diodes and transistors, light-emitting diodes, displays, photocouplers, infrared sensitive devices, photoconductive devices.

S9 **Power MOS transistors**

S10 **Wideband transistors and wideband hybrid IC modules**

S11 **Microwave transistors**

S12 **Surface acoustic wave devices**

S13 **Semiconductor sensors**

INTEGRATED CIRCUITS (PURPLE SERIES)

The purple series of data handbooks comprises:

EXISTING SERIES		Superseded by:
IC1	**Bipolar ICs for radio and audio equipment**	IC01N
IC2	**Bipolar ICs for video equipment**	IC02Na and IC02Nb
IC3	**ICs for digital systems in radio, audio and video equipment**	IC01N, IC02Na and IC02Nb
IC4	**Digital integrated circuits** CMOS HE4000B family	
IC5	**Digital integrated circuits – ECL** ECL10 000 (GX family), ECL100 000 (HX family), dedicated designs	IC08N
IC6	**Professional analogue integrated circuits**	
IC7	**Signetics bipolar memories**	
IC8	**Signetics analogue circuits**	IC11N
IC9	**Signetics TTL logic**	IC09N and IC15N
IC10	**Signetics Integrated Fuse Logic (IFL)**	IC13N
IC11	**Microprocessors, microcomputers and peripheral circuitry**	IC14N

NEW SERIES

IC01N	**Radio, audio and associated systems** Bipolar, MOS	(published 1985)
IC02Na	**Video and associated systems** Bipolar, MOS Types MAB8031AH to TDA1524A	(published 1985)
IC02Nb	**Video and associated systems** Bipolar, MOS Types TDA2501 to TEA1002	(published 1985)
IC03N	**Integrated circuits for telephony**	(published 1985)
IC04N	**HE4000B logic family** CMOS	
IC05N	**HE4000B logic family – uncased ICs** CMOS	(published 1984)
IC06N	**High-speed CMOS; PC54/74HC/HCT/HCU** Logic family	(published 1985)
Supplement to IC06N	**High-speed CMOS; PC74HC/HCT/HCU** Logic family	(published 1985)
IC07N	**High-speed CMOS; PC54/74HC/HCT/HCU – uncased ICs** Logic family	
IC08N	**ECL 10K and 100K logic families**	(published 1984)
IC09N	**TTL logic series**	(published 1984)
IC10N	**Memories** MOS, TTL, ECL	
IC11N	**Linear LSI**	(published 1985)
IC12N	**Semi-custom gate arrays & cell libraries** ISL, ECL, CMOS	
IC13N	**Semi-custom** Integrated Fuse Logic	(published 1985)
IC14N	**Microprocessors, microcontrollers & peripherals** Bipolar, MOS	(published 1985)
IC15N	**FAST TTL logic series**	(published 1984)

Note

Books available in the new series are shown with their date of publication.

COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

C1 **Programmable controller modules**
PLC modules, PC20 modules

C2 **Television tuners, coaxial aerial input assemblies, surface acoustic wave filters**

C3 **Loudspeakers**

C4 **Ferroxcube potcores, square cores and cross cores**

C5 **Ferroxcube for power, audio/video and accelerators**

C6 **Synchronous motors and gearboxes**

C7 **Variable capacitors**

C8 **Variable mains transformers**

C9 **Piezoelectric quartz devices**

C10 **Connectors**

C11 **Non-linear resistors**

C12 **Potentiometers, encoders and switches**

C13 **Fixed resistors**

C14 **Electrolytic and solid capacitors**

C15 **Ceramic capacitors**

C16 **Permanent magnet materials**

C17 **Stepping motors and associated electronics**

C18 **Direct current motors**

C19 **Piezoelectric ceramics**

C20 **Wire-wound components for TVs and monitors**

C21* **Assemblies for industrial use**
HNIL FZ/30 series, NORbits 60-, 61-, 90-series, input devices

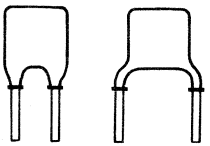
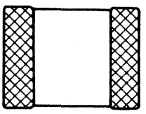
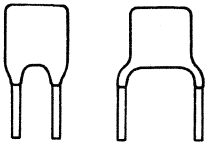
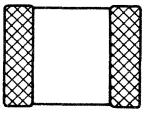
C22 **Film capacitors**

* To be issued shortly

SELECTION GUIDE
INTRODUCTION

SELECTION GUIDE

CERAMIC CAPACITORS

type	class	application	series number 2222 . . .	nominal capacitance pF	rated voltage (U_R) V	page
Plate; leads with flange 	1	high-frequency circuits, temperature compensating, high stability, space saving	678 to 683 689	0,56 to 560	100	33
			652 653 654	0,47 to 270	500	21
			691	0,47 to 270	500	47
	2	general purpose, coupling/decoupling, space saving	629	1000 to 22 000	63	
			630	180 to 4 700	100	11
			640	1000 to 10 000	100	
			655	100 to 2 700	500	29
Multilayer; surface mounted 	1	high-frequency circuits, temperature compensating, high stability, space saving		0,47 to 10 000	50	69
	2	general purpose, coupling/decoupling, space saving		180 to 1 000 000	50	69
Plate; maintenance types 	1	high-frequency circuits, temperature compensating, high stability, space saving	631, 638, 641, 642	0,56 to 560	100	99
			650 651	0,47 to 270	500	113
	2	general purpose, coupling/decoupling, space saving	629	1000 to 22 000	63	
			630	180 to 4 700	100	89
			640	1000 to 10 000	100	
			655	100 to 2 700	500	121
Multilayer; surface mounted 	2	general purpose, coupling/decoupling, space saving		2200 to 100 000	50	125

INTRODUCTION

1. GENERAL

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

Ceramic capacitors can be divided into two classes:

Class 1 In these capacitors dielectric materials are used which have very high specific resistance, very good Q and linear temperature dependence (ϵ_r from 6 up to 250). They are used in such applications as oscillators and filters where low losses, capacitance drift compensation and high stability are required.

Class 2 These capacitors have higher losses and have non-linear temperature characteristics ($\epsilon_r > 250$). They are used for coupling and decoupling.

The survey below shows the various materials we use for plate capacitors and their basic chemical composition.

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

2. CONSTRUCTION

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

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

The working voltage is dependent on the dielectric strength.

Two constructions are shown in the figures below:

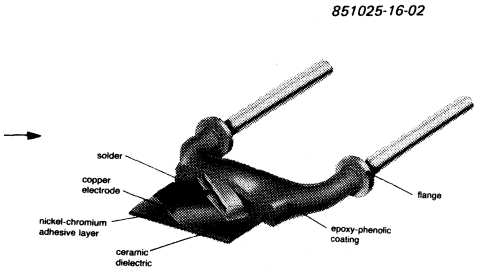


Fig. 1 Plate capacitor.

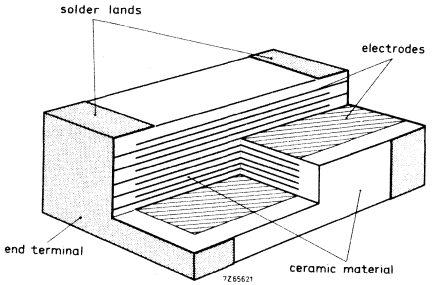


Fig. 2 Cross-section of a multilayer capacitor.

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

The dielectric material

The raw materials are finely ground and carefully mixed. After calcining at a temperature below the dissociation or melting point, the resultant mass is reground. The calcined, finely ground material is mixed with, for instance, water and binding matter. The shapes are obtained by extruding or rolling. A carefully controlled drying sequence follows before the capacitor bodies are fired in a controlled atmosphere at temperatures between 1200 °C and 1400 °C.

Normally the leads are soldered to the electrodes of the capacitor body with a high melting point solder.

The capacitors are lacquered to ensure good behaviour under humid conditions and to protect the electrodes.

The capacitance is marked on the body of the plate capacitors. The temperature coefficient or temperature dependence are indicated by colour coding in accordance with international standards (see the table on the preceding page).

3. EQUIVALENT CIRCUIT

Figure 3 shows the equivalent circuit of a capacitor.

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

R_p is the insulation resistance of insulation and dielectric. Generally R_p is very high, and of decreasing importance with increasing frequency.
R_p also represents the polarization losses of the dielectric material in an alternating electric field.

R_s is the losses in the leads, the electrodes and the contacts. Up to several hundreds of MHz the current penetration depth is greater than the conductor thickness so that no skin-effect occurs. For ceramic capacitors R_s is extremely low.

L is the inductance of the leads and the internal inductance of the capacitor; the latter, however, is almost negligible.
The inductance is only important in high frequency applications, since the capacitor will act as an inductance when the frequency is higher than its resonance frequency.

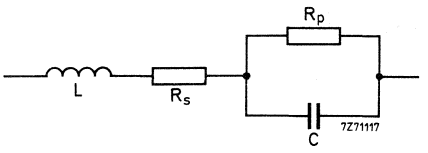


Fig. 3.

4. TANGENT OF THE LOSS ANGLE

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

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

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

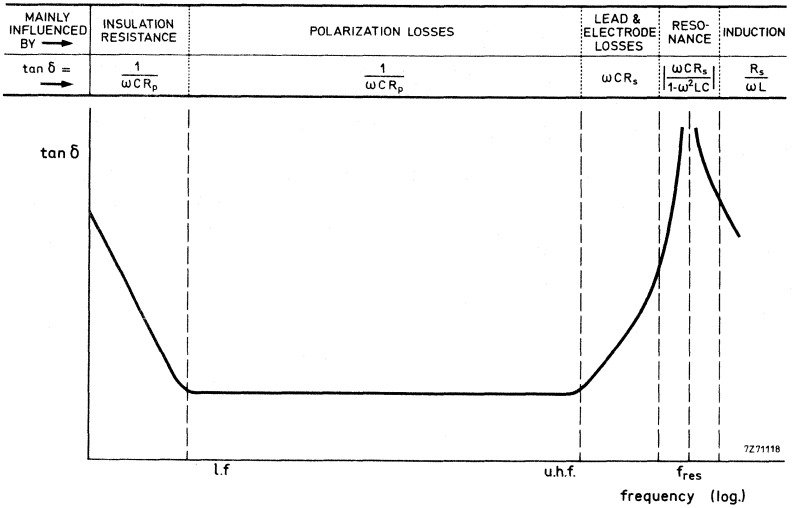


Fig. 4.

5. RELIABILITY

		failure rate (F.R.) in 10^{-6}/h			
		catastrophic + degradation		catastrophic	
		test	normalized	test	normalized
Plate capacitors	2222 629	1,5	0,09	0,33	0,02
	2222 630	0,4	0,01	0,4	0,01
	2222 631–				
	2222 642	2	0,04	1,4	0,03
	2222 650				
	2222 652				
	2222 653				
	2222 654	0,96	0,02	0,37	0,01
	2222 655	1,2	0,03	1,2	0,03
	2222 678–				
	2222 683	2	0,04	1,4	0,03
	2222 689				

Normalized failure rate = F.R. at 25 °C and nominal voltage.
Test failure rate = F.R. at maximum temperature and 1,5 x nominal voltage.

Catastrophic failures are open and short circuits and insulation resistance too low. The degradation failures include

$\tan \delta > 2$ x requirement after 1000 h

$R_{ins} < 0{,}1$ x requirement after 1000 h

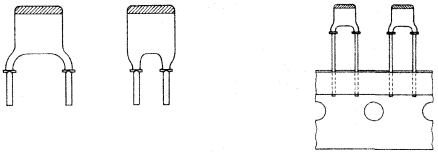
The Failure Rate has a confidence level of 60%.

MINIATURE CERAMIC PLATE CAPACITORS

MINIATURE CERAMIC PLATE CAPACITORS

class 2

- General purpose
- Coupling and decoupling
- Space saving



QUICK REFERENCE DATA

	2222 629-series	2222 630-series	2222 640-series
Capacitance range	1000-22000 pF	180-4700 pF	1000-10000 pF
	E3 series	E12 series	E6 series
Rated d.c. voltage	63 V	100 V	100 V
Tolerance on capacitance	−20/+ 80%	± 10%	−20/+ 50%
Sectional specification	IEC 384-9	IEC 384-9 (2C2)	IEC 384-9 (2E2)
Climatic category (IEC 68)	10/055/21	55/085/21	55/085/21

APPLICATION

Electronic circuits where a non-linear change of capacitance with temperature is permissible and very low losses are not essential, e.g. coupling and decoupling.
Because of their small size and their availability with a pitch of 2,54 mm over the whole range, the capacitors are ideal for circuitry with a 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 with a high melting point solder. The leads are provided with a flange the guarantees leads without lacquer, making these capacitors perfectly suited for automatic insertion.

The capacitors are protected by several layers of tan lacquer that ensures a good behaviour under humid conditions and is resistant to all commonly used cleaning solvents.
No silver migration can occur.

MECHANICAL DATA

Dimensions in mm

→ **Outlines**

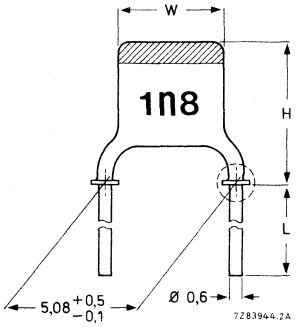


Fig. 1.

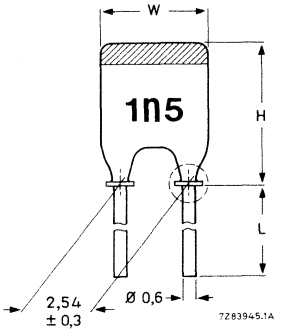
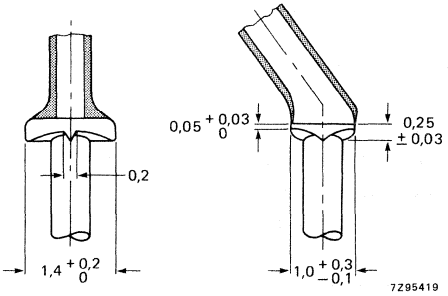


Fig. 2.

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



DETAIL

→ Table 1

lead sparing	lead diam	Fig.	catalogue number *			
			bulk packed		on tape on reel	on tape in ammopack
			L ⩾ 13 mm	L = 4 ± 0,5 mm		
5,08 mm (0,2 in)	0,6 mm (0,024 in)	1	2222 629 09 . . . 2222 630 09 . . . 2222 640 09 . . .	2222 629 19 . . . 2222 630 19 . . . 2222 640 19 . . .	2222 629 53 . . . 2222 630 53 . . . 2222 640 53 . . .	2222 629 63 . . . 2222 630 63 . . . 2222 640 63 . . .
2,54 mm (0,1 in)	0,6 mm (0,024 in)	2	2222 629 08 . . . 2222 630 08 . . . 2222 640 08 . . .	2222 629 18 . . . 2222 630 18 . . . 2222 640 18 . . .	2222 629 51 . . . 2222 630 51 . . . 2222 640 51 . . .	

* 3 dots to be replaced by code for capacitance value, see Tables 3, 4 and 5.

Table 2

size	W(mm)	H(mm) Fig. 1	H(mm) Fig. 2	approx. mass g
I	3,6(−1,1)	6,3(−1,8)	5,0(−1,5)	0,14
IIA	3,9(−1,2)	6,7(−1,8)	5,3(−1,5)	0,15
IIB	4,5(−1,2)	7,3(−1,8)	6,0(−1,5)	0,15
III	5,1(−0,9)	7,9(−1,7)	6,6(−1,4)	0,17
IV	6,2(−1,0)	9,0(−1,7)	7,7(−1,4)	0,20

Note: Tolerances are given between brackets.

The thickness of the capacitors does not exceed 2,3 mm (0,08 in), except for one type as is indicated in Table 4.

Marking

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

Mounting

When bending and cutting or flattening the leads, one should relieve them of the applied load at the capacitor body.

Soldering conditions max. 270 °C, max. 10 s

The capacitors are mounted on printed-wiring boards (hand mounting or automatic insertion). Due to the flange on the leads solder connections are free from lacquer. The flange is provided with a degassing groove.

PACKING

See "General Data on Miniature ceramic plate capacitors", section "Packing".

ELECTRICAL DATA

Capacitors 2222 629 (colour mark green)

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

Capacitance values measured at 1 kHz, 1 V	1000–22 000 pF; E3 series (see Table 3)
Tolerance on the capacitance	−20 to + 80%
Rated d.c. voltage at 55 °C	63 V
Derated d.c. voltage at 85 °C	40 V
Test voltage (d.c.) for 1 min	200 V
Test voltage (d.c.) of coating for 1 min	200 V
→ Insulation resistance at 10 V (d.c.) after 1 min	⩾ 4000 MΩ
Tan δ at 1 kHz, 1 V	⩽ 6,5%
Category temperature range	−10 to + 55 °C
Storage temperature range	−55 to + 85 °C
Climatic category, IEC 68	10/055/21

Table 3

cap. pF	size see Table 2	marking	code in catalogue number, see Table 1
1 000	I	1n0	102
2 200	I	2n2	222
4 700	I	4n7	472
10 000	IIB	10n	103
22 000	IV	22n	223

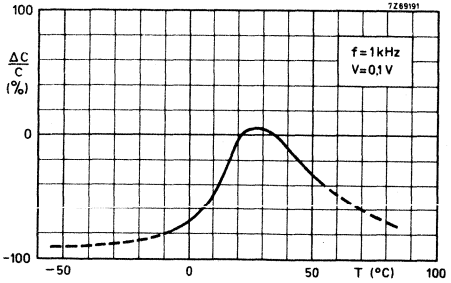


Fig. 3 Typical capacitance change as a function of temperature for capacitance values 2200 pF to 22 000 pF; dotted lines give an indication of the behaviour at higher and lower temperatures.

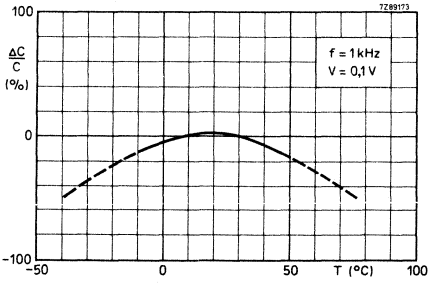


Fig. 4 Typical capacitance change as a function of temperature for capacitance value 1000 pF; dotted lines give an indication of the behaviour at higher and lower temperatures.

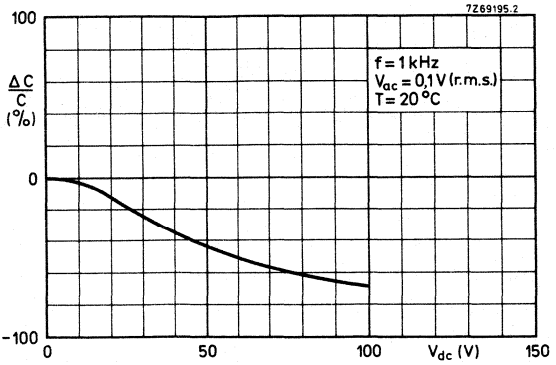


Fig. 5 Typical capacitance change with respect to the capacitance value at 0 V, as a function of d.c. voltage, for capacitance values 2200 to 22 000 pF.

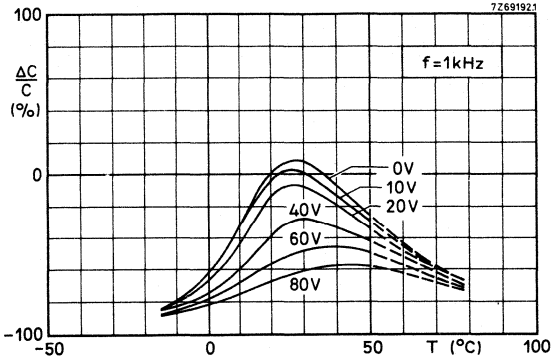


Fig. 6 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different d.c. voltages, for capacitance values 2200 to 22 000 pF; V_{ac} = 0,1 V (r.m.s.).

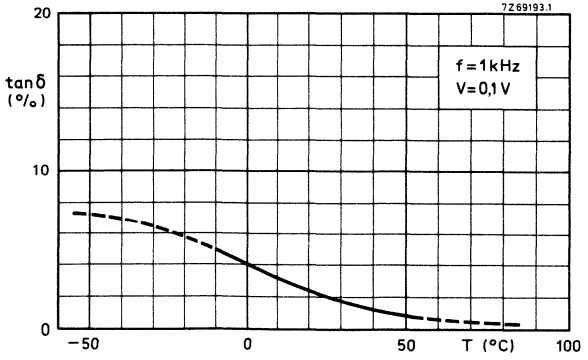


Fig. 7 Typical tan δ as a function of temperature, for capacitance values 2200 to 22 000 pF.

ELECTRICAL DATA (continued)

Capacitors 2222 630 (colour mark yellow)

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

Capacitance values, measured at 1 kHz, 1 V	180 – 4700 pF, E12 series (see Table 4)
Tolerance on the capacitance	± 10%
Rated d.c. voltage	100 V
Test voltage (d.c.) for 1 min	300 V
Test voltage (d.c.) of coating for 1 min	300 V
Insulation resistance at 100 V (d.c.) after 1 min	⩾ 4000 MΩ
Tan δ at 1 kHz, 1 V	⩽ 3,5%
Maximum voltage dependence of the capacitance between 0 and 40 V	−5%
Category temperature range	−55 to + 85 °C
Storage temperature range	−55 to + 85 °C
Climatic category (IEC 68)	55/085/21

Table 4

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

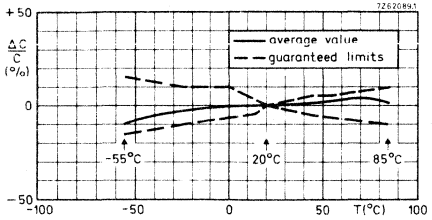


Fig. 8 ΔC with respect to C at 20 °C as a function of temperature. V = 0,1 V, f = 1 kHz.

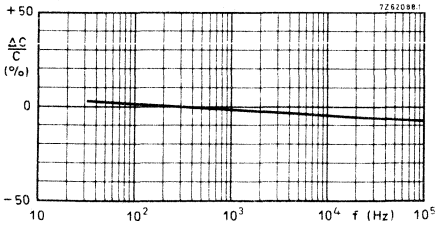


Fig. 9 Typ. ΔC with respect to C at 300 Hz, as a function of frequency. V = 0,1 V.

* Maximum thickness 2,5 mm.

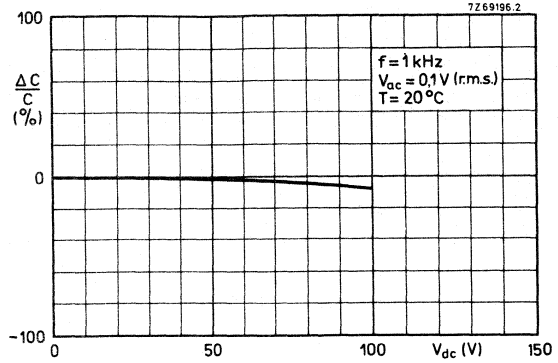


Fig. 10 Typical capacitance change with respect to the capacitance value at 0 V, as a function of d.c. voltage.

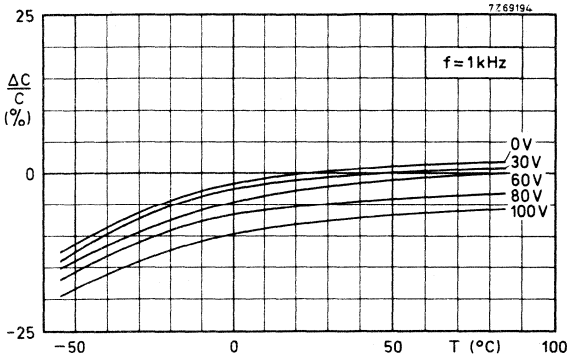


Fig. 11 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different d.c. voltages.
V_{ac} = 0,1 V (r.m.s.).

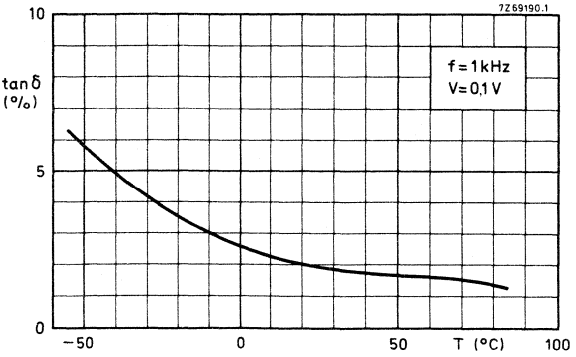


Fig. 12 Typical tan δ as a function of temperature.

ELECTRICAL DATA (continued)

Capacitors 2222 640 (colour mark blue)

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

Capacitance values, measured at 1 kHz, 1 V	1000–10 000 pF; E6 series (see Table 5)
Tolerance on the capacitance	−20 to + 50%
Rated d.c. voltage	100 V
Test voltage (d.c.) for 1 min	300 V
Test voltage (d.c.) of coating for 1 min	300 V
Insulation resistance at 100 V (d.c.) after 1 min	⩾ 3000 MΩ
Tan δ at 1 kHz, 1 V	⩽ 3,5%
Category temperature range	−55 to + 85 °C
Storage temperature range	−55 to + 85 °C
Climatic category (IEC 68)	55/085/21

Table 5

capacitance pF	size see Table 2	marking	code in catalogue number, see Table 1
1000	I	1n0	102
1500	I	1n5	152
2200	I	2n2	222
3300	IIA	3n3	332
4700	IIB	4n7	472
6800	III	6n8	682
10000	IV	10n	103

Graphs,
measured at
V_{ac} = 1 V (r.m.s.)
f = 1 kHz.

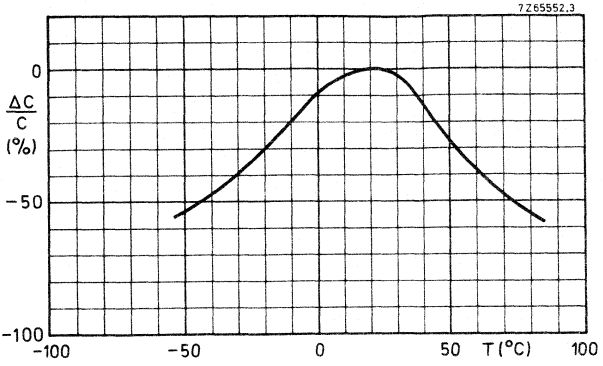


Fig. 13 Typical capacitance change versus temperature at 0 V (d.c.).

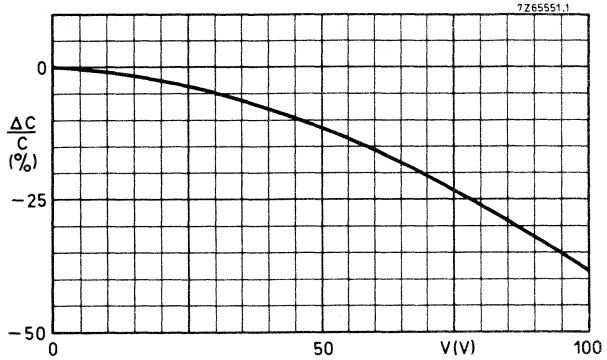


Fig. 14 Typical capacitance change with respect to the capacitance at 20 °C versus d.c. voltage.

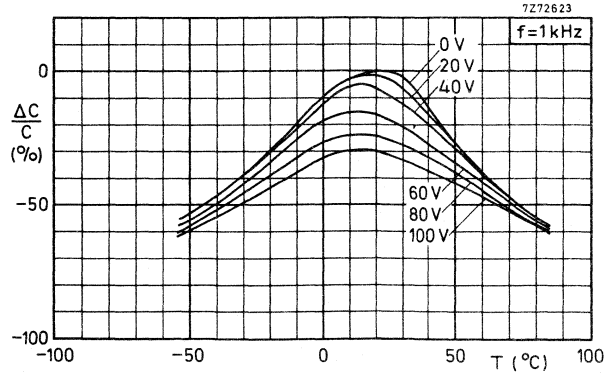
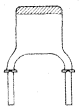


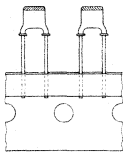
Fig. 15 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different voltages.

MINIATURE CERAMIC PLATE CAPACITORS

class 1, 500 V (d.c.)

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





QUICK REFERENCE DATA

Capacitance range	0,47 to 270 pF (E12 series)
Rated d.c. voltage	500 V
Tolerance on capacitance	± 2% or ± 0,25 pF
Temperature coefficients	P100, NP0, N150, N750, N1500
Sectional specification	IEC 384-8, sub-class 1B
Category (IEC 68)	55/085/21

APPLICATION

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

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized and provided with connecting leads. They are insulated by a coating that ensures a good behaviour under humid conditions. The colour of the capacitor body is grey. The capacitors distinguish themselves by small dimensions and narrow tolerances on the lead spacing. The leads are provided with a flange, that guarantees leads without lacquer, making them perfectly suited for automatic insertion.
The electrical properties are characterized by low losses, a very close standard tolerance on the capacitance (± 0,25 pF or 2%), high stability and, owing to the absence of silver, an extremely good d.c. behaviour.

MECHANICAL DATA

Dimensions in mm

Outlines

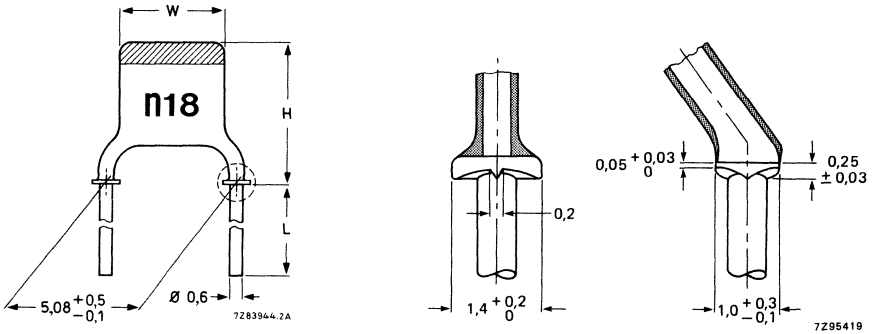


Fig. 1.

DETAIL

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

Table 1

lead sparing	lead diam	catalogue number *		
		bulk packed		on tape on reel
		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 . . . . .

Table 2

size	W	H	approx. mass g
I	3,6(−1,1)	6,3(−1,8)	0,15
IIA	3,9(−1,2)	6,7(−1,8)	0,15
IIB	4,5(−1,2)	7,3(−1,8)	0,16
III	5,1(−0,9)	7,9(−1,7)	0,17
IV	6,2(−1,0)	9,0(−1,7)	0,21
V	6,2(−1,0)	11,2(−2,1)	0,23

Note: Tolerances are given between brackets.

Except for the types indicated in Tables 3 to 7, the thickness of the capacitor does not exceed 2,3 mm.

* For catalogue number suffix see Tables 3 to 7.

Marking

The temperature coefficient is indicated by a colour code as per IEC and EIA recommendations. The capacitance value and the voltage are indicated on the body by figures in a contrasting colour, see Tables 3 to 7.

Mounting

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

Soldering conditions max. 270 °C, max. 10 s

The capacitors are mounted on printed-wiring boards (hand mounting or automatic insertion). Due to the flange on the leads solder connections are free from lacquer. The flange is provided with a degassing groove.

PACKING

See "General Data on Miniature ceramic plate capacitors", section "Packing".

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 384-8. Unless stated otherwise all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 63 to 67%.

Capacitance values* and tolerances, measured at 1 MHz, $\leqslant$ 5 V	0,47 to 270 pF, E12 series, see Tables 3 to 7
Rated d.c. voltage	500 V
Test voltage (d.c.) for 1 minute	1250 V
Test voltage (d.c.) of coating for 1 minute	1250 V
Insulation resistance at 500 V (d.c.) after 1 min	$>$ 10 000 MΩ
Tan δ* at 1 MHz, $\leqslant$ 5 V for C $<$ 50 pF	$\leqslant 15\,(\frac{15}{C} + 0{,}7).10^{-4}$
for C $>$ 50 pF	$\leqslant 15.10^{-4}$
Category temperature range	−55 to + 85 °C
Storage temperature range	−55 to + 85 °C
Climatic category (IEC 68)	55/085/21

* Including 2 mm per connecting lead.

Capacitors with temperature coefficient P100

Capacitance range	0,47 to 33 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	+ 100 x 10^{-6}/K
Tolerance on the temperature coefficient	
for C < 22 pF	(−40 to + 120) x 10^{-6}/K
for C ⩾ 22 pF	± 40 x 10^{-6}/K
Marking colour of the temperature coefficient	red/violet

Table 3

capacitance pF	tolerance	size see Table 2	marking		suffix of catalogue number see Table 1
0,47*	± 0,25 pF	I	p47	500	03477
0,68	± 0,25 pF	I	p68	500	03687
1,0	± 0,25 pF	I	1p0	500	03108
1,2	± 0,25 pF	I	1p2	500	03128
1,5*	± 0,25 pF	I	1p5	500	03158
1,8	± 0,25 pF	I	1p8	500	03188
2,2	± 0,25 pF	I	2p2	500	03228
2,7	± 0,25 pF	I	2p7	500	03278
3,3	± 0,25 pF	I	3p3	500	03338
3,9	± 0,25 pF	I	3p9	500	03398
4,7	± 0,25 pF	IIA	4p7	500	03478
5,6	± 0,25 pF	IIA	5p6	500	03568
6,8	± 0,25 pF	IIB	6p8	500	03688
8,2	± 0,25 pF	IIB	8p2	500	03828
10	± 2%	III	10p	500	04109
12	± 2%	III	12p	500	04129
15	± 2%	III	15p	500	04159
18	± 2%	IV	18p	500	04189
22	± 2%	IV	22p	500	04229
27	± 2%	V	27p	500	04279
33	± 2%	V	33p	500	04339

* Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient NP0

Capacitance range	0,82 to 47 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	0×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-40 +120) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 30 \times 10^{-6}$/K
Marking colour for the temperature coefficient	black

Table 4

capacitance pF	tolerance	size see table 2	marking		suffix of catalogue number see Table 1
0,82*	± 0,25 pF	I	p82	500	09827
1 *	± 0,25 pF	I	1p0	500	09108
1,2	± 0,25 pF	I	1p2	500	09128
1,5	± 0,25 pF	I	1p5	500	09158
1,8	± 0,25 pF	I	1p8	500	09188
2,2	± 0,25 pF	I	2p2	500	09228
2,7	± 0,25 pF	I	2p7	500	09278
3,3	± 0,25 pF	I	3p3	500	09338
3,9	± 0,25 pF	I	3p9	500	09398
4,7	± 0,25 pF	I	4p7	500	09478
5,6	± 0,25 pF	I	5p6	500	09568
6,8	± 0,25 pF	IIA	6p8	500	09688
8,2	± 0,25 pF	IIA	8p2	500	09828
10	± 2%	IIB	10p	500	10109
12	± 2%	IIB	12p	500	10129
15	± 2%	IIB	15p	500	10159
18	± 2%	III	18p	500	10189
22	± 2%	III	22p	500	10229
27	± 2%	IV	27p	500	10279
33	± 2%	IV	33p	500	10339
39	± 2%	IV	39p	500	10399
47	± 2%	V	47p	500	10479

* Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient N150

Capacitance range	2,2 to 56 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-150×10^{-6}/K
Tolerance on the temperature coefficient	
for C < 22 pF	$(-40 + 60) \times 10^{-6}$/K
for C ⩾ 22 pF	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	orange

Table 5

capacitance pF	tolerance	size see Table 2	marking		suffix of catalogue number see Table 1
2,2*	± 0,25 pF	I	2p2	500	33228
2,7*	± 0,25 pF	I	2p7	500	33278
3,3	± 0,25 pF	I	3p3	500	33338
3,9	± 0,25 pF	I	3p9	500	33398
4,7	± 0,25 pF	I	4p7	500	33478
5,6	± 0,25 pF	I	5p6	500	33568
6,8	± 0,25 pF	I	6p8	500	33688
8,2	± 0,25 pF	IIA	8p2	500	33828
10	± 2%	IIA	10p	500	34109
12	± 2%	IIB	12p	500	34129
15	± 2%	IIB	15p	500	34159
18	± 2%	IIB	18p	500	34189
22	± 2%	III	22p	500	34229
27	± 2%	III	27p	500	34279
33	± 2%	IV	33p	500	34339
39	± 2%	IV	39p	500	34399
47	± 2%	IV	47p	500	34479
56	± 2%	V	56p	500	34569

* Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient N750

Capacitance range	1,8 to 120 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-750×10^{-6}/K
Tolerance on the temperature coefficient	
for C < 22 pF	$(-120 + 250) \times 10^{-6}$/K
for C ⩾ 22 pF	$\pm 120 \times 10^{-6}$/K
Marking colour of the temperature coefficient	violet

Table 6

capacitance pF	tolerance	size see Table 2	marking		suffix of catalogue number see Table 1
1,8*	± 0,25 pF	I	1p8	500	57188
2,2**	± 0,25 pF	I	2p2	500	57228
2,7	± 0,25 pF	I	2p7	500	57278
3,3	± 0,25 pF	I	3p3	500	57338
3,9	± 0,25 pF	I	3p9	500	57398
4,7**	± 0,25 pF	I	4p7	500	57478
5,6	± 0,25 pF	I	5p6	500	57568
6,8	± 0,25 pF	I	6p8	500	57688
8,2	± 0,25 pF	I	8p2	500	57828
10	± 2%	I	10p	500	58109
12	± 2%	I	12p	500	58129
15	± 2%	I	15p	500	58159
18	± 2%	IIA	18p	500	58189
22	± 2%	IIA	22p	500	58229
27	± 2%	IIB	27p	500	58279
33	± 2%	IIB	33p	500	58339
39	± 2%	IIB	39p	500	58399
47	± 2%	III	47p	500	58479
56	± 2%	III	56p	500	58569
68	± 2%	IV	68p	500	58689
82	± 2%	IV	82p	500	58829
100	± 2%	IV	n10	500	58101
120	± 2%	V	n12	500	58121

* Maximum thickness 2,7 mm.
** Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient N1500

Capacitance range	8,2 to 270 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-1500×10^{-6}/K
Tolerance on the temperature coefficient	$(-0 + 500) \times 10^{-6}$/K
Marking colour of the temperature coefficient	orange/orange

Table 7

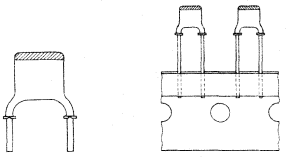
capacitance pF	tolerance	size see Table 2	marking		suffix of catalogue number see Table 1
8,2*	± 0,25 pF	I	8p2	500	69828
10 **	± 2%	I	10p	500	70109
12 **	± 2%	I	12p	500	70129
15	± 2%	I	15p	500	70159
18	± 2%	I	18p	500	70189
22	± 2%	I	22p	500	70229
27	± 2%	I	27p	500	70279
33	± 2%	IIA	33p	500	70339
39	± 2%	IIA	39p	500	70399
47	± 2%	IIA	47p	500	70479
56	± 2%	IIB	56p	500	70569
68	± 2%	IIB	68p	500	70689
82	± 2%	IIB	82p	500	70829
100	± 2%	III	n10	500	70101
120	± 2%	III	n12	500	70121
150	± 2%	IV	n15	500	70151
180	± 2%	IV	n18	500	70181
220	± 2%	IV	n22	500	70221
270	± 2%	V	n27	500	70271

* Maximum thickness 3,0 mm.
** Maximum thickness 2,5 mm.

MINIATURE CERAMIC PLATE CAPACITORS

class 2, 500 V (d.c.)

- General purpose
- Coupling and decoupling
- Space saving



QUICK REFERENCE DATA

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

APPLICATION

Electronic circuits where a non-linear change of capacitance with temperature is permissible and very low losses are not essential, e.g. coupling and decoupling.
Because of their small size the capacitors are ideal for circuitry with a 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 with a high melting point solder. The leads are provided with a flange that guarantees leads without lacquer, making these capacitors perfectly suited for automatic insertion.

The capacitors are protected by several layers of tan lacquer that ensures a good behaviour under humid conditions and is resistant to all commonly used cleaning solvents.
No silver migration can occur.

MECHANICAL DATA

Dimensions in mm

→ **Outlines**

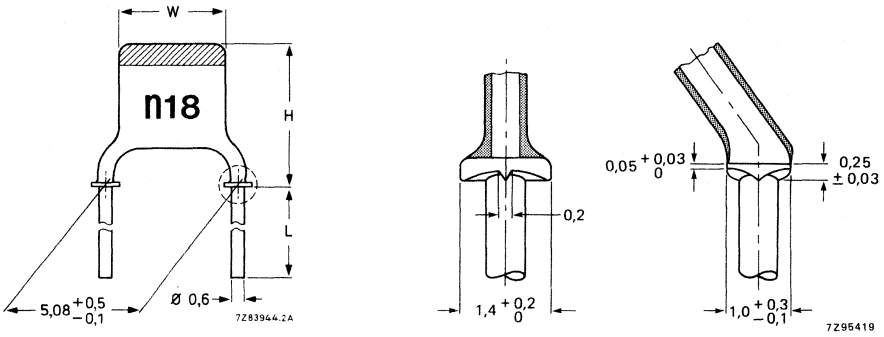


Fig. 1.

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

→ Table 1

lead sparing	lead diam	catalogue number *			
		bulk packed		on tape on reel	on tape in ammopack
		L ⩾ 13 mm	L = 4 ± 0,5 mm		
5,08 mm (0,2 in)	0,6 mm (0,024 in)	2222 655 09 . . .	2222 655 19 . . .	2222 655 53 . . .	2222 655 63 . . .

Table 2

size	W	H	approx. mass g
I	3,6(−1,1)	6,3(−1,8)	0,15
IIA	3,9(−1,2)	6,7(−1,8)	0,15
IIB	4,5(−1,2)	7,3(−1,8)	0,15
III	5,1(−0,9)	7,9(−1,7)	0,17
IV	6,2(−1,0)	9,0(−1,7)	0,21
V	6,2(−1,0)	11,2(−2,1)	0,23

Note: Tolerances are given between brackets.

Except for a few types as indicated in Table 3, the thickness of the capacitor does not exceed 2,3 mm.

* 3 dots to be replaced by code for capacitance value, see Table 3.

Marking

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

Mounting

When bending, cutting or flattening the leads, one should relieve them of the applied load at the capacitor body.

Soldering conditions max. 270 °C, max. 10 s

The capacitors are mounted on printed-wiring boards (hand mounting or automatic insertion). Due to the flange on the leads solder connections are free from lacquer. The flange is provided with a de-gassing groove.

PACKING

See "General Data on Miniature ceramic plate capacitors", section "Packing".

ELECTRICAL DATA

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

Capacitance values, measured at 1 kHz, 1 V	100 to 2700 pF, E12 series, see Table 3
Tolerance on the capacitance	± 10%
Rated d.c. voltage	500 V
Test voltage (d.c.) for 1 min	1250 V
Test voltage (d.c.) of coating for 1 min	1250 V
Insulation resistance at 500 V (d.c.) after 1 min	> 4000 MΩ
Tan δ at 1 kHz, 1 V	< 3,5%
Category temperature range	−55 to + 85 °C
Climatic category	55/085/21
Storage temperature range	−55 to + 85 °C
Capacitance change versus temperature	see Fig. 2
Capacitance change versus frequency	see Fig. 3

Table 3

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

* Maximum thickness 2,7 mm. ** Maximum thickness 2,5 mm.

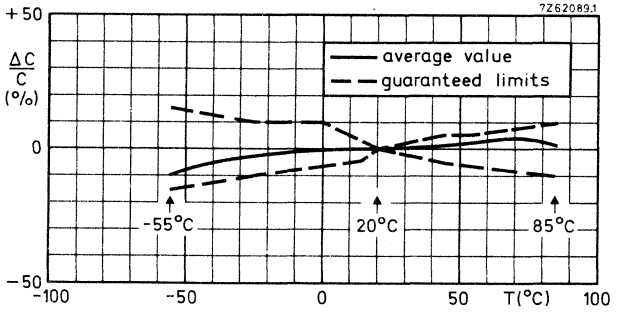


Fig. 2 Capacitance change with respect to the capacitance at 20 °C as a function of temperature.

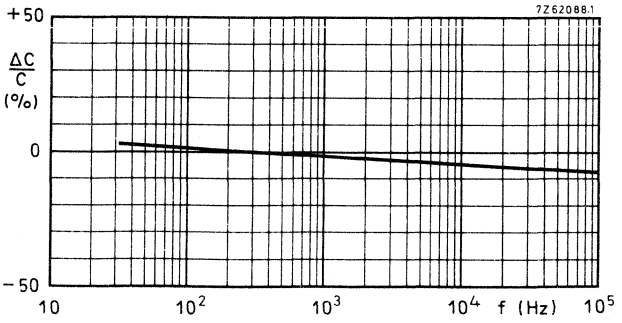
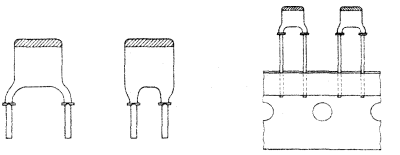


Fig. 3 Typical capacitance change with respect to the capacitance at 300 Hz as a function of frequency.

MINIATURE CERAMIC PLATE CAPACITORS

class 1

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



QUICK REFERENCE DATA

Capacitance range	0,56 to 560 pF (E12 series)
Rated d.c. voltage	100 V
Tolerance on capacitance	± 2% or ± 0,25 pF
Temperature coefficients	P100, NP0, N075, N150, N220 N330, N470, N750, N1500
Sectional specification	IEC 384-8, sub-class 1B
Climatic category (IEC 68)	55/085/21

APPLICATION

In a wide variety of electronic equipment, e.g. as temperature compensating capacitors in tuning circuits and filters, as coupling and decoupling capacitors in high-frequency circuits where low losses and good d.c. behaviour are required.
Because of their small size and their availability with a pitch of 2,54 mm over the whole range, the capacitors are ideal for circuitry with a high component density.

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized and provided with connecting leads. They are insulated by a coating that ensures a good behaviour under humid conditions. The colour of the capacitor body is grey. The capacitors distinguish themselves by small dimensions and narrow tolerances on the lead spacing. They are available with different lead shapes. The leads are provided with a flange, that guarantees leads without lacquer, making them perfectly suited for automatic insertion.
The electrical properties are characterized by low losses, a very close standard tolerance on the capacitance (± 0,25 pF or 2%), high stability and, owing to the absence of silver, an extremely good d.c. behaviour.
(Capacitors with silver electrodes suffer from the "silver migration" effect. Silver particles move from one electrode to the other under the influence of a d.c. voltage and moisture. Capacitors with silver electrodes are considerably larger.)

MECHANICAL DATA

Dimensions in mm

→ **Outlines**

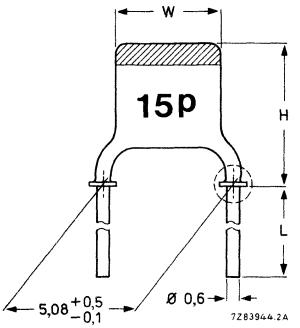


Fig. 1.

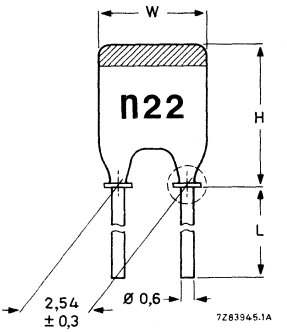
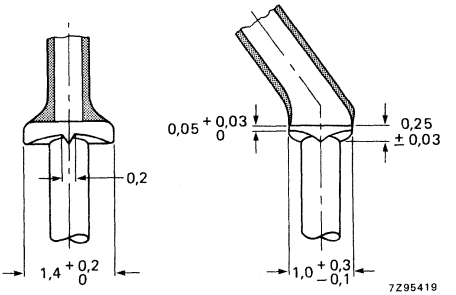


Fig. 2.

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



DETAIL

→ Table 1

lead spacing	lead diam	Fig.	catalogue number *			
			bulk packed		on tape on reel	on tape in ammopack
			L ⩾ 13 mm	L = 4 ± 0,5 mm		
5,08 mm (0,2 in)	0,6 mm (0,024 in)	1	2222 681	2222 683	2222 679	2222 689 .....
2,54 mm (0,1 in)	0,6 mm (0,024 in)	2	2222 680	2222 682	2222 678	

* For catalogue number suffix see Tables 3 to 11.

Table 2

size	W (mm)	H (mm) Fig. 1	H (mm) Fig. 2	approx. mass g
I	3,6(−1,1)	6,3(−1,8)	5,0(−1,5)	0,14
IIA	3,9(−1,2)	6,7(−1,8)	5,3(−1,5)	0,15
IIB	4,5(−1,2)	7,3(−1,8)	6,0(−1,5)	0,15
III	5,1(−0,9)	7,9(−1,7)	6,6(−1,4)	0,17
IV	6,2(−1,0)	9,0(−1,7)	7,7(−1,4)	0,20
V	6,2(−1,0)	11,2(−2,1)	9,9(−1,8)	0,20

Note: Tolerances are given between brackets.

The thickness of the capacitors does not exceed 2,3 mm (0,08 in), except for a few types as is indicated in Tables 3 to 11.

Marking

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

Mounting

When bending, cutting or flattening the leads, they should be relieved of the applied load of the capacitor body,

Soldering conditions max. 270 °C, max. 10 s

The capacitors are mounted on printed-wiring boards (hand mounting or automatic insertion). Due to the flange on the leads solder connections are free from lacquer. The flange is provided with a degassing groove.

PACKING

See "General Data on Miniature ceramic plate capacitors", section "Packing".

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 384-8. Unless stated otherwise all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 63 to 67%.

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

* Including 2 mm per connecting lead.

Capacitors with a temperature coefficient P100, rated voltage 100 V (d.c.)

Capacitance range	0,56 to 47 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	+ 100 x 10^{-6}/K
Tolerance on the temperature coefficient	
for C < 22 pF	(−40 to + 120) x 10^{-6}/K
for C ⩾ 22 pF	± 40 x 10^{-6}/K
Marking colour of the temperature coefficient	red/violet

Table 3

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
0,56*	± 0,25 pF	I	p56	03567
0,68**	± 0,25 pF	I	p68	03687
0,82***	± 0,25 pF	I	p82	03827
1,0***	± 0,25 pF	I	1p0	03108
1,2	± 0,25 pF	I	1p2	03128
1,5	± 0,25 pF	I	1p5	03158
1,8	± 0,25 pF	I	1p8	03188
2,2	± 0,25 pF	I	2p2	03228
2,7	± 0,25 pF	I	2p7	03278
3,3	± 0,25 pF	I	3p3	03338
3,9	± 0,25 pF	I	3p9	03398
4,7	± 0,25 pF	I	4p7	03478
5,6	± 0,25 pF	I	5p6	03568
6,8	± 0,25 pF	I	6p8	03688
8,2	± 0,25 pF	IIA	8p2	03828
10	± 2%	IIA	10p	04109
12	± 2%	IIB	12p	04129
15	± 2%	IIB	15p	04159
18	± 2%	III	18p	04189
22	± 2%	III	22p	04229
27	± 2%	IV	27p	04279
33	± 2%	IV	33p	04339
39	± 2%	V	39p	04399
47	± 2%	V	47p	04479

* Maximum thickness 3,0 mm.
** Maximum thickness 2,7 mm.
*** Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient NP0, rated voltage 100 V (d.c.)

Capacitance range	1,8 to 120 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	0 x 10^{-6}/K
Tolerance on the temperature coefficient	
for C < 22 pF	(−40 to + 120) x 10^{-6}/K
for C ⩾ 22 pF	± 30 x 10^{-6}/K
Marking colour of the temperature coefficient	black

Table 4

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
1,8	± 0,25 pF	I	1p8	09188
2,2	± 0,25 pF	I	2p2	09228
2,7	± 0,25 pF	I	2p7	09278
3,3	± 0,25 pF	I	3p3	09338
3,9	± 0,25 pF	I	3p9	09398
4,7	± 0,25 pF	I	4p7	09478
5,6	± 0,25 pF	I	5p6	09568
6,8	± 0,25 pF	I	6p8	09688
8,2	± 0,25 pF	I	8p2	09828
10	± 2%	I	10p	10109
12	± 2%	I	12p	10129
15	± 2%	I	15p	10159
18	± 2%	I	18p	10189
22	± 2%	I	22p	10229
27	± 2%	I	27p	10279
33	± 2%	I	33p	10339
39	± 2%	IIA	39p	10399
47	± 2%	IIA	47p	10479
56	± 2%	IIB	56p	10569
68	± 2%	IIB	68p	10689
82	± 2%	IIB	82p	10829
100	± 2%	III	n10	10101
120	± 2%	III	n12	10121

Capacitors with a temperature coefficient N075, rated voltage 100 V (d.c.)

Capacitance range	3,9 to 120 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-75×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	red

Table 5

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
3,9	± 0,25 pF	I	3p9	27398
4,7	± 0,25 pF	I	4p7	27478
5,6	± 0,25 pF	I	5p6	27568
6,8	± 0,25 pF	I	6p8	27688
8,2	± 0,25 pF	I	8p2	27828
10	± 2%	I	10p	28109
12	± 2%	I	12p	28129
15	± 2%	I	15p	28159
18	± 2%	I	18p	28189
22	± 2%	IIA	22p	28229
27	± 2%	IIA	27p	28279
33	± 2%	IIB	33p	28339
39	± 2%	IIB	39p	28399
47	± 2%	III	47p	28479
56	± 2%	III	56p	28569
68	± 2%	IV	68p	28689
82	± 2%	IV	82p	28829
100	± 2%	V	n10	28101
120	± 2%	V	n12	28121

Capacitors with a temperature coefficient N150, rated voltage 100 V (d.c.)

Capacitance range	3,9 to 150 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-150×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 40 \times 10^{-6}$/K
Marking colour of the temperature coefficient	orange

Table 6

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
3,9*	± 0,25 pF	I	3p9	33398
4,7	± 0,25 pF	I	4p7	33478
5,6	± 0,25 pF	I	5p6	33568
6,8	± 0,25 pF	I	6p8	33688
8,2	± 0,25 pF	I	8p2	33828
10	± 2%	I	10p	34109
12	± 2%	I	12p	34129
15	± 2%	I	15p	34159
18	± 2%	I	18p	34189
22	± 2%	I	22p	34229
27	± 2%	I	27p	34279
33	± 2%	I	33p	34339
39	± 2%	IIA	39p	34399
47	± 2%	IIA	47p	34479
56	± 2%	IIB	56p	34569
68	± 2%	IIB	68p	34689
82	± 2%	III	82p	34829
100	± 2%	III	n10	34101
120	± 2%	IV	n12	34121
150	± 2%	IV	n15	34151

* Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient N220, rated voltage 100 V (d.c.)

Capacitance range	3,9 to 150 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-220×10^{-6}/K
Tolerance on the temperature coefficient	
for C < 22 pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for C ⩾ 22 pF	$\pm 40 \times 10^{-6}$/K
Marking colour of the temperature coefficient	yellow

Table 7

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
3,9*	± 0,25 pF	I	3p9	39398
4,7	± 0,25 pF	I	4p7	39478
5,6	± 0,25 pF	I	5p6	39568
6,8	± 0,25 pF	I	6p8	39688
8,2	± 0,25 pF	I	8p2	39828
10	± 2%	I	10p	40109
12	± 2%	I	12p	40129
15	± 2%	I	15p	40159
18	± 2%	I	18p	40189
22	± 2%	I	22p	40229
27	± 2%	IIA	27p	40279
33	± 2%	IIA	33p	40339
39	± 2%	IIB	39p	40399
47	± 2%	IIB	47p	40479
56	± 2%	III	56p	40569
68	± 2%	III	68p	40689
82	± 2%	IV	82p	40829
100	± 2%	IV	n10	40101
120	± 2%	V	n12	40121
150	± 2%	V	n15	40151

* Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient N330, rated voltage 100 V (d.c.)

Capacitance range	4,7 to 180 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-330×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 60 \times 10^{-6}$/K
Marking colour of the temperature coefficient	green

Table 8

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
4,7	± 0,25 pF	I	4p7	45478
5,6	± 0,25 pF	I	5p6	45568
6,8	± 0,25 pF	I	6p8	45688
8,2	± 0,25 pF	I	8p2	45828
→ 10	± 2%	I	10p	46109
12	± 2%	I	12p	46129
15	± 2%	I	15p	46159
18	± 2%	I	18p	46189
22	± 2%	I	22p	46229
27	± 2%	I	27p	46279
33	± 2%	IIA	33p	46339
39	± 2%	IIA	39p	46399
47	± 2%	IIB	47p	46479
56	± 2%	IIB	56p	46569
68	± 2%	III	68p	46689
82	± 2%	III	82p	46829
100	± 2%	IV	n10	46101
120	± 2%	IV	n12	46121
150	± 2%	V	n15	46151
180	± 2%	V	n18	46181

Capacitors with a temperature coefficient N470, rated voltage 100 V (d.c.)

Capacitance range	6,8 to 220 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-470×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-90 \text{ to } +250) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 60 \times 10^{-6}$/K
Marking colour of the temperature coefficient	blue

Table 9

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
6,8	± 0,25 pF	I	6p8	51688
8,2	± 0,25 pF	I	8p2	51828
10	± 2%	I	10p	52109
12	± 2%	I	12p	52129
15	± 2%	I	15p	52159
18	± 2%	I	18p	52189
22	± 2%	I	22p	52229
27	± 2%	I	27p	52279
33	± 2%	I	33p	52339
39	± 2%	IIA	39p	52399
47	± 2%	IIA	47p	52479
56	± 2%	IIB	56p	52569
68	± 2%	IIB	68p	52689
82	± 2%	III	82p	52829
100	± 2%	III	n10	52101
120	± 2%	IV	n12	52121
150	± 2%	IV	n15	52151
180	± 2%	V	n18	52181
220	± 2%	V	n22	52221

Capacitors with a temperature coefficient N750, rated voltage 100 V (d.c.)

Capacitance range	3,9 to 330 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-750×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-120$ to $+250) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 120 \times 10^{-6}$/K
Marking colour of the temperature coefficient	violet

Table 10

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
3,9	± 0,25 pF	I	3p9	57398
4,7	± 0,25 pF	I	4p7	57478
5,6	± 0,25 pF	I	5p6	57568
6,8	± 0,25 pF	I	6p8	57688
8,2	± 0,25 pF	I	8p2	57828
10	± 2%	I	10p	58109
12	± 2%	I	12p	58129
15	± 2%	I	15p	58159
18	± 2%	I	18p	58189
22	± 2%	I	22p	58229
27	± 2%	I	27p	58279
33	± 2%	I	33p	58339
39	± 2%	I	39p	58399
47	± 2%	I	47p	58479
56	± 2%	IIA	56p	58569
68	± 2%	IIA	68p	58689
82	± 2%	IIB	82p	58829
100	± 2%	IIB	n10	58101
120	± 2%	III	n12	58121
150	± 2%	III	n15	58151
180	± 2%	IV	n18	58181
220	± 2%	IV	n22	58221
270	± 2%	V	n27	58271
330	± 2%	V	n33	58331

Capacitors with a temperature coefficient N1500, rated voltage 100 V (d.c.)

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

Table 11

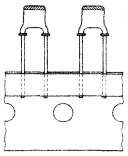
cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
18*	± 2%	I	18p	70189
22	± 2%	I	22p	70229
27	± 2%	I	27p	70279
33	± 2%	I	33p	70339
39	± 2%	I	39p	70399
47	± 2%	I	47p	70479
56	± 2%	I	56p	70569
68	± 2%	I	68p	70689
82	± 2%	I	82p	70829
100	± 2%	IIA	n10	70101
120	± 2%	IIA	n12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

* Maximum thickness 2,5 mm.

MINIATURE CERAMIC PLATE CAPACITORS

class 1, 500 V (d.c.)

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



QUICK REFERENCE DATA

Capacitance range	0,47 to 270 pF (E12 series)
Rated d.c. voltage	500 V
Tolerance on capacitance	± 2% or ± 0,25 pF
Temperature coefficients	P100, NP0, N150, N750, N1500
Sectional specification	IEC 384-8, sub-class 1B
Category (IEC 68)	55/085/21

APPLICATION

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

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized and provided with connecting leads. They are insulated by a coating that ensures a good behaviour under humid conditions. The colour of the capacitor body is grey. The capacitors distinguish themselves by small dimensions and narrow tolerances on the lead spacing. The leads are provided with a flange, that guarantees leads without lacquer, making them perfectly suited for automatic insertion.
The electrical properties are characterized by low losses, a very close standard tolerance on the capacitance (± 0,25 pF or 2%), high stability and, owing to the absence of silver, an extremely good d.c. behaviour.

MECHANICAL DATA

Dimensions in mm

Outlines

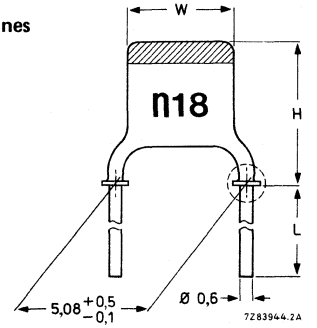
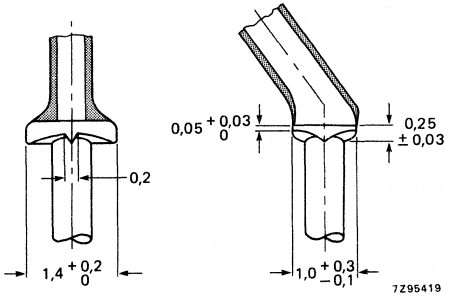


Fig. 1.



DETAIL

For dimensions H and W see Table 1.
The lead length (L) is shown in section "Packing" of "General Data on Miniature ceramic plate capacitors".

Table 1

	W	H	approx. mass g
I	3,6(−1,1)	6,3(−1,8)	0,15
IIA	3,9(−1,2)	6,7(−1,8)	0,15
IIB	4,5(−1,2)	7,3(−1,8)	0,16
III	5,1(−0,9)	7,9(−1,7)	0,17
IV	6,2(−1,0)	9,0(−1,7)	0,21
V	6,2(−1,0)	11,2(−2,1)	0,23

Except for the types indicated in Tables 2 to 6, the thickness of the capacitor does not exceed 2,3 mm.

Marking

The temperature coefficient is indicated by a colour code as per IEC and EIA recommendations. The capacitance value and the voltage are indicated on the body by figures in a contrasting colour, see Tables 2 to 6.

Mounting

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

Soldering conditions max. 270 °C, max. 10 s

The capacitors are mounted on printed-wiring boards (hand mounting or automatic insertion). Due to the flange on the leads solder connections are free from lacquer. The flange is provided with a degassing groove.

PACKING

The capacitors are supplied on tape in ammunition packing; see "General Data on Miniature ceramic plate capacitors", section "Packing".

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 384-8. Unless stated otherwise all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 63 to 67%.

Capacitance values* and tolerances, measured at 1 MHz, ≤ 5 V	0,47 to 270 pF, E12 series, see Tables 2 to 6
Rated d.c. voltage	500 V
Test voltage (d.c.) for 1 minute	1250 V
Test voltage (d.c.) of coating for 1 minute	1250 V
Insulation resistance at 500 V (d.c.) after 1 min	> 10 000 MΩ
Tan δ* at 1 MHz, ≤ 5 V for C < 50 pF	$\leq 15\,(\frac{15}{C} + 0{,}7).10^{-4}$
for C > 50 pF	$\leq 15.10^{-4}$
Category temperature range	−55 to +85 °C
Storage temperature range	−55 to +85 °C
Climatic category (IEC 68)	55/085/21

* Including 2 mm per connecting lead.

Capacitors with temperature coefficient P100

Capacitance range	0,47 to 33 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	+ 100 x 10^{-6}/K
Tolerance on the temperature coefficient	
for C < 22 pF	(−40 to + 120) x 10^{-6}/K
for C ⩾ 22 pF	± 40 x 10^{-6}/K
Marking colour of the temperature coefficient	red/violet

Table 2

capacitance pF	tolerance	size see Table 1	marking		catalogue number
0,47*	± 0,25 pF	I	p47	500	2222 691 03477
0,68	± 0,25 pF	I	p68	500	03687
1,0	± 0,25 pF	I	1p0	500	03108
1,2	± 0,25 pF	I	1p2	500	03128
1,5*	± 0,25 pF	I	1p5	500	03158
1,8	± 0,25 pF	I	1p8	500	03188
2,2	± 0,25 pF	I	2p2	500	03228
2,7	± 0,25 pF	I	2p7	500	03278
3,3	± 0,25 pF	I	3p3	500	03338
3,9	± 0,25 pF	I	3p9	500	03398
4,7	± 0,25 pF	IIA	4p7	500	03478
5,6	± 0,25 pF	IIA	5p6	500	03568
6,8	± 0,25 pF	IIB	6p8	500	03688
8,2	± 0,25 pF	IIB	8p2	500	03828
10	± 2%	III	10p	500	04109
12	± 2%	III	12p	500	04129
15	± 2%	III	15p	500	04159
18	± 2%	IV	18p	500	04189
22	± 2%	IV	22p	500	04229
27	± 2%	V	27p	500	04279
33	± 2%	V	33p	500	04339

* Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient NP0

Capacitance range	0,82 to 47 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	$0 \times 10^{-6}/K$
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-40 + 120) \times 10^{-6}/K$
for $C \geqslant 22$ pF	$\pm 30 \times 10^{-6}/K$
Marking colour for the temperature coefficient	black

Table 3

capacitance pF	tolerance	size see Table 1	marking		catalogue number
0,82*	± 0,25 pF	I	p82	500	2222 691 09827
1 *	± 0,25 pF	I	1p0	500	09108
1,2	± 0,25 pF	I	1p2	500	09128
1,5	± 0,25 pF	I	1p5	500	09158
1,8	± 0,25 pF	I	1p8	500	09188
2,2	± 0,25 pF	I	2p2	500	09228
2,7	± 0,25 pF	I	2p7	500	09278
3,3	± 0,25 pF	I	3p3	500	09338
3,9	± 0,25 pF	I	3p9	500	09398
4,7	± 0,25 pF	I	4p7	500	09478
5,6	± 0,25 pF	I	5p6	500	09568
6,8	± 0,25 pF	IIA	6p8	500	09688
8,2	± 0,25 pF	IIA	8p2	500	09828
10	± 2%	IIB	10p	500	10109
12	± 2%	IIB	12p	500	10129
15	± 2%	IIB	15p	500	10159
18	± 2%	III	18p	500	10189
22	± 2%	III	22p	500	10229
27	± 2%	IV	27p	500	10279
33	± 2%	IV	33p	500	10339
39	± 2%	IV	39p	500	10399
47	± 2%	V	47p	500	10479

* Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient N150

Capacitance range	2,2 to 56 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	$-150 \times 10^{-6}/K$
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-40 + 60) \times 10^{-6}/K$
for $C \geqslant 22$ pF	$\pm 30 \times 10^{-6}/K$
Marking colour of the temperature coefficient	orange

Table 4

capacitance pF	tolerance	size see Table 1	marking		catalogue number
2,2*	± 0,25 pF	I	2p2	500	2222 691 33228
2,7*	± 0,25 pF	I	2p7	500	33278
3,3	± 0,25 pF	I	3p3	500	33338
3,9	± 0,25 pF	I	3p9	500	33398
4,7	± 0,25 pF	I	4p7	500	33478
5,6	± 0,25 pF	I	5p6	500	33568
6,8	± 0,25 pF	I	6p8	500	33688
8,2	± 0,25 pF	IIA	8p2	500	33828
10	± 2%	IIA	10p	500	34109
12	± 2%	IIB	12p	500	34129
15	± 2%	IIB	15p	500	34159
18	± 2%	IIB	18p	500	34189
22	± 2%	III	22p	500	34229
27	± 2%	III	27p	500	34279
33	± 2%	IV	33p	500	34339
39	± 2%	IV	39p	500	34399
47	± 2%	IV	47p	500	34479
56	± 2%	V	56p	500	34569

* Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient N750

Capacitance range	1,8 to 120 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-750×10^{-6}/K
Tolerance on the temperature coefficient	
for C < 22 pF	$(-120 + 250) \times 10^{-6}$/K
for C ≥ 22 pF	$\pm 120 \times 10^{-6}$/K
Marking colour of the temperature coefficient	violet

Table 5

capacitance pF	tolerance	size see Table 1	marking		catalogue number
1,8*	± 0,25 pF	I	1p8	500	2222 691 57188
2,2**	± 0,25 pF	I	2p2	500	57228
2,7	± 0,25 pF	I	2p7	500	57278
3,3	± 0,25 pF	I	3p3	500	57338
3,9	± 0,25 pF	I	3p9	500	57398
4,7**	± 0,25 pF	I	4p7	500	57478
5,6	± 0,25 pF	I	5p6	500	57568
6,8	± 0,25 pF	I	6p8	500	57688
8,2	± 0,25 pF	I	8p2	500	57828
10	± 2%	I	10p	500	58109
12	± 2%	I	12p	500	58129
15	± 2%	I	15p	500	58159
18	± 2%	IIA	18p	500	58189
22	± 2%	IIA	22p	500	58229
27	± 2%	IIB	27p	500	58279
33	± 2%	IIB	33p	500	58339
39	± 2%	IIB	39p	500	58399
47	± 2%	III	47p	500	58479
56	± 2%	III	56p	500	58569
68	± 2%	IV	68p	500	58689
82	± 2%	IV	82p	500	58829
100	± 2%	IV	n10	500	58101
120	± 2%	V	n12	500	58121

* Maximum thickness 2,7 mm.
** Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient N1500

Capacitance range	8,2 to 270 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-1500×10^{-6}/K
Tolerance on the temperature coefficient	$(-0 + 500) \times 10^{-6}$/K
Marking colour of the temperature coefficient	orange/orange

Table 6

capacitance pF	tolerance	size see Table 1	marking		catalogue number
8,2*	± 0,25 pF	I	8p2	500	2222 691 69828
10 **	± 2%	I	10p	500	70109
12 **	± 2%	I	12p	500	70129
15	± 2%	I	15p	500	70159
18	± 2%	I	18p	500	70189
22	± 2%	I	22p	500	70229
27	± 2%	I	27p	500	70279
33	± 2%	IIA	33p	500	70339
39	± 2%	IIA	39p	500	70399
47	± 2%	IIA	47p	500	70479
56	± 2%	IIB	56p	500	70569
68	± 2%	IIB	68p	500	70689
82	± 2%	IIB	82p	500	70829
100	± 2%	III	n10	500	70101
120	± 2%	III	n12	500	70121
150	± 2%	IV	n15	500	70151
180	± 2%	IV	n18	500	70181
220	± 2%	IV	n22	500	70221
270	± 2%	V	n27	500	70271

* Maximum thickness 3,0 mm.
** Maximum thickness 2,5 mm.

GENERAL DATA ON MINIATURE CERAMIC PLATE CAPACITORS

Packing

Tests and requirements

GENERAL DATA

PACKING

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

size	number of capacitors		
	per box	per reel	per ammunition packing
I, IIA, IIB, III	1000	4000	4000
IV, V	500	4000	4000

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

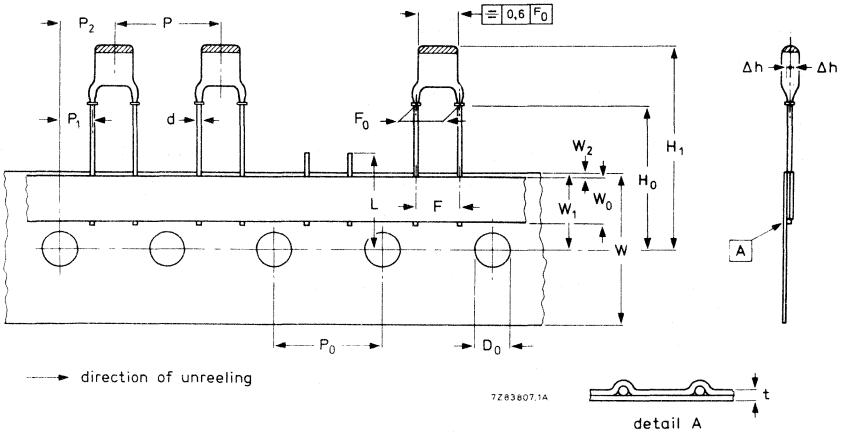


Fig. 1 Capacitors, lead spacing 5,08 mm, on tape; see Table 1 for dimensions.

Table 1

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

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

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

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

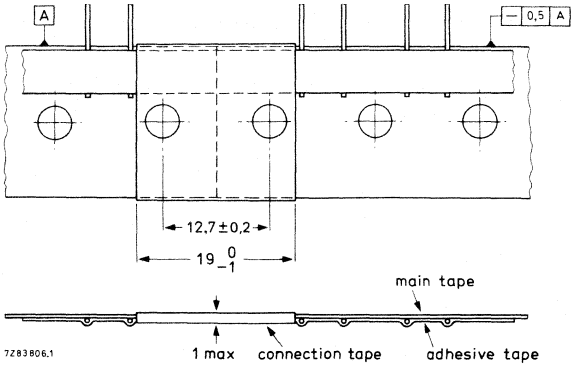


Fig. 2 Connection of tapes, lead spacing 5,08 mm.

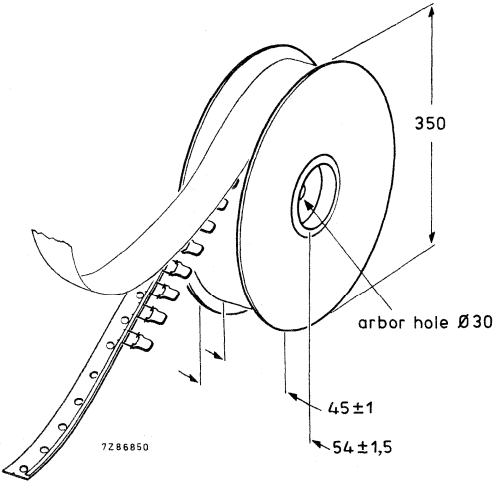


Fig. 3 Reel with capacitors on tape.

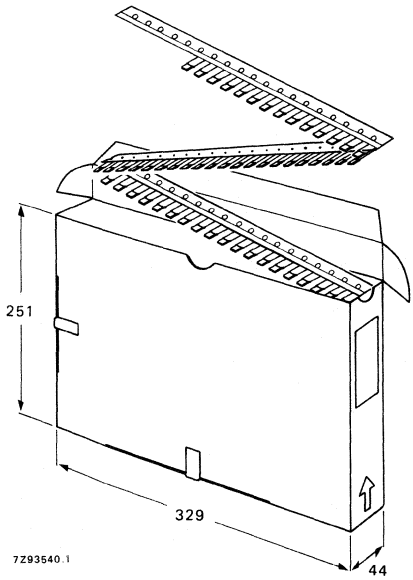


Fig. 4 Ammunition packing with capacitors on tape.

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

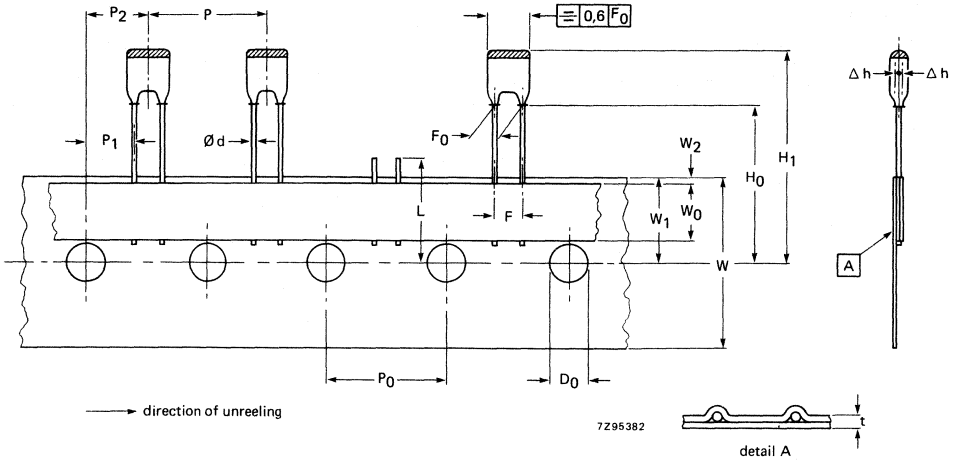


Fig. 5 Capacitors, lead spacing 2,54 mm, on tape; see Table 2 for dimensions.

Table 2

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

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

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

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

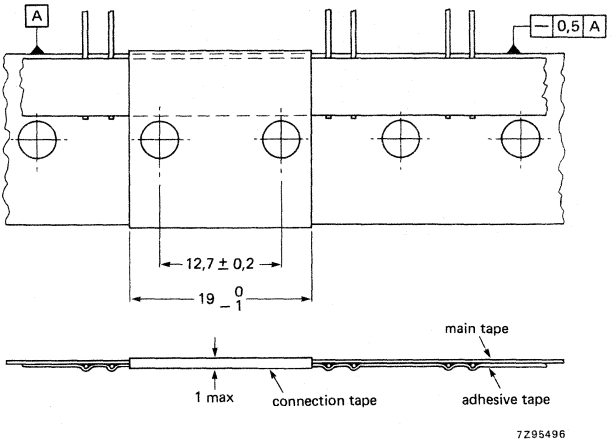


Fig. 6 Connection of tapes, lead spacing 2,54 mm.

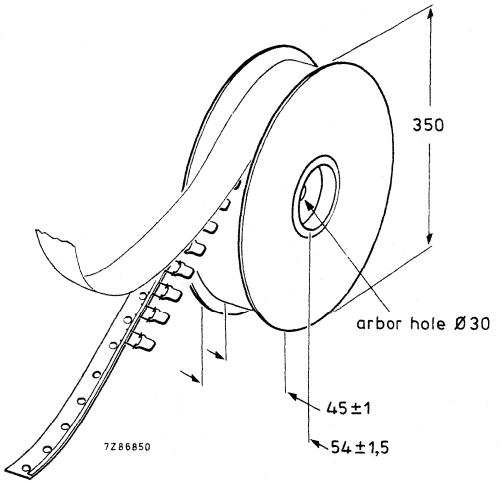
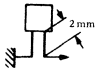


Fig. 7 Reel with capacitors on tape.

TESTS AND REQUIREMENTS

Class 1 capacitors

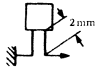
After manufacture, *each* capacitor is checked on capacitance, tan δ and test voltage. Apart from this the following quality checks are carried out by frequent inspections.
Essentially all tests mentioned in the schedule of IEC publication 384-8, category 55/085/21 (temperature range −55/+ 85 °C; damp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

IEC 384-8 clause	IEC 68-2 test method	name of test	procedure	requirements
–	–	Robustness of terminations Pull-off	pull velocity 15 cm/min load 5 N 	no wire breakage or complete damage of capacitor
10.1	Ua	Tensile strength	axial force 10 N	
10.1	Ub	Bending	load 5 N, 4 x 90°	no wire breakage
10.2.1	Ta method 1	Soldering	solderability: 2 s 235 °C	good tinning
10.2.2	Tb method 1A	Resistance to soldering heat	270 °C, 10 s	no visible damage $\Delta C/C \pm \leqslant 0{,}5\%$ or 0,5 pF after 1 h to 2 h
10.3	Na	Rapid change of temperature	30 min −55 °C/30 min + 85 °C, 5 cycles	no damage, after 24 h $\Delta C/C \pm \leqslant 0{,}5\%$ or 0,5 pF
10.4	Fc	Vibration	10-55-10 Hz 0,75 mm displacement 3 directions, 6 h	no visible damage
10.5	Eb	Bump	4000 bumps in 2 directions, 40g; pulse time 6 ms	no visible damage
–	–	Inflammability	15 s, 35 mm above bunsen burner with flame-height 40-60 mm	self-extinguishing within 15 s after removal of bunsen burner
9.5	–	Temperature coefficient	between + 20 and −55 °C, and between + 20 and + 85 °C	within tolerance as specified for each particular material

IEC 384-8 clause	IEC 68-2 test method	name of test	procedure	requirements
		Climatic sequence		
10.6.2	B	Dry heat	16 h + 85 °C	no visible damage
10.6.3	Db	Damp heat (accel.) 1st cycle	12 h + 55 °C, 12 h + 25 °C, 100% R.H.	after recovery of 1-2 h immediately followed by cold test
10.6.4	A	Cold	2 h −55 °C	no visible damage
10.6.5	M	Low air pressure	1 h 8,5 kPa, last 2 min rated voltage	no breakdown or flashover
10.6.6	Db	Damp heat (accel.)	1 day + 55 °C, 100% R.H.	$\Delta C/C \pm \leqslant 1\%$ or 1 pF tan $\delta < 2$ x specified tan δ R_{ins} after 1-2 h: $>$ 5000 MΩ for 2222 650 to 654, 691, ← $>$ 100 MΩ for other types
10.7	Ca	Damp heat, steady state (half number of the lot at rated voltage, other half at zero voltage)	21 days + 40 °C 90 to 95% R.H.	$\Delta C/C \pm \leqslant 1\%$ or 1 pF tan $\delta \leqslant 2$ x specified tan δ R_{ins} after 1-2 h: $>$ 5000 MΩ for 2222 650 to 654, 691, ← $>$ 100 MΩ for other types
10.8	–	Endurance	1000 h at + 85 °C; 2222 650 to 654, 691: 750 V (d.c.), other types: 150 V (d.c.)	$\Delta C/C \pm \leqslant 1\%$ or 1 pF tan $\delta \leqslant 1{,}5$ x specified tan δ R_{ins}: $>$ 3000 MΩ for 2222 650 to 654, 691, ← $>$ 300 MΩ for other types
–	–	Resistance to solvents	3 min ultrasonic washing in trichloroethylene 1 min drying, 30 °C 10 brush strokes	marking and colour code must remain legible and not be discoloured; no mechanical or electrical damage or deterioration of the material
–	H	Storage	72 h −65 °C, recovery 1-2 h	electrical parameters within specification

Class 2 capacitors

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

IEC 384-9 clause	IEC 68-2 test method	name of test	procedure	requirements
		Robustness of terminations	pull velocity 15 cm/min, load 5 N, axial force 10 N 	no wire breakage or complete damage of capacitor
		Pull-off		
10.1	Ua	Tensile strength		
10.1	Ub	Bending (half number of samples)	load 5 N, 4 x 90°	no wire breakage
10.2.1	Ta method 1	Soldering (solder bath)	solderability: 2 s at 235 °C	good tinning
		Pre-conditioning	2222 629 : 1 h + 55 °C 2222 630/640/655: 1 h + 85 °C reference measurements after 24 h	
10.2.2	Tb method 1A	Resistance to soldering heat	270 °C, 10 s	no visible damage, ΔC/C after 24 h, 2222 630: ± < 10% 2222 629, 2222 640: ± < 20% 2222 655: between –10 and + 20%
		Pre-conditioning		
10.3	Na		5 cycles, 2222 630, 2222 640, 2222 655: ½ h –55 °C/½ h + 85 °C 2222 629: ½ h –10 °C/½ h + 55 °C	no damage, ΔC/C after 24 h, 2222 630, 2222 655: ± < 10% 2222 629, 2222 640: ± < 20%

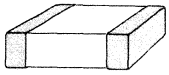
IEC 384-9 clause	IEC 68-2 test method	name of test	procedure	requirements
10.4	Fb	Vibration	10-55-10 Hz 0,75 mm displacement 3 directions, 6 h	no visible damage
10.5	Eb	Bump	4000 bumps in 2 directions, 40g; pulse time 6 ms	no visible damage
–	–	Inflammability	15 s, 35 mm above bunsen burner with flame-height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

IEC 384-9 clause	IEC 68-2 test method	name of test	procedure	requirements
		Pre-conditioning		
10.7	Ca	Damp heat (steady state) half number of samples rated voltage, half number of samples no voltage applied	21 days + 40 °C, 90 to 95% R.H.	no visible damage; after 24 h: $\Delta C/C$, 2222 630, 2222 655: $\pm < 10\%$ 2222 629, 2222 640: $\pm < 20\%$ tan $\delta < 7\%$ R_{ins}, 2222 629/630/640: > 100 MΩ 2222 655: > 1000 MΩ
		Pre-conditioning		
10.9.3	–	Endurance	1000 h (IEC) 2222 630, 2222 640: + 85 °C, 150 V (d.c.) 2222 629: + 55 °C, 100 V (d.c.), 2222 655: + 85 °C, 750 V (d.c.)	after 24 h at 20 °C: $\Delta C/C$, 2222 630, 2222 655: $\pm < 10\%$ 2222 629, 2222 640: $\pm < 20\%$ tan $\delta < 5\%$ (2222 629 $< 6{,}5\%$) R_{ins}, 2222 629/630/640: > 300 MΩ 2222 655: > 1000 MΩ
		Pre-conditioning		
–	H	Storage	72 h –65 °C, recovery 1 - 2 h	electr. parameters within specification

CERAMIC MULTILAYER CAPACITORS

SURFACE MOUNTED CERAMIC MULTILAYER CAPACITORS

- Six standard sizes
- High capacitance per unit volume
- Supplied in boxes or in tape on reel



QUICK REFERENCE DATA

Capacitance range	
class 1, NP0 dielectric	0,47 to 10 000 pF (E12-series)*
N220 dielectric	4,7 to 820 pF (E12-series)*
N750 dielectric	6,8 to 1200 pF (E12-series)*
class 2, X7R dielectric	180 to 470 000 pF (E12-series)
Y5V dielectric	2200 to 100 000 pF (E6-series)**
Rated voltage U_R (d.c.)	50 V (EIA), 63 V (IEC)
Tolerance on capacitance	
NP0, N220, N750 dielectrics	± 10%, ± 5%; below 10 pF: ± 0,5 or ± 0,25 pF
X7R dielectric	± 20%, ± 10%
Y5V dielectric	−20 to + 80%, ± 20%
Sectional specification	IEC 384-10, 40 (secretariat) 544 (EIA RS198/B)
Climatic category (IEC 68)	
NP0, N220, N750 dielectrics	55/125/56
X7R dielectric	55/125/56
Y5V dielectric	25/085/56
Resistance to soldering heat	260 °C, 10 s

APPLICATION

These capacitors with high capacitance per unit volume are for surface mounted assembly. Their dimensions, performance, and reliability make them very attractive for a wide range of applications, specially where high package density is required.
Typical application areas are e.g. radio, television, cameras, pocket calculators, telecommunication and military equipment.
The taped versions are especially suitable for automatic placement.

* Below 10 pF other values on request.
** Values up to 1 μF under development.

DESCRIPTION

The capacitors consist of a rectangular block of ceramic dielectric in which a number of interleaved precious-metal electrodes yield a high capacitance per unit volume. They are Pd Ag (35/65) metallized at the end terminations (see Fig. 1).

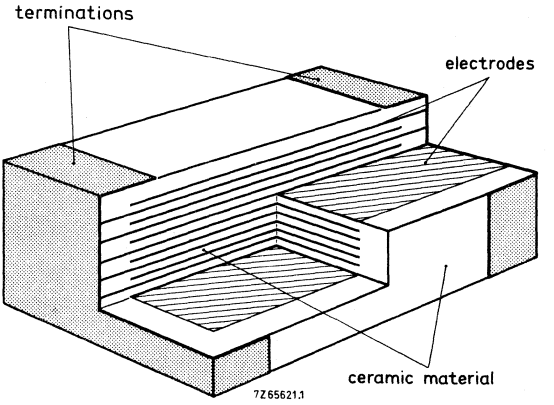


Fig. 1.

MECHANICAL DATA

Dimensions in mm

Outlines

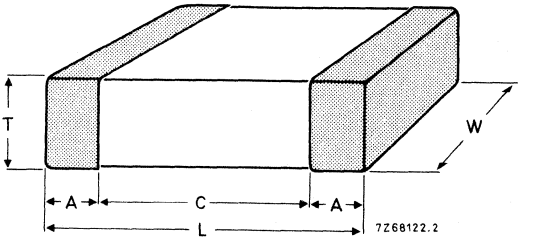


Fig. 2.

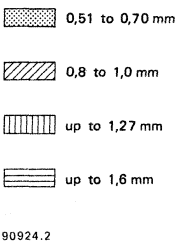
Table 1

size	L	W	T min.	T max.	A min.	A max.	C min.
0805	2,0 ± 0,15	1,25 ± 0,15	0,51*	1,27*	0,25	0,75	0,4
1206	3,2 ± 0,15	1,6 ± 0,15	0,51*	1,60*	0,25	0,75	
1210	3,2 ± 0,2	2,5 ± 0,2	0,51	1,90	0,3	1,0	
1808	4,5 ± 0,2	2,0 ± 0,2	0,51	1,90	0,3	1,0	
1812	4,5 ± 0,2	3,2 ± 0,2	0,51	1,90	0,3	1,0	
2220	5,7 ± 0,2	5,0 ± 0,2	0,51	1,90	0,3	1,0	

* See also Table 2.

Table 2 Capacitor thickness for sizes 0805 and 1206

C pF	SIZE 0805					SIZE 1206				
	NP0	N220	N750	X7R	Y5V	NP0	N220	N750	X7R	Y5V
0,47										
0,56										
0,68										
0,82										
1,0										
1,2										
1,5										
1,8										
2,2										
2,7										
3,3										
3,9										
4,7										
5,6										
6,8										
8,2										
10										
12										
15										
18										
22										
27										
33										
39										
47										
56										
68										
82										
100										
120										
150										
180										
220										
270										
330										
390										
470										
560										
680										
820										
1000										
1200										
1500										
1800										
2200										
2700										
3300										
3900										
4700										
5600										
6800										
8200										
10000										
12000										
15000										
18000										
22000										
27000										
33000										
39000										
47000										
56000										
68000										
82000										
100000										



7Z90924.2

ELECTRICAL DATA

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

Class 1

	NP0	N220	N750
Capacitance range (E12-series)*	0,47 to 10 000 pF	4,7 to 820 pF	6,8 to 1200 pF
Tolerance on capacitance			
$C \geqslant 10$ pF	± 10%, ± 5%		
5 pF $\leqslant C <$ 10 pF	± 0,5 pF		
$C <$ 5 pF	± 0,25 pF		
Rated voltage U_R (d.c.)	50 V (EIA), 63 V (IEC)		
Test voltage (d.c.) for 1 min	2,5 x U_R		
Tan δ, measured at 1,0 V,			
1 MHz, $C \leqslant 30$ pF	$10\,(\frac{10}{C} + 0{,}7) \times 10^{-4}$, max. 27×10^{-4}		
1 MHz, 30 pF $< C \leqslant$ 1000 pF	$\leqslant 10 \times 10^{-4}$		
1 kHz, $C >$ 1000 pF	$\leqslant 10 \times 10^{-4}$		
Insulation resistance	> 100 000 MΩ		
Climatic category (IEC 68)	55/125/56		

	NP0	N220	N750
Temperature coefficient			
0,47 pF $\leqslant C <$ 5 pF	$(0 \pm 120) \times 10^{-6}$/K	$(-220 \pm 60) \times 10^{-6}$/K	
5 pF $\leqslant C <$ 10 pF	$(0 \pm 120) \times 10^{-6}$/K	$(-220 \pm 60) \times 10^{-6}$/K	$(-750 \pm 120) \times 10^{-6}$/K
$C \geqslant 10$ pF	$(0 \pm 30) \times 10^{-6}$/K	$(-220 \pm 60) \times 10^{-6}$/K	$(-750 \pm 120) \times 10^{-6}$/K

* Measured at 1,0 V, 1 MHz for $C \leqslant 1000$ pF, and at 1,0 V, 1 kHz for $C >$ 1000 pF, by a four-gauge method.

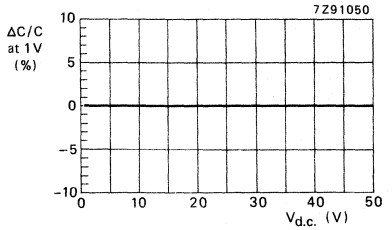


Fig. 3 Typical capacitance change with respect to the capacitance at 1 V as a function of d.c. voltage, for NP0 dielectric.

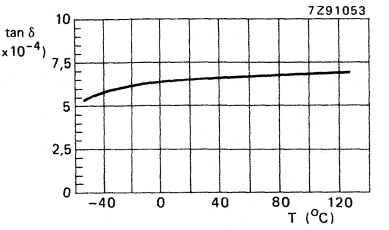


Fig. 4 Typical tan δ as a function of temperature for NP0 dielectric.

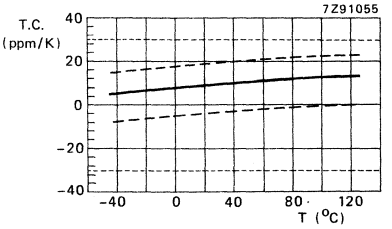


Fig. 5 Typical temperature coefficient as a function of temperature, for NP0 dielectric. The dashed curves indicate sample limits, dotted lines indicate requirement levels.

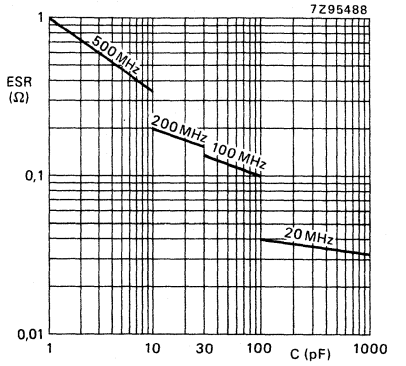


Fig. 6 Typical ESR at high frequencies as a function of capacitance, for NP0 dielectric, size 0805 (measuring equipment HP4191A).

Table 3 Selection chart for class 1 capacitors

C pF	DIELECTRIC									
	NP0						N220		N750	
	0805	1206	1210	1808	1812	2220	0805	1206	0805	1206
0,47	▒	▒								
0,56	▒	▒								
0,68	▒	▒								
0,82	▒	▒								
1,0	▒	▒								
1,2	▒	▒								
1,5	▒	▒								
1,8	▒	▒								
2,2	▒	▒								
2,7	▒	▒								
3,3	▒	▒								
3,9	▒	▒								
4,7	▒	▒					▒			
5,6	▒	▒					▒			
6,8	▒	▒					▒		▒	▒
8,2	▒	▒					▒	▒	▒	▒
10	▒	▒					▒	▒	▒	▒
12	▒	▒					▒	▒	▒	▒
15	▒	▒					▒	▒	▒	▒
18	▒	▒					▒	▒	▒	▒
22	▒	▒					▒	▒	▒	▒
27	▒	▒					▒	▒	▒	▒
33	▒	▒					▒	▒	▒	▒
39	▒	▒					▒	▒	▒	▒
47	▒	▒	▨				▒	▒	▒	▒
56	▒	▒	▨				▒	▒	▒	▒
68	▒	▒	▨				▒	▒	▒	▒
82	▒	▒	▨				▒	▒	▒	▒
100	▒	▒	▨	▨			▒	▒	▒	▒
120	▒	▒	▨	▨			▒	▒	▒	▒
150	▒	▒	▨	▨			▒	▒	▒	▒
180	▒	▒	▨	▨			▒	▒	▒	▒
220	▒	▒	▨	▨			▒	▒	▒	▒
270	▒	▒	▨	▨			▒	▒	▒	▒
330	▒	▒	▨	▨	▨			▒	▒	▒
390	▒	▒	▨	▨	▨			▒	▒	▒
470	▒	▒	▨	▨	▨	▨		▒		▒
560	▒	▒	▨	▨	▨	▨		▒		▒
680	▨	▒	▨	▨	▨	▨		▒		▒
820	▨	▒	▨	▨	▨	▨		▨		▒
1000	▨	▒	▨	▨	▨	▨				▒
1200		▒	▨	▨	▨	▨				▒
1500		▒	▨	▨	▨	▨				
1800		▒	▨	▨	▨	▨				
2200		▨	▨	▨	▨	▨				
2700		▨	▨	▨	▨	▨				
3300		▨	▨	▨	▨	▨				
3900			▨	▨	▨	▨				
4700			▨	▨	▨	▨				
5600				▨	▨	▨				
6800						▨				
8200						▨				
10000						▨				

▒ available in box and in 8 mm tape on reel

▨ available in box

7Z90923.1

Class 2, X7R dielectric

Capacitance range (E12-series)*	180 to 470 000 pF
Tolerance on capacitance, at age of 1000 h	± 20%, ± 10%
Rated voltage U_R (d.c.)	50 V (EIA), 63 V (IEC)
Test voltage (d.c.) for 1 min	2,5 x U_R
Tan δ, measured at 1 kHz, 1,0 V	⩽ 2,5%
Insulation resistance	
C ⩽ 10 000 pF	> 100 000 MΩ
C > 10 000 pF	R_{ins} x C > 1000 s
Climatic category (IEC 68)	55/125/56
Maximum capacitance variation as a function of temperature	± 15%, see Fig. 9
Ageing	typ. 1% per time decade

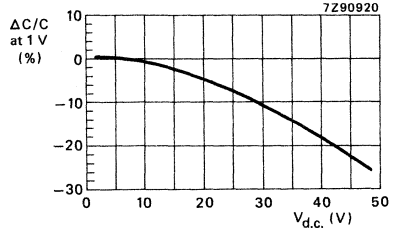


Fig. 7 Typical capacitance change with respect to the capacitance at 1 V as a function of d.c. voltage, for X7R dielectric.

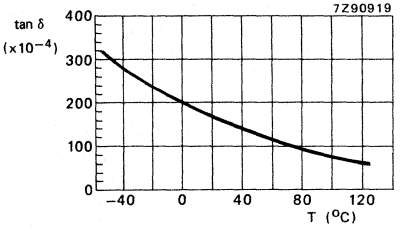


Fig. 8 Typical tan δ as a function of temperature, for X7R dielectric.

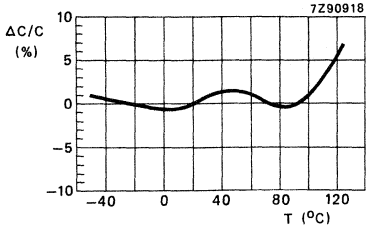


Fig. 9 Typical capacitance change as a function of temperature, for X7R dielectric.

* Measured at 1,0 V, 1 kHz, by a four-gauge method.

Table 4 Selection chart for class 2 capacitors, X7R dielectric

C pF	DIELECTRIC X7R					
	0805	1206	1210	1808	1812	2220
180	▒					
220	▒					
270	▒					
330	▒					
390	▒					
470	▒					
560	▒					
680	▒	▒				
820	▒	▒				
1000	▒	▒				
1200	▒	▒				
1500	▒	▒				
1800	▒	▒				
2200	▒	▒	▨	▨		
2700	▒	▒	▨	▨		
3300	▒	▒	▨	▨		
3900	▒	▒	▨	▨		
4700	▒	▒	▨	▨	▨	
5600	▒	▒	▨	▨	▨	
6800	▒	▒	▨	▨	▨	
8200	▒	▒	▨	▨	▨	
10000	▒	▒	▨	▨	▨	
12000	▒	▒	▨	▨	▨	▨
15000	▒	▒	▨	▨	▨	▨
18000	▒	▒	▨	▨	▨	▨
22000	▒	▒	▨	▨	▨	▨
27000	▒	▒	▨	▨	▨	▨
33000	▒	▨	▨	▨	▨	▨
39000		▨	▨	▨	▨	▨
47000		▨	▨	▨	▨	▨
56000		▨	▨	▨	▨	▨
68000		▨	▨	▨	▨	▨
82000		▨	▨	▨	▨	▨
100000		▨	▨	▨	▨	▨
120000				▨	▨	▨
150000				▨	▨	▨
180000					▨	▨
220000					▨	▨
270000					▨	▨
330000						▨
390000						▨
470000						▨

▒ available in box and in 8 mm tape on reel

▨ available in box

7Z90922.2

Class 2, Y5V dielectric (For Z5U dielectric see section "Maintenance Types".)

Capacitance range (E6-series)*	2200 to 100 000 pF (values up to 1 μF under development)
Tolerance on capacitance at age of 1000 h	−20 to + 80% and ± 20%
Rated voltage U_R (d.c.)	50 V (EIA), 63 V (IEC)
Test voltage (d.c.) for 1 min	2,5 x U_R
Tan δ, measured at 1 kHz, 1,0 V	$\leqslant$ 2,5%
Insulation resistance	
$C \leqslant 25\,000$ pF	> 4000 MΩ
$C > 25\,000$ pF	$R_{ins} \times C > 100$ s
Climatic category (IEC 68)	25/085/56
Maximum capacitance variation with respect	
to C at 20 °C (IEC)	+ 30 to −80%, see Fig. 12
to C at 25 °C (EIA)	+ 22 to −82%
Ageing	typ. 5% per time decade

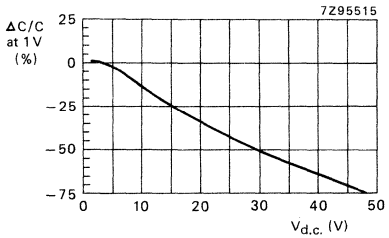


Fig. 10 Typical capacitance change with respect to the capacitance at 1 V as a function of d.c. voltage, for Y5V dielectric.

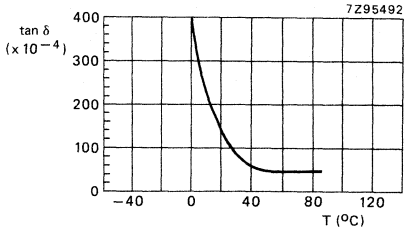


Fig. 11 Typical tan δ as a function of temperature, for Y5V dielectric.

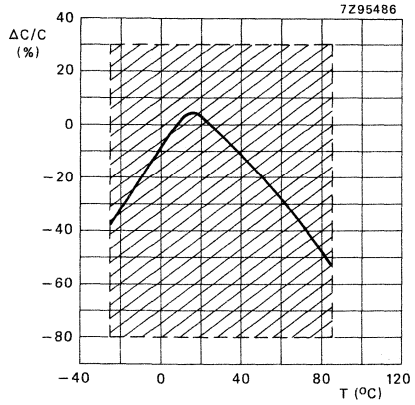


Fig. 12 Typical capacitance change as a function of temperature, for Y5V dielectric (hatched area according to IEC 384-10).

* Measured at 1,0 V, 1 kHz, by a four-gauge method.

Table 5 Selection chart for class 2 capacitors, Y5V dielectric

C pF	DIELECTRIC Y5V					
	0805	1206	1210	1808	1812	2220
47						
68						
100						
150						
220						
330						
470						
680						
1000						
1500						
2200	▒					
3300	▒					
4700	▒					
6800	▒					
10000	▒	▒				
15000	▒	▒				
22000	▒	▒				
33000	▒	▒				
47000		▒				
68000		▒	▤	▤	▤	▤
100000		▒	▤	▤	▤	▤
150000			▤	▤	▤	▤
220000			▤	▤	▤	▤
330000				▤	▤	▤
470000					▤	▤
680000						▤
1000000						▤

▒ available in box and in 8 mm tape on reel

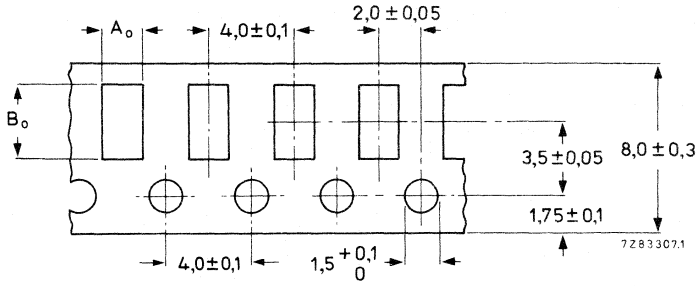
▤ under development

7Z90921.2

PACKING

The capacitors are supplied in cardboard boxes of 1000; the sizes 0805 and 1206 are also supplied in tape (cardboard or blister) on reels of 4000.

Cardboard tape



dimensions	size	
	0805	1206
A_o	1,5 + 0,2	1,85 + 0,2
B_o	2,25 + 0,2	3,45 + 0,2

Fig. 13 Dimensions of carrier tape (mm).
Cumulative pitch error 0,2 mm over 10 pitches.

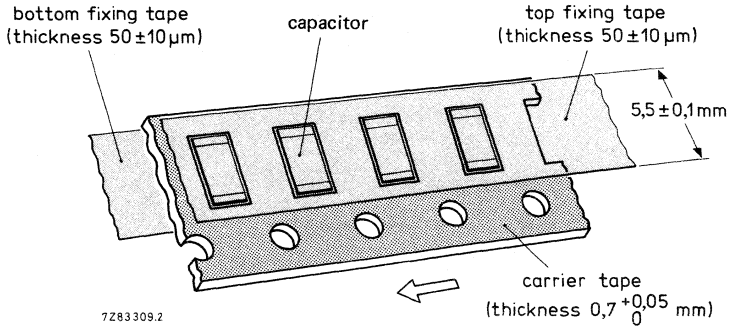
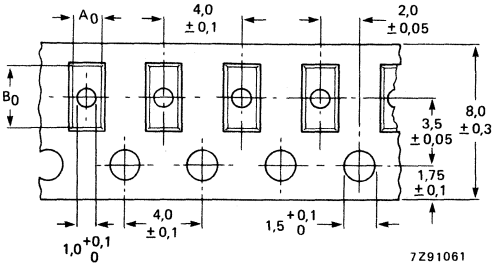


Fig. 14 Cardboard tape.

Blister tape



dimension	size	
	0805	1206
A_o	1,55 ± 0,1	1,85 ± 0,1
B_o	2,3 ± 0,1	3,55 ± 0,1

Fig. 15 Dimensions of carrier tape.
Cumulative pitch error 0,2 mm over 10 pitches.

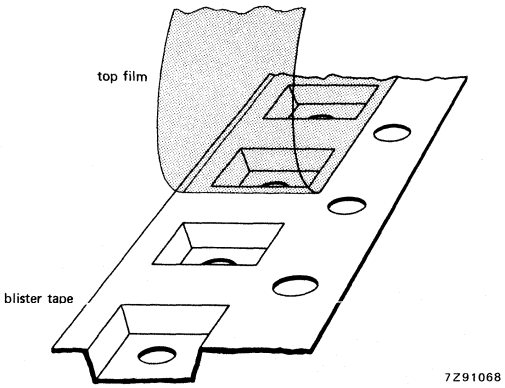


Fig. 16 Blister tape.

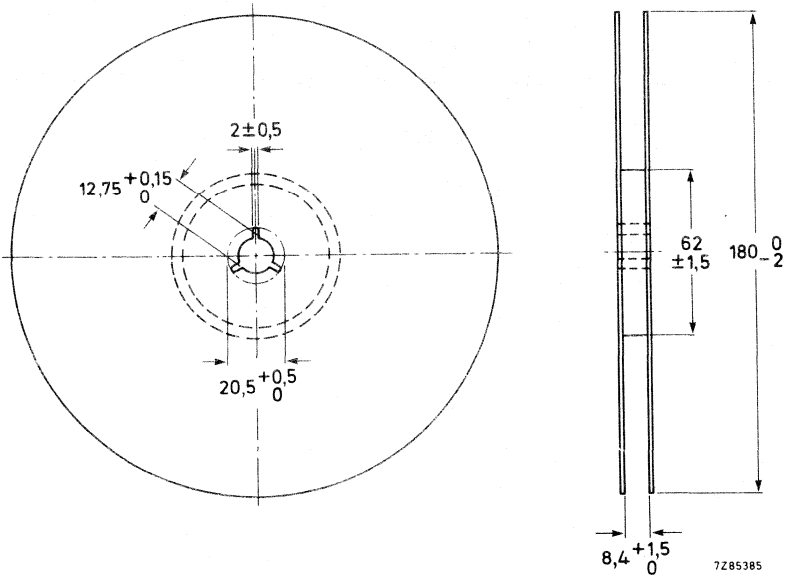


Fig. 17 Reel.

At least 40 positions at the beginning and 75 at the end of the tape are not used. The tape has a 230 mm leader.

SOLDER CONDITIONS

Limiting conditions	235 °C, min. 2 s, max. 100 s 260 °C, max. 40 s	see Fig. 18
Typical solder conditions	see Figs 19, 20 and 21	

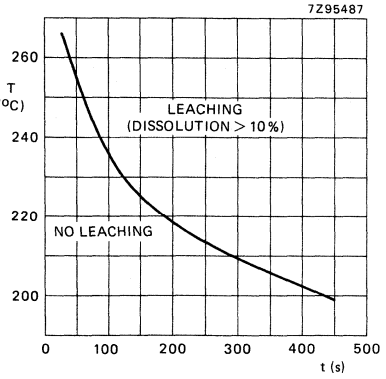


Fig. 18 Resistance to leaching of terminations (in static solder bath).

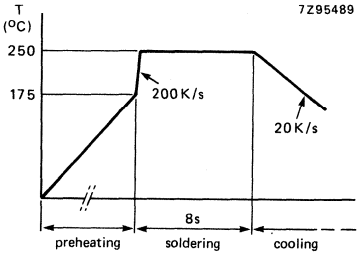


Fig. 19 Reflow soldering.

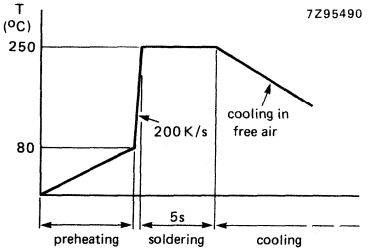


Fig. 20 Wave soldering.
The capacitors may be soldered twice according to this method if necessary.

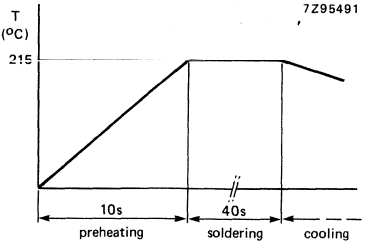
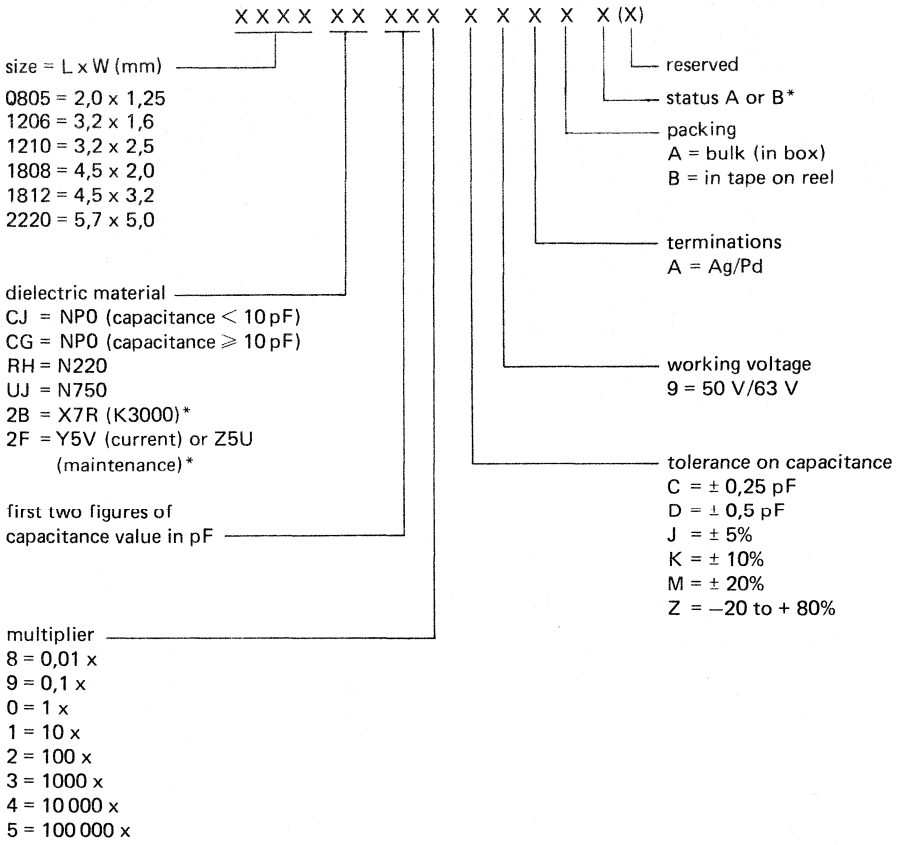


Fig. 21 Vapour phase soldering.

HOW TO ORDER

Order the capacitors by quoting the 15-digit ordering code, which can be constructed as shown below. Check for availability with Tables 3, 4 and 5.



Example

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

8000 x 1206CG151J9AB.

* For X7R use B as 14th digit; for Y5V use A, for Z5U use B as 14th digit.

TESTS AND REQUIREMENTS–IEC

IEC 384-10 par.	IEC 68-2 par.	test	procedure	requirements
4.5		Visual inspection and check of dimensions	any applicable method	in accordance with specification
4.6.1		Capacitance	$C \leqslant 1000$ pF f = 1 MHz $C > 1000$ pF f = 1 kHz measuring voltage 1 V, T = +20 °C	within specified tolerance, class 2 1000 h after manufacturing date
4.6.2		Tan δ	see 9.1	in accordance with specification
4.6.3		Insulation resistance	at 10 V (d.c.), 1 min	in accordance with specification
4.6.4		Voltage proof	2,5 U_R, 1 min	no breakdown or flashover
4.7.1		Temperature coefficient, class 1	between min. and max. temperature	in accordance with specification
4.7.2		Temperature characteristic, class 2	X7R and Y5V between min. and max. temperature	in accordance with specification
4.11	Ta	Solderability	Zero hour test, and test after storage (20 to 24 months) in original packing, in normal atmosphere; unmounted chips completely immersed for 2 ± 0,5 s in a solder bath of 235 ± 10 °C	the terminations must be well tinned.
4.10	Tb	Resistance to soldering heat	260 ± 5 °C, 10 ± 0,5 s	the terminations must be well tinned, after recovery. $\Delta C/C$, class 1 : $\leqslant \pm 0{,}5\%$ or $\pm 0{,}5$ pF, whichever is greater X7R : $> -5\%$ and $\leqslant +10\%$ Y5V : $> -10\%$ and $\leqslant +20\%$
		Resistance to leaching	260 ± 5 °C, 40 ± 1 s, in static solder bath	with visual enlargement of 10x: dissolution of terminations may not exceed 10%
4.8		Adhesion	a force of 5 N shall be applied normal to the line joining the terminations and in a plane parallel to the substrate	no visible damage.

TESTS AND REQUIREMENTS–IEC (continued)

IEC 384-10 par.	IEC 68-2 par.	test	procedure	requirements
4.9		Bond strength of end face plating	mounting according to 4.4; conditions: bending 1 mm at a rate of 1 mm/s	no visible damage; $\Delta C/C \leqslant 10\%$.
4.1		Pre-conditioning class 2	X7R and Y5V : 1 h at 175 °C, then 24 h recovery	
4.12	Na	Rapid change of temperature	pre-conditioning (class 2 only) −55/ + 125 °C, 5 cycles	no visible damage; after 24 h recovery class 1: $\Delta C/C \leqslant \pm 1\%$ or 1 pF* X7R : $\Delta C/C \leqslant \pm 10\%$ Y5V : $\Delta C/C \leqslant \pm 20\%$
4.13		Climatic sequence	pre-conditioning (class 2 only)	
4.13.3	Ba	Dry heat	16 h + 125 °C	ni visible damage
4.13.4	Db	Damp heat accelerated, 1 cycle	24 h, R.H. 100% at + 55 °C	
4.13.5	Aa	Cold	2 h at −55 °C	no visible damage
4.13.6	Db	Damp heat accelerated, remaining cycles	at 55 °C, R.H. 100% 5 cycles of 24 h	after recovery, class 1 1-2 h, class 2 24 h $\Delta C/C$, class 1 : $\leqslant \pm 2\%$ or 1 pF* X7R : $\leqslant \pm 10\%$; Y5V: $\leqslant \pm 20\%$ tan δ, class 1 : $\leqslant 2$ x specified value X7R : $\leqslant 5\%$ Y5V : $\leqslant 7\%$ R_{ins}, class 1 : $\geqslant 2500$ MΩ or $R_iC_R \geqslant 25$ s** X7R, Y5V : $\geqslant 1000$ MΩ or $R_iC_R \geqslant 25$ s**
4.14	Ca	Damp heat, steady state	pre-conditioning (class 2 only) 56 days, R.H. 90-95% at 40 °C, no voltage applied	no visible damage; electrical: same as 4.13.6, except for $\Delta C/C$, Y5V: $\leqslant \pm 30\%$

* Whichever is greater.
** Whichever is less.

TESTS AND REQUIREMENTS–IEC (continued)

IEC 384-10 par.	IEC 68-2 par.	test	procedure	requirements
4.15		Endurance	Pre-conditioning (class 2 only) 1000 h at 1,5 x rated voltage at maximum temperature	no visible damage, after 24 h recovery $\Delta C/C$, class 1: $\leqslant \pm 2\%$ or 1 pF* X7R : $\leqslant \pm 10\%$; Y5V: $\leqslant \pm 30\%$ tan δ, class 1: $\leqslant 2$ x specified value X7R : $\leqslant 5\%$, Y5V: $\leqslant 7\%$ R_{ins}, class 1: $\geqslant 4000$ MΩ or $\geqslant 40$ s** X7R : $\geqslant 2000$ MΩ or $R_iC_R \geqslant 50$ s** Y5V : $\geqslant 2000$ MΩ or $R_iC_R \geqslant 50$ s**

TESTS AND REQUIREMENTS–EIA

EIA RS 198/B test	EIA RS 198/B par.	test	procedure	requirements
2.5.5	2.4.6	Temperature characteristic	X7R : + 25, –55, + 25, + 125 °C Y5V : + 25, + 10, + 25, + 85 °C	X7R : $\Delta C/C \pm \leqslant 15\%$ Y5V : $\Delta C/C$ + 30%/–56%
1.6.6 2.5.6	1.5.7 2.4.7	Seal test	5 cycles of 15 min at + 25 °C, –20 °C, + 25 °C and + 85 °C followed by 100 h at R.H. 90-95% and 40 °C	within 30 min to be measured; $\Delta C/C$, class 1: $\leqslant \pm 2\%$ or 0,25 pF* X7R : $\leqslant \pm 20\%$; Y5V: $\leqslant \pm 20\%$ tan δ, class 1: $\leqslant 2$ x specified tan δ X7R : $\leqslant 5\%$ Y5V : $\leqslant 5\%$ R_{ins}, class 1 : $> 10^4$ MΩ X7R : $> 10^4$ MΩ or $R_iC_R > 100$ s Y5V : > 500 MΩ or $R_iC_R > 50$ s
1.6.7	1.5.8	Endurance	250 h at 2 x rated voltage at maximum temperature	same as under seal test.

* Whichever is greater.

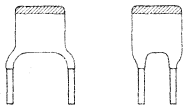
** Whichever is less.

MAINTENANCE TYPES

MINIATURE CERAMIC PLATE CAPACITORS

class 2

- General purpose
- Coupling and decoupling
- Space saving



QUICK REFERENCE DATA

	2222 629-series	2222 630-series	2222 640-series
Capacitance range	1000-22000 pF	180-4700 pF	1000-10000 pF
	E3 series	E12 series	E6 series
Rated d.c. voltage	63 V	100 V	100 V
Tolerance on capacitance	−20/+ 80%	± 10%	−20/+ 50%
Sectional specification	IEC 384-9	IEC 384-9 (2C2)	IEC 384-9 (2E2)
Climatic category (IEC 68)	10/055/21	55/085/21	55/085/21

APPLICATION

In a great variety of electronic circuits where a non-linear change of capacitance with temperature is permissible and very low losses are not of major importance, e.g. coupling and decoupling purposes. Because of their small dimensions and close tolerance on lead-spacing the capacitors are very suitable for circuitry with a high component density.

DESCRIPTION

The capacitors consists of a thin rectangular ceramic plate, both sides being metallized and provided with solder-coated connecting leads that are fixed with solder having a high melting point.

The capacitors are protected by several layers of lacquer that ensures a good behaviour under humid conditions and is resistant against commonly used cleaning solvents. They are tan coloured.
No silver migration can occur.

MECHANICAL DATA

Dimensions in mm

Outlines

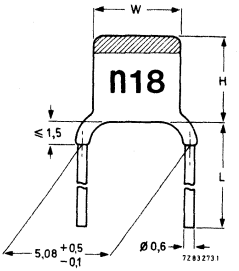


Fig. 1.

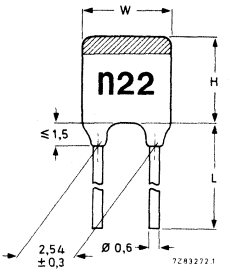


Fig. 2.

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

Table 1

lead spacing	lead diameter	Fig.	catalogue number *	
			L ⩾ 15 mm	L = 6 +0 −2
5,08 mm (0,2 in)	0,6 mm (0,024 in)	1	2222 629 03 . . . 2222 630 03 . . . 2222 640 03 . . .	2222 629 06 . . . 2222 630 06 . . . 2222 640 06 . . .
2,54 mm (0,1 in)	0,6 mm (0,024 in)	2	2222 629 01 . . . 2222 630 01 . . . 2222 640 01 . . .	2222 629 05 . . . 2222 630 05 . . . 2222 640 05 . . .

* 3 dots to be replaced by code for capacitance value, see Tables 3, 4 and 5.

Table 2

size	W mm	H mm	approx. mass g
I	3,6(−1,1)	3,7(−1,2)	0,14
IIA	3,9(−1,2)	4,0(−1,3)	0,15
IIB	4,5(−1,2)	4,7(−1,4)	0,16
III	5,1(−0,9)	5,3(−1,1)	0,17
IV	6,2(−1,0)	6,4(−1,2)	0,20

Note: Tolerances are given between brackets.

The thickness of the capacitors does not exceed 2,3 mm (0,09 in), except for the type as is indicated in Table 4.

Lacquer on the leads

When capacitors shown in Figs 1 and 2 are mounted on printed-wiring boards with a thickness of 1,5 mm and with holes of 1,3 mm diameter or on printed-wiring boards with a thickness of 1 mm and with holes of 0,8 mm diameter, there will be no lacquer on the leads at the lower side of the board. For the capacitance value indicated with an asterisk in Table 4, and lead pitch of 5,08 mm, the lacquer on the leads is less than 2 mm.

Marking

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

Mounting

When bending, cutting or flattening the leads, one should relieve them of the applied load at the capacitor body.

Soldering conditions max. 270 °C, max. 10 s

PACKING

The capacitors are supplied in boxes of 1000 (sizes I, IIA, IIB, III) or 500 (size IV).

ELECTRICAL DATA

Capacitors 2222 629 (colour mark green)

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

Capacitance values measured at 1 kHz, 1 V	1000–22 000 pF; E3 series (see Table 3)
Tolerance on the capacitance	−20 to + 80%
Rated d.c. voltage at 55 °C	63 V
Derated d.c. voltage at 85 °C	40 V
Test voltage (d.c.) for 1 min	200 V
Test voltage (d.c.) of coating for 1 min	200 V
→ Insulation resistance at 10 V (d.c.) after 1 min	⩾ 4000 MΩ
Tan δ at 1 kHz, 1 V	⩽ 6,5%
Category temperature range	−10 to + 55 °C
Storage temperature range	−55 to + 85 °C
Climatic category, IEC 68	10/055/21

Table 3

cap. pF	size see Table 2	marking	code in catalogue number, see Table 1
1 000	I	1n0	102
2 200	I	2n2	222
4 700	I	4n7	472
10 000	IIB	10n	103
22 000	IV	22n	223

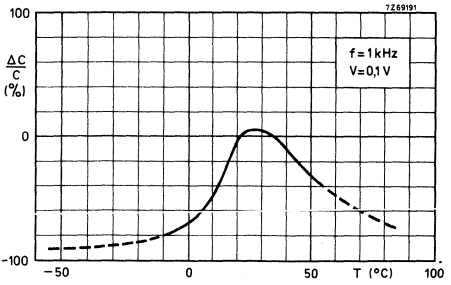


Fig. 3 Typical capacitance change as a function of temperature for capacitance values 2200 pF to 22 000 pF; dotted lines give an indication of the behaviour at higher and lower temperatures.

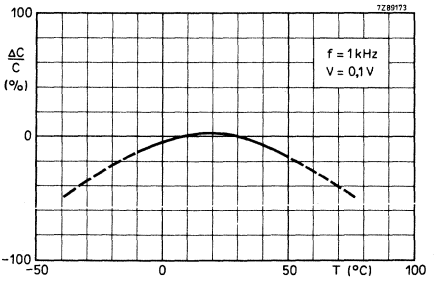


Fig. 4 Typical capacitance change as a function of temperature for capacitance value 1000 pF; dotted lines give an indication of the behaviour at higher and lower temperatures.

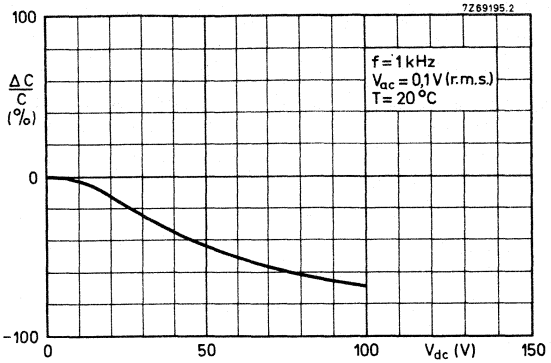


Fig. 5 Typical capacitance change with respect to the capacitance value at 0 V, as a function of d.c. voltage, for capacitance values 2200 to 22 000 pF.

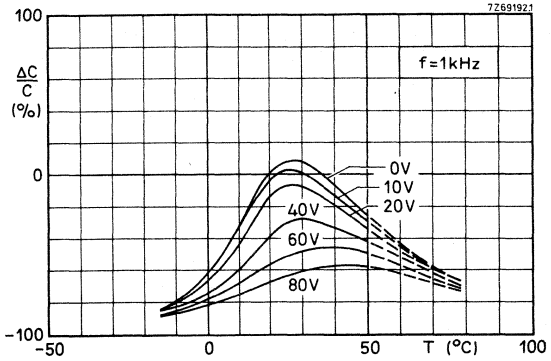


Fig. 6 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different d.c. voltages, for capacitance values 2200 to 22 000 pF; V_{ac} = 0,1 V (r.m.s.).

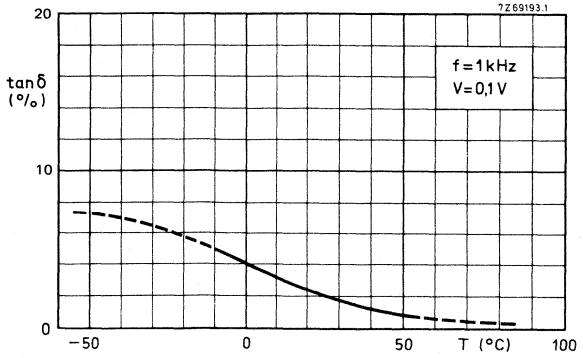


Fig. 7 Typical tan δ as a function of temperature, for capacitance values 2200 to 22 000 pF.

ELECTRICAL DATA (continued)

Capacitors 2222 630 (colour mark yellow)

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

Capacitance values, measured at 1 kHz, 1 V	180 – 4700 pF, E12 series (see Table 4)
Tolerance on the capacitance	± 10%
Rated d.c. voltage	100 V
Test voltage (d.c.) for 1 min	300 V
Test voltage (d.c.) of coating for 1 min	300 V
Insulation resistance at 100 V (d.c.) after 1 min	⩾ 4000 MΩ
Tan δ at 1 kHz, 1 V	⩽ 3,5%
Maximum voltage dependence of the capacitance between 0 and 40 V	–5%
Category temperature range	–55 to + 85 °C
Storage temperature range	–55 to + 85 °C
Climatic category (IEC 68)	55/085/21

Table 4

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

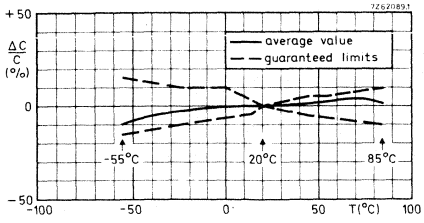


Fig. 8 ΔC with respect to C at 20 °C as a function of temperature. V = 0,1 V; f = 1 kHz.

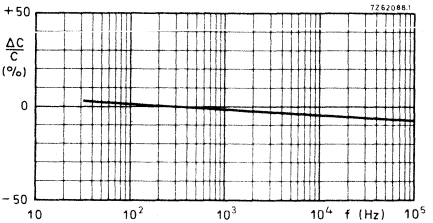


Fig. 9 Typ. ΔC with respect to C at 300 Hz, as a function of frequency. V = 0,1 V.

* Maximum thickness 2,5 mm, H_{max} = 4,5 mm.

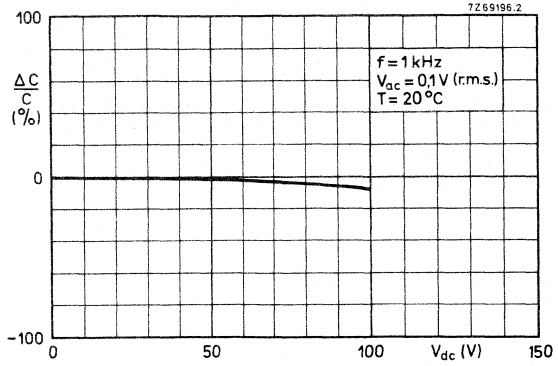


Fig. 10 Typical capacitance change with respect to the capacitance value at 0 V, as a function of d.c. voltage.

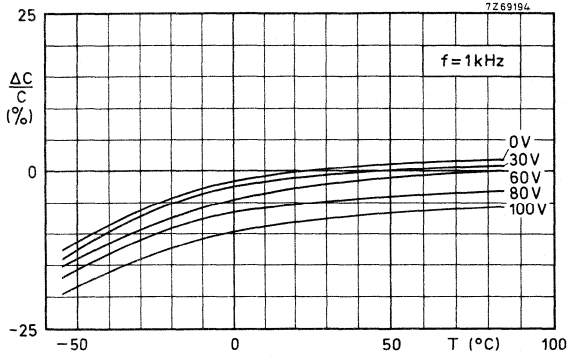


Fig. 11 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different d.c. voltages.
V_{ac} = 0,1 V (r.m.s.).

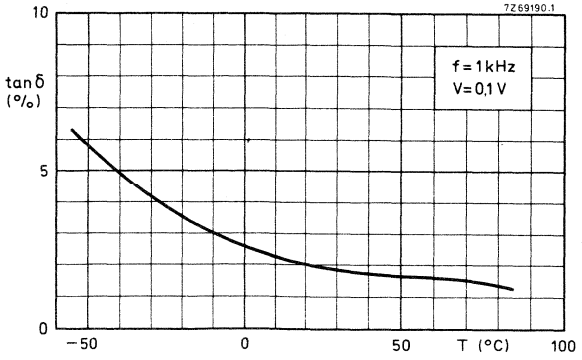


Fig. 12 Typical tan δ as a function of temperature.

ELECTRICAL DATA (continued)

Capacitors 2222 640 (colour mark blue)

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

Capacitance values, measured at 1 kHz, 1 V	1000–10 000 pF; E6 series (see Table 5)
Tolerance on the capacitance	−20 to + 50%
Rated d.c. voltage	100 V
Test voltage (d.c.) for 1 min	300 V
Test voltage (d.c.) of coating for 1 min	300 V
Insulation resistance at 100 V (d.c.) after 1 min	⩾ 3000 MΩ
Tan δ at 1 kHz, 1 V	⩽ 3,5%
Category temperature range	−55 to + 85 °C
Storage temperature range	−55 to + 85 °C
Climatic category (IEC 68)	55/085/21

Table 5

capacitance pF	size see Table 2	marking	code in catalogue number, see Table 1
1000	I	1n0	102
1500	I	1n5	152
2200	I	2n2	222
3300	IIA	3n3	332
4700	IIB	4n7	472
6800	III	6n8	682
10000	IV	10n	103

Graphs

measured at
V_{ac} = 1 V (r.m.s.),
f = 1 kHz.

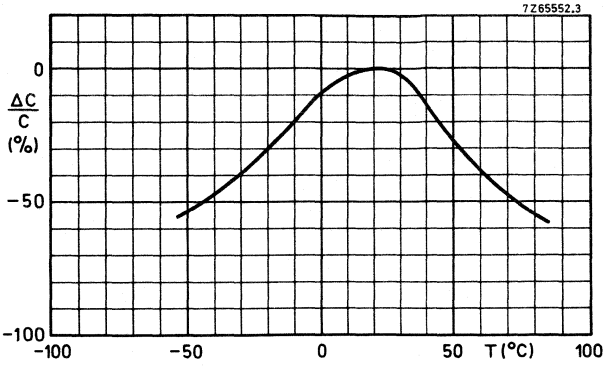


Fig. 13 Typical capacitance change versus temperature at 0 V (d.c.).

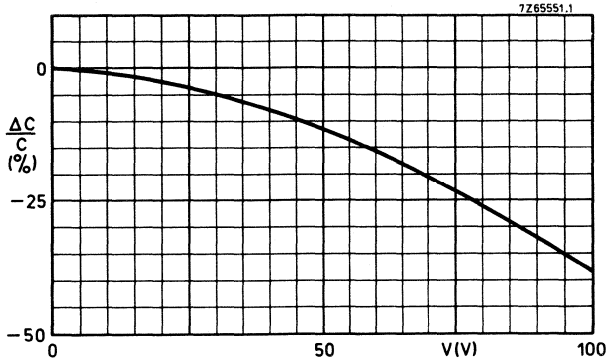


Fig. 14 Typical capacitance change with respect to the capacitance at 20 °C versus d.c. voltage.

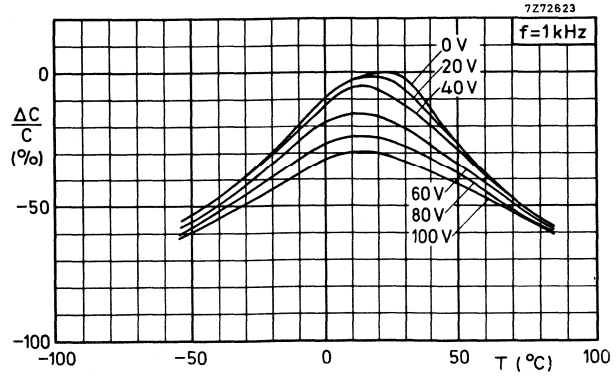
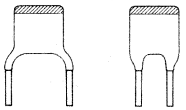


Fig. 15 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different voltages.

MINIATURE CERAMIC PLATE CAPACITORS

class 1,

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



QUICK REFERENCE DATA

Capacitance range	0,56 to 560 pF (E12 series)
Rated d.c. voltage	100 V
Tolerance on capacitance	± 2% or ± 0,25 pF
Temperature coefficients	P100, NP0, N075, N150, N220 N330, N470, N750, N1500
Sectional specification	IEC 384-8, sub-class 1B
Climatic category (IEC 68)	55/085/21

APPLICATION

In a wide variety of electronic equipment, e.g. as temperature compensating capacitors in tuning circuits and filters, as coupling and decoupling capacitors in high-frequency circuits where low losses and good d.c. behaviour are required.
Their small dimensions are an advantage in all cases where space-saving is important.

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides being metallized and provided with connecting leads. They are insulated by a coating method that ensures an excellent behaviour under humid conditions. The colour of the capacitor body is grey. The capacitors distinguish themselves by small dimensions, narrow tolerances on the lead spacing and very little and well defined lacquer on the leads. The electrical properties are characterized by low losses, a very close standard tolerance on the capacitance (± 0,25 pF or 2%), high stability and, owing to the absence of silver, an extremely good d.c. behaviour.
(Capacitors with silver electrodes suffer from the "silver migration" effect. Silver particles move from one electrode to the other under the influence of a d.c. voltage and moisture. Capacitors with silver electrodes are considerably larger.)

MECHANICAL DATA

Dimensions in mm

Outlines

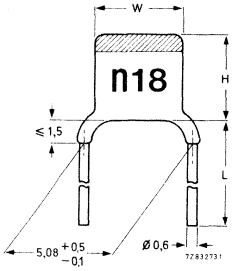


Fig. 1.

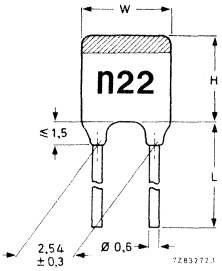


Fig. 2.

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

→ Table 1

lead spacing	lead diameter	Fig.	catalogue number *	
			L ⩾ 15 mm	L = 6 $^{+0}_{-2}$
5,08 mm (0,2 in)	0,6 mm (0,024 in)	1	2222 638	2222 642 . . . . .
2,54 mm (0,1 in)	0,6 mm (0,024 in)	2	2222 631	2222 641 . . . . .

* For catalogue number suffix, see Tables 3 to 11.

Table 2

size	W mm	H mm	approx. mass g
I	3,6 (−1,1)	3,7 (−1,2)	0,14
IIA	3,9 (−1,2)	4,0 (−1,3)	0,15
IIB	4,5 (−1,2)	4,7 (−1,4)	0,15
III	5,1 (−0,9)	5,3 (−1,1)	0,17
IV	6,2 (−1,0)	6,4 (−1,2)	0,20
V	6,2 (−1,0)	8,6 (−1,6)	0,20

Note: Tolerances are given between brackets.

The thickness of the capacitors does not exceed 2,3 mm (0,08 in), except for a few types as is indicated in Tables 3 to 11.

Lacquer on the leads

When capacitors shown in Figs 1 and 2 are mounted on printed-wiring boards with a thickness of 1,5 mm and with holes of 1,3 mm diameter, or on printed-wiring boards with a thickness of 1 mm and with holes of 0,8 mm diameter, there will be no lacquer on the leads at the lower side of the board.

For those capacitance values indicated with asterisks in Tables 3 to 10, and lead pitch of 5,08 mm, the lacquer on the leads is less than 2 mm.

Marking

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

Mounting

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

Soldering conditions max. 270 °C, max. 10 s

PACKING

The capacitors are supplied in boxes of 1000 (sizes I, IIA, IIB, III) or 500 (sizes IV, V).

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 384-8. Unless stated otherwise all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 63 to 67%.

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

* Including 2 mm per connecting lead.

Capacitors with a temperature coefficient P100, rated voltage 100 V (d.c.)

Capacitance range	0,56 to 47 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	+ 100 x 10^{-6}/K
Tolerance on the temperature coefficient	
for C < 22 pF	(–40 to + 120) x 10^{-6}/K
for C ⩾ 22 pF	± 40 x 10^{-6}/K
Marking colour of the temperature coefficient	red/violet

Table 3

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
0,56*	± 0,25 pF	I	p56	03567
0,68**	± 0,25 pF	I	p68	03687
0,82***	± 0,25 pF	I	p82	03827
1,0***	± 0,25 pF	I	1p0	03108
1,2	± 0,25 pF	I	1p2	03128
1,5	± 0,25 pF	I	1p5	03158
1,8	± 0,25 pF	I	1p8	03188
2,2	± 0,25 pF	I	2p2	03228
2,7	± 0,25 pF	I	2p7	03278
3,3	± 0,25 pF	I	3p3	03338
3,9	± 0,25 pF	I	3p9	03398
4,7	± 0,25 pF	I	4p7	03478
5,6	± 0,25 pF	I	5p6	03568
6,8	± 0,25 pF	I	6p8	03688
8,2	± 0,25 pF	IIA	8p2	03828
10	± 2%	IIA	10p	04109
12	± 2%	IIB	12p	04129
15	± 2%	IIB	15p	04159
18	± 2%	III	18p	04189
22	± 2%	III	22p	04229
27	± 2%	IV	27p	04279
33	± 2%	IV	33p	04339
39	± 2%	V	39p	04399
47	± 2%	V	47p	04479

* Maximum thickness 3,0 mm, H_{max} = 4,5 mm.
** Maximum thickness 2,7 mm, H_{max} = 4,5 mm.
*** Maximum thickness 2,5 mm, H_{max} = 4,5 mm.

Capacitors with a temperature coefficient NP0, rated voltage 100 V (d.c.)

Capacitance range	1,8 to 120 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	0 x 10^{-6}/K
Tolerance on the temperature coefficient	
for C < 22 pF	(–40 to + 120) x 10^{-6}/K
for C ⩾ 22 pF	± 30 x 10^{-6}/K
Marking colour of the temperature coefficient	black

Table 4

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
1,8	± 0,25 pF	I	1p8	09188
2,2	± 0,25 pF	I	2p2	09228
2,7	± 0,25 pF	I	2p7	09278
3,3	± 0,25 pF	I	3p3	09338
3,9	± 0,25 pF	I	3p9	09398
4,7	± 0,25 pF	I	4p7	09478
5,6	± 0,25 pF	I	5p6	09568
6,8	± 0,25 pF	I	6p8	09688
8,2	± 0,25 pF	I	8p2	09828
10	± 2%	I	10p	10109
12	± 2%	I	12p	10129
15	± 2%	I	15p	10159
18	± 2%	I	18p	10189
22	± 2%	I	22p	10229
27	± 2%	I	27p	10279
33	± 2%	I	33p	10339
39	± 2%	IIA	39p	10399
47	± 2%	IIA	47p	10479
56	± 2%	IIB	56p	10569
68	± 2%	IIB	68p	10689
82	± 2%	IIB	82p	10829
100	± 2%	III	n10	10101
120	± 2%	III	n12	10121

Capacitors with a temperature coefficient N075, rated voltage 100 V (d.c.)

Capacitance range	3,9 to 120 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-75×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	red

Table 5

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
3,9	± 0,25 pF	I	3p9	27398
4,7	± 0,25 pF	I	4p7	27478
5,6	± 0,25 pF	I	5p6	27568
6,8	± 0,25 pF	I	6p8	27688
8,2	± 0,25 pF	I	8p2	27828
10	± 2%	I	10p	28109
12	± 2%	I	12p	28129
15	± 2%	I	15p	28159
18	± 2%	I	18p	28189
22	± 2%	IIA	22p	28229
27	± 2%	IIA	27p	28279
33	± 2%	IIB	33p	28339
39	± 2%	IIB	39p	28399
47	± 2%	III	47p	28479
56	± 2%	III	56p	28569
68	± 2%	IV	68p	28689
82	± 2%	IV	82p	28829
100	± 2%	V	n10	28101
120	± 2%	V	n12	28121

Capacitors with a temperature coefficient N150, rated voltage 100 V (d.c.)

Capacitance range	3,9 to 150 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-150×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 40 \times 10^{-6}$/K
Marking colour of the temperature coefficient	orange

Table 6

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
3,9*	± 0,25 pF	I	3p9	33398
4,7	± 0,25 pF	I	4p7	33478
5,6	± 0,25 pF	I	5p6	33568
6,8	± 0,25 pF	I	6p8	33688
8,2	± 0,25 pF	I	8p2	33828
10	± 2%	I	10p	34109
12	± 2%	I	12p	34129
15	± 2%	I	15p	34159
18	± 2%	I	18p	34189
22	± 2%	I	22p	34229
27	± 2%	I	27p	34279
33	± 2%	I	33p	34339
39	± 2%	IIA	39p	34399
47	± 2%	IIA	47p	34479
56	± 2%	IIB	56p	34569
68	± 2%	IIB	68p	34689
82	± 2%	III	82p	34829
100	± 2%	III	n10	34101
120	± 2%	IV	n12	34121
150	± 2%	IV	n15	34151

* Maximum thickness 2,5 mm, H_{max} = 4,5 mm.

Capacitors with a temperature coefficient N220, rated voltage 100 V (d.c.)

Capacitance range	3,9 to 150 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-220×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 40 \times 10^{-6}$/K
Marking colour of the temperature coefficient	yellow

Table 7

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
3,9*	± 0,25 pF	I	3p9	39398
4,7	± 0,25 pF	I	4p7	39478
5,6	± 0,25 pF	I	5p6	39568
6,8	± 0,25 pF	I	6p8	39688
8,2	± 0,25 pF	I	8p2	39828
10	± 2%	I	10p	40109
12	± 2%	I	12p	40129
15	± 2%	I	15p	40159
18	± 2%	I	18p	40189
22	± 2%	I	22p	40229
27	± 2%	IIA	27p	40279
33	± 2%	IIA	33p	40339
39	± 2%	IIB	39p	40399
47	± 2%	IIB	47p	40479
56	± 2%	III	56p	40569
68	± 2%	III	68p	40689
82	± 2%	IV	82p	40829
100	± 2%	IV	n10	40101
120	± 2%	V	n12	40121
150	± 2%	V	n15	40151

* Maximum thickness 2,5 mm, H_{max} = 4,5 mm.

Capacitors with a temperature coefficient N330, rated voltage 100 V (d.c.)

Capacitance range	4,7 to 180 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-330×10^{-6}/K
Tolerance on the temperature coefficient	$\pm 60 \times 10^{-6}$/K
Marking colour of the temperature coefficient	green

Table 8

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
4,7	± 0,25 pF	I	4p7	45478
5,6	± 0,25 pF	I	5p6	45568
6,8	± 0,25 pF	I	6p8	45688
8,2	± 0,25 pF	I	8p2	45828
10	± 2%	I	10p	46109
12	± 2%	I	12p	46129
15	± 2%	I	15p	46159
18	± 2%	I	18p	46189
22	± 2%	I	22p	46229
27	± 2%	I	27p	46279
33	± 2%	IIA	33p	46339
39	± 2%	IIA	39p	46399
47	± 2%	IIB	47p	46479
56	± 2%	IIB	56p	46569
68	± 2%	III	68p	46689
82	± 2%	III	82p	46829
100	± 2%	IV	n10	46101
120	± 2%	IV	n12	46121
150	± 2%	V	n15	46151
180	± 2%	V	n18	46181

Capacitors with a temperature coefficient N470, rated voltage 100 V (d.c.)

Capacitance range	6,8 to 220 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-470×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-90 \text{ to } +250) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 60 \times 10^{-6}$/K
Marking colour of the temperature coefficient	blue

Table 9

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
6,8	± 0,25 pF	I	6p8	51688
8,2	± 0,25 pF	I	8p2	51828
10	± 2%	I	10p	52109
12	± 2%	I	12p	52129
15	± 2%	I	15p	52159
18	± 2%	I	18p	52189
22	± 2%	I	22p	52229
27	± 2%	I	27p	52279
33	± 2%	I	33p	52339
39	± 2%	IIA	39p	52399
47	± 2%	IIA	47p	52479
56	± 2%	IIB	56p	52569
68	± 2%	IIB	68p	52689
82	± 2%	III	82p	52829
100	± 2%	III	n10	52101
120	± 2%	IV	n12	52121
150	± 2%	IV	n15	52151
180	± 2%	V	n18	52181
220	± 2%	V	n22	52221

Capacitors with a temperature coefficient N750, rated voltage 100 V (d.c.)

Capacitance range	3,9 to 330 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-750×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-120 \text{ to } +250) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 120 \times 10^{-6}$/K
Marking colour of the temperature coefficient	violet

Table 10

cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
3,9	± 0,25 pF	I	3p9	57398
4,7	± 0,25 pF	I	4p7	57478
5,6	± 0,25 pF	I	5p6	57568
6,8	± 0,25 pF	I	6p8	57688
8,2	± 0,25 pF	I	8p2	57828
10	± 2%	I	10p	58109
12	± 2%	I	12p	58129
15	± 2%	I	15p	58159
18	± 2%	I	18p	58189
22	± 2%	I	22p	58229
27	± 2%	I	27p	58279
33	± 2%	I	33p	58339
39	± 2%	I	39p	58399
47	± 2%	I	47p	58479
56	± 2%	IIA	56p	58569
68	± 2%	IIA	68p	58689
82	± 2%	IIB	82p	58829
100	± 2%	IIB	n10	58101
120	± 2%	III	n12	58121
150	± 2%	III	n15	58151
180	± 2%	IV	n18	58181
220	± 2%	IV	n22	58221
270	± 2%	V	n27	58271
330	± 2%	V	n33	58331

Capacitors with a temperature coefficient N1500, rated voltage 100 V (d.c.)

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

Table 11

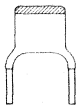
cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
18*	± 2%	I	18p	70189
22	± 2%	I	22p	70229
27	± 2%	I	27p	70279
33	± 2%	I	33p	70339
39	± 2%	I	39p	70399
47	± 2%	I	47p	70479
56	± 2%	I	56p	70569
68	± 2%	I	68p	70689
82	± 2%	I	82p	70829
100	± 2%	IIA	n10	70101
120	± 2%	IIA	n12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

* Maximum thickness 2,5 mm, H_{max} = 4,5 mm.

MINIATURE CERAMIC PLATE CAPACITORS

class 1, 500 V (d.c.)

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



QUICK REFERENCE DATA

Capacitance range	0,47 to 270 pF (E12 series)
Rated d.c. voltage	500 V
Tolerance on capacitance	± 2% or ± 0,25 pF
Temperature coefficients	P100, NP0, N150, N750, N1500
Sectional specification	IEC 384-8, sub-class 1B
Category (IEC 68)	55/085/21

APPLICATION

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

DESCRIPTION

The capacitors consist of a thin rectangular ceramic plate, both sides of which are metallized and provided with connecting leads. They are insulated by a coating that ensures a good behaviour under humid conditions. The colour of the capacitor body is grey. The capacitors distinguish themselves by small dimensions and narrow tolerances on the lead spacing.
The electrical properties are characterized by low losses, a very close standard tolerance on the capacitance (± 0,25 pF or 2%), high stability and, owing to the absence of silver, an extremely good d.c. behaviour.

MECHANICAL DATA

Dimensions in mm

Outlines

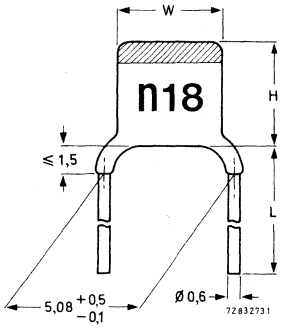


Fig. 1.

Table 1

lead spacing	lead diameter	catalogue number *	
		L ⩾ 13 mm	L = 4 ± 0,5
5,08 mm (0,2 in)	0,6 mm (0,024 in)	2222 650	2222 651 . . . . .

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

Table 2

size	W	H	approx. mass g
I	3,6 (−1,1)	3,7 (−1,2)	0,15
IIA	3,9 (−1,2)	4,0 (−1,3)	0,15
IIB	4,5 (−1,2)	4,7 (−1,4)	0,16
III	5,1 (−0,9)	5,3 (−1,1)	0,17
IV	6,2 (−1,0)	6,4 (−1,2)	0,21
V	6,2 (−1,0)	8,6 (−1,5)	0,23

Note: Tolerances are given between brackets.

Except for the types indicated in Tables 3 to 7, the thickness of the capacitor does not exceed 2,3 mm.

Lacquer on the leads

When the capacitors are mounted on printed-wiring boards with a thickness of 1,5 mm and with holes of 1,3 mm diameter or on printed-wiring boards with a thickness of 1 mm and with holes of 0,8 mm diameter, there will be no lacquer on the leads at the lower side of the board. For those capacitance values indicated with asterisks in Tables 3 to 7, the lacquer on the leads is less than 2 mm.

Marking

The temperature coefficient is indicated by a colour code as per IEC and EIA recommendations. The capacitance value and the voltage are indicated on the body by figures in a contrasting colour, see Tables 3 to 7.

Mounting

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

Soldering conditions max. 270 °C, max. 10 s

PACKING

The capacitors are packed in boxes of 1000 (sizes I, IIA, IIB, III) or 500 (sizes IV and V).

* For catalogue number suffix, see Tables 3 to 7.

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 384-8. Unless stated otherwise all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 63 to 67%.

Capacitance values* and tolerances, measured at 1 MHz, ≤ 5 V	0,47 to 270 pF, E12 series, see Tables 3 to 7
Rated d.c. voltage	500 V
Test voltage (d.c.) for 1 minute	1250 V
Test voltage (d.c.) of coating for 1 minute	1250 V
Insulation resistance at 500 V (d.c.) after 1 min	> 10 000 MΩ
Tan δ* at 1 MHz, ≤ 5 V for C < 50 pF	$\leqslant 15\ (\frac{15}{C} + 0{,}7).10^{-4}$
for C > 50 pF	$\leqslant 15.10^{-4}$
Category temperature range	−55 to + 85 °C
Storage temperature range	−55 to + 85 °C
Climatic category (IEC 68)	55/085/21

* Including 2 mm per connecting lead.

Capacitors with temperature coefficient P100

Capacitance range	0,47 to 33 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	+ 100 x 10^{-6}/K
Tolerance on the temperature coefficient	
for C < 22 pF	(−40 to + 120) x 10^{-6}/K
for C ⩾ 22 pF	± 40 x 10^{-6}/K
Marking colour of the temperature coefficient	red/violet

Table 3

capacitance pF	tolerance	size see Table 2	marking		suffix of catalogue number see Table 1
0,47*	± 0,25 pF	I	p47	500	03477
0,68	± 0,25 pF	I	p68	500	03687
1,0	± 0,25 pF	I	1p0	500	03108
1,2	± 0,25 pF	I	1p2	500	03128
1,5*	± 0,25 pF	I	1p5	500	03158
1,8	± 0,25 pF	I	1p8	500	03188
2,2	± 0,25 pF	I	2p2	500	03228
2,7	± 0,25 pF	I	2p7	500	03278
3,3	± 0,25 pF	I	3p3	500	03338
3,9	± 0,25 pF	I	3p9	500	03398
4,7	± 0,25 pF	IIA	4p7	500	03478
5,6	± 0,25 pF	IIA	5p6	500	03568
6,8	± 0,25 pF	IIB	6p8	500	03688
8,2	± 0,25 pF	IIB	8p2	500	03828
10	± 2%	III	10p	500	04109
12	± 2%	III	12p	500	04129
15	± 2%	III	15p	500	04159
18	± 2%	IV	18p	500	04189
22	± 2%	IV	22p	500	04229
27	± 2%	V	27p	500	04279
33	± 2%	V	33p	500	04339

* Maximum thickness 2,5 mm, H'_{max} = 4,5 mm.

Capacitors with a temperature coefficient NP0

Capacitance range	0,82 to 47 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	0×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-40 +120) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 30 \times 10^{-6}$/K
Marking colour for the temperature coefficient	black

Table 4

capacitance pF	tolerance	size see table 2	marking		suffix of catalogue number see Table 1
0,82*	± 0,25 pF	I	p82	500	09827
1 *	± 0,25 pF	I	1p0	500	09108
1,2	± 0,25 pF	I	1p2	500	09128
1,5	± 0,25 pF	I	1p5	500	09158
1,8	± 0,25 pF	I	1p8	500	09188
2,2	± 0,25 pF	I	2p2	500	09228
2,7	± 0,25 pF	I	2p7	500	09278
3,3	± 0,25 pF	I	3p3	500	09338
3,9	± 0,25 pF	I	3p9	500	09398
4,7	± 0,25 pF	I	4p7	500	09478
5,6	± 0,25 pF	I	5p6	500	09568
6,8	± 0,25 pF	IIA	6p8	500	09688
8,2	± 0,25 pF	IIA	8p2	500	09828
10	± 2%	IIB	10p	500	10109
12	± 2%	IIB	12p	500	10129
15	± 2%	IIB	15p	500	10159
18	± 2%	III	18p	500	10189
22	± 2%	III	22p	500	10229
27	± 2%	IV	27p	500	10279
33	± 2%	IV	33p	500	10339
39	± 2%	IV	39p	500	10399
47	± 2%	V	47p	500	10479

* Maximum thickness 2,5 mm, H_{max} = 4,5 mm.

Capacitors with a temperature coefficient N150

Capacitance range	2,2 to 56 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-150×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-40 + 60) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	orange

Table 5

capacitance pF	tolerance	size see table 2	marking		suffix of catalogue number see Table 1
2,2*	± 0,25 pF	I	2p2	500	2222 650 33228
2,7*	± 0,25 pF	I	2p7	500	33278
3,3	± 0,25 pF	I	3p3	500	33338
3,9	± 0,25 pF	I	3p9	500	33398
4,7	± 0,25 pF	I	4p7	500	33478
5,6	± 0,25 pF	I	5p6	500	33568
6,8	± 0,25 pF	I	6p8	500	33688
8,2	± 0,25 pF	IIA	8p2	500	33828
10	± 2%	IIA	10p	500	34109
12	± 2%	IIB	12p	500	34129
15	± 2%	IIB	15p	500	34159
18	± 2%	IIB	18p	500	34189
22	± 2%	III	22p	500	34229
27	± 2%	III	27p	500	34279
33	± 2%	IV	33p	500	34339
39	± 2%	IV	39p	500	34399
47	± 2%	IV	47p	500	34479
56	± 2%	V	56p	500	34569

* Maximum thickness 2,5 mm, H_{max} = 4,5 mm.

Capacitors with a temperature coefficient N750

Capacitance range	1,8 to 120 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-750×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 22$ pF	$(-120 + 250) \times 10^{-6}$/K
for $C \geqslant 22$ pF	$\pm 120 \times 10^{-6}$/K
Marking colour of the temperature coefficient	violet

Table 6

capacitance pF	tolerance	size see Table 2	marking		suffix of catalogue number see Table 1
1,8*	± 0,25 pF	I	1p8	500	57188
2,2**	± 0,25 pF	I	2p2	500	57228
2,7	± 0,25 pF	I	2p7	500	57278
3,3	± 0,25 pF	I	3p3	500	57338
3,9	± 0,25 pF	I	3p9	500	57398
4,7**	± 0,25 pF	I	4p7	500	57478
5,6	± 0,25 pF	I	5p6	500	57568
6,8	± 0,25 pF	I	6p8	500	57688
8,2	± 0,25 pF	I	8p2	500	57828
10	± 2%	I	10p	500	58109
12	± 2%	I	12p	500	58129
15	± 2%	I	15p	500	58159
18	± 2%	IIA	18p	500	58189
22	± 2%	IIA	22p	500	58229
27	± 2%	IIB	27p	500	58279
33	± 2%	IIB	33p	500	58339
39	± 2%	IIB	39p	500	58399
47	± 2%	III	47p	500	58479
56	± 2%	III	56p	500	58569
68	± 2%	IV	68p	500	58689
82	± 2%	IV	82p	500	58829
100	± 2%	IV	n10	500	58101
120	± 2%	V	n12	500	58121

* Maximum thickness 2,7 mm, H_{max} = 4,5 mm.
** Maximum thickness 2,5 mm, H_{max} = 4,5 mm.

Capacitors with a temperature coefficient N1500

Capacitance range	8,2 to 270 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-1500×10^{-6}/K
Tolerance on the temperature coefficient	$(-0 + 500) \times 10^{-6}$/K
Marking colour of the temperature coefficient	orange/orange

Table 7

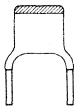
capacitance pF	tolerance	size see Table 2	marking		suffix of catalogue number see Table 1
8,2*	± 0,25 pF	I	8p2	500	69828
10 **	± 2%	I	10p	500	70109
12 **	± 2%	I	12p	500	70129
15	± 2%	I	15p	500	70159
18	± 2%	I	18p	500	70189
22	± 2%	I	22p	500	70229
27	± 2%	I	27p	500	70279
33	± 2%	IIA	33p	500	70339
39	± 2%	IIA	39p	500	70399
47	± 2%	IIA	47p	500	70479
56	± 2%	IIB	56p	500	70569
68	± 2%	IIB	68p	500	70689
82	± 2%	IIB	82p	500	70829
100	± 2%	III	n10	500	70101
120	± 2%	III	n12	500	70121
150	± 2%	IV	n15	500	70151
180	± 2%	IV	n18	500	70181
220	± 2%	IV	n22	500	70221
270	± 2%	V	n27	500	70271

* Maximum thickness 3,0 mm, H_{max} = 4,5 mm.
** Maximum thickness 2,5 mm, H_{max} = 4,5 mm.

MINIATURE CERAMIC PLATE CAPACITORS

class 2, 500 V (d.c.)

- General purpose
- Coupling and decoupling
- Space saving



QUICK REFERENCE DATA

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

APPLICATION

Electronic circuits where a non-linear change of capacitance with temperature is permissible and very low losses are not essential, e.g. coupling and decoupling.
Because of their small size the capacitors are ideal for circuitry with a 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 with a high melting point solder.

The capacitors are protected by several layers of tan lacquer that ensures a good behaviour under humid conditions and is resistant to all commonly used cleaning solvents.
No silver migration can occur.

MECHANICAL DATA

Dimensions in mm

Outlines

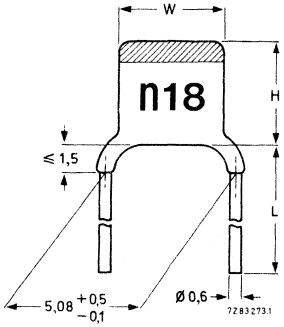


Fig. 1.

Table 1

lead spacing	lead diameter	catalogue number*	
		L ⩾ 13 mm	L = 4 ± 0,5
5,08 mm (0,2 in)	0,6 mm (0,024 in)	2222 655 03 . . .	2222 655 06 . . .

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

Table 2

size	W	H	approx. mass g
I	3,6 (−1,1)	3,7 (−1,2)	0,15
IIA	3,9 (−1,2)	4,0 (−1,3)	0,15
IIB	4,5 (−1,2)	4,7 (−1,4)	0,16
III	5,1 (−0,9)	5,3 (−1,1)	0,17
IV	6,2 (−1,0)	6,4 (−1,2)	0,21
V	6,2 (−1,0)	8,6 (−1,5)	0,23

Note: Tolerances are given between brackets.

Except for the types indicated in Table 3, the thickness of the capacitor does not exceed 2,3 mm.

Lacquer on the leads

When the capacitors are mounted on printed-wiring boards with a thickness of 1,5 mm and with holes of 1,3 mm diameter or on printed-wiring boards with a thickness of 1 mm and with holes of 0,8 mm diameter there will be no lacquer on the leads at the lower side of the board. For those capacitance values indicated with asterisks in Table 3, the lacquer on the leads is less than 2 mm.

Marking

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

Mounting

When bending, cutting or flattening the leads, one should relieve them of the applied load at the capacitor body.

Soldering conditions max. 270 °C, max. 10 s

PACKING

The capacitors are supplied in boxes of 1000 (sizes I, IIA, IIB, III) or 500 (sizes IV and V).

* 3 dots to be replaced by code for capacitance value, see Table 3.

ELECTRICAL DATA

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

Capacitance values, measured at 1 kHz, 1 V	100 to 2700 pF, E12 series see Table 3
Tolerance on the capacitance	± 10%
Rated d.c. voltage	500 V
Test voltage (d.c.) for 1 min	1250 V
Test voltage (d.c.) of coating for 1 min	1250 V
Insulation resistance at 500 V (d.c.) after 1 min	> 4000 MΩ
Tan δ at 1 kHz, 1 V	< 3,5%
Category temperature range	−55 to + 85 °C
Climatic category	55/085/21
Storage temperature range	−55 to + 85 °C
Capacitance change versus temperature	see Fig. 2
Capacitance change versus frequency	see Fig. 3

Table 3

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

* Maximum thickness 2,7 mm, H_{max} = 4,5 mm.
** Maximum thickness 2,5 mm, H_{max} = 4,5 mm.

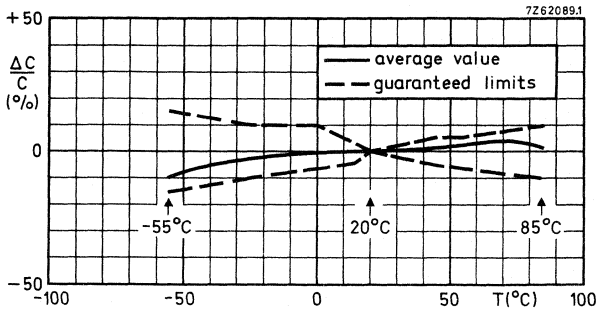


Fig. 2 Capacitance change with respect to the capacitance at 20 °C as a function of temperature.

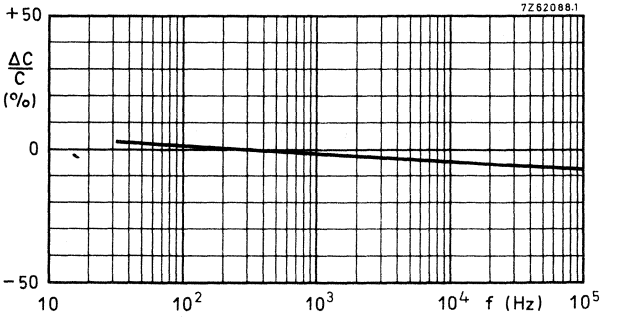


Fig. 3 Typical capacitance change with respect to the capacitance at 300 Hz as a function of frequency.

SURFACE MOUNTED CERAMIC MULTILAYER CAPACITORS

Class 2, Z5U dielectric

Capacitance range (E6-series)*	2200 to 100 000 pF
Tolerance on capacitance	−20 to + 80% and ± 20%
Rated voltage U_R (d.c.)	50 V (EIA), 63 V (IEC)
Test voltage (d.c.) for 1 min	2,5 x U_R
Tan δ, measured at 1 kHz, 1,0 V	⩽ 2,5%
Insulation resistance	
C ⩽ 25 000 pF	> 4000 MΩ
C > 25 000 pF	R_{ins} x C > 100 s
Climatic category (IEC 68)	30/085/56
Maximum capacitance variation with respect	
to C at 20 °C (IEC)	+ 30 to −55%, see Fig. 3
to C at 25 °C (EIA)	+ 30 to −56%
Ageing	typ. 5% per time decade

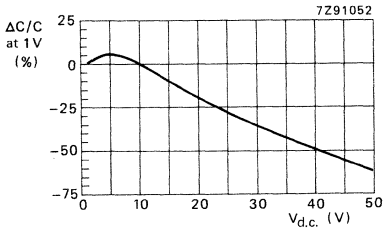


Fig 1 Typical capacitance change with respect to the capacitance at 1 V as a function of d.c. voltage for Z5U dielectric.

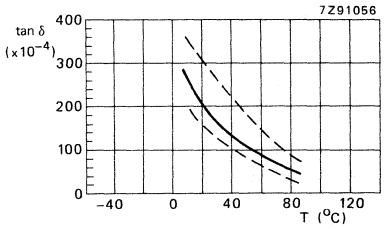


Fig. 2 Typical tan δ as a function of temperature, for Z5U dielectric.

* Measured at 1,0 V, 1 kHz, by a four-gauge method.

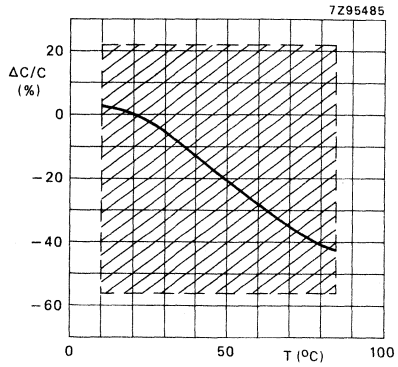


Fig. 3 Typical capacitance change as a function of temperature, for Z5U dielectric.

Table 1 Selection chart for class 2 capacitors, Z5U dielectric

C pF	Z5U	
	0805	1206
47		
68		
100		
150		
220		
330		
470		
680		
1000		
1500		
2200	▒	
3300	▒	
4700	▒	
6800	▒	
10000	▒	▒
15000	▒	▒
22000	▒	▒
33000	▨	▒
47000		▒
68000		▒
100000		▨
150000		
220000		
330000		
470000		
680000		
1000000		

▒ available in box and in 8 mm tape on reel

▨ available in box

7Z93567

STANDARD SERIES OF VALUES IN A DECADE

for resistances and capacitances

according to IEC publication 63

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

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