PHILIPS

Data handbook

Electronic components and materials

Components and materials

Book C15 1987

Ceramic capacitors

PHILIPS

Ceramic capacitors

C15

1987

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 vii.

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

When ratings or specifications differ from those published in the preceding edition they are indicated with arrows in the page margin. Where application information is given it is advisory and does not form part of the product specification.

Condensed data on the preferred products of Philips Electronic Components and Materials Division is given in our Preferred Type Range catalogue (issued annually).

Information on current Data Handbooks and on how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.
Product specialists are at your service and enquiries will be answered promptly.

ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks comprises:

T1 **Tubes for r.f. heating**

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

T2b **Transmitting tubes for communications, ceramic types**

T3 **Klystrons**

T4 **Magnetrons for microwave heating**

T5 **Cathode-ray tubes**
Instrument tubes, monitor and display tubes, C.R. tubes for special applications

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**

T15 **Dry reed switches**

T16 **Monochrome tubes and deflection units**
Black and white TV picture tubes, monochrome data graphic display tubes, deflection units

SEMICONDUCTORS (RED SERIES)

The red series of data handbooks comprises:

S1 **Diodes**
Small-signal silicon diodes, voltage regulator diodes (< 1,5 W), voltage reference diodes, tuner diodes, rectifier diodes

S2a **Power diodes**

S2b **Thyristors and triacs**

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**

S8a **Light-emitting diodes**

S8b **Devices for optoelectronics**
Optocouplers, photosensitive diodes and transistors, infrared light-emitting diodes and infrared sensitive devices, laser and fibre-optic components

S9 **Power MOS transistors**

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

S11 **Microwave transistors**

S12 **Surface acoustic wave devices**

S13 **Semiconductor sensors**

***S14** **Liquid Crystal Displays**

*To be issued shortly.

INTEGRATED CIRCUITS (PURPLE SERIES)

The NEW SERIES of handbooks is now completed. With effect from the publication date of this handbook the "N" in the handbook code number will be deleted.
Handbooks to be replaced during 1986 are shown below.

The purple series of handbooks comprises:

IC01	**Radio, audio and associated systems** Bipolar, MOS	new issue 1986 IC01N 1985
IC02a/b	**Video and associated systems** Bipolar, MOS	new issue 1986 IC02Na/b 1985
IC03	**Integrated circuits for telephony** Bipolar, MOS	new issue 1987 IC03N 1985
IC04	**HE4000B logic family** CMOS	new issue 1986 IC4 1983
IC05N	**HE4000B logic family – uncased ICs** CMOS	published 1984
IC06N	**High-speed CMOS; PC74HC/HCT/HCU** Logic family	published 1986
IC08	**ECL 10K and 100K logic families**	New issue 1986 IC08N 1984
IC09N	**TTL logic series**	published 1986
IC10	**Memories** MOS, TTL, ECL	new issue 1986 IC7 1982
IC11N	**Linear LSI**	published 1985
Supplement to IC11N	**Linear LSI**	published 1986
IC12	**I^2C-bus compatible ICs**	not yet issued
IC13	**Semi-custom** Programmable Logic Devices (PLD)	new issue 1986 IC13N 1985
IC14	**Microcontrollers and peripherals** Bipolar, MOS	published 1986
IC15	**FAST TTL logic series**	new issue 1986 IC15N 1985
IC16	**CMOS integrated circuits for clocks and watches**	first issue 1986
IC17	**Integrated Services Digital Networks (ISDN)**	not yet issued
IC18	**Microprocessors and peripherals**	new issue 1986

COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

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

C11 Varistors, thermistors and sensors

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

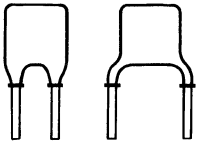
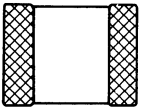
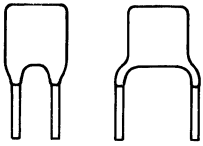
C20 Wire-wound components for TVs and monitors

C22 Film capacitors

SELECTION GUIDE
INTRODUCTION

SELECTION GUIDE

CERAMIC CAPACITORS

type	class	application	series number 2222 . . .	nominal capacitance pF	rated voltage (U_R) V	page
Plate; leads with flange		high-frequency circuits	678 to 683 688; 689	0,56 to 560	100	33
	1	temperature compensating high stability	652 653 654	0,47 to 270	500	21
		space saving	691	0,47 to 270	500	47
	2	general purpose coupling/decoupling space saving	629 630 640	1000 to 22 000 180 to 4 700 1000 to 10 000	63 100 100	11
			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	107
	2	general purpose coupling/decoupling space saving		180 to 1 000 000	50	107
Plate; maintenance types 	1	high-frequency circuits temperature compensating	631, 638, 641, 642	0,56 to 560	100	79
		high stability space saving	650 651	0,47 to 270	500	93
	2	general purpose coupling/decoupling space saving	629 630 640	1000 to 22 000 180 to 4 700 1000 to 10 000	63 100 100	69
			655	100 to 2 700	500	101

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:

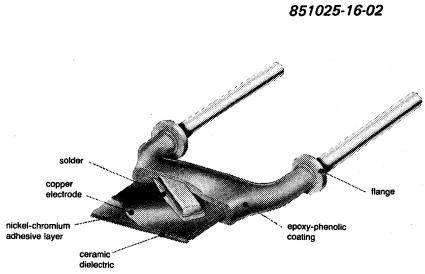


Fig. 1 Plate capacitor.

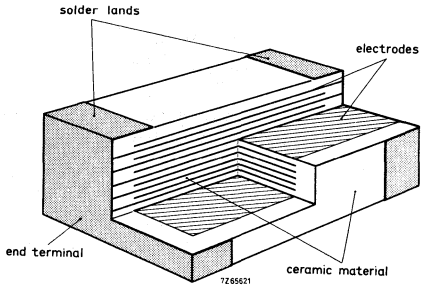


Fig. 2 Cross-section of a multilayer capacitor.

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

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

For plate capacitors these sheets are fired in a carefully controlled atmosphere at temperatures between 1200 and 1400 °C. For multilayer capacitors electrode material is printed on the sheets and after stacking and pressing of the sheets cofired with the ceramic compact at temperatures between 100 and 1400 °C.

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

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.

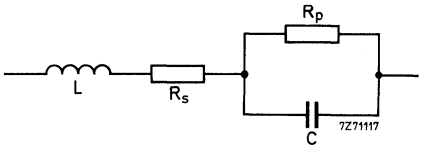


Fig. 3.

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.

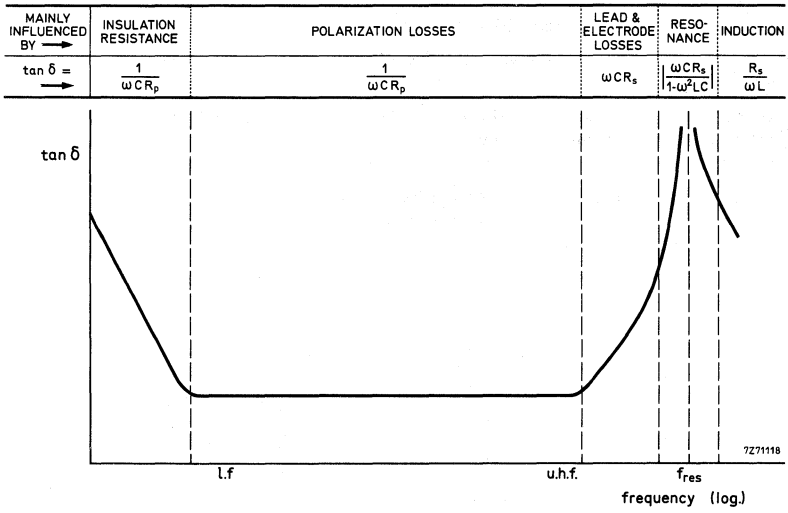


Fig. 4.

5. RELIABILITY

The failure rates shown below have a confidence level of 60% and refer to observations of plate capacitors up to and including 1984.

number of component hours	failure rate		
	catastrophic	degradation	field result
17 290 000	6 FIT	42 FIT	$<$0,2 FIT

Notes

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

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

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

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

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

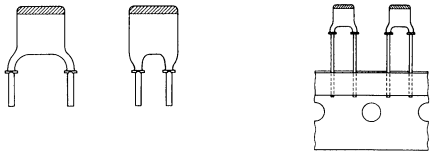
The field result value has been obtained from measurements in applications with very low environmental stress, at ½ x rated voltage (d.c.), continuous operation, and equipment temperature between 10 and 55 °C.

MINIATURE CERAMIC PLATE CAPACITORS

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

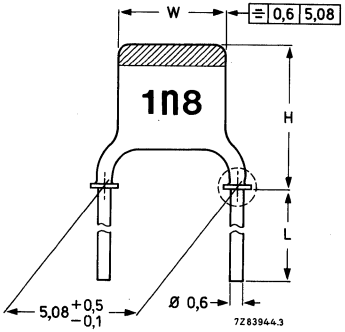


Fig. 1.

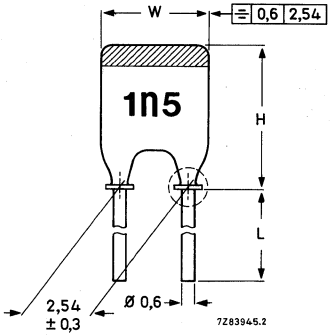
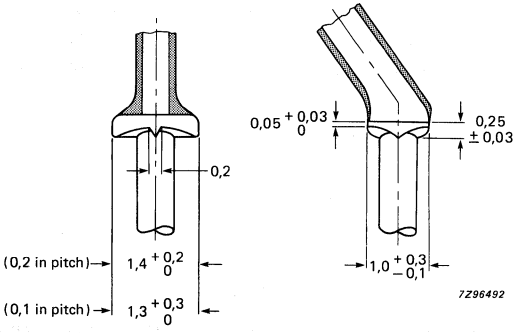


Fig. 2.

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

pitch	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 . . .	2222 629 61 . . . 2222 630 61 . . . 2222 640 61 . . .

* 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 value is 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	⩽ 3,5%
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

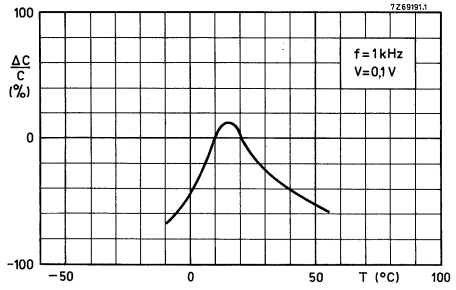


Fig. 3 Typical capacitance change as a function of temperature for capacitance values 2200 pF to 22 000 pF; dotted lines give an indication of the behaviour at higher and lower temperatures.

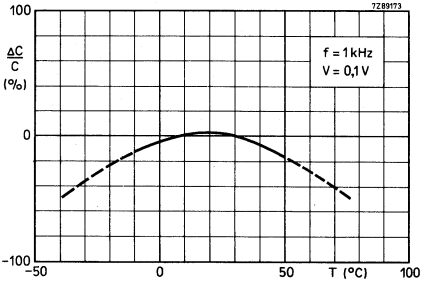


Fig. 4 Typical capacitance change as a function of temperature for capacitance value 1000 pF; dotted lines give an indication of the behaviour at higher and lower temperatures.

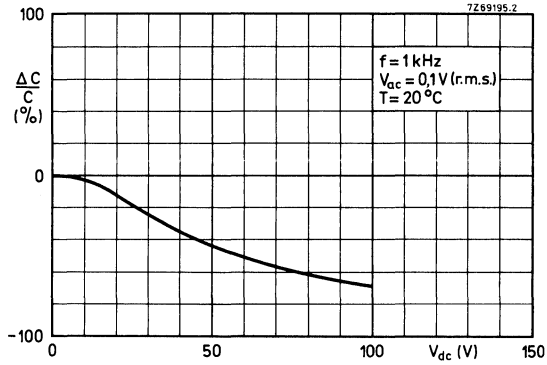


Fig. 5 Typical capacitance change with respect to the capacitance value at 0 V, as a function of d.c. voltage, for capacitance values 2200 to 22 000 pF.

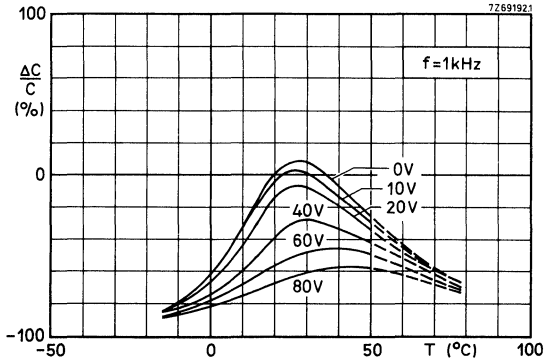


Fig. 6 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different d.c. voltages, for capacitance values 2200 to 22 000 pF; V_{ac} = 0,1 V (r.m.s.).

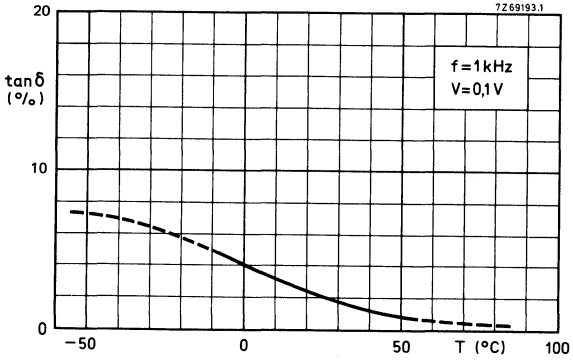


Fig. 7 Typical tan δ as a function of temperature, for capacitance values 2200 to 22 000 pF.

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

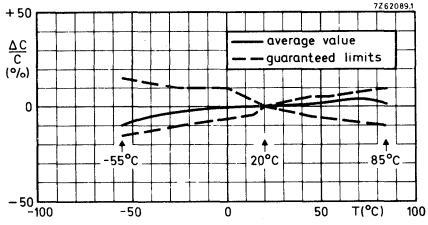


Fig. 8 ΔC with respect to C at 20 °C as a function of temperature. V = 0,1 V, f = 1 kHz.

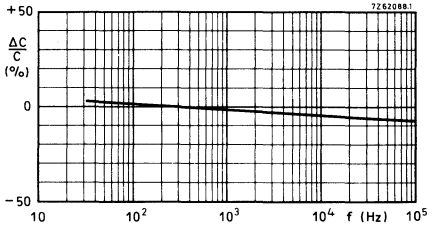


Fig. 9 Typ. ΔC with respect to C at 300 Hz, as a function of frequency. V = 0,1 V.

* Maximum thickness 2,5 mm.

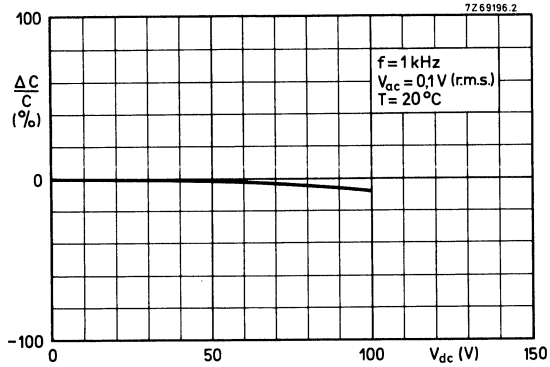


Fig. 10 Typical capacitance change with respect to the capacitance value at 0 V, as a function of d.c. voltage.

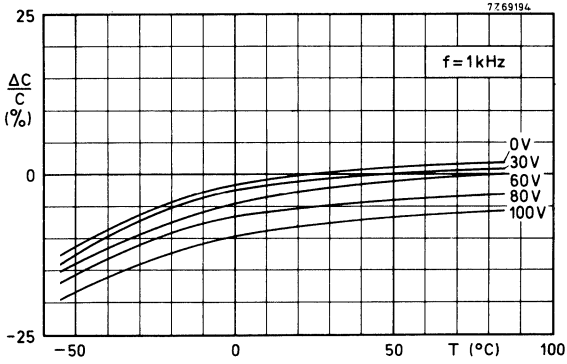


Fig. 11 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different d.c. voltages.
V_{ac} = 0,1 V (r.m.s.).

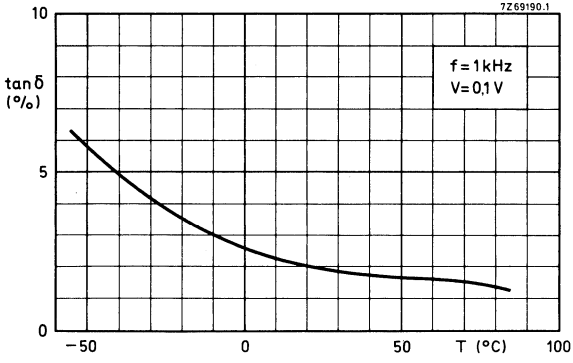


Fig. 12 Typical tan δ as a function of temperature.

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	⩾4000 MΩ
Tan δ at 1 kHz, 1 V	⩽3,5%
Category temperature range	−55 to + 85 °C
Storage temperature range	−55 to + 85 °C
Climatic category (IEC 68)	55/085/21

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.

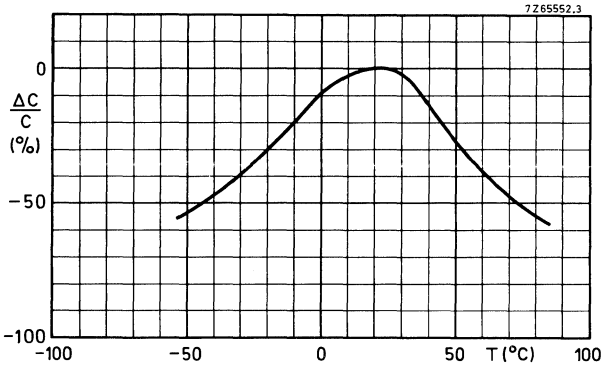


Fig. 13 Typical capacitance change versus temperature at 0 V (d.c.).

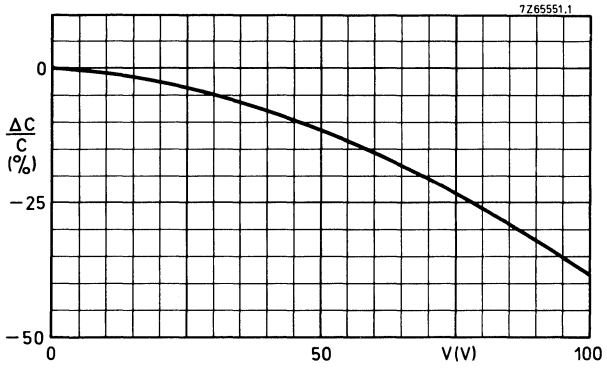


Fig. 14 Typical capacitance change with respect to the capacitance at 20 °C versus d.c. voltage.

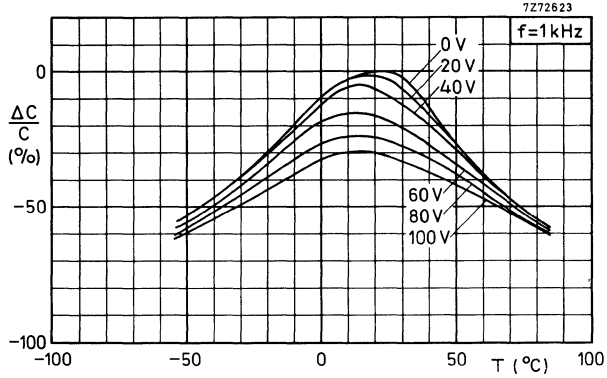
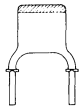


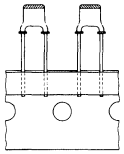
Fig. 15 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different voltages.

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
Climatic category (IEC 68)	55/085/21

APPLICATION

In a great variety of electronic circuits, e.g. in filters and tuning circuits where high stability and/or temperature compensation are 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

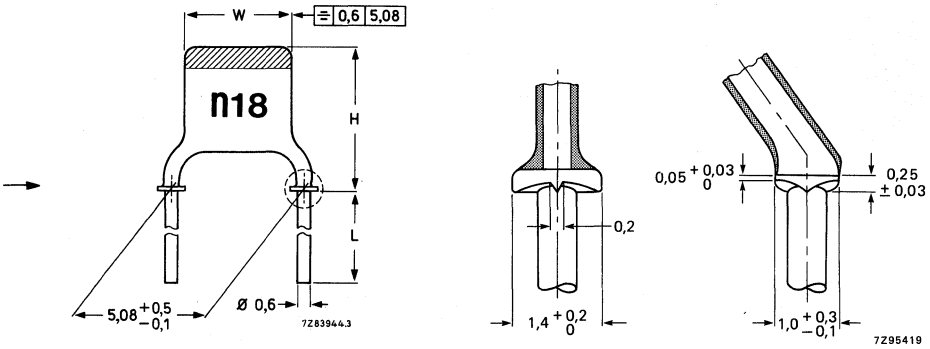


Fig. 1.

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

pitch	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 < 20 pF	(−40 to + 120) x 10^{-6}/K
for C ⩾ 20 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 < 20 pF	$(-40 +120) \times 10^{-6}$/K
for C ⩾ 20 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 < 20 pF	$(-40 + 60) \times 10^{-6}$/K
for C ⩾ 20 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 < 20 pF	$(-120 + 250) \times 10^{-6}$/K
for C ⩾ 20 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

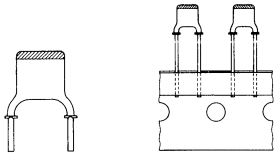
capacitance pF	tolerance	size see Table 2	marking		suffix of catalogue number see Table 1
8,2*	± 0,25 pF	I	8p2	500	69828
10 **	± 2%	I	10p	500	70109
12 **	± 2%	I	12p	500	70129
15	± 2%	I	15p	500	70159
18	± 2%	I	18p	500	70189
22	± 2%	I	22p	500	70229
27	± 2%	I	27p	500	70279
33	± 2%	IIA	33p	500	70339
39	± 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)
Climatic 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

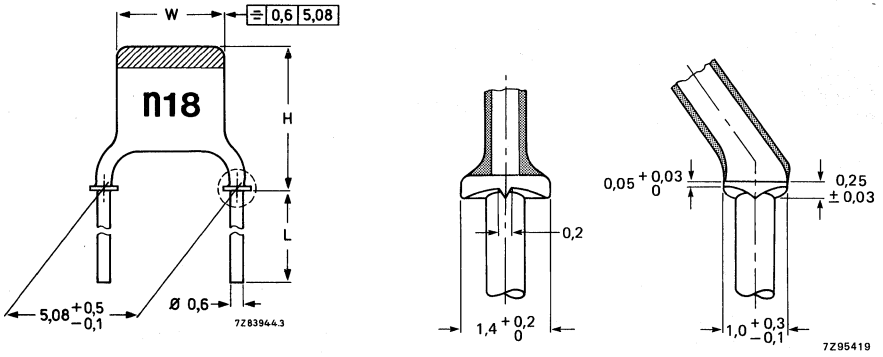


Fig. 1.

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

pitch	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.

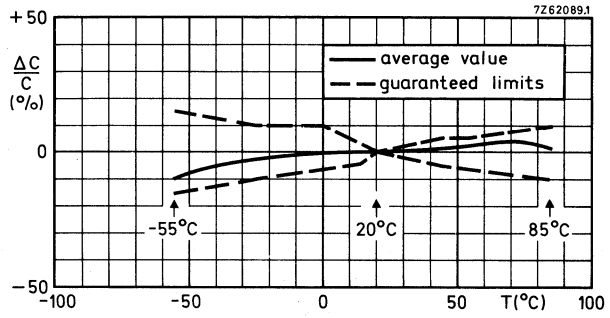


Fig. 2 Capacitance change with respect to the capacitance at 20 °C as a function of temperature.

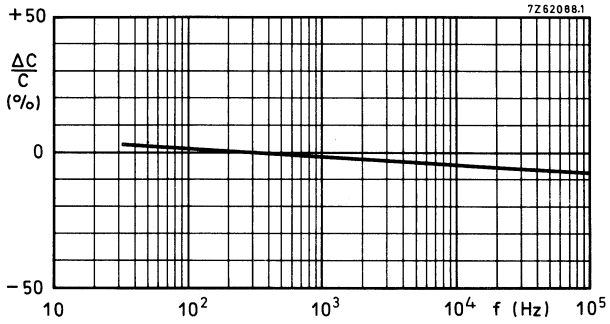
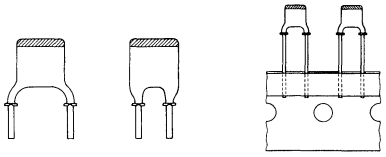


Fig. 3 Typical capacitance change with respect to the capacitance at 300 Hz as a function of frequency.

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

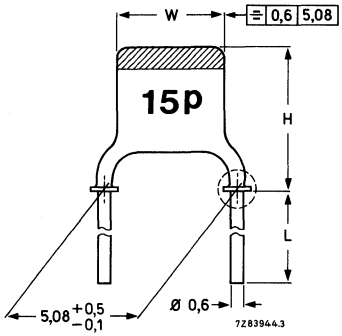


Fig. 1.

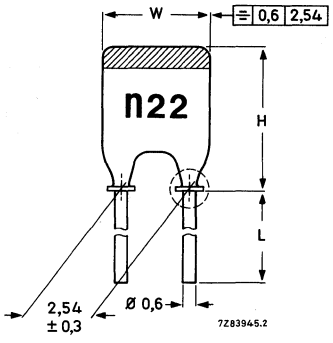
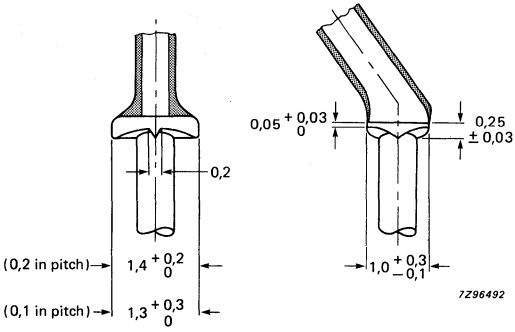


Fig. 2.

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

pitch	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	2222 688 .....

* 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	$\leq 15 \left(\frac{15}{C} + 0{,}7\right) \times 10^{-4}$; max. 55×10^{-4}
for C > 50 pF	$\leq 15 \times 10^{-4}$
Category temperature range	−55 to + 85 °C
Storage temperature range	−55 to + 85 °C
Climatic category, IEC 68	55/085/21

* 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 < 20 pF	(−40 to + 120) x 10^{-6}/K
for C ⩾ 20 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 $(\frac{\Delta C}{C.\Delta T})$	$0 \times 10^{-6}/K$
→ Tolerance on the temperature coefficient	
for $C < 20$ pF	$(-40 \text{ to } +120) \times 10^{-6}/K$
for $C \geqslant 20$ pF	$\pm 30 \times 10^{-6}/K$
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%	IIA	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 $C < 20$ pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for $C \geqslant 20$ 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 $C < 20$ pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for $C \geqslant 20$ 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%	IIB	82p	34829
100	± 2%	III	n10	34101
→ 120	± 2%	III	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 < 20 pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for C ⩾ 20 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 $(\frac{\Delta C}{C.\Delta T})$	$-330 \times 10^{-6}/K$
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 $C < 20$ pF	$(-90 \text{ to } +250) \times 10^{-6}$/K
for $C \geqslant 20$ 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 < 20 pF	$(-120 \text{ to } +250) \times 10^{-6}$/K
for C ⩾ 20 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

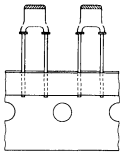
cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
18*	± 2%	I	18p	70189
22	± 2%	I	22p	70229
27	± 2%	I	27p	70279
33	± 2%	I	33p	70339
39	± 2%	I	39p	70399
47	± 2%	I	47p	70479
56	± 2%	I	56p	70569
68	± 2%	I	68p	70689
82	± 2%	I	82p	70829
100	± 2%	IIA	n10	70101
120	± 2%	IIA	n12	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
Climatic category (IEC 68)	55/085/21

APPLICATION

In a great variety of electronic circuits, e.g. in filters and tuning circuits where high stability and/or temperature compensation are 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

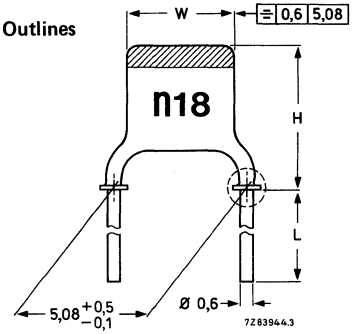
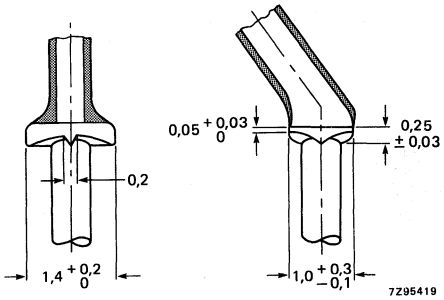


Fig. 1.



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	$\leqslant 15\ (\frac{15}{C} + 0{,}7).10^{-4}$
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 < 20 pF	(−40 to + 120) x 10^{-6}/K
for C ⩾ 20 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 ($\frac{\Delta C}{C.\Delta T}$)	0×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 20$ pF	$(-40 + 120) \times 10^{-6}$/K
for $C \geqslant 20$ 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 $C < 20$ pF	$(-40 + 60) \times 10^{-6}/K$
for $C \geqslant 20$ 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 < 20 pF	$(-120 + 250) \times 10^{-6}$/K
for C ⩾ 20 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 ($\frac{\Delta C}{C.\Delta T}$)	$-1500 \times 10^{-6}/K$
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 pitch 5,08 mm (0,2 in)

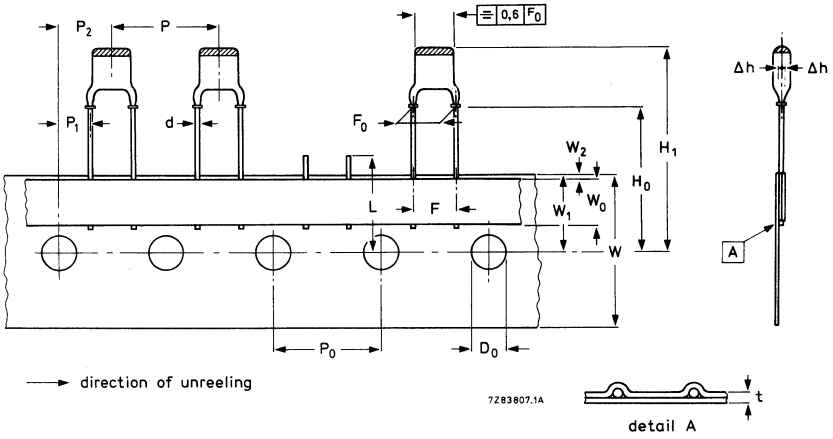


Fig. 1 Capacitors, lead pitch 5,08 mm, on tape; see Table 1 for dimensions.

Table 1

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

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

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.

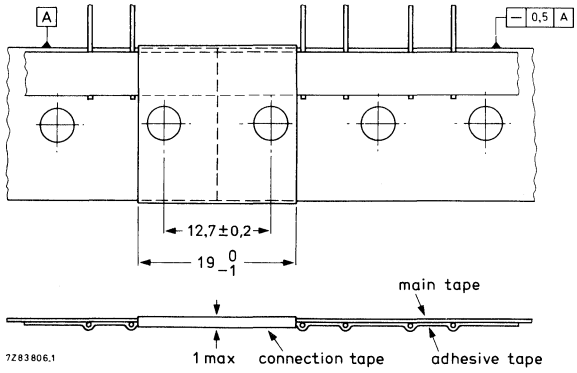


Fig. 2 Connection of tapes, lead pitch 5,08 mm.

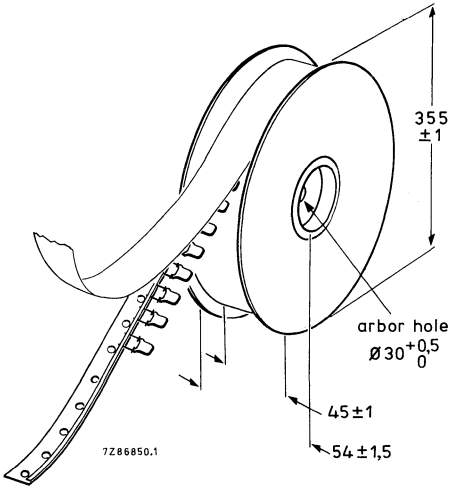


Fig. 3 Reel with capacitors on tape.

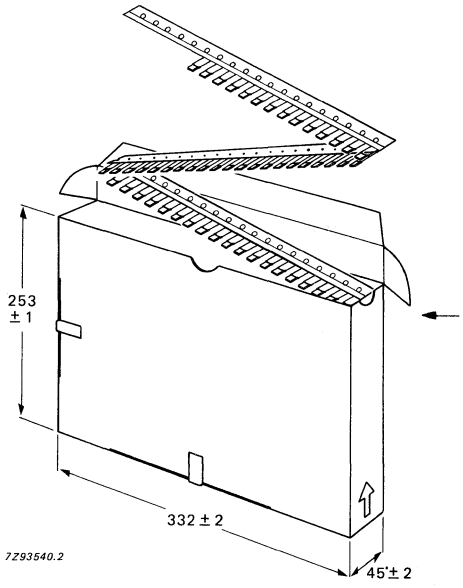


Fig. 4 Ammunition packing with capacitors on tape.

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

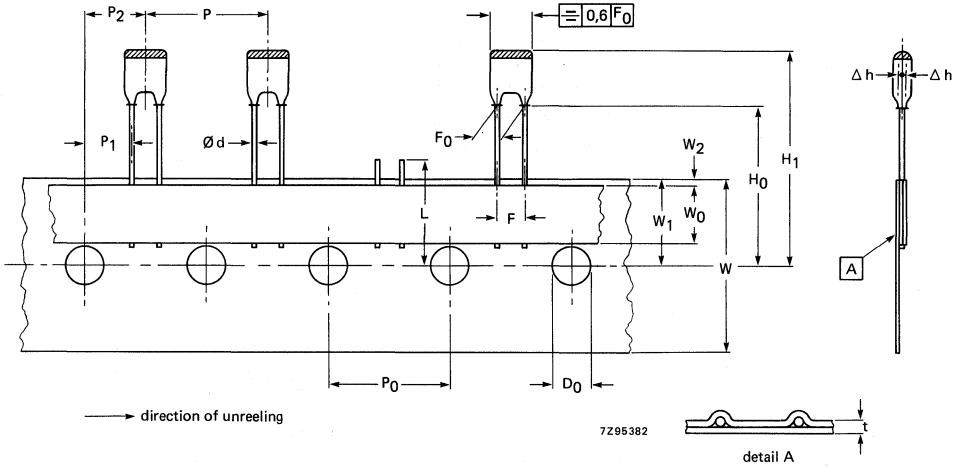


Fig. 5 Capacitors, lead pitch 2,54 mm, on tape; see Table 2 for dimensions.

Table 2

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

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

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

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

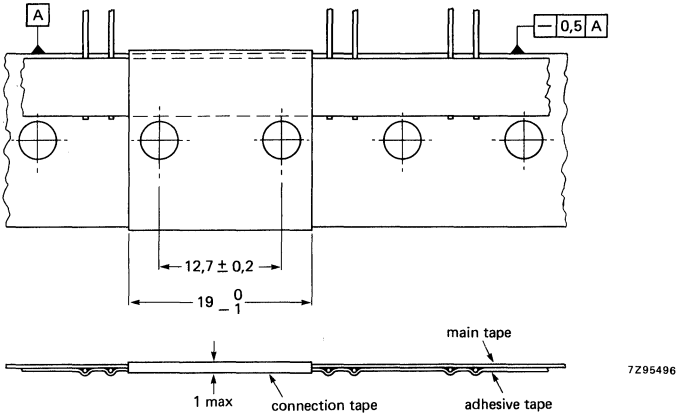


Fig. 6 Connection of tapes, lead pitch 2,54 mm.

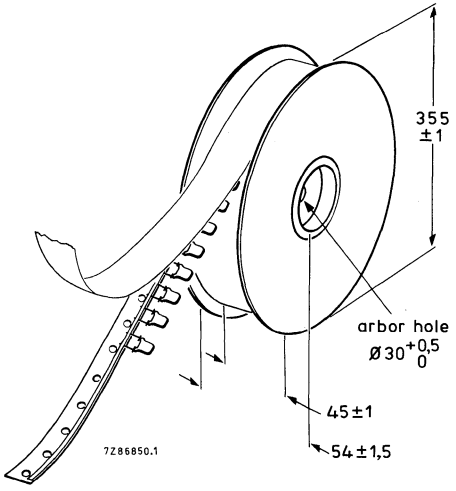


Fig. 7 Reel with capacitors on tape.

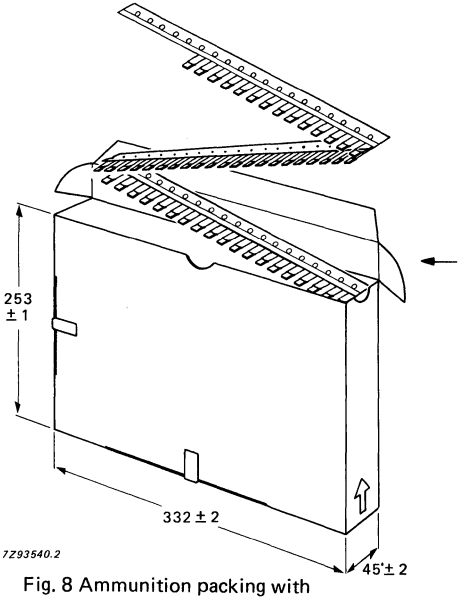
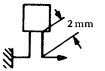


Fig. 8 Ammunition packing with capacitors on tape.

TESTS AND REQUIREMENTS

Class 1 capacitors

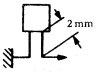
After manufacture, *each* capacitor is checked on capacitance, tan δ and test voltage. Apart from this the following quality checks are carried out by frequent inspections.
Essentially all tests mentioned in the schedule of IEC publication 384-8, category 55/085/21 (temperature range −55/+ 85 °C; damp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

IEC 384-8 clause	IEC 68-2 test method	name of test	procedure	requirements
–	–	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, 90 to 96% R.H. 12 h + 25 °C, 95 to 100% R.H.	after recovery of 1-2 h immediately followed by cold test
10.6.4	A	Cold	2 h −55 °C	no visible damage
10.6.5	M	Low air pressure	1 h 8,5 kPa, last 2 min rated voltage	no breakdown or flashover
10.6.6	Db	Damp heat (accel.) remaining cycle	12 h + 55 °C, 90 to 96% R.H. 12 h + 25 °C, 95 to 100% R.H.	$\Delta C/C \pm \leqslant 1\%$ or 1 pF tan $\delta \leqslant 2$ x specified tan δ R_{ins} after 1-2 h: $>$ 5000 MΩ for 2222 650 to 654, 691, $>$ 100 MΩ for other types
10.7	Ca	Damp heat, steady state (half number of the lot at rated voltage, other half at zero voltage)	21 days + 40 °C 90 to 95% R.H.	$\Delta C/C \pm \leqslant 1\%$ or 1 pF tan $\delta \leqslant 2$ x specified tan δ R_{ins} after 1-2 h: $>$ 5000 MΩ for 2222 650 to 654, 691, $>$ 100 MΩ for other types
10.8	–	Endurance	1000 h at + 85 °C; 2222 650 to 654, 691: 750 V (d.c.), other types: 150 V (d.c.)	$\Delta C/C \pm \leqslant 1\%$ or 1 pF tan $\delta \leqslant 1{,}5$ x specified tan δ R_{ins}: $>$ 3000 MΩ for 2222 650 to 654, 691, $>$ 300 MΩ for other types
–	–	Resistance to solvents	3 min ultrasonic washing in trichloroethylene 1 min drying, 30 °C 10 brush strokes	marking and colour code must remain legible and not be discoloured; no mechanical or electrical damage or deterioration of the material
–	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-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 (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 + 55 °C, 90 to 96% R.H. 12 h + 25 °C, 95 to 100% R.H.	no visible damage; after recovery of 1 - 2 h immediately followed by cold test
10.6.4	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 cycle	12 h + 55 °C, 90 to 96% R.H. 12 h + 25 °C, 95 to 100% R.H.	after 24 h recovery: $\Delta C/C$, 2222 630, 2222 655: $\pm \leqslant 10\%$ 2222 629, 2222 640: $\pm \leqslant 20\%$ $\tan \delta \leqslant 7\%$ R_{ins}, 2222 629/630/640: > 100 MΩ 2222 655: > 1000 MΩ

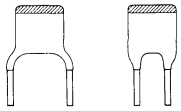
IEC 384-9 clause	IEC 68-2 test method	name of test	procedure	requirements
		Pre-conditioning		
10.7	Ca	Damp heat (steady state) half number of samples rated voltage, half number of samples no voltage applied	21 days + 40 °C, 90 to 95% R.H.	no visible damage; after 24 h: $\Delta C/C$, 2222 630, 2222 655: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

MINIATURE CERAMIC PLATE CAPACITORS
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

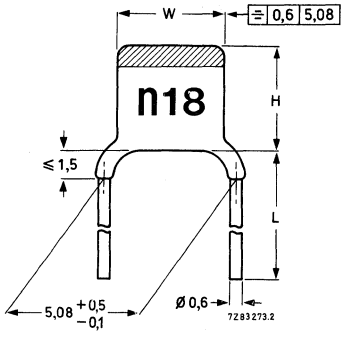


Fig. 1.

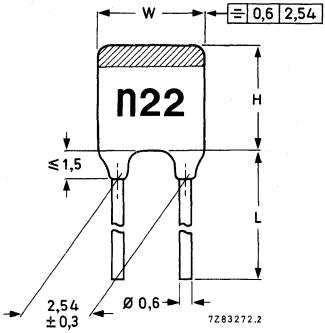


Fig. 2.

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

Table 1

pitch	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	⩽ 3,5 %
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

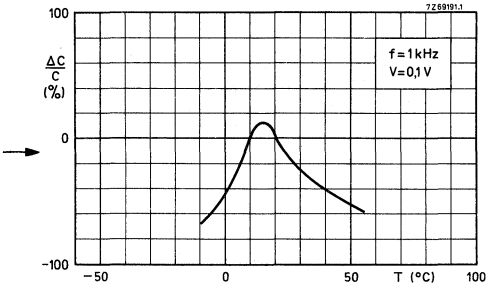


Fig. 3 Typical capacitance change as a function of temperature for capacitance values 2200 pF to 22 000 pF; dotted lines give an indication of the behaviour at higher and lower temperatures.

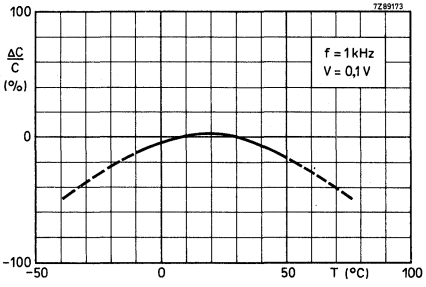


Fig. 4 Typical capacitance change as a function of temperature for capacitance value 1000 pF; dotted lines give an indication of the behaviour at higher and lower temperatures.

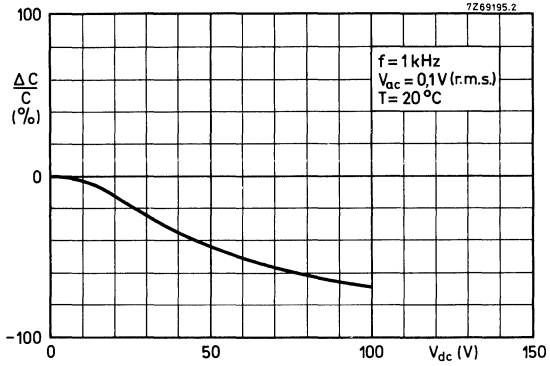


Fig. 5 Typical capacitance change with respect to the capacitance value at 0 V, as a function of d.c. voltage, for capacitance values 2200 to 22 000 pF.

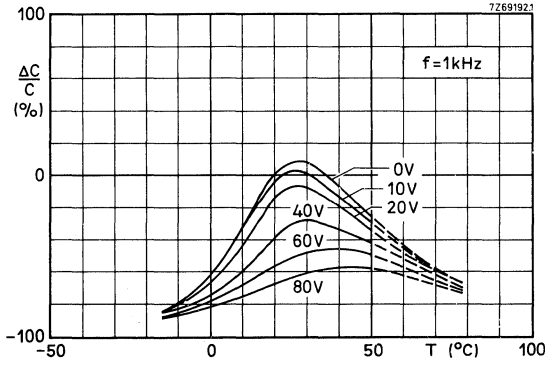


Fig. 6 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different d.c. voltages, for capacitance values 2200 to 22 000 pF; V_{ac} = 0,1 V (r.m.s.).

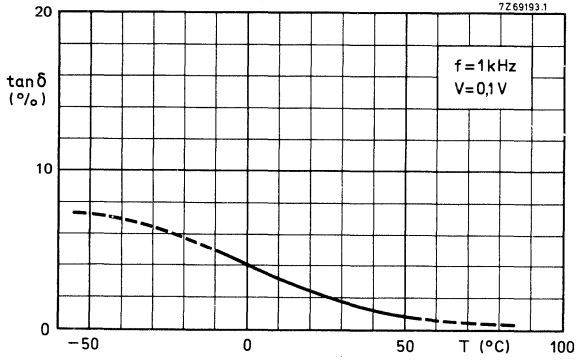


Fig. 7 Typical tan δ as a function of temperature, for capacitance values 2200 to 22 000 pF.

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

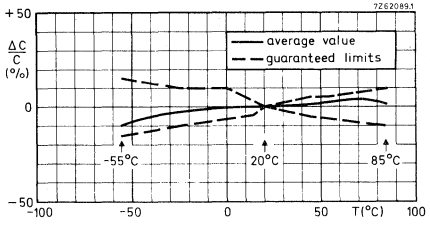


Fig. 8 ΔC with respect to C at 20 °C as a function of temperature. V = 0,1 V; f = 1 kHz.

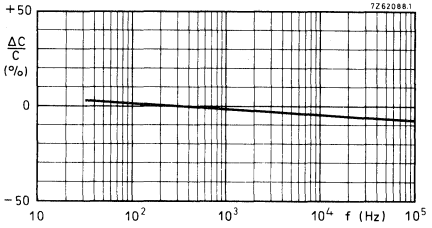


Fig. 9 Typ. ΔC with respect to C at 300 Hz, as a function of frequency. V = 0,1 V.

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

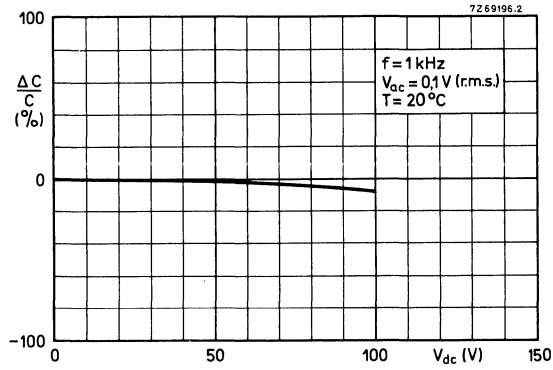


Fig. 10 Typical capacitance change with respect to the capacitance value at 0 V, as a function of d.c. voltage.

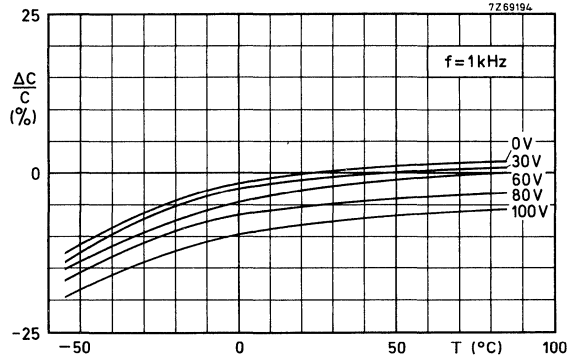


Fig. 11 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different d.c. voltages.
V_{ac} = 0,1 V (r.m.s.).

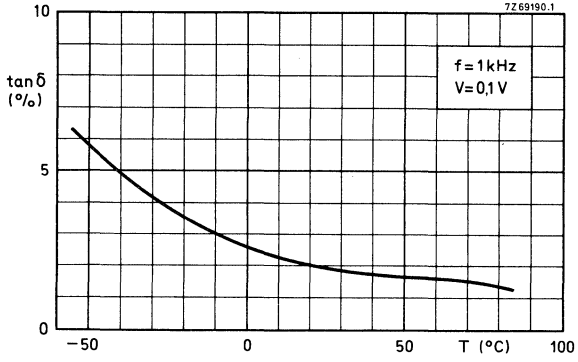


Fig. 12 Typical tan δ as a function of temperature.

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	⩾ 4000 MΩ
Tan δ at 1 kHz, 1 V	⩽ 3,5%
Category temperature range	−55 to + 85 °C
Storage temperature range	−55 to + 85 °C
Climatic category (IEC 68)	55/085/21

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.

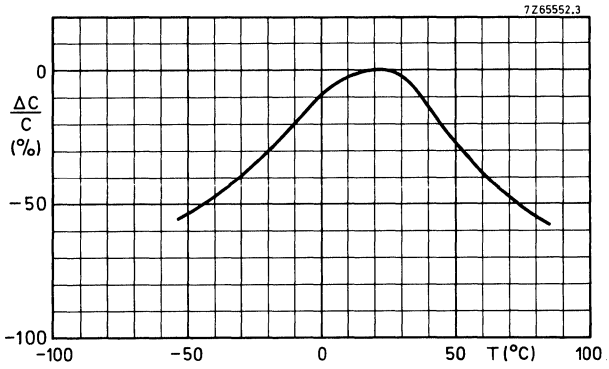


Fig. 13 Typical capacitance change versus temperature at 0 V (d.c.).

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

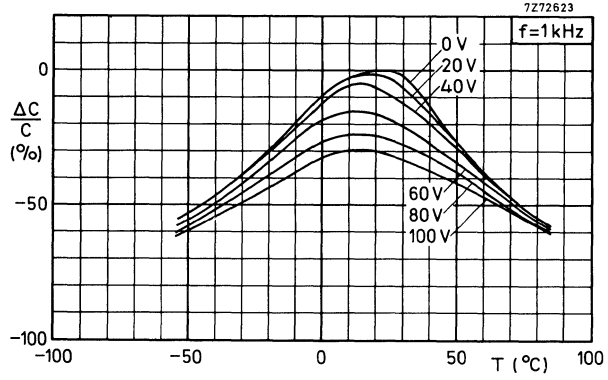
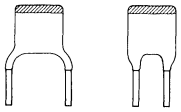


Fig. 15 Typical capacitance change with respect to the capacitance value at 0 V and 20 °C, as a function of temperature at different voltages.

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

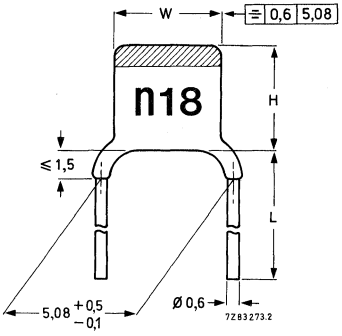


Fig. 1.

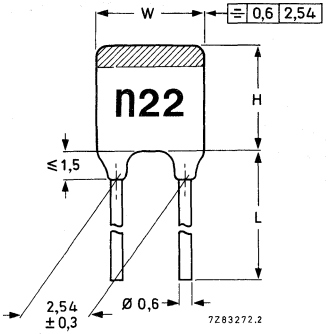


Fig. 2.

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

Table 1

pitch	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 < 20 pF	(−40 to + 120) x 10^{-6}/K
for C ⩾ 20 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 < 20 pF	(−40 to + 120) x 10^{-6}/K
for C ⩾ 20 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%	IIA	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 $C < 20$ pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for $C \geqslant 20$ 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 $(\frac{\Delta C}{C.\Delta T})$	$-150 \times 10^{-6}/K$
→ Tolerance on the temperature coefficient	
for C < 20 pF	$(-40 \text{ to } +60) \times 10^{-6}/K$
for C ⩾ 20 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%	IIB	82p	34829
100	± 2%	III	n10	34101
→ 120	± 2%	III	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 $(\frac{\Delta C}{C.\Delta T})$	$-220 \times 10^{-6}/K$
Tolerance on the temperature coefficient	
for $C < 20$ pF	$(-40 \text{ to } +60) \times 10^{-6}/K$
for $C \geqslant 20$ 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 $C < 20$ pF	$(-90 \text{ to } +250) \times 10^{-6}$/K
for $C \geqslant 20$ 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 < 20 pF	$(-120 \text{ to } +250) \times 10^{-6}$/K
for C ⩾ 20 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 $(\frac{\Delta C}{C.\Delta T})$	-1500×10^{-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

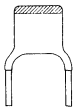
cap. pF	tolerance	size see Table 2	marking	suffix of catalogue number see Table 1
18*	± 2%	I	18p	70189
22**	± 2%	I	22p	70229
27	± 2%	I	27p	70279
33	± 2%	I	33p	70339
39	± 2%	I	39p	70399
47	± 2%	I	47p	70479
56	± 2%	I	56p	70569
68	± 2%	I	68p	70689
82	± 2%	I	82p	70829
100	± 2%	IIA	n10	70101
120	± 2%	IIA	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
** H_{max} = 4,0 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
Climatic category (IEC 68)	55/085/21

APPLICATION

In a great variety of electronic circuits, e.g. in filters and tuning circuits where high stability and/or temperature compensation are 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

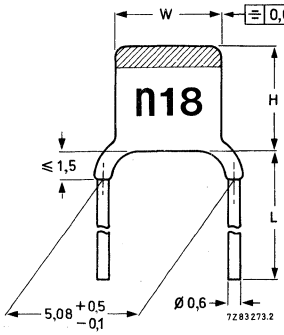


Fig. 1.

Table 1

pitch	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 < 20 pF	(−40 to + 120) x 10^{-6}/K
for C ⩾ 20 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 x 10^{-6}/K
Tolerance on the temperature coefficient	
for C < 20 pF	(−40 +120) x 10^{-6}/K
for C ⩾ 20 pF	± 30 x 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 < 20 pF	$(-40 + 60) \times 10^{-6}$/K
for C ⩾ 20 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 $C < 20$ pF	$(-120 + 250) \times 10^{-6}$/K
for $C \geqslant 20$ 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

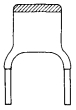
capacitance pF	tolerance	size see Table 2	marking		suffix of catalogue number see Table 1
8,2*	± 0,25 pF	I	8p2	500	69828
10 **	± 2%	I	10p	500	70109
12 **	± 2%	I	12p	500	70129
15	± 2%	I	15p	500	70159
18	± 2%	I	18p	500	70189
22	± 2%	I	22p	500	70229
27	± 2%	I	27p	500	70279
33	± 2%	IIA	33p	500	70339
39	± 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)
Climatic 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 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

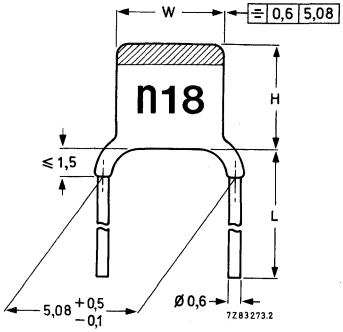


Fig. 1.

Table 1

pitch	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.

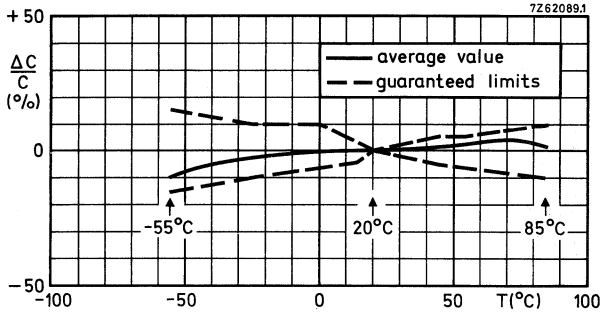


Fig. 2 Capacitance change with respect to the capacitance at 20 °C as a function of temperature.

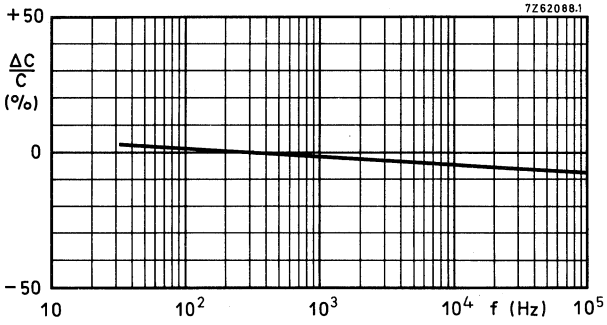
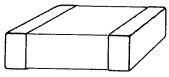


Fig. 3 Typical capacitance change with respect to the capacitance at 300 Hz as a function of frequency.

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 pF to 1 μF (E12-series)
Y5V dielectric	2200 to 100 000 pF (E6-series)**
Rated voltage U_R (d.c.)	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
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 AgPd (35/65) metallized → or NiSn metallized at the terminations (see Fig. 1).

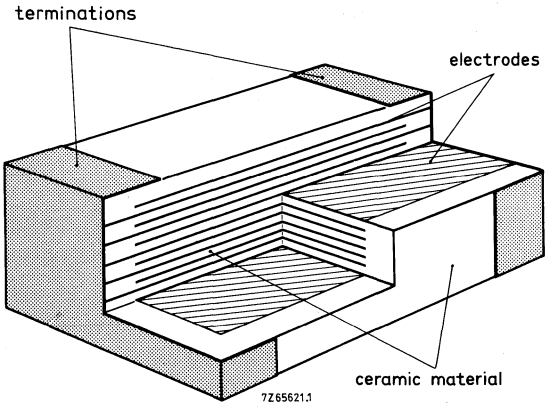


Fig. 1.

MECHANICAL DATA

Dimensions in mm

Outlines

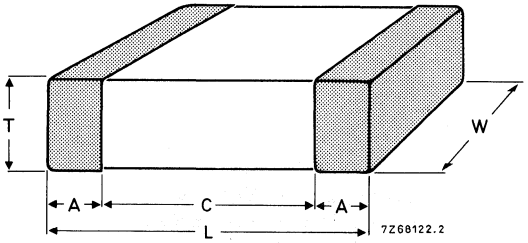


Fig. 2.

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, 1206 and 1210

C pF	SIZE 0805					SIZE 1206					SIZE 1210	
	NP0	N220	N750	X7R	Y5V	NP0	N220	N750	X7R	Y5V	NP0	X7R
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												
120000												
150000												
180000												
220000												

0,51 to 0,70 mm

0,8 to 1,0 mm

0,51 to 1,0 mm

1,0 to 1,27 mm

1,0 to 1,6 mm

1,0 to 1,9 mm

7Z90924.3

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.)	63 V (IEC)		
Test voltage (d.c.) for 1 min	$2{,}5 \times U_R$		
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	$(0 \pm 150) \times 10^{-6}/K$	$(-220 \pm 60) \times 10^{-6}/K$	
$5\ pF \leqslant C < 10$ pF	$(0 \pm 150) \times 10^{-6}/K$	$(-220 \pm 60) \times 10^{-6}/K$	$(-750 \pm 250) \times 10^{-6}/K$
$C \geqslant 10$ pF	$(0 \pm 30) \times 10^{-6}/K$	$(-220 \pm 60) \times 10^{-6}/K$	$(-750 \pm 250) \times 10^{-6}/K$
→ Terminations	AgPd or NiSn metallized▲		

* 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.

** ± 2% to special order.

▲ For NP0 and N220 NiSn metallized terminations are available in the course of 1987.

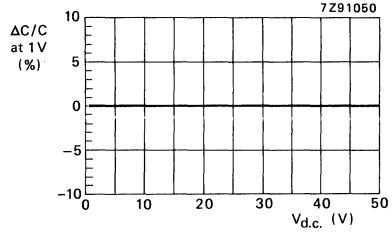


Fig. 3 Typical capacitance change with respect to the capacitance at 1 V as a function of d.c. voltage, for NP0 dielectric.

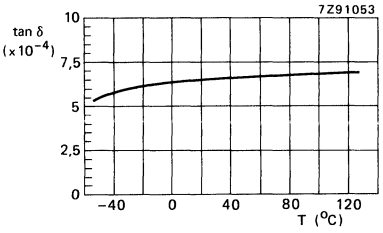


Fig. 4 Typical tan δ as a function of temperature for NP0 dielectric.

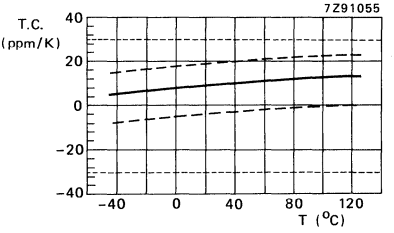


Fig. 5 Typical temperature coefficient as a function of temperature, for NP0 dielectric. The dashed curves indicate sample limits, dotted lines indicate requirement levels.

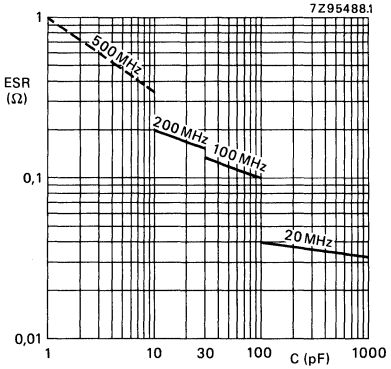


Fig. 6 Typical ESR at high frequencies as a function of capacitance, for NP0 dielectric, size 0805 (measuring equipment HP4191A).

Table 3 Selection chart for class 1 capacitors with AgPd and NiSn metallized terminations.
Note: For NP0 and N220 NiSn metallized terminations are available in the course of 1987.

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 bulk and in 8 mm tape on reel

available in bulk

7Z90923.2

Class 2, X7R dielectric

Capacitance range (E12-series)*	180 pF to 1 μF ←
Tolerance on capacitance, at age of 1000 h	± 20%, ± 10%** ←
Rated voltage U_R (d.c.)	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
Terminations	AgPd or NiSn metallized ←

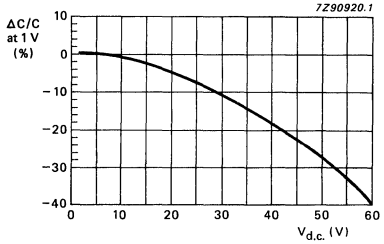


Fig. 7 Typical capacitance change with respect to the capacitance at 1 V as a function of d.c. voltage, for X7R dielectric.

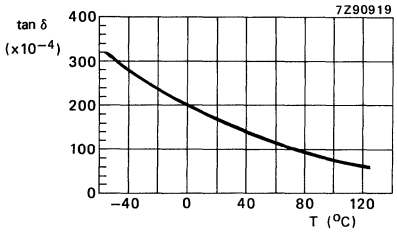


Fig. 8 Typical tan δ as a function of temperature, for X7R dielectric.

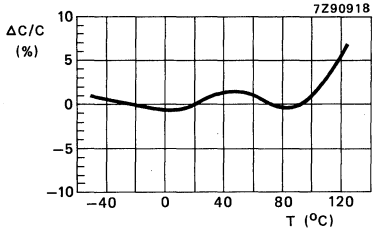


Fig. 9 Typical capacitance change as a function of temperature, for X7R dielectric.

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

** ± 2% to special order.

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

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						
560000						
680000						
820000						
1000000						

available in bulk and in 8 mm tape on reel

available in bulk

7Z90922.3

Class 2, Y5V dielectric

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.)	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
Terminations	AgPd or NiSn metallized

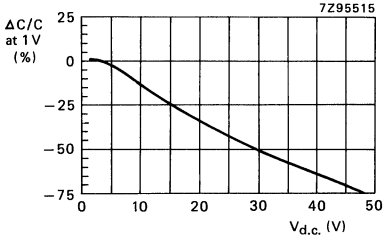


Fig. 10 Typical capacitance change with respect to the capacitance at 1 V as a function of d.c. voltage, for Y5V dielectric.

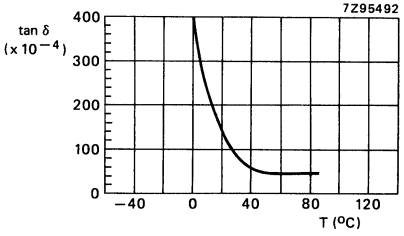


Fig. 11 Typical tan δ as a function of temperature, for Y5V dielectric.

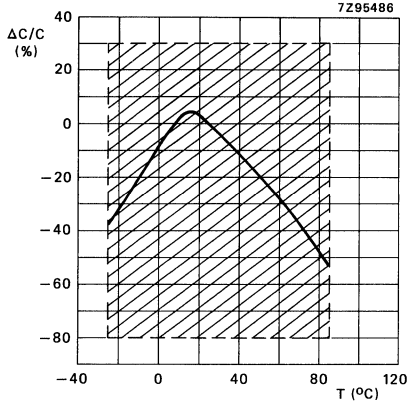


Fig. 12 Typical capacitance change as a function of temperature, for Y5V dielectric (hatched area according to IEC 384-10).

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

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

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 bulk and in 8 mm tape on reel

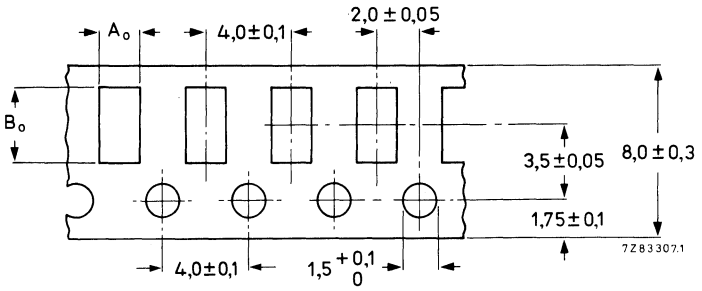
▥ under development

7Z90921.3

PACKING

The capacitors are supplied in bulk in cardboard boxes of 1000; the sizes 0805, 1206 and 1210 are also supplied in tape (cardboard or blister) on reels of 4000.
Capacitors with sizes 0805 and 1206 (with the smaller tolerance) are also available in bulkpacking of 100; see Appendix II.

Cardboard tape



dimensions	size 0805	size 1206
A_o	$1,5 + {}^{+0,2}_{0}$	$1,85 + {}^{+0,2}_{0}$
B_o	$2,25 + {}^{+0,2}_{0}$	$3,45 + {}^{+0,2}_{0}$

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

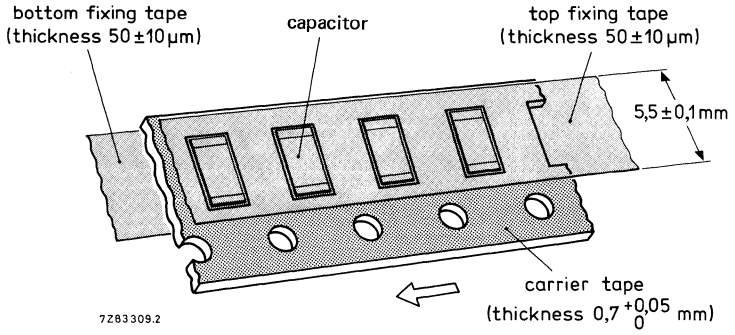
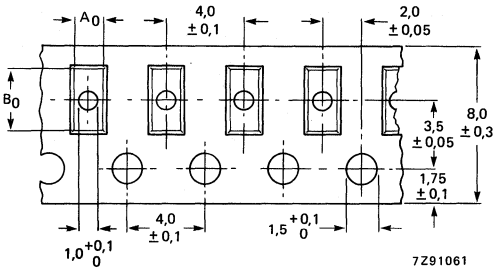


Fig. 14 Carboard tape.

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.

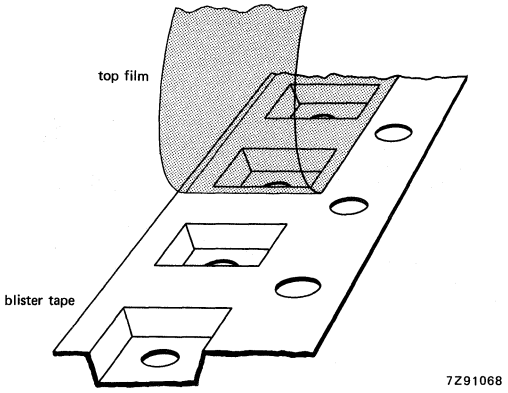


Fig. 16 Blister tape.

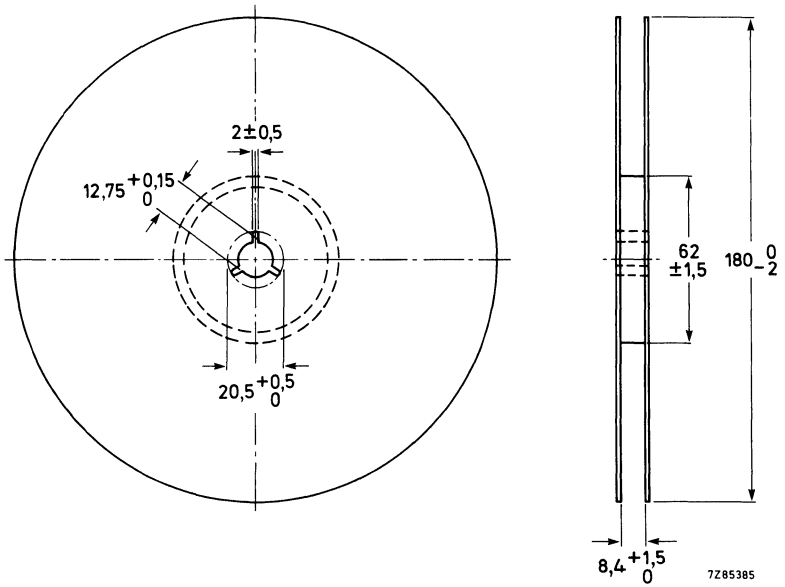
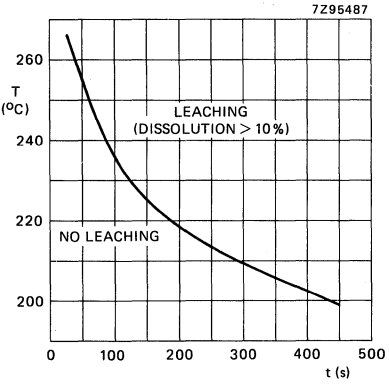


Fig. 17 Reel.

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. 30 s	see Fig. 18
Typical solder conditions	see Figs 19, 20 and 21 (The use of weakly Cl-activated flux is advised). ←	



→ Fig. 18 Resistance to leaching of AgPd metallized terminations (in static solder bath) at various temperatures. For NiSn metallized terminations the leaching resistance is 10 x better than shown in the graph.

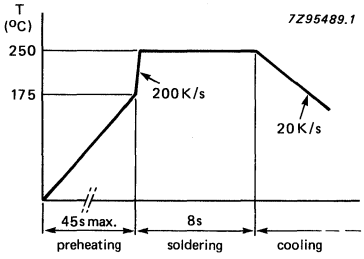


Fig. 19 Reflow soldering.

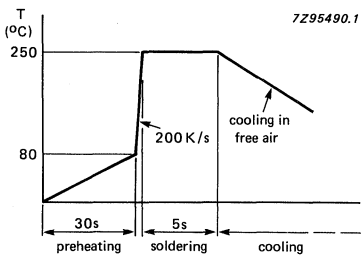


Fig. 20 Wave soldering.
The capacitors may be soldered twice according to this method if necessary.

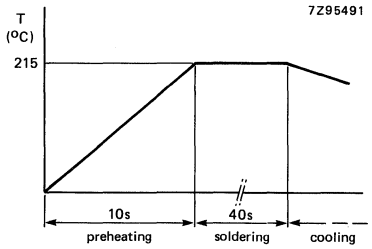
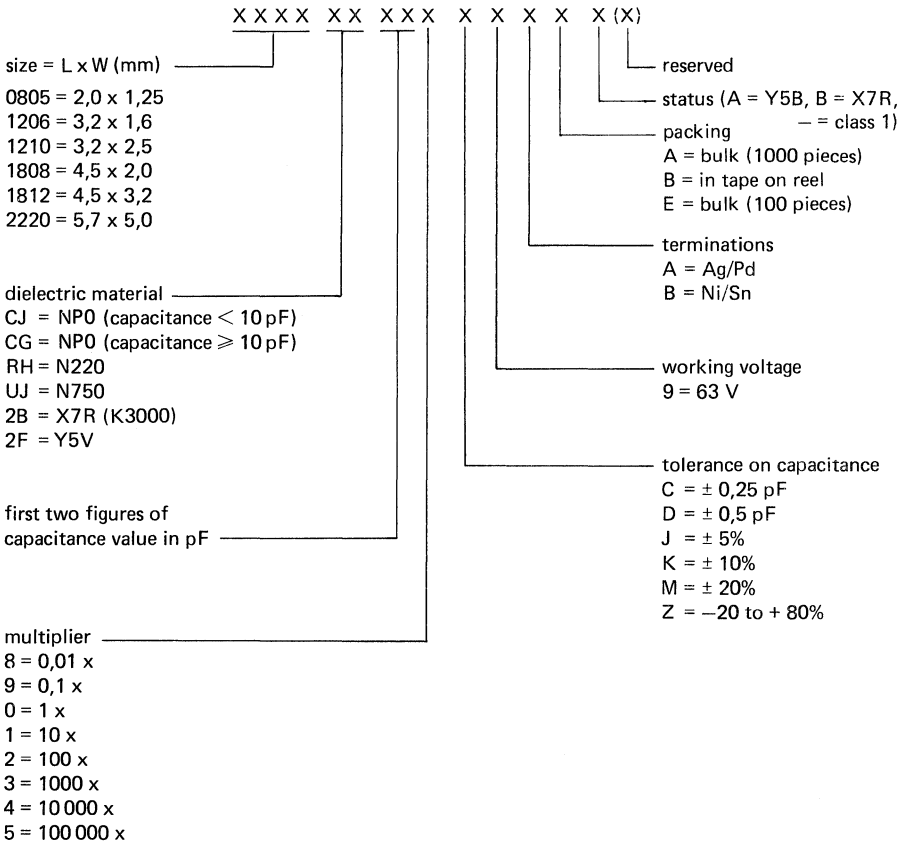


Fig. 21 Vapour phase soldering.

HOW TO ORDER

One can 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, and with section PACKING.



Example

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

8000 x 1206CG151J9AP − .

* If required the 12 NC-catalogue number can be found in Appendices I and II.

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 10 X magnification	in accordance with specification
4.6.1		Capacitance	$C \leqslant 1000$ pF f = 1 MHz $C > 1000$ pF f = 1 kHz measuring voltage 1 V, 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 ± 5 °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, 30 ± 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 at max. temperature	no 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 min. temperature	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 $R_i C_R \geqslant 25$ s** X7R, Y5V : $\geqslant 1000$ MΩ or $R_i C_R \geqslant 25$ s**
4.14	Ca	Damp heat, steady state	pre-conditioning (class 2 only) 56 days, R.H. 90-95% at 40 °C, 1,0 V 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)

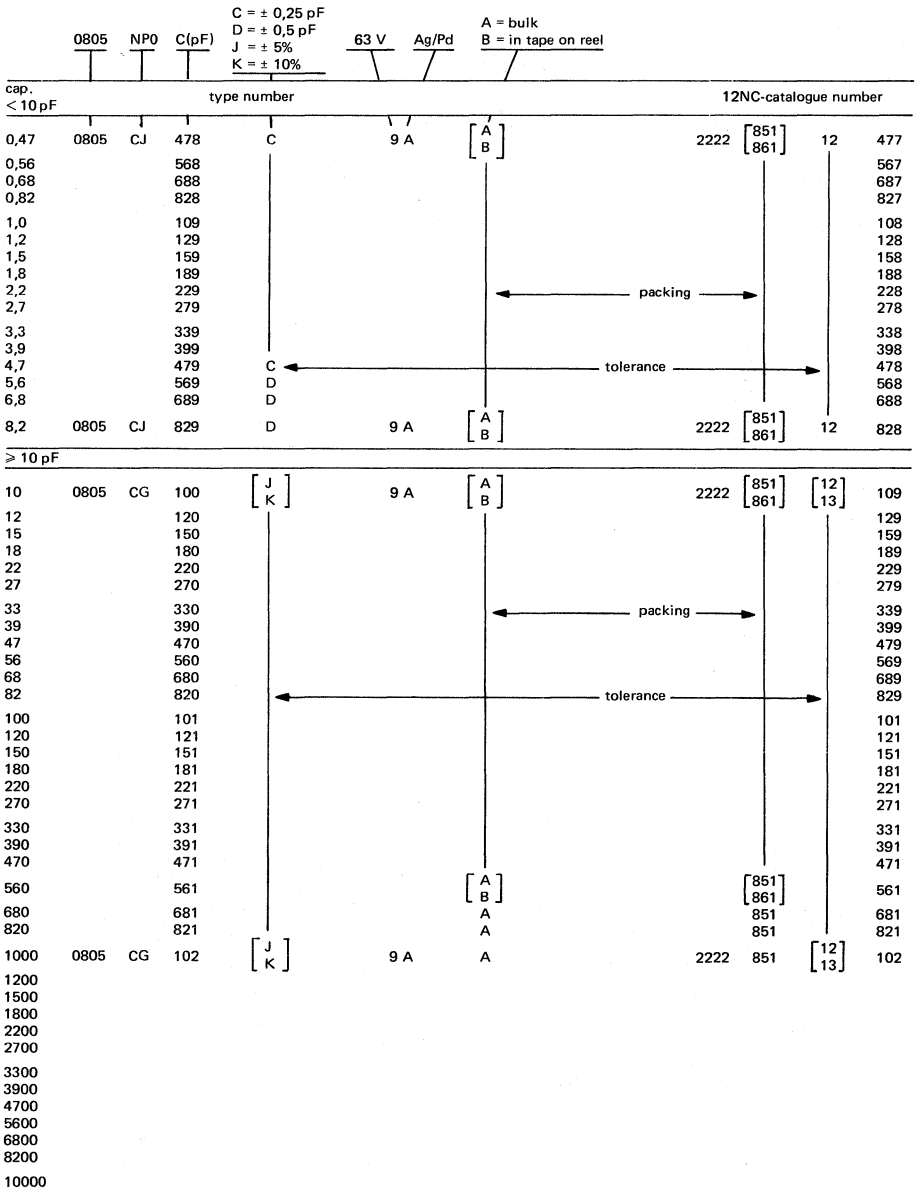
IEC 384-10 par.	IEC 68-2 par.	test	procedure	requirements
4.15		Endurance	Pre-conditioning (class 2 only) 1000 h at 1,5 x rated voltage at maximum temperature	no visible damage, after 24 h recovery $\Delta C/C$, class 1: $\leqslant \pm 2\%$ or 1 pF* X7R : $\leqslant \pm 10\%$; Y5V: $\leqslant \pm 30\%$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

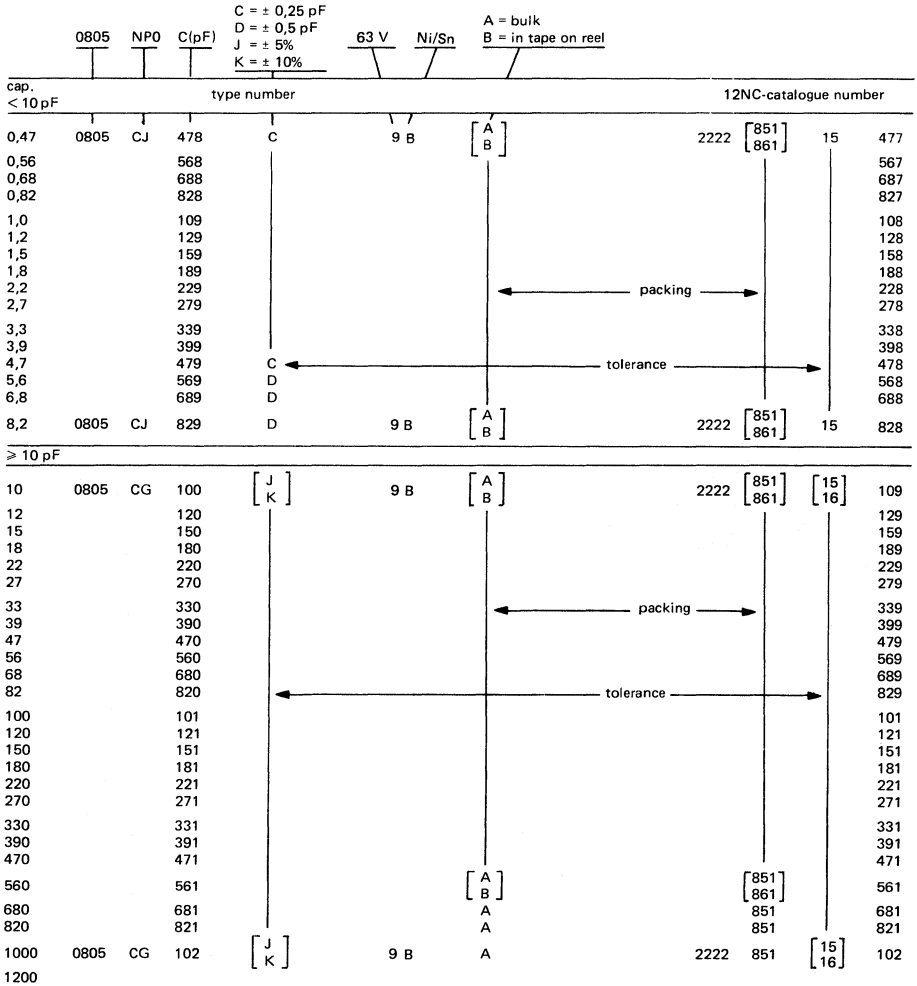
APPENDIX I

CONVERSION LIST
type number to 12NC-catalogue number
for 1000-piece bulk
and 4000-piece tape packing

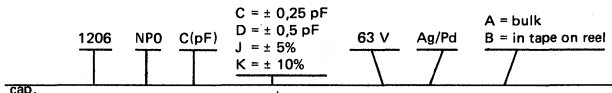
Examples: A 63 V ceramic multilayer capacitor of 12 pF ± 10%, NP0, size 0805, with Ag/Pd terminations, supplied in tape, has the type number 0805CG120K9AB- and the 12NC-catalogue number 2222 861 13129, see next page.

A 63 V ceramic multilayer capacitor of 820 pF ± 20%, X7R, size 1206, with Ni/Sn terminations, supplied in bulk, has the type number 12062B821M9BAB, and the 12NC-catalogue number 2222 581 06713.

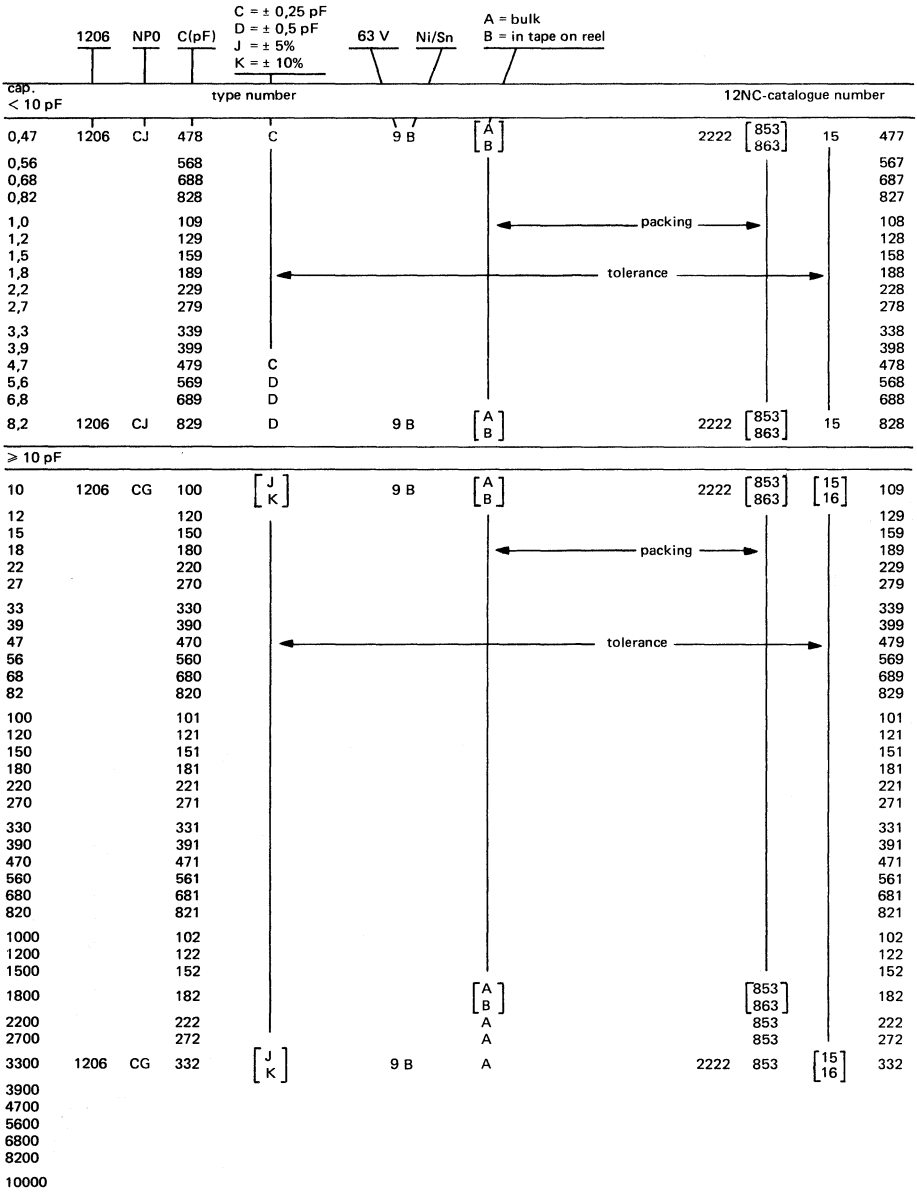

0805
NP0
C(pF)
C = ± 0,25 pF
D = ± 0,5 pF
J = ± 5%
K = ± 10%
63 V
Ag/Pd
A = bulk
B = in tape on reel
cap.
type number
12NC-catalogue number
< 10 pF
0,47 0805 CJ 478 C 9 A [A B] 2222 [851 861] 12 477
0,56 568 567
0,68 688 687
0,82 828 827
1,0 109 108
1,2 129 128
1,5 159 158
1,8 189 188
2,2 229 228
2,7 279 278
3,3 339 338
3,9 399 398
4,7 479 C 478
5,6 569 D 568
6,8 689 D 688
8,2 0805 CJ 829 D 9 A [A B] 2222 [851 861] 12 828
packing
tolerance
≥ 10 pF
10 0805 CG 100 [J K] 9 A [A B] 2222 [851 861] [12 13] 109
12 120 129
15 150 159
18 180 189
22 220 229
27 270 279
33 330 339
39 390 399
47 470 479
56 560 569
68 680 689
82 820 829
100 101 101
120 121 121
150 151 151
180 181 181
220 221 221
270 271 271
330 331 331
390 391 391
470 471 471
560 561 [A B] [851 861] 561
680 681 A 851 681
820 821 A 851 821
1000 0805 CG 102 [J K] 9 A A 2222 851 [12 13] 102
1200
1500
1800
2200
2700
3300
3900
4700
5600
6800
8200
10000

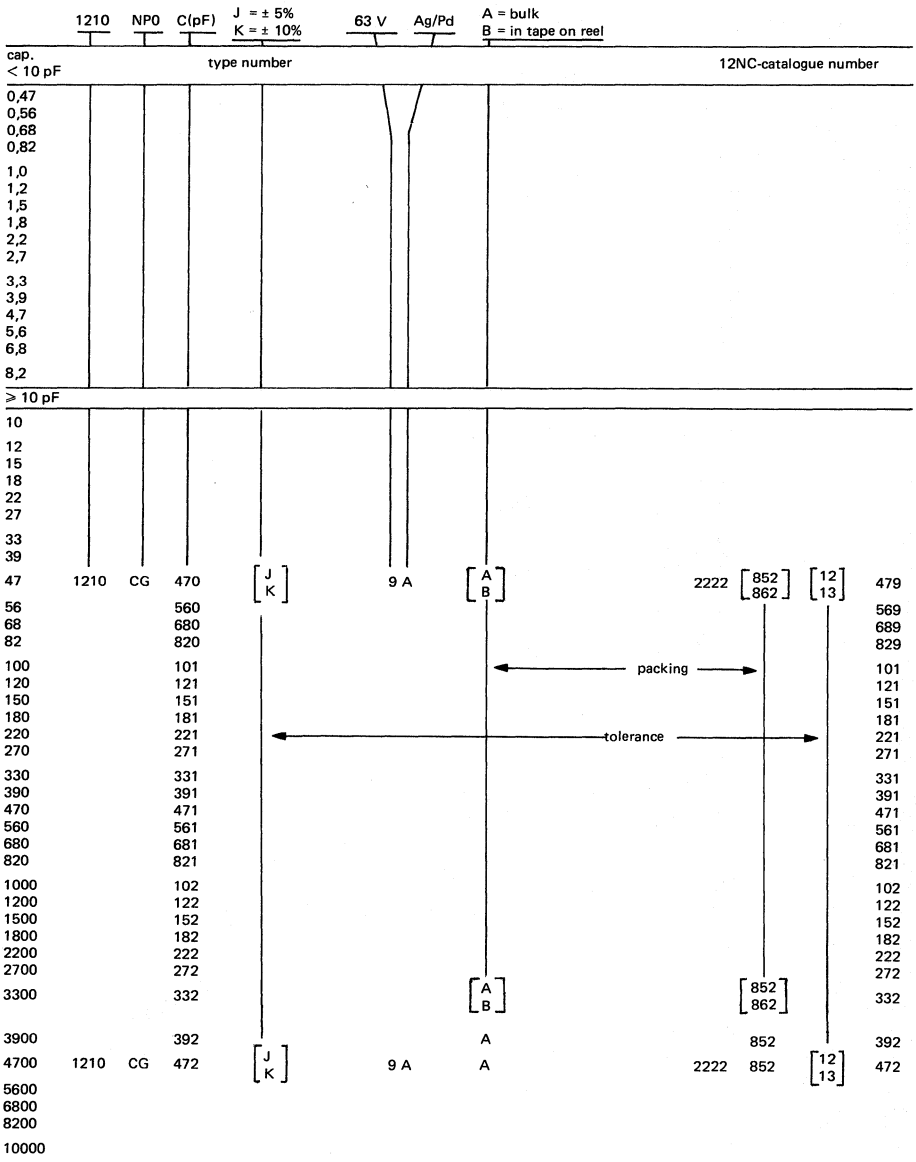


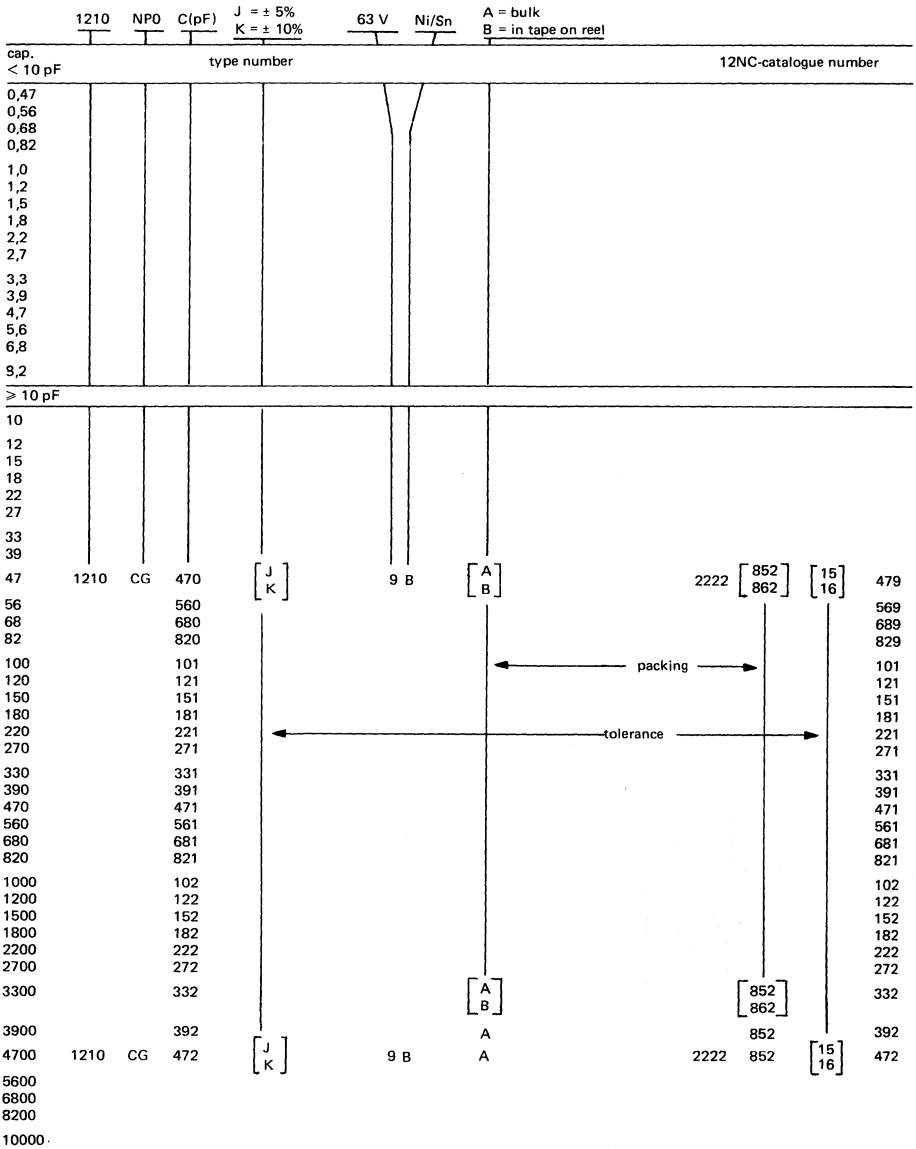
cap.				type number				12NC-catalogue number			
< 10 pF											
0,47	0805	CJ	478	C	9	B	[A B]	2222	[851 861]	15	477
0,56			568								567
0,68			688								687
0,82			828								827
1,0			109								108
1,2			129								128
1,5			159								158
1,8			189								188
2,2			229								228
2,7			279								278
3,3			339								338
3,9			399								398
4,7			479	C							478
5,6			569	D							568
6,8			689	D							688
8,2	0805	CJ	829	D	9	B	[A B]	2222	[851 861]	15	828
≥ 10 pF											
10	0805	CG	100	[J K]	9	B	[A B]	2222	[851 861]	[15 16]	109
12			120								129
15			150								159
18			180								189
22			220								229
27			270								279
33			330								339
39			390								399
47			470								479
56			560								569
68			680								689
82			820								829
100			101								101
120			121								121
150			151								151
180			181								181
220			221								221
270			271								271
330			331								331
390			391								391
470			471								471
560			561				[A B]		[851 861]		561
680			681				A		851		681
820			821				A		851		821
1000	0805	CG	102	[J K]	9	B	A	2222	851	[15 16]	102
1200											
1500											
1800											
2200											
2700											
3300											
3900											
4700											
5600											
6800											
8200											
10000											

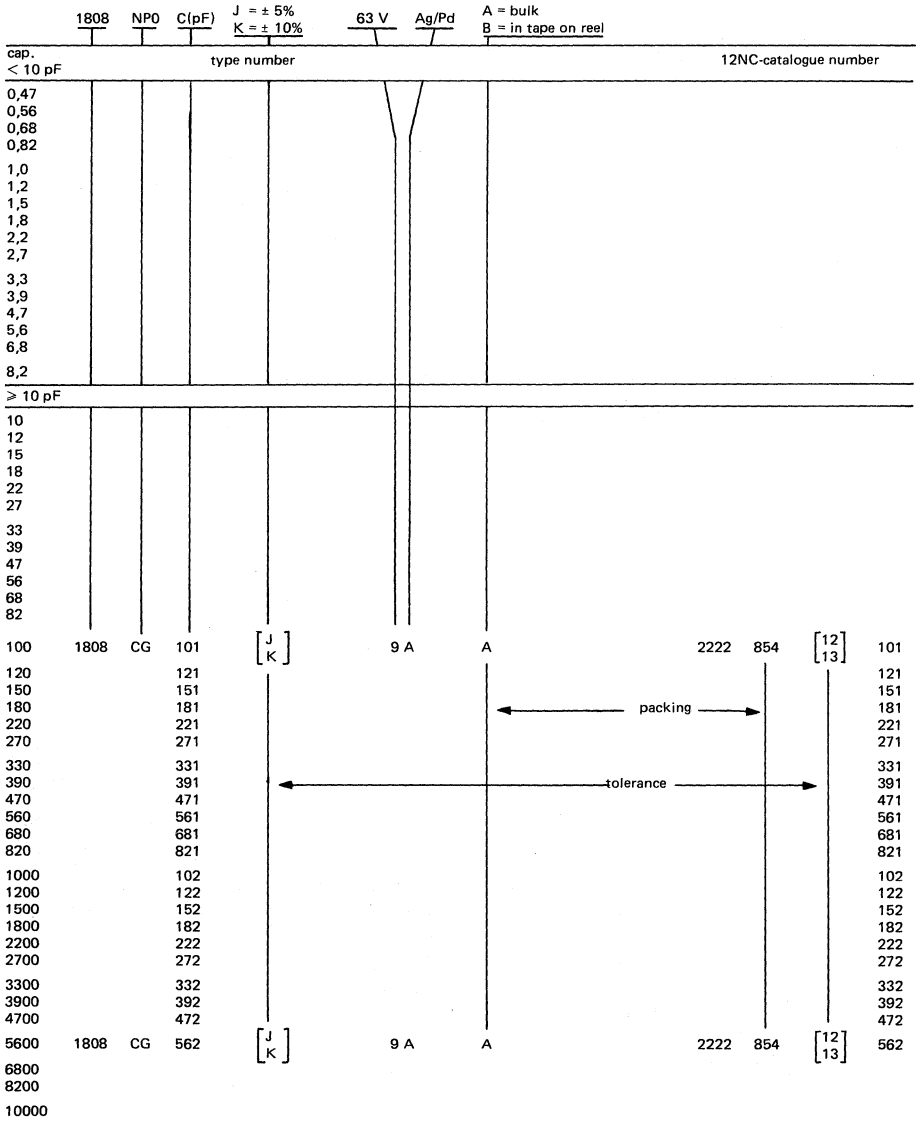


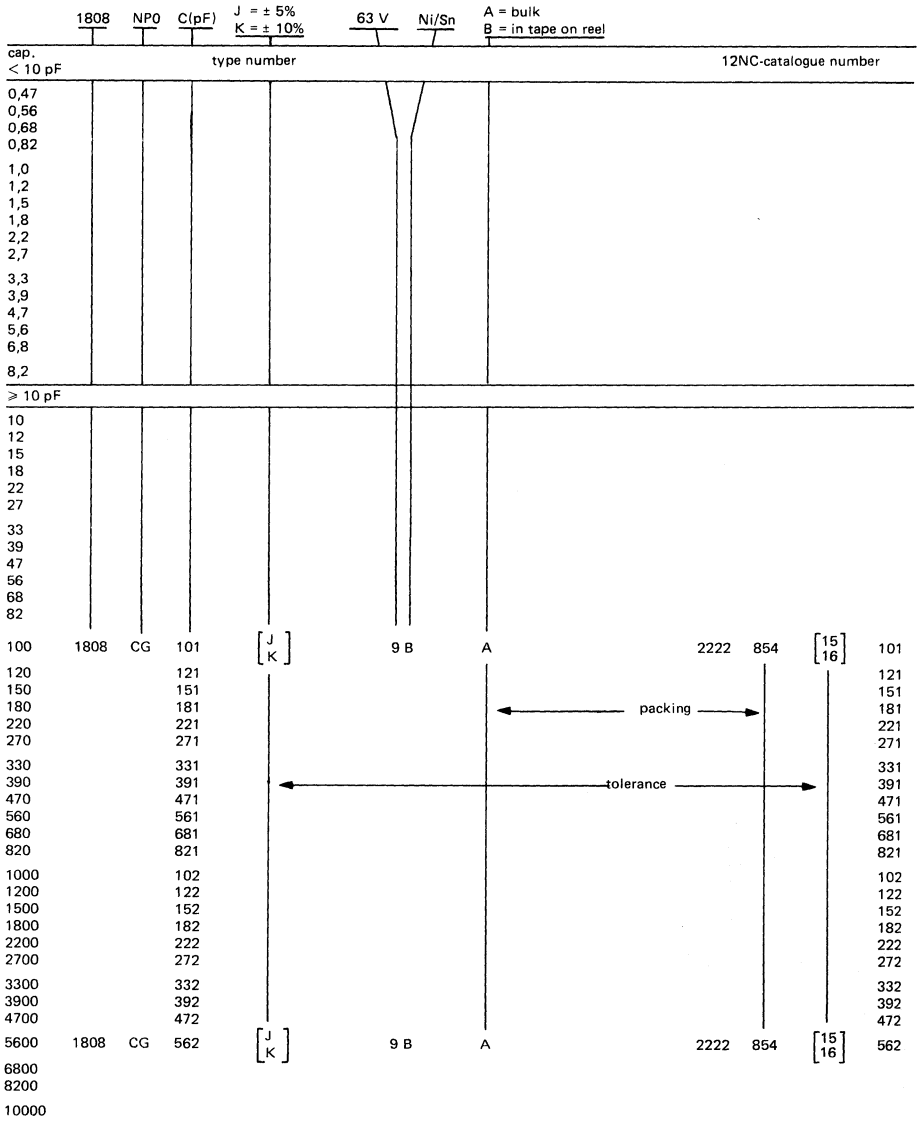
cap.	type number							12NC-catalogue number			
< 10 pF											
0,47	1206	CJ	478	C	9 A	[A B]		2222	[853 863]	12	477
0,56			568								567
0,68			688								687
0,82			828								827
1,0			109				packing →				108
1,2			129								128
1,5			159								158
1,8			189				tolerance →				188
2,2			229								228
2,7			279								278
3,3			339								338
3,9			399								398
4,7			479	C							478
5,6			569	D							568
6,8			689	D							688
8,2	1206	CJ	829	D	9 A	[A B]		2222	[853 863]	12	828
⩾ 10 pF											
10	1206	CG	100	[J K]	9 A	[A B]		2222	[853 863]	[12 13]	109
12			120								129
15			150								159
18			180				packing →				189
22			220								229
27			270								279
33			330								339
39			390								399
47			470				tolerance →				479
56			560								569
68			680								689
82			820								829
100			101								101
120			121								121
150			151								151
180			181								181
220			221								221
270			271								271
330			331								331
390			391								391
470			471								471
560			561								561
680			681								681
820			821								821
1000			102								102
1200			122								122
1500			152								152
1800			182			[A B]			[853 863]		182
2200			222			A			853		222
2700			272			A			853		272
3300	1206	CG	332	[J K]	9 A	A		2222	853	[12 13]	332
3900											
4700											
5600											
6800											
8200											
10000											

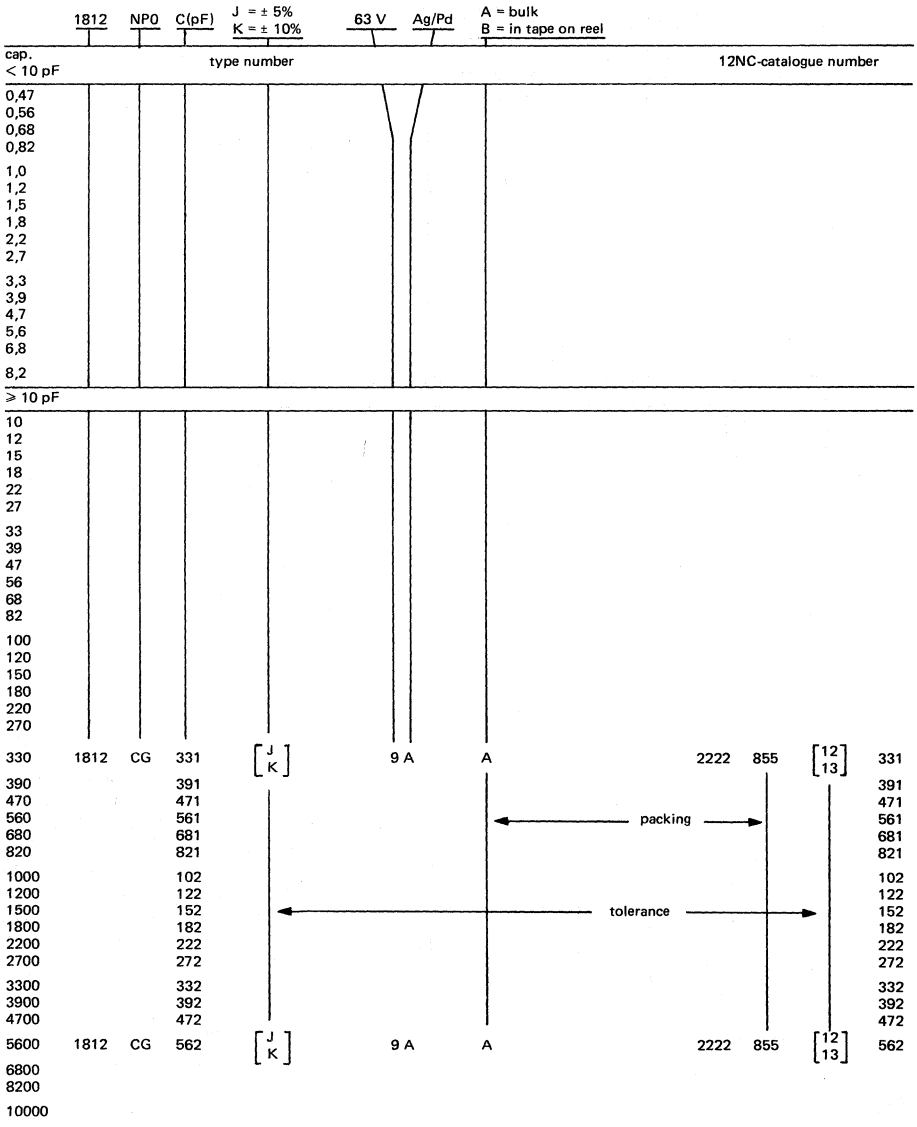

1206
NP0
C(pF)
C = ± 0,25 pF
D = ± 0,5 pF
J = ± 5%
K = ± 10%
63 V
Ni/Sn
A = bulk
B = in tape on reel
cap.
type number
12NC-catalogue number
< 10 pF
0,47 1206 CJ 478 C 9 B [A B] 2222 [853 863] 15 477
0,56 568 567
0,68 688 687
0,82 828 827
1,0 109 108
1,2 129 128
1,5 159 158
1,8 189 188
2,2 229 228
2,7 279 278
3,3 339 338
3,9 399 398
4,7 479 C 478
5,6 569 D 568
6,8 689 D 688
8,2 1206 CJ 829 D 9 B [A B] 2222 [853 863] 15 828
packing
tolerance
⩾ 10 pF
10 1206 CG 100 [J K] 9 B [A B] 2222 [853 863] [15 16] 109
12 120 129
15 150 159
18 180 189
22 220 229
27 270 279
33 330 339
39 390 399
47 470 479
56 560 569
68 680 689
82 820 829
100 101 101
120 121 121
150 151 151
180 181 181
220 221 221
270 271 271
330 331 331
390 391 391
470 471 471
560 561 561
680 681 681
820 821 821
1000 102 102
1200 122 122
1500 152 152
1800 182 [A B] [853 863] 182
2200 222 A 853 222
2700 272 A 853 272
3300 1206 CG 332 [J K] 9 B A 2222 853 [15 16] 332
3900
4700
5600
6800
8200
10000

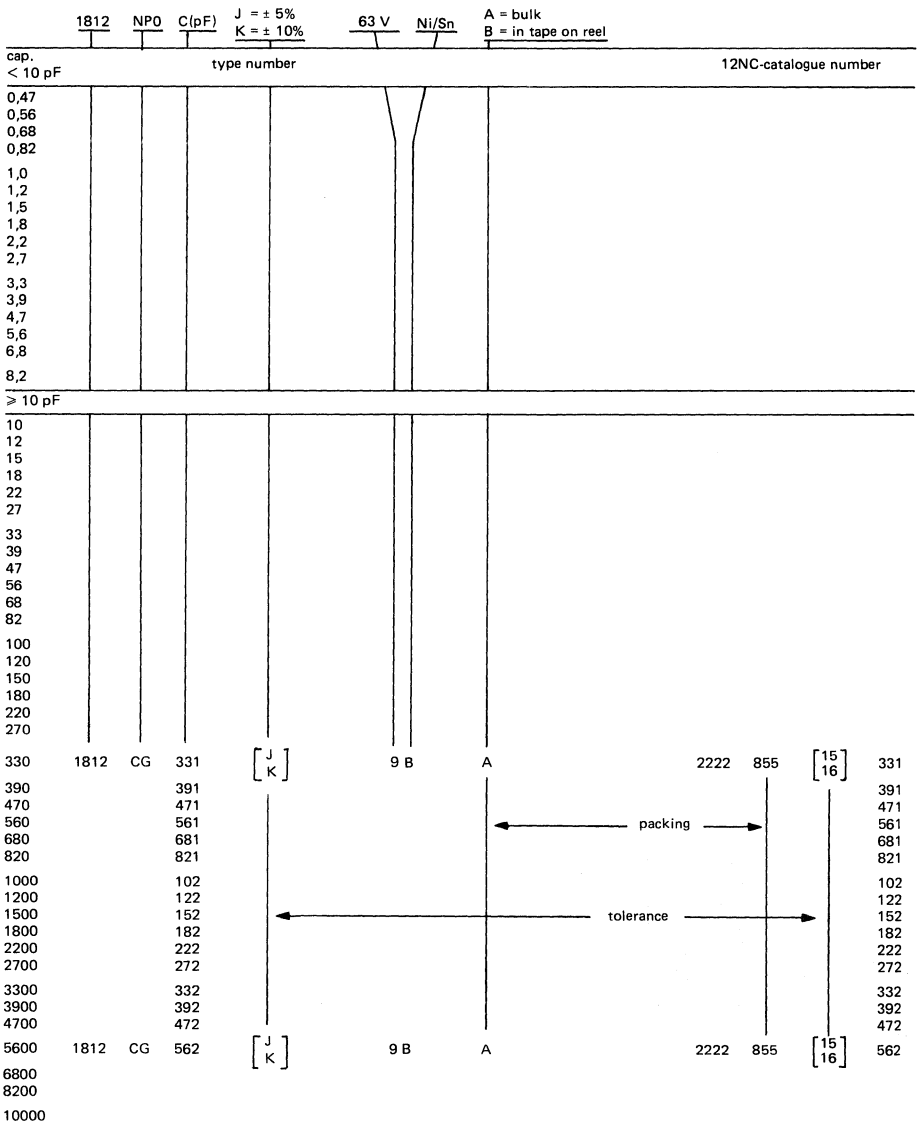

1210
NP0
C(pF)
J = ± 5%
K = ± 10%
63 V
Ag/Pd
A = bulk
B = in tape on reel
cap.
< 10 pF
type number
12NC-catalogue number
0,47
0,56
0,68
0,82
1,0
1,2
1,5
1,8
2,2
2,7
3,3
3,9
4,7
5,6
6,8
8,2
≥ 10 pF
10
12
15
18
22
27
33
39
47
56
68
82
100
120
150
180
220
270
330
390
470
560
680
820
1000
1200
1500
1800
2200
2700
3300
3900
4700
5600
6800
8200
10000
1210 CG 470 [J K] 9 A [A B] 2222 [852 862] [12 13] 479
560 569
680 689
820 829
101 101
121 121
151 151
181 181
221 221
271 271
331 331
391 391
471 471
561 561
681 681
821 821
102 102
122 122
152 152
182 182
222 222
272 272
332 [A B] [852 862] 332
392 A 852 392
1210 CG 472 [J K] 9 A A 2222 852 [12 13] 472
packing
tolerance

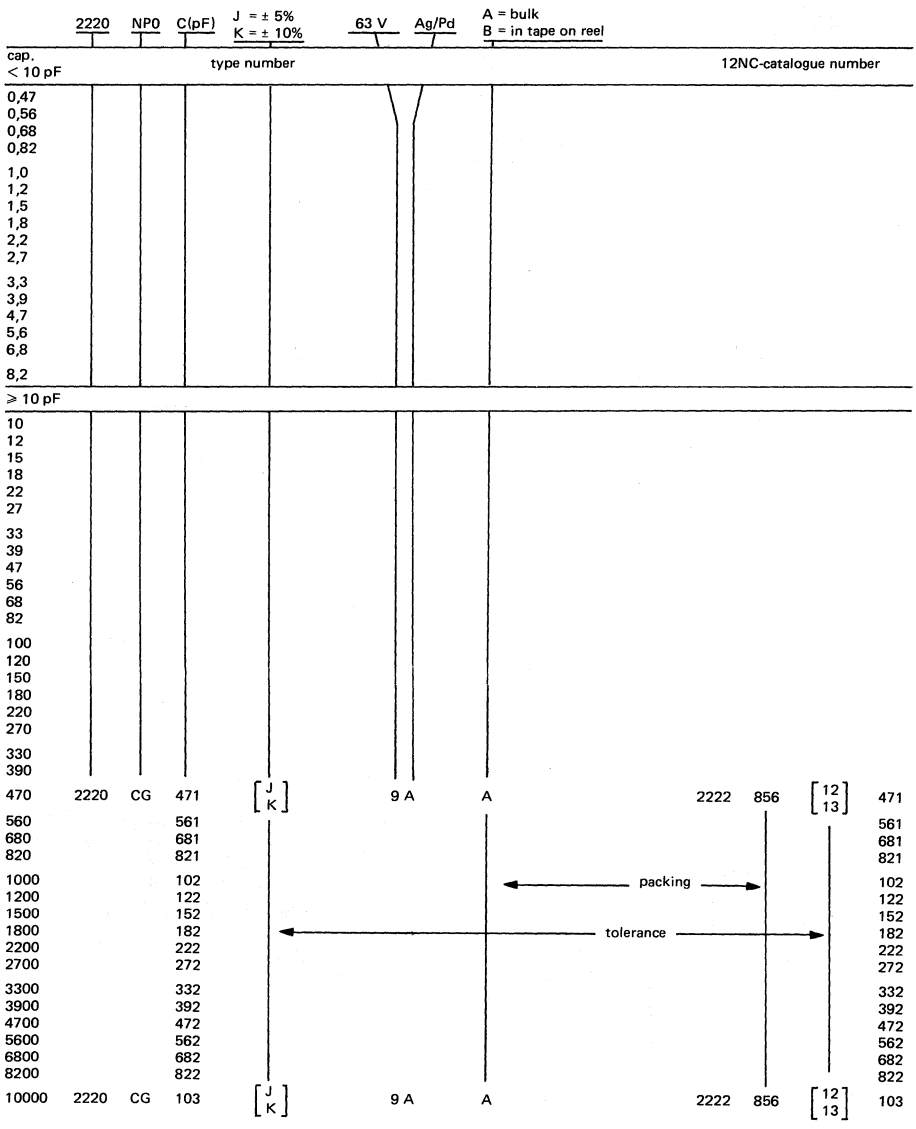

1210
NP0
C(pF)
J = ± 5%
K = ± 10%
63 V
Ni/Sn
A = bulk
B = in tape on reel
cap.
< 10 pF
type number
12NC-catalogue number
0,47
0,56
0,68
0,82
1,0
1,2
1,5
1,8
2,2
2,7
3,3
3,9
4,7
5,6
6,8
8,2
≥ 10 pF
10
12
15
18
22
27
33
39
47
56
68
82
100
120
150
180
220
270
330
390
470
560
680
820
1000
1200
1500
1800
2200
2700
3300
3900
4700
5600
6800
8200
10000
1210 CG 470 [J K] 9 B [A B] 2222 [852 862] [15 16] 479
560 569
680 689
820 829
packing
101 101
121 121
151 151
181 181
tolerance
221 221
271 271
331 331
391 391
471 471
561 561
681 681
821 821
102 102
122 122
152 152
182 182
222 222
272 272
[A B] [852 862] 332
A 852 392
1210 CG 472 [J K] 9 B A 2222 852 [15 16] 472

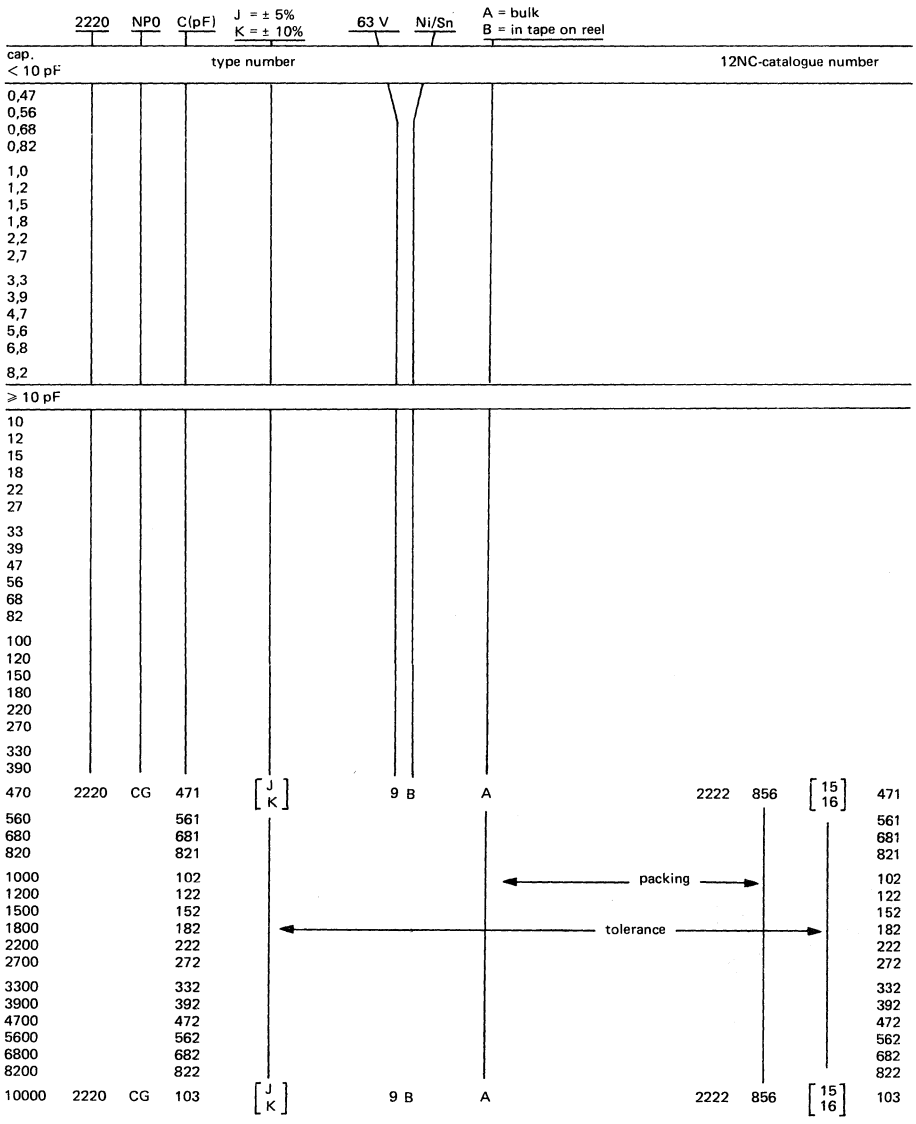

1808
NP0
C(pF)
J = ± 5%
K = ± 10%
63 V
Ag/Pd
A = bulk
B = in tape on reel
cap.
< 10 pF
type number
12NC-catalogue number
0,47
0,56
0,68
0,82
1,0
1,2
1,5
1,8
2,2
2,7
3,3
3,9
4,7
5,6
6,8
8,2
≥ 10 pF
10
12
15
18
22
27
33
39
47
56
68
82
100 1808 CG 101 [J K] 9 A A 2222 854 [12 13] 101
120 121 121
150 151 151
180 181 181
220 221 221
270 271 271
330 331 331
390 391 391
470 471 471
560 561 561
680 681 681
820 821 821
1000 102 102
1200 122 122
1500 152 152
1800 182 182
2200 222 222
2700 272 272
3300 332 332
3900 392 392
4700 472 472
5600 1808 CG 562 [J K] 9 A A 2222 854 [12 13] 562
6800
8200
10000
packing
tolerance

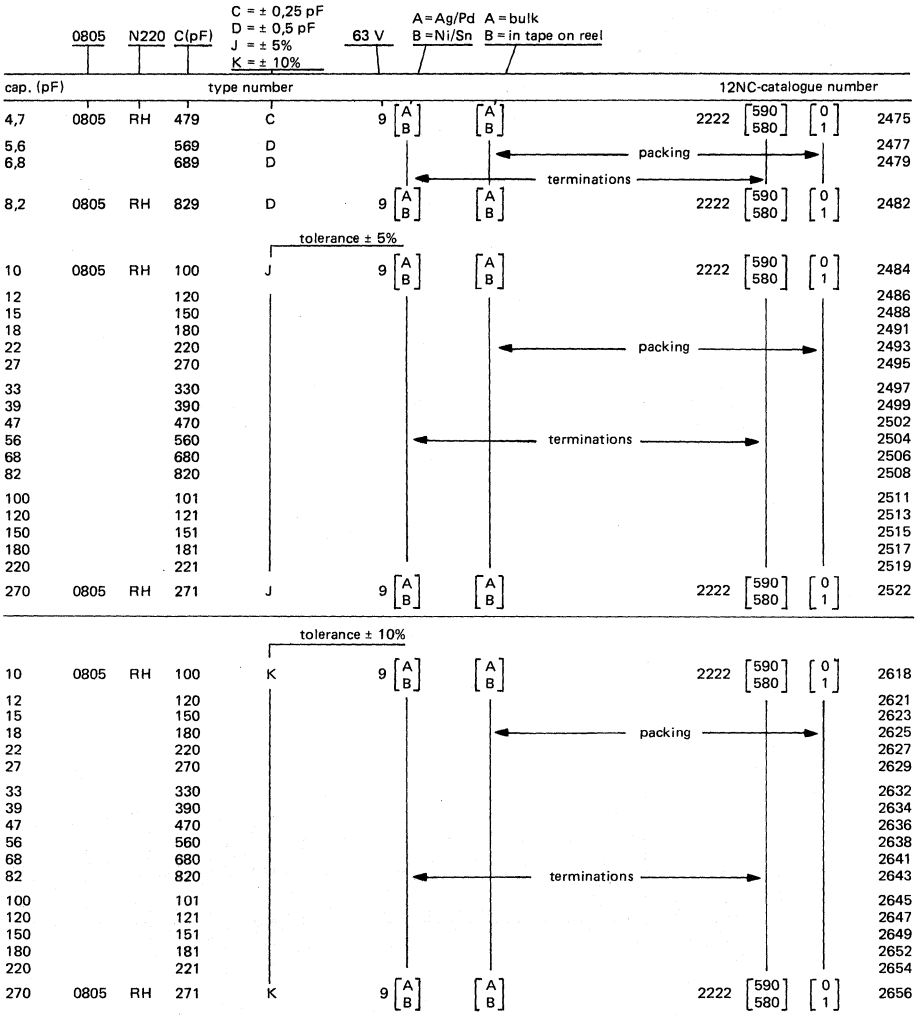

1808
NP0
C(pF)
J = ± 5%
K = ± 10%
63 V
Ni/Sn
A = bulk
B = in tape on reel
cap.
< 10 pF
type number
12NC-catalogue number
0,47
0,56
0,68
0,82
1,0
1,2
1,5
1,8
2,2
2,7
3,3
3,9
4,7
5,6
6,8
8,2
⩾ 10 pF
10
12
15
18
22
27
33
39
47
56
68
82
100 1808 CG 101 [J K] 9 B A 2222 854 [15 16] 101
120 121 121
150 151 151
180 181 181
220 221 221
270 271 271
330 331 331
390 391 391
470 471 471
560 561 561
680 681 681
820 821 821
1000 102 102
1200 122 122
1500 152 152
1800 182 182
2200 222 222
2700 272 272
3300 332 332
3900 392 392
4700 472 472
5600 1808 CG 562 [J K] 9 B A 2222 854 [15 16] 562
6800
8200
10000
packing
tolerance


1812
NP0
C(pF)
J = ± 5%
K = ± 10%
63 V
Ag/Pd
A = bulk
B = in tape on reel
cap.
type number
12NC-catalogue number
< 10 pF
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 pF
10
12
15
18
22
27
33
39
47
56
68
82
100
120
150
180
220
270
330 1812 CG 331 [J K] 9 A A 2222 855 [12 13] 331
390 391 391
470 471 471
560 561 561
680 681 681
820 821 821
1000 102 102
1200 122 122
1500 152 152
1800 182 182
2200 222 222
2700 272 272
3300 332 332
3900 392 392
4700 472 472
5600 1812 CG 562 [J K] 9 A A 2222 855 [12 13] 562
6800
8200
10000
packing
tolerance

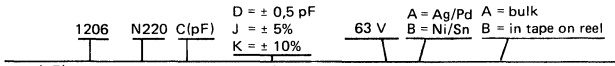

1812
NP0
C(pF)
J = ± 5%
K = ± 10%
63 V
Ni/Sn
A = bulk
B = in tape on reel
cap.
< 10 pF
type number
12NC-catalogue number
0,47
0,56
0,68
0,82
1,0
1,2
1,5
1,8
2,2
2,7
3,3
3,9
4,7
5,6
6,8
8,2
≥ 10 pF
10
12
15
18
22
27
33
39
47
56
68
82
100
120
150
180
220
270
330
1812 CG 331
[J K]
9 B
A
2222 855
[15 16]
331
390
470
560
680
820
1000
1200
1500
1800
2200
2700
3300
3900
4700
5600
1812 CG 562
[J K]
9 B
A
2222 855
[15 16]
562
6800
8200
10000
packing
tolerance


2220
NP0
C(pF)
J = ± 5%
K = ± 10%
63 V
Ag/Pd
A = bulk
B = in tape on reel
cap.
< 10 pF
type number
12NC-catalogue number
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 pF
10
12
15
18
22
27
33
39
47
56
68
82
100
120
150
180
220
270
330
390
470 2220 CG 471 [J K] 9 A A 2222 856 [12 13] 471
560 561 561
680 681 681
820 821 821
1000 102 102
1200 122 122
1500 152 152
1800 182 182
2200 222 222
2700 272 272
3300 332 332
3900 392 392
4700 472 472
5600 562 562
6800 682 682
8200 822 822
10000 2220 CG 103 [J K] 9 A A 2222 856 [12 13] 103
packing
tolerance


2220
NP0
C(pF)
J = ± 5%
K = ± 10%
63 V
Ni/Sn
A = bulk
B = in tape on reel
cap.
< 10 pF
type number
12NC-catalogue number
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 pF
10
12
15
18
22
27
33
39
47
56
68
82
100
120
150
180
220
270
330
390
470 2220 CG 471 [J K] 9 B A 2222 856 [15 16] 471
560 561 561
680 681 681
820 821 821
1000 102 102
1200 122 122
1500 152 152
1800 182 182
2200 222 222
2700 272 272
3300 332 332
3900 392 392
4700 472 562
5600 562 682
6800 682 822
8200 822
10000 2220 CG 103 [J K] 9 B A 2222 856 [15 16] 103
packing
tolerance



cap. (pF)				type number					12NC-catalogue number			
4,7	0805	RH	479	C	9	[A B]	[A B]		2222	[590 580]	[0 1]	2475
5,6			569	D								2477
6,8			689	D								2479
8,2	0805	RH	829	D	9	[A B]	[A B]		2222	[590 580]	[0 1]	2482
10	0805	RH	100	J	9	[A B]	[A B]		2222	[590 580]	[0 1]	2484
12			120									2486
15			150									2488
18			180									2491
22			220									2493
27			270									2495
33			330									2497
39			390									2499
47			470									2502
56			560									2504
68			680									2506
82			820									2508
100			101									2511
120			121									2513
150			151									2515
180			181									2517
220			221									2519
270	0805	RH	271	J	9	[A B]	[A B]		2222	[590 580]	[0 1]	2522
10	0805	RH	100	K	9	[A B]	[A B]		2222	[590 580]	[0 1]	2618
12			120									2621
15			150									2623
18			180									2625
22			220									2627
27			270									2629
33			330									2632
39			390									2634
47			470									2636
56			560									2638
68			680									2641
82			820									2643
100			101									2645
120			121									2647
150			151									2649
180			181									2652
220			221									2654
270	0805	RH	271	K	9	[A B]	[A B]		2222	[590 580]	[0 1]	2656



cap. (pF)	type number							12NC-catalogue number			
8,2	1206	RH	829	D	9	[A B]	[A B]	2222	[591 581]	[0 1]	2482
				tolerance ± 5%							
10	1206	RH	100	J	9	[A B]	[A B]	2222	[591 581]	[0 1]	2484
12			120								2486
15			150								2488
18			180								2491
22			220				packing				2493
27			270								2495
33			330								2497
39			390								2499
47			470								2502
56			560			terminations					2504
68			680								2506
82			820								2508
100			101								2511
120			121								2513
150			151								2515
180			181								2517
220			221								2519
270			271								2522
330			331								2524
390			391								2526
470			471								2528
560			561								2531
680			681								2533
820	1206	RH	821	J	9	[A B]	[A B]	2222	[591 581]	[0 1]	2535
				tolerance ± 10%							
10	1206	RH	100	K	9	[A B]	[A B]	2222	[591 581]	[0 1]	2618
12			120								2621
15			150								2623
18			180								2625
22			220				packing				2627
27			270								2629
33			330								2632
39			390								2634
47			470								2636
56			560								2638
68			680								2641
82			820								2643
100			101			terminations					2645
120			121								2647
150			151								2649
180			181								2652
220			221								2654
270			271								2656
330			331								2658
390			391								2661
470			471								2663
560			561								2665
680			681								2667
820	1206	RH	821	K	9	[A B]	[A B]	2222	[591 581]	[0 1]	2669

cap. (pF)	0805	N750	C(pF)	D = ± 0,5 pF J = ± 5% K = ± 10% type number	63 V	A = Ag/Pd B = Ni/Sn	A = bulk B = in tape on reel	12NC-catalogue number
6,8	0805	UJ	689	D	9	[A B]	[A B]	2222 [590 580] [0 1] 4099
8,2	0805	UJ	829	D	9	[A B]	[A B]	2222 [590 580] [0 1] 4102
				tolerance ± 5%				
10	0805	UJ	100	J	9	[A B]	[A B]	2222 [590 580] [0 1] 4104
12			120					4106
15			150					4108
18			180					4111
22			220				packing	4113
27			270					4115
33			330					4117
39			390					4119
47			470					4122
56			560					4124
68			680					4126
82			820			terminations		4128
100			101					4131
120			121					4133
150			151					4135
180			181					4137
220			221					4139
270			271					4142
330			331					4144
390	0805	UJ	391	J	9	[A B]	[A B]	2222 [590 580] [0 1] 4146
				tolerance ± 10%				
10	0805	UJ	100	K	9	[A B]	[A B]	2222 [590 580] [0 1] 4238
12			120					4241
15			150					4243
18			180					4245
22			220				packing	4247
27			270					4249
33			330					4252
39			390					4254
47			470					4256
56			560					4258
68			680					4261
82			820			terminations		4263
100			101					4265
120			121					4267
150			151					4269
180			181					4272
220			221					4274
270			271					4276
330			331					4278
390	0805	UJ	391	K	9	[A B]	[A B]	2222 [590 580] [0 1] 4281

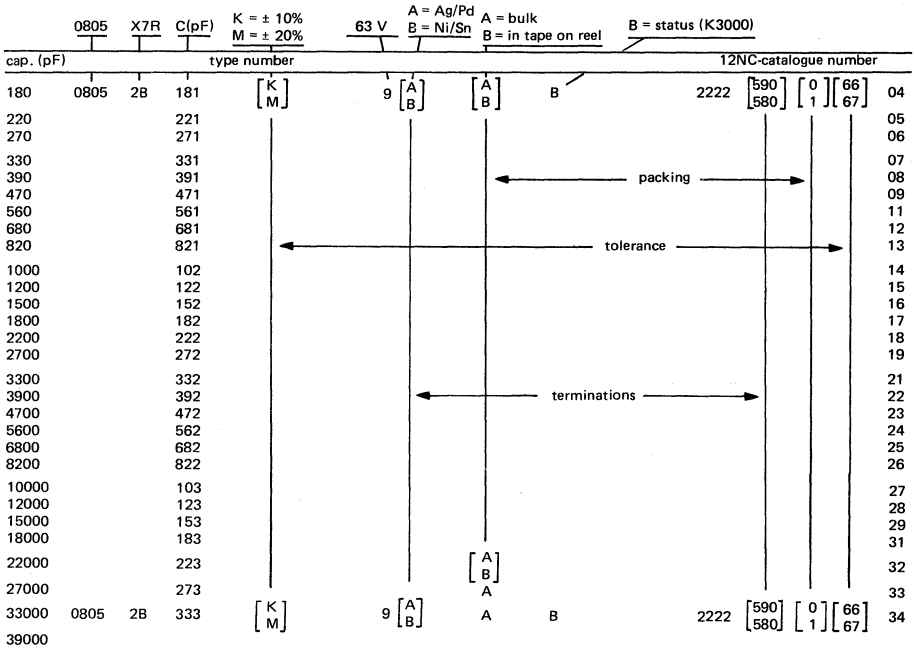
cap. (pF)	1206	N750	C(pF)	type number (D = ± 0,5 pF; J = ± 5%; K = ± 10%)	63 V	A = Ag/Pd B = Ni/Sn	A = bulk B = in tape on reel	12NC-catalogue number
6,8	1206	UJ	689	D	9	[A B]	[A B]	2222 [591 581] [0 1] 4099
8,2	1206	UJ	829	D	9	[A B]	[A B]	2222 [591 581] [0 1] 4102

tolerance ± 5%

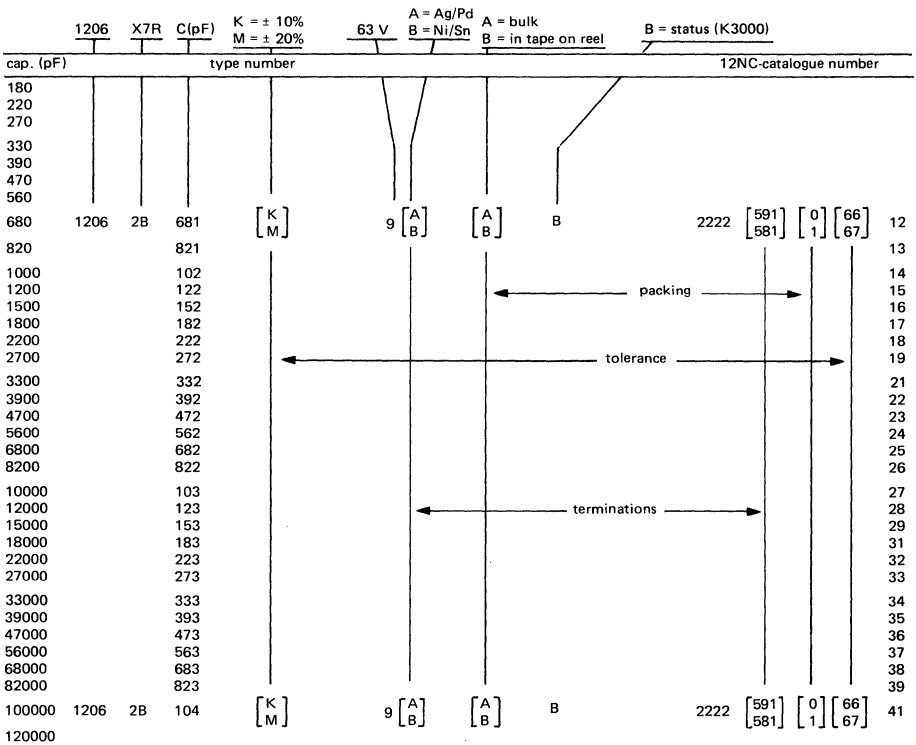
10	1206	UJ	100	J	9	[A B]	[A B]	2222 [591 581] [0 1] 4104
12			120					4106
15			150					4108
18			180					4111
22			220				packing	4113
27			270					4115
33			330					4117
39			390					4119
47			470					4122
56			560					4124
68			680				terminations	4126
82			820					4128
100			101					4131
120			121					4133
150			151					4135
180			181					4137
220			221					4139
270			271					4142
330			331					4144
390			391					4146
470			471					4148
560			561					4151
680			681					4153
820			821					4155
1000			102					4157
1200	1206	UJ	122	J	9	[A B]	[A B]	2222 [591 581] [0 1] 4159

tolerance ± 10%

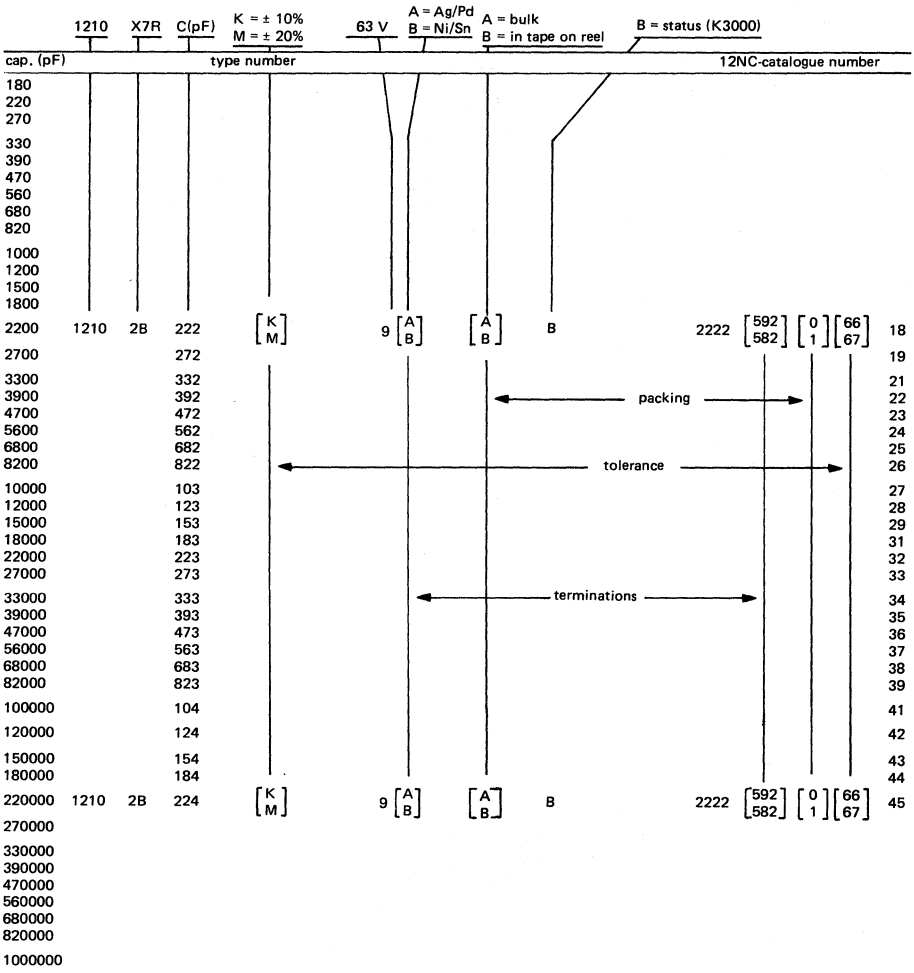
10	1206	UJ	100	K	9	[A B]	[A B]	2222 [591 581] [0 1] 4238
12			120					4241
15			150					4243
18			180					4245
22			220				packing	4247
27			270					4249
33			330					4252
39			390					4254
47			470					4256
56			560					4258
68			680				terminations	4261
82			820					4263
100			101					4265
120			121					4267
150			151					4269
180			181					4272
220			221					4274
270			271					4276
330			331					4278
390			391					4281
470			471					4283
560			561					4285
680			681					4287
820			820					4289
1000			102					4292
1200	1206	UJ	122	K	9	[A B]	[A B]	2222 [591 581] [0 1] 4294

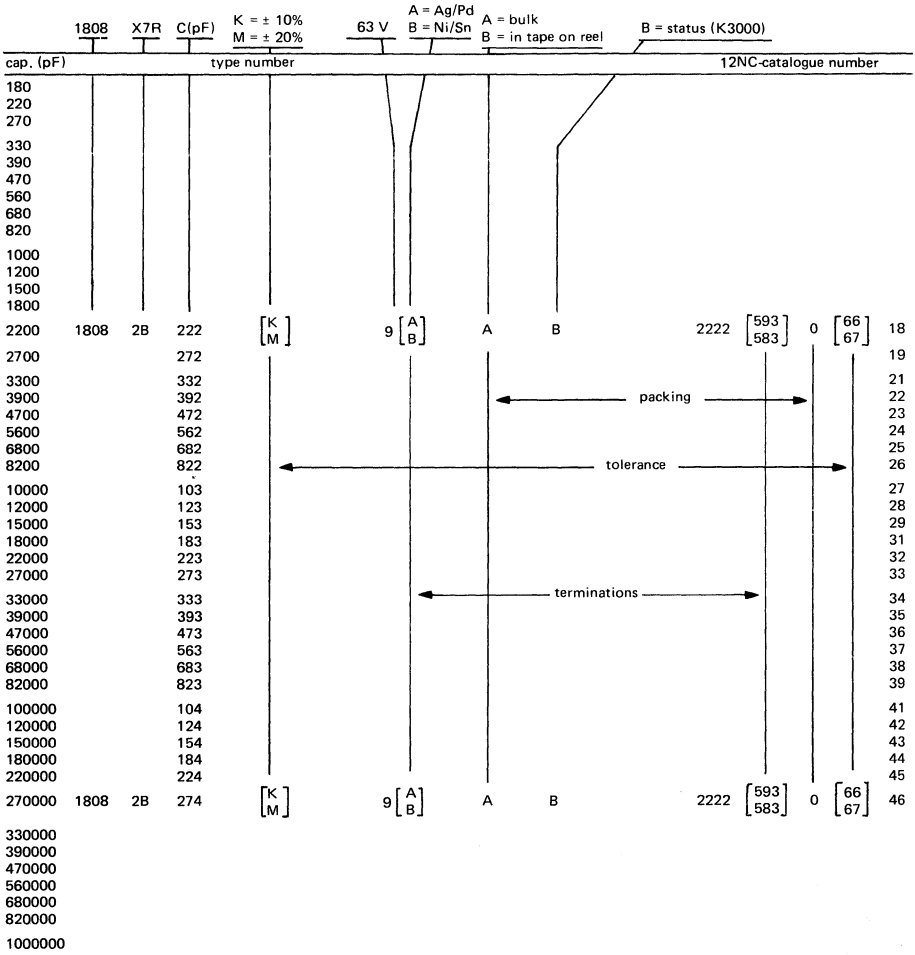


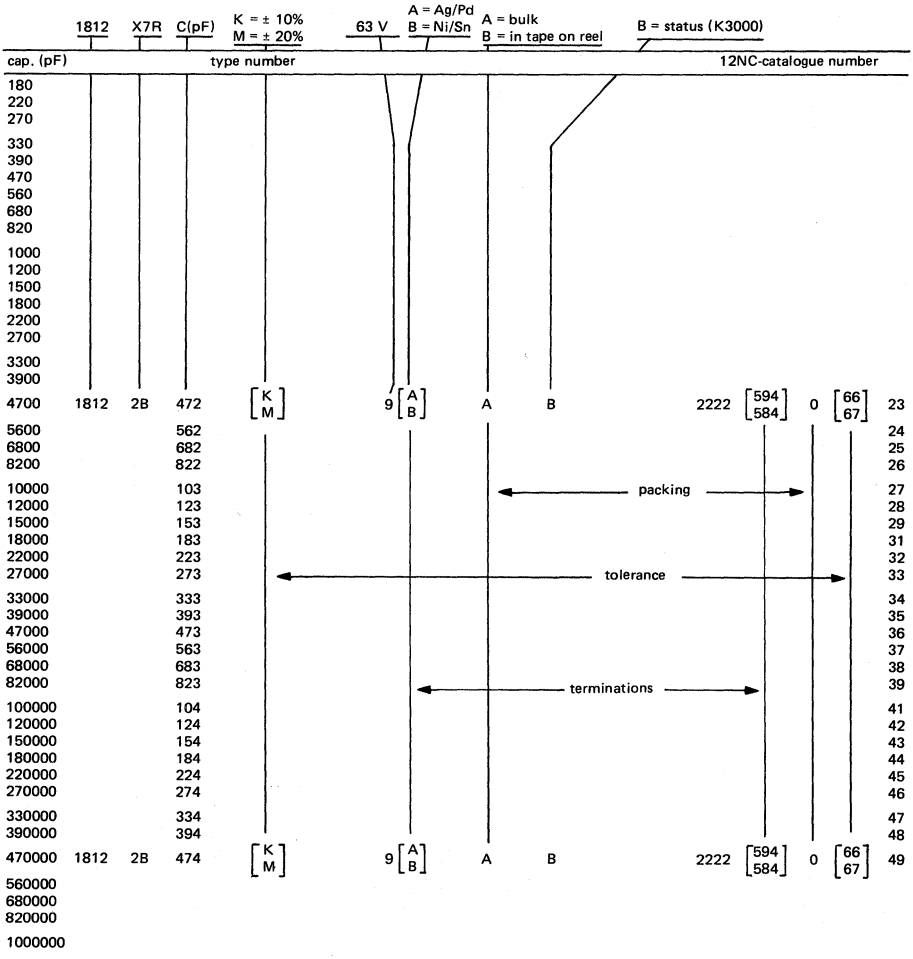
cap. (pF)			type number						12NC-catalogue number	
180	0805	2B	181	[K M]	9	[A B]	[A B]	B	2222 [590 580] [0 1] [66 67]	04
220			221							05
270			271							06
330			331							07
390			391							08
470			471							09
560			561							11
680			681							12
820			821							13
1000			102							14
1200			122							15
1500			152							16
1800			182							17
2200			222							18
2700			272							19
3300			332							21
3900			392							22
4700			472							23
5600			562							24
6800			682							25
8200			822							26
10000			103							27
12000			123							28
15000			153							29
18000			183							31
22000			223				[A B] A			32
27000			273							33
33000	0805	2B	333	[K M]	9	[A B]	A	B	2222 [590 580] [0 1] [66 67]	34
39000										
47000										
56000										
68000										
82000										
100000										
120000										
150000										
180000										
220000										
270000										
330000										
390000										
470000										
560000										
680000										
820000										
1000000										

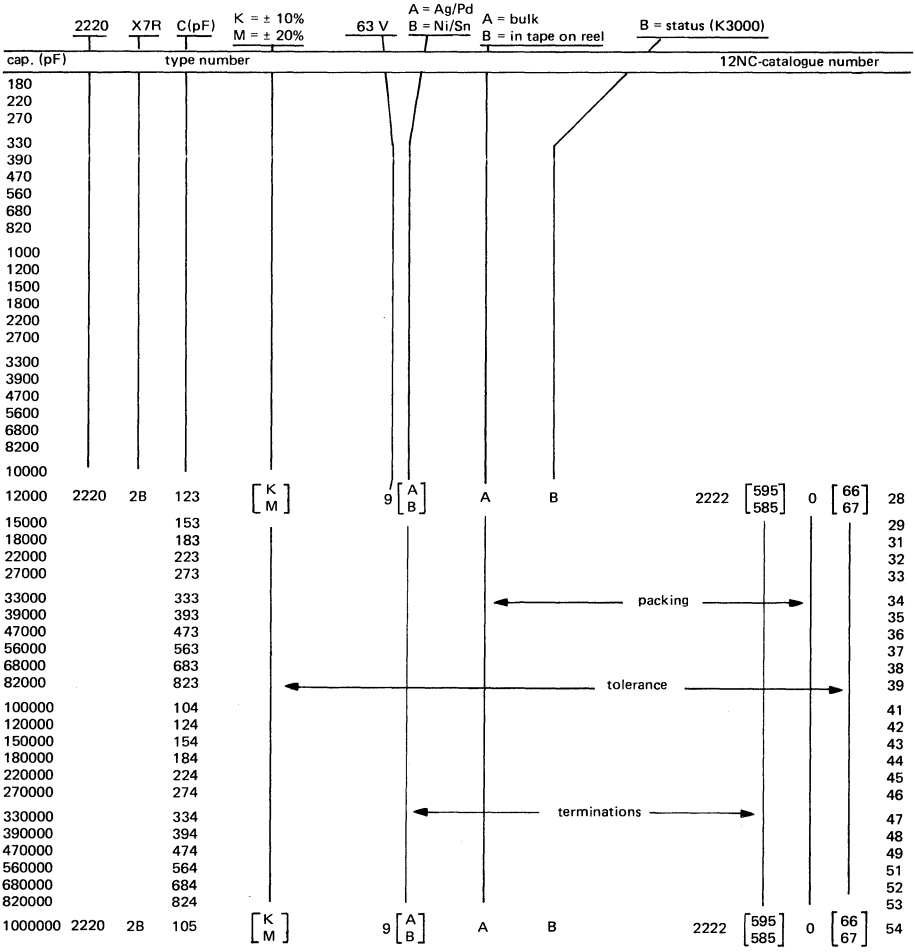


cap. (pF)				type number					12NC-catalogue number			
180												
220												
270												
330												
390												
470												
560												
680	1206	2B	681	[K M]	9	[A B]	[A B]	B	2222	[591 581]	[0 1]	[66 67]	12
820			821										13
1000			102										14
1200			122										15
1500			152										16
1800			182										17
2200			222										18
2700			272										19
3300			332										21
3900			392										22
4700			472										23
5600			562										24
6800			682										25
8200			822										26
10000			103										27
12000			123										28
15000			153										29
18000			183										31
22000			223										32
27000			273										33
33000			333										34
39000			393										35
47000			473										36
56000			563										37
68000			683										38
82000			823										39
100000	1206	2B	104	[K M]	9	[A B]	[A B]	B	2222	[591 581]	[0 1]	[66 67]	41
120000													
150000													
180000													
220000													
270000													
330000													
390000													
470000													
560000													
680000													
820000													
1000000													

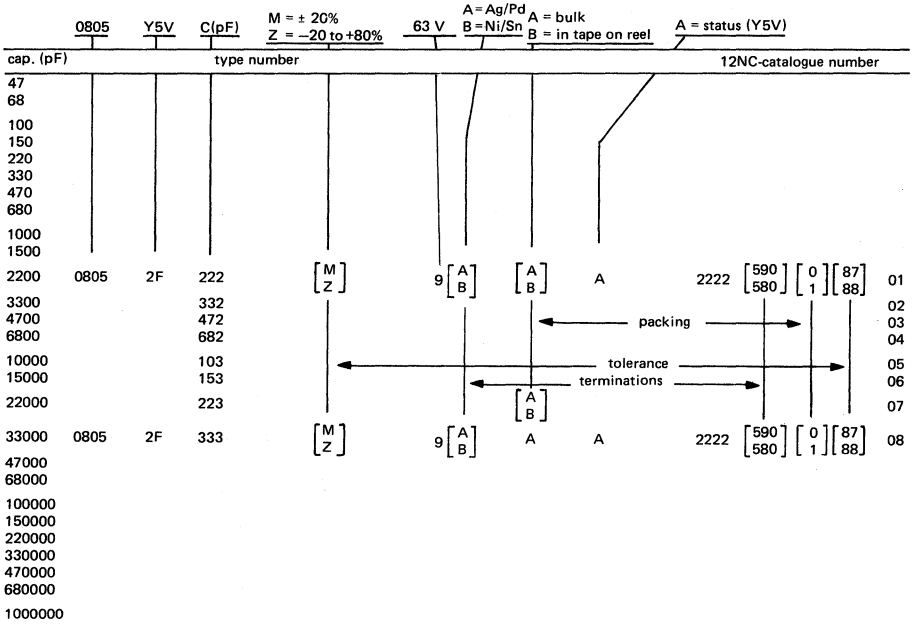

1210
X7R
C(pF)
K = ± 10%
M = ± 20%
63 V
A = Ag/Pd
B = Ni/Sn
A = bulk
B = in tape on reel
B = status (K3000)
cap. (pF)
type number
12NC-catalogue number
packing
tolerance
terminations

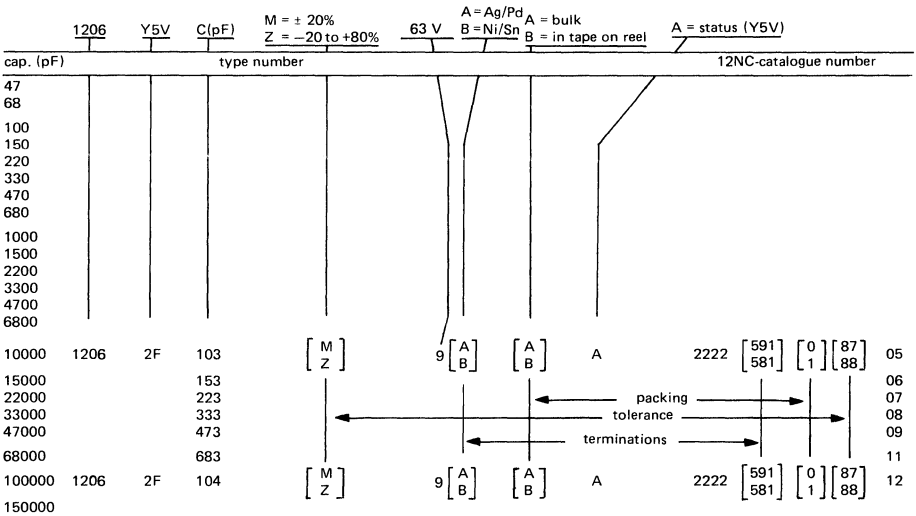

1808
X7R
C(pF)
K = ± 10%
M = ± 20%
63 V
A = Ag/Pd
B = Ni/Sn
A = bulk
B = in tape on reel
B = status (K3000)
cap. (pF)
type number
12NC-catalogue number
180
220
270
330
390
470
560
680
820
1000
1200
1500
1800
2200 1808 2B 222 [K M] 9 [A B] A B 2222 [593 583] 0 [66 67] 18
2700 272 19
3300 332 21
3900 392 22
4700 472 23
5600 562 24
6800 682 25
8200 822 26
10000 103 27
12000 123 28
15000 153 29
18000 183 31
22000 223 32
27000 273 33
33000 333 34
39000 393 35
47000 473 36
56000 563 37
68000 683 38
82000 823 39
100000 104 41
120000 124 42
150000 154 43
180000 184 44
220000 224 45
270000 1808 2B 274 [K M] 9 [A B] A B 2222 [593 583] 0 [66 67] 46
330000
390000
470000
560000
680000
820000
1000000
packing
tolerance
terminations


1812
X7R
C(pF)
K = ± 10%
M = ± 20%
63 V
A = Ag/Pd
B = Ni/Sn
A = bulk
B = in tape on reel
B = status (K3000)
cap. (pF)
type number
12NC-catalogue number
180
220
270
330
390
470
560
680
820
1000
1200
1500
1800
2200
2700
3300
3900
4700 1812 2B 472 [K M] 9 [A B] A B 2222 [594 584] 0 [66 67] 23
5600 562 24
6800 682 25
8200 822 26
10000 103 27
12000 123 28
15000 153 29
18000 183 31
22000 223 32
27000 273 33
33000 333 34
39000 393 35
47000 473 36
56000 563 37
68000 683 38
82000 823 39
100000 104 41
120000 124 42
150000 154 43
180000 184 44
220000 224 45
270000 274 46
330000 334 47
390000 394 48
470000 1812 2B 474 [K M] 9 [A B] A B 2222 [594 584] 0 [66 67] 49
560000
680000
820000
1000000
packing
tolerance
terminations


2220
X7R
C(pF)
K = ± 10%
M = ± 20%
63 V
A = Ag/Pd
B = Ni/Sn
A = bulk
B = in tape on reel
B = status (K3000)
cap. (pF)
type number
12NC-catalogue number
180
220
270
330
390
470
560
680
820
1000
1200
1500
1800
2200
2700
3300
3900
4700
5600
6800
8200
10000
12000 2220 2B 123 [K M] 9 [A B] A B 2222 [595 585] 0 [66 67] 28
15000 153 29
18000 183 31
22000 223 32
27000 273 33
33000 333 34
39000 393 35
47000 473 36
56000 563 37
68000 683 38
82000 823 39
100000 104 41
120000 124 42
150000 154 43
180000 184 44
220000 224 45
270000 274 46
330000 334 47
390000 394 48
470000 474 49
560000 564 51
680000 684 52
820000 824 53
1000000 2220 2B 105 [K M] 9 [A B] A B 2222 [595 585] 0 [66 67] 54
packing
tolerance
terminations

Y5V
size 0805





cap. (pF)			type number							12NC-catalogue number	
47											
68											
100											
150											
220											
330											
470											
680											
1000											
1500											
2200											
3300											
4700											
6800											
10000	1206	2F	103	[M Z]	9	[A B]	[A B]	A	2222	[591 581] [0 1] [87 88]	05
15000			153								06
22000			223								07
33000			333								08
47000			473								09
68000			683								11
100000	1206	2F	104	[M Z]	9	[A B]	[A B]	A	2222	[591 581] [0 1] [87 88]	12
150000											
220000											
330000											
470000											
680000											
1000000											

APPENDIX II

CONVERSION LIST

type number to 12NC-catalogue number

for 100-piece bulk packing

(for sampling capacitors in sizes 0805 and 1206)

Note: This small packing quantity is available in sizes 0805 and 1206 in all dielectrics but limited to the smaller capacitance tolerances: ± 5% NP0, N220 and N750; ± 10% X7R; ± 20% Y5V.

Examples: A 63 V ceramic multilayer capacitor of 12 pF ± 5%, NP0, size 0805, with Ag/Pd terminations, supplied in bag of 100 pieces, has the type number 0805CG120J9AE- and the 12NC-catalogue number 2222 851 72129, see next page.

A 63 V ceramic multilayer capacitor of 820 pF ± 20%, X7R, size 1206, with Ni/Sn terminations, supplied in bag of 100 pieces, has the type number 12062B821K9BEB, and the 12NC-catalogue number 2222 581 76613.

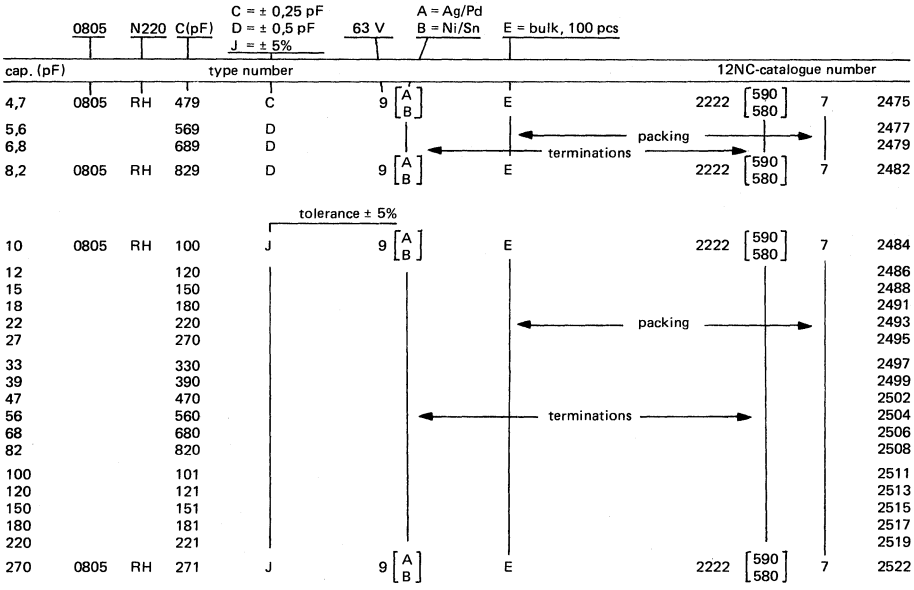
	0805	NP0	C(pF)	C = ± 0,25 pF D = ± 0,5 pF J = ± 5%	63 V	Ag/Pd	E = bulk, 100 pcs				
cap.			type number					12NC-catalogue number			
< 10 pF											
0,47	0805	CJ	478	C	9 A		E	2222	851	72	477
0,56			568								567
0,68			688								687
0,82			828								827
1,0			109								108
1,2			129								128
1,5			159								158
1,8			189								188
2,2			229								228
2,7			279								278
3,3			339								338
3,9			399								398
4,7			479	C							478
5,6			569	D							568
6,8			689	D							688
8,2	0805	CJ	829	D	9 A		E	2222	851	72	828
≥ 10 pF											
10	0805	CG	100	J	9 A		E	2222	851	72	109
12			120								129
15			150								159
18			180								189
22			220								229
27			270								279
33			330								339
39			390								399
47			470								479
56			560								569
68			680								689
82			820								829
100			101								101
120			121								121
150			151								151
180			181								181
220			221								221
270			271								271
330			331								331
390			391								391
470			471								471
560			561								561
680			681								681
820			821								821
1000	0805	CG	102	J	9 A		E	2222	851	72	102
1200											
1500											
1800											
2200											
2700											
3300											
3900											
4700											
5600											
6800											
8200											
10000											

	0805	NP0	C(pF)	C = ± 0,25 pF D = ± 0,5 pF J = ± 5%	63 V	Ni/Sn	E = bulk, 100 pcs				
cap.				type number				12NC-catalogue number			
< 10 pF											
0,47	0805	CJ	478	C	9	B	E	2222	851	75	477
0,56			568								567
0,68			688								687
0,82			828								827
1,0			109								108
1,2			129								128
1,5			159								158
1,8			189								188
2,2			229								228
2,7			279								278
3,3			339								338
3,9			399								398
4,7			479	C							478
5,6			569	D							568
6,8			689	D							688
8,2	0805	CJ	829	D	9	B	E	2222	851	75	828
≥ 10 pF											
10	0805	CG	100	J	9	B	E	2222	851	75	109
12			120								129
15			150								159
18			180								189
22			220								229
27			270								279
33			330								339
39			390								399
47			470								479
56			560								569
68			680								689
82			820								829
100			101								101
120			121								121
150			151								151
180			181								181
220			221								221
270			271								271
330			331								331
390			391								391
470			471								471
560			561								561
680			681								681
820			821								821
1000	0805	CG	102	J	9	B	E	2222	851	75	102
1200											
1500											
1800											
2200											
2700											
3300											
3900											
4700											
5600											
6800											
8200											
10000											

1206	NP0	C(pF)	C = ± 0,25 pF D = ± 0,5 pF J = ± 5%	63 V	Ag/Pd	E = bulk, 100 pcs

cap.	type number						12NC-catalogue number			
< 10 pF										
0,47	1206	CJ	478	C	9 A	E	2222	853	72	477
0,56			568							567
0,68			688							687
0,82			828							827
1,0			109							108
1,2			129							128
1,5			159							158
1,8			189							188
2,2			229							228
2,7			279							278
3,3			339							338
3,9			399							398
4,7			479	C						478
5,6			569	D						568
6,8			689	D						688
8,2	1206	CJ	829	D	9 A	E	2222	853	72	828
≥ 10 pF										
10	1206	CG	100	J	9 A	E	2222	853	72	109
12			120							129
15			150							159
18			180							189
22			220							229
27			270							279
33			330							339
39			390							399
47			470							479
56			560							569
68			680							689
82			820							829
100			101							101
120			121							121
150			151							151
180			181							181
220			221							221
270			271							271
330			331							331
390			391							391
470			471							471
560			561							561
680			681							681
820			821							821
1000			102							102
1200			122							122
1500			152							152
1800			182							182
2200			222							222
2700			272							272
3300	1206	CG	332	J	9 A	E	2222	853	72	332
3900										
4700										
5600										
6800										
8200										
10000										

cap.	1206	NP0	C(pF)	C = ± 0,25 pF D = ± 0,5 pF J = ± 5%	63 V	Ni/Sn	E = bulk, 100 pcs	12NC-catalogue number			
				type number							
< 10 pF											
0,47	1206	CJ	478	C	9	B	E	2222	853	75	477
0,56			568								567
0,68			688								687
0,82			828								827
1,0			109								108
1,2			129								128
1,5			159								158
1,8			189								188
2,2			229								228
2,7			279								278
3,3			339								338
3,9			399								398
4,7			479	C							478
5,6			569	D							568
6,8			689	D							688
8,2	1206	CJ	829	D	9	B	E	2222	853	75	828
⩾ 10 pF											
10	1206	CG	100	J	9	B	E	2222	853	75	109
12			120								129
15			150								159
18			180								189
22			220								229
27			270								279
33			330								339
39			390								399
47			470								479
56			560								569
68			680								689
82			820								829
100			101								101
120			121								121
150			151								151
180			181								181
220			221								221
270			271								271
330			331								331
390			391								391
470			471								471
560			561								561
680			681								681
820			821								821
1000			102								102
1200			122								122
1500			152								152
1800			182								182
2200			222								222
2700			272								272
3300	1206	CG	332	J	9	B	E	2222	853	75	332
3900											
4700											
5600											
6800											
8200											
10000											

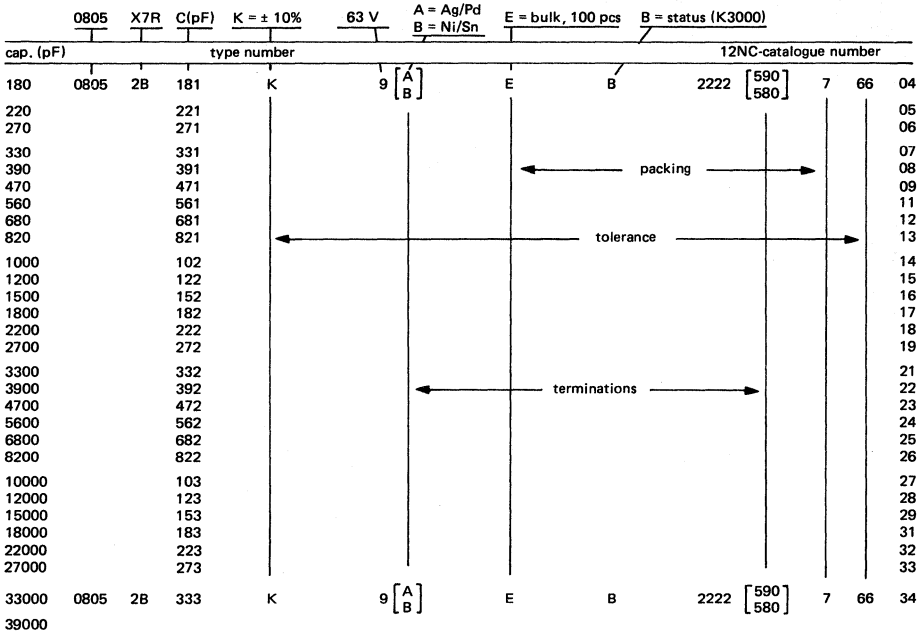

0805
N220
C(pF)
C = ± 0,25 pF
D = ± 0,5 pF
J = ± 5%
63 V
A = Ag/Pd
B = Ni/Sn
E = bulk, 100 pcs
cap. (pF)
type number
12NC-catalogue number
4,7 0805 RH 479 C 9 [A B] E 2222 [590 580] 7 2475
5,6 569 D 2477
6,8 689 D 2479
8,2 0805 RH 829 D 9 [A B] E 2222 [590 580] 7 2482
packing
terminations
tolerance ± 5%
10 0805 RH 100 J 9 [A B] E 2222 [590 580] 7 2484
12 120 2486
15 150 2488
18 180 2491
22 220 2493
27 270 2495
33 330 2497
39 390 2499
47 470 2502
56 560 2504
68 680 2506
82 820 2508
100 101 2511
120 121 2513
150 151 2515
180 181 2517
220 221 2519
270 0805 RH 271 J 9 [A B] E 2222 [590 580] 7 2522

	1206	N220	C(pF)	D = ± 0,5 pF J = ± 5%	63 V	A = Ag/Pd B = Ni/Sn	E = bulk, 100 pcs		
cap. (pF)			type number					12NC-catalogue number	
8,2	1206	RH	829	D	9 [A B]	E	2222 [591 581]	7	2482
				tolerance ± 5%					
10	1206	RH	100	J	9 [A B]	E	2222 [591 581]	7	2484
12			120						2486
15			150						2488
18			180						2491
22			220				packing		2493
27			270						2495
33			330						2497
39			390						2499
47			470						2502
56			560				terminations		2504
68			680						2506
82			820						2508
100			101						2511
120			121						2513
150			151						2515
180			181						2517
220			221						2519
270			271						2522
330			331						2524
390			391						2526
470			471						2528
560			561						2531
680			681						2533
820	1206	RH	821	J	9 [A B]	E	2222 [591 581]	7	2535

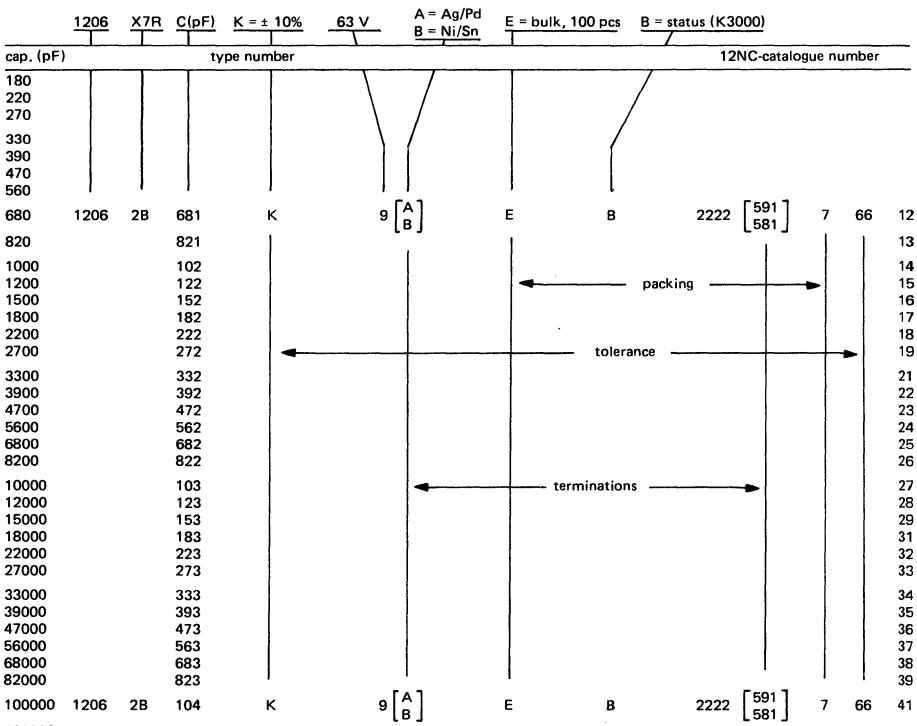
	0805	N750	C(pF)	D = ± 0,5 pF J = ± 5%	63 V	A = Ag/Pd B = Ni/Sn	E = bulk, 100 pcs			
cap. (pF)	type number							12NC-catalogue number		
6,8	0805	UJ	689	D	9	[A/B]	E	2222	[590/580]	7 4099
8,2	0805	UJ	829	D	9	[A/B]	E	2222	[590/580]	7 4102
				tolerance ± 5%						
10	0805	UJ	100	J	9	[A/B]	E	2222	[590/580]	7 4104
12			120							4106
15			150							4108
18			180							4111
22			220				packing			4113
27			270							4115
33			330							4117
39			390							4119
47			470							4122
56			560							4124
68			680				terminations			4126
82			820							4128
100			101							4131
120			121							4133
150			151							4135
180			181							4137
220			221							4139
270			271							4142
330			331							4144
390	0805	UJ	391	J	9	[A/B]	E	2222	[590/580]	7 4146

	1206	N750	C(pF)	D = ± 0,5 pF J = ± 5%	63 V	A = Ag/Pd B = Ni/Sn	E = bulk, 100 pcs		
cap. (pF)				type number				12NC-catalogue number	
6,8	1206	UJ	689	D	9 [A/B]	E	2222 [591/581]	7	4099
8,2	1206	UJ	829	D	9 [A/B]	E	2222 [591/581]	7	4102
				tolerance ± 5%					
10	1206	UJ	100	J	9 [A/B]	E	2222 [591/581]	7	4104
12			120						4106
15			150						4108
18			180						4111
22			220				packing		4113
27			270						4115
33			330						4117
39			390						4119
47			470						4122
56			560				terminations		4124
68			680						4126
82			820						4128
100			101						4131
120			121						4133
150			151						4135
180			181						4137
220			221						4139
270			271						4142
330			331						4144
390			391						4146
470			471						4148
560			561						4151
680			681						4153
820			821						4155
1000			102						4157
1200	1206	UJ	122	J	9 [A/B]	E	2222 [591/581]	7	4159

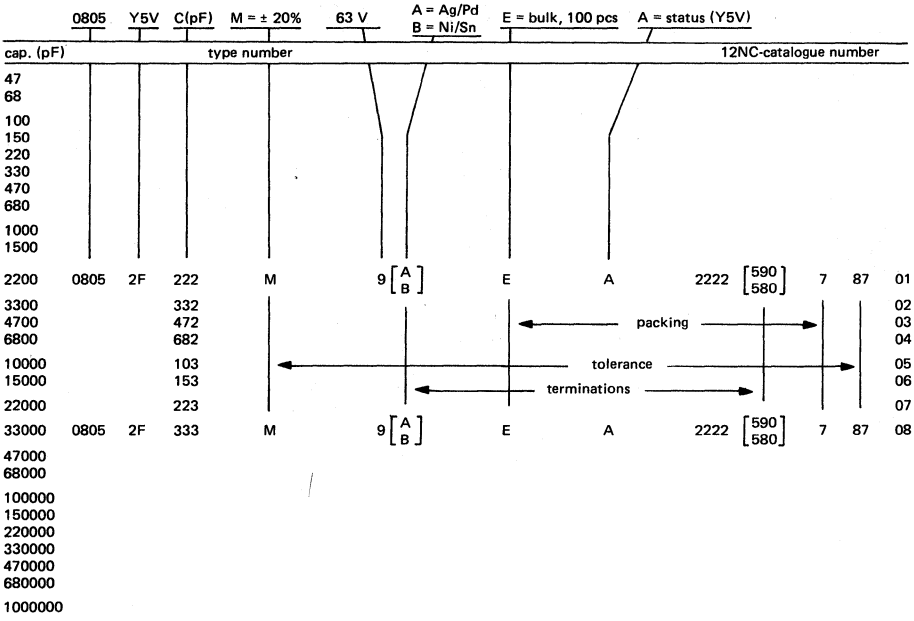
X7R
size 0805

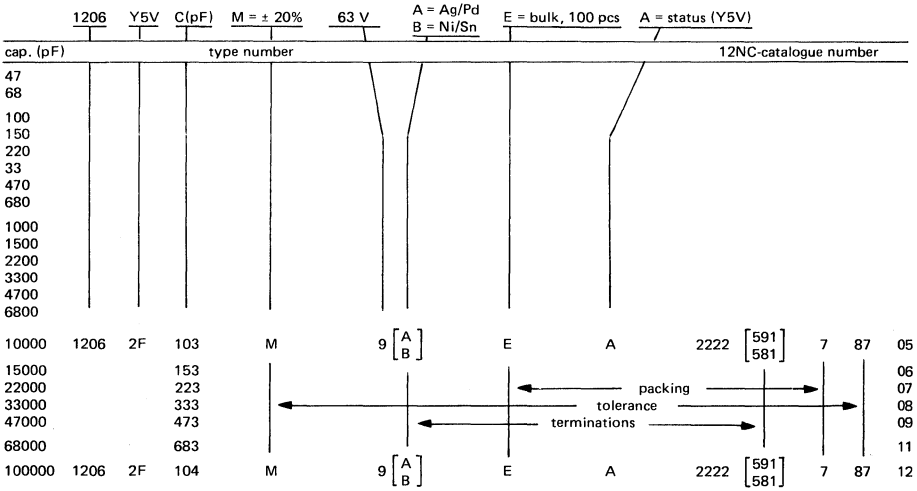


cap. (pF)			type number					12NC-catalogue number			
180	0805	2B	181	K	9	E	B	2222	590/580	7	66	04
220			221									05
270			271									06
330			331									07
390			391									08
470			471									09
560			561									11
680			681									12
820			821									13
1000			102									14
1200			122									15
1500			152									16
1800			182									17
2200			222									18
2700			272									19
3300			332									21
3900			392									22
4700			472									23
5600			562									24
6800			682									25
8200			822									26
10000			103									27
12000			123									28
15000			153									29
18000			183									31
22000			223									32
27000			273									33
33000	0805	2B	333	K	9	E	B	2222	590/580	7	66	34
39000												
47000												
56000												
68000												
82000												
100000												
120000												
150000												
180000												
220000												
270000												
330000												
390000												
470000												
560000												
680000												
820000												
1000000												



cap. (pF)											
180											
220											
270											
330											
390											
470											
560											
680	1206	2B	681	K	9	E	B	2222	591/581	7	66	12
820			821									13
1000			102									14
1200			122									15
1500			152									16
1800			182									17
2200			222									18
2700			272									19
3300			332									21
3900			392									22
4700			472									23
5600			562									24
6800			682									25
8200			822									26
10000			103									27
12000			123									28
15000			153									29
18000			183									31
22000			223									32
27000			273									33
33000			333									34
39000			393									35
47000			473									36
56000			563									37
68000			683									38
82000			823									39
100000	1206	2B	104	K	9	E	B	2222	591/581	7	66	41
120000												
150000												
180000												
220000												
270000												
330000												
390000												
470000												
560000												
680000												
820000												
1000000												


0805
Y5V
C(pF)
M = ± 20%
63 V
A = Ag/Pd
B = Ni/Sn
E = bulk, 100 pcs
A = status (Y5V)
cap. (pF)
type number
12NC-catalogue number
47
68
100
150
220
330
470
680
1000
1500
2200 0805 2F 222 M 9 [A B] E A 2222 [590 580] 7 87 01
3300 332 02
4700 472 03
6800 682 04
10000 103 05
15000 153 06
22000 223 07
33000 0805 2F 333 M 9 [A B] E A 2222 [590 580] 7 87 08
47000
68000
100000
150000
220000
330000
470000
680000
1000000
packing
tolerance
terminations



cap. (pF)	type number											12NC-catalogue number
47												
68												
100												
150												
220												
33												
470												
680												
1000												
1500												
2200												
3300												
4700												
6800												
10000	1206	2F	103	M	9	[A B]	E	A	2222	[591 581]	7	87	05
15000			153										06
22000			223										07
33000			333										08
47000			473										09
68000			683										11
100000	1206	2F	104	M	9	[A B]	E	A	2222	[591 581]	7	87	12
150000													
220000													
330000													
470000													
680000													
1000000													

NOTES

NOTES

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			

Electronic components and materials for professional, industrial and consumer uses from the world-wide Philips Group of Companies

Argentina: PHILIPS ARGENTINA S.A., Div. Elcoma, Vedia 3892, 1430 BUENOS AIRES, Tel. (01) 541 - 7141 to 7747.
Australia: PHILIPS INDUSTRIES LTD., Elcoma Division, 11 Waltham Street, ARTARMON, N.S.W. 2064, Tel. (02)439 3322.
Austria: ÖSTERREICHISCHE PHILIPS INDUSTRIE G.m.b.H., UB Bauelemente, Triester Str. 64, A-1101 WIEN, Tel. (0222) 6291 11-0.
Belgium: N.V. PHILIPS & MBLE ASSOCIATED, 80 Rue Des Deux Gares, B-1070 BRUXELLES, Tel. (02) 525-61-11.
Brazil: CONSTANTA-IBRAPE; (Active Devices): Av. Brigadeiro Faria Lima, 1735-SAO PAULO-SP, Tel. (011) 211-2600,
(Passive Devices & Materials): Av. Francisco Monteiro, 702 - RIBEIRAO PIRES-SP, Tel. (011) 459-8211.
Canada: PHILIPS ELECTRONICS LTD., Elcoma Division, 601 Milner Ave., SCARBOROUGH, Ontario, M1B 1M8, Tel. (416) 292-5161.
Chile: PHILIPS CHILENA S.A., Av. Santa Maria 0760, SANTIAGO, Tel. (02) 77 38 16.
Colombia: IND. PHILIPS DE COLOMBIA S.A., c/o IPRELENSO LTD., Cra. 21, No. 56-17, BOGOTA, D.E., Tel. (01) 249 76 24.
Denmark: MINIWATT A/S, Strandlodsvej 2, P.O. Box 1919, DK 2300 COPENHAGEN S, Tel. (01) 54 11 33.
Finland: OY PHILIPS AB, Elcoma Division, Kaivokatu 8, SF-00100 HELSINKI 10, Tel. (90) 1 72 71.
France: RTC-COMPELEC, 130 Avenue Ledru Rollin, F-75540 PARIS 11, Tel. (01) 43 38 80 00.
Germany (Fed. Republic): VALVO, UB Bauelemente der Philips G.m.b.H., Valvo Haus, Burchardstrasse 19, D-2 HAMBURG 1, Tel. (040) 3296-0.
Greece: PHILIPS HELLENIQUE S.A., Elcoma Division, No. 15, 25th March Street, GR 17778 TAVROS, Tel. (01) 489 4339/489 4911.
Hong Kong: PHILIPS HONG KONG LTD., Elcoma Div., 15/F Philips Ind. Bldg., 24-28 Kung Yip St., KWAI CHUNG, Tel. (0)-24 51 21.
India: PEICO ELECTRONICS & ELECTRICALS LTD., Elcoma Dept., Band Box Building,
254-D Dr. Annie Besant Rd., BOMBAY - 400 025, Tel. (022) 4930311/4930590.
Indonesia: P.T. PHILIPS-RALIN ELECTRONICS, Elcoma Div., Setiabudi II Building, 6th Fl., Jalan H.R. Rasuna Said (P.O. Box 223/KBY) Kuningan,
JAKARTA 12910, Tel. (021) 51 79 95.
Ireland: PHILIPS ELECTRICAL (IRELAND) LTD., Elcoma Division, Newstead, Clonskeagh, DUBLIN 14, Tel. (01) 69 33 55.
Italy: PHILIPS S.p.A., Div. Componenti Elcoma, Piazza IV Novembre 3, I-20124 MILANO, Tel. (02) 6752.1.
Japan: NIHON PHILIPS CORP., Shuwa Shinagawa Bldg., 26-33 Takanawa 3-chome, Minato-ku, TOKYO (108), Tel. (03) 448-5611.
(IC Products) SIGNETICS JAPAN LTD., 8-7 Sanbancho Chiyoda-ku, TOKYO 102, Tel. (03) 230-1521.
Korea (Republic of): PHILIPS ELECTRONICS (KOREA) LTD., Elcoma Div., Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,
Tel. (02) 794-5011.
Malaysia: PHILIPS MALAYSIA SDN BHD, Elcoma Div., 345 Jalan Gelugor, 11700 PULAU PINANG, Tel. (04) 87 00 44.
Mexico: ELECTRONICA, S.A de C.V., Carr. México-Toluca km. 62.5, TOLUCA, Edo. de México 50140, Tel. Toluca 91 (721) 613-00.
Netherlands: PHILIPS NEDERLAND, Marktgroep Elonco, Postbus 90050, 5600 PB EINDHOVEN, Tel. (040) 78 37 49.
New Zealand: PHILIPS NEW ZEALAND LTD., Elcoma Division, 110 Mt. Eden Road, C.P.O. Box 1041, AUCKLAND, Tel. (09) 605-914.
Norway: NORSK A/S PHILIPS, Electronica Dept., Sandstuveien 70, OSLO 6, Tel. (02) 68 02 00.
Pakistan: PHILIPS ELECTRICAL CO. OF PAKISTAN LTD., Philips Markaz, M.A. Jinnah Rd., KARACHI-3, Tel. (021) 72 57 72.
Peru: CADESA, Av. Alfonso Ugarte 1268, LIMA 5, Tel. (014) 326070.
Philippines: PHILIPS INDUSTRIAL DEV. INC., 2246 Pasong Tamo, P.O. Box 911, Makati Comm. Centre, MAKATI-RIZAL 3116, Tel. (02) 86 89 51 to 59.
Portugal: PHILIPS PORTUGUESA S.A.R.L., Av. Eng. Duarte Pacheco 6, 1009 LISBOA Codex, Tel. (019) 68 31 21.
Singapore: PHILIPS PROJECT DEV. (Singapore) PTE LTD., Elcoma Div., Lorong 1, Toa Payoh, SINGAPORE 1231, Tel. 350 2 000.
South Africa: S.A. PHILIPS (Pty) LTD., EDAC Div., 3rd Floor Rainer House, Upper Railway Rd. & Ove St., New Doornfontein, JOHANNESBURG 2001,
Tel. (011) 402-4600/07.
Spain: MINIWATT S.A., Balmes 22, BARCELONA 7, Tel. (03) 301 63 12.
Sweden: PHILIPS KOMPONENTER A.B., Lidingövägen 50, S-11584 STOCKHOLM 27, Tel. (08) 7821000.
Switzerland: PHILIPS A.G., Elcoma Dept., Allmendstrasse 140-142, CH-8027 ZÜRICH, Tel. (01) 488 22 11.
Taiwan: PHILIPS TAIWAN LTD., 150 Tun Hua North Road, P.O. Box 22978, TAIPEI, Taiwan, Tel. (02) 7120500.
Thailand: PHILIPS ELECTRICAL CO. OF THAILAND LTD., 283 Silom Road, P.O. Box 961, BANGKOK, Tel. (02) 233-6330-9.
Turkey: TÜRK PHILIPS TICARET A.S., Elcoma Department, Inönü Cad., No. 78-80, 80090 Ayazpasa ISTANBUL, Tel. (01) 143 59 10.
United Kingdom: MULLARD LTD., Mullard House, Torrington Place, LONDON WC1E 7HD, Tel. (01) 580 6633.
United States: (Active Devices & Materials) AMPEREX SALES CORP., Providence Pike, SLATERSVILLE, R.I. 02876, Tel. (401) 762-9000.
(Passive & Electromech. Dev.) MEPCO/CENTRALAB, INC., 2001 West Blue Heron Blvd, RIVIERA BEACH, Florida 33404,
Tel. (305) 881-3200.
(IC Products) SIGNETICS CORPORATION, 811 East Arques Avenue, SUNNYVALE, CA 94088-3409, Tel. (408) 991-2000.
Uruguay: LUZILECTRON S.A., Avda Uruguay 1287, P.O. Box 907, MONTEVIDEO, Tel. (02) 98 53 95.
Venezuela: IND. VENEZOLANAS PHILIPS S.A., c/o MAGNETICA S.A., Calle 6, Ed. Las Tres Jotas, App. Post. 78117, CARACAS, Tel. (02) 239 39 31.

For all other countries apply to: Philips Electronic Components and Materials Division, International Business Relations, P.O. Box 218,
5600 MD EINDHOVEN, The Netherlands, Telex 35000 phtcnl

AB54

Printed in The Netherlands

9398 146 70011