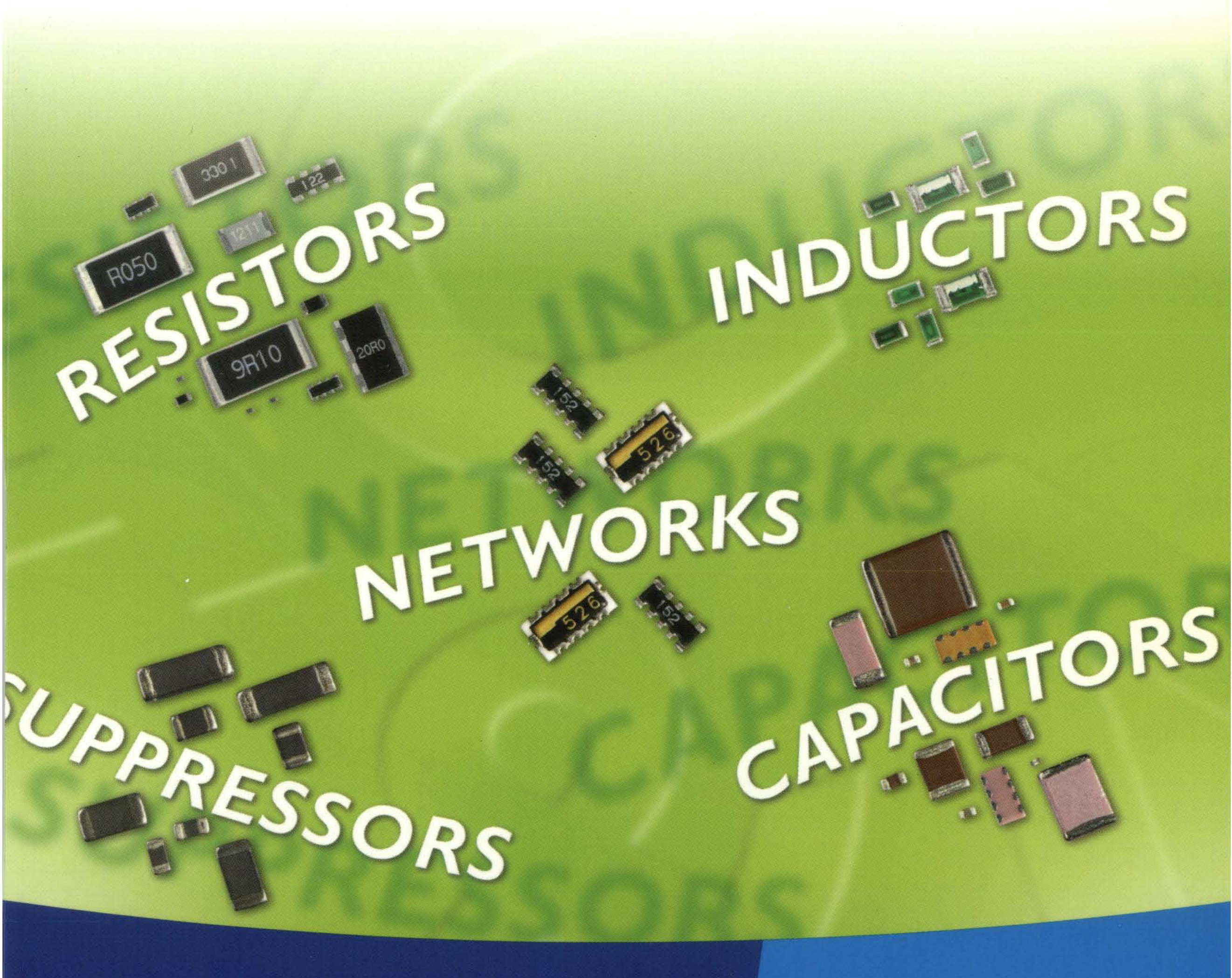
PHILIPS COMPONENTS

Surface Mount Discrete Ceramics

1999/2000

Data Handbook ACM2



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Surface Mount Discrete Ceramics

CONTENTS

DEFINITIONS

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

LIFE SUPPORT APPLICATIONS

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

CAPACITOR INTRODUCTION

Surface mount ceramic multilayer capacitors

GENERAL DATA

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

Ceramic capacitors can be divided into two classes:

- Class 1

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

- Class 2

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

CONSTRUCTION

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

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

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

Figure 2 shows the construction of a multilayer capacitor.

MANUFACTURING OF CERAMIC CAPACITORS

The raw materials are finely milled and carefully mixed. Thereafter the powders are calcined at temperatures between 1 100 and 1 300 °C to achieve the required chemical composition. The resultant mass is reground and dopes and/or sintering means are added.

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

For multilayer capacitors electrode material is printed on the sheets and after stacking and pressing of the sheets cofired with the ceramic compact at temperatures between 1 000 and 1 400 °C.

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

EQUIVALENT CIRCUIT FOR CERAMIC CAPACITORS

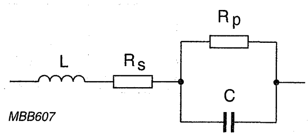


Fig.1 Equivalent circuit.

Definition of symbols; see Fig.1

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

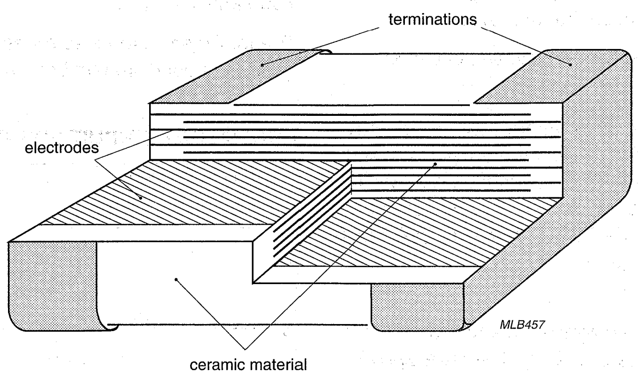


Fig.2 Cross-section of a multilayer capacitor.

TANGENT OF THE LOSS ANGLE

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

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

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

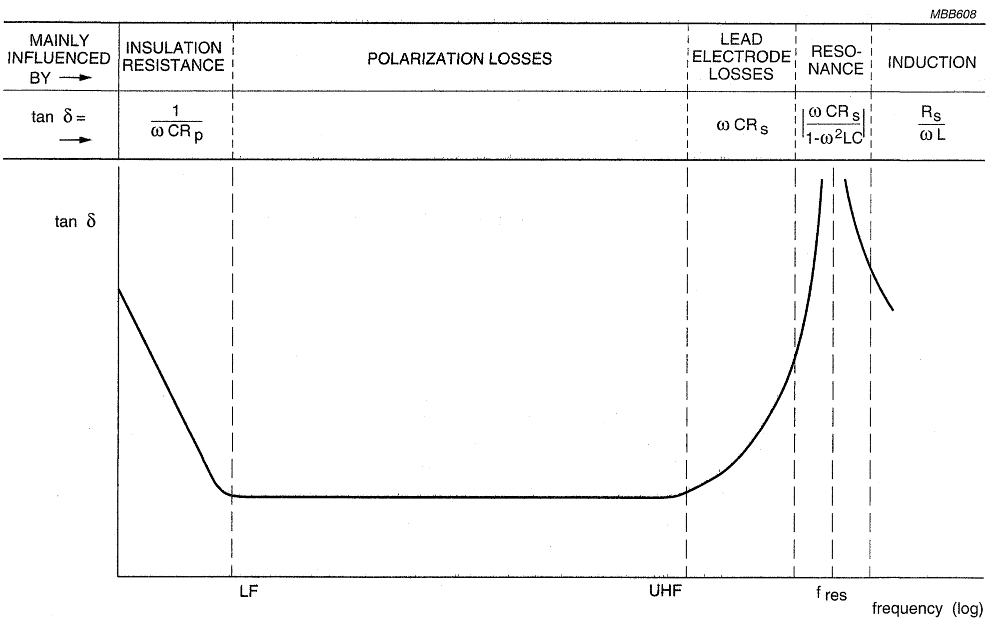


Fig.3 Tan δ as a function of frequency.

RELIABILITY

The failure rates shown in Table 1 have a confidence level of 60% and refer to observations of ceramic multilayer capacitors (CMC) up to and including 1997.

Table 1 Reliability.

CAPACITOR TYPE	NUMBER OF COMPONENT HOURS	FAILURE RATE AT NORMALIZED CONDITIONS
CMC	32130000	2.5 FIT

Remarks

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

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

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

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

GENERAL DATA

PACKAGING

Tape on reel

Packaging conforms fully with *"IEC 60286-3"*, *"EIA 481-1"* and *"JIS C0806"* industrial standards.

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

CARRIER TAPE

Polycarbonate.

Table 1 Properties of carrier tape

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

COVER TAPE

Polyester (antistatic).

Table 2 Properties of cover tape

PARAMETER	WIDTH	
	5.5 ±0.1 mm	**9.5 ±0.1 mm**
Breaking force	≥10.7 N	≥17.6 N
Elongation at break	≥63%	≥63%
Surface resistance	<10^{10} Ω/sq.	<10^{10} Ω/sq.
Softening point	71 ±5 °C	71 ±5 °C
Thickness	62 μm	62 μm

General information

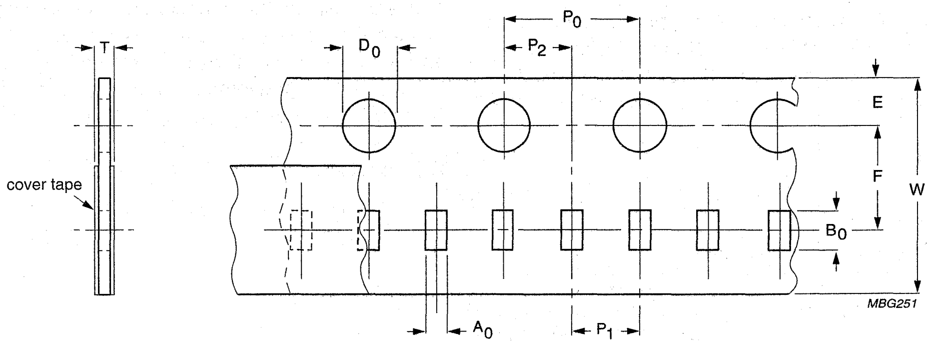
For the combination carrier/cover tape no electrostatic behaviour is observed (relative humidity ≥30%). The products do not stick to the cover tape.

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

Bulk packaging

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

Paper tape specifications



For dimensions see Table 3.

Fig.1 Paper tape.

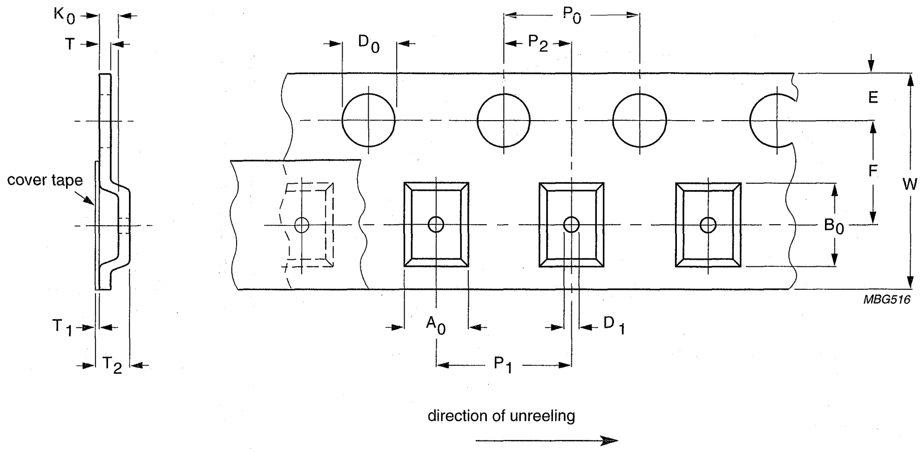
Table 3 Dimensions of paper tape for relevant product size; see Fig.1

SYMBOL	PRODUCT SIZE CODE								UNIT
	0402		0603		0805		1206		
	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	
A_0	0.62	±0.05	1.10	±0.05	1.65	±0.05	2.0	±0.1	mm
B_0	1.12	±0.05	1.90	±0.05	2.40	±0.05	3.5	±0.1	mm
W	8.0	±0.2	8.0	±0.2	8.0	±0.2	8.0	±0.2	mm
E	1.75	±0.1	1.75	±0.1	1.75	±0.1	1.75	±0.1	mm
F	3.5	±0.05	3.5	±0.05	3.5	±0.05	3.5	±0.05	mm
D_0	1.5	+0.1/–0	1.5	+0.1/–0	1.5	+0.1/–0	1.5	+0.1/–0	mm
P_0; note 1	4	±0.05	4	±0.05	4	±0.05	4	±0.05	mm
P_1	2	±0.05	4	±0.1	4	±0.1	4	±0.1	mm
P_2	2	±0.05	2	±0.05	2	±0.05	2	±0.05	mm
T_{max}	0.6	±0.05	0.95	±0.05	0.95	±0.05	0.95	±0.05	mm

Note

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

Blister tape specifications



K_0: so chosen that the orientation of the component cannot change.
For W = 8 mm: T_2 = 3.5 mm max.
For W = 12 mm: T_2 = 6.5 mm max.
For dimensions see Table 4.

Fig.2 Blister tape.

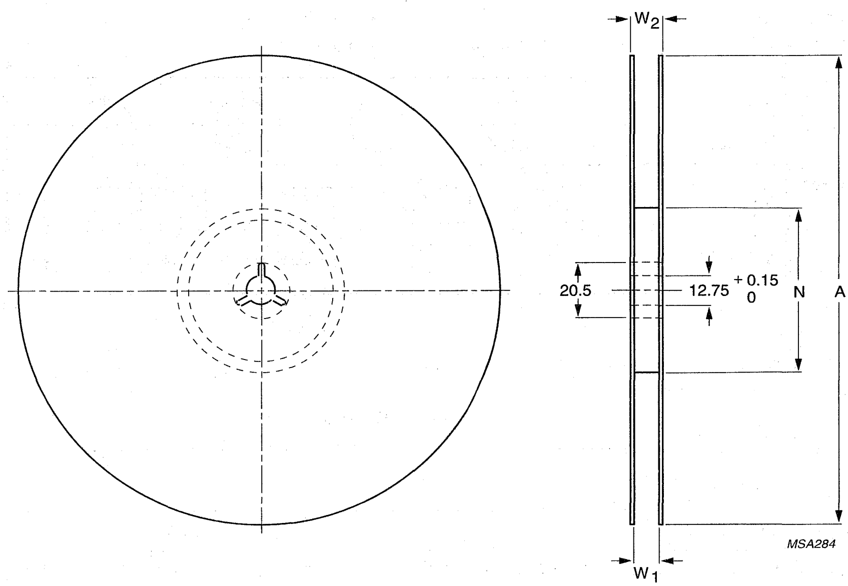
Table 4 Dimensions of blister tape for relevant product size code; see Fig.2

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

Notes

1. Typical capacitor displacement in pocket.
2. P_0 pitch tolerance over any 10 pitches is ±0.2 mm.

Reel specifications



Dimensions in mm.

Fig.3 Reel.

Table 5 Reel dimensions; see Fig.3

TAPE WIDTH (mm)	A (mm)	N (mm)	W_1 (mm)	W_2 MAX. (mm)
8	180	62 ±1.5	8.4 +1.5/–0.0	14.4
8	330	62 ±1.5	8.4 +1.5/–0.0	14.4
12	180	62 ±1.5	12.4 +2/–0.0	18.4

Properties of reel

Material: polystyrene

Surface resistance: $<10^{10}$ Ω/sq.

Leader/trailer tape specification

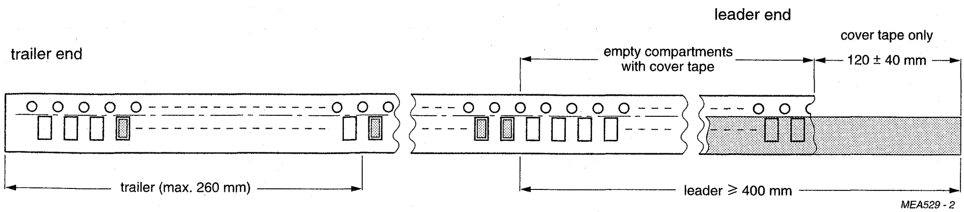


Fig.4 Leader/trailer tape.

Table 6 Leader/trailer tape data

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

Bulk case specification

In accordance with *"IEC 60286-6"*.

Features and benefits:

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

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

SIZE CODE	DIMENSIONS OF CAPACITOR (mm)			QUANTITY
	L_1	W	T	
0402	1.0	0.5	0.5	50000
0603	1.6	0.8	0.8	15000
0805	2.0	1.25	0.6	10000
0805	2.0	1.25	0.9	8000
0805	2.0	1.25	1.25	5000

Note

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

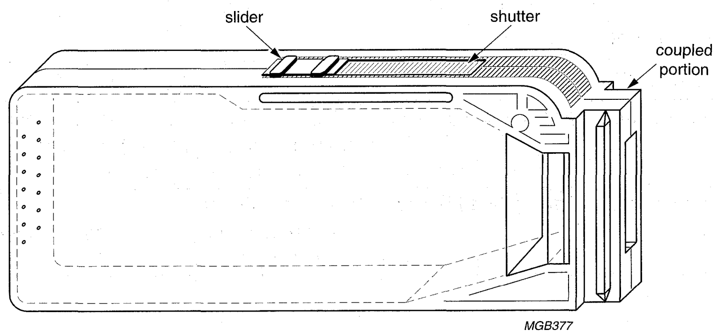


Fig.5 Bulk case outline.

Multi-pack box specification

Features and benefits:

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

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

REEL SIZE (mm)	TAPE SIZE (mm)	QUANTITY PER BOX	
		MIN.	MAX.
∅180	8	5	25
	12	5	10
∅330	8	5	15

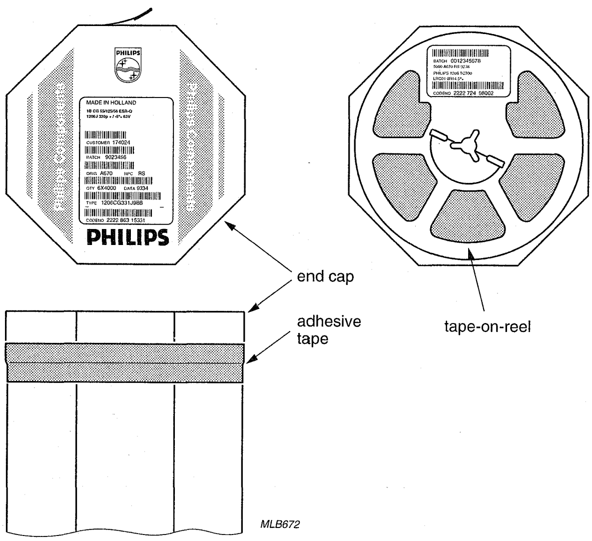
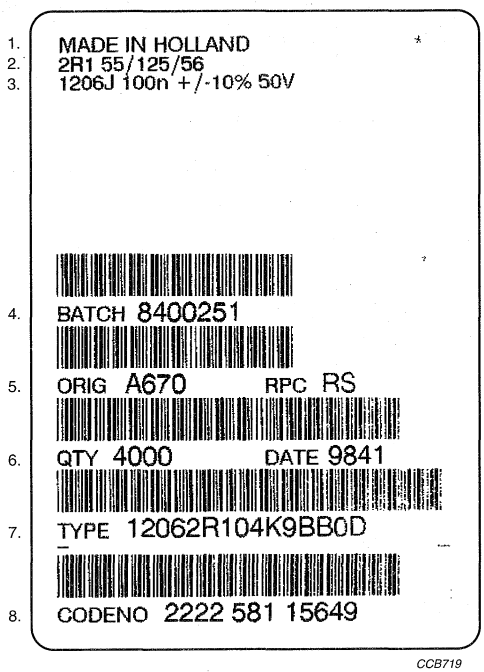


Fig.6 Multi-pack box outline.

Surface mount ceramic multilayer capacitors

LABELLING

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



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

Fig.7 Packaging label (example).

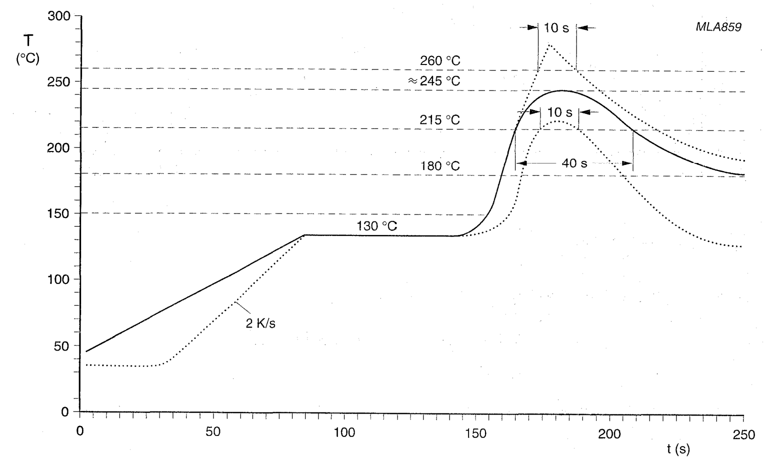
LINE	MARKING EXPLANATION
1.	Unique batch number
2.	Quantity and date code
3.	Material code and climatic category
4.	Size, termination code, value, tolerance and rated voltage
5.	15-digit code
6.	Catalogue number (12NC)

Fig.8 Reel label (example).

METHOD OF MOUNTING AND DIMENSIONS OF SOLDER LANDS

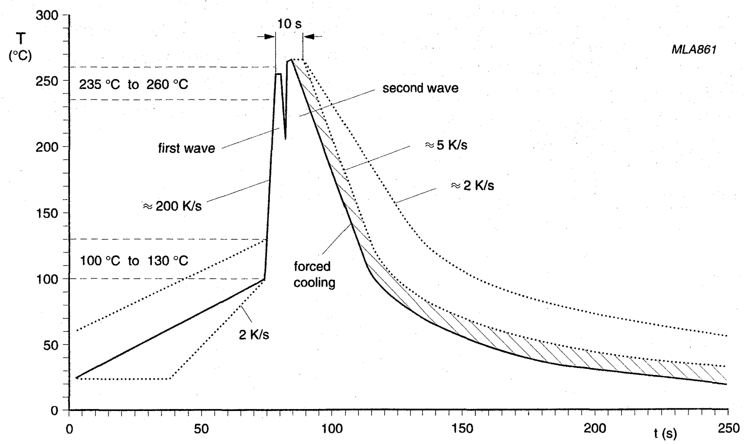
For normal use the capacitors may be mounted on printed-circuit boards or ceramic substrates by applying wave soldering, reflow soldering (including vapour phase soldering) or conductive adhesive in accordance with CECC 00802 classification A. For advised soldering profiles see Figs 9, 10 and 11.

An improper combination of soldering, substrate and chip size can lead to a damaging of the component. The risk increases with the chip size and with temperature fluctuations (>100 °C). Therefore, it is advised to use the smallest possible size and follow the dimensional recommendations given in Tables 9, 10 and 11 for reflow and wave soldering. More detailed information is available on request.



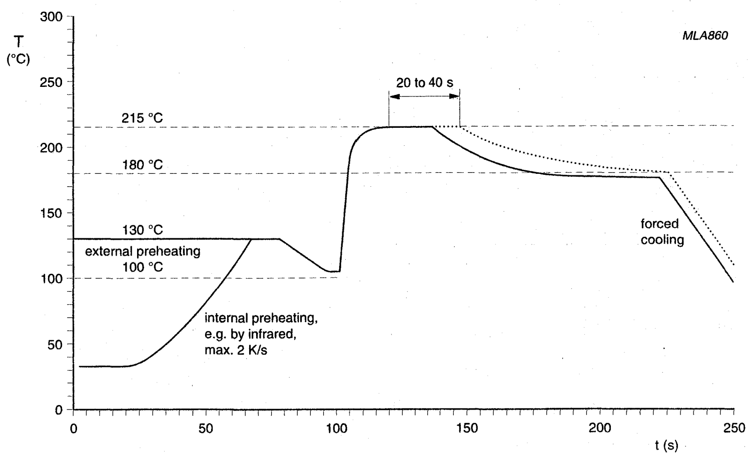
Typical values (solid line).
Process limits (dotted lines).

Fig.9 Reflow soldering.



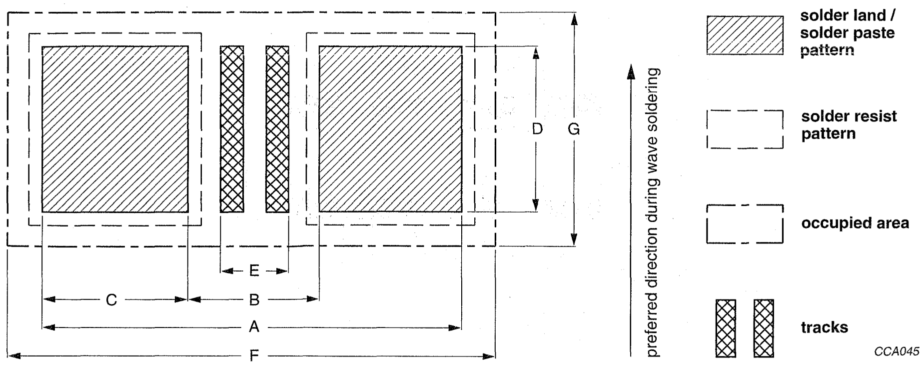
Typical values (solid line).
Process limits (dotted lines).
The capacitors may be soldered twice in accordance with this method if desired.

Fig.10 Double wave soldering.



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

Fig.11 Vapour phase soldering.



E = available track area under the CMC.

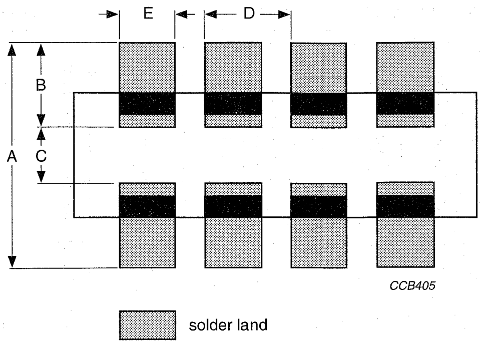
Fig.12 Recommended dimensions of solder lands.

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

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

Table 10 Wave soldering (no dummy tracks allowed for ≥500 V); for dimensions also see Fig.12

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



For dimensions see Table 11.

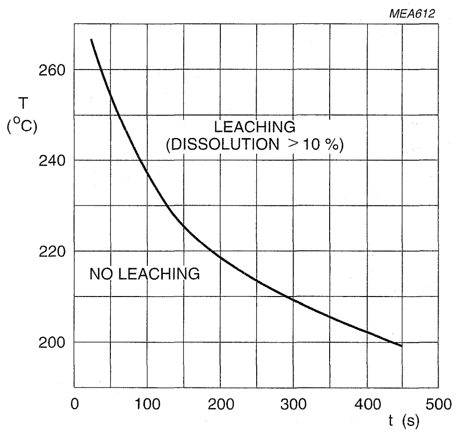
Fig.13 Recommended dimensions of solder lands for C-Array.

Table 11 C-Array solder land dimensions; see Fig.13

CASE SIZE	FOOTPRINT DIMENSIONS (mm)				
	A	B	C	D	E
0612 (4 × 0603)	2.54 ±0.15	0.89 ±0.10	0.76 ±0.10	0.80 ±0.10	0.45 ±0.10

TEST CONDITIONS IN STATIC SOLDER BATH

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



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

Fig.14 Resistance to leaching of AgPd metallized terminations (in static solder bath) at various temperatures.

TESTS AND REQUIREMENTS

Table 12 Test procedures and requirements

IEC 60384-10/ CECC 32 100 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.4		mounting	the capacitors may be mounted on printed-circuit boards or ceramic substrates by applying wave soldering, reflow soldering (including vapour phase soldering) or conductive adhesive	no visible damage
4.5		visual inspection and dimension check	any applicable method using ×10 magnification	in accordance with specification

4.6.1		capacitance	class 1:
			C ≤ 1000 pF, f = 1 MHz;
			C > 1000 pF, f = 1 kHz;
			NP0: measuring voltage
			1 V at 20 °C
			class 2:
			for all capacitors f = 1 kHz;
			X7R: measuring voltage
			1 V at 20 °C
			Y5V/Z5U: measuring voltage
			1 V at 25 °C
				within specified tolerance

4.6.2		tan δ	class 1:
			C ≤ 1000 pF, f = 1 MHz;
			C > 1000 pF, f = 1 kHz;
			NP0: measuring voltage
			1 V at 20 °C
			class 2:
			for all capacitors f = 1 kHz;
			X7R: measuring voltage
			1 V at 20 °C
			Y5V/Z5U: measuring voltage
			1 V at 25 °C
				in accordance with specification

4.6.3		insulation resistance	at U_R (DC) for 1 minute	in accordance with specification
4.6.4		voltage proof	$U_R \leq 100$ V: $2.5 \times U_R$ for 1 minute; $U_R > 100$ V: $1.5 \times U_R$ +100 for 1 minute	no breakdown or flashover
4.7.1		temperature coefficient	class 1: between minimum and maximum temperature	in accordance with specification
4.7.2		temperature characteristic	class 2: between minimum and maximum temperature	in accordance with specification

IEC 60384-10/ CECC 32 100 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.8		adhesion	a force of 5 N applied for 10 s to the line joining the terminations and in a plane parallel to the substrate	no visible damage
4.9		bond strength of plating on end face	mounted in accordance with CECC 32 100, paragraph 4.4	no visible damage
			conditions: bending 1 mm at a rate of 1 mm/s, radius jig. 340 mm	ΔC/C: class 1: within ±10% class 2, X7R: within ±10% class 2, Y5V: within ±30%

4.10	Tb	resistance to soldering heat	260 ±5 °C for 10 ±0.5 s in a static solder bath	the terminations shall be well tinned after recovery
				ΔC/C:
				class 1: within ±0.5% or 0.5 pF whichever is greater
				class 2, X7R:
				>−5% and ≤10%
				class 2, Y5V:
				>−10% and ≤20%

		resistance to leaching	260 ±5 °C for 30 ±1 s in a static solder bath	using visual enlargement of ×10, dissolution of the terminations shall not exceed 10%
4.11	Ta	solderability	zero hour test, and test after storage (20 to 24 months) in original packing in normal atmosphere; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±5 °C	the terminations shall be well tinned

IEC 60384-10/ CECC 32 100 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.12	Na	rapid change of temperature	preconditioning, class 2 only: NP0/X7R: −55 to +125 °C; 5 cycles Y5V: −25 to +85 °C; 5 cycles	no visible damage after 24 hours recovery $\Delta C/C$: class 1: within ±1% or 1 pF class 2, X7R: within ±15% class 2, Y5V: within ±20%

4.14	Ca	damp heat	preconditioning, class 2 only:
			56 days at 40 °C;
			90 to 95% RH; U_R applied (max. 500 V)
				no visual damage
				after recovery
				class 1: 1 to 2 hours
				class 2: 24 hours
				$\Delta C/C$:
				class 1: within ±2% or 1 pF, whichever is greater
				class 2, X7R: within ±15%, ±20%
				class 2, Y5V: within ±30%, +30/−40% (according to Philips specification)
				tan δ:
				class 1: $\leq 2 \times$ specified value
				class 2: X7R: ≤7%
				class 2: Y5V: ≤12.5%, 15% (according to Philips specification)
				R_{ins}:
				class 1:
				2500 MΩ or $R_iC_R \geq 25$ s, whichever is less
				class 2:
				1000 MΩ or $R_iC_R \geq 25$ s, whichever is less

IEC 60384-10/ CECC 32 100 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS

4.15		endurance	preconditioning, class 2 only:
			1000 hours at upper category temperature at:
			$2 \times U_R$ for $U_R \leq 50$ V;
			$1.5 \times U_R$ for other rated voltages
				no visible damage after 24 hours recovery:
				$\Delta C/C$:
				class 1: within ±2% or 1 pF, whichever is greater
				class 2, X7R: within ±20%
				class 2, Y5V: within ±30%, +30/−40% (according to Philips specification)
				tan δ:
				class 1: ≤2 × specified value
				class 2: X7R: ≤7%
				class 2: Y5V: ≤12.5%, 15% (according to Philips specification)
				R_{ins}:
				class 1:
				4000 MΩ or $R_iC_R \geq 40$ s, whichever is less
				class 2:
				2 000 MΩ or $R_iC_R \geq 50$ s, whichever is less

PROGRAMME SURVEY

Product overview

Class 1	NP0 50 V (note)							NP0 100 V					NP0 200 V				NP0 500 V			NP0 1 kV		NP0 3 kV		Class 1
Capacitance (pF)	0402	0603	0805	1206	1210	1812	2220	0603	0805	1206	1210	1812	0805	1206	1210	1812	1206	1210	1812	1812	2220	1808	1812	Capacitance (pF)
0.47	•	•	•	•																				0.47
↕ E12	•	•	•	•																				↕ E12
3.9	•	•	•	•																				3.9
4.7	•	•	•	•																				4.7
5.6	•	•	•	•																				5.6
6.8	•	•	•	•																				6.8
8.2	•	•	•	•																				8.2
10	•	•	•	•				•	•	•			•	•			•					•	•	10
12	•	•	•	•				•	•	•			•	•			•					•	•	12
15	•	•	•	•				•	•	•			•	•			•					•	•	15
18	•	•	•	•				•	•	•			•	•			•					•	•	18
22	•	•	•	•				•	•	•			•	•			•					•	•	22
27	•	•	•	•				•	•	•			•	•			•					•	•	27
33	•	•	•	•				•	•	•			•	•			•					•	•	33
39	•	•	•	•				•	•	•			•	•			•					•	•	39
47	•	•	•	•				•	•	•			•	•			•	•				•	•	47
56	•	•	•	•				•	•	•			•	•			•	•					•	56
68	•	•	•	•				•	•	•			•	•			•	•					•	68
82	•	•	•	•				•	•	•			•	•			•	•					•	82
100	•	•	•	•				•	•	•			•	•			•	•		•	•		•	100
120	•	•	•	•				•	•	•			•	•			•	•		•	•			120
150	•	•	•	•				•	•	•			•	•			•	•		•	•			150
180	•	•	•	•				•	•	•			•	•			•	•		•	•			180
220	•	•	•	•				•	•	•			•	•			•	•		•	•			220
270		•	•	•				•	•	•			•	•			•	•		•	•			270
330		•	•	•				•	•	•			•	•			•	•		•	•			330
390		•	•	•				•	•	•			•	•			•	•		•	•			390
470		•	•	•				•	•	•			•	•			•	•		•	•			470
560		•	•	•				•	•	•			•	•			•	•		•	•			560
680		•	•	•				•	•	•				•			•	•		•	•			680
820		▲	•	•					•	•				•			•	•		•	•			820
1 000		▲	•	•	•				•	•				•			•	•		•	•			1 000
1 200		▲	•	•	•				•	•				•				•		•	•			1 200
1 500			•	•	•				•	•				•				•		•	•			1 500
1 800			•	•	•				•	•					•			•			•			1 800
2 200			•	•	•	•			•	•					•				•		•			2 200
2 700			•	•	•	•			•	•					•				•		•			2 700
3 300			▲	•	•	•				•					•				•		•			3 300
3 900			▲	•	•	•				•						•								3 900
4 700			▲	•	•	•				•						•								4 700
5 600			▲	•	•	•				•						•								5 600
6 800				•	•	•				•														6 800
8 200				▲	•	•					•													8 200
10 000				▲	•	•	•				•													10 000
12 000				▲	▲	•	•					•												12 000
15 000				▲	▲	•	•					•												15 000
18 000					▲	•	•					•												18 000
22 000					▲	•	•					•												22 000
27 000						▲	•																	27 000
33 000						▲	•																	33 000
39 000							•																	39 000
47 000							•																	47 000
56 000							▲																	56 000
68 000							▲																	68 000
82 000							▲																	82 000
100 000							▲																	100 000

• = Standard technology, noble metal electrode type

▲ = Compact technology, noble metal electrode type

note: Compact series meet IEC 60063 V

CCA598

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

Class 2	X7R 10 V			X7R 16 V				X7R 25 V							X7R 50 V (note)							X7R 50 V LI	X7R 100 V				X7R 200 V				X7R 500V			X7R 1 kV		Class 2
C (pF)	0603	0805	1206	0402	0603	0805	1206	0402	0603	0805	1206	1210	1812	2220	0402	0603	0805	1206	1210	1812	2220	0612	0805	1206	1210	1812	0805	1206	1210	1812	1206	1210	1812	1808	1812	C (nF)
100															•	•■																				0.1
120															•	•■																				0.12
150															•	•■																				0.15
180															•	•■	•■						•				•									0.18
220															•	•■	•■	•■					•	•			•									0.22
270															•	•■	•■	•■					•	•			•									0.27
330															•	•■	•■	•■					•	•			•									0.33
390															•	•■	•■	•■					•	•			•									0.39
470															•	•■	•■	•■					•	•			•				•					0.47
560															•	•■	•■	•■					•	•			•				•					0.56
680															•	•■	•■	•■					•	•			•	•			•					0.68
820															•	•■	•■	•■					•	•			•	•			•					0.82
1000															•	•■	•■	•■					•	•			•	•			•			•	•	1
1200															•	•■	•■	•■					•	•			•	•			•			•	•	1.2
1500															•	•■	•■	•■					•	•			•	•			•			•	•	1.5
1800															•	•■	•■	•■					•	•			•	•			•			•	•	1.8
2200															•	•■	•■	•■					•	•			•	•			•			•	•	2.2
2700															•	•	•■	•■					•	•			•	•				•		•	•	2.7
3300								•							•	•	•■	•■					•	•			•	•				•		•	•	3.3
3900								•								•	•■	•■					•	•			•	•				•			•	3.9
4700				•				•								•	•■	•■					•	•			•	•				•			•	4.7
5600				•												•	•■	•■					•	•			•	•				•			•	5.6
6800				•												•	•■	•■					•	•			•	•				•			•	6.8
8200				•												•	•■	•■					•	•			•	•				•			•	8.2
10 000				•					•■	•■						•	•■	•■	•■			■	•	•				•					•		•	10
12 000				•					•■	•■						•	•■	•■	•■			■	•	•				•					•			12
15 000				•					•■	•■						•	•■	•■	•■			■	•	•				•					•			15
18 000				•					•■	•■						•	•■	•■	•■			■	•	•				•								18
22 000				•	•■				•■	•■							•■	•■	•■			■	•	•				•	•							22
27 000					•■				•■	•■							•■	•■	•■				•	•				•	•							27
33 000					•■					•■							•■	•■	•■					•					•							33
39 000					•■					•■							•■	•■	•■					•					•							39
47 000					•■	•■				•■							•■	•■	•■					•	•				•	•						47
56 000					•■	•■				•■							•■	•■	•■					•	•				•	•						56
68 000					•■	•■				•■							•■	•■	•■					•	•					•						68
82 000					•■	•■				•■							•■	•■	•■					•	•					•						82
100 000					•■	•■				•■	•■						•■	•■	•■	•■				•	•	•				•						100
120 000						•■				▲	•■							•■	•■	•■					•	•				•						120
150 000	■					•■					•■							•■	•■	•■					•	•										150
180 000	■					•■					•■							•■	•■	•■						•										180
220 000	■	■				•■	•■				•■	•■						•■	•■	•■	•■					•										220
270 000		■				•■	•■				•■	•■							▲	•■	•■					•										270
330 000		■				•■	•■				•■	•■							▲	•■	•■					•										330
390 000		■				•■	•■				▲	•■							▲	•■	•■															390
470 000		■				•■	•■				▲	•■							▲	•■	•■															470
560 000		■					•■					▲							▲	▲	•■															560
680 000		■					•■					▲								▲	•■															680
820 000		■					•■					▲	▲							▲	•■															820
1 000 000		■	■				•■					▲	▲							▲	•■															1 000
1 200 000			■				▲						▲								▲															1 200
1 500 000			■				▲						▲								▲															1 500
1 800 000			■										▲								▲															1 800
2 200 000			■											▲							▲															2 200
2 700 000														▲																						2 700
3 300 000														▲																						3 300
3 900 000														▲																						3 900
4 700 000														▲																						4 700

• = Standard technology, noble metal electrode type
■ = Standard technology, base metal electrode type
▲ = Compact technology, noble metal electrode type
LI = Low Inductance

note: Compact series meet IEC 60063 V

CCA599

Fig.2 Class 2, X7R general purpose and high voltage.

Class 2	Y5V 10 V			Y5V 16 V				Y5V 25 V			Y5V 50 V			Z5U 25 V		Z5U 50 V			Class 2
Capacitance (µF)	0603	0805	1206	0402	0603	0805	1206	0603	0805	1206	0603	0805	1206	0603	1206	0805	1206	1210	Capacitance (nF)
0.010				■				■			■	■		■		■	■		10
0.012														■		■	■		12
0.015				■				■			■	■		■		■	■		15
0.018														■		■	■		18
0.022				■				■			■	■		■		■	■		22
0.027														■		■	■		27
0.033				■				■			■	■		■		■	■		33
0.039														■		■	■		39
0.047				■				■			■	■		■		■	■		47
0.056														■		■	■		56
0.068				■				■			■	■		■		■	■		68
0.082														■		■	■		82
0.10				■				■	■	■	■	■	■	■		■	■	■	100
0.12																■	■	■	120
0.15					■				■	■		■	■			■	■	■	150
0.18																■	■	■	180
0.22					■				■	■		■	■			■	■	■	220
0.27																	■	■	270
0.33					■				■	■		■	■				■	■	330
0.39																	■	■	390
0.47					■	■				■			■		■		■	■	470
0.56															■			■	560
0.68						■				■			■		■			■	680
0.82															■			■	820
1.0	■		■			■	■			■			■		■			■	1000
1.2																			1200
1.5			■			■	■												1500
1.8																			1800
2.2		■	■			■	■												2200
2.7																			2700
3.3		■	■				■												3300
3.9																			3900
4.7			■				■												4700
5.6																			5600
6.8			■																6800
8.2																			8200
10			■																10000

■ = Standard technology, base metal electrode type

CCA600

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

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

CCA714

Fig.4 Class 1, NP0 microwave.

Class 1	NP0 25 V				
C (pF)	0402	0603	0805	1206	1210
220	▲				
270	▲				
330	▲				
390					
470					
560					
680					
820		•			
1 000		•			
1 200		•			
1 500		•			
1 800					
2 200					
2 700					
3 300			•		
3 900			•		
4 700			•		
5 600					
6 800					
8 200				•	
10 000				•	
12 000					•
15 000					•
18 000					•
22 000					•

• = Standard technology, noble metal electrode type
▲ = Compact technology, noble metal electrode type

CCB775

Fig.5 Class 1, NP0 25 V.

Class 1	NP0 50/63 V
Capacitance (pF)	4 × 0603
22	•
27	•
33	•
39	•
47	•
56	•
68	•
82	•
100	•
120	•
150	•
180	•
220	•
270	•
330	•
390	•
470	•
560	•
680	•
820	•
1000	•

CCA715

Fig.6 C-Array Class 1, NP0.

Class 1

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

CCA713

Fig.7 Class 1, NP0 narrow tolerance.

Class 2

Capacitance (nF)	X7R 16 V 4 × 0603	X7R 25 V 4 × 0603	X7R 50 V 4 × 0603
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			

CCA805

Fig.8 C-Array Class 2, X7R.

Class 2

Capacitance (nF)	X7R 16 V 4 × 0603	Y5V 25 V 4 × 0603
10	■	■
12	■	■
15	■	■
18	■	■
22	■	■
27	■	■
33	■	■
39	■	■
47	■	■
56	■	■
68	■	■
82	■	■
100	■	■

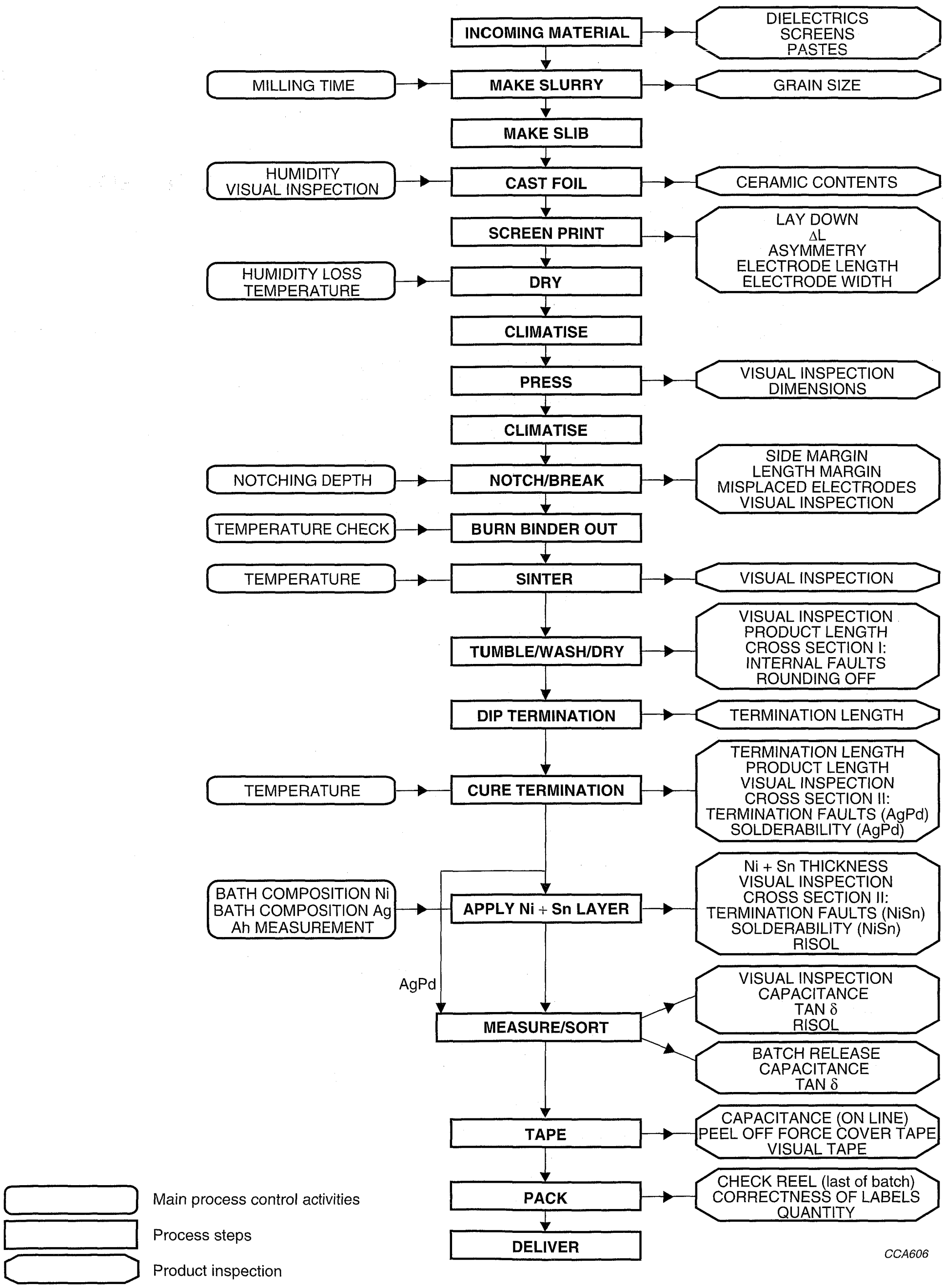
CCB774

Fig.9 C-Array, X7R and Y5V Base Metal Electrode.

NUMERICAL INDEX

Sequence of catalogue numbers in accordance with the “12-DIGIT CODE”

SERIES	DESCRIPTION	TERMINATION	PAGE
2222 550.6	X7R 10 V, Compact	Ni-barrier	142
2222 57	NP0 50 V, Microwave	Ni-barrier	68
2222 58..5	X7R 50 V	Ni-barrier	92
2222 58..6	X7R 50 V, NME	Ni-barrier	104
2222 58..9	Y5V 50 V	Ni-barrier	124
2222 595.6	X7R 50 V, NME (size 2220)	AgPd	104
2222 60..1	NP0 100 V, NME	Ni-barrier	42
2222 60..6	X7R 100 V, NME	Ni-barrier	104
2222 615.1	NP0 100 V, NME (size 2220)	AgPd	42
2222 62..8	Z5U 50 V	Ni-barrier	136
2222 78..6	X7R 16 V, NME	Ni-barrier	104
2222 78..9	Y5V 16 V	Ni-barrier	124
2222 86	NP0 50 V, NME	Ni-barrier	42
2222 866	NP0 50 V, NME (size 2220)	AgPd	42
2222 87..6	X7R 25 V, Compact	Ni-barrier	142
2222 877.0	NP0 25 V, Compact (size 0402)	Ni-barrier	140
2222 885	X7R 25 V, Compact (size 2220)	Ni-barrier	142
2222 89..0	NP0 50 V/63 V, Compact	Ni-barrier	142
2222 89..6	X7R 50 V/63 V, Compact	Ni-barrier	142
2222 90..0	NP0 50 V/63 V, Compact	AgPd	142
2222 905.6	X7R 50 V/63 V, Compact	AgPd	142
2222 91..5	X7R 25 V	Ni-barrier	92
2222 91..6	X7R 25 V, NME	Ni-barrier	104
2222 91..9	Y5V 25 V	Ni-barrier	124
2222 93..1	NP0 200 V, NME	Ni-barrier	42
2222 93..6	X7R 200 V, NME	Ni-barrier	104
2222 95	X7R 16 V, Compact	Ni-barrier	142
2222 964	X7R 16 V, Compact (size 1812)	AgPd	142
2222 97..1	NP0 500 V, NME	Ni-barrier	42
2222 97..6	X7R 500 V, NME	Ni-barrier	104
2238 57	NP0 50 V, Microwave	Ni-barrier	68
2238 58..5	X7R 50 V	Ni-barrier	92
2238 58..6	X7R 50 V, NME	Ni-barrier	104
2238 58..9	Y5V 50 V	Ni-barrier	124
2238 60..1	NP0 100 V, NME	Ni-barrier	42
2238 60	X7R 100 V, NME	Ni-barrier	104
2238 62	Z5U 50 V	Ni-barrier	136
2238 78..6	X7R 16 V, NME	Ni-barrier	104


INCOMING MATERIAL
DIELECTRICS
SCREENS
PASTES
MILLING TIME
MAKE SLURRY
GRAIN SIZE
MAKE SLIB
HUMIDITY
VISUAL INSPECTION
CAST FOIL
CERAMIC CONTENTS
SCREEN PRINT
LAY DOWN
ΔL
ASYMMETRY
ELECTRODE LENGTH
ELECTRODE WIDTH
HUMIDITY LOSS
TEMPERATURE
DRY
CLIMATISE
PRESS
VISUAL INSPECTION
DIMENSIONS
CLIMATISE
NOTCHING DEPTH
NOTCH/BREAK
SIDE MARGIN
LENGTH MARGIN
MISPLACED ELECTRODES
VISUAL INSPECTION
TEMPERATURE CHECK
BURN BINDER OUT
TEMPERATURE
SINTER
VISUAL INSPECTION
TUMBLE/WASH/DRY
VISUAL INSPECTION
PRODUCT LENGTH
CROSS SECTION I:
INTERNAL FAULTS
ROUNDING OFF
DIP TERMINATION
TERMINATION LENGTH
TEMPERATURE
CURE TERMINATION
TERMINATION LENGTH
PRODUCT LENGTH
VISUAL INSPECTION
CROSS SECTION II:
TERMINATION FAULTS (AgPd)
SOLDERABILITY (AgPd)
BATH COMPOSITION Ni
BATH COMPOSITION Ag
Ah MEASUREMENT
APPLY Ni + Sn LAYER
Ni + Sn THICKNESS
VISUAL INSPECTION
CROSS SECTION II:
TERMINATION FAULTS (NiSn)
SOLDERABILITY (NiSn)
RISOL
AgPd
MEASURE/SORT
VISUAL INSPECTION
CAPACITANCE
TAN δ
RISOL
BATCH RELEASE
CAPACITANCE
TAN δ
TAPE
CAPACITANCE (ON LINE)
PEEL OFF FORCE COVER TAPE
VISUAL TAPE
PACK
CHECK REEL (last of batch)
CORRECTNESS OF LABELS
QUANTITY
DELIVER
Main process control activities
Process steps
Product inspection
CCA606

CAPACITOR PRODUCT DATA

Surface mount ceramic multilayer capacitors

Class 1, NP0 25 V Noble Metal Electrode

FEATURES

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

APPLICATIONS

- Consumer electronics
- Telecommunications
- Automotive
- Data processing.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	25 V (IEC)
Capacitance range (E12 series); Class 1, subclass 1B, letter code CG (NP0):	
case size 0603	820 pF to 1.5 nF
case size 0805	3.3 nF to 4.7 nF
case size 1206	8.2 nF to 10 nF
case size 1210	12 nF to 22 nF
Tolerance on capacitance at T_{amb} = 20 °C	±10%, ±5%, ±2% and ±1%
Test voltage (DC) for 1 minute	2.5 × U_R
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

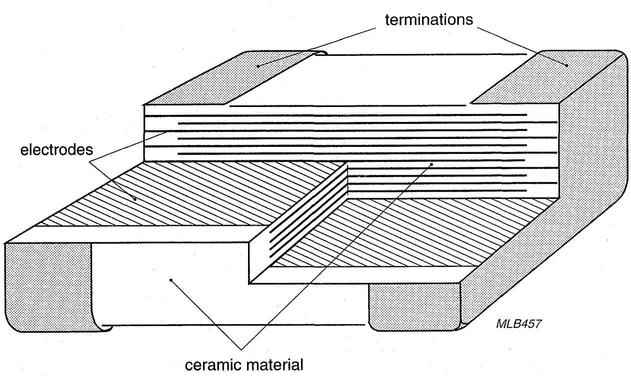
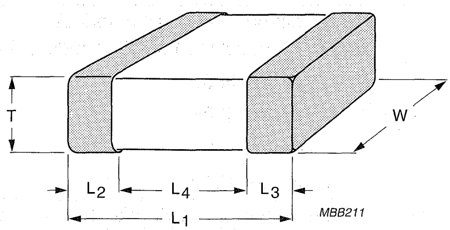


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T MIN.	T MAX.	L_2 and L_3 MIN.	L_2 and L_3 MAX.	L_4 MIN.
Dimensions in millimetres							
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
Dimensions in inches							
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056

SELECTION CHART FOR 25 V

<table>
<tr><th rowspan="2">C (pF)</th><th rowspan="2">LAST TWO DIGITS OF 12NC</th><th colspan="4">25 V</th></tr>
<tr><th>0603</th><th>0805</th><th>1206</th><th>1210</th></tr>
<tr><td>820</td><td>48</td><td rowspan="4">0.8 ±0.07</td><td rowspan="7"></td><td rowspan="12"></td><td rowspan="14"></td></tr>
<tr><td>1000</td><td>49</td></tr>
<tr><td>1200</td><td>51</td></tr>
<tr><td>1500</td><td>52</td></tr>
<tr><td>1800</td><td>53</td><td rowspan="11"></td></tr>
<tr><td>2200</td><td>54</td></tr>
<tr><td>2700</td><td>55</td></tr>
<tr><td>3300</td><td>56</td><td>0.85 ±0.1</td></tr>
<tr><td>3900</td><td>57</td><td rowspan="2">1.25 ±0.1</td></tr>
<tr><td>4700</td><td>58</td></tr>
<tr><td>5600</td><td>59</td><td rowspan="5"></td></tr>
<tr><td>6800</td><td>61</td></tr>
<tr><td>8200</td><td>62</td><td rowspan="2">0.85 ±0.1</td></tr>
<tr><td>10000</td><td>63</td></tr>
<tr><td>12000</td><td>64</td><td></td><td rowspan="3">0.5 to 1.0</td></tr>
<tr><td>15000</td><td>65</td><td colspan="3">Values in shaded cells indicate thickness classification.</td></tr>
<tr><td>18000</td><td>66</td><td></td><td></td><td></td></tr>
<tr><td>22000</td><td>67</td><td></td><td></td><td></td><td>0.9 to 1.3</td></tr>
</table>

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE	
	∅180 mm; 7"		∅330 mm; 13"			
	PAPER	BLISTER	PAPER	BLISTER	0603	0805
0.8 ±0.07	4000	4000	20000	10000	15000	10000
0.85 ±0.1	4000	4000	15000	10000	–	8000
0.5 to 1.0	–	4000	–	10000	–	–
0.9 to 1.3	–	3000	–	10000	–	–
1.25 ±0.1	–	3000	–	10000	–	5000

ORDERING INFORMATION FOR 25 V

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

Clear text code

EXAMPLE: 0805CG102J8B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206 1210	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	F ±1% G ±2% J ±5% K ±10%	8 = 25 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking	0 = conv. ceramic

Ordering code 12NC

2 2 X X 9 1 X X 1 X X X

Carrier type
22 blister(2)
38 paper
54 bulk

Size - Termination
6 0603 Ni-barrier
0 0805 Ni-barrier
1 1206 Ni-barrier
2 1210 Ni-barrier

Packaging(3)
1 reel: ∅180 mm
5 reel: ∅330 mm
4 bulk case (sizes 0603 and 0805 only)

Capacitance value(1)

Tolerance
3 1%
4 2%
5 5%
6 10%

CCB106

(1) Refer to Chapter "Selection chart for 25 V".
(2) Blister tape only for products with a thickness >1 mm.
(3) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

ELECTRICAL CHARACTERISTICS

Class 1 capacitors; NP0 dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); Class 1, subclass 1B, letter code CG (NP0):	
case size 0603	820 pF to 1.5 nF
case size 0805	3.3 nF to 4.7 nF
case size 1206	8.2 nF to 10 nF
case size 1210	12 nF to 22 nF
Tolerance on capacitance after 1 000 hours	±10%, ±5%, ±2% and ±1%
Tan δ	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 100$ GΩ
Temperature coefficient	$(0 \pm 30) \times 10^{-6}$/K

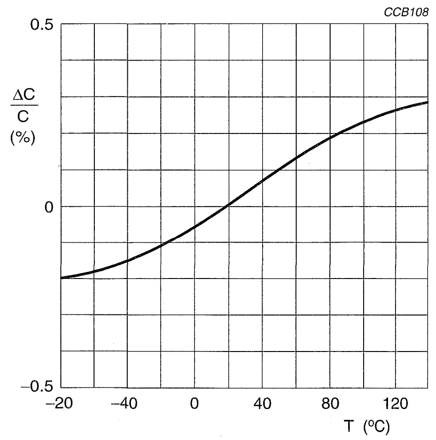


Fig.3 Typical capacitance change as a function of temperature.

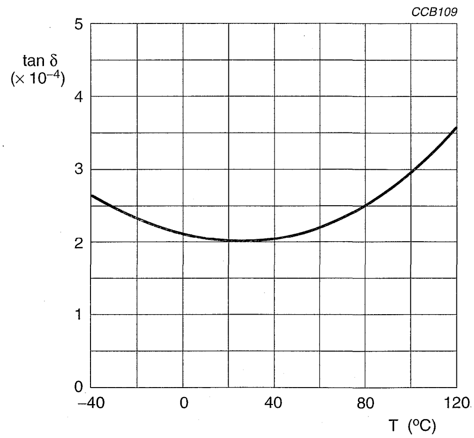


Fig.4 Typical tan δ as a function of temperature.

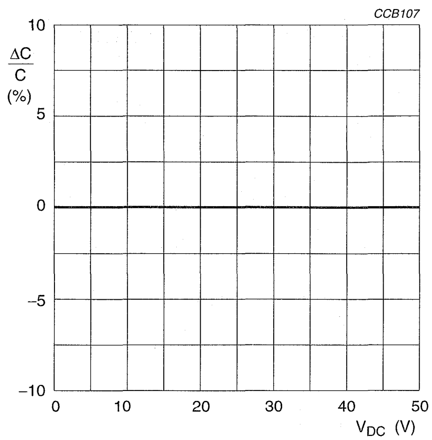


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

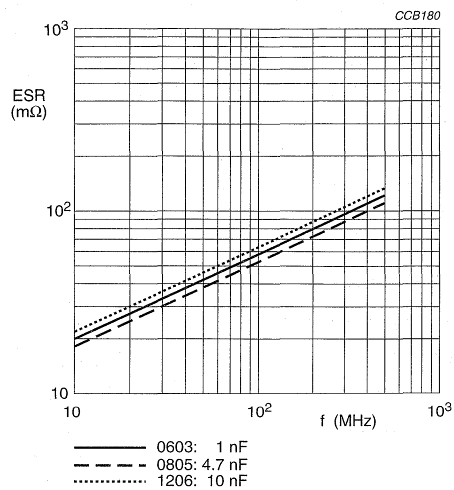


Fig.6 Typical ESR as a function of frequency.

Surface mount ceramic multilayer capacitors

Class 1, NP0 50/100/200/500 V Noble Metal Electrode

TFEATURES

- Seven standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case (case sizes 0402, 0603 and 0805 only)
- For high frequency applications
- NiSn terminations (AgPd on request).

APPLICATIONS

- Consumer electronics
- Telecommunications
- Automotive
- Data processing.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V, 100 V, 200 V and 500 V (IEC)
Capacitance range (E12 series); note 1:	
50 V; note 2	0.47 pF to 47000 pF
100 V	10 pF to 22 nF
200 V	10 pF to 5600 pF
500 V	10 pF to 3300 pF
Tolerance on capacitance:	
C ≥ 10 pF	±10%, ±5%, ±2%
C < 10 pF	±0.5 pF, ±0.25 pF
Test voltage (DC) for 1 minute:	
50 V and 100 V	2.5 × U_R
200 V	3 × U_R
500 V	2 × U_R
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Notes

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

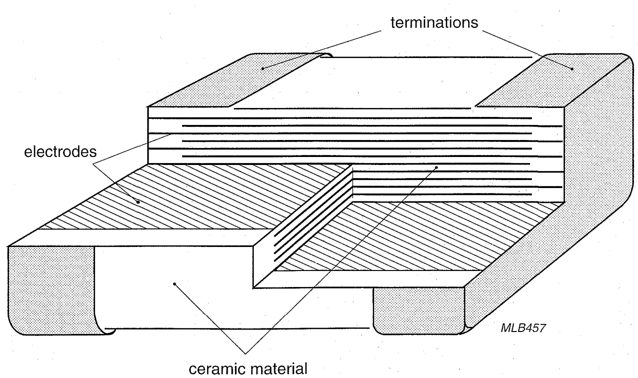
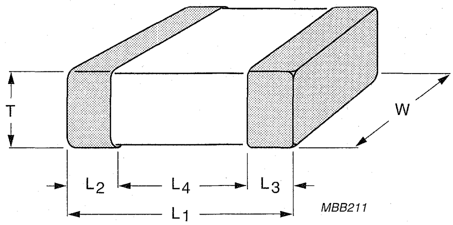


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T		L_2 and L_3		L_4 MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0402	1.0 ±0.05	0.5 ±0.05	0.45	0.55	0.20	0.30	0.40
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.80	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	1.80	0.25	0.75	2.90
Dimensions in inches							
0402	0.040 ±0.002	0.020 ±0.002	0.018	0.022	0.008	0.012	0.016
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056
1812	0.177 ±0.008	0.126 ±0.008	0.020	0.072	0.010	0.030	0.088
2220	0.224 ±0.008	0.197 ±0.008	0.020	0.072	0.010	0.030	0.114

SELECTION CHART FOR 50 V

<table>
<tr><th rowspan="2">C (pF)</th><th rowspan="2">LAST THREE DIGITS OF 12NC</th><th colspan="7">50 V</th></tr>
<tr><th>0402</th><th>0603</th><th>0805</th><th>1206</th><th>1210</th><th>1812</th><th>2220</th></tr>
<tr><td>0.47</td><td>477</td><td rowspan="33">0.5 ±0.05</td><td rowspan="39">0.8 ±0.07</td><td rowspan="41">0.6 ±0.1</td><td rowspan="46">0.6 ±0.1</td><td rowspan="40"></td><td rowspan="44"></td><td rowspan="52"></td></tr>
<tr><td>0.56</td><td>567</td></tr>
<tr><td>0.68</td><td>687</td></tr>
<tr><td>0.82</td><td>827</td></tr>
<tr><td>1.0</td><td>108</td></tr>
<tr><td>1.2</td><td>128</td></tr>
<tr><td>1.5</td><td>158</td></tr>
<tr><td>1.8</td><td>188</td></tr>
<tr><td>2.2</td><td>228</td></tr>
<tr><td>2.7</td><td>278</td></tr>
<tr><td>3.3</td><td>338</td></tr>
<tr><td>3.9</td><td>398</td></tr>
<tr><td>4.7</td><td>478</td></tr>
<tr><td>5.6</td><td>568</td></tr>
<tr><td>6.8</td><td>688</td></tr>
<tr><td>8.2</td><td>828</td></tr>
<tr><td>10</td><td>109</td></tr>
<tr><td>12</td><td>129</td></tr>
<tr><td>15</td><td>159</td></tr>
<tr><td>18</td><td>189</td></tr>
<tr><td>22</td><td>229</td></tr>
<tr><td>27</td><td>279</td></tr>
<tr><td>33</td><td>339</td></tr>
<tr><td>39</td><td>399</td></tr>
<tr><td>47</td><td>479</td></tr>
<tr><td>56</td><td>569</td></tr>
<tr><td>68</td><td>689</td></tr>
<tr><td>82</td><td>829</td></tr>
<tr><td>100</td><td>101</td></tr>
<tr><td>120</td><td>121</td></tr>
<tr><td>150</td><td>151</td></tr>
<tr><td>180</td><td>181</td></tr>
<tr><td>220</td><td>221</td></tr>
<tr><td>270</td><td>271</td><td rowspan="18"></td></tr>
<tr><td>330</td><td>331</td></tr>
<tr><td>390</td><td>391</td></tr>
<tr><td>470</td><td>471</td></tr>
<tr><td>560</td><td>561</td></tr>
<tr><td>680</td><td>681</td></tr>
<tr><td>820</td><td>821</td><td rowspan="12"></td></tr>
<tr><td>1000</td><td>102</td><td rowspan="13">0.5 to 1.0</td></tr>
<tr><td>1200</td><td>122</td><td rowspan="3">0.85 ±0.1</td></tr>
<tr><td>1500</td><td>152</td></tr>
<tr><td>1800</td><td>182</td></tr>
<tr><td>2200</td><td>222</td><td rowspan="2">1.25 ±0.1</td><td rowspan="10">0.5 to 1.0</td></tr>
<tr><td>2700</td><td>272</td></tr>
<tr><td>3300</td><td>332</td><td rowspan="5"></td><td rowspan="3">0.85 ±0.1</td></tr>
<tr><td>3900</td><td>392</td></tr>
<tr><td>4700</td><td>472</td></tr>
<tr><td>5600</td><td>562</td><td rowspan="2">1.15 ±0.1</td></tr>
<tr><td>6800</td><td>682</td></tr>
<tr><td>8200</td><td>822</td><td colspan="4" rowspan="2">Values in shaded cells indicate thickness classification.</td></tr>
<tr><td>10000</td><td>103</td><td rowspan="2">0.5 to 1.0</td></tr>
<tr><td>12000</td><td>123</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

C (pF)	LAST THREE DIGITS OF 12NC	50 V						
		0402	0603	0805	1206	1210	1812	2220
15000	153						0.5 to 1.0	0.5 to 1.0
18000	183						0.9 to 1.3	
22000	223							
27000	273							
33000	333							
39000	393							
47000	473							0.9 to 1.3

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE		
	∅180 mm; 7"		∅330 mm; 13"		∅180 mm; 7" BLISTER				
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805
0.5 ±0.05	10000	–	50000	–	–	–	50000	–	–
0.6 ±0.1	4000	4000	20000	10000	–	–	–	–	10000
0.85 ±0.1	4000	4000	15000	10000	–	–	–	–	8000
0.5 to 1.0	–	4000	–	10000	2000	1500	–	–	–
0.8 ±0.07	4000	4000	15000	15000	–	–	–	15000	–
0.9 to 1.3	–	3000	–	10000	1500	–	–	–	–
1.15 ±0.1	–	3000	–	10000	–	–	–	–	–
1.25 ±0.1	–	3000	–	10000	–	–	–	–	5000

ORDERING INFORMATION FOR 50 V

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

Clear text code

EXAMPLE: 0805CG102J9B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402 0603 0805 1206 1210 1812 2220 (AgPd only)	CG = NP0	102 = 1 000 pF; the third digit signifies the number of zeros	C ±0.25 pF D ±0.5 pF F ±1% G ±2% J ±5% K ±10%	9 = 50 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

2 2 X X 8 6 X X X X X X

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Size
- 9 0402
- 7 0603
- 1 0805
- 3 1206
- 2 1210
- 5 1812
- 6 2220 (AgPd only)

Packaging(2)
- 1 reel: ∅180 mm; 7"
- 7 reel: ∅330 mm; 13"
- 4 bulk case

Capacitance value(1)

Tolerance

NiSn terminations
- 4 ±0.25 pF for C = 5.6 to 8.2 pF; ±2% for C ≥ 10 pF
- 5 ±0.25 pF for C = 0.47 to 4.7 pF; ±0.5 pF for C = 5.6 to 8.2 pF; ±5% for C ≥ 10 pF
- 6 ±10% for C ≥ 10 pF

AgPd terminations
- 1 ±0.25 pF for C = 5.6 to 8.2 pF; ±2% for C ≥ 10 pF
- 2 ±0.25 pF for C = 0.47 to 4.7 pF; ±0.5 pF for C = 5.6 to 8.2 pF; ±5% for C ≥ 10 pF
- 3 ±10% for C ≥ 10 pF

CCA622

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

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

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SELECTION CHART FOR 100 V

C (pF)	LAST TWO DIGITS OF 12NC	100 V 0603	100 V 0805	100 V 1206	100 V 1210	100 V 1812
10	23					
12	24					
15	25					
18	26					
22	27					
27	28					
33	29					
39	31					
47	32					
56	33					
68	34					
82	35	0.8 ±0.07				
100	36					
120	37		0.6 ±0.1			
150	38					
180	39					
220	41			0.6 ±0.1		
270	42					
330	43					
390	44					
470	45					
560	46					
680	47					
820	48					
1000	49					
1200	51					
1500	52		0.85 ±0.1			
1800	53					
2200	54		1.25 ±0.1			
2700	55					
3300	56					
3900	57			0.85 ±0.1		
4700	58					
5600	59			1.15 ±0.1		
6800	61					
8200	62				0.5 to 1.0	
10000	63					
12000	64					0.5 to 1.0
15000	65					
18000	66					0.9 to 1.3
22000	67					
27000	68					
33000	69					
39000	71					
47000	72					

Values in shaded cells indicate thickness classification.

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE	
	∅180 mm; 7"		∅330 mm; 13"		∅180 mm; 7" BLISTER			
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0603	0805
0.6 ±0.1	4000	4000	20000	10000	–	–	–	10000
0.85 ±0.1	4000	4000	15000	10000	–	–	–	8000
0.5 to 1.0	–	4000	–	10000	2000	1500	–	–
0.8 ±0.07	4000	4000	15000	15000	–	–	15000	–
0.9 to 1.3	–	3000	–	10000	1500	–	–	–
1.15 ±0.1	–	3000	–	10000	–	–	–	–
1.25 ±0.1	–	3000	–	10000	–	–	–	5000

ORDERING INFORMATION FOR 100 V

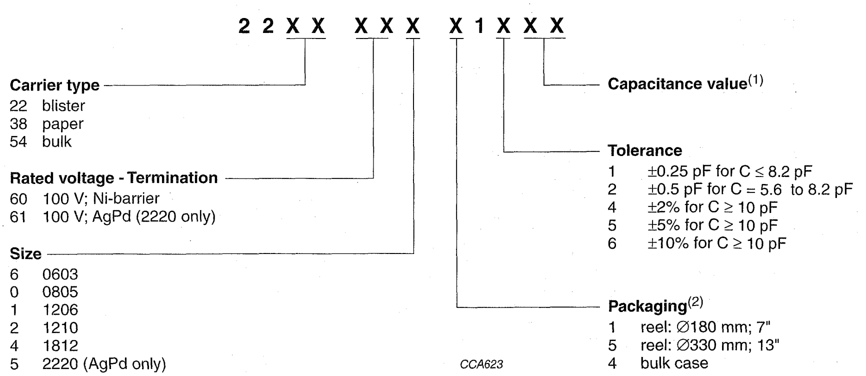
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 0805CG102G0B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206 1210 1812 2220 (AgPd only)	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	C ±0.25 pF D ±0.5 pF G ±2% J ±5% K ±10%	0 = 100 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC



(1) Refer to Chapter “Selection chart for 100 V”.

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

SELECTION CHART FOR 200 V AND 500 V

<table>
<tr><th rowspan="2">C
(pF)</th><th rowspan="2">LAST TWO DIGITS OF 12NC</th><th colspan="4">200 V</th><th colspan="3">500 V</th></tr>
<tr><th>0805</th><th>1206</th><th>1210</th><th>1812</th><th>1206</th><th>1210</th><th>1812</th></tr>
<tr><td>10</td><td>23</td><td rowspan="16">0.6 ±0.1</td><td rowspan="23">0.6 ±0.1</td><td rowspan="27"></td><td rowspan="31"></td><td rowspan="20">0.6 ±0.1</td><td rowspan="8"></td><td rowspan="28"></td></tr>
<tr><td>12</td><td>24</td></tr>
<tr><td>15</td><td>25</td></tr>
<tr><td>18</td><td>26</td></tr>
<tr><td>22</td><td>27</td></tr>
<tr><td>27</td><td>28</td></tr>
<tr><td>33</td><td>29</td></tr>
<tr><td>39</td><td>31</td></tr>
<tr><td>47</td><td>32</td><td rowspan="16">0.8 to 1.0</td></tr>
<tr><td>56</td><td>33</td></tr>
<tr><td>68</td><td>34</td></tr>
<tr><td>82</td><td>35</td></tr>
<tr><td>100</td><td>36</td></tr>
<tr><td>120</td><td>37</td></tr>
<tr><td>150</td><td>38</td></tr>
<tr><td>180</td><td>39</td></tr>
<tr><td>220</td><td>41</td><td rowspan="5">0.85 ±0.1</td></tr>
<tr><td>270</td><td>42</td></tr>
<tr><td>330</td><td>43</td></tr>
<tr><td>390</td><td>44</td></tr>
<tr><td>470</td><td>45</td><td rowspan="3">0.85 ±0.1</td></tr>
<tr><td>560</td><td>46</td><td>1.25 ±0.1</td></tr>
<tr><td>680</td><td>47</td><td rowspan="12"></td></tr>
<tr><td>820</td><td>48</td><td rowspan="3">0.85 ±0.1</td><td rowspan="2">1.15 ±0.1</td></tr>
<tr><td>1000</td><td>49</td><td rowspan="3">0.9 to 1.3</td></tr>
<tr><td>1200</td><td>51</td><td rowspan="12"></td></tr>
<tr><td>1500</td><td>52</td><td>1.15 ±0.1</td></tr>
<tr><td>1800</td><td>53</td><td rowspan="7"></td><td>0.8 to 1.0</td><td>1.2 to 1.75</td></tr>
<tr><td>2200</td><td>54</td><td rowspan="3">0.9 to 1.3</td><td rowspan="9"></td><td rowspan="3">0.9 to 1.3</td></tr>
<tr><td>2700</td><td>55</td></tr>
<tr><td>3300</td><td>56</td></tr>
<tr><td>3900</td><td>57</td><td rowspan="3"></td><td>0.8 to 1.0</td><td rowspan="6"></td></tr>
<tr><td>4700</td><td>58</td><td rowspan="2">0.9 to 1.3</td></tr>
<tr><td>5600</td><td>59</td></tr>
<tr><td>6800</td><td>61</td><td colspan="4" rowspan="2">Values in shaded cells indicate thickness classification.</td></tr>
<tr><td>8200</td><td>62</td></tr>
<tr><td>10000</td><td>63</td><td></td><td></td><td></td><td></td></tr>
</table>

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL	AMOUNT PER BULK CASE
	∅180 mm; 7"		∅330 mm; 13"		∅180 mm; 7" BLISTER	
	PAPER	BLISTER	PAPER	BLISTER	1812	0805
0.6 ±0.1	4000	4000	20000	10000	–	10000
0.85 ±0.1	4000	4000	15000	10000	–	8000
0.8 to 1.0	–	4000	–	10000	2000	–
0.9 to 1.3	–	3000	–	10000	1500	–
1.15 ±0.1	–	3000	–	10000	–	–
1.25 ±0.1	–	3000	–	10000	–	5000
1.2 to 1.75	–	2500	–	7000	1200	–

ORDERING INFORMATION FOR 200 V AND 500 V

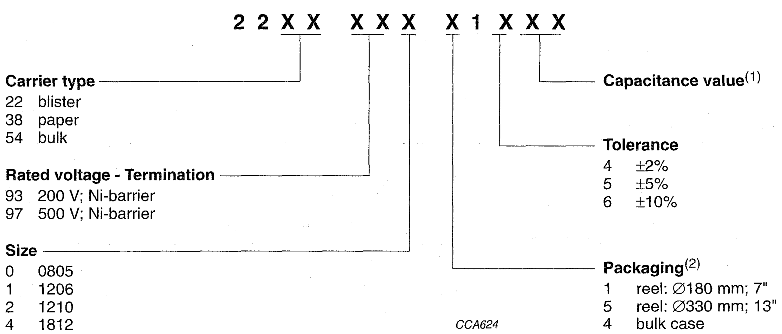
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 1206CG102GBB200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0805 1206 1210 1812	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	G ±2% J ±5% K ±10%	B = 200 V D = 500 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC



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

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

ELECTRICAL CHARACTERISTICS

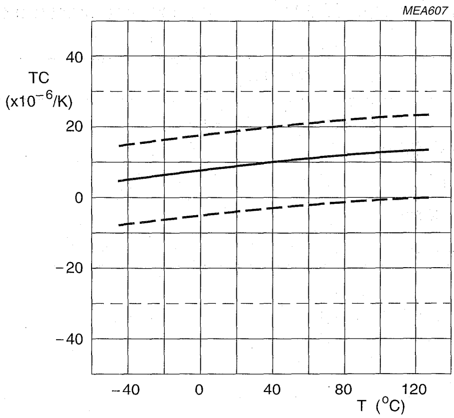
Class 1 capacitors; NP0 dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1:	
50 V	0.47 pF to 47000 pF
100 V	10 pF to 22 nF
200 V	10 pF to 5600 pF
500 V	10 pF to 3300 pF
Tolerance on capacitance after 1000 hours:	
$C \geq 10$ pF	±10%, ±5%, ±2% and ±1%
5 pF $\leq C <$ 10 pF	±0.5 pF, ±0.25 pF
$C < 5$ pF	±0.25 pF
Tan δ; note 1:	
$C < 10$ pF	$\leq 10\left(\frac{3}{C} + 0.7\right) \times 10^{-4}$ or 30×10^{-4}, whichever is smallest
$C \geq 10$ pF	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 100$ GΩ
Temperature coefficient:	
$C < 10$ pF	$(0 \pm 150) \times 10^{-6}$/K; note 2
$C \geq 10$ pF	$(0 \pm 30) \times 10^{-6}$/K; note 2
Ageing	not applicable

Notes

1. Measured at 1 V, 1 MHz for $C \leq 1000$ pF and 1 V, 1 kHz for $C > 1000$ pF, using a four-gauge method.
2. For sizes 0402 and 0603 all capacitance values from 0.47 pF to 150 pF have a temperature coefficient of $(0 \pm 30) \times 10^{-6}$/K.



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

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

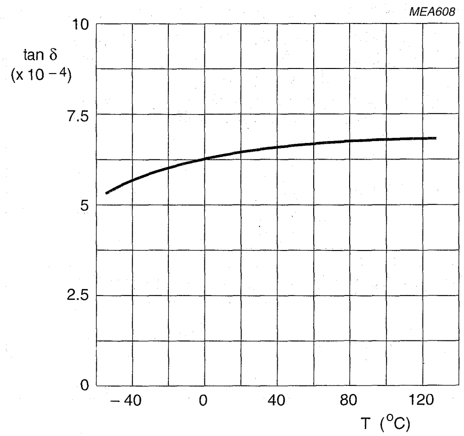


Fig.4 Typical tan δ as a function of temperature.

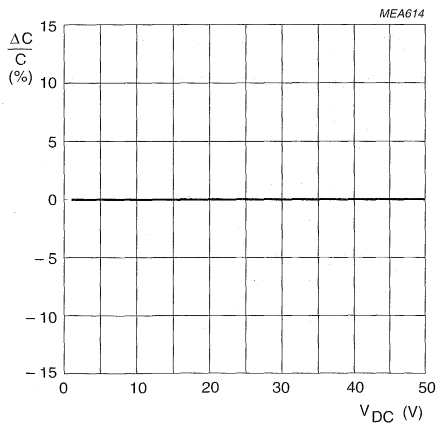
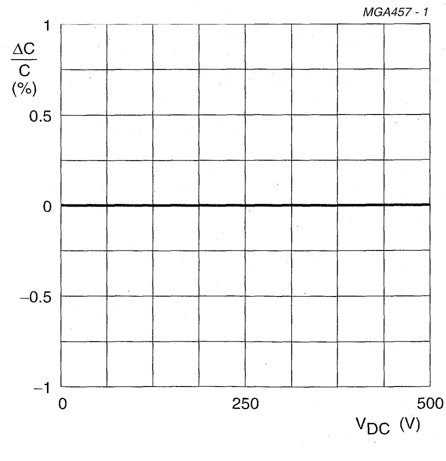
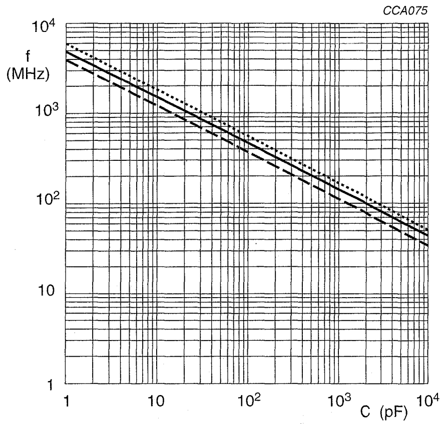


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.



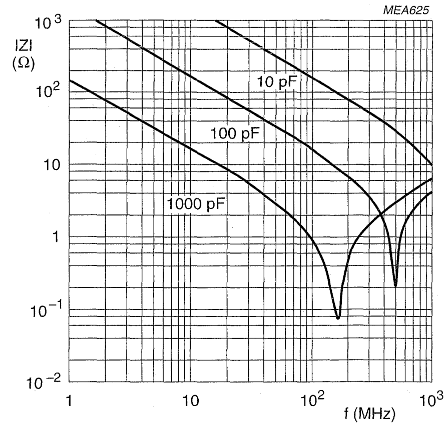
High voltage series.

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



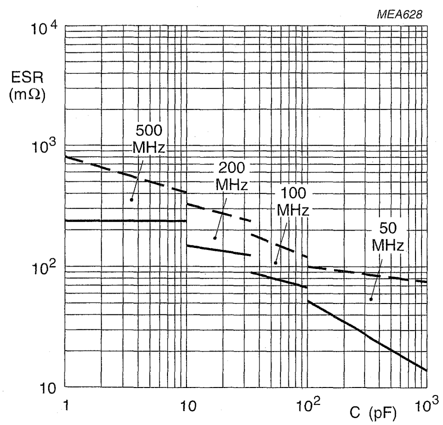
Case size **0603**: L = 0.6 nH (dotted line).
Case sizes **0805**, **1206** and **1210**: L = 1 nH (solid line).
Case sizes **1812** and **2220**: L = 1.5 nH (broken line).

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



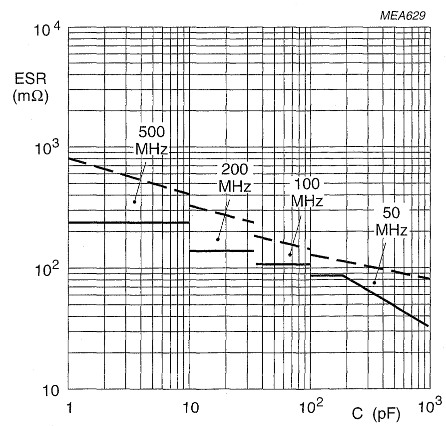
Case sizes **0603** to **1210**.

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



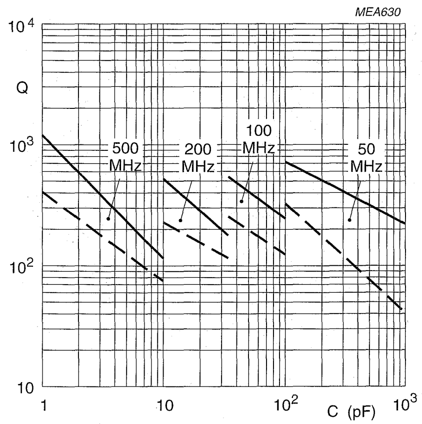
Case sizes **0603** and **0805**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

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



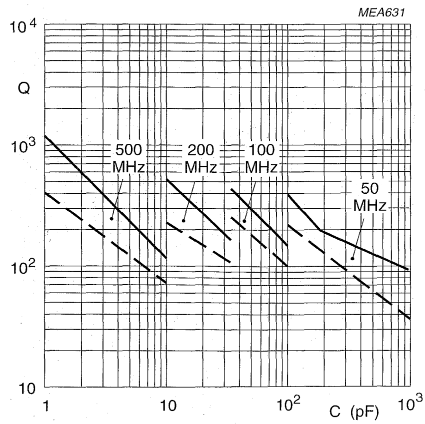
Case size **1206**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.
For C > 1 nF, maximum value of ESR = 80 mΩ measured at 50 MHz.

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



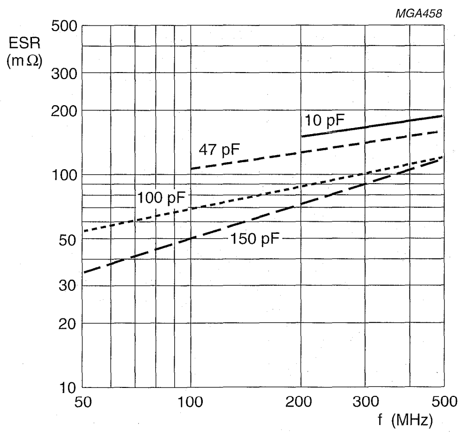
Case sizes **0603** and **0805**.
Typical values (solid lines).
Minimum values (broken lines).
Measuring equipment HP4191A.

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



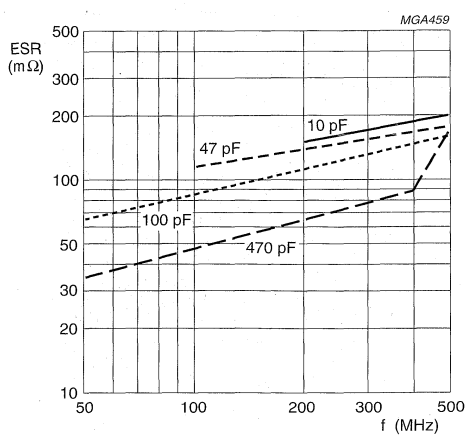
Case size **1206**.
Typical values (solid lines).
Minimum values (broken lines).
Measuring equipment HP4191A.
For C > 1 nF, Q_{min} = 35 measured at 50 MHz.

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



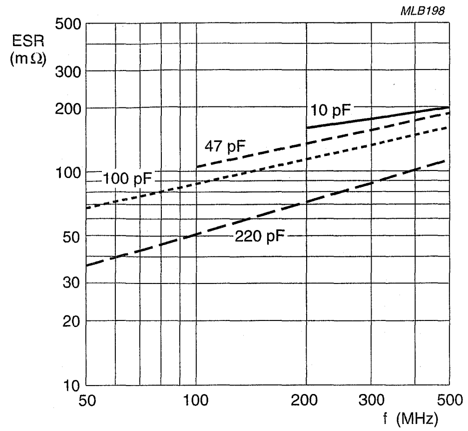
Case size **0805**.
High voltage 200 V.

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



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

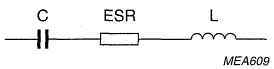
Fig.14 Typical equivalent series resistance as a function of frequency.



Case size **1206**.

High voltage 500 V.

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



C = capacitance.

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

L = equivalent series self-inductance.

Fig.16 Equivalent series representation of a CMC.

HIGH FREQUENCY BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

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

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

The equivalent series self-inductance L is:

- Independent of the dielectric material.
- Dependent on the size of the capacitor, it increases with increasing length and decreases with increasing width or thickness of the product.
- The value of L is approximately:
  - 0.6 nH for case size 0603
  - 1 nH for case sizes 0805, 1206 and 1210
  - 1.5 nH for case sizes 1812 and 2220.

These figures are accurate to within 20%.

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

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

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

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

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

The impedance (Z) is given by:

$$Z = \frac{1 - (2\pi f)^2 LC}{2j\pi fC} + ESR$$

The quality factor (Q) is given by:

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

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V narrow tolerance series Noble Metal Electrode

FEATURES

- Four standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case (case sizes 0402, 0603 and 0805 only)
- For high frequency applications
- NiSn terminations (AgPd on request).

APPLICATIONS

- Consumer electronics
- Telecommunications
- Automotive
- Data processing.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V (IEC)
Capacitance range (E12 series); note 1	0.47 pF to 6800 pF
Tolerance on capacitance:	
$C \geq 10$ pF	±1%
$C < 10$ pF	±0.1 pF
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Note

1. Non E12 values are available on request.

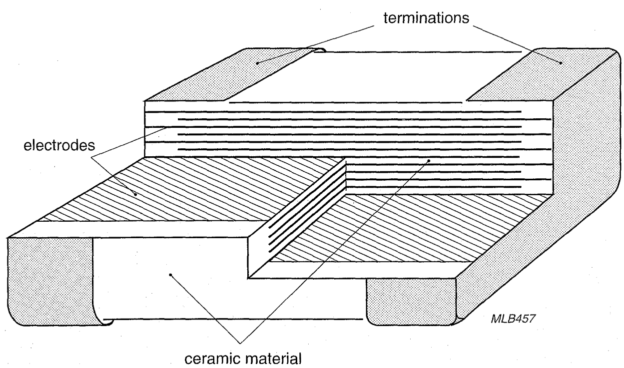
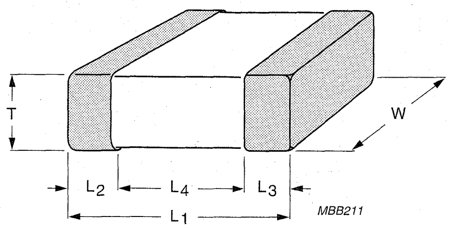


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T MIN.	T MAX.	L_2 and L_3 MIN.	L_2 and L_3 MAX.	L_4 MIN.
Dimensions in millimetres							
0402	1.0 ±0.05	0.5 ±0.05	0.45	0.55	0.20	0.30	0.40
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
Dimensions in inches							
0402	0.04 ±0.002	0.02 ±0.002	0.018	0.022	0.008	0.012	0.016
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056

SELECTION CHART

<table>
<tr><th rowspan="2">C
(pF)</th><th rowspan="2">LAST THREE DIGITS OF 12NC</th><th colspan="4">50 V</th></tr>
<tr><th>0402</th><th>0603</th><th>0805</th><th>1206</th></tr>
<tr><td>0.47</td><td>477</td><td rowspan="33">0.5 ±0.05</td><td rowspan="39">0.8 ±0.07</td><td rowspan="41">0.6 ±0.1</td><td rowspan="46">0.6 ±0.1</td></tr>
<tr><td>0.56</td><td>567</td></tr>
<tr><td>0.68</td><td>687</td></tr>
<tr><td>0.82</td><td>827</td></tr>
<tr><td>1.0</td><td>108</td></tr>
<tr><td>1.2</td><td>128</td></tr>
<tr><td>1.5</td><td>158</td></tr>
<tr><td>1.8</td><td>188</td></tr>
<tr><td>2.2</td><td>228</td></tr>
<tr><td>2.7</td><td>278</td></tr>
<tr><td>3.3</td><td>338</td></tr>
<tr><td>3.9</td><td>398</td></tr>
<tr><td>4.7</td><td>478</td></tr>
<tr><td>5.6</td><td>568</td></tr>
<tr><td>6.8</td><td>688</td></tr>
<tr><td>8.2</td><td>828</td></tr>
<tr><td>10</td><td>109</td></tr>
<tr><td>12</td><td>129</td></tr>
<tr><td>15</td><td>159</td></tr>
<tr><td>18</td><td>189</td></tr>
<tr><td>22</td><td>229</td></tr>
<tr><td>27</td><td>279</td></tr>
<tr><td>33</td><td>339</td></tr>
<tr><td>39</td><td>399</td></tr>
<tr><td>47</td><td>479</td></tr>
<tr><td>56</td><td>569</td></tr>
<tr><td>68</td><td>689</td></tr>
<tr><td>82</td><td>829</td></tr>
<tr><td>100</td><td>101</td></tr>
<tr><td>120</td><td>121</td></tr>
<tr><td>150</td><td>151</td></tr>
<tr><td>180</td><td>181</td></tr>
<tr><td>220</td><td>221</td></tr>
<tr><td>270</td><td>271</td><td rowspan="15"></td></tr>
<tr><td>330</td><td>331</td></tr>
<tr><td>390</td><td>391</td></tr>
<tr><td>470</td><td>471</td></tr>
<tr><td>560</td><td>561</td></tr>
<tr><td>680</td><td>681</td></tr>
<tr><td>820</td><td>821</td><td rowspan="9"></td></tr>
<tr><td>1000</td><td>102</td></tr>
<tr><td>1200</td><td>122</td><td rowspan="3">0.85 ±0.1</td></tr>
<tr><td>1500</td><td>152</td></tr>
<tr><td>1800</td><td>182</td></tr>
<tr><td>2200</td><td>222</td><td rowspan="2">1.25 ±0.1</td></tr>
<tr><td>2700</td><td>272</td></tr>
<tr><td>3300</td><td>332</td><td rowspan="2"></td><td rowspan="3">0.85 ±0.1</td></tr>
<tr><td>3900</td><td>392</td></tr>
<tr><td>4700</td><td>472</td><td colspan="3" rowspan="2">Values in shaded cells indicate thickness classification.</td></tr>
<tr><td>5600</td><td>562</td><td rowspan="2">1.15 ±0.1</td></tr>
<tr><td>6800</td><td>682</td><td></td><td></td><td></td></tr>
</table>

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE		
	∅180 mm; 7"		∅330 mm; 13"				
	PAPER	BLISTER	PAPER	BLISTER	0402	0603	0805
0.5 ±0.05	10000	–	50000	–	50000	–	–
0.6 ±0.1	4000	4000	20000	10000	–	–	10000
0.85 ±0.1	4000	4000	15000	10000	–	–	8000
0.8 ±0.07	4000	4000	15000	15000	–	15000	–
1.15 ±0.1	–	3000	–	10000	–	–	–
1.25 ±0.1	–	3000	–	10000	–	–	5000

ORDERING INFORMATION

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

Clear text code

Example: 0805CG102F9BB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402 0603 0805 1206	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	B ±0.1 pF F ±1%	9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

2 2 X X 8 6 X X X X X X

Carrier type
22 blister
38 paper
54 bulk

Size
9 0402
7 0603
1 0805
3 1206

Capacitance value(1)

Tolerance
4 ±0.1 pF for C = 0.47 to 4.7 pF
8 ±0.1 pF for C = 5.6 to 8.2 pF
8 ±1% for C ≥ 10 pF

Packaging(2)
1 reel: ∅180 mm; 7"
7 reel: ∅330 mm; 13"
4 bulk case

CCA615

(1) Refer to Chapter “Selection chart”.
(2) Amount on reel depends on thickness classification, see Section “Thickness classification and packaging quantities”.

ELECTRICAL CHARACTERISTICS

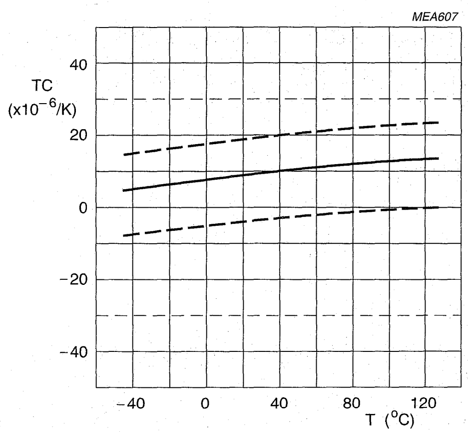
Class 1 capacitors; NP0 dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1:	
narrow tolerance; 50 V	0.47 pF to 6800 pF
Tolerance on capacitance after 1000 hours:	
$C \geq 10$ pF	±1%
$5\ pF \leq C < 10$ pF	±0.1 pF
Tan δ; note 1:	
$C < 10$ pF	$\leq 10\left(\frac{3}{C} + 0.7\right) \times 10^{-4}$ or 30×10^{-4}, whichever is smallest
$C \geq 10$ pF	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 100\ G\Omega$
Temperature coefficient:	
$C < 10$ pF	$(0 \pm 150) \times 10^{-6}$/K; note 2
$C \geq 10$ pF	$(0 \pm 30) \times 10^{-6}$/K; note 2
Ageing	not applicable

Notes

1. Measured at 1 V, 1 MHz for $C \leq 1000$ pF and 1 V, 1 kHz for $C > 1000$ pF, using a four-gauge method.
2. For sizes 0402 and 0603 all capacitance values have a temperature coefficient of $(0 \pm 30) \times 10^{-6}$/K.



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

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

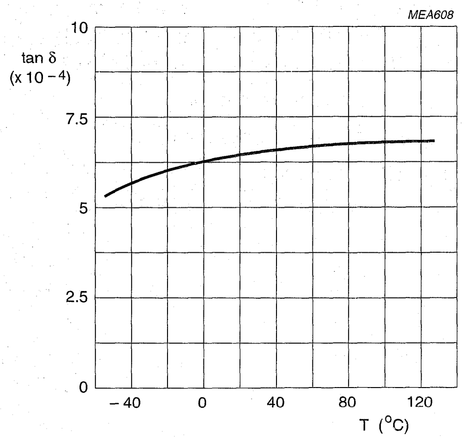


Fig.4 Typical tan δ as a function of temperature.

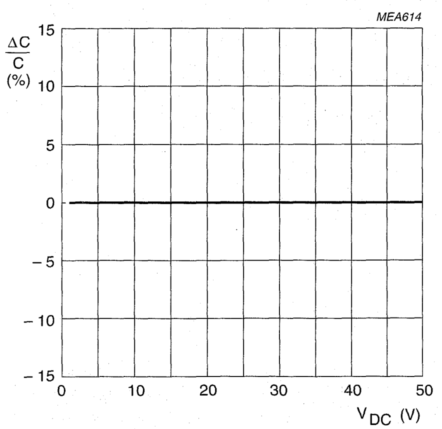
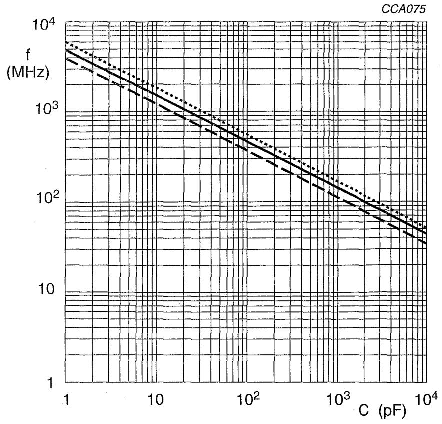
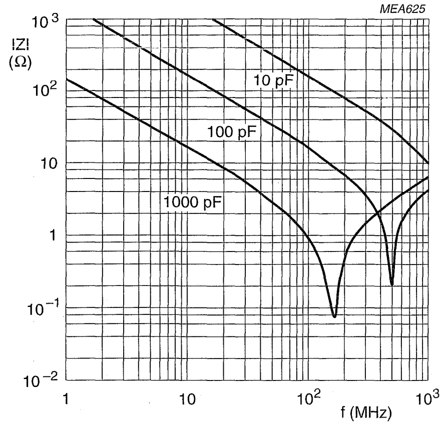


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.



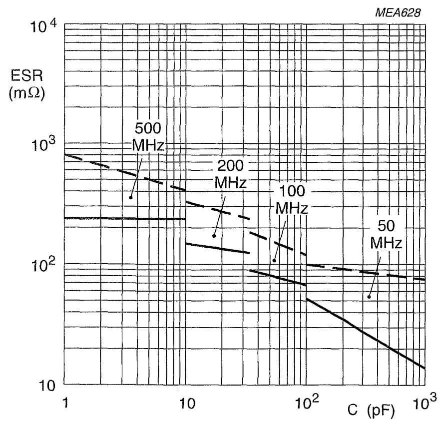
Case size **0603**: L = 0.6 nH (dotted line).
Case sizes **0805** and **1206**: L = 1 nH (solid line).

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



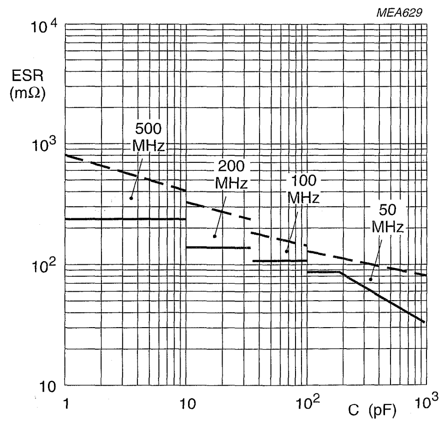
Case sizes **0603** to **1206**.

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



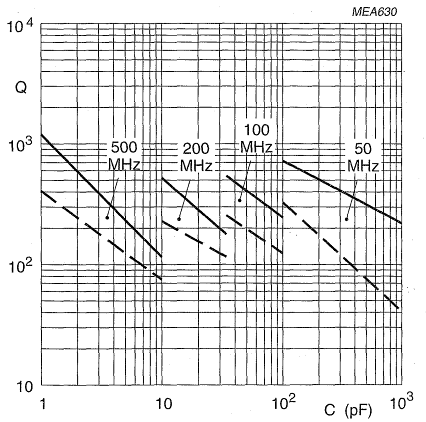
Case sizes **0603** and **0805**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

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



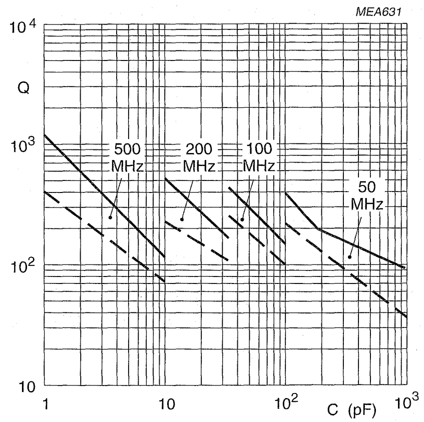
Case size **1206**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.
For C > 1 nF, maximum value of ESR = 80 mΩ measured at 50 MHz.

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



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

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



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

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

HIGH FREQUENCY BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

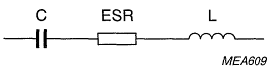
Ceramic multilayer capacitors (CMC) are suitable for use at high frequencies. At frequencies below the series resonance frequency, the CMC can be represented by an equivalent circuit as shown in Fig.12.

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

The equivalent series self-inductance L is:

- Independent of the dielectric material.
- Dependent on the size of the capacitor, it increases with increasing length and decreases with increasing width or thickness of the product.
- The value of L is approximately:
  - 0.6 nH for case size 0603
  - 1 nH for case sizes 0805.

These figures are accurate to within 20%.



C = capacitance.

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

L = equivalent series self-inductance.

Fig.12 Equivalent series representation of a CMC.

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

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

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

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

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

The impedance (Z) is given by:

$$Z = \frac{1 - (2\pi f)^2 LC}{2j\pi fC} + ESR$$

The quality factor (Q) is given by:

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

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V microwave series Noble Metal Electrode

FEATURES

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

APPLICATIONS

- Mobile telephones
- Satellite television
- Instrumentation.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V (IEC); note 1
Capacitance range (E12 series), NP0 dielectric; note 2:	
case size 0603	0.47 pF to 47 pF
case size 0805	0.47 pF to 82 pF
case size 1206	0.47 pF to 120 pF
Tolerance on capacitance:	
$C \geq 10$ pF	±10%, ±5%, ±2% and ±1%
5 pF $\leq C <$ 10 pF	±0.5 pF, ±0.25 pF and ±0.1 pF
$C <$ 5 pF	±0.25 pF and ±0.1 pF
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Insulation resistance after 60 s at U_R (DC)	>100 GΩ
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Notes

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

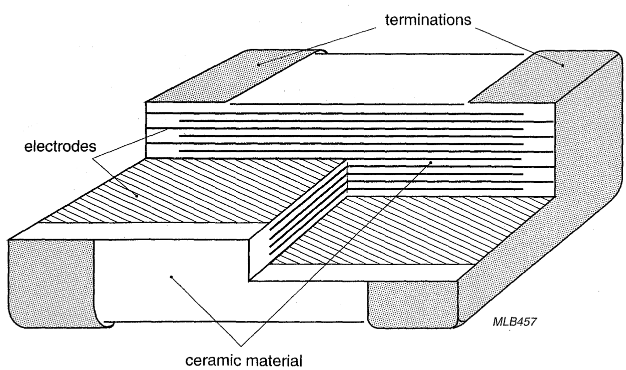
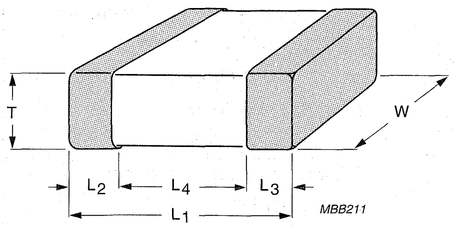


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T		L_2 and L_3		L_4
			MIN.	MAX.	MIN.	MAX.	MIN.
Dimensions in millimetres							
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
Dimensions in inches							
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056

SELECTION CHART

<table>
<tr><th rowspan="2">C
(pF)</th><th rowspan="2">LAST
TWO DIGITS
OF 12NC</th><th colspan="3">50 V</th></tr>
<tr><th>0603</th><th>0805</th><th>1206</th></tr>
<tr><td>0.47</td><td>05</td><td rowspan="25">0.8 ±0.07</td><td rowspan="28">0.6 ±0.1</td><td rowspan="30">0.6 ±0.1</td></tr>
<tr><td>0.56</td><td>06</td></tr>
<tr><td>0.68</td><td>07</td></tr>
<tr><td>0.82</td><td>08</td></tr>
<tr><td>1.0</td><td>09</td></tr>
<tr><td>1.2</td><td>11</td></tr>
<tr><td>1.5</td><td>12</td></tr>
<tr><td>1.8</td><td>13</td></tr>
<tr><td>2.2</td><td>14</td></tr>
<tr><td>2.7</td><td>15</td></tr>
<tr><td>3.3</td><td>16</td></tr>
<tr><td>3.9</td><td>17</td></tr>
<tr><td>4.7</td><td>18</td></tr>
<tr><td>5.6</td><td>19</td></tr>
<tr><td>6.8</td><td>21</td></tr>
<tr><td>8.2</td><td>22</td></tr>
<tr><td>10</td><td>23</td></tr>
<tr><td>12</td><td>24</td></tr>
<tr><td>15</td><td>25</td></tr>
<tr><td>18</td><td>26</td></tr>
<tr><td>22</td><td>27</td></tr>
<tr><td>27</td><td>28</td></tr>
<tr><td>33</td><td>29</td></tr>
<tr><td>39</td><td>31</td></tr>
<tr><td>47</td><td>32</td></tr>
<tr><td>56</td><td>33</td><td rowspan="3"></td></tr>
<tr><td>68</td><td>34</td></tr>
<tr><td>82</td><td>35</td></tr>
<tr><td>100</td><td>36</td><td colspan="2" rowspan="2">Values in shaded cells indicate thickness classification.</td></tr>
<tr><td>120</td><td>37</td></tr>
</table>

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE	
	∅180 mm; 7"		∅330 mm; 13"		0603	0805
	PAPER	BLISTER	PAPER	BLISTER		
0.6 ±0.1	4000	4000	20000	10000	–	10000
0.8 ±0.07	4000	4000	15000	15000	15000	–

ORDERING INFORMATION

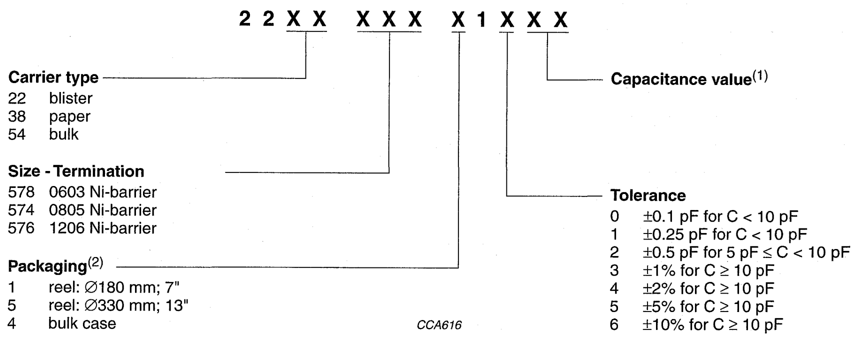
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 0805CG100G9BB0M

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206	CG = NP0	100 = 10 pF; the third digit signifies the number of zeros	B ±0.1 pF C ±0.25 pF D ±0.5pF F ±1% G ±2% J ±5% K ±10%	9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	M = microwave

Ordering code 12NC



(1) Refer to Chapter “Selection chart”.
(2) Amount on reel depends on thickness classification, see Section “Thickness classification and packaging quantities”.

ELECTRICAL CHARACTERISTICS

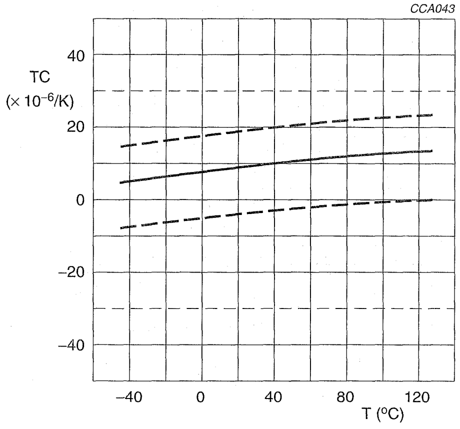
Class 1 capacitors; NP0 dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series), NP0 dielectric; note 1:	
case size 0603	0.47 pF to 47 pF
case size 0805	0.47 pF to 82 pF
case size 1206	0.47 pF to 120 pF
Tolerance on capacitance:	
$C \geq 10$ pF	±10%, ±5%, ±2% and ±1%
5 pF $\leq C <$ 10 pF	±0.5 pF, ±0.25 pF and ±0.1 pF
$C < 5$ pF	±0.25 pF and ±0.1 pF
Tan δ; note 1:	
$C < 10$ pF	$\leq 10\left(\frac{3}{C} + 0.7\right) \times 10^{-4}$ or 30×10^{-4}, whichever is the smallest
$C \geq 10$ pF	$\leq 10 \times 10^{-4}$
Temperature coefficient; note 2:	
0.47 pF $\leq C <$ 5 pF	$(0 \pm 150) \times 10^{-6}$/K
5 pF $\leq C <$ 10 pF	$(0 \pm 150) \times 10^{-6}$/K
$C \geq 10$ pF	$(0 \pm 30) \times 10^{-6}$/K
High frequency properties	for ESR values see Figs 7, 8 and 9. The first parallel resonance frequency in the s_{21} and s_{12} scattering parameters lies above 2 GHz and the second resonance frequency above 3 GHz.

Notes

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



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

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

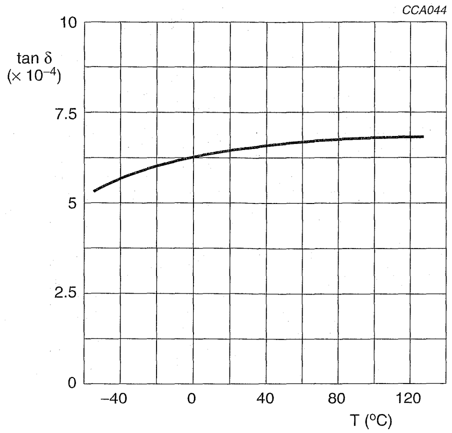


Fig.4 Typical tan δ as a function of temperature.

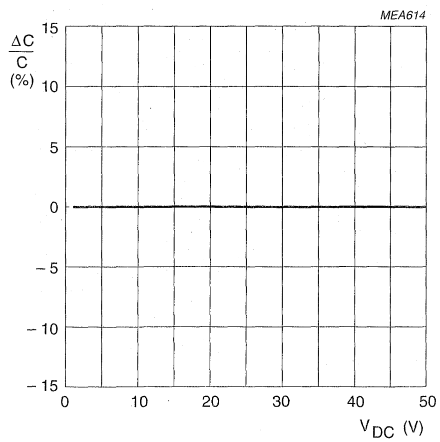
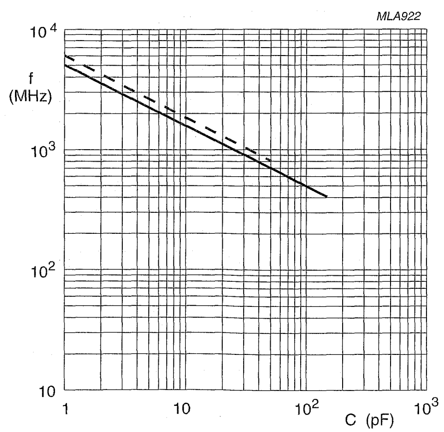
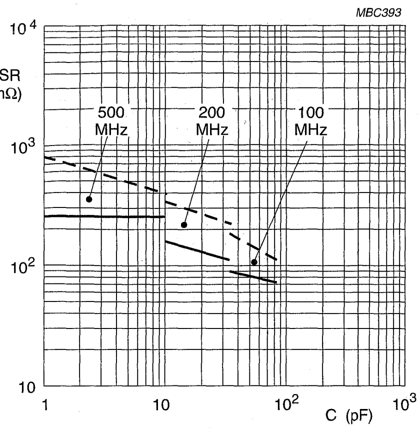


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.



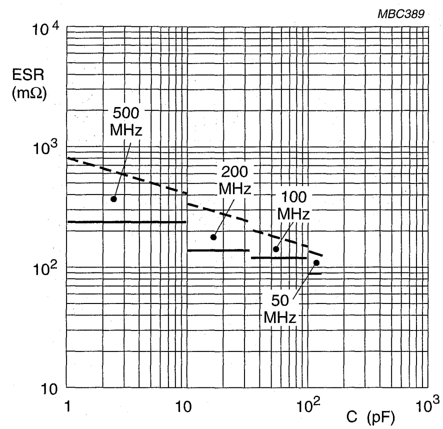
Case sizes **0805** and **1206** (solid line).
Case size **0603** (broken line).

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



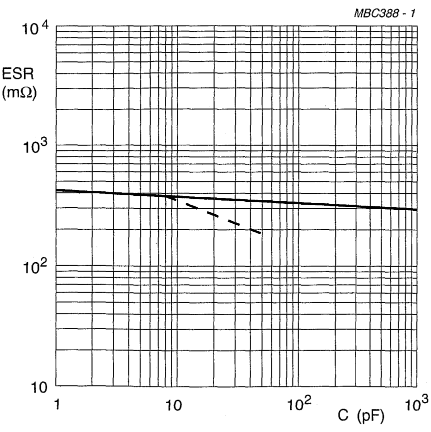
Case sizes **0603** and **0805**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

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



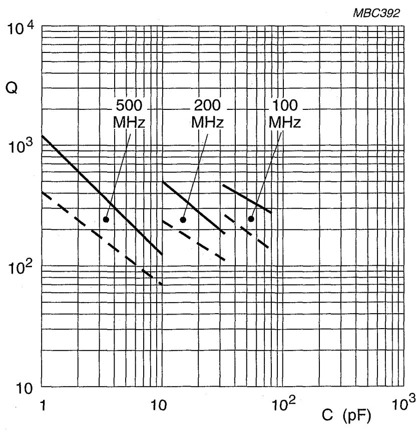
Case size **1206**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

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



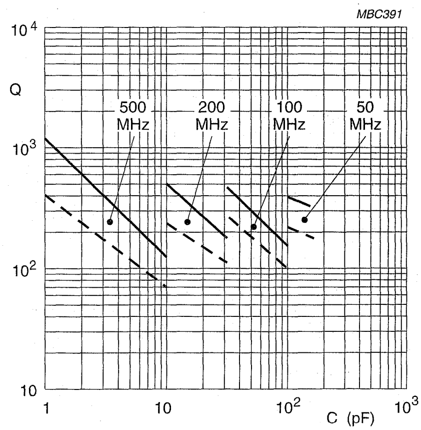
Case sizes **0805** and **1206** (solid line).
Case size **0603** (broken line).
Measuring equipment HP4191A.

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



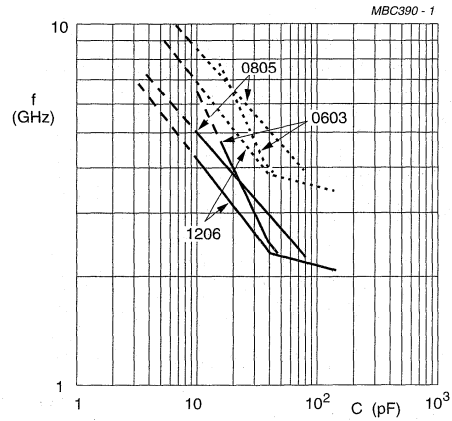
Case sizes **0603** and **0805**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

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



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

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



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

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

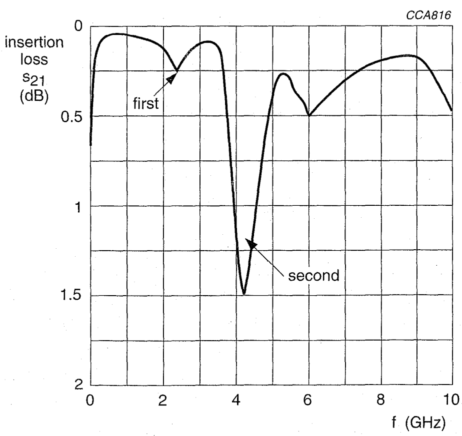


Fig.13 Example of the insertion loss as a function of frequency showing the parallel resonances.

MICROWAVE BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

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

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

The equivalent series self-inductance L is:

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

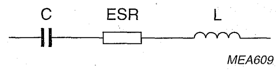
Because of the inductance L, associated with the CMC, there will be a frequency at which the inductive reactance will be equal to the reactance of the capacitor.

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

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

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

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



C = capacitance.

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

L = equivalent series self-inductance.

Fig.14 Equivalent series representation of a CMC.

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

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

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

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

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

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

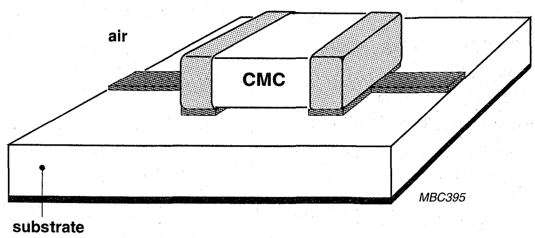
s_{22} is the reflection coefficient at the output port with the input port terminated into a 50 Ω load.

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

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

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

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



Substrate permittivity: ε_r = 9.8.
Substrate thickness = 0.635 mm.

Fig.15 Microwave behaviour measured using a microstrip.

Surface mount ceramic multilayer capacitors

Class 1, NP0 1 kV high voltage series Noble Metal Electrode

FEATURES

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

APPLICATIONS

- Power supplies
- Voltage multiplier circuits
- Surge protection.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	1 kV (IEC)
Capacitance range (E12 series); note 1	100 pF to 3300 pF
Tolerance on capacitance at T_{amb} = 20 °C	±10%, ±5%, ±2%; note 2
Test voltage (DC) for 1 minute	$2 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Notes

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

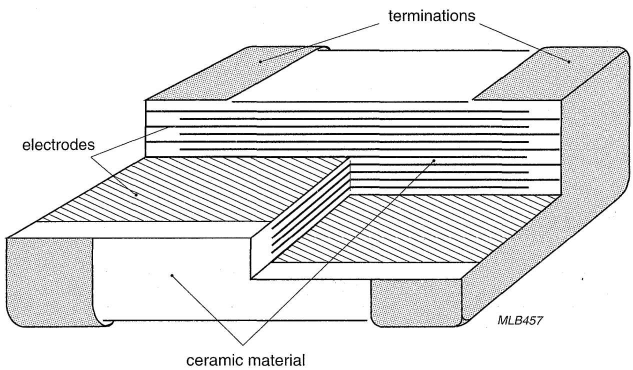
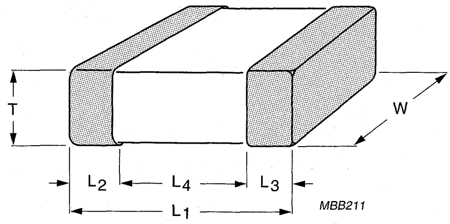


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T MIN.	T MAX.	L_2 and L_3 MIN.	L_2 and L_3 MAX.	L_4 MIN.
Dimensions in millimetres							
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.30	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	1.30	0.25	0.75	2.90
Dimensions in inches							
1812	0.177 ±0.008	0.126 ±0.008	0.020	0.051	0.010	0.030	0.088
2220	0.224 ±0.008	0.197 ±0.008	0.020	0.051	0.010	0.030	0.114

SELECTION CHART

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

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	12 mm TAPE WIDTH AMOUNT PER REEL	
	∅180 mm; 7" BLISTER	
	1812	2220
0.5 to 1.0	2000	1500
0.9 to 1.3	1500	1500

ORDERING INFORMATION

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

Clear text code

Example: 1812CG102JEBB00

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

Ordering code 12NC

2 2 5 0 X X X X 1 X X X

Termination
00 NiSn

Size
4 1812
5 2220

Packaging(2)
1 reel: ∅180 mm; 7" reel
12 mm blister tape

Capacitance value(1)

Tolerance
4 ±2%
5 ±5%
6 ±10%

CCA640

(1) Refer to Chapter "Selection chart".
(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

ELECTRICAL CHARACTERISTICS

Class 1 capacitors; NP0 dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	100 pF to 3300 pF
Tolerance on capacitance after 1000 hours	±10%, ±5%, ±2%; note 1
Rated voltage U_R (DC)	1 kV (IEC)
Test voltage (DC) for 1 minute	$2 \times U_R$
Tan δ	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 100$ GΩ
Temperature coefficient	$(0 \pm 30) \times 10^{-6}$/K
Ageing	not applicable

Note

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

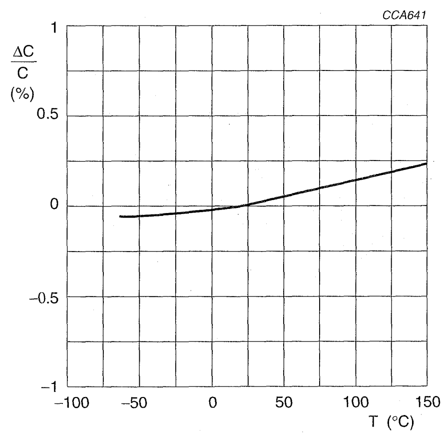


Fig.3 Typical capacitance change as a function of temperature.

Surface mount ceramic multilayer capacitors

Class 1, NP0 3 kV high voltage series Noble Metal Electrode

FEATURES

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

APPLICATIONS

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

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

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

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	3 kV (IEC)
Capacitance range (E12 series); note 1	10 pF to 100 pF
Tolerance on capacitance at T_{amb} = 20 °C	±10%, ±5%, ±2%; note 2
Test voltage (DC) for 1 minute	1.2 × U_R
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Notes

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

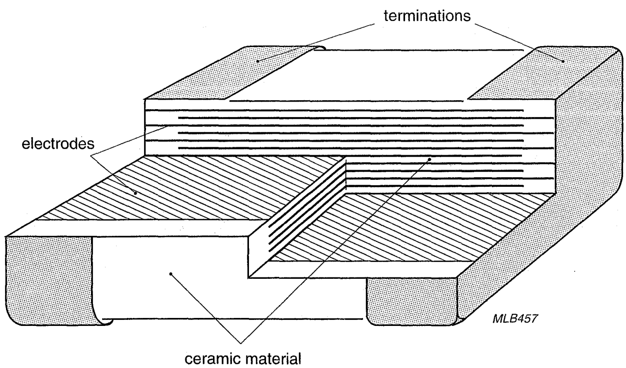
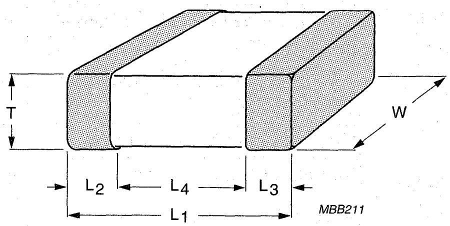


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T MAX.	L_2 and L_3 MAX.	L_4 MIN.
Dimensions in millimetres					
1808	4.5 ±0.20	2.0 ±0.20	1.30	0.75	2.20
1812	4.5 ±0.20	3.2 ±0.20	1.30	0.75	2.20
Dimensions in inches					
1808	0.177 ±0.008	0.079 ±0.008	0.051	0.030	0.088
1812	0.177 ±0.008	0.126 ±0.008	0.051	0.030	0.088

SELECTION CHART

<table>
<tr><th rowspan="2">C (pF)</th><th rowspan="2">LAST TWO DIGITS OF 12NC</th><th colspan="2">3 kV</th></tr>
<tr><th>1808</th><th>1812</th></tr>
<tr><td>10</td><td>23</td><td rowspan="9">1.2 to 1.75</td><td rowspan="9">1.2 to 1.75</td></tr>
<tr><td>12</td><td>24</td></tr>
<tr><td>15</td><td>25</td></tr>
<tr><td>18</td><td>26</td></tr>
<tr><td>22</td><td>27</td></tr>
<tr><td>27</td><td>28</td></tr>
<tr><td>33</td><td>29</td></tr>
<tr><td>39</td><td>31</td></tr>
<tr><td>47</td><td>32</td></tr>
<tr><td>56</td><td>33</td><td rowspan="4"></td><td rowspan="4">1.6 to 2.2</td></tr>
<tr><td>68</td><td>34</td></tr>
<tr><td>82</td><td>35</td></tr>
<tr><td>100</td><td>36</td></tr>
</table>

Thickness classification and packaging quantities

<table>
<tr><th rowspan="3">THICKNESS CLASSIFICATION (mm)</th><th colspan="2">12 mm TAPE WIDTH AMOUNT PER REEL</th></tr>
<tr><th colspan="2">∅180 mm; 7" BLISTER</th></tr>
<tr><th>1808</th><th>1812</th></tr>
<tr><td>1.2 to 1.75</td><td>1000</td><td>1000</td></tr>
<tr><td>1.6 to 2.2</td><td>1000</td><td>1000</td></tr>
</table>

ORDERING INFORMATION

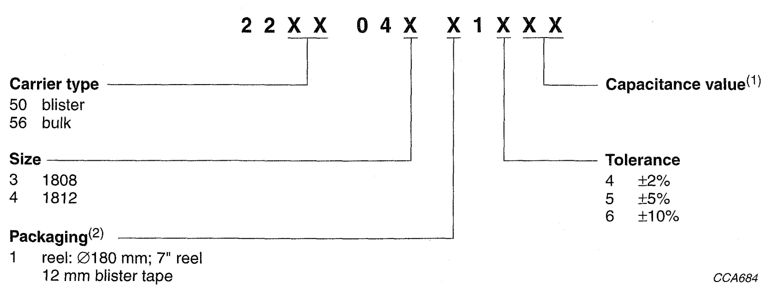
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 1808CG270JGBB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
1808 1812	CG = NP0	27 = 27 pF; the third digit signifies the number of zeros	G ±2% J ±5% K ±10%	G = 3 kV	B = Ni-barrier	B = 180 mm; 7" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC



(1) Refer to Chapter "Selection chart".

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

ELECTRICAL CHARACTERISTICS

Class 1 capacitors; NP0 dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	10 pF to 100 pF
Tolerance on capacitance after 1 000 hours:	±10%, ±5%, ±2%; note 1
Rated voltage U_R (DC)	3 kV (IEC)
Test voltage (DC) for 1 minute	$1.2 \times U_R$
Tan δ	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 100$ GΩ
Temperature coefficient	$(0 \pm 30) \times 10^{-6}$/K
Ageing	not applicable

Note

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

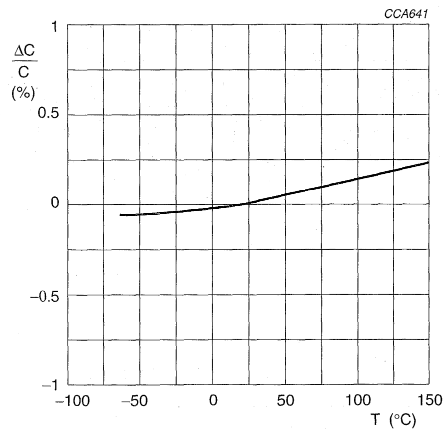


Fig.3 Typical capacitance change as a function of temperature.

Surface mount ceramic multilayer capacitors

Class 2, X7R 10 V

FEATURES

- Three standard sizes
- For high frequency applications
- Supplied in tape on reel or in bulk case
- Nickel-barrier end terminations.

APPLICATIONS

Consumer electronics, for example:

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

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	10 V
Capacitance range (E6 series)	150 nF to 1 µF; note 1
Tolerance on capacitance after 1000 hours	±10%
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
End terminations	NiSn
Climatic category (IEC 60068)	55/125/21

Note

1. Measured at 20 °C, 1 V and 1 kHz, using a four-gauge method.

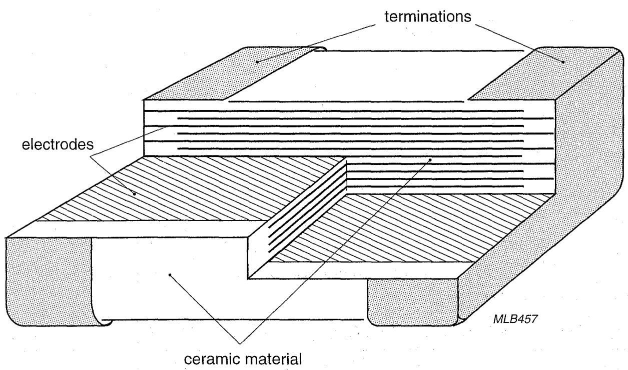
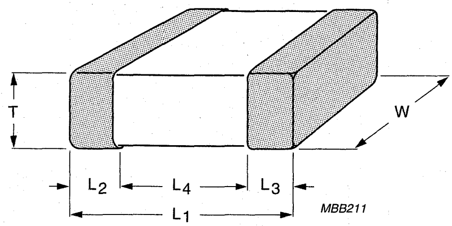


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions; see Fig.2

CASE SIZE	L_1	W	T		L_2 and L_3		L_4
			MIN.	MAX.	MIN.	MAX.	MIN.
Dimensions in millimetres							
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.50	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
Dimensions in inches							
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	10 V		
		0603	0805	1206
150	52			
180	53	0.80 ±0.07		
220	54		0.6 ±0.10	
270	55			
330	56			
390	57		0.85 ±0.10	
470	58			
560	59			
680	61		1.25 ±0.10	
820	62	Values in shaded cells indicate thickness classification		
1000	63			0.85 ±0.10
1200	64			
1500	65			
1800	66			1.15 ±0.10
2200	67			

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE	
	∅180 mm; 7"		∅330 mm; 13"		0603	0805
	PAPER	BLISTER	PAPER	BLISTER		
0.6 ±0.10	4000	4000	20000	10000	–	–
0.80 ±0.07	4000	4000	15000	15000	15000	–
0.85 ±0.10	4000	4000	15000	10000	–	–
1.15 ±0.10	–	3000	–	10000	–	–
1.25 ±0.10	–	3000	–	10000	–	5000

Surface mount ceramic multilayer capacitors

Class 2, X7R 10 V

ORDERING INFORMATION

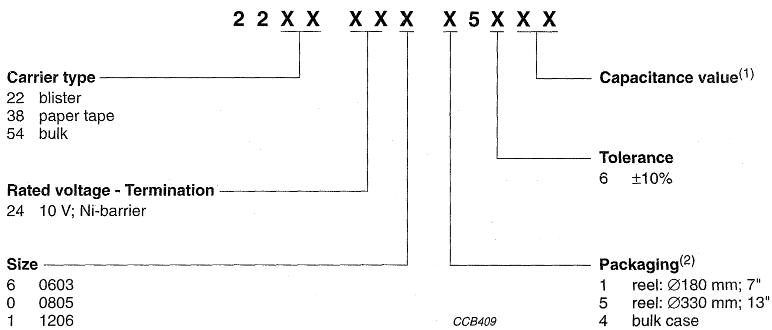
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 08052R105K6BB0D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206	2R = X7R	105 = 1000000 pF; the third digit signifies the number of zeros	K = ±10%	6 = 10 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking	D = BME

Ordering code 12NC



(1) Refer to Chapter "Selection chart".

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

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; X7R dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 20 ±1 °C, an atmospheric pressure of 86 to 105 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1	150 nF to 1 μF
Tolerance on capacitance after 1 000 hours	±10%
Tan δ; note 1	≤5%
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} \times C \geq 500$ seconds
Maximum capacitance change as a function of temperature	±15%
Ageing	typical 3% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

1. Measured at 20 °C, 1 V and 1 kHz, using a four-gauge method.

Surface mount ceramic multilayer capacitors

Class 2, X7R 16 V, 25 V and 50 V

FEATURES

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

APPLICATIONS

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

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	16 V, 25 V and 50 V (IEC)
Capacitance range (E12 series):	
16 V	22 nF to 1 μF
25 V	10 nF to 470 nF
50 V	100 pF to 1 μF
Tolerance on capacitance	±20%, ±10%, ±5%
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

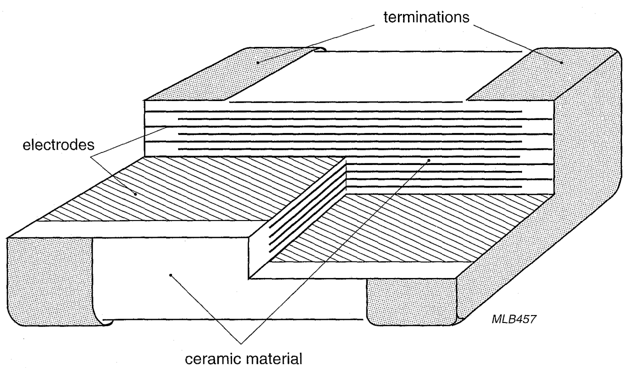
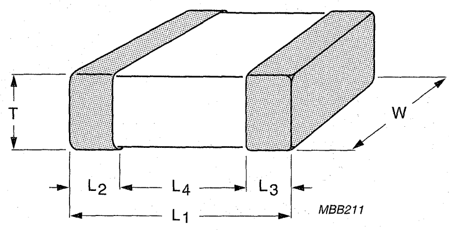


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T MIN.	T MAX.	L_2 and L_3 MIN.	L_2 and L_3 MAX.	L_4 MIN.
Dimensions in millimetres							
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.80	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	1.80	0.25	0.75	2.90
Dimensions in inches							
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056
1812	0.177 ±0.008	0.126 ±0.008	0.020	0.072	0.010	0.030	0.088
2220	0.224 ±0.008	0.197 ±0.008	0.020	0.072	0.010	0.030	0.114

SELECTION CHART FOR 16 V AND 25 V

C (pF)	LAST TWO DIGITS OF 12NC	16 V			25 V			
		0603	0805	1206	0603	0805	1206	1210
10000	36							
12000	37							
15000	38				0.8 ±0.07			
18000	39					0.6 ±0.1		
22000	41							
27000	42							
33000	43							
39000	44							
47000	45	0.8 ±0.07						
56000	46		0.6 ±0.1			0.85 ±0.1		
68000	47							
82000	48							
100000	49							
120000	51							
150000	52		0.85 ±0.1				0.85 ±0.1	
180000	53							
220000	54							
270000	55			0.85 ±0.1			1.15 ±0.1	0.5 to 1.0
330000	56							
390000	57		1.25 ±0.1					
470000	58							0.9 to 1.3
560000	59							
680000	61			1.15 ±0.1	Values in shaded cells indicate thickness classification.			
820000	62							
1000000	63							

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE		
	∅180 mm; 7"		∅330 mm; 13"				
	PAPER	BLISTER	PAPER	BLISTER	0603	0805	1206
0.6 ±0.1	4000	4000	20000	10000	–	10000	–
0.85 ±0.1	4000	4000	15000	10000	–	8000	3000
0.5 to 1.0	–	4000	–	10000	–	–	–
0.8 ±0.07	4000	4000	15000	15000	15000	–	–
0.9 to 1.3	–	3000	–	10000	–	–	–
1.15 ±0.1	–	3000	–	10000	–	–	3000
1.25 ±0.1	–	3000	–	10000	–	5000	–

ORDERING INFORMATION

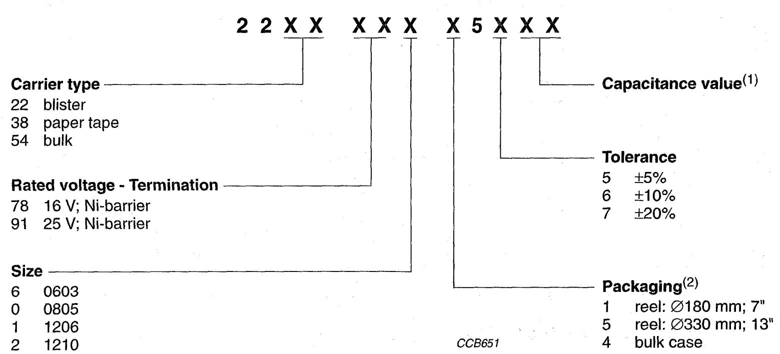
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 08052R104K7BB0D

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

Ordering code 12NC



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

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

SELECTION CHART FOR 50 V

C (pF)	LAST TWO DIGITS OF 12NC	50 V					
		0603	0805	1206	1210	1812	2220
100	09						
120	11						
150	12						
180	13						
220	14						
270	15						
330	16						
390	17						
470	18						
560	19						
680	21						
820	22						
1000	23						
1200	24						
1500	25	0.8 ±0.07					
1800	26		0.6 ±0.1				
2200	27						
2700	28						
3300	29						
3900	31			0.85 ±0.1			
4700	32						
5600	33						
6800	34						
8200	35						
10000	36						
12000	37						
15000	38						
18000	39						
22000	41						
27000	42						
33000	43						
39000	44		0.85 ±0.1		0.5 to 1.0		
47000	45						
56000	46						
68000	47						
82000	48		1.25 ±0.1				
100000	49						
120000	51						
150000	52						
180000	53			1.15 ±0.1	0.9 to 1.3		
220000	54					0.5 to 1.0	
270000	55						
330000	56	Values in shaded cells indicate thickness classification.					
390000	57						0.5 to 1.0
470000	58					0.9 to 1.3	
560000	59						
680000	61						
820000	62						
1000000	63						0.9 to 1.3

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE			
	∅180 mm; 7"		∅330 mm; 13"		∅180 mm; 7" BLISTER					
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805	1206
0.6 ±0.1	4000	4000	20000	10000	–	–	–	–	10000	–
0.85 ±0.1	4000	4000	15000	10000	–	–	–	–	8000	3000
0.5 to 1.0	–	4000	–	10000	2000	1500	–	–	–	–
0.8 ±0.07	4000	4000	15000	15000	–	–	–	15000	–	–
0.9 to 1.3	–	3000	–	10000	1500	1500	–	–	–	–
1.15 ±0.1	–	3000	–	10000	–	–	–	–	–	2000
1.25 ±0.1	–	3000	–	10000	–	–	–	–	5000	–
1.2 to 1.75	–	2500	–	7000	1000	–	–	–	–	–

ORDERING INFORMATION

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

Clear text code

Example: 08052R104K9B20D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206 1210 1812 2220	2R = X7R	104 = 100000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

Ordering code 12NC

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

Carrier type
22 blister
38 paper tape
54 bulk

Rated voltage - Termination
58 50 V; Ni-barrier

Size
6 0603
0 0805
1 1206
2 1210
4 1812
5 2220

Capacitance value(1)

Tolerance
5 ±5%
6 ±10%
7 ±20%

Packaging(2)
1 reel: ∅180 mm; 7"
5 reel: ∅330 mm; 13"
4 bulk case

CCB652

(1) Refer to Chapter “Selection chart for 50 V”.
(2) Amount on reel depends on thickness classification, see Section “Thickness classification and packaging quantities”.

ELECTRICAL CHARACTERISTICS

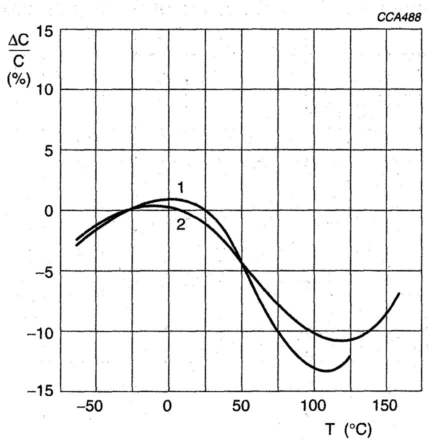
Class 2 capacitors; X7R dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	100 pF to 1 μF
Tolerance on capacitance after 1000 hours	±20%, ±10%, ±5%
Tan δ; note 1	
16 V	≤3.5%
25 V and 50 V	≤2.5%
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} \times C > 500$ seconds
Maximum capacitance change as a function of temperature; see Fig.3	±15%
Ageing	typical 1% per time decade

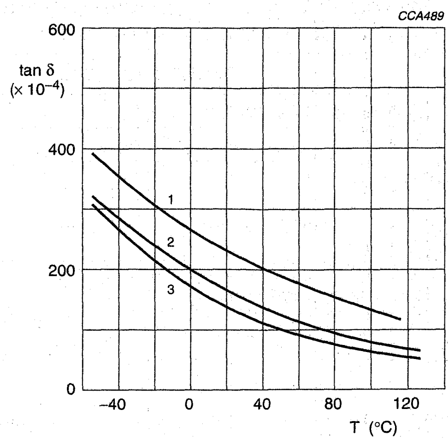
Note

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



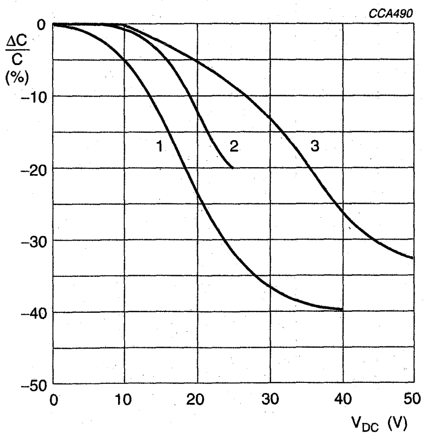
Curve 1 = 16 V product
Curve 2 = 25 V and 50 V products.

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



Curve 1 = 16 V product
Curve 2 = 25 V product
Curve 3 = 50 V product.

Fig.4 Typical tan δ as a function of temperature.



Curve 1 = 16 V product
Curve 2 = 25 V product
Curve 3 = 50 V product.

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

Surface mount ceramic multilayer capacitors

Class 2, X7R 50 V Low Inductance

FEATURES

- One standard size
- For high frequency applications
- Supplied in tape on reel or in bulk case
- Nickel-barrier end terminations.

APPLICATIONS

Consumer electronics, for example:

- High speed IC packages
- Processor package decoupling
- AC noise reduction in multi-chip modules.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V
Capacitance range (E6 series)	10 to 22 nF; note 1
Tolerance on capacitance after 1 000 hours	±10%; note 2
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Equivalent series inductance (ESL)	500 pH
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
End terminations	NiSn
Climatic category (IEC 60068)	55/125/21

Notes

1. Other values on request.
2. Special tolerance values available on request.

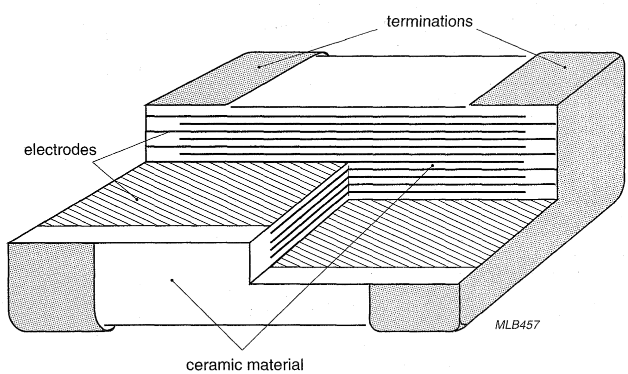
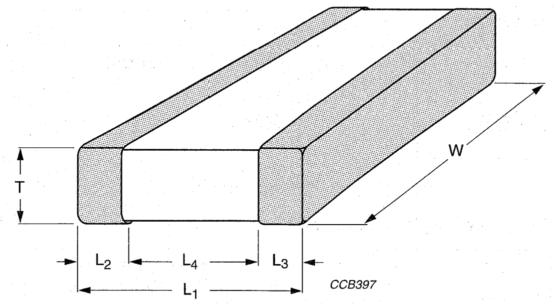


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

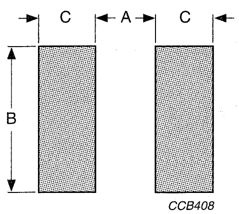
Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions; see Fig.2

CASE SIZE	L_1	W	T	L_2 and L_3		L_4
				MIN.	MAX.	MIN.
Dimensions in millimetres						
0612	1.60 ±0.20	3.20 ±0.20	0.85 ±0.10	0.13	0.46	0.50
Dimensions in inches						
0612	0.062 ±0.008	0.125 ±0.008	0.033 ±0.004	0.005	0.018	0.019

Footprint



For dimensions see Table 2.

Fig.3 Footprint dimensions.

Table 2 Footprint dimensions; see Fig.3

FOOTPRINT DIMENSIONS (mm)		
A	B	C
0.762	3.048	0.889

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	50 V
		0612
10	36	thickness classification: 0.85 ±0.10
12	37	
15	38	
18	39	
22	41	

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL			
	∅180 mm; 7"		∅330 mm; 13"	
	PAPER	BLISTER	PAPER	BLISTER
0.85 ±0.10	4000	4000	15000	10000

ORDERING INFORMATION

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

Clear text code

Example: 06122R101K9BB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0612	2R = X7R	101 = 100 pF; the third digit signifies the number of zeros	K = ±10%	9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister	0 = no marking	0 = conv. ceramic

Ordering code 12NC

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

Carrier type
50 blister
55 paper tape
56 bulk

Rated voltage - Termination
06 50 V; Ni-barrier

Size
0 0612 low inductance

Capacitance value(1)

Tolerance
6 ±10%

Packaging(2)
1 reel: ∅180 mm; 7"
5 reel: ∅330 mm; 13"
4 bulk case

CCB398

(1) Refer to Chapter “Selection chart”.
(2) Amount on reel depends on thickness classification, see Section “Thickness classification and packaging quantities”.

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; low inductance; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 20 ±1 °C, an atmospheric pressure of 86 to 105 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1	10 to 22 nF
Tolerance on capacitance after 1 000 hours	±10%
Tan δ; note 1	≤2.5%
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} \geq 1.5$ MΩ or $R_{ins} \times C \geq 1000$ seconds
Typical capacitance change as a function of temperature	±15%
Ageing	typical 1% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

1. Measured at 20 °C, 1 V and 1 kHz, using a four-gauge method.

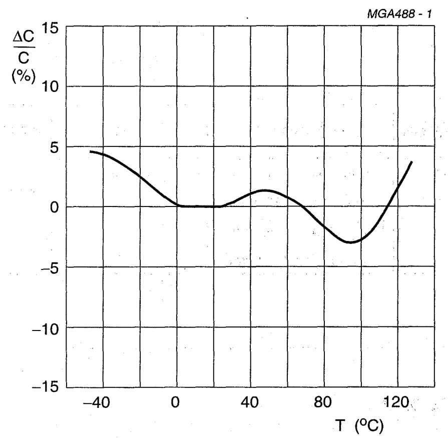


Fig.4 Typical capacitance change as a function of temperature.

Surface mount ceramic multilayer capacitors — Class 2, X7R 16/25/50/100/200 and 500 V Noble Metal Electrode

FEATURES

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

APPLICATIONS

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

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	16 V, 25 V, 50 V, 100 V, 200 V and 500 V (IEC)
Capacitance range (E12 series); note 1:	
16 V	4.7 nF to 100 nF
25 V	3.3 nF to 220 nF
50 V; note 2	100 pF to 470 nF
100 V	180 pF to 330 nF
200 V	180 pF to 120 nF
500 V	470 pF to 15 nF
Tolerance on capacitance	±20%, ±10%, ±5%
Test voltage (DC) for 1 minute:	
16 V, 25 V, 50 V and 100 V	$2.5 \times U_R$
200 V	$3 \times U_R$
500 V	$2 \times U_R$
Sectional specifications	IEC 384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 68)	55/125/56

Notes

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

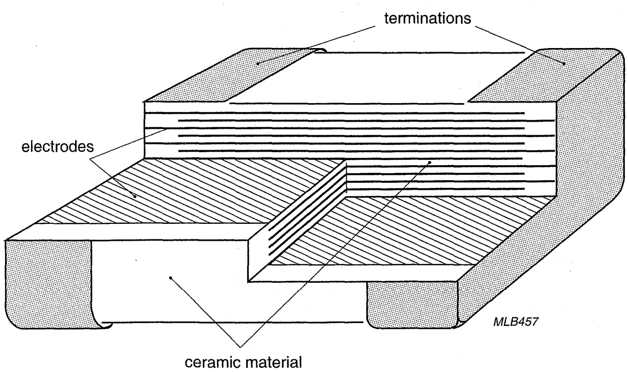
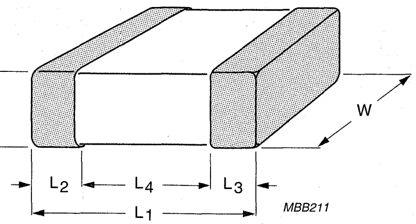


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T		L_2 and L_3		L_4
			MIN.	MAX.	MIN.	MAX.	MIN.
Dimensions in millimetres							
0402	1.0 ±0.05	0.5 ±0.05	0.45	0.55	0.20	0.30	0.40
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.80	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	1.80	0.25	0.75	2.90
Dimensions in inches							
0402	0.040 ±0.002	0.020 ±0.002	0.018	0.022	0.008	0.012	0.016
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056
1812	0.177 ±0.008	0.126 ±0.008	0.020	0.072	0.010	0.030	0.088
2220	0.224 ±0.008	0.197 ±0.008	0.020	0.072	0.010	0.030	0.114

SELECTION CHART FOR 16 V AND 25 V

<table>
<tr><th rowspan="2">C (nF)</th><th rowspan="2">LAST TWO DIGITS OF 12NC</th><th colspan="4">16 V</th><th colspan="5">25 V</th></tr>
<tr><th>0402</th><th>0603</th><th>0805</th><th>1206</th><th>0402</th><th>0603</th><th>0805</th><th>1206</th><th>1210</th></tr>
<tr><td>3.3</td><td>29</td><td rowspan="2"></td><td rowspan="10"></td><td rowspan="14"></td><td rowspan="22"></td><td rowspan="3">0.5 ±0.05</td><td rowspan="6"></td><td rowspan="6"></td><td rowspan="18"></td><td rowspan="22"></td></tr>
<tr><td>3.9</td><td>31</td></tr>
<tr><td>4.7</td><td>32</td><td rowspan="9">0.5 ±0.05</td></tr>
<tr><td>5.6</td><td>33</td><td rowspan="25"></td></tr>
<tr><td>6.8</td><td>34</td></tr>
<tr><td>8.2</td><td>35</td></tr>
<tr><td>10</td><td>36</td><td rowspan="6">0.8 ±0.07</td><td rowspan="7">0.6 ±0.1</td></tr>
<tr><td>12</td><td>37</td></tr>
<tr><td>15</td><td>38</td></tr>
<tr><td>18</td><td>39</td></tr>
<tr><td>22</td><td>41</td><td rowspan="9">0.8 ±0.07</td></tr>
<tr><td>27</td><td>42</td><td rowspan="20"></td></tr>
<tr><td>33</td><td>43</td><td rowspan="16"></td></tr>
<tr><td>39</td><td>44</td><td rowspan="6">0.85 ±0.1</td></tr>
<tr><td>47</td><td>45</td><td rowspan="3">0.6 ±0.1</td></tr>
<tr><td>56</td><td>46</td></tr>
<tr><td>68</td><td>47</td></tr>
<tr><td>82</td><td>48</td><td rowspan="8">0.85 ±0.1</td></tr>
<tr><td>100</td><td>49</td><td rowspan="5">0.85 ±0.1</td></tr>
<tr><td>120</td><td>51</td><td rowspan="12"></td><td rowspan="9"></td></tr>
<tr><td>150</td><td>52</td></tr>
<tr><td>180</td><td>53</td></tr>
<tr><td>220</td><td>54</td><td rowspan="4">0.85 ±0.1</td><td rowspan="4">0.5 to 1.0</td></tr>
<tr><td>270</td><td>55</td><td rowspan="2">1.15 ±0.1</td></tr>
<tr><td>330</td><td>56</td></tr>
<tr><td>390</td><td>57</td><td rowspan="2">1.25 ±0.1</td><td rowspan="3"></td></tr>
<tr><td>470</td><td>58</td><td rowspan="5">1.15 ±0.1</td><td>0.9 to 1.3</td></tr>
<tr><td>560</td><td>59</td><td rowspan="4"></td><td></td></tr>
<tr><td>680</td><td>61</td><td colspan="5" rowspan="2">Values in shaded cells indicate thickness classification.</td></tr>
<tr><td>820</td><td>62</td></tr>
<tr><td>1000</td><td>63</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE		
	∅180 mm; 7"		∅330 mm; 13"				
	PAPER	BLISTER	PAPER	BLISTER	0402	0603	0805
0.5 ±0.05	10000	–	50000	–	50000	–	–
0.6 ±0.1	4000	4000	20000	10000	–	–	10000
0.85 ±0.1	4000	4000	15000	10000	–	–	8000
0.5 to 1.0	–	4000	–	10000	–	–	–
0.8 ±0.07	4000	4000	15000	15000	–	15000	–
0.9 to 1.3	–	3000	–	10000	–	–	–
1.15 ±0.1	–	3000	–	10000	–	–	–
1.25 ±0.1	–	3000	–	10000	–	–	5000

ORDERING INFORMATION FOR 16 V AND 25 V

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

Clear text code

Example: 08052R104K8BB00

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

Ordering code 12NC

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

Carrier type
- 22 blister
- 38 paper
- 54 bulk

Rated voltage - Termination
- 78 16 V; Ni-barrier
- 91 25 V; Ni-barrier

Size
- 7 0402
- 6 0603
- 0 0805
- 1 1206
- 2 1210

Capacitance value(1)

Tolerance
- 5 ±5%
- 6 ±10%
- 7 ±20%

Packaging(2)
- 1 reel: Ø180 mm; 7"
- 5 reel: Ø330 mm; 13"
- 4 bulk case

CCA611

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

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

SELECTION CHART FOR 50 V

<table>
<tr><th rowspan="2">C
(pF)</th><th rowspan="2">LAST
TWO DIGITS
OF 12NC</th><th colspan="7">50 V</th></tr>
<tr><th>0402</th><th>0603</th><th>0805</th><th>1206</th><th>1210</th><th>1812</th><th>2220</th></tr>
<tr><td>100</td><td>01</td><td rowspan="19">0.5 ±0.05</td><td rowspan="28">0.8 ±0.07</td><td rowspan="3"></td><td rowspan="4"></td><td rowspan="24"></td><td rowspan="36"></td><td rowspan="40"></td></tr>
<tr><td>120</td><td>02</td></tr>
<tr><td>150</td><td>03</td></tr>
<tr><td>180</td><td>04</td><td rowspan="26">0.6 ±0.1</td></tr>
<tr><td>220</td><td>05</td><td rowspan="34">0.85 ±0.1</td></tr>
<tr><td>270</td><td>06</td></tr>
<tr><td>330</td><td>07</td></tr>
<tr><td>390</td><td>08</td></tr>
<tr><td>470</td><td>09</td></tr>
<tr><td>560</td><td>11</td></tr>
<tr><td>680</td><td>12</td></tr>
<tr><td>820</td><td>13</td></tr>
<tr><td>1000</td><td>14</td></tr>
<tr><td>1200</td><td>15</td></tr>
<tr><td>1500</td><td>16</td></tr>
<tr><td>1800</td><td>17</td></tr>
<tr><td>2200</td><td>18</td></tr>
<tr><td>2700</td><td>19</td></tr>
<tr><td>3300</td><td>21</td></tr>
<tr><td>3900</td><td>22</td><td rowspan="30"></td></tr>
<tr><td>4700</td><td>23</td></tr>
<tr><td>5600</td><td>24</td></tr>
<tr><td>6800</td><td>25</td></tr>
<tr><td>8200</td><td>26</td></tr>
<tr><td>10000</td><td>27</td><td rowspan="15">0.5 to 1.0</td></tr>
<tr><td>12000</td><td>28</td></tr>
<tr><td>15000</td><td>29</td></tr>
<tr><td>18000</td><td>31</td></tr>
<tr><td>22000</td><td>32</td><td rowspan="18"></td></tr>
<tr><td>27000</td><td>33</td><td rowspan="5">0.85 ±0.1</td></tr>
<tr><td>33000</td><td>34</td></tr>
<tr><td>39000</td><td>35</td></tr>
<tr><td>47000</td><td>36</td></tr>
<tr><td>56000</td><td>37</td></tr>
<tr><td>68000</td><td>38</td><td rowspan="3">1.25 ±0.1</td></tr>
<tr><td>82000</td><td>39</td></tr>
<tr><td>100000</td><td>41</td><td rowspan="8">0.5 to 1.0</td></tr>
<tr><td>120000</td><td>42</td><td rowspan="9"></td></tr>
<tr><td>150000</td><td>43</td><td rowspan="3">1.15 ±0.1</td></tr>
<tr><td>180000</td><td>44</td><td rowspan="2">0.9 to 1.3</td></tr>
<tr><td>220000</td><td>45</td><td rowspan="8">0.5 to 1.0</td></tr>
<tr><td>270000</td><td>46</td><td rowspan="5"></td><td rowspan="5"></td></tr>
<tr><td>330000</td><td>47</td></tr>
<tr><td>390000</td><td>48</td></tr>
<tr><td>470000</td><td>49</td><td>0.9 to 1.3</td></tr>
<tr><td>560000</td><td>51</td><td rowspan="4"></td></tr>
<tr><td>680000</td><td>52</td><td colspan="4" rowspan="2">Values in shaded cells indicate thickness classification.</td></tr>
<tr><td>820000</td><td>53</td></tr>
<tr><td>1000000</td><td>54</td><td></td><td></td><td></td><td></td><td>0.9 to 1.3</td></tr>
</table>

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE		
	∅180 mm; 7"		∅330 mm; 13"		∅180 mm; 7" BLISTER				
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805
0.5 ±0.05	10000	–	50000	–	–	–	50000	–	–
0.6 ±0.1	4000	4000	20000	10000	–	–	–	–	10000
0.85 ±0.1	4000	4000	15000	10000	–	–	–	–	8000
0.5 to 1.0	–	4000	–	10000	2000	1500	–	–	–
0.8 ±0.07	4000	4000	15000	15000	–	–	–	15000	–
0.9 to 1.3	–	3000	–	10000	1500	1500	–	–	–
1.15 ±0.1	–	3000	–	10000	–	–	–	–	–
1.25 ±0.1	–	3000	–	10000	–	–	–	–	5000
1.2 to 1.75	–	–	–	–	1200	–	–	–	–

ORDERING INFORMATION FOR 50 V

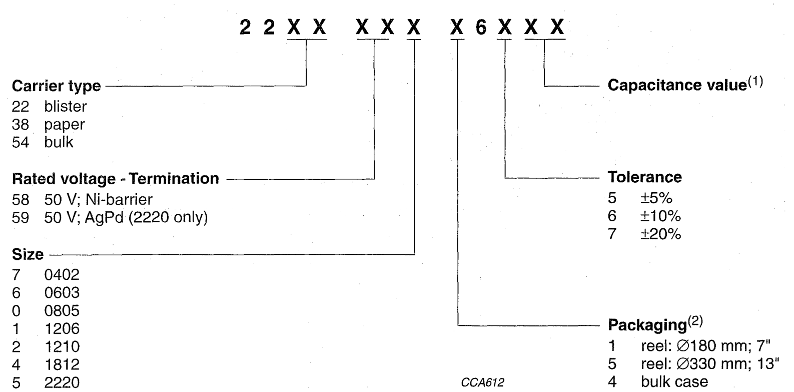
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 08052R104K9BB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402 0603 0805 1206 1210 1812 2220	2R = X7R	104 = 100000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	9 = 50 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC



(1) Refer to Chapter "Selection chart for 50 V".
(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

SELECTION CHART FOR 100 V, 200 V AND 500 V

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

Values in shaded cells indicate thickness classification.

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL	AMOUNT PER BULK CASE
	∅180 mm; 7"		∅330 mm; 13"		∅180 mm; 7" BLISTER	
	PAPER	BLISTER	PAPER	BLISTER	1812	0805
0.6 ±0.1	4000	4000	20000	10000	–	10000
0.85 ±0.1	4000	4000	15000	10000	–	8000
0.8 to 1.0	–	4000	–	10000	–	–
0.5 to 1.0	–	4000	–	10000	2000	–
0.8 ±0.07	4000	4000	15000	15000	–	–
0.9 to 1.3	–	3000	–	10000	1500	–
1.15 ±0.1	–	3000	–	10000	–	–
1.25 ±0.1	–	3000	–	10000	–	5000
1.2 to 1.75	–	2500	–	10000	–	–

ORDERING INFORMATION FOR 100 V, 200 V AND 500 V

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

Clear text code

Example: 18122R103KBBB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0805 1206 1210 1812	2R = X7R	103 = 10000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	0 = 100 V B = 200 V D = 500 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

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

Carrier type
22 blister
38 paper
54 bulk

Rated voltage - Termination
60 100 V; Ni-barrier
93 200 V; Ni-barrier
97 500 V; Ni-barrier

Size
0 0805
1 1206
2 1210
4 1812

Capacitance value(1)

Tolerance
5 ±5%
6 ±10%
7 ±20%

Packaging(2)
1 reel: ∅180 mm; 7"
5 reel: ∅330 mm; 13"
4 bulk case

CCA613

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

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

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; X7R dielectric; AgPd and NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	100 pF to 100 nF
Tolerance on capacitance after 1 000 hours	±20%, ±10%, ±5%; note 2
Tan δ; note 1	≤2.5%; 16 V range ≤3.5%
Insulation resistance after 1 minute at U_R (DC): C ≤ 10 nF C > 10 nF	 R_{ins} > 100 GΩ R_{ins} × C > 1 000 seconds
Maximum capacitance change as a function of temperature (for typical values see Fig.3)	±15%
Ageing	typical 1% per time decade

Notes

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

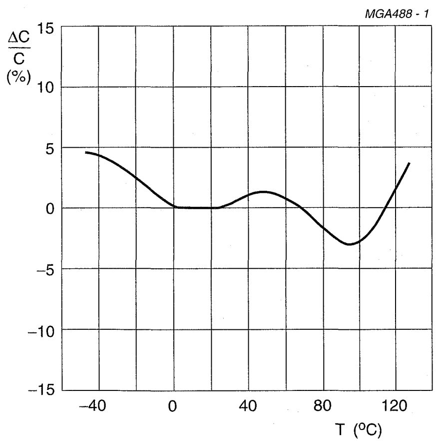
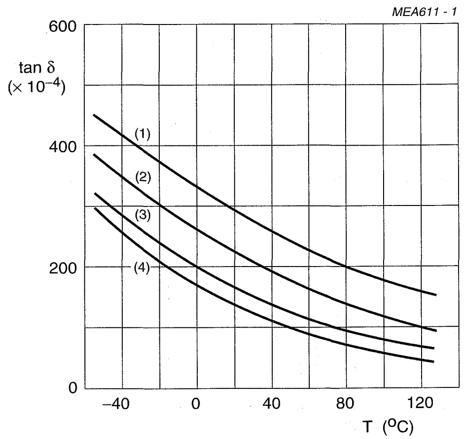


Fig.3 Typical capacitance change as a function of temperature.



Curve 1 = 16 V product.
Curve 2 = 25 V product.
Curve 3 = 50 V and 100 V products.
Curve 4 = 200 V and 500 V products.

Fig.4 Typical tan δ as a function of temperature.

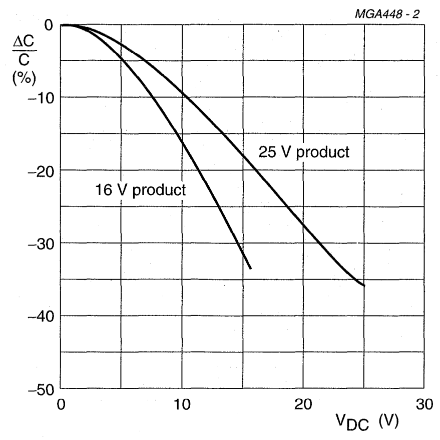


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

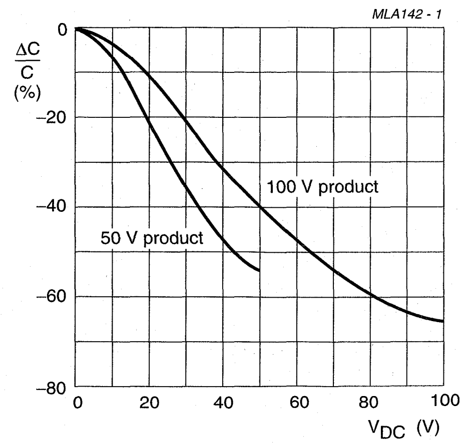


Fig.6 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

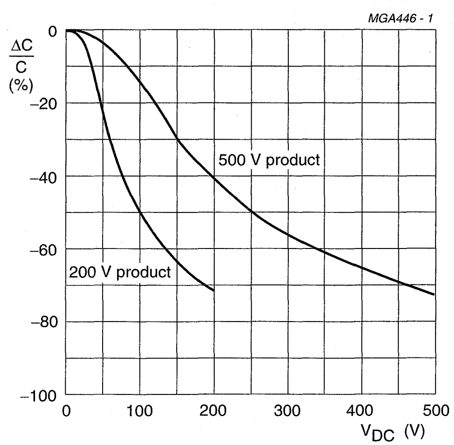


Fig.7 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

FEATURES

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

APPLICATIONS

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

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

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

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	1 kV (IEC)
Capacitance range (E12 series); note 1	1 nF to 10 nF
Tolerance on capacitance at T_{amb} = 20 °C	±20%, ±10%, ±5%; note 2
Test voltage (DC) for 1 minute	1.5 × U_R
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Notes

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

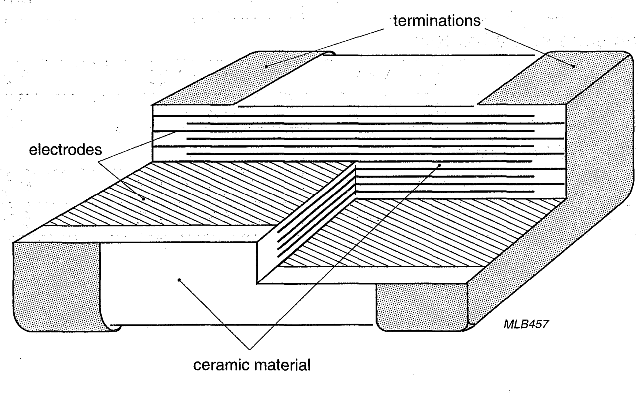
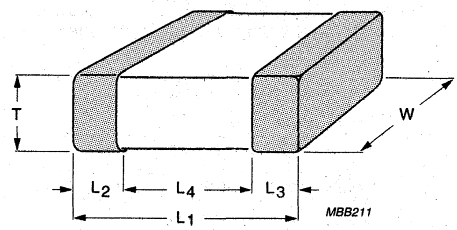


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T MAX.	L_2 and L_3 MAX.	L_4 MIN.
Dimensions in millimetres					
1808	4.5 ±0.20	2.0 ±0.20	2.0	0.75	2.20
1812	4.5 ±0.20	3.2 ±0.20	2.5	0.75	2.20
Dimensions in inches					
1808	0.177 ±0.008	0.079 ±0.008	0.028	0.030	0.088
1812	0.177 ±0.008	0.126 ±0.008	0.072	0.030	0.088

SELECTION CHART

<table>
<tr><th rowspan="2">C
(nF)</th><th rowspan="2">LAST TWO DIGITS OF 12NC</th><th colspan="2">1 kV</th></tr>
<tr><th>1808</th><th>1812</th></tr>
<tr><td>1.0</td><td>23</td><td rowspan="7">1.2 to 1.75</td><td rowspan="13">1.2 to 1.75</td></tr>
<tr><td>1.2</td><td>24</td></tr>
<tr><td>1.5</td><td>25</td></tr>
<tr><td>1.8</td><td>26</td></tr>
<tr><td>2.2</td><td>27</td></tr>
<tr><td>2.7</td><td>28</td></tr>
<tr><td>3.3</td><td>29</td></tr>
<tr><td>3.9</td><td>31</td><td rowspan="6"></td></tr>
<tr><td>4.7</td><td>32</td></tr>
<tr><td>5.6</td><td>33</td></tr>
<tr><td>6.8</td><td>34</td></tr>
<tr><td>8.2</td><td>35</td></tr>
<tr><td>10</td><td>36</td></tr>
</table>

Thickness classification and packaging quantities

<table>
<tr><th rowspan="3">THICKNESS CLASSIFICATION (mm)</th><th colspan="2">12 mm TAPE WIDTH AMOUNT PER REEL</th></tr>
<tr><th colspan="2">∅180 mm; 7" BLISTER</th></tr>
<tr><th>1808</th><th>1812</th></tr>
<tr><td>1.2 to 1.75</td><td>1000</td><td>1000</td></tr>
</table>

ORDERING INFORMATION

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

Clear text code

Example: 18082R102KEBB00

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

Ordering code 12NC

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

Carrier type
50 blister
56 bulk

Size
3 1808
4 1812

Packaging(2)
1 reel: ∅180 mm; 7" reel
12 mm blister tape

Capacitance value(1)

Tolerance
5 ±5%
6 ±10%
7 ±20%

CCA685

(1) Refer to Chapter "Selection chart".
(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; X7R dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	1 nF to 10 nF
Tolerance on capacitance	±20%, ±10%, ±5%; note 2
Tan δ; note 1	≤2.5%
Insulation resistance after 1 minute at U_R (DC):	
$C \leq 10$ nF	$R_{ins} > 100$ GΩ
$C > 10$ nF	$R_{ins} \times C > 1000$ seconds
Typical capacitance change as a function of temperature; see Fig.3	±15%
Ageing	typical 1% per time decade

Notes

1. Measured at 1 V, 1 MHz for $C \leq 1000$ pF, and 1 V, 1 kHz for $C > 1000$ pF, using a four-gauge method.
2. Special tolerance available on request.

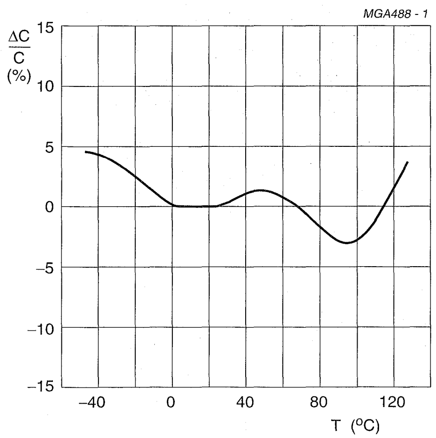


Fig.3 Typical capacitance change as a function of temperature.

Surface mounted ceramic multilayer capacitors

Class 2, Y5V 10 V

FEATURES

- Three standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case
- Nickel-barrier end terminations.

APPLICATIONS

Consumer electronics, for example:

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

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	10 V
Capacitance range (E6 series)	1.0 to 10 μF; note 1
Tolerance on capacitance after 1000 hours	−20% to +80% (Z)
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
End terminations	NiSn
Climatic category (IEC 60068)	25/085/21

Note

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

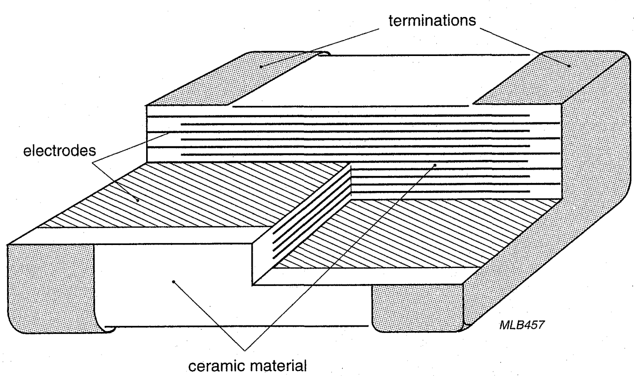
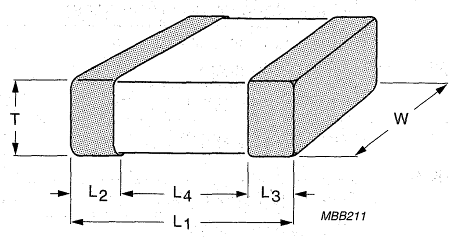


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T MIN.	T MAX.	L_2 and L_3 MIN.	L_2 and L_3 MAX.	L_4 MIN.
Dimensions in millimetres							
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.1	1.25 ±0.1	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
Dimensions in inches							
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056

SELECTION CHART FOR 10 V

C (nF)	LAST TWO DIGITS OF 12NC	10 V		
		0603	0805	1206
1000	63	0.8 ±0.07		0.85 ±0.10
1500	65			
2200	67		1.25 ±0.10	
3300	69			1.15 ±0.10
4700	72			
6800	74	Values in shaded cells indicate thickness classification.		1.60 ±0.15
10000	76			

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE	
	∅180 mm; 7"		∅330 mm; 13"		0603	0805
	PAPER	BLISTER	PAPER	BLISTER		
0.8 ±0.07	4000	4000	15000	15000	15000	–
0.85 ±0.10	4000	4000	15000	15000	–	–
1.15 ±0.10	–	3000	–	10000	–	–
1.25 ±0.10	–	3000	–	10000	–	5000
1.60 ±0.15	–	2000	–	7000	–	–

ORDERING INFORMATION

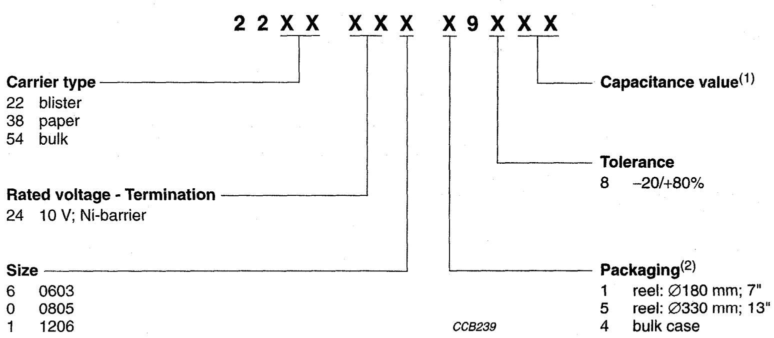
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 06032F102Z24BB0D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206	2F = Y5V	102 = 1000 pF; the third digit signifies the number of zeros	Z = −20%/+80%	6 = 10 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking	D = BME

Ordering code 12NC



(1) Refer to Chapter “Selection chart for 10 V”.

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

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; Y5V dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1.	1.0 to 10 μF
Tolerance on capacitance after 1000 hours	−20% to +80% (Z)
Tan δ; note 1.	≤12.5%
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} \times C \geq 500$ seconds
Maximum capacitance change as a function of temperature	+30% to −80%
Ageing	typical 7% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

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

Surface mount ceramic multilayer capacitors

Class 2, Y5V 16 V, 25 V and 50 V

FEATURES

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

APPLICATIONS

Consumer electronics, for example:

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

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	16 V, 25 V, 50 V
Capacitance range (E6 series)	10 nF to 4.7 µF; note 1
Tolerance on capacitance after 1000 hours	±20% (M); −20% to +80% (Z)
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
End terminations	NiSn
Climatic category (IEC 60068)	25/85/21

Note

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

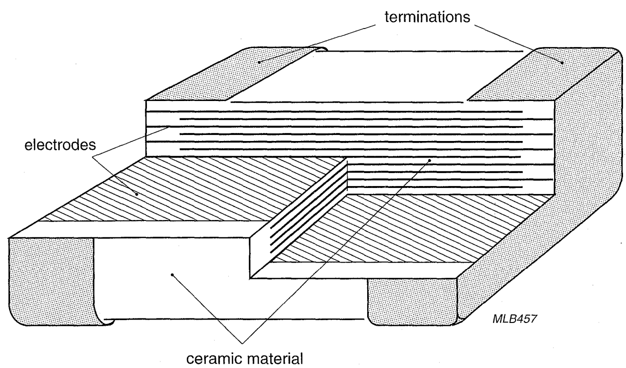
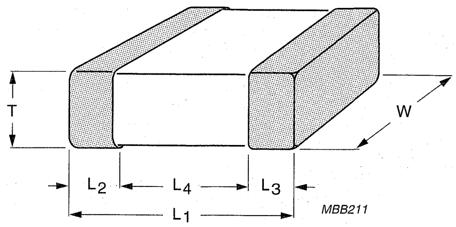


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T		L_2 and L_3		L_4 MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0402	1.0 ±0.05	0.50 ±0.05	0.45	0.55	0.15	0.30	0.40
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
Dimensions in inches							
0402	0.040 ±0.002	0.020 ±0.002	0.018	0.022	0.008	0.012	0.016
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056

SELECTION CHART FOR 16 V AND 25 V

<table>
<tr><th rowspan="2">C
(nF)</th><th rowspan="2">LAST
TWO DIGITS
OF 12NC</th><th colspan="4">16 V</th><th colspan="3">25 V</th></tr>
<tr><th>0402</th><th>0603</th><th>0805</th><th>1206</th><th>0603</th><th>0805</th><th>1206</th></tr>
<tr><td>10</td><td>36</td><td rowspan="7">0.5 ±0.05</td><td rowspan="7"></td><td rowspan="7"></td><td rowspan="7"></td><td rowspan="7">0.8 ±0.07</td><td rowspan="6"></td><td rowspan="6"></td></tr>
<tr><td>15</td><td>38</td></tr>
<tr><td>22</td><td>41</td></tr>
<tr><td>33</td><td>43</td></tr>
<tr><td>47</td><td>45</td></tr>
<tr><td>68</td><td>47</td></tr>
<tr><td>100</td><td>49</td><td>0.6 ±0.1</td><td rowspan="4">0.6 ±0.1</td></tr>
<tr><td>150</td><td>52</td><td rowspan="12"></td><td rowspan="4">0.8 ±0.07</td><td colspan="2" rowspan="2">Values in shaded cells indicate thickness classification.</td><td rowspan="12"></td><td rowspan="2">0.85 ±0.1</td></tr>
<tr><td>220</td><td>54</td></tr>
<tr><td>330</td><td>56</td><td></td><td rowspan="3"></td><td>1.25 ±0.1</td></tr>
<tr><td>470</td><td>58</td><td rowspan="2">0.85 ±0.1</td><td rowspan="9"></td><td rowspan="2">0.85 ±0.1</td></tr>
<tr><td>680</td><td>61</td><td rowspan="8"></td></tr>
<tr><td>1000</td><td>63</td><td rowspan="3">1.25 ±0.1</td><td rowspan="2">0.85 ±0.1</td><td>1.15 ±0.1</td></tr>
<tr><td>1500</td><td>65</td><td rowspan="6"></td></tr>
<tr><td>2200</td><td>67</td><td rowspan="5">1.15 ±0.1</td></tr>
<tr><td>2700</td><td>68</td><td rowspan="4"></td></tr>
<tr><td>3300</td><td>69</td></tr>
<tr><td>3900</td><td>71</td></tr>
<tr><td>4700</td><td>72</td></tr>
</table>

SELECTION CHART FOR 50 V

<table>
<tr><th rowspan="2">C
(nF)</th><th rowspan="2">LAST
TWO DIGITS
OF 12NC</th><th colspan="3">50 V</th></tr>
<tr><th>0603</th><th>0805</th><th>1206</th></tr>
<tr><td>10</td><td>05</td><td rowspan="7">0.8 ±0.07</td><td rowspan="7">0.6 ±0.1</td><td rowspan="6"></td></tr>
<tr><td>15</td><td>06</td></tr>
<tr><td>22</td><td>07</td></tr>
<tr><td>33</td><td>08</td></tr>
<tr><td>47</td><td>09</td></tr>
<tr><td>68</td><td>11</td></tr>
<tr><td>100</td><td>12</td><td rowspan="4">0.6 ±0.1</td></tr>
<tr><td>150</td><td>13</td><td rowspan="4"></td><td rowspan="2">0.85 ±0.1</td></tr>
<tr><td>220</td><td>14</td></tr>
<tr><td>330</td><td>15</td><td>1.25 ±0.1</td></tr>
<tr><td>470</td><td>16</td><td></td><td rowspan="2">0.85 ±0.1</td></tr>
<tr><td>680</td><td>17</td><td colspan="2" rowspan="2">Values in shaded cells indicate thickness classification.</td></tr>
<tr><td>1000</td><td>18</td><td>1.15 ±0.1</td></tr>
</table>

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE		
	∅180 mm; 7"		∅330 mm; 13"		0402	0603	0805
	PAPER	BLISTER	PAPER	BLISTER			
0.5 ±0.05	10000	–	50000	–	50000	–	10000
0.6 ±0.1	4000	4000	10000	10000	–	–	10000
0.85 ±0.1	4000	4000	10000	10000	–	–	8000
0.8 ±0.07	4000	4000	15000	15000	–	15000	–
1.25 ±0.1	–	3000	–	10000	–	–	5000
1.15 ±0.1	–	3000	–	10000	–	–	–

ORDERING INFORMATION

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

Clear text code

Example: 12062F105M8BB0D

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

Ordering code 12NC

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

Carrier type
22 blister
38 paper
54 bulk

Rated voltage - Termination
78 16 V; Ni-barrier
91 25 V; Ni-barrier
58 50 V; Ni-barrier

Size
7 0402
6 0603
0 0805
1 1206

Capacitance value(1)

Tolerance
7 ±20%
8 −20/+80%

Packaging(2)
1 reel: ∅180 mm; 7"
5 reel: ∅330 mm; 13"
4 bulk case

CCA620

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

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

ELECTRICAL CHARACTERISTICS

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

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

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1	10 nF to 4.7 μF
Tolerance on capacitance after 1000 hours	−20% (M); −20% to +80% (Z)
Tan δ; note 1:	
all 25 V and 50 V (except 1206 and 1 μF; 0603 and 100 nF; 0805 and 330 nF)	≤5%
sizes 1206 and 1 μF; 0603 and 100 nF; 0805 and 330 nF	≤7%
all 16 V (except 0402; 0603 and 330 nF, 470 nF; 0805 and 2.2 μF; 1206 and 3.3 μF, 4.4 μF)	≤9%
sizes 0402; 0603 and 330 nF, 470 nF; 0805 and 2.2 μF; 1206 and 3.3 μF, 4.4 μF	≤12.5%
Insulation resistance after 1 minute at U_R (DC)	$I_R \times C > 500$ seconds
Maximum capacitance change with respect to capacitance at 25 °C (for typical values see Fig.5)	+22% to −82%
Ageing	typical 7% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

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

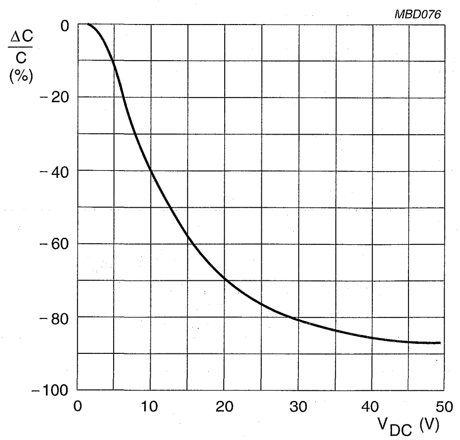


Fig.3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 25 °C.

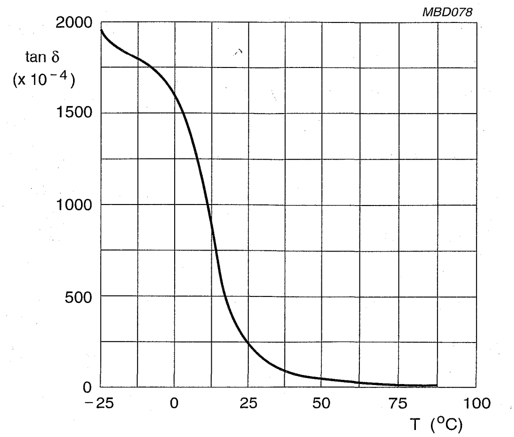


Fig.4 Typical tan δ as a function of temperature.

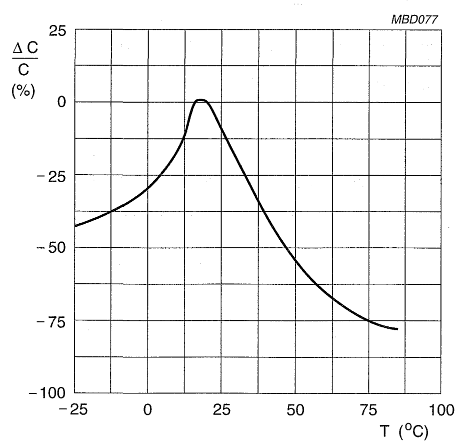


Fig.5 Typical capacitance change as a function of temperature.

Surface mount ceramic multilayer capacitors

Class 2, Z5U 25 V

FEATURES

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

APPLICATIONS

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

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	25 V
Capacitance range (E12 series):	
case size 0603	10 nF to 100 nF
case size 1206	470 nF to 1 μF
Tolerance on capacitance after 1000 hours	±20% (M); −20% to ±80% (Z)
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	10/085/21

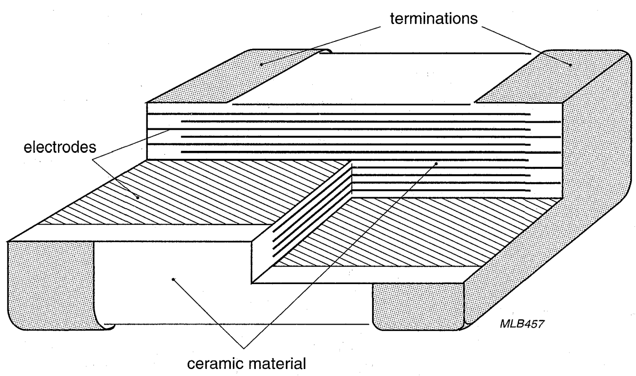
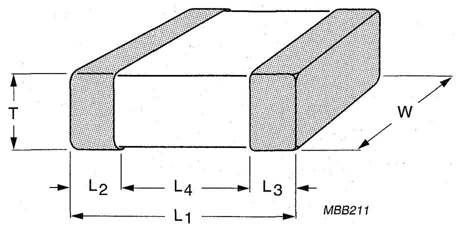


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T MIN.	T MAX.	L_2 and L_3 MIN.	L_2 and L_3 MAX.	L_4 MIN.
Dimensions in millimetres							
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
1206	3.2 ±0.15	1.6 ±0.15	0.50	1.75	0.25	0.75	1.40
Dimensions in inches							
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	25 V	
		0603	1206
10	36		
12	37		
15	38		
18	39		
22	41		
27	42		
33	43	0.80 ±0.07	
39	44		
47	45		
56	46		
68	47		
82	48		
100	49		
120	51		
150	52	Values in shaded cells indicate thickness classification	
180	53		
220	54		
270	55		
330	56		
390	57		
470	58		
560	59		
680	61		1.15 ±0.1
820	62		
1000	63		

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE
	∅180 mm; 7"		∅330 mm; 13"		0603
	PAPER	BLISTER	PAPER	BLISTER	
0.80 ±0.07	4000	4000	15000	15000	15000
1.15 ±0.1	–	3000	–	10000	–

ORDERING INFORMATION

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

Clear text code

Example: 06032E104Z8B20D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 1206	2E = Z5U	104 = 100000 pF; the third digit signifies the number of zeros	M ±20% Z −20%/+80%	8 = 25 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

Ordering code 12NC

2 2 X X 6 2 X X 8 X X X

Carrier type
22 blister
38 paper
54 bulk

Size
5 0603
7 1206

Capacitance value(1)

Tolerance
7 ±20%
8 −20%/+80%

Packaging(2)
1 reel: ∅180 mm; 7"
5 reel: ∅330 mm; 13"
4 bulk case

CCB394

(1) Refer to Chapter “Selection chart”.
(2) Amount on reel depends on thickness classification, see Section “Thickness classification and packaging quantities”.

Surface mount ceramic multilayer capacitors

Class 2, Z5U 25 V

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; Z5U dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series):	
case size 0603	10 nF to 100 nF
case size 1206	470 nF to 1 μF
Tolerance on capacitance after 1 000 hours	±20% (M); −20% to +80% (Z)
Tan δ; note 1	≤6%
Insulation resistance after 1 minute at U_R (DC)	R_{ins} > 10 GΩ or $R_{ins} \times C$ > 1 000 seconds, whichever is smaller
Maximum capacitance change with respect to capacitance at 25 °C	+22% to −56%
Ageing	typical 4% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

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

Surface mount ceramic multilayer capacitors

Class 2, Z5U 50 V

FEATURES

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

APPLICATIONS

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

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V
Capacitance range (E12 series):	
case size 0805	10 nF to 220 nF
case size 1206	10 nF to 470 nF
case size 1210	100 nF to 1 μF
Tolerance on capacitance after 1000 hours	±20% (M) −20% to +80% (Z)
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	10/085/21

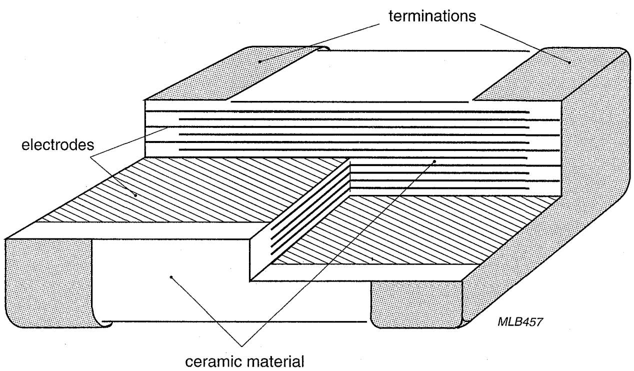
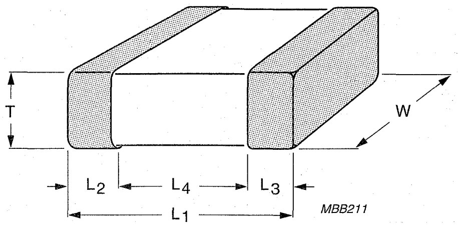


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T		L_2 and L_3		L_4
			MIN.	MAX.	MIN.	MAX.	MIN.
Dimensions in millimetres							
0805	2.0 ±0.1	1.25 ±0.1	0.50	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.50	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.50	1.80	0.25	0.75	1.40
Dimensions in inches							
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056

SELECTION CHART

<table>
<tr><th rowspan="2">C
(nF)</th><th rowspan="2">LAST
TWO DIGITS
OF 12NC</th><th colspan="3">50 V</th></tr>
<tr><th>0805</th><th>1206</th><th>1210</th></tr>
<tr><td>10</td><td>36</td><td rowspan="13">0.6 ±0.1</td><td rowspan="17">0.6 ±0.1</td><td rowspan="12"></td></tr>
<tr><td>12</td><td>37</td></tr>
<tr><td>15</td><td>38</td></tr>
<tr><td>18</td><td>39</td></tr>
<tr><td>22</td><td>41</td></tr>
<tr><td>27</td><td>42</td></tr>
<tr><td>33</td><td>43</td></tr>
<tr><td>39</td><td>44</td></tr>
<tr><td>47</td><td>45</td></tr>
<tr><td>56</td><td>46</td></tr>
<tr><td>68</td><td>47</td></tr>
<tr><td>82</td><td>48</td></tr>
<tr><td>100</td><td>49</td><td rowspan="11">0.5 to 1.0</td></tr>
<tr><td>120</td><td>51</td><td rowspan="2">0.85 ±0.1</td></tr>
<tr><td>150</td><td>52</td></tr>
<tr><td>180</td><td>53</td><td rowspan="2">1.25 ±0.1</td></tr>
<tr><td>220</td><td>54</td></tr>
<tr><td>270</td><td>55</td><td rowspan="5"></td><td rowspan="3">0.85 ±0.1</td></tr>
<tr><td>330</td><td>56</td></tr>
<tr><td>390</td><td>57</td></tr>
<tr><td>470</td><td>58</td><td>1.15 ±0.1</td></tr>
<tr><td>560</td><td>59</td><td></td></tr>
<tr><td>680</td><td>61</td><td colspan="2">Values in shaded cells indicate thickness classification.</td></tr>
<tr><td>820</td><td>62</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">0.9 to 1.3</td></tr>
<tr><td>1000</td><td>63</td></tr>
</table>

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE
	∅180 mm; 7"		∅330 mm; 13"		0805
	PAPER	BLISTER	PAPER	BLISTER	
0.6 ±0.1	4000	4000	20000	10000	–
0.85 ±0.1	4000	4000	15000	10000	–
0.5 to 1.0	–	4000	–	10000	–
0.9 to 1.3	–	3000	–	10000	–
1.15 ±0.1	–	3000	–	10000	–
1.25 ±0.1	–	3000	–	10000	10000

ORDERING INFORMATION

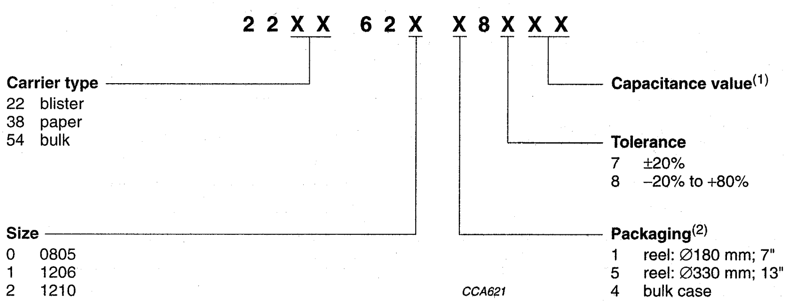
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC number.

Clear text code

Example: 12062E104M9B20D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0805 1206 1210	2E = Z5U	104 = 100000 pF; the third digit signifies the number of zeros	M ±20%	9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

Ordering code 12NC



(1) Refer to Chapter “Selection chart”.

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

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; Z5U dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	
case size 0805	10 nF to 220 nF
case size 1206	10 nF to 470 nF
case size 1210	100 nF to 1 μF
Tolerance on capacitance after 1000 hours	±20% (M); −20% to +80% (Z)
Tan δ; note 1	≤4%
Insulation resistance after 1 minute at U_R (DC)	R_{ins} > 10 GΩ or $R_{ins} \times C$ > 1000 seconds, whichever is smaller
Maximum capacitance change with respect to capacitance at 25 °C (for typical values see Fig.5)	+22% to −56%
Ageing	typical 3% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

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

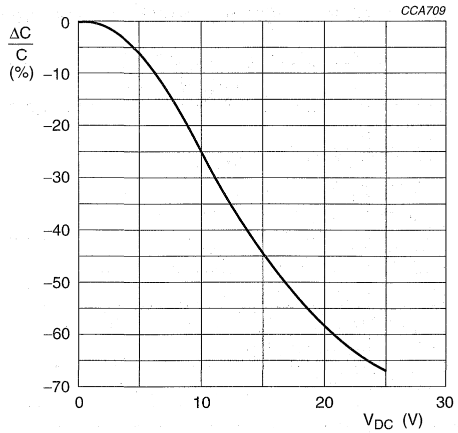


Fig.3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 25 °C.

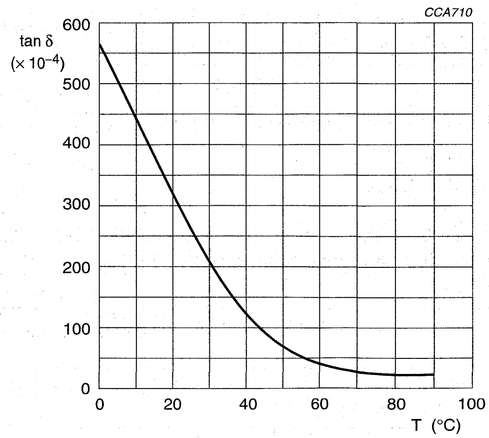


Fig.4 Typical tan δ as a function of temperature.

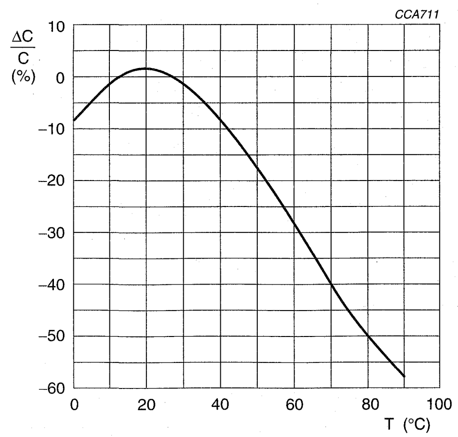


Fig.5 Typical capacitance change as a function of temperature.

Surface mount ceramic multilayer capacitors

FEATURES

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

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC):	
NP0 dielectric	25 V, 50 V and 63 V (IEC)
X7R dielectric	16 V, 25 V and 63 V (IEC)
Capacitance range (E12 series):	
class 1, NP0 dielectric	220 pF to 100000 pF
class 2, X7R dielectric	12 nF to 4.7 μF
Tolerance on capacitance:	
class 1, NP0 dielectric	±10%, ±5% and ±2%; note 1
class 2, X7R dielectric	±20%, ±10% and ±5%
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068):	
class 1, NP0 dielectric	55/125/56
class 2, X7R dielectric	55/125/56

Note

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

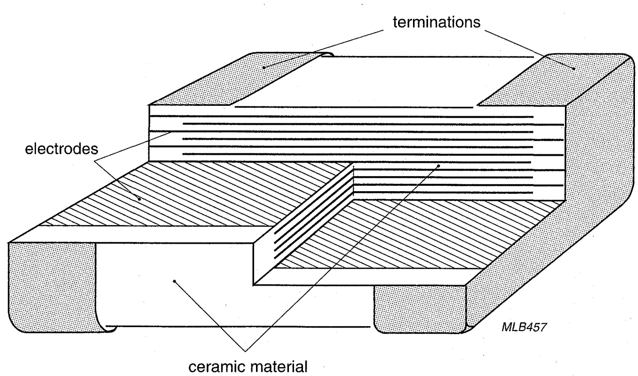
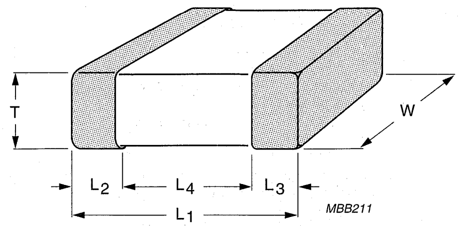


Fig.1 Construction of a ceramic multilayer capacitor.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T MIN.	T MAX.	L_2 and L_3 MIN.	L_2 and L_3 MAX.	L_4 MIN.
Dimensions in millimetres							
0402	1.0 ±0.05	0.5 ±0.05	0.45	0.55	0.20	0.30	0.40
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.80	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	1.80	0.25	0.75	2.90
Dimensions in inches							
0402	0.040 ±0.002	0.020 ±0.002	0.018	0.022	0.008	0.012	0.016
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056
1812	0.177 ±0.008	0.126 ±0.008	0.020	0.072	0.010	0.030	0.088
2220	0.224 ±0.008	0.197 ±0.008	0.020	0.072	0.010	0.030	0.114

SELECTION CHART FOR NP0

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

Values in shaded cells indicate thickness classification.

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE		
	∅180 mm; 7"		∅330 mm; 13"		∅180 mm; 7" BLISTER				
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805
0.6 ±0.1	4000	4000	10000	10000	2000	–	–	–	10000
0.5 ±0.05	10000	–	50000	–	–	–	50000	–	–
0.85 ±0.1	4000	4000	10000	10000	–	–	–	–	8000
0.8 ±0.07	4000	4000	15000	15000	–	–	–	15000	–
0.9 to 1.3	–	3000	–	8000	1500	1500	–	–	–
1.25 ±0.1	–	3000	–	8000	–	–	–	–	5000
1.2 to 1.75	–	2500	–	7000	1000	1000	–	–	–
1.6 to 2.2	–	–	–	–	1000	1000	–	–	–

ORDERING INFORMATION FOR NP0

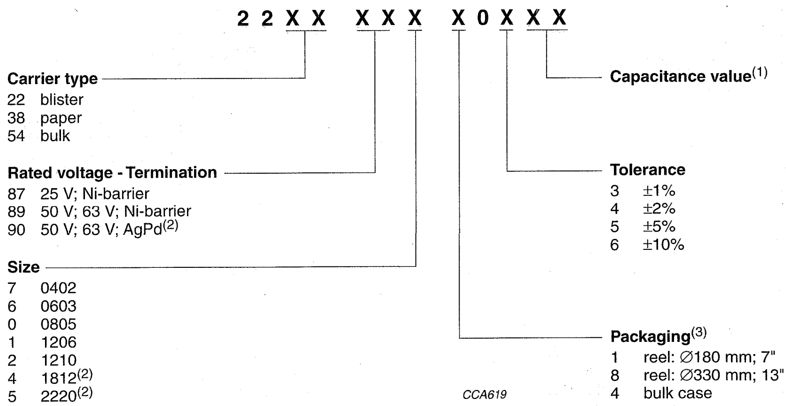
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 0603CG102G9B20C

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

Ordering code 12NC



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

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

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

SELECTION CHART FOR X7R 16 V AND 25 V

<table>
<tr><th rowspan="2">C (nF)</th><th rowspan="2">LAST TWO DIGITS OF 12NC</th><th>16 V</th><th colspan="5">25 V</th></tr>
<tr><th>1206</th><th>0805</th><th>1206</th><th>1210</th><th>1812</th><th>2220</th></tr>
<tr><td>12</td><td>37</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>15</td><td>38</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>18</td><td>39</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>22</td><td>41</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>27</td><td>42</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>33</td><td>43</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>39</td><td>44</td><td></td><td rowspan="3">0.6 ±0.1</td><td></td><td></td><td></td><td></td></tr>
<tr><td>47</td><td>45</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>56</td><td>46</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>68</td><td>47</td><td></td><td rowspan="3">0.85 ±0.1</td><td></td><td></td><td></td><td></td></tr>
<tr><td>82</td><td>48</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>100</td><td>49</td><td></td><td rowspan="3">0.6 ±0.1</td><td></td><td></td><td></td></tr>
<tr><td>120</td><td>51</td><td></td><td>1.25 ±0.1</td><td></td><td></td><td></td></tr>
<tr><td>150</td><td>52</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>180</td><td>53</td><td></td><td></td><td rowspan="3">0.85 ±0.1</td><td></td><td></td><td></td></tr>
<tr><td>220</td><td>54</td><td></td><td></td><td rowspan="2">0.6 ±0.1</td><td></td><td></td></tr>
<tr><td>270</td><td>55</td><td></td><td></td><td></td><td></td></tr>
<tr><td>330</td><td>56</td><td></td><td></td><td>0.9 to 1.3</td><td rowspan="3">0.85 ±0.1</td><td></td><td></td></tr>
<tr><td>390</td><td>57</td><td></td><td></td><td rowspan="2">1.2 to 1.75</td><td></td><td></td></tr>
<tr><td>470</td><td>58</td><td rowspan="4">0.85 ±0.1</td><td></td><td></td><td></td></tr>
<tr><td>560</td><td>59</td><td></td><td></td><td rowspan="2">0.9 to 1.3</td><td></td><td></td></tr>
<tr><td>680</td><td>61</td><td></td><td></td><td></td><td></td></tr>
<tr><td>820</td><td>62</td><td></td><td></td><td>1.2 to 1.75</td><td rowspan="3">0.9 to 1.3</td><td></td></tr>
<tr><td>1000</td><td>63</td><td>0.9 to 1.3</td><td></td><td></td><td>1.6 to 2.2</td><td></td></tr>
<tr><td>1200</td><td>64</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1500</td><td>65</td><td></td><td></td><td></td><td></td><td rowspan="2">1.2 to 1.75</td><td></td></tr>
<tr><td>1800</td><td>66</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2200</td><td>67</td><td></td><td></td><td></td><td></td><td></td><td>0.9 to 1.3</td></tr>
<tr><td>2700</td><td>68</td><td></td><td></td><td></td><td></td><td></td><td rowspan="2">1.2 to 1.75</td></tr>
<tr><td>3300</td><td>69</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3900</td><td>71</td><td colspan="5" rowspan="2">Values in shaded cells indicate thickness classification.</td><td rowspan="2">1.6 to 2.2</td></tr>
<tr><td>4700</td><td>72</td></tr>
</table>

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE		
	∅180 mm; 7"		∅330 mm; 13"		∅180 mm; 7" BLISTER				
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805
0.6 ±0.1	4000	4000	10000	10000	2000	–	–	–	10000
0.5 ±0.05	10000	–	50000	–	–	–	15000	–	–
0.85 ±0.1	4000	4000	10000	10000	–	–	–	–	8000
0.9 to 1.3	–	3000	–	8000	1500	1500	–	–	–
1.25 ±0.1	–	3000	–	8000	–	–	–	–	5000
1.2 to 1.75	–	2500	–	7000	1000	1000	–	–	–
1.6 to 2.2	–	–	–	–	1000	1000	–	–	–

ORDERING INFORMATION FOR X7R 16 V AND 25 V

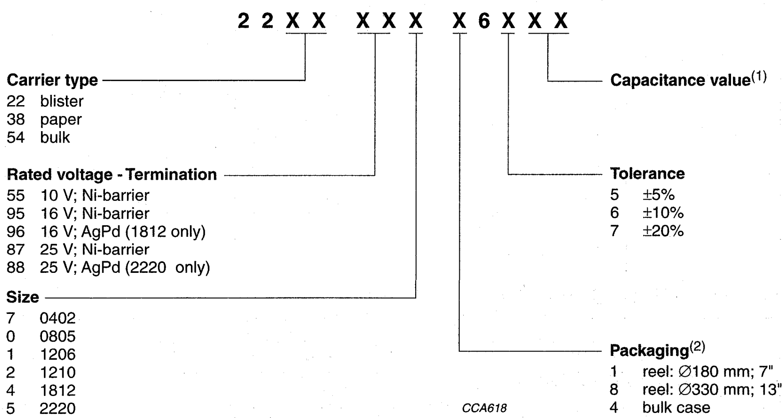
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 12062R104K8BB0C

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402 0805 1206 1210 1812 2220 (AgPd only)	2R = X7R	104 = 100000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	7 = 16 V 8 = 25 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	C = compact

Ordering code 12NC



(1) Refer to Chapter "Selection chart for X7R 16 V and 25 V".

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

SELECTION CHART FOR X7R 50 V AND 63 V

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

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE		
	∅180 mm; 7"		∅330 mm; 13"		∅180 mm; 7" BLISTER				
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805
0.6 ±0.1	4000	4000	10000	10000	2000	–	–	–	10000
0.85 ±0.1	4000	4000	10000	10000	–	–	–	–	8000
0.9 to 1.3	–	3000	–	8000	1500	1500	–	–	–
1.25 ±0.1	–	3000	–	8000	–	–	–	–	5000
1.2 to 1.75	–	2500	–	7000	1000	1000	–	–	–
1.6 to 2.2	–	–	–	–	1000	1000	–	–	–

ORDERING INFORMATION FOR X7R 50 V AND 63 V

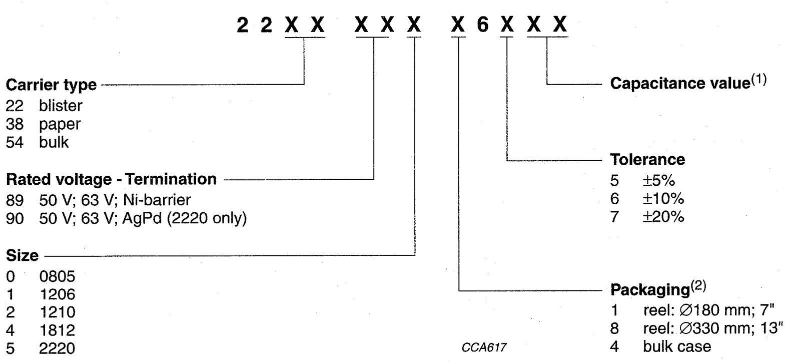
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 18122R105K9BB0C

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0805 1206 1210 1812 2220 (AgPd only)	2R = X7R	105 = 1000000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	9 = 50 V/63 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	C = compact

Ordering code 12NC



(1) Refer to Chapter "Selection chart for X7R 50 V and 63 V".
(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

ELECTRICAL CHARACTERISTICS FOR CLASS 1, CAPACITORS

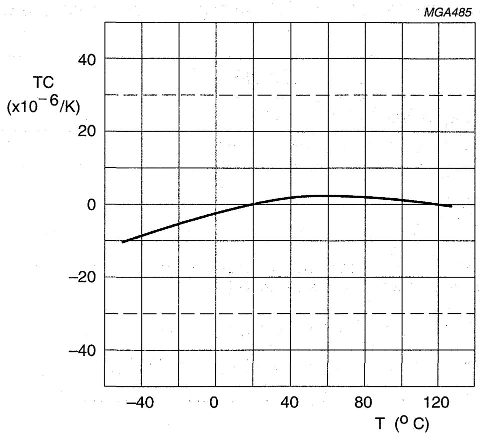
Class 1 capacitors; NP0 dielectric; NiSn and AgPd terminations

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

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

Notes

1. Measured at 1 V, 1 MHz for C ≤ 1000 pF and at 1 V, 1 kHz for C > 1000 pF, using a four-gauge method.
2. Capacitors with a tolerance of ±1% are available on request.



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

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

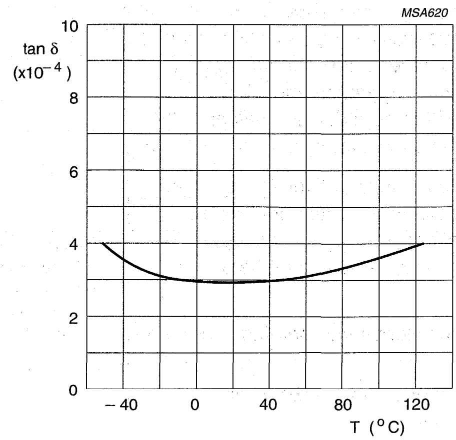


Fig.4 Typical tan δ as a function of temperature for NP0 dielectric.

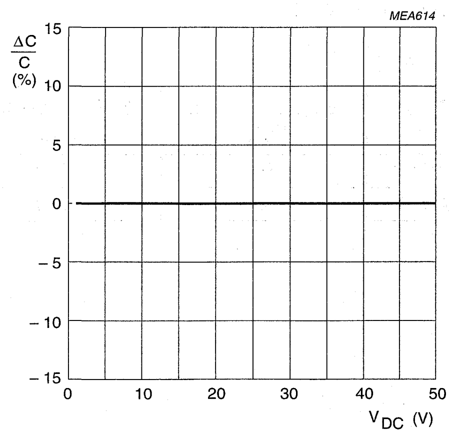


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage for NP0 dielectric.

HIGH FREQUENCY BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

Ceramic multilayer capacitors (CMC) from the high voltage series are suitable for use at high frequencies. At frequencies below the series resonance frequency, the CMC can be represented by an equivalent circuit as shown in Fig.6.

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

The equivalent series self-inductance L is:

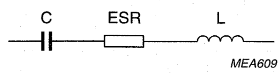
- Independent of the dielectric material.
- Dependent on the size of the capacitor, it increases with increasing length and decreases with increasing width or thickness of the product.
- The value of L is approximately:
  - 0.6 nH for case size 603
  - 1 nH for case sizes 0805, 1206 and 1210
  - 1.5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

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

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

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

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



C = capacitance.

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

L = equivalent series self-inductance.

Fig.6 Equivalent series representation of a CMC.

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

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

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

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

Table 2 Maximum ESR for NP0

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

ELECTRICAL CHARACTERISTICS FOR CLASS 2, CAPACITORS

Class 2 capacitors; X7R dielectric; NiSn and AgPd terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	12 nF to 4.7 μF
Tolerance on capacitance after 1 000 hours	±20%, ±10% and ±5%
Tan δ; note 1	≤2.5%
Insulation resistance after 1 minute at U_R (DC):	
C ≤ 10 nF	R_{ins} > 100000 MΩ
C > 10 nF	R_{ins} × C > 1 000 seconds
Maximum capacitance change as a function of temperature (for typical values see Fig.9)	±15%

Note

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

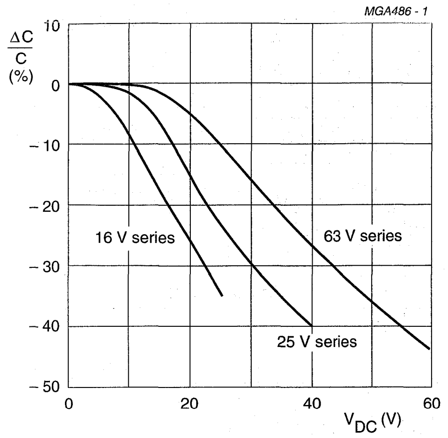


Fig.7 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage for X7R dielectric.

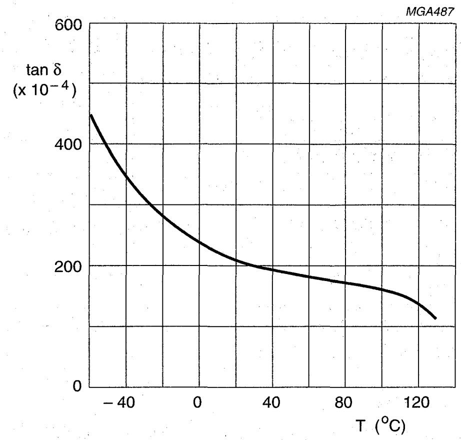
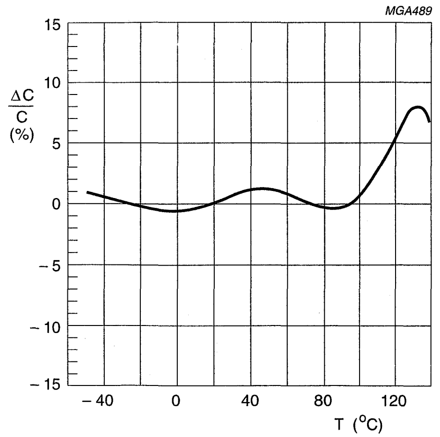
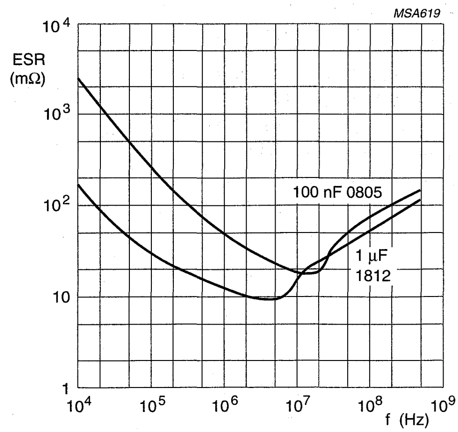


Fig.8 Typical tan δ as a function of temperature for X7R dielectric.



U_{DC} = 0 V.

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



Measuring equipment HP4191A and HP4194A.

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

Surface mount ceramic multilayer capacitors

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

FEATURES

- 4 × 0603 capacitors (of the same capacitance value) per array
- Less than 50% board space of an equivalent discrete component
- High volumetric efficiency
- Dense dielectric layers
- Supplied in tape on reel or loose in bag
- Increased throughput, by time saved in mounting
- Cost savings on manufacturing time.

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

DESCRIPTION

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

The inner electrodes are connected to the two terminations, silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (Nickel-barrier). An outline of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V and 63 V (IEC)
Capacitance range (E12 series)	22 pF to 1 nF
Tolerance on capacitance	±5%, ±10%
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

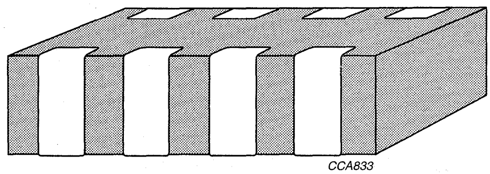
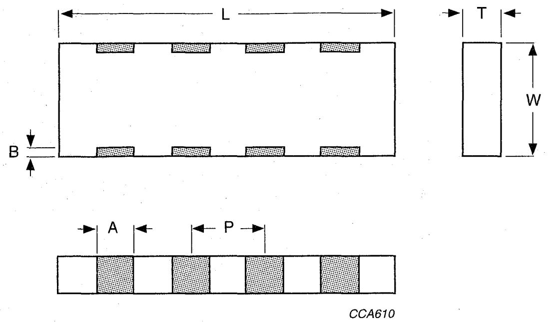


Fig.1 Simplified outline.

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Dimensional outline.

Physical dimensions

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

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

SELECTION CHART FOR NP0

C (pF)	LAST TWO DIGITS OF 12NC	50/63 V 0612 (4 × 0603)
22	27	
27	28	
33	29	
39	31	
47	32	
56	33	
68	34	0.8 ±0.1
82	35	
100	36	
120	37	
150	38	
180	39	
220	41	
270	42	
330	43	
390	44	
470	45	
560	46	0.8 ±0.1
680	47	
820	48	
1000	49	

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL	
	∅180 mm; 7"	
	PAPER	BLISTER
0.8 ±0.1	4000	4000

ORDERING INFORMATION

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

Clear text code

EXAMPLE: 0612CG102J9B200

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

Ordering code 12NC

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

Carrier type
50 blister
55 paper

Termination
14 NiSn

Size
6 0612 (4 × 0603)

Capacitance value(1)

Tolerance
5 ±5%
6 ±10%

Packaging(2)
1 reel: ∅180 mm; 7" reel

CCA682

(1) Refer to Chapter "Selection chart for NP0".
(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

ELECTRICAL CHARACTERISTICS FOR CLASS 1, CAPACITORS

Class 1 capacitors; NP0 dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	22 pF to 1 nF
Tolerance on capacitance after 1000 hours	±5%, ±10%
Tan δ; note 1	≤0.1%
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Insulation resistance after 1 minute at U_R (DC)	>100000 MΩ
Temperature coefficient	$(0 \pm 30) \times 10^{-6}$/K

Note

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

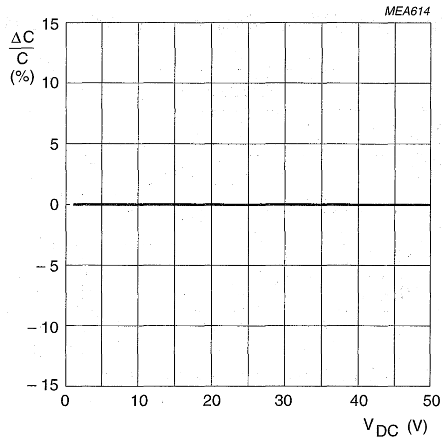


Fig.3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

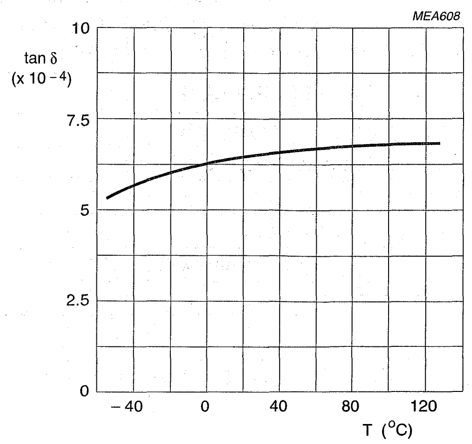


Fig.4 Typical tan δ as a function of temperature.

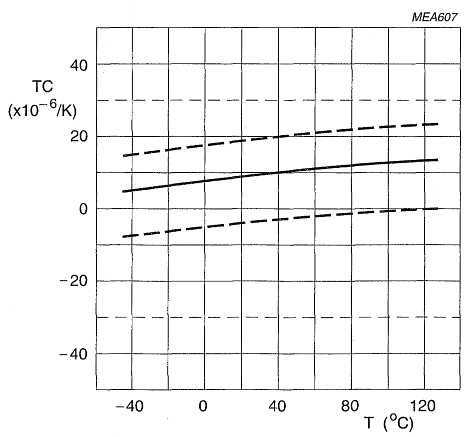
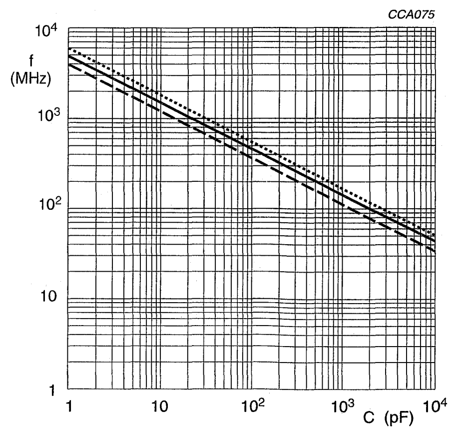


Fig.5 Typical temperature coefficient as a function of temperature.



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

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

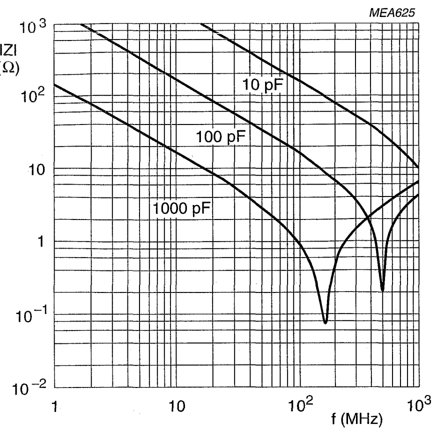
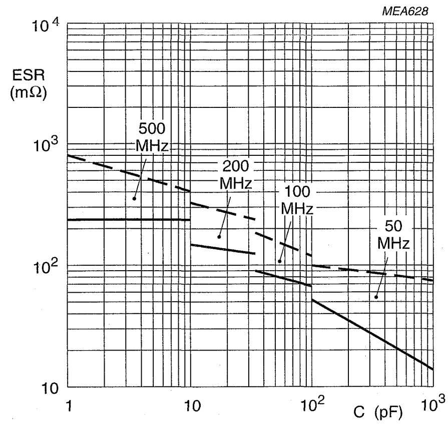
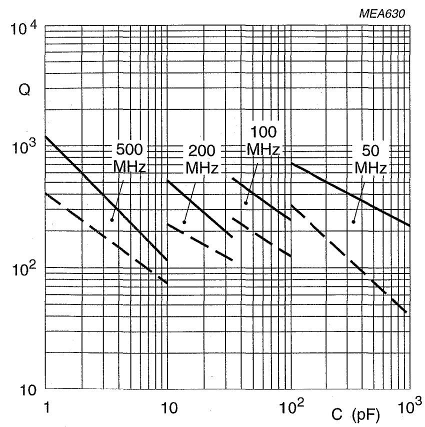


Fig.7 Typical impedance (|Z|) as a function of frequency.



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

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



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

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

FEATURES

- 0612 (4 × 0603) capacitors (of the same capacitance value) per array
- Less than 50% board space of an equivalent discrete component
- High volumetric efficiency
- Dense dielectric layers
- Supplied in tape on reel or loose in bag
- Increased throughput, by time saved in mounting
- Cost savings on manufacturing time.

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

DESCRIPTION

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

The inner electrodes are connected to the two terminations, silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (Nickel-barrier). An outline of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	16 V; 25 V; 50 V (IEC)
Capacitance (E12 series):	
16 V	10 nF to 100 nF
25 V	10 nF to 47 nF
50 V	220 pF to 10 nF
Tolerance on capacitance	±5%; ±10%; ±20%
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

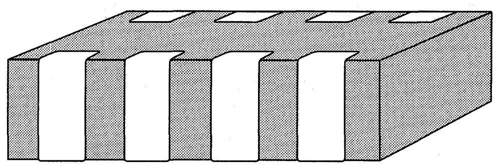
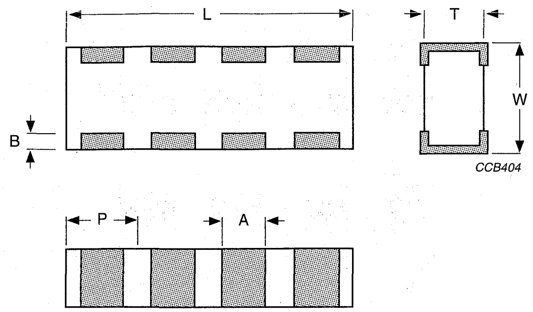


Fig.1 Simplified outline.

MECHANICAL DATA



For dimensions see Table 1.

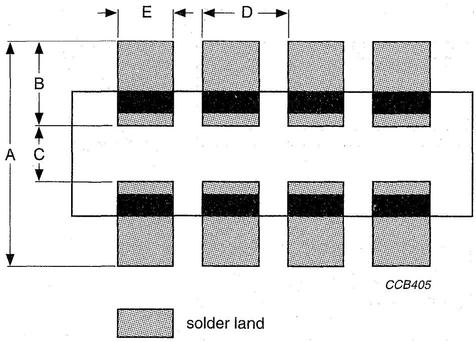
Fig.2 Dimensional outline.

Physical dimensions

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

CASE SIZE	L	W	T		A	B	P
			MIN.	MAX.			
Dimensions in millimetres							
0612 (4 × 0603)	3.20 ±0.15	1.60 ±0.15	0.50	1.20	0.40 ±0.1	0.30 ±0.2	0.80 ±0.1
Dimensions in inches							
0612 (4 × 0603)	0.125 ±0.006	0.063 ±0.006	0.020	0.047	0.016 ±0.006	0.012 ±0.006	0.031 ±0.004

DIMENSIONS OF SOLDER LANDS



For dimensions see Table 2.

Fig.3 Recommended dimensions of solder lands.

Table 2 Solder land dimensions; see Fig.3

CASE SIZE	FOOTPRINT DIMENSIONS (mm)				
	A	B	C	D	E
0612 (4 × 0603)	2.54 ±0.15	0.89 ±0.10	0.76 ±0.10	0.80 ±0.10	0.45 ±0.10

SELECTION CHART

C (pF)	LAST TWO DIGITS OF 12NC	16 V	25 V	50 V
		0612 (4 × 0603)		
220	14			
270	15			
330	16			
390	17			
470	18			
560	19			
680	21			
820	22			
1 000	23			
1 200	24			
1 500	25			0.8 ±0.1
1 800	26			
2 200	27			
2 700	28			
3 300	29			
3 900	31			
4 700	32			
5 600	33			
6 800	34			
8 200	35			
10 000	36			
12 000	37			
15 000	38			
18 000	39			
22 000	41		0.8 ±0.1	
27 000	42			
33 000	43	0.8 ±0.1		
39 000	44			
47 000	45			
56 000	46			
68 000	47		Values in shaded cells indicate thickness classification.	
82 000	48			
100 000	49			

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL			
	∅180 mm; 7"		∅330 mm; 13"	
	PAPER	BLISTER	PAPER	BLISTER
0.8 ±0.1	4 000	4 000	10 000	10 000

ORDERING INFORMATION

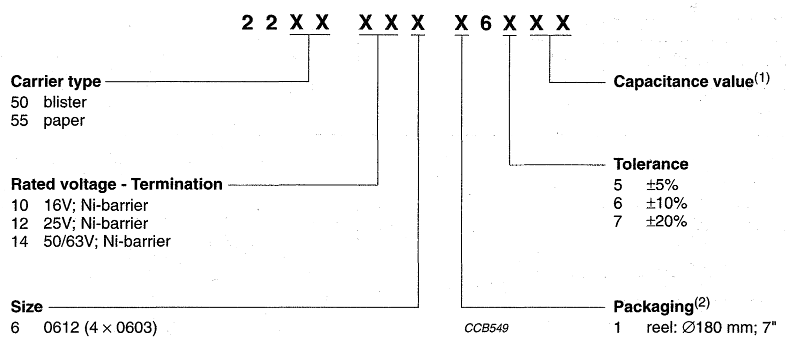
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 06122R104K7B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0612 (4 × 0603)	2R = X7R	104 = 100000 pF; the third digit signifies the number of zeros	J = ±5% K = ±10% M = ±20%	7 = 16 V 8 = 25 V 9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper B = 180 mm; 7" blister	0 = no marking	0 = conv. ceramic

Ordering code 12NC



(1) Refer to Chapter “Selection chart”.

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

ELECTRICAL CHARACTERISTICS FOR CLASS 2, CAPACITORS

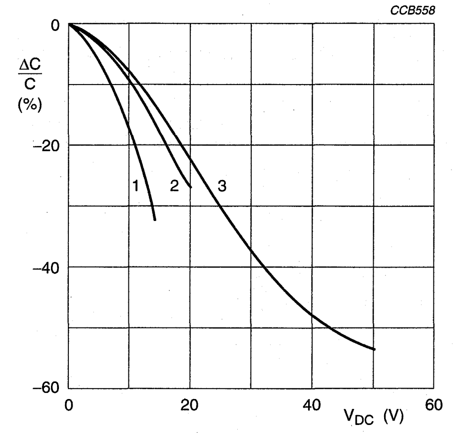
Class 2 capacitors; X7R dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance (E12 series):	
16 V	10 nF to 100 nF
25 V	10 nF to 47 nF
50 V	220 pF to 10 nF
Tolerance on capacitance after 1000 hours	±5%; ±10%; ±20%
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Tan δ; note 1	
16 V	≤3.5%
25 V and 50 V	≤2.5%
Insulation resistance after 1 minute at U_R (DC):	
C ≤ 10 nF	$R_{ins} \times C \geq 10^5$ MΩ
C > 10 nF	$R_{ins} \times C > 1000$ s
Ageing	typical 1% per time decade
Resistance to soldering heat	260 °C; 10 seconds

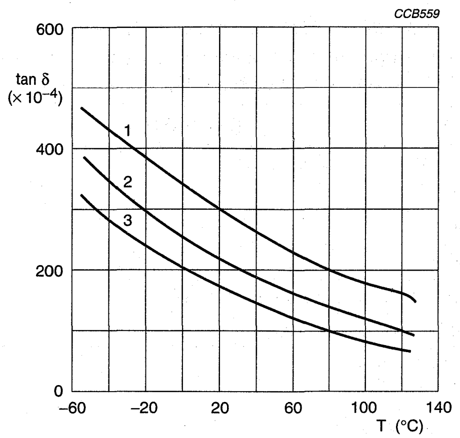
Note

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



Curve 1 = 16 V product.
Curve 2 = 25 V product.
Curve 3 = 50 V product.

Fig.4 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 25 °C.



Curve 1 = 16 V product.
Curve 2 = 25 V product.
Curve 3 = 50 V product.

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

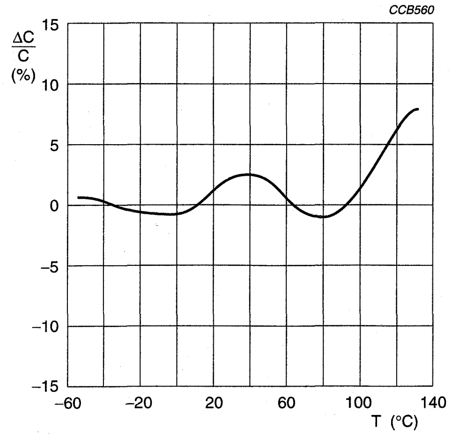


Fig.6 Typical capacitance change as a function of temperature.

Surface mount ceramic multilayer capacitors

C-Array: Class 2, X7R 16 V

FEATURES

- 0612 (4 × 0603) capacitors (of the same capacitance value) per array
- Less than 50% board space of an equivalent discrete component
- High volumetric efficiency
- Dense dielectric layers
- Supplied in tape on reel or loose in bag
- Increased throughput, by time saved in mounting
- Cost savings on manufacturing time.

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	16 V (IEC)
Capacitance (E6 series)	10 nF to 100 nF
Tolerance on capacitance	±10%
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/21

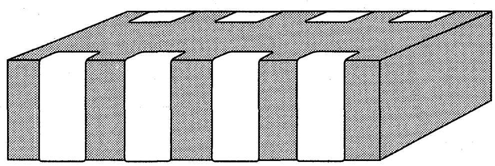
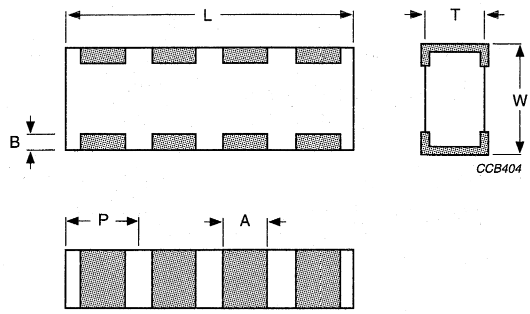


Fig.1 Simplified outline.

MECHANICAL DATA



For dimensions see Table 1.

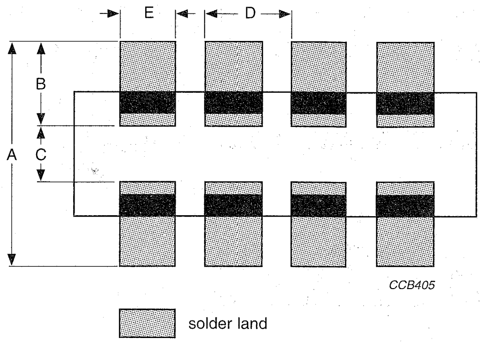
Fig.2 Dimensional outline.

Physical dimensions

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

CASE SIZE	L	W	T		A	B	P
			MIN.	MAX.			
Dimensions in millimetres							
0612 (4 × 0603)	3.20 ±0.15	1.60 ±0.15	0.50	1.20	0.40 ±0.1	0.30 ±0.2	0.80 ±0.1
Dimensions in inches							
0612 (4 × 0603)	0.125 ±0.006	0.063 ±0.006	0.020	0.047	0.016 ±0.006	0.012 ±0.006	0.031 ±0.004

DIMENSIONS OF SOLDER LANDS



For dimensions see Table 2.

Fig.3 Recommended dimensions of solder lands.

Table 2 Solder land dimensions; see Fig.3

CASE SIZE	FOOTPRINT DIMENSIONS (mm)				
	A	B	C	D	E
0612 (4 × 0603)	2.54 ±0.15	0.89 ±0.10	0.76 ±0.10	0.80 ±0.10	0.45 ±0.10

Surface mount ceramic multilayer capacitors

C-Array: Class 2, X7R 16 V

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	16 V
		0612 (4 × 0603)
10	36	thickness classification 0.6 ±0.1
15	38	
22	41	
33	43	
39	44	
47	45	
68	47	
100	49	

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL			
	∅180 mm; 7"		∅330 mm; 13"	
	PAPER	BLISTER	PAPER	BLISTER
0.6 ±0.1	4000	4000	10000	10000

ORDERING INFORMATION

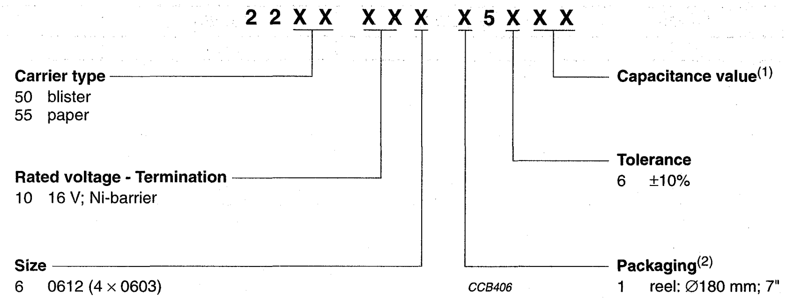
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 06122R104K7B20D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0612 (4 × 0603)	2R = X7R	104 = 100000 pF; the third digit signifies the number of zeros	K = ±10%	7 = 16 V	B = Ni-barrier	2 = 180 mm; 7" paper B = 180 mm; 7" blister	0 = no marking	D = BME

Ordering code 12NC



(1) Refer to Chapter "Selection chart".

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

ELECTRICAL CHARACTERISTICS FOR CLASS 2, CAPACITORS

Class 2 capacitors; X7R dielectric; NiSn terminations

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

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1	10 nF to 100 nF
Tolerance on capacitance after 1000 hours	±10%
Tan δ; note 1	≤3.5%
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} \times C \geq 500$ s
Ageing	typical 3% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

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

Surface mount ceramic multilayer capacitors

C-Array: Class 2, Y5V 25 V

FEATURES

- 4 × 0603 capacitors (of the same capacitance value) per array
- Less than 50% board space of an equivalent discrete component
- High volumetric efficiency
- Dense dielectric layers
- Supplied in tape on reel or loose in bag
- Increased throughput, by time saved in mounting
- Cost savings on manufacturing time.

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

DESCRIPTION

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

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

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC):	25 V (IEC)
Capacitance (E6 series)	10 nF to 100 nF
Tolerance on capacitance:	−20 to +80% (Z)
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	25/85/21

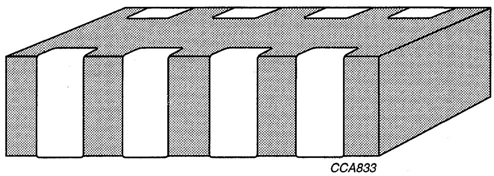
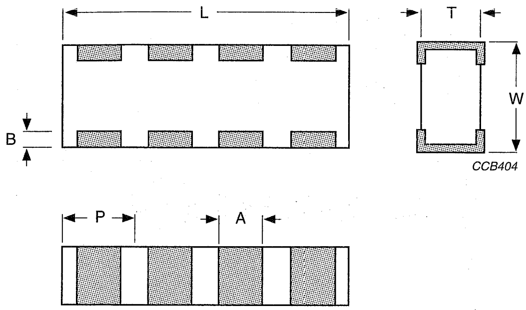


Fig.1 Simplified outline.

MECHANICAL DATA



For dimensions see Table 1.

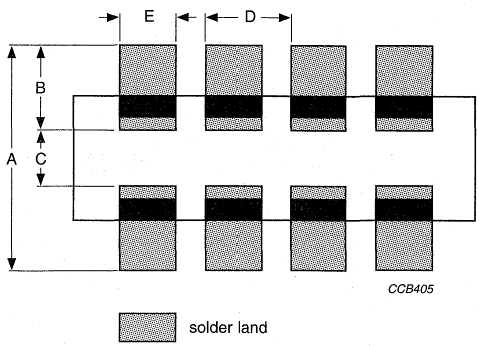
Fig.2 Dimensional outline.

Physical dimensions

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

CASE SIZE	L	W	T		A	B	P
			MIN.	MAX.			
Dimensions in millimetres							
0612 (4 × 0603)	3.20 ±0.15	1.60 ±0.15	0.50	1.20	0.40 ±0.1	0.30 ±0.2	0.80 ±0.1
Dimensions in inches							
0612 (4 × 0603)	0.125 ±0.006	0.063 ±0.006	0.020	0.047	0.016 ±0.006	0.012 ±0.006	0.031 ±0.004

DIMENSIONS OF SOLDER LANDS



For dimensions see Table 2.

Fig.3 Recommended dimensions of solder lands.

Table 2 Solder land dimensions; see Fig.3

CASE SIZE	FOOTPRINT DIMENSIONS (mm)				
	A	B	C	D	E
0612 (4 × 0603)	2.54 ±0.15	0.89 ±0.10	0.76 ±0.10	0.80 ±0.10	0.45 ±0.10

Surface mount ceramic multilayer capacitors

C-Array: Class 2, Y5V 25 V

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	25 V 0612 (4 × 0603)
10	36	thickness classification: 0.6 ±0.1
12	37	
15	38	
18	39	
22	41	
27	42	
33	43	
39	44	
47	45	
56	46	
68	47	
82	48	
100	49	

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL			
	∅180 mm; 7"		∅330 mm; 13"	
	PAPER	BLISTER	PAPER	BLISTER
0.6 ±0.1	4000	4000	10000	10000

ORDERING INFORMATION

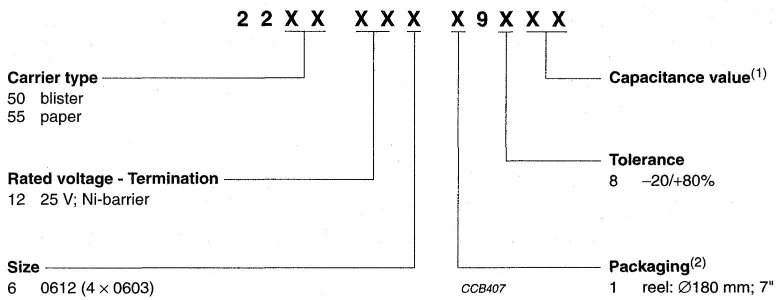
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 06122F104K7B20D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0612 (4 × 0603)	2F = Y5V	104 = 100000 pF; the third digit signifies the number of zeros	Z = -20/+80	8 = 25 V	B = Ni-barrier	2 = 180 mm; 7" paper B = 180 mm; 7" blister	0 = no marking	D = BME

Ordering code 12NC



(1) Refer to Chapter "Selection chart".

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

ELECTRICAL CHARACTERISTICS FOR CLASS 2, CAPACITORS

Class 2 capacitors; Y5V dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 25 ±1 °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1	10 nF to 100 nF
Tolerance on capacitance after 1000 hours	−20 to +80% (Z)
Tan δ; note 1	≤7%
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} \times C \geq 500$ s
Ageing	typical 7% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

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

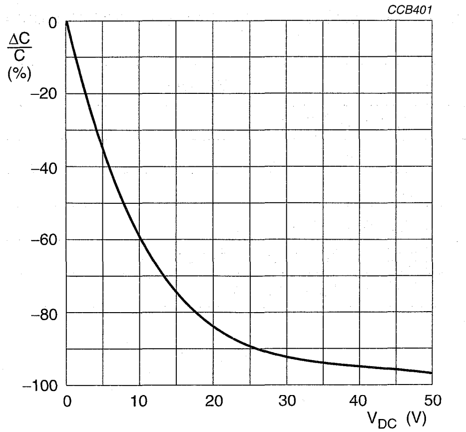


Fig.4 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 25 °C.

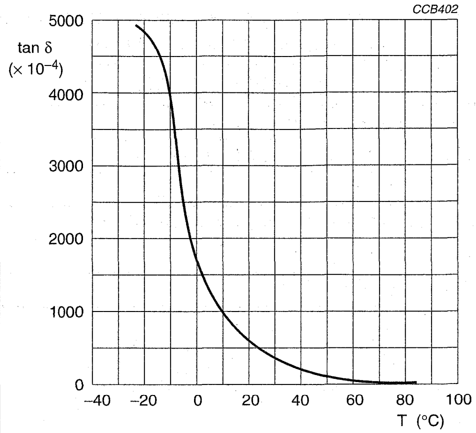


Fig.5 Typical tan δ as a function of temperature.

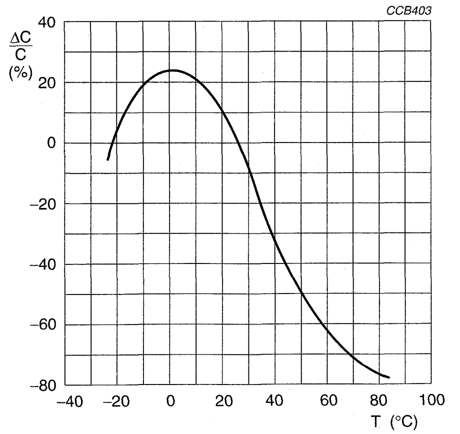


Fig.6 Typical capacitance change as a function of temperature.

RESISTOR INTRODUCTION

INTRODUCTION

Data in data sheets is presented - whenever possible - according to a 'format', in which the following chapters are stated:

- TITLE
- FEATURES
- APPLICATIONS
- DESCRIPTION
- QUICK REFERENCE DATA
- ORDERING INFORMATION
- FUNCTIONAL DESCRIPTION
  - Product characterization
  - Limiting values
- MECHANICAL DATA
  - Mass
  - Marking
  - Outlines
- TESTS AND REQUIREMENTS

The chapters listed above are explained in this section *"General introduction Chip resistors"*, with detailed information in the relevant data sheet. Chapters "Mounting" and "Packaging" are detailed in separate sections.

DESCRIPTION

All types of chip resistors have a rectangular ceramic body. The resistive element is a metal glaze film. The chips have been trimmed to the required ohmic resistance by cutting one or more grooves in the resistive layer. This process is completely computer controlled and yields a high reliability. The terminations are attached using either a silver dipping method or by applying nickel terminations which are covered with lead/tin.

The resistive layer is coated with a coloured protective layer. This protective layer provides electrical, mechanical and/or environmental protection - also against soldering flux and cleaning solvents, in accordance with *"MIL-STD-202E"*, method 215 and *"IEC 60068-2-45"*.

ORDERING INFORMATION

Resistors are ordered by their **ordering code**, a 12-digit number. In general, the packaging method and resistance code are integral parts of this number.

Exceptions to this rule are customer/application specific resistors that are not included in our standard series, such as higher ohmic values and non-standard values.

FUNCTIONAL DESCRIPTION

The functional description includes: nominal resistance range and tolerance, limiting voltage, temperature coefficient, absolute maximum dissipation, climatic category and stability.

The **limiting voltage** (DC or RMS) is the maximum voltage that may be continuously applied to the resistor element, see *"IEC publications 60115-8"*.

The temperature rise in a resistor due to power dissipation, is determined by the laws of heat - conduction, convection and radiation. The maximum body temperature usually occurs in the middle of the resistor and is called the **hot-spot** temperature.

In the normal operating temperature range of chip resistors the temperature rise at the hot-spot, ΔT, is proportional to the power dissipated: $\Delta T = A \times P$.
The proportionally constant 'A' gives the temperature rise per Watt of dissipated power and can be interpreted as a thermal resistance in K/W. This thermal resistance is dependent on the heat conductivity of the materials used (including the PCB), the way of mounting and the dimensions of the resistor. The sum of the temperature rise and the ambient temperature is:

$$T_m = T_{amb} + \Delta T$$

where:

T_m = hot-spot temperature

T_{amb} = ambient temperature

ΔT = temperature rise at hot-spot.

The stability of a chip resistor during endurance tests is mainly determined by the hot-spot temperature and the resistive materials used.

Summarizing

DESCRIPTION	RELATIONSHIP
Dimensions, conductance of materials and mounting determine	heat resistance
Heat resistance × dissipation gives	temperature rise
Temperature rise + ambient temperature give	hot-spot temperature

Performance

When specifying the performance of a resistor, the dissipation is given as a function of the hot-spot temperature, with the ambient temperature as a parameter.

From $\Delta T = A \times P$ and $T_m = T_{amb} + \Delta T$ it follows that:

$$P = \frac{T_m - T_{amb}}{A}$$

If P is plotted against T_m for a constant value of A, parallel straight lines are obtained for different values of the ambient temperature. The slope of these lines,

$$\frac{dP}{dT_m} = \frac{I}{A}$$

is the reciprocal of the heat resistance and is the characteristic for the resistor and its environment.

The temperature coefficient

The temperature coefficient of resistance is a ratio which indicates the rate of increase (decrease) of resistance per Kelvin (K) increase (decrease) of temperature within a specified range, and is expressed in parts per million per K ($\times 10^{-6}$/K).

EXAMPLE

If the temperature coefficient of a resistor of R_{nom} = 1 kΩ between –55 °C and +155 °C is $\pm 200 \times 10^{-6}$/K, its resistance will be:

at 25 °C:

1000 Ω (nominal = rated value)

at +155 °C:

1000 Ω $\pm(130 \times 200 \times 10^{-6}) \times 1000$ Ω
= 1026 Ω or 974 Ω

at –55 °C:

1000 Ω $\pm(80 \times 200 \times 10^{-6}) \times 1000$ Ω
= 1016 Ω or 984 Ω

If the temperature coefficient is specified as $\leq 200 \times 10^{-6}$/K the resistance will be within the shaded area as shown in Fig.1.

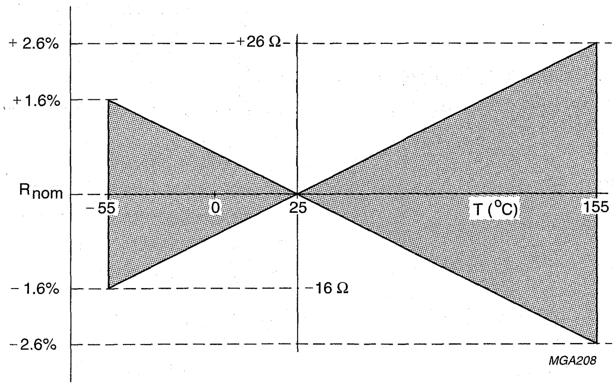


Fig.1 Temperature coefficient.

Noise

Most resistors generate noise due to the passage of current through the resistor. This noise is dependent on the amount of current, the resistive material and the physical construction of the resistor. The physical construction is partly influenced by the laser trimming process which cuts a groove in the resistive material. Typical current noise levels are shown in Fig.2.

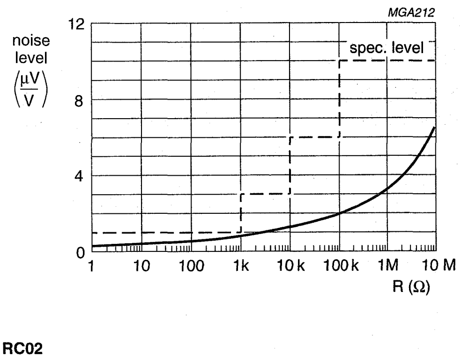


Fig.2 Typical noise levels as a function of rated resistance.

Frequency behaviour

Resistors in general are designed to function according to ohmic laws. This is basically true of rectangular chip resistors for frequencies up to 100 kHz. At higher frequencies, the capacitance of the terminations and the inductance of the resistive path length begin to have an effect.

Basically, chip resistors can be represented by an ideal resistor switched in series with a coil and both switched parallel to a capacitor. The values of the capacitance and inductance are mainly determined by the dimensions of the terminations and the conductive path length. The trimming pattern has a negligible influence on the inductance as the path length is not influenced. Also, its influence on the capacitance is negligible as the total capacitance is largely determined by the terminations.

The environment surrounding chips (e.g. landing paths, nearby tracks and the material of the printed-circuit board) has a large influence on the behaviour of the chip on the printed-circuit board.

Typical values of capacitance and inductance

QUANTITY	CHIP PROPERTIES			
	THIN FILM	THICK FILM		
	1206 R < 1 kΩ	1206	0805	0603
Capacitance	0.05 pF	0.05 pF	0.09 pF	0.05 pF
Inductance	2 nH	2 nH	1 nH	0.4 nH

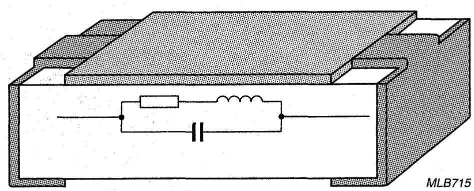
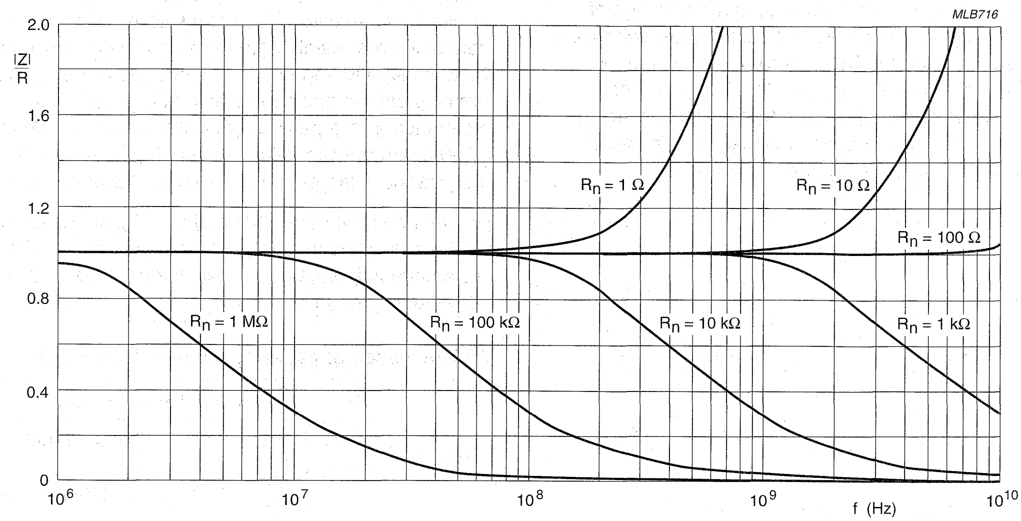
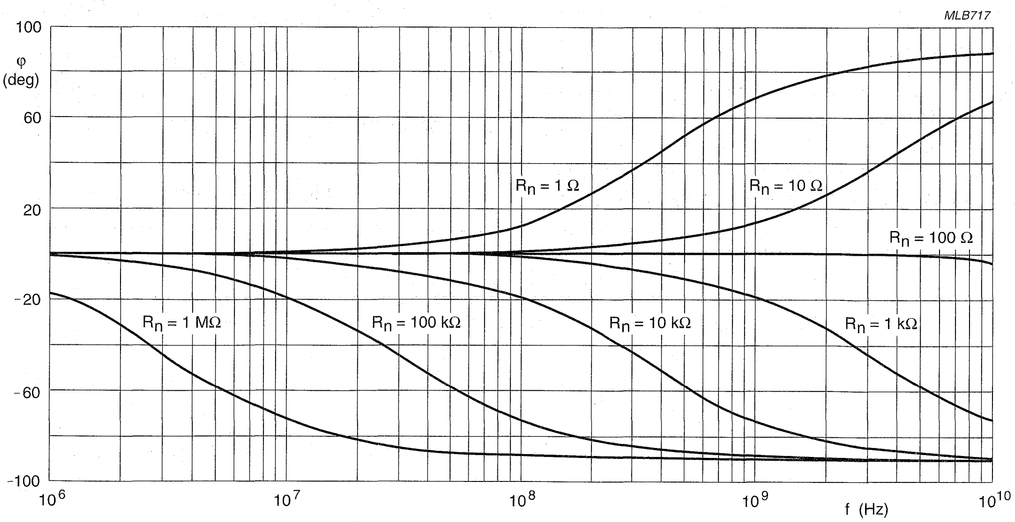


Fig.3 Equivalent circuit.



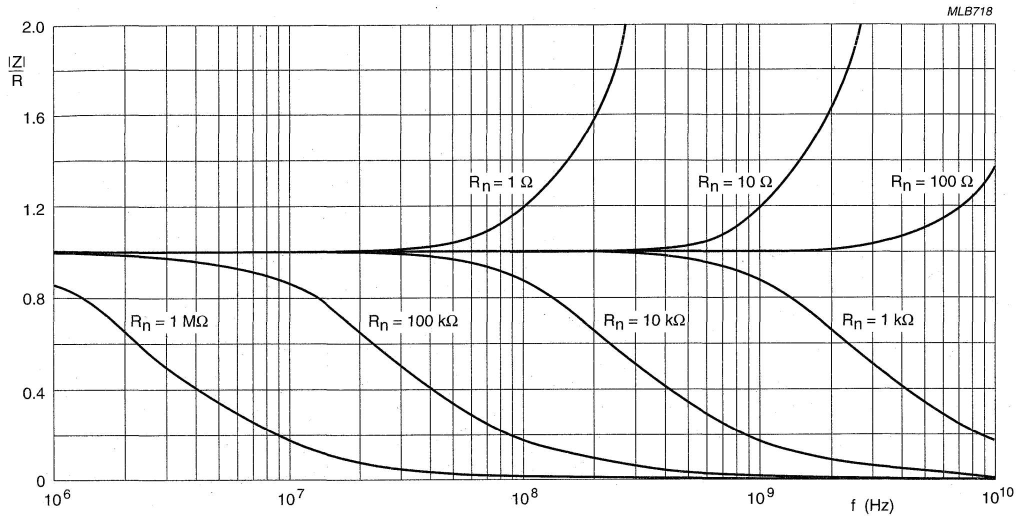
Size 0603

Fig.4 Impedance as a function of frequency for a chip resistor.



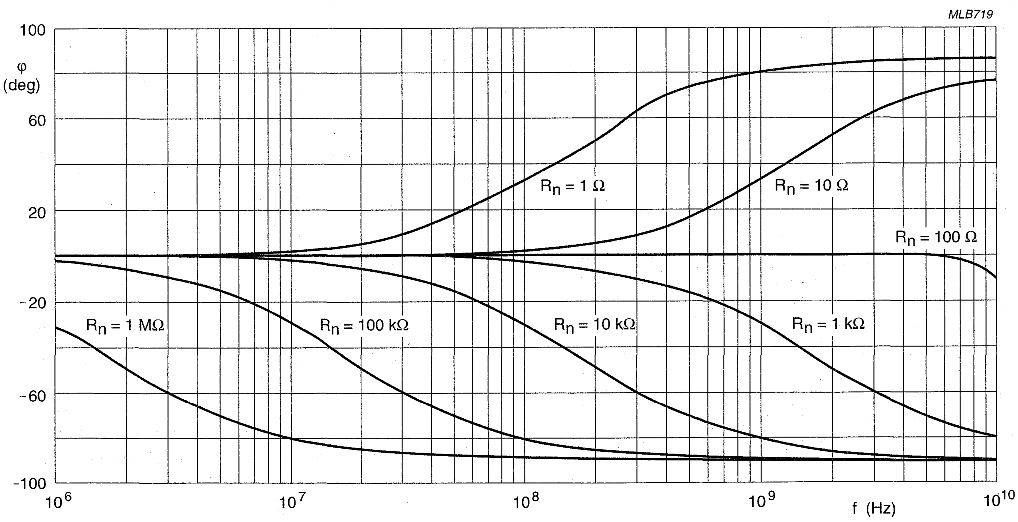
Size 0603

Fig.5 Phase shift as a function of frequency for a chip resistor.



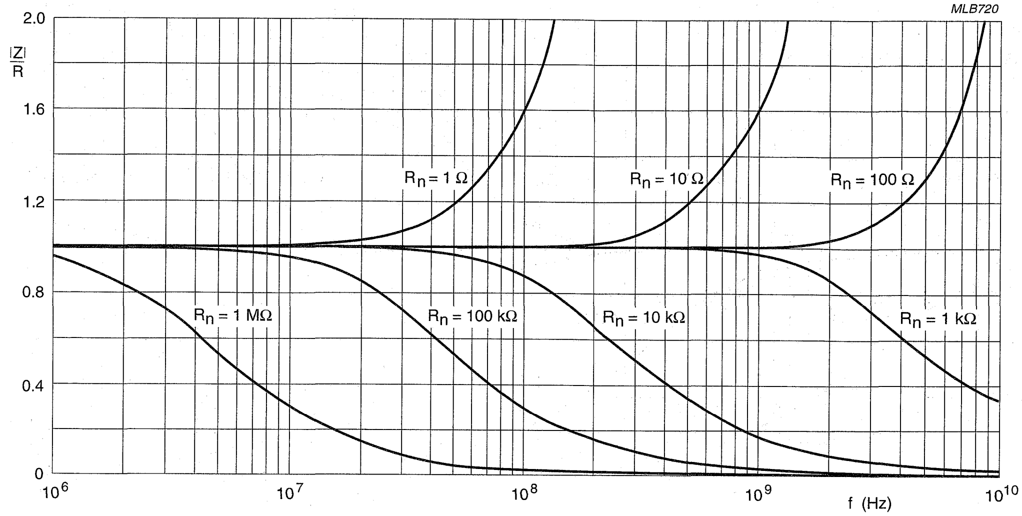
Size 0805

Fig.6 Impedance as a function of frequency for a chip resistor.



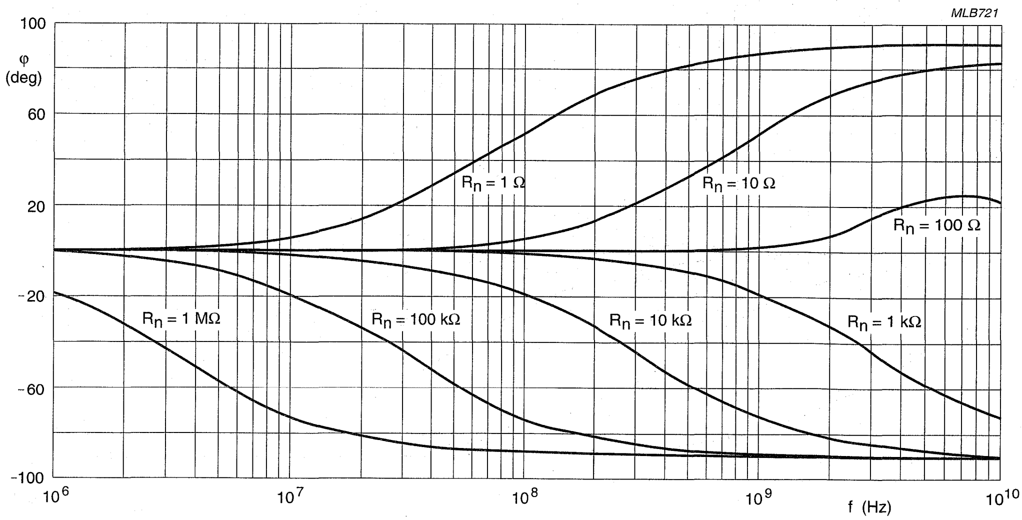
Size 0805

Fig.7 Phase shift as a function of frequency for a chip resistor.



Size 1206

Fig.8 Impedance as a function of frequency for a chip resistor.



Size 1206

Fig.9 Phase shift as a function of frequency for a chip resistor.

PULSE-LOAD BEHAVIOUR

The load, due to a single pulse at which chip resistors fail by going open circuit, is determined by shape and time. A standard way to establish pulse load limits is shown in Table 1.

Table 1 Pulse load limits

PARAMETER	VALUE	UNIT
Exponential time constant	50 to 700	µs
Repetition time	12 to 25	s
Amount of pulses	5 to 10	

With this test, it can be determined at which applied voltage the resistive value changes about 0.5% of its nominal value under the above mentioned pulse conditions. Figure 10 shows test results for the RC02 chip resistors. If applied regularly the load is destructive, therefore the load must not be applied regularly during the load life of the resistors. However, the magnitude of a pulse at which failure occurs is of little practical value. The maximum 'single-pulse' load that may be applied in a regular way can be determined in a similar manner.

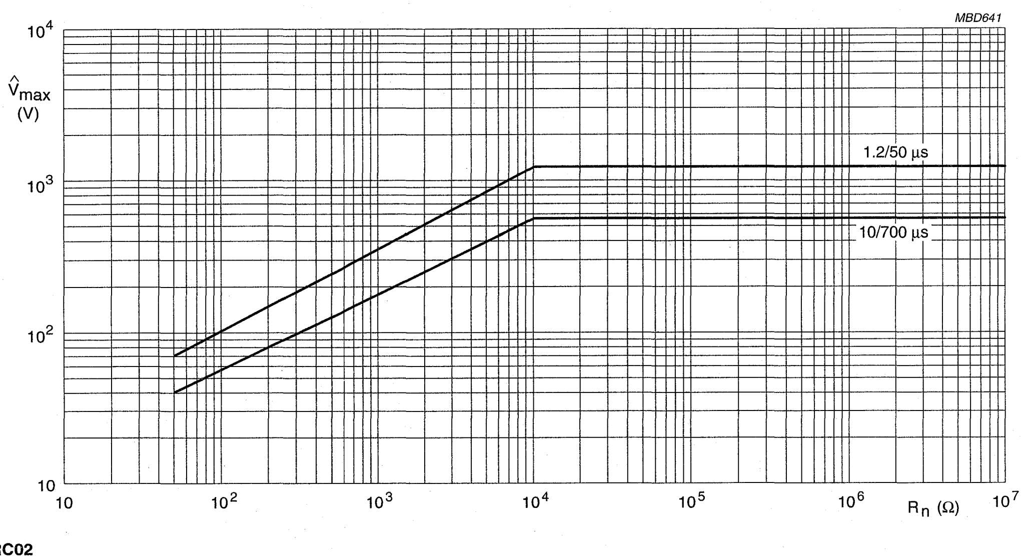


Fig.10 Maximum permissible peak pulse voltage ($\hat{V}_{max}$) without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533.

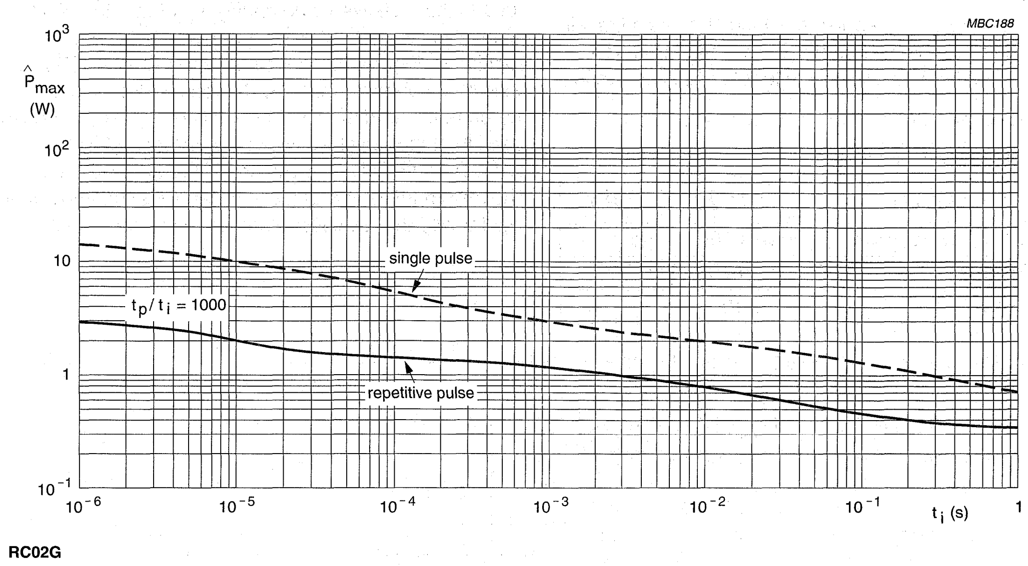


Fig.11 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for R ≤ 10 kΩ, single pulse and repetitive pulse $t_p/t_i = 1000$.

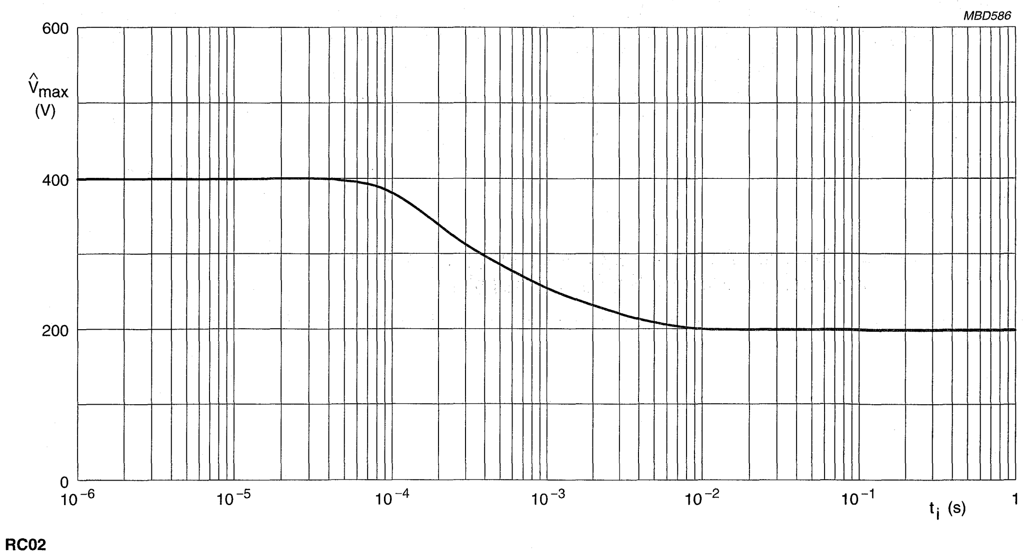


Fig.12 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration (t_i).

Definitions of pulses

SINGLE PULSE

The resistor is considered to be operating under single pulse conditions if, during its life, it is loaded with a limited number (approximately 1 500) of pulses over long time intervals (greater than one hour).

REPETITIVE PULSE

The resistor is operating under repetitive pulse conditions if it is loaded by a continuous train of pulses of similar power.

The dashed line in Fig.11 shows the observed maximum load for the RC02G chip resistors under single-pulse loading.

More usually, the resistor must withstand a continuous train of pulses of repetition time 't_p' during which only a small resistance change is acceptable. This resistance change ($\Delta R/R$) is equal to the change permissible under continuous load conditions. The continuous pulse train and small permissible resistance change reduces the maximum handling capability.

The continuous pulse train maximum handling capacity of chip resistors has been determined experimentally. Measurements have shown that the handling capacity varies with the resistive value applied.
However, maximum peak pulse voltages as indicated in Fig.12, should not be exceeded.

Determination of pulse-load

The graphs in Figs 11 and 12 may be used to determine the maximum pulse-load for a resistor.

- For repetitive rectangular pulses:
  - $\frac{\hat{V}_i^2}{R}$ must be lower than the value of $\hat{P}_{max}$ given by the solid lines of Fig.11 for the applicable value of t_i and duty cycle t_p/t_i.
  - $\hat{V}_i$ must be lower than the value of $\hat{V}_{max}$ given in Fig.12 for the applicable value of t_i.
- For repetitive exponential pulses:
  - As for rectangular pulses, except that $t_i = 0.5\ \tau$.
- For single rectangular pulses:
  - $\frac{\hat{V}_i^2}{R}$ must be lower than the $\hat{P}_{max}$ given by the dashed line of Fig.11 for the applicable value of t_i.
  - $\hat{V}_i$ must be lower than the value of $\hat{V}_{max}$ given in Fig.12 for the applicable value of t_i.

Definition of symbols (see Figs 11, 12, 13 and 14)

SYMBOL	DESCRIPTION
$\hat{P}$	applied peak pulse power
$\hat{P}_{max}$	maximum permissible peak pulse power (Fig.11)
$\hat{V}_i$	applied peak pulse voltage (Figs 13 and 14)
$\hat{V}_{max}$	maximum permissible peak pulse voltage (Fig.12)
R_{nom}	nominal resistance value
t_i	pulse duration (rectangular pulses)
t_p	pulse repetition time
τ	time constant (exponential pulses)
T_{amb}	ambient temperature
$T_{m(max)}$	maximum hot-spot temperature of the resistor

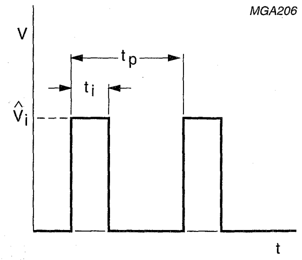


Fig.13 Rectangular pulses.

Examples

Determine the stability of a typical resistor for operation under the following pulse-load conditions.

CONTINUOUS PULSE TRAIN

A 100 Ω resistor is required to operate under the following conditions: $V_i = 10$ V; $t_i = 10^{-5}$ s; $t_p = 10^{-2}$ s.

Therefore:

$$\hat{P} = \frac{10^2}{100} = 1 \text{ W and } \frac{t_p}{t_i} = \frac{10^{-2}}{10^{-5}} = 1000$$

For $t_i = 10^{-5}$ s and $\frac{t_p}{t_i} = 1000$, Fig.11 gives $\hat{P}_{max} = 2$ W and Fig.12 gives $\hat{V}_{max} = 400$ V. As the operating conditions $\hat{P} = 1$ W and $\hat{V}_i = 10$ V are lower than these limiting values, this resistor may be safely used.

SINGLE PULSE

A 10 kΩ resistor is required to operate under the following conditions: $\hat{V}_i = 250$ V; $t_i = 10^{-5}$ s.

Therefore:

$$\hat{P}_{max} = \frac{250^2}{10000} = 6.25 \text{ W}$$

The dashed curve of Fig.11 shows that at $t_i = 10^{-5}$ s, the permissible $\hat{P}_{max} = 10$ W and Fig.12 shows a permissible $\hat{V}_{max}$ of 400 V, so this resistor may be used.

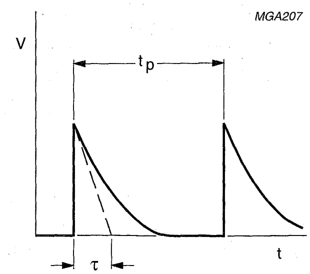
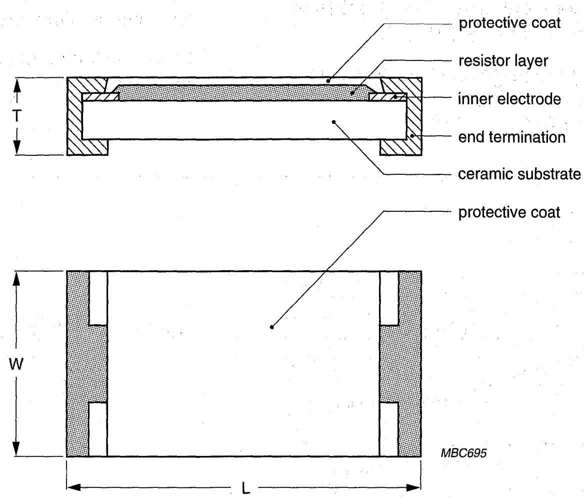


Fig.14 Exponential pulses.

MECHANICAL DATA

Outlines



For dimensions see Table 2.

Fig.15 Component outline.

Table 2 Chip resistor type; USA case size code; mass per 100 units and relevant physical dimensions; see Fig.15

TYPE	USA SIZE CODE	L (mm)	W (mm)	T (mm)	MASS (g)
RC0...	1206	3.2	1.6	0.6	1.0
RC1..	0805	2.0	1.25	0.6	0.55
RC2..	0603	1.6	0.8	0.45	0.25
RC3.	0402	1.0	0.5	0.35	0.052

Marking

Wherever possible chip resistors are provided with a **resistance code**; see Table 3. The resistance code includes the first two or three significant digits of the resistance value (in ohms) followed by the number of zeros to follow. Whether two or three significant values are represented depends on the tolerance:

- ±5% requires two digits
- ±2% tolerance may be marked with two or three digits
- ±1% and lower requires three digits.

Table 3 Resistance value indication

INDICATOR	TOL. ≥ ±2%	TOL. ≤ ±1%
0	0.0 Ω; jumper	–
R(1)	1 to 91 Ω	1 to 976 Ω
1	100 to 910 Ω	1 to 9.76 kΩ
2	1 to 9.1 kΩ	10 to 97.6 kΩ
3	10 to 91 kΩ	100 to 976 kΩ
4	100 to 910 kΩ	1 MΩ
5	1 to 9.1 MΩ	–
6	10 MΩ	–

Note

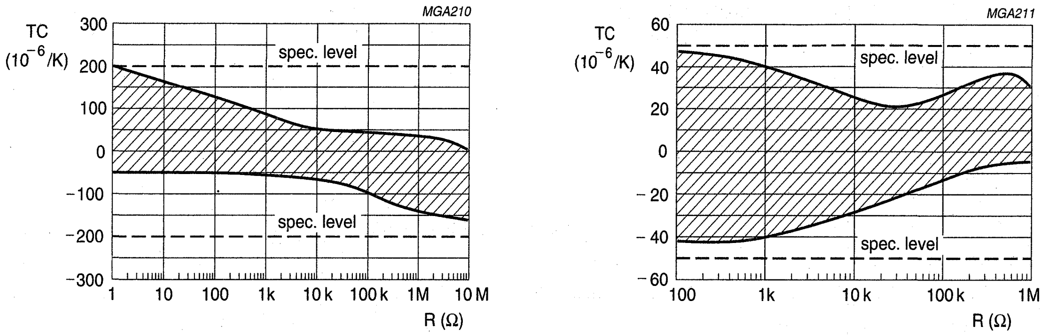
1. R denotes the decimal point.

TESTS AND PROCEDURES

To guarantee zero defect production standards, Statistical Process Control is an essential part of our production processes. Furthermore, our production process is operating in accordance with *"ISO 9000"*.

Essentially all tests on resistors are carried out in accordance with the schedule of *"IEC publication 60115-1"* in the specified climatic category and in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"*. In some instances deviations from the IEC recommendations are made.

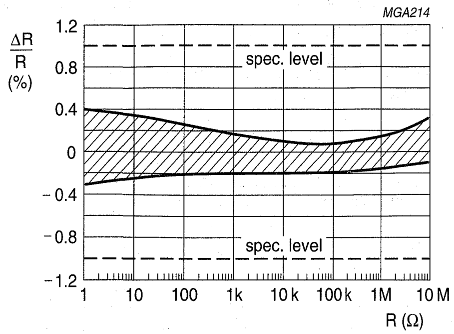
Tests and their requirements are described in detail in the data sheets.



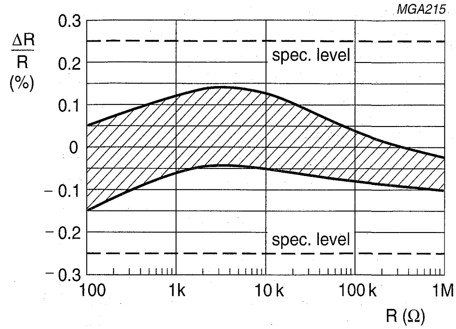
a. RC01.

b. RC02G.

Fig.16 Typical temperature coefficients between the lower and upper category temperatures.

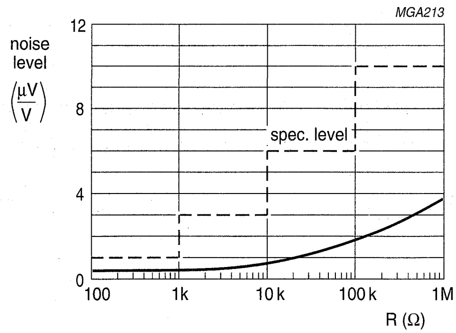


a. RC01.



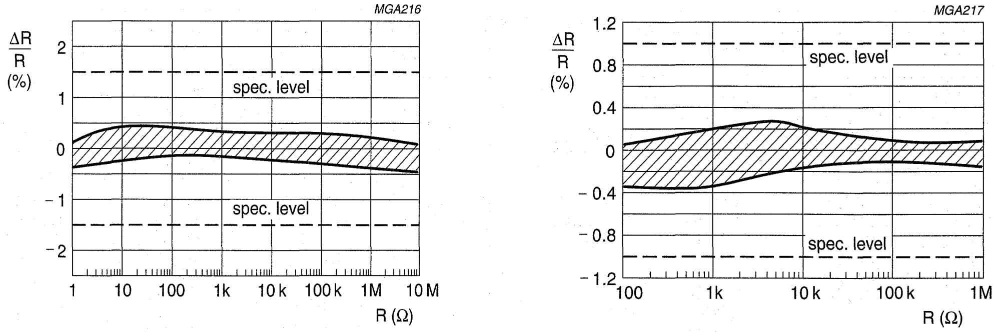
b. RC02G.

Fig.17 Typical percentage change in resistance after soldering for 10 seconds at 260 °C, completely immersed.



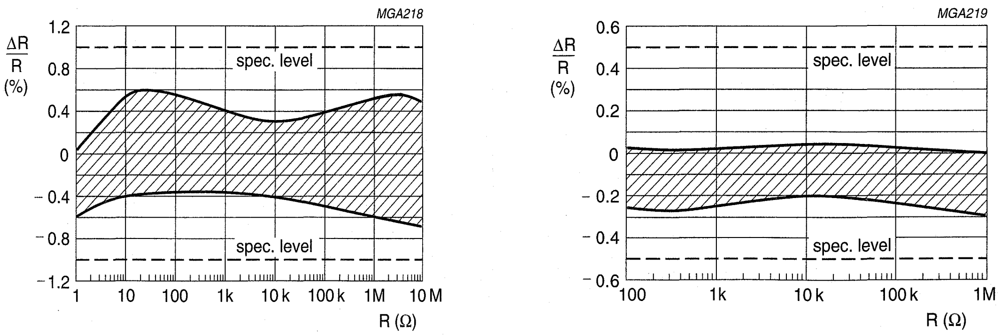
RC02G

Fig.18 Typical noise level as a function of rated resistance measured using Quantech - equipment.



a. RC01. b. RC02G.

Fig.19 Typical percentage change in resistance after 56 days at 40 °C and 90 to 95% relative humidity loaded with P_{nom}.



a. RC01. b. RC02G.

Fig.20 Typical percentage change in resistance after 1 000 hours loaded with P_{nom} at 70 °C ambient temperature.

SURFACE MOUNT RESISTORS

GENERAL PURPOSE	PRECISION	HIGH PRECISION	LOW OHMIC	HIGH OHMIC	POWER	NET WORK	APPLICATION SPECIFIC
RC01	**RC02H**	**RC03G**	**LRC01**	**HRC01**	**PRC221**	**RNA310**	**RC02TR**
RC11	**RC02G**	**RC13G**	**LRC02**	**HRC11**	general purpose	**RCB210**	**RC12TR**
RC21	**RC12H**	**TFR01**	**LRC11**	**HRC21**	precision	**CRB210**	**RC22TR**
RC31	**RC12G**	**TFR11**			low ohmic	**ARC241**	**FRC01**
	RC22H	**TFR21**			**PRC111**	**ARC242**	**SRC01**
	RC32	**TFR31**			general purpose	**ARV241**	
		TFR41			precision	**ARV242**	
		MPC01			low ohmic	**ARV341**	
		MPC11				**ARV342**	
		MPC21			**PRC201**		

CCB776

APPLICATION	TYPE	SIZE CODE	TOL. (%)	RESISTANCE RANGE	TEMP. COEFF. ($\times 10^{-6}$/K)	MAX. (V)	MAX. (W)	SERIES	CATALOGUE NUMBER	PAGE
Thick Film RSMD										
General purpose	RC01	1206	5	1 Ω to 10 MΩ	±200(1)	200	0.25	E24	2322 711 61...	214
	RC11	0805		1 Ω to 10 MΩ		150	0.125		2322 730 61...	
	RC21	0603		1 Ω to 10 MΩ		50	0.063		2322 702 60...	
	RC31	0402		6.8 Ω to 2.2 MΩ		50	0.063		2322 705 70...	
	RC01	1206	2	1 Ω to 10 MΩ	±200(1)	200	0.25	E24	2322 711 41...	214
	RC11	0805		1 Ω to 10 MΩ		150	0.125		2322 730 31...	
	RC21	0603		1 Ω to 10 MΩ		50	0.063		2322 702 65...	
	RC31	0402		6.8 Ω to 2.2 MΩ		50	0.063		2322 705 75...	
Precision TC100	RC02H	1206	1	1 Ω to 10 MΩ	±100(1)	200	0.25	E24/E96	2322 724 6....	227
	RC12H	0805		1 Ω to 10 MΩ		150	0.125		2322 734 6....	
	RC22H	0603		1 Ω to 10 MΩ		50	0.063		2322 704 6....	
	RC32	0402		10 Ω to 1 MΩ	±200(1)	50	0.063		2322 706 7....	
Precision TC50	RC02G	1206	1	90 Ω to 2.74 MΩ	±50	200	0.25	E24/E96	2322 722 2....	227
	RC12G	0805				150	0.125		2322 732 6....	
High precision TC50	RC03G	1206	0.5	90 Ω to 2.74 MΩ	±50	200	0.25	E24/E96	2322 725 2....	239
	RC13G	0805				150	0.125		2322 738 2....	244
Power chip	PRC221	2512	5	1 Ω to 10 MΩ	±200(1)	250	1	E24	2322 762 60...	309
	PRC111	2010		1 Ω to 10 MΩ		200	0.5		2322 760 60...	297
	PRC201	1218		1 Ω to 1 MΩ	±100(1)	200	1	E24/E96	2322 735 60...	281
Power precision	PRC221	2512	1	1 Ω to 10 MΩ	±100(1)	250	1	E96	2322 763 6....	303
	PRC111	2010		1 Ω to 10 MΩ		200	0.5		2322 761 6....	291
	PRC201	1218		1 Ω to 1 MΩ		200	1	E24/E96	2322 735 2....	281

Chip resistors

Selection guide

APPLICATION	TYPE	SIZE CODE	TOL. (%)	RESISTANCE RANGE	TEMP. COEFF. ($\times 10^{-6}$/K)	MAX. (V)	MAX. (W)	SERIES	CATALOGUE NUMBER	PAGE
APPLICATION SPECIFIC										
Power low ohmic	PRC221	2512	5	0.01 Ω to 0.99 Ω	±75/±1500	250	1	E24	2322 762 90.../60...	309
	PRC111	2010		0.01 Ω to 0.99 Ω		200	0.5		2322 760 90.../60...	data on request
	PRC201	1218		0.02 Ω to 0.99 Ω	±250/±2000	200	1	E96	2322 735 60...	281
	PRC221	2512	2	0.01 Ω to 0.99 Ω	±75/±1500	250	1	E24	2322 762 91.../80...	309
	PRC111	2010		0.01 Ω to 0.99 Ω		200	0.5		2322 760 91.../80...	data on request
	PRC221	2512	1	0.02 Ω to 0.99 Ω	±75/±1500	250	1	E24/E96	2322 763 90.../6....	data on request
	PRC111	2010		0.02 Ω to 0.99 Ω		200	0.5		2322 761 90.../6....	
	PRC201	1218		0.1 Ω to 0.99 Ω	±250/±700	200	1	E96	2322 735 2....	281
Low ohmic	LRC01	1206	5	0.02 Ω to 0.99 Ω	±75/±1500	200	0.25	E24	2350 510 10...	321
	LRC11	0805				150	0.125		2350 511 10...	331
	LRC11	0805	2	0.02 Ω to 0.99 Ω		150	0.125		2350 511 11...	331
	LRC02	1206	1	0.02 Ω to 0.99 Ω		200	0.25		2350 510 12...	326
High ohmic	HRC01	1206	5	11 MΩ to 100 MΩ	±300	200	0.25	E24	2350 520 10...	336
	HRC11	0805		11 MΩ to 100 MΩ		150	0.125		2350 521 10...	341
	HRC21	0603		11 MΩ to 22 MΩ	±300(1)	50	0.063		2350 522 10...	346
	HRC01	1206	2	11 MΩ to 100 MΩ	±300	200	0.25		2350 520 11...	336
	HRC11	0805		11 MΩ to 100 MΩ		150	0.125		2350 521 11...	341
	HRC21	0603		11 MΩ to 22 MΩ	±300(1)	50	0.063		2350 522 11...	346
Trimmable	RC02TR	1206	0/–20	1 Ω to 10 MΩ	±100(1)	200	0.25	E24	2350 500 11...	351
	RC12TR	0805				150	0.125		2350 501 11...	351
	RC22TR	0603				50	0.063		2350 502 11...	356
	RC02TR	1206	0/–30	1 Ω to 10 MΩ	±100(1)	200	0.25	E24	2350 500 10...	351
	RC12TR	0805				150	0.125		2350 501 10...	351
	RC22TR	0603				50	0.063		2350 502 10...	356
Fusible	FRC01	1206	5	1 Ω to 510 Ω	±200(1)	200	0.125	E96	2322 750 6....	361
Surge current	SRC01	1206	5	1 Ω to 100 kΩ	±200	200	0.25	E24	2350 550 10...	368
	SRC01		2	1 Ω to 100 kΩ		200	0.25		2350 550 11...	368

APPLICATION	TYPE	SIZE CODE	TOL. (%)	RESISTANCE RANGE	TEMP. COEFF. ($\times 10^{-6}$/K)	MAX. (V)	MAX. (W)	SERIES	CATALOGUE NUMBER	PAGE
Thin Film RSMD										
High precision, high stability	TFR01	1206	0.5	10 Ω to 1 MΩ	±25/±50	150	0.125	E24/E96	2350 61. 6....	248
	TFR11	0805		10 Ω to 1 MΩ	±25/±50	100	0.1		2350 60. 6....	
	TFR21	0603		10 Ω to 360 kΩ	±25/±50	75	0.063		2350 60. 6....	
	TFR31	0402		10 Ω to 100 kΩ	±25/±100	25	0.063		2350 60. 6....	
	TFR41	0201		33 Ω to 22 kΩ	±25	15	0.05		2350 614 6....	
Ultra high precision, high stability	MPC01	1206	0.1	100 Ω to 1 MΩ	±10/±50	150	0.125	E24/E96	2322 741 3....	254
	MPC11	0805		100 Ω to 1 MΩ		100	0.1		2322 744 3....	
	MPC21	0603		100 Ω to 332 kΩ		75	0.063		2322 747 3....	
Network and Arrays										
Network 10P8R	RNA310	1206	5	10 Ω to 100 kΩ	±200	25	0.031	E24/E96	2350 230 10...	263
R-C Network 10P4R4C	RCB210	1608	5	10 Ω to 1 kΩ	±200	25	0.063	on request	2350 321 2....	374
			30/−20	10 pF to 180 pF						
C-R Network 10P4C4R	CRB210	1608	5; 10; 20	10 Ω to 100 kΩ	±200	50	0.063	on request	2250 46.	381
			30/−20	15 pF to 22 nF						
Array Concave	ARC241	4 × 0603	5	10 Ω to 1 MΩ	±200	50	0.063	E24	2350 034 10...	269
	ARC242		1		±100			E24/E96	2350 024 1....	
Array Convex	ARV241	4 × 0603	5	10 Ω to 1 MΩ	±200	50	0.063	E24	2350 035 10...	269
	ARV242		1					E24/E96	2350 025 1....	
	ARV341	4 × 0402	5	10 Ω to 1 MΩ	±300	50	0.063	E24	2350 033 10...	276
	ARV342		1					E24/E96	2350 023 1....	

Note

1. ≤10 Ω; TCR: 0/+500 ppm
   >1 MΩ; TCR: ±300 ppm.

12-DIGIT ORDERING CODE

The resistors have a 12-digit ordering code starting with 2350 or 2322.

Subsequent digits indicate style, packaging, resistance value and tolerance.
Refer to individual data sheets for detailed composition of the ordering code.

In Table 1 the 12NC is referenced to the applicable page number where a detailed composition will be found.

Table 1 First 6 or 7 digits of the ordering code

TYPE NAME	ORDERING CODE	PAGE
2350 (first 4 digits followed by next 2 or 3 digits)		
ARC241/ARV241	03	269
ARV341	03	276
ARC242/ARV242	02	269
ARV342	02	276
RNA310	230	263
RCB210	321	374
CRB210	46	381
RC02TR	500	351
RC12TR	501	351
RC22TR	502	356
CRB210	46	381
CRB210	46	381
LRC01	510	321
LRC11	511	331
LRC02	510	326
HRC01	520	336
HRC11	521	341
HRC21	522	346
SRC01	550	368
TFR01	61	248

TYPE NAME	ORDERING CODE	PAGE
2322 (first 4 digits followed by next 2 or 3 digits)		
RC21	702	214
RC22	704	227
RC31	705	214
RC32	706	227
RC01	711	214
RC02	722	227
RC02	724	227
RC03G	725	239
RC11	730	214
RC11	731	214
RC12	732	227
RC12	734	227
PRC201	735	281
RC13G	738	244
MPC01	741	254
MPC11	744	254
MPC21	747	254
PRC111	760	297
PRC111	761	291
PRC221	762	309
PRC221	763	303

MOUNTING

Due to their rectangular shape and small dimensional tolerances, Surface Mounted Resistors are suitable for handling by automatic placement systems. Chip placement can be on ceramic substrates and printed-circuit boards (PCBs). Electrical connection to the circuit is by wave, vapour phase or infrared soldering. The end terminations guarantee a reliable contact and the protective coating enables 'face down' mounting.

The temperature rise in a resistor due to power dissipation, is determined by the laws of heat - conduction, convection and radiation. The maximum body temperature usually occurs in the middle of the resistor and is called the **hot-spot** temperature.

The hot-spot temperature depends on the ambient temperature and the dissipated power. This is described in the data sheets under the chapter heading "Functional description".

The hot-spot temperature is important for mounting because the connections to the chip resistors will reach a temperature close to the hot-spot temperature. Heat conducted by the connections must not reach the melting point of the solder at the joints. Therefore a maximum solder joint temperature of 110 °C is advised.

The ambient temperature on large or very dense printed-circuit boards (PCBs) is influenced by the dissipated power. The ambient temperature will again influence the hot-spot temperature. Therefore, the packing density that is allowed on the PCB is influenced by the dissipated power.

Example of mounting effects

Assume that the maximum temperature of a PCB is 95 °C and the ambient temperature is 50 °C. In this case the maximum temperature rise that may be allowed is 45 °C. In the graph (see Fig.1), this point is found by drawing the line from point A (PCB = 95 °C) to point B (T_{amb} = 50 °C) and from here to the left axis.

To find the maximum packing density, this horizontal line is extended until it intersects with the curve, 0.125 W (point C). The maximum packing density, 19 units/50 × 50 mm^2 (point D), is found on the horizontal axis.

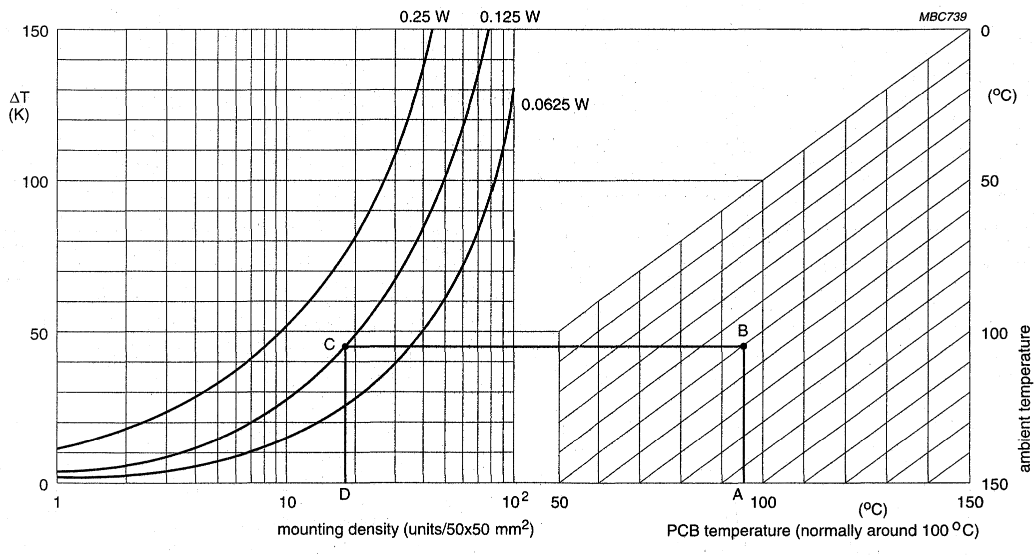


Fig.1 PCB temperature as a function of applied power, mounting density and ambient temperature.

Thermal resistance (R_{th})

Thermal resistance prohibits the release of heat generated within the resistor to the surrounding environment. It is expressed in K/W and defines the surface temperature (T_{HS}) of the resistor in relation to the ambient temperature (T_{amb}) and the load (P) of the resistor, as follows:

$T_{HS} = T_{amb} + P \times R_{th}$

Due to their direct contact with the solder spot, chip resistors dissipate over 85% of their heat via conduction to the solder spot and hence to the PCB. Thus the PCB on which the chip resistor is mounted functions as a heat sink. Different PCBs have different heat conductance. Figure 2 shows the different values of heat resistance per material type. Substrates with a higher heat conductance give lower thermal resistance figures; substrates with a lower heat conductance give higher thermal resistance figures.

It should be noted that the temperature of the terminations of the chip resistor is virtually the same as the hot-spot temperature. Therefore the power that may be dissipated by the resistor is dependent on:

T_{amb} (which is also dependent on the packing density)

R_{th} of the PCB

maximum solder spot temperature (generally 110 °C).

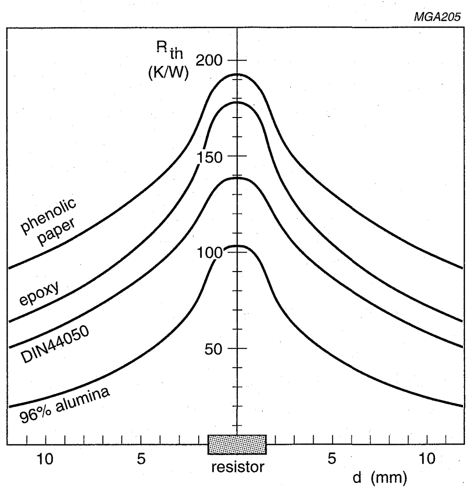
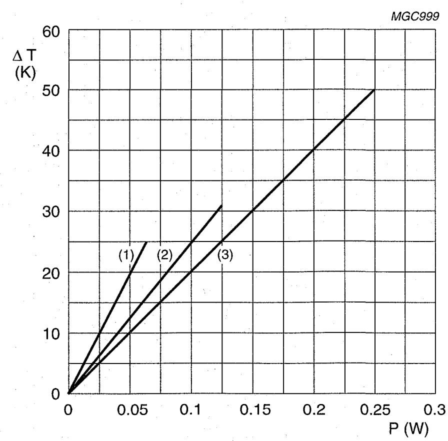


Fig.2 Heat resistance for 1206 sized resistors as a function of distance and material.



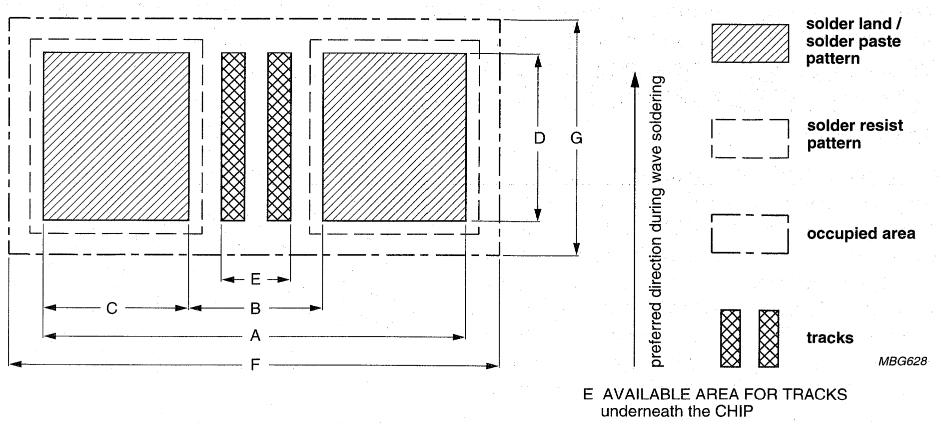
(1) For size 0603: R_{th} = 400 K/W.

(2) For size 0805: R_{th} = 250 K/W.

(3) For size 1206: R_{th} = 200 K/W.

Fig.3 Hot-spot temperature rise (ΔT) as a function of dissipated power.

FOOTPRINT DIMENSIONS



For dimensions see Tables 1 and 2.

Fig.4 Recommended dimensions of footprints.

Table 1 Reflow soldering; for dimensions see also Fig.4

SIZE CODE	FOOTPRINT DIMENSIONS (mm)							PROCESSING REMARKS	PLACEMENT ACCURACY (mm)
	A	B	C	D	E	F	G		
0402	1.5	0.5	0.5	0.6	0.1	1.9	1.0	IR or hot plate soldering	±0.15
0603	2.1	0.5	0.8	0.9	0.0	2.5	1.7		±0.25
0805	2.6	0.9	0.85	1.4	0.5	3.0	2.1		±0.25
1206	3.8	2.0	0.9	1.8	1.4	4.2	2.5		±0.25
1218	3.8	2.0	0.9	1.8	1.4	4.2	2.5		±0.25
2010	5.6	3.8	0.9	2.8	3.4	5.85	3.15		±0.25
2512	7.0	3.8	1.6	3.5	3.4	7.25	3.85		±0.25

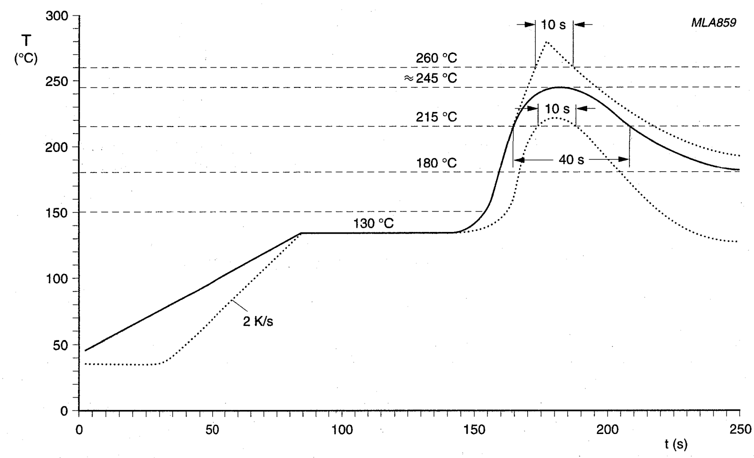
Table 2 Wave soldering (no dummy tracks allowed for the high voltage series); for dimensions see also Fig.4

SIZE CODE	FOOTPRINT DIMENSIONS (mm)							PROPOSED NUMBER AND DIMENSIONS OF DUMMY TRACKS (mm)	PLACEMENT ACCURACY (mm)
	A	B	C	D	E	F	G		
0603	2.7	0.9	0.9	0.8	0.15	3.2	1.9	$1 \times (0.15 \times 0.8)$	±0.25
0805	3.3	1.3	1.0	1.3	0.34	3.9	2.4	$1 \times (0.3 \times 1.3)$	±0.25
1206	4.5	2.5	1.0	1.7	1.25	3.9	2.4	$3 \times (0.25 \times 1.7)$	±0.25
1218	4.5	2.5	1.0	1.7	1.25	4.6	3.6	–	±0.25
2010	6.3	4.3	1.0	2.5	3.00	7.0	3.6	–	±0.25
2512	7.7	5.7	1.0	3.2	3.00	8.4	4.3	–	±0.25

SOLDERING CONDITIONS

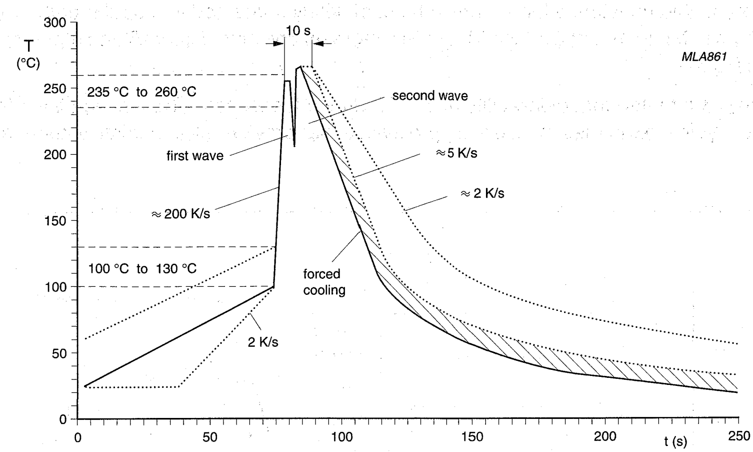
The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260 °C for one minute. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235 °C during 2 seconds. The test condition for no leaching is 260 °C for 60 seconds. Typical examples of soldering processes that provide reliable joints without any damage, are given in Figs 5, 6 and 7.



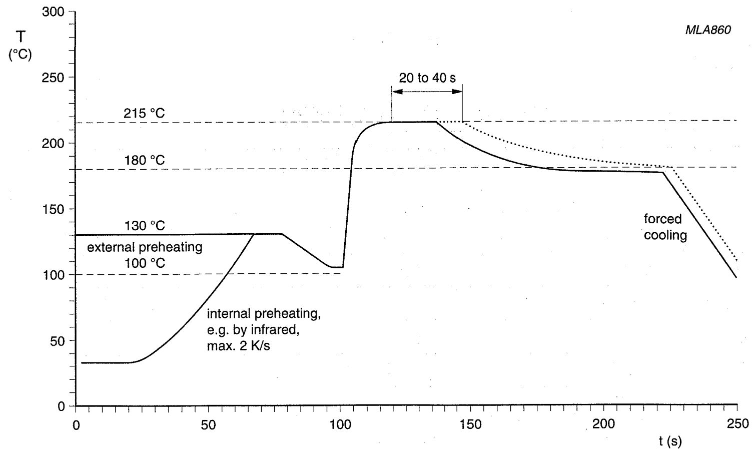
Typical values (solid line).
Process limits (dotted lines).

Fig.5 Infrared soldering.



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

Fig.6 Double wave soldering.



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

Fig.7 Vapour phase soldering.

PACKAGING

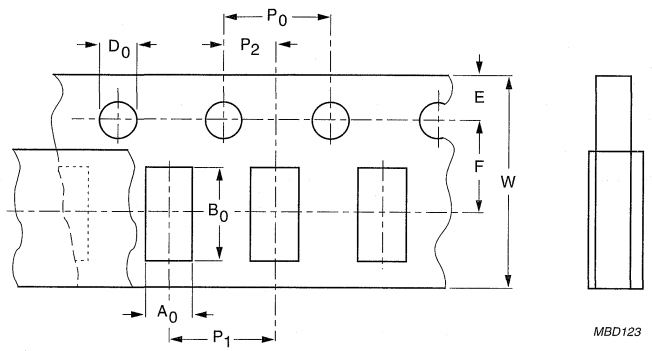
Tape and reel specifications

All tape and reel specifications are in accordance with the second edition of *"IEC 60286-3"*. Basic dimensions are given in Figs 1, 2 and 5, and Tables 1, 2 and 3.

Peel-off force

Peel-off forces of both paper and blister tapes are in accordance with *"IEC 60286-3"*; that is, at a peel-off speed of 300 ±10 mm/minute, 0.1 N to 1.0 N for 8 mm tape and 0.1 N to 1.3 N for tape larger than 8 mm. The peel-off angle should be between 165° and 180°.

Paper tape



Cumulative tolerance over 10 holes: ±0.2 mm.
Bottom fixing tape thickness: 50 ±10 μm.
Top fixing tape thickness: 50 ±10 μm.
For dimensions see Table 1.
Carrier tape thickness:
0.4 ±0.05 mm (0402)
0.6 ±0.05 mm (0603)
0.75 ±0.05 mm (1206; 0805).

Fig.1 Paper tape.

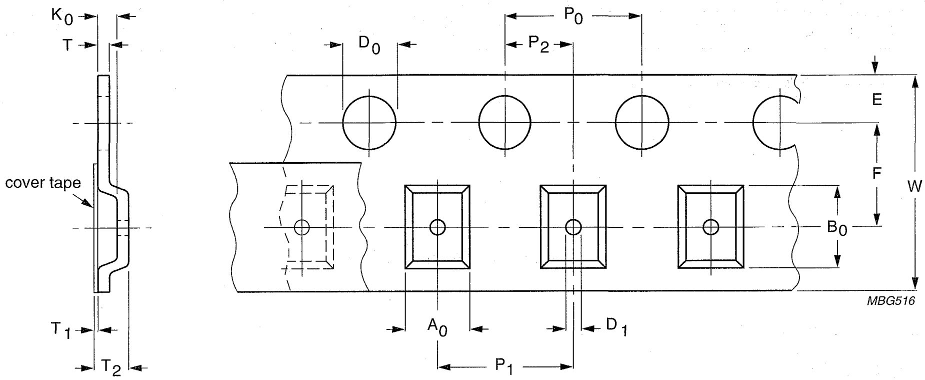
Table 1 Dimensions of paper tape for relevant chip size; see Fig.1

SYMBOL	PRODUCT SIZE CODE								UNIT
	0402		0603		0805		1206		
	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	
A_0	0.70	±0.05	1.0	+0.2/–0	1.50	+0.2/–0	1.85	+0.2/–0	mm
B_0	1.20	±0.05	1.8	+0.2/–0	2.25	+0.2/–0	3.45	+0.2/–0	mm
W	8	±0.2	8	±0.3	8.00	±0.3	8	±0.3	mm
E	1.75	±0.1	1.75	±0.1	1.75	±0.1	1.75	±0.1	mm
F	3.5	±0.05	3.5	±0.05	3.50	±0.05	3.5	±0.05	mm
D_0	1.5	+0.1/–0	1.5	+0.1/–0	1.50	+0.1/–0	1.5	+0.1/–0	mm
P_0	4	±0.1	4	±0.1	4.0	±0.1	4	±0.1	mm
P_1	2	±0.1	4	±0.1	4.0	±0.1	4	±0.1	mm
P_2	2 or 0	±0.05	2	±0.05	2.0	±0.05	2	±0.05	mm

Blister tape

ENVIRONMENTAL CONSIDERATIONS

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



Cumulative pitch error: 0.2 mm over 10 pitches.
Cumulative tolerance over 10 holes: ±0.2 mm.
K_0: chosen so that the orientation of the component cannot change.
For W = 8 mm: T_2 = 2.5 mm max.
For W = 12 mm: T_2 = 4.5 mm max.
For dimensions see Table 2.

Fig.2 Blister tape.

Table 2 Dimensions of blister tape for relevant chip size; see Fig.2

SYMBOL	PRODUCT SIZE CODE				TOL.	UNIT
	1218	1608	2010	2512		
A_0 nominal clearance; note 1	0.30	2.50	2.77	3.6	–	mm
B_0 nominal clearance; note 1	0.20	4.40	5.49	6.9	–	mm
K_0 minimum clearance; note 1	0.10	–	–	–	–	mm
W	12	12.0	12.0	12.0	±0.2	mm
E	1.75	1.75	1.75	1.75	±0.1	mm
F	5.5	5.5	5.5	5.5	±0.05	mm
D_0	1.5	1.5	1.5	1.5	+0.1/–0.0	mm
D_1	≥1.5	–	–	–	+0.1/–0.0	mm
P_0; note 2	4	4	4	4	±0.1	mm
P_1	8	4	4	4	±0.1	mm
P_2	2	2	2	2	±0.05	mm
T	1.1	1.15	1.2	1.2	±0.2	mm

Notes

1. Possible product displacement in pocket.
2. P_0 pitch tolerance over any 10 pitches is ±0.2 mm.

Leader/trailer tape specification

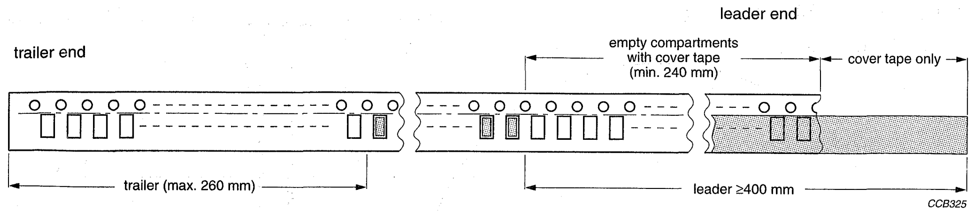


Fig.3 Leader/trailer tape.

Taping package requirements

Resistance side facing up.

Component is free and not sticking to top and/or bottom tape.

Component should be easy to remove from carrier tape and the chip hole should have no mechanical damage.

Peel-off force

Peel-off force of paper and blister tape is in accordance with *"IEC 60286-3"*; that is, 0.2 to 1.0 N at a peel-off speed of 300 mm/minute.

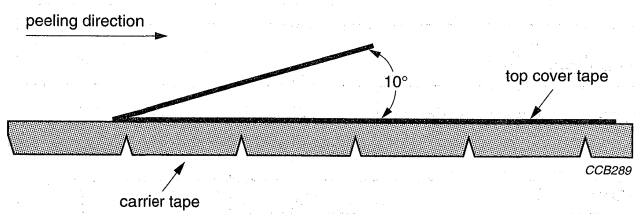
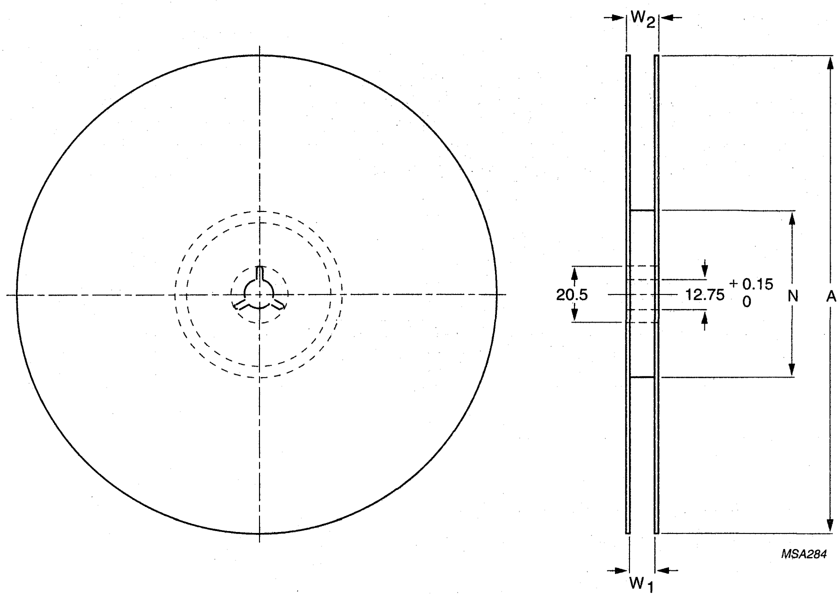


Fig.4 Peel-off force.

REEL SPECIFICATIONS



Dimensions in mm.
For reel dimensions see Table 3.

Fig.5 Reel.

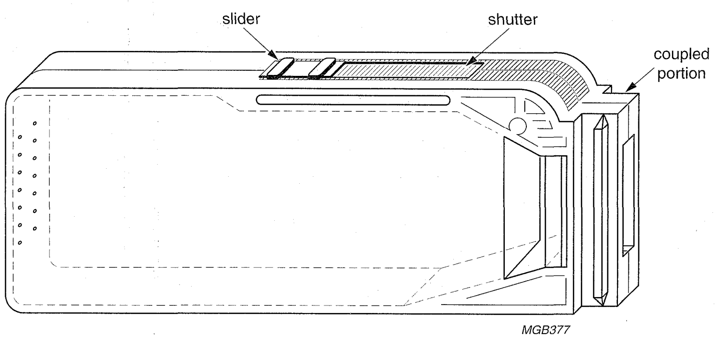
Table 3 Reel dimensions; see Fig.5

<table>
<tr><th>PRODUCT SIZE CODE</th><th>UNITS PER REEL</th><th>TAPE WIDTH (mm)</th><th>A (mm)</th><th>N (mm)</th><th>W_1 (mm)</th><th>W_2 MAX. (mm)</th></tr>
<tr><td>0402</td><td>10000</td><td rowspan="5">8</td><td>180</td><td rowspan="4">62 ±1.5</td><td rowspan="4">8.4 +1.5/−0.0</td><td rowspan="4">14.4</td></tr>
<tr><td rowspan="3">1206; 0603; 0805</td><td>20000</td><td>330</td></tr>
<tr><td>10000</td><td>250</td></tr>
<tr><td>5000</td><td>180</td></tr>
<tr><td>1608</td><td>4000</td><td>178 ±2.0</td><td rowspan="3">60 ±0.5</td><td>13.0 ±0.3</td><td>15.7 ±0.5</td></tr>
<tr><td rowspan="2">1218</td><td>1000</td><td rowspan="4">12</td><td>180</td><td rowspan="2">12.4 +2/−0.0</td><td rowspan="2">18.4</td></tr>
<tr><td>5000</td><td>286</td></tr>
<tr><td>2010</td><td>4000</td><td>178 +0/−0.3</td><td>60 ±1.0</td><td>14.0 ±0.1</td><td>16.7 ±0.5</td></tr>
<tr><td>2512</td><td>4000</td><td>178 +0/−0.3</td><td>60 ±1.0</td><td>9.0 ±1</td><td>14.4</td></tr>
</table>

BULK CASE SPECIFICATION

Features and benefits:

- Reduced costs
  - Storage
  - Transport
  - Machine handling
  - Packaging.



For dimensions see Table 4.

Fig.6 Bulk case outline.

Table 4 Bulk case dimensions; see Fig.6

LENGTH (mm)	WIDTH (mm)	THICKNESS (mm)
110	35	12

Table 5 Product size versus packaged quantity

PRODUCT SIZE CODE	UNITS PER CASE
0402	50000
0603	25000

RESISTOR PRODUCT DATA

General purpose chip resistors sizes 1206, 0805, 0603 and 0402

RC01/11/21/31 5%; 2%

FEATURES

- Low assembly costs
- High component and equipment reliability
- Excellent performance at high frequency, especially the RC31
- Complete standard SMD family.

APPLICATIONS

- All general purpose applications.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coat and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE			
	RC01	RC11	RC21	RC31
Size code	1206 (3216)	0805 (2012)	0603 (1608)	0402(1005)
Resistance range	1 Ω to 10 MΩ			6.8 Ω to 2.2 MΩ
Resistance tolerance and E-series	±5%, ±2%; E24 series			
Temperature coefficient: 1 Ω ≤ R < 10 Ω 10 Ω < R ≤ 10 MΩ	 $\leq 250 \pm 250 \times 10^{-6}$/K $\leq \pm 200 \times 10^{-6}$/K			
Maximum dissipation at T_{amb} = 70 °C	0.25 W	0.125 W	0.063 W	0.063 W
Maximum permissible voltage	200 V (DC or RMS)	150 V (DC or RMS)	50 V (DC or RMS)	50 V (DC or RMS)
Climatic category (IEC 60068)	55/155/56			55/125/56
Basic specification	IEC 60115-8			

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	TOL. (%)	ORDERING CODE 2322					
		PAPER TAPE ON REEL(1)				BULK CASE	
		5000 units	10000 units	20000 units	50000 units	10000 units	25000 units
RC01	±5	711 61...	711 51...	711 81...	–	–	–
	±2	711 41...	–	711 71...	–	–	–
RC11	±5	730 61...	730 71...	730 81...	–	731 81...	–
	±2	730 31...	–	730 41...	–	731 51...	–
RC21	±5	702 60...	702 70...	702 81...	–	–	702 80...
	±2	702 65...	–	702 75...	–	–	702 50...
RC31	±5	–	705 70...	–	705 87...	–	–
	±2	–	705 75...	–	–	–	702 50...
Jumper 0 Ω							
RC01(1)	–	711 91032	711 91005	711 92004	–	–	–
RC11(1)	–	730 91002	730 91003	730 92002	–	731 91006	–
RC21(2)	–	702 96001	702 97001	702 92002	–	–	702 91002
RC31(2)	–	–	705 91001	–	705 91007	–	–

Notes

1. The jumper has a maximum resistance R_{max} = 50 mΩ and a rated current I_R = 2 A.
2. The jumper has a maximum resistance R_{max} = 50 mΩ and a rated current I_R = 1 A.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322
- The subsequent 5 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 kΩ	4
1 to 9.76 MΩ	5
10 MΩ	6

ORDERING EXAMPLE

The ordering code of a RC11 resistor, value 4700 Ω with ±2% tolerance, supplied on paper tape of 5000 units per reel is: 2322 730 31472.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of ±5% or ±2%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
RC01	200	0.25
RC11	150	0.125
RC21	50	0.063
RC31		

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

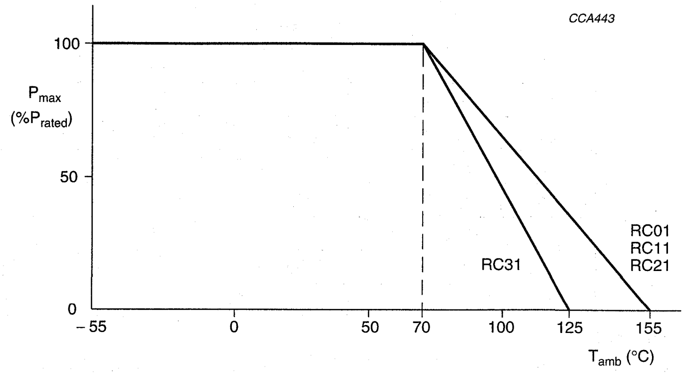
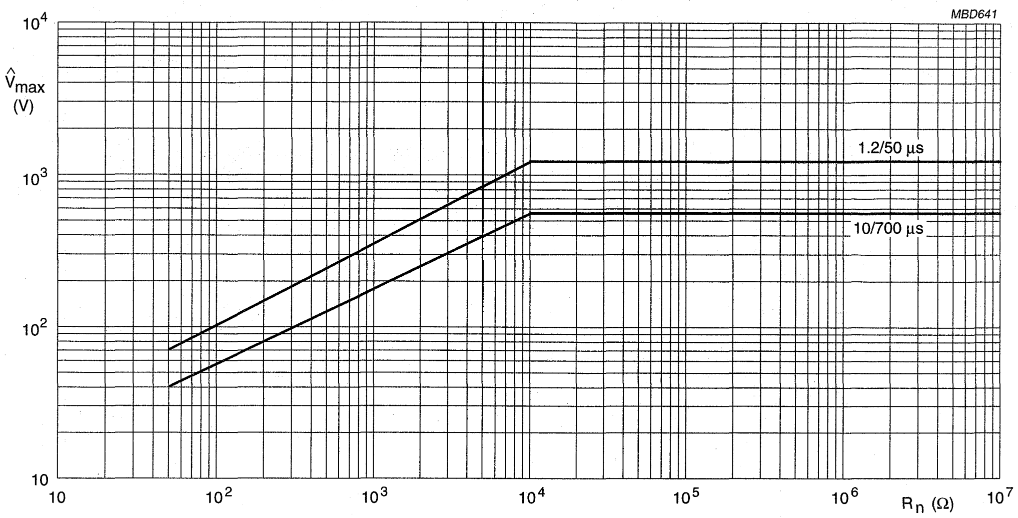


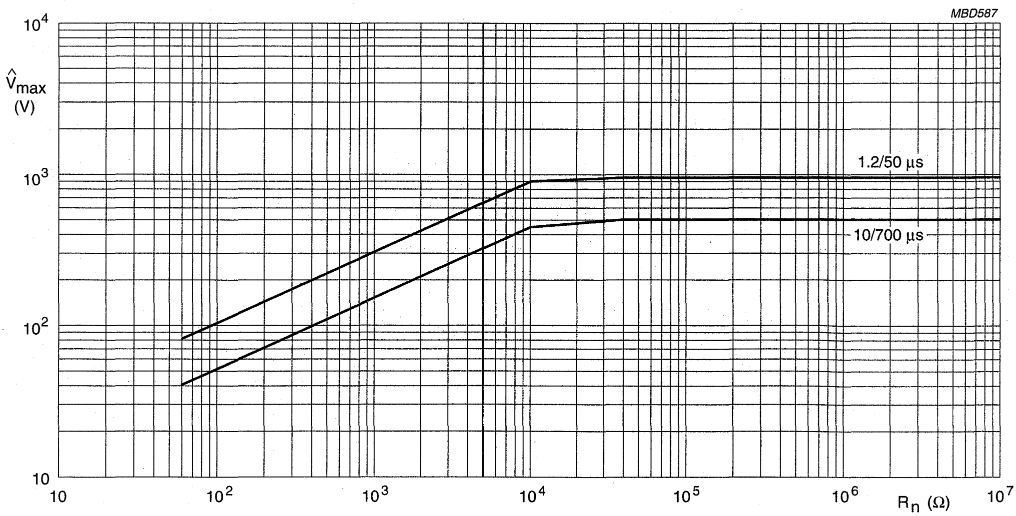
Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

PULSE LOADING CAPABILITIES



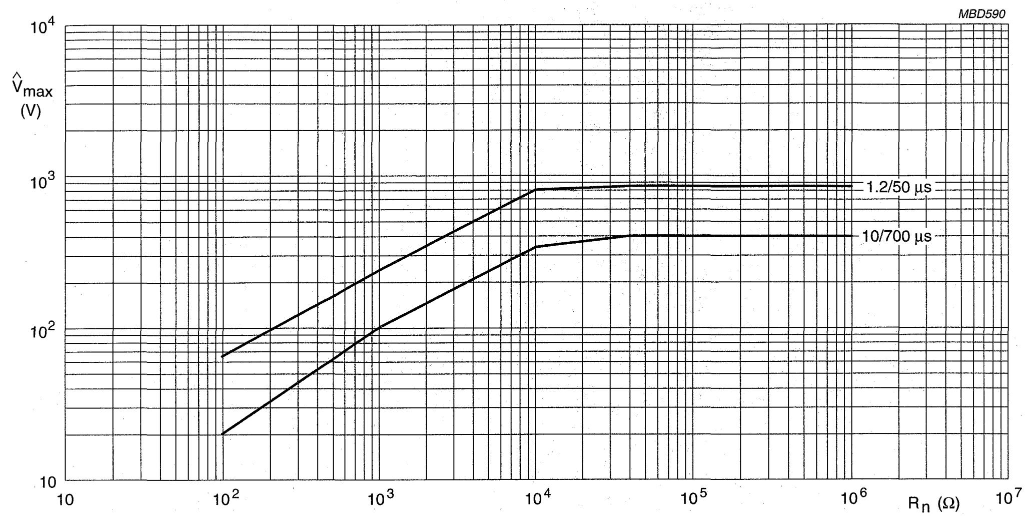
These pulses may not be applied on a regular basis.

Fig.2 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533 for type: **RC01**.



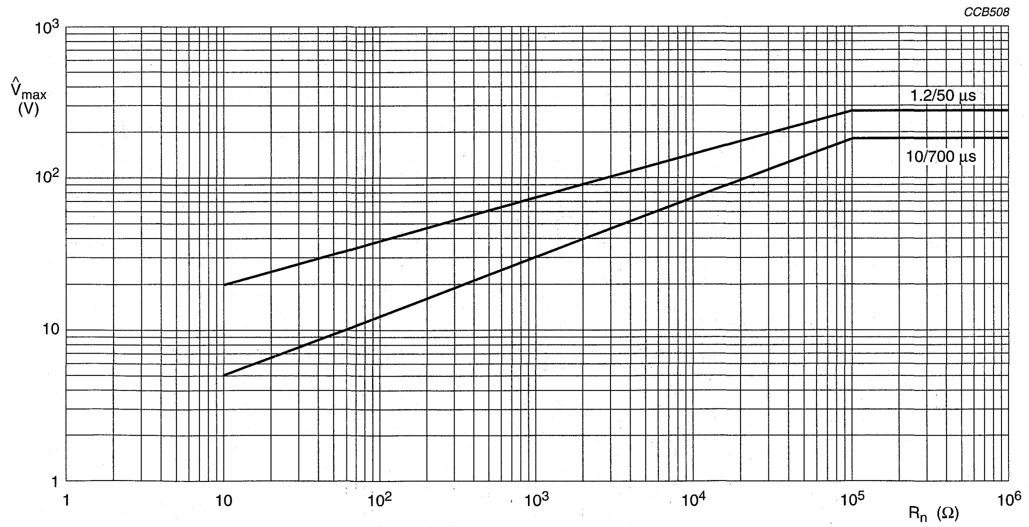
These pulses may not be applied on a regular basis.

Fig.3 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533 for type: **RC11**.



These pulses may not be applied on a regular basis.

Fig.4 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533 for type: **RC21**.



These pulses may not be applied on a regular basis.

Fig.5 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533 for type: **RC31**.

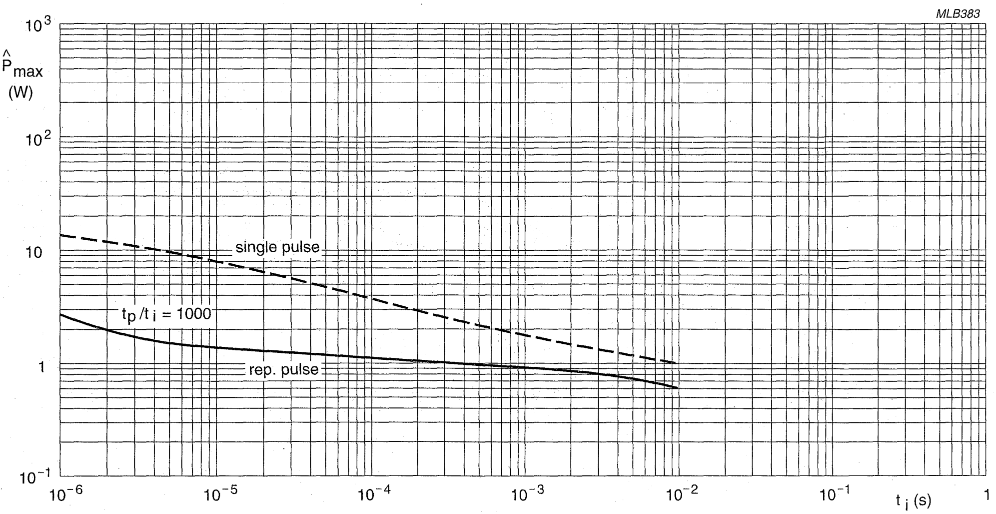


Fig.6 Pulse on a regular basis for type: **RC01**; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for R ≤ 10 kΩ, single pulse and repetitive pulse t_p/t_i = 1000.

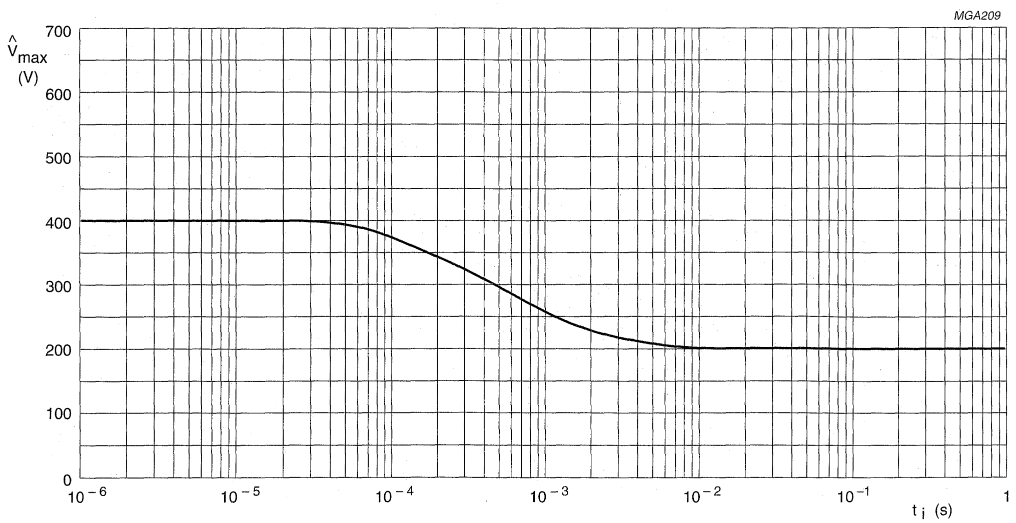


Fig.7 Pulse on a regular basis for type: **RC01**; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

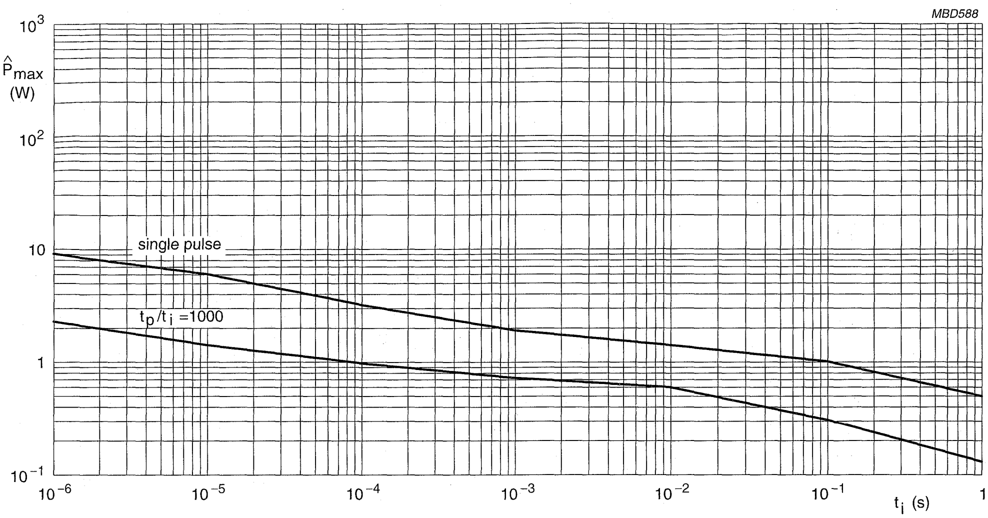


Fig.8 Pulse on a regular basis for type: **RC11**; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for R ≤ 10 kΩ, single pulse and repetitive pulse t_p/t_i = 1000.

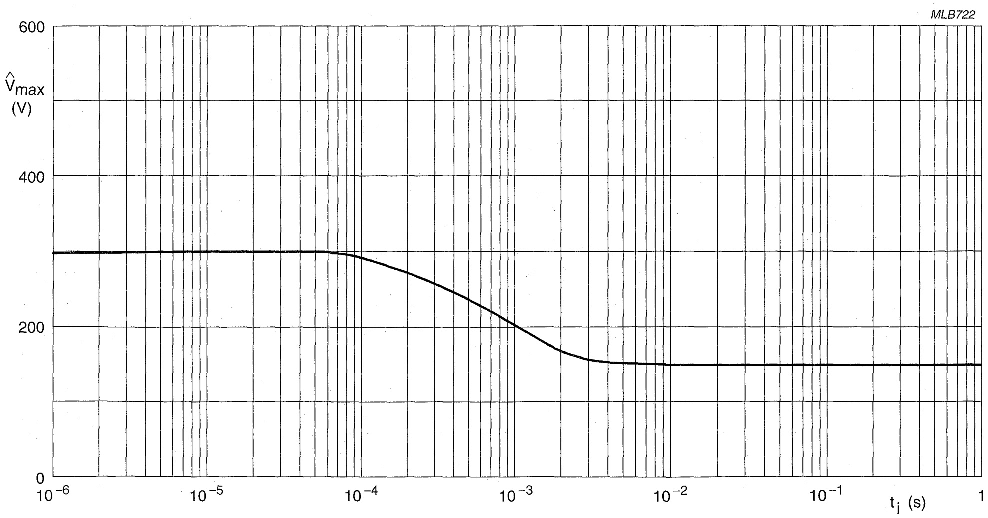


Fig.9 Pulse on a regular basis for type: **RC11**; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

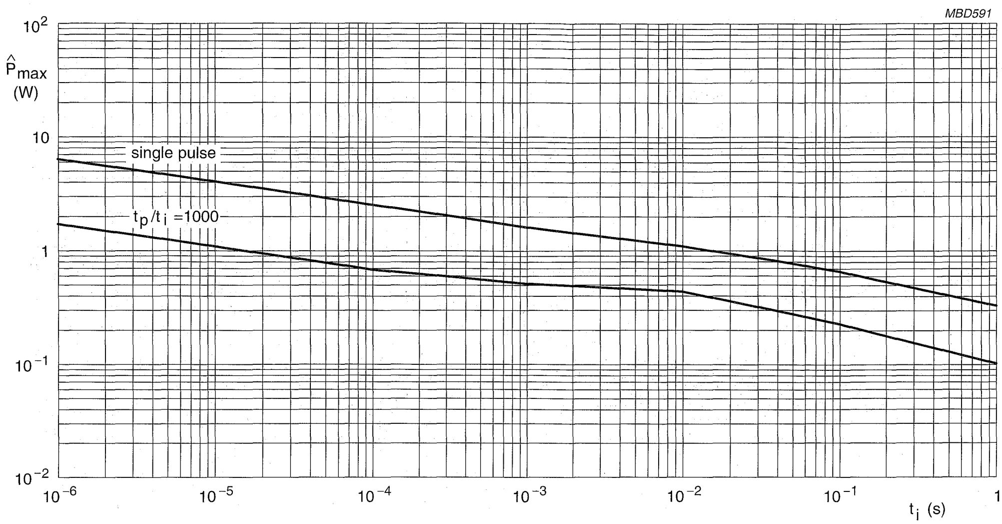


Fig.10 Pulse on a regular basis for type: **RC21**; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for R ≤ 10 kΩ, single pulse and repetitive pulse t_p/t_i = 1000.

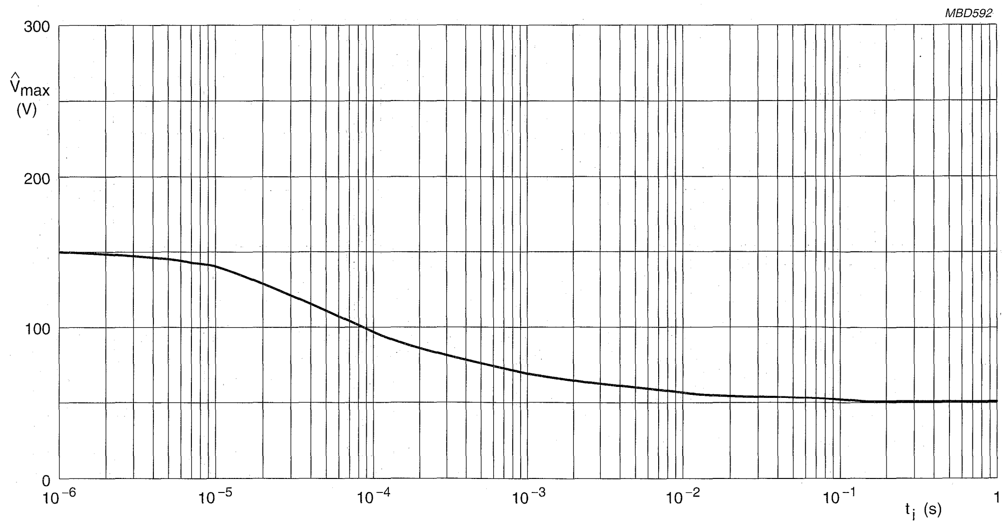


Fig.11 Pulse on a regular basis for type: **RC21**; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

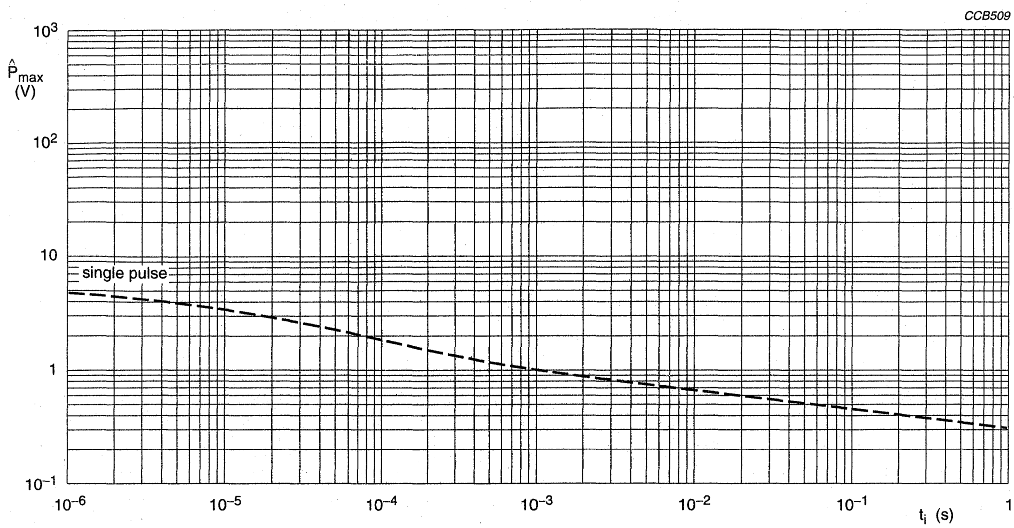


Fig.12 Pulse on a regular basis for type: **RC31**; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for $R \leq 10\ k\Omega$, single pulse and repetitive pulse $t_p/t_i = 1000$.

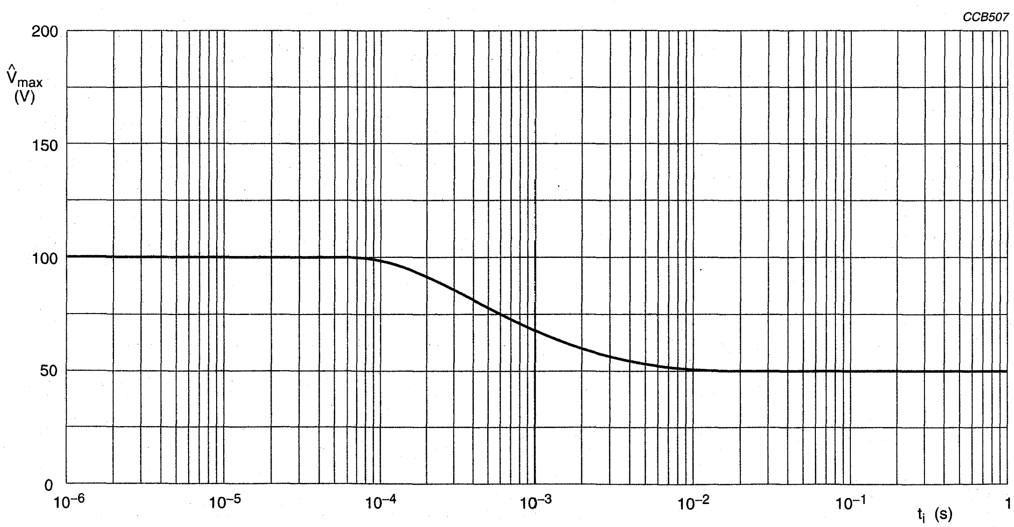


Fig.13 Pulse on a regular basis for type: **RC31**; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RC01	1.0
RC11	0.55
RC21	0.25
RC31	0.052

Marking

Each resistor, except RC31, is marked with a three digit code (occasionally four digit) on the protective coating to designate the nominal resistance value.

3-DIGIT MARKING

For values up to 91 Ω the R is used as a decimal point. For values of 100 Ω or greater the first 2 digits are significant, the third indicates the number of zeros to follow.

Example

MARKING	RESISTANCE
12R	12 Ω
823	82 kΩ

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits are significant, the fourth indicates the number of zeros to follow.

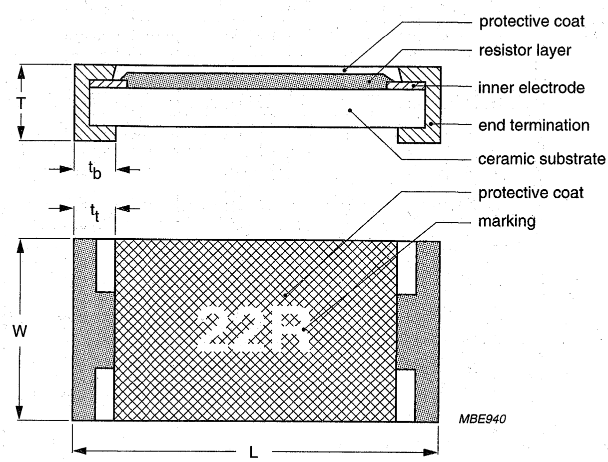
Example

MARKING	RESISTANCE
12R0	12 Ω
8202	82 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.14 Outlines.

Table 3 Chip resistor types and relevant physical dimensions; see Fig.14

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
RC01	3.20 +0.10/−0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25
RC11	2.00 ±0.15	1.25 ±0.15	0.55 ±0.10	0.40 ±0.20	0.40 ±0.20
RC21	1.60 ±0.10	0.80 +0.15/−0.05	0.45 ±0.10	0.30 ±0.20	0.30 ±0.20
RC31	1.00 ±0.05	0.50 ±0.05	0.35 ±0.05	0.20 ±0.10	0.25 ±0.10

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category **LCT/UCT/56** (rated temperature range: **L**ower **C**ategory **T**emperature, **U**pper **C**ategory **T**emperature; damp heat, long term, **56** days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS			
				RC01	RC11	RC21	RC31
Tests in accordance with the schedule of IEC publication 60115-8							
4.4.1		visual examination		no holes; clean surface; no visible damage			
4.4.2		dimensions (see Fig.14)	gauge (mm)	see Table 3			
4.5		resistance	applied voltage (+0/−10%): $R < 10\ \Omega$: 0.1 V $10\ \Omega \leq R < 100\ \Omega$: 0.3 V $100\ \Omega \leq R < 1\ k\Omega$: 1 V $1\ k\Omega \leq R < 10\ k\Omega$: 3 V $10\ k\Omega \leq R < 100\ k\Omega$: 10 V $100\ k\Omega \leq R < 1\ M\Omega$: 25 V $R \geq 1\ M\Omega$: 50 V	$R - R_{nom}$: max. ±2% or $R - R_{nom}$: max. ±5%			
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage $\Delta R/R$ max.: ±(0.5% +0.05 Ω)			no visible damage $\Delta R/R$ max.: ±(1% +0.05 Ω)
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H_2O followed by brushing in accordance with *"MIL 202 F"*	no visible damage			

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS			
				RC01	RC11	RC21	RC31
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage			
4.7		voltage proof on insulation	maximum voltage (RMS) during 1 minute metal block method	no breakdown or flashover			
4.13		short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	ΔR/R max.: ±(1% +0.05 Ω)			ΔR/R max.: ±(2% +0.1 Ω)
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm for **RC01** and 5 mm for **RC11**, **RC21** and **RC31**	no visible damage; ΔR/R max.: ±(1% +0.05 Ω)			
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage; ΔR/R max.: ±(0.5% +0.05 Ω)			no visible damage; ΔR/R max.: ±(2% +0.1 Ω)
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01 P_n: R ≤ 1 MΩ R > 1 MΩ	 ΔR/R max.: ±(1.5% +0.1 Ω) ΔR/R max.: ±(3% +0.1 Ω)			 ΔR/R max.: ±(3% +0.1 Ω) –
4.25.1		endurance	1 000 +48/−0 hours; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off: R ≤ 1 MΩ R > 1 MΩ	 ΔR/R max.: ±(1.5% +0.1 Ω) ΔR/R max.: ±(3% +0.1 Ω)			 ΔR/R max.: ±(3% +0.1 Ω) –
4.23.2	27 (Ba)	endurance at upper category temperature	1 000 +48/−0 hours; no load: R ≤ 1 MΩ R > 1 MΩ	 ΔR/R max.: ±(1.5% +0.1 Ω) ΔR/R max.: ±(3% +0.1 Ω)			 ΔR/R max.: ±(3% +0.1 Ω) –
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: R ≤ 10 Ω 10 Ω < R	 $\leq 250 \pm 250 \times 10^{-6}$/K $\leq \pm 200 \times 10^{-6}$/K			

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS			
				RC01	RC11	RC21	RC31
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method							
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage			
4.6.1.1		insulation resistance	voltage (DC) after 1 minute, metal block method: 100 V for **RC01** and **RC11**, 50 V for **RC21** and **RC31**	R_{ins} min.: 10^3 MΩ			
4.12		noise	IEC publication 60195 (measured with Quantech - equipment): R ≤ 100 Ω 100 Ω < R ≤ 1 kΩ 1 kΩ < R ≤ 10 kΩ 10 kΩ < R ≤ 100 kΩ 100 kΩ < R ≤ 1 MΩ 1 MΩ < R ≤ 10 MΩ	 max. 0.316 μV/V (−10 dB) max. 1 μV/V (0 dB) max. 3 μV/V (9.54 dB) max. 6 μV/V (15.56 dB) max. 10 μV/V (20 dB) max. 32 μV/V (30.10 dB)			
Other applicable tests							
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/−0 hours; 40 ±2 °C; 93 +2/−3% RH; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off: R ≤ 1 MΩ R > 1 MΩ	 ΔR/R max.: ±(3% +0.1 Ω) ΔR/R max.: ±(5% +0.1 Ω)			
		leaching	unmounted chips; 60 ±1 s; 260 ±5 °C	good tinning; no leaching			
		trio damp heat test	1 000 +48/−0 hours; 85 ±2 °C; 85 ±5% RH; loaded with 0.01 P_n or V_{max} R ≤ 1 MΩ R > 1 MΩ	 ΔR/R max.: ±(3% +0.1 Ω) ΔR/R max.: ±(5% +0.1 Ω)			

Precision chip resistors sizes 1206, 0805, 0603 and 0402

RC02/12/22/32 1%

FEATURES

- Low assembly costs
- High component and equipment reliability
- Excellent performance at high frequency, especially the RC32.
- TC 50 in thick film technology
- Complete precision SMD family.

APPLICATIONS

- All general purpose applications.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coat and printed with the resistance value (no printing on RC22H and RC32). Finally, the two external end terminations are added. For ease of soldering the outerlayer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE					
	RC02H	**RC02G**	**RC12H**	**RC12G**	**RC22H**	**RC32**
Size code	1206 (3216)		0805 (2012)		0603 (1608)	0402 (1005)
Resistance range	1 Ω to 10 MΩ	90 Ω to 2.74 MΩ	1 Ω to 10 MΩ	90 Ω to 2.74 MΩ	1 Ω to 10 MΩ	6.8 Ω to 2.2 MΩ
Resistance tolerance and E-series	±1%; E24/E96 series					
Temperature coefficient; note 1:						
$1\ \Omega \leq R \leq 10\ \Omega$	≤250 ±250	–	≤250 ±250	–	≤250 ±250	≤250 ±250
$10\ \Omega < R \leq 10\ M\Omega$	≤±100	≤±50	≤±100	≤±50	≤±100	≤±200
Maximum dissipation at T_{amb} = 70 °C	0.25 W		0.125 W		0.063 W	0.063 W
Maximum permissible voltage	200 V (DC or RMS)		150 V (DC or RMS)		50 V (DC or RMS)	50 V (DC or RMS)
Climatic category (IEC 60068)	55/155/56					55/125/56
Basic specification	IEC 60115-8					

Note

1. All TC values should be multiplied by 10^{-6}/K.

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	ORDERING CODE 2322		
	PAPER TAPE ON REEL		
	5000 units	10000 units	20000 units
RC02H	724 6....	724 7....	724 8....
RC02G	722 2....	722 3....	–
RC12H	734 6....	734 7....	734 8....
RC12G	732 6....	732 7....	–
RC22H	704 6....	704 7....	704 8....
RC32	–	706 7....	–
Jumper 0 Ω			
RC02H; note 1	724 92006	724 92007	–
RC12H; note 1	734 92006	734 92007	–
RC22H; note 2	704 92006	704 92007	–
RC32; note 2	–	704 92006	–

Notes

1. The jumper has a maximum resistance R_{max} = 50 mΩ and a rated current I_R = 2 A.
2. The jumper has a maximum resistance R_{max} = 50 mΩ and a rated current I_R = 1 A.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322.
- The subsequent 4 digits indicate the resistor type and packaging; see Table 1.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 kΩ	4
1 to 9.76 MΩ	5
10 MΩ	6

ORDERING EXAMPLE

The ordering code of a RC02H resistor, value 4750 Ω, supplied on paper tape of 5000 units per reel is: 2322 724 64752.

Precision chip resistors sizes 1206, 0805, 0603 and 0402

RC02/12/22/32 1%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of ±1%. The values of the E24/96 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
RC02	200	0.25
RC12	150	0.125
RC22	50	0.063
RC32	50	0.063

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

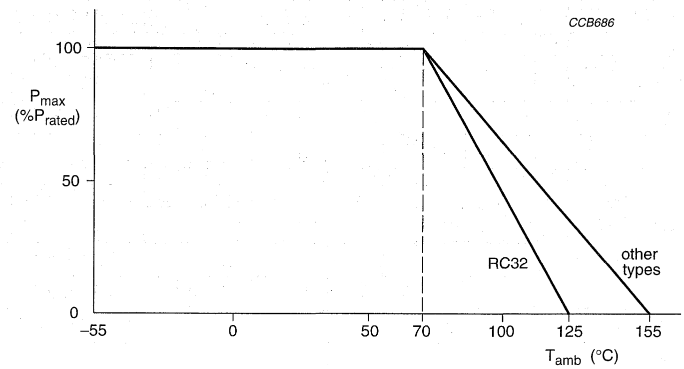
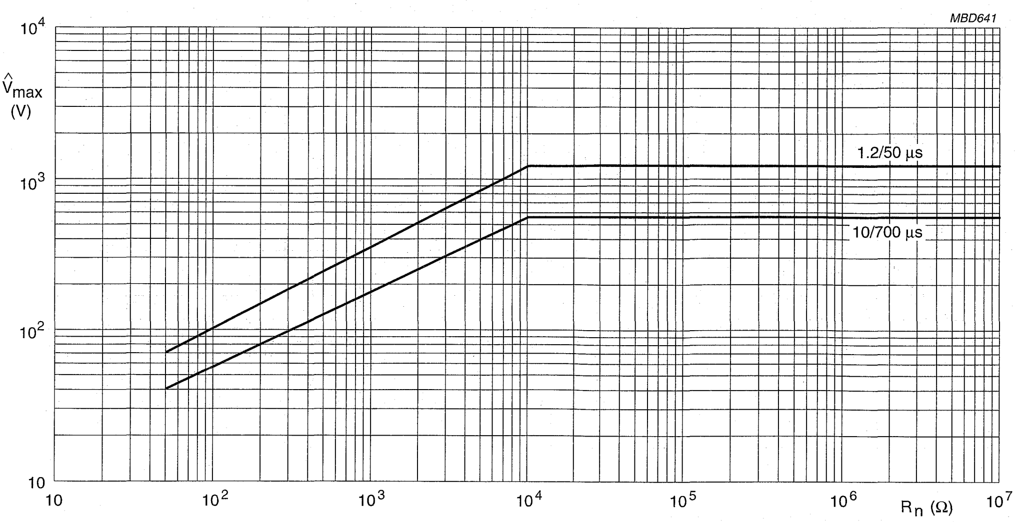


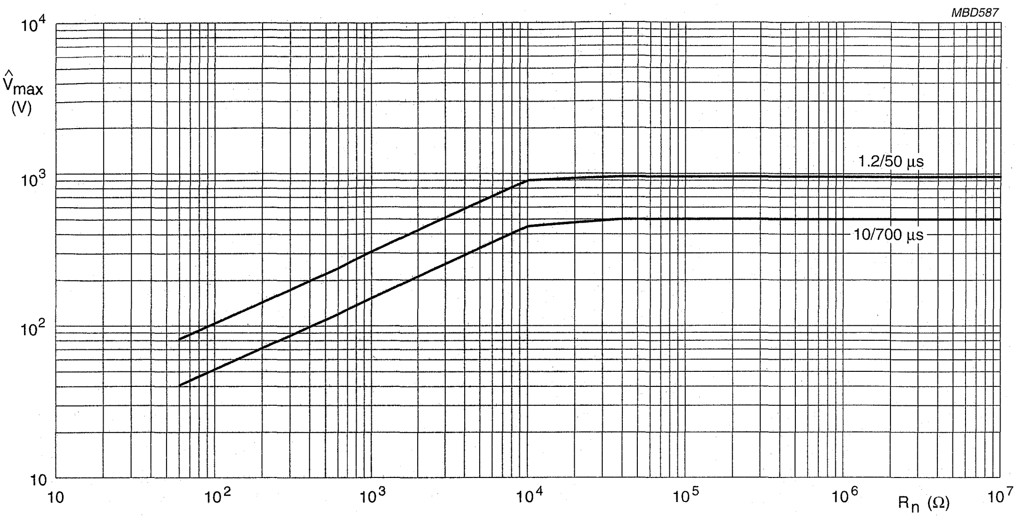
Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

PULSE LOADING CAPABILITIES



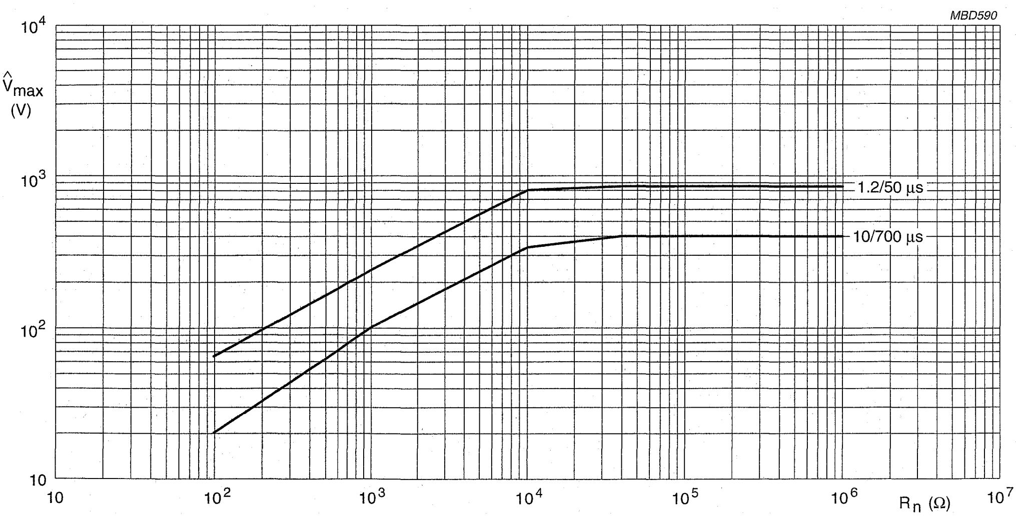
These pulses may not be applied on a regular basis.

Fig.2 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533 for type: **RC02**.



These pulses may not be applied on a regular basis.

Fig.3 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533 for type: **RC12**.



These pulses may not be applied on a regular basis.

Fig.4 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533 for type: **RC22**.

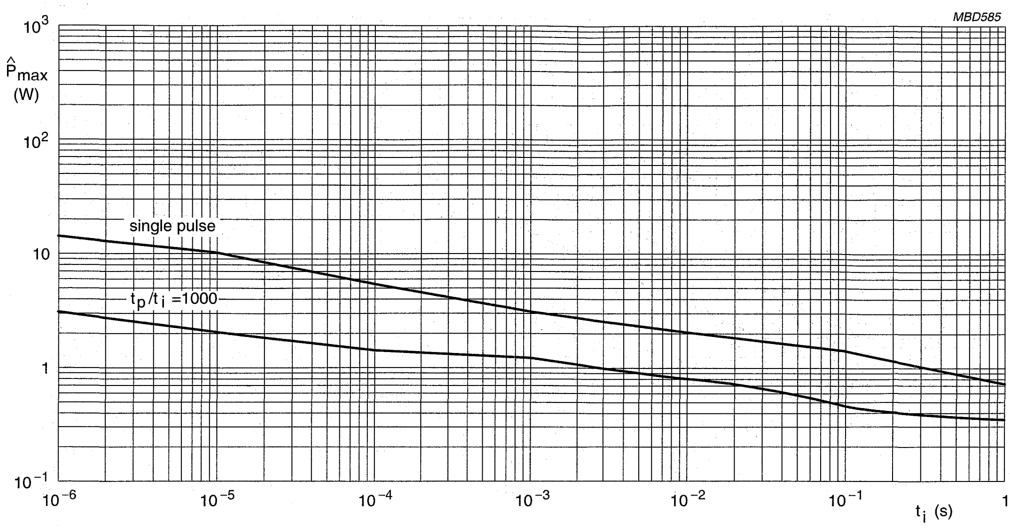


Fig.5 Pulse on a regular basis for type: **RC02**; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for $R \leq 10\ k\Omega$, single pulse and repetitive pulse $t_p/t_i = 1000$.

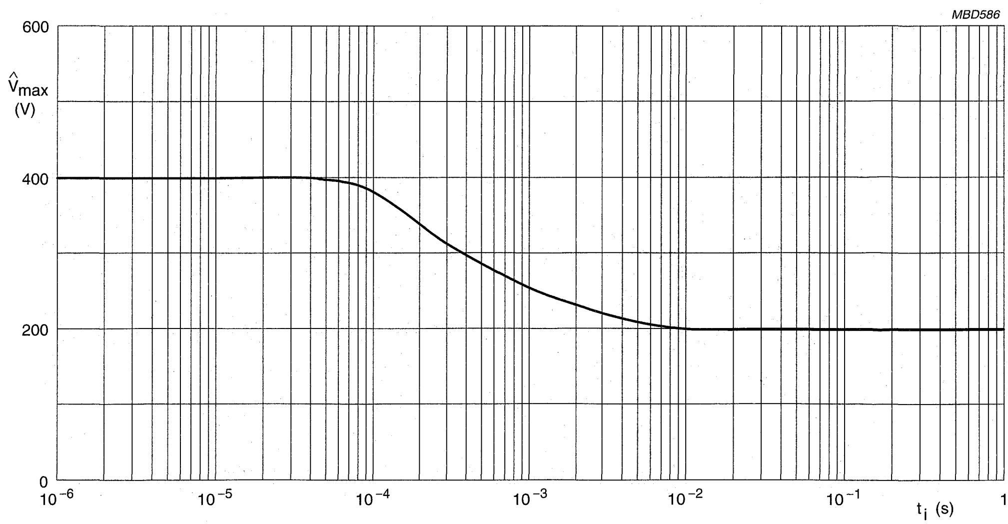


Fig.6 Pulse on a regular basis for type: **RC02**; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

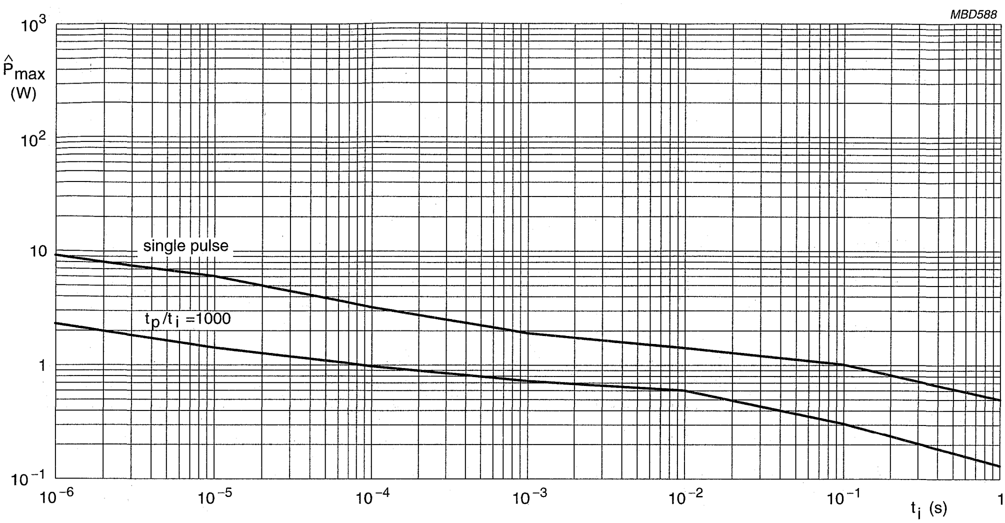


Fig.7 Pulse on a regular basis for type: **RC12**; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for R ≤ 10 kΩ, single pulse and repetitive pulse t_p/t_i = 1000.

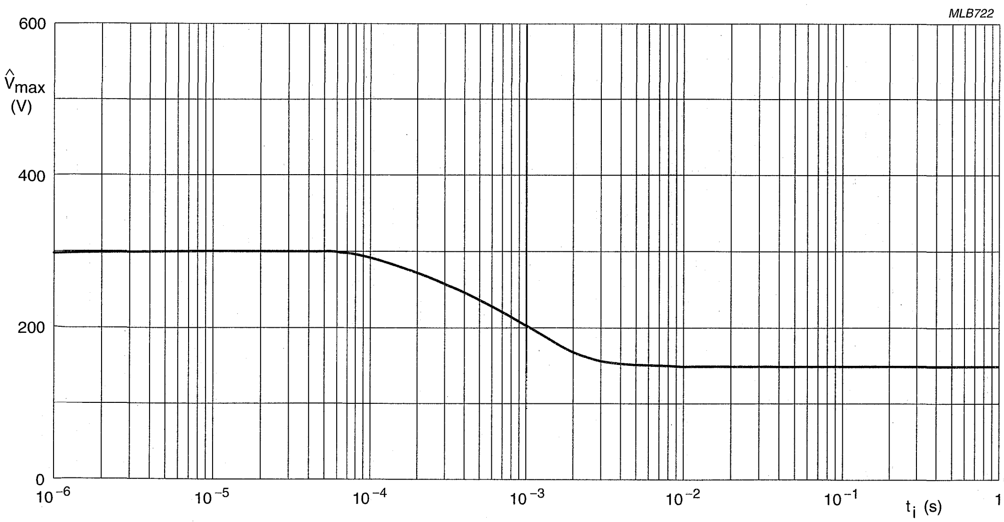


Fig.8 Pulse on a regular basis for type: **RC12**; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

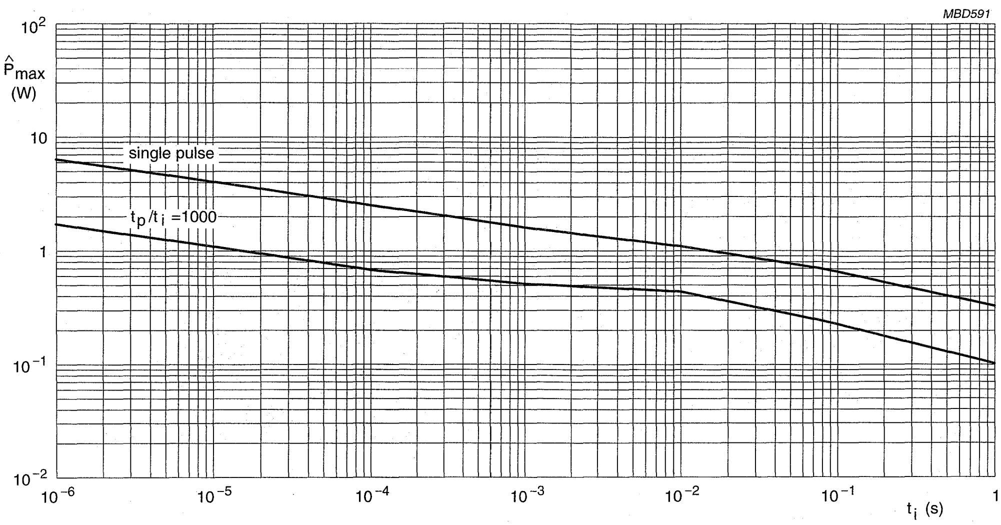


Fig.9 Pulse on a regular basis for type: **RC22**; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for R ≤ 10 kΩ, single pulse and repetitive pulse t_p/t_i = 1000.

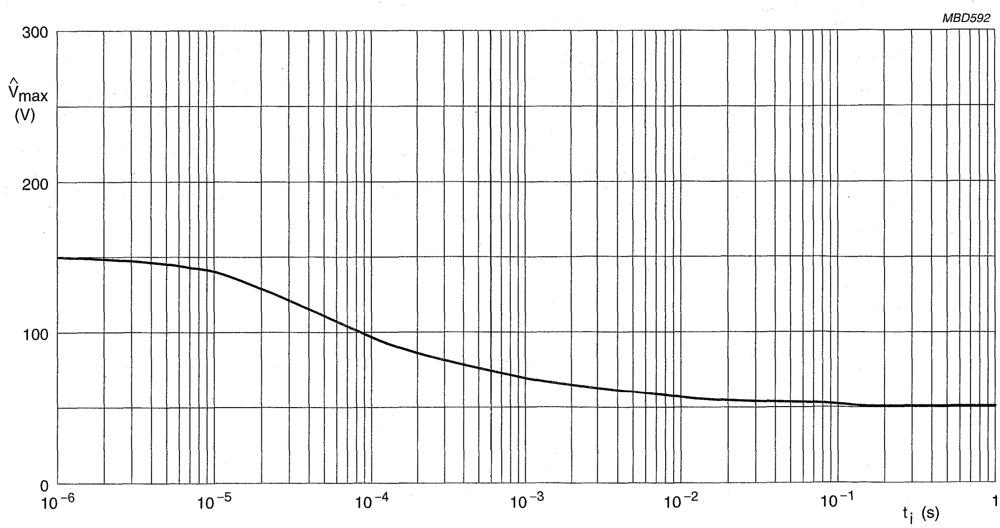


Fig.10 Pulse on a regular basis for type: **RC22**; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RC02	1.0
RC12	0.55
RC22	0.25
RC32	0.058

Marking

All resistors except RC22 and RC32 are marked with a four digit code on the protective coat to designate the nominal resistance value.

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

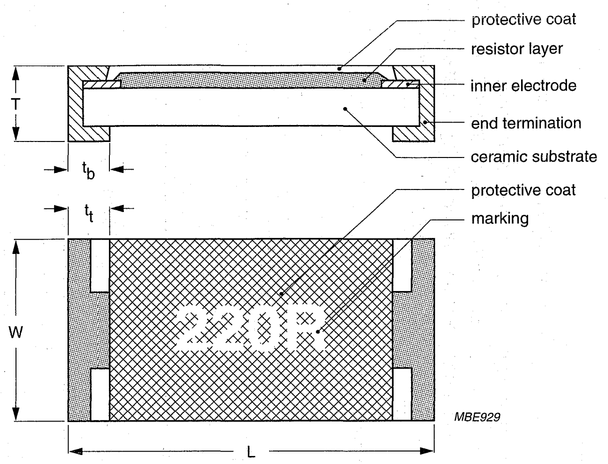
Example

MARKING	RESISTANCE
121R	121 Ω
4021	4.02 kΩ
1503	150 kΩ

PACKAGE MARKING

The packaging of all resistors including RC22 is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.11 Outlines.

Table 3 Chip resistor types and relevant physical dimensions; see Fig.11

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
RC02	3.20 +0.10/−0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25
RC12	2.00 ±0.15	1.25 ±0.15	0.55 ±0.10	0.40 ±0.20	0.40 ±0.20
RC22	1.60 ±0.10	0.80 +0.15/−0.05	0.45 ±0.10	0.30 ±0.20	0.30 ±0.20
RC32	1.00 ±0.05	0.50 ±0.05	0.35 ±0.05	0.20 ±0.10	0.25 ±0.10

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category **LCT/UCT/56** (rated temperature range: **L**ower **C**ategory **T**emperature, **U**pper **C**ategory **T**emperature; damp heat, long term, **56** days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

- Temperature: 15 °C to 35 °C
- Relative humidity: 45% to 75%
- Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS					
				RC02H	RC02G	RC12H	RC12G	RC22H	RC32
Tests in accordance with the schedule of IEC publication 60115-8									
4.4.1		visual examination		no holes; clean surface; no visible damage					
4.4.2		dimensions (see Fig.11)	gauge (mm)	see Table 3					
4.5		resistance	applied voltage (+0/−10%): $R < 10\ \Omega$: 0.1 V $10\ \Omega \leq R < 100\ \Omega$: 0.3 V $100\ \Omega \leq R < 1\ k\Omega$: 1 V $1\ k\Omega \leq R < 10\ k\Omega$: 3 V $10\ k\Omega \leq R < 100\ k\Omega$: 10 V $100\ k\Omega \leq R < 1\ M\Omega$: 25 V $R \geq 1\ M\Omega$: 50 V	$R - R_{nom}$: max. ±1%					
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage $\Delta R/R$ max.: ±(0.5% +0.05 Ω)					no visible damage $\Delta R/R$ max.: ±(1% +0.05 Ω)
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H_2O followed by brushing in accordance with *"MIL 202 F"*	no visible damage					

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS					
				RC02H	**RC02G**	**RC12H**	**RC12G**	**RC22H**	**RC32**
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage					
4.7		voltage proof on insulation	maximum voltage (RMS) during 1 minute, metal block method	no breakdown or flashover					
4.13		short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	ΔR/R max.: ±(1% +0.05 Ω)					ΔR/R max.: ±(2% +0.1 Ω)
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm for **RC02H** and **RC02G**; 5 mm for **RC12H**, **RC12G**, **RC22H** and **RC32**	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)					no visible damage ΔR/R max.: ±(1% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)					no visible damage ΔR/R max.: ±(2% +0.1 Ω)
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01 P_n: R ≤ 1 MΩ R > 1 MΩ	ΔR/R max.: ±(1.0% +0.05 Ω) ΔR/R max.: ±(1.5% +0.05 Ω)					ΔR/R max.: ±(2% +0.1 Ω) –
4.25.1		endurance	1000 +48/−0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off: R ≤ 1 MΩ R > 1 MΩ	ΔR/R max.: ±(1.0% +0.05 Ω) ΔR/R max.: ±(1.5% +0.05 Ω)					ΔR/R max.: ±(2% +0.1 Ω) –
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/−0 hours; no load: R ≤ 1 MΩ R > 1 MΩ	ΔR/R max.: ±(1.0% +0.05 Ω) ΔR/R max.: ±(1.5% +0.05 Ω)					ΔR/R max.: ±(2% +0.1 Ω) –

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS					
				RC02H	**RC02G**	**RC12H**	**RC12G**	**RC22H**	**RC32**
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C:						
			1 Ω ≤ R ≤ 10 Ω	≤250 ±250	–	≤250 ±250	–	≤250 ±250	≤250 ±250
			10 Ω < R ≤ 10 MΩ	≤±100	≤±50	≤±100	≤±50	≤±100	≤±200
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method									
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage					
4.6.1.1		insulation resistance	voltage (DC) after 1 minute, metal block method: 100 V for **RC02H**, **RC02G**, **RC12H** and **RC12G**, 50 V for **RC22H** and **RC32**	R_{ins} min.: 10^3 MΩ					
4.12		noise	IEC publication 60195 (measured with Quantech - equipment):						
			R ≤ 100 Ω	max. 0.316 μV/V (−10 dB)					
			100 Ω < R ≤ 1 kΩ	max. 1 μV/V (0 dB)					
			1 kΩ < R ≤ 10 kΩ	max. 3 μV/V (9.54 dB)					
			10 kΩ < R ≤ 100 kΩ	max. 6 μV/V (15.56 dB)					
			100 kΩ < R ≤ 1 MΩ	max. 10 μV/V (20 dB)					
			1 MΩ < R ≤ 10 MΩ	max. 32 μV/V (30.10 dB)					

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS					
				RC02H	RC02G	RC12H	RC12G	RC22H	RC32
Other applicable tests									
	(JIS) C 5205 7.5	resistance to damp heat (steady state)	1000 +48/−0 hours; 40 ±2 °C; 93 +2/−3% RH; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off: R ≤ 1 MΩ R > 1 MΩ	 ΔR/R max.: ±(2% +0.1 Ω) ΔR/R max.: ±(3% +0.1 Ω)					
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching					
		trio damp heat test	1000 +48/−0 hours; 85 ±2 °C; 85 ±5% RH; loaded with 0.01 P_n or V_{max}: R ≤ 1 MΩ R > 1 MΩ	 ΔR/R max.: ±(2% +0.1 Ω) ΔR/R max.: ±(3% +0.1 Ω)					

High precision chip resistor size 1206

RC03G 0.5%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Excellent performance at high frequency.

APPLICATIONS

- Power supply in small sized equipment
- Telecommunication
- Medical and Military
- Automotive industry.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	90 Ω to 2.74 MΩ
Resistance tolerance and E-series	±0.5%; E24/E96 series
Temperature coefficient:	
90 Ω ≤ R < 250 Ω	$\leq \pm 100 \times 10^{-6}$/K
250 Ω ≤ R ≤ 2.74 MΩ	$\leq \pm 50 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.25 W
Maximum permissible voltage	200 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	RESISTANCE VALUE	TOL. (%)	ORDERING CODE 2322 725 ..... PAPER TAPE ON REEL 5000 units
RC03G	90 Ω to 2.74 MΩ	±0.5	1....

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322 725.
- The subsequent first digit indicates the resistor type and packaging; see Table 1.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12 NC

RESISTANCE	LAST DIGIT
90 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 kΩ	4
1 to 2.74 MΩ	5

ORDERING EXAMPLE

The ordering code of a RC03G resistor, value 4750 Ω, supplied on paper tape of 5000 units per reel is: 2322 725 14752.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of ±0.5%. The values of the E24/96 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
RC03G	200	0.25

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

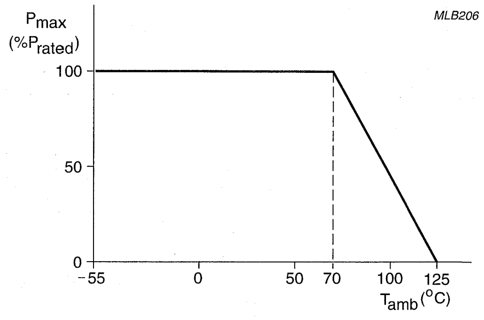
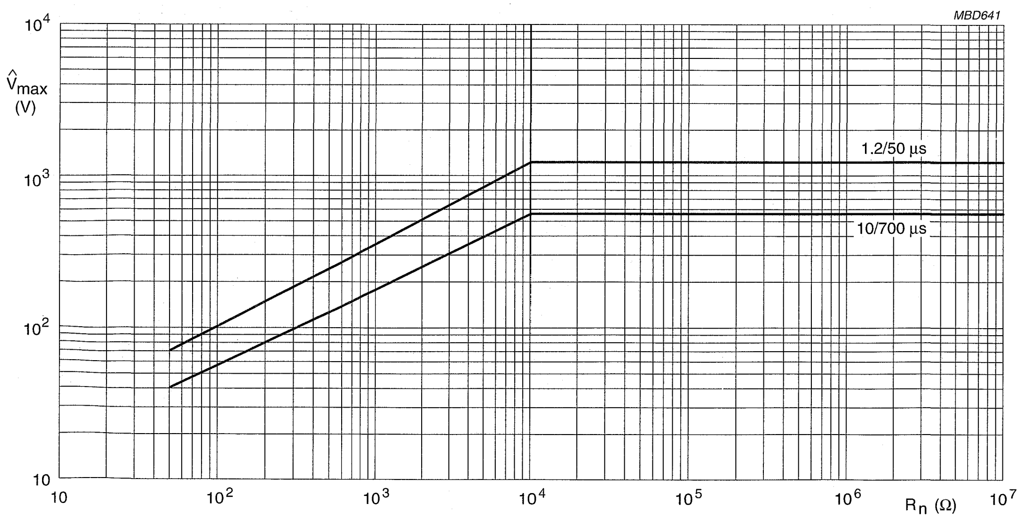


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

PULSE LOADING CAPABILITIES



These pulses may not be applied on a regular basis.

Fig.2 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533.

High precision chip resistor size 1206

RC03G 0.5%

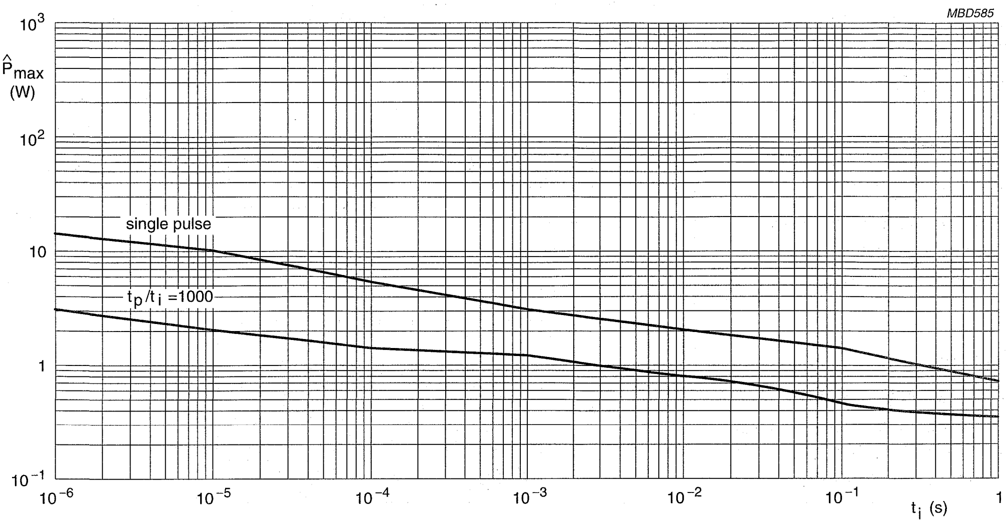


Fig.3 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for R ≤ 10 kΩ, single pulse and repetitive pulse t_p/t_i = 1000.

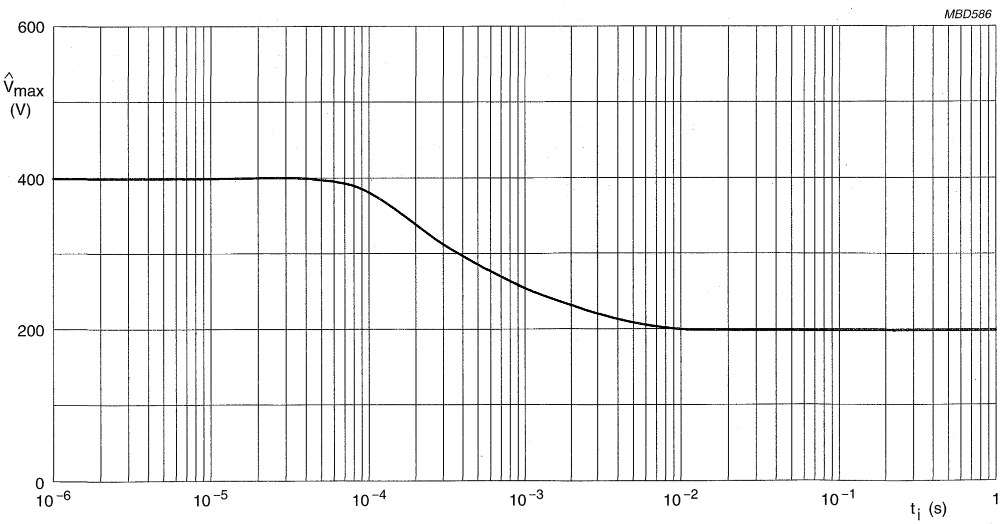


Fig.4 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RC03G	1

Marking

All resistors are marked with a four digit code on the protective coat to designate the nominal resistance value.

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

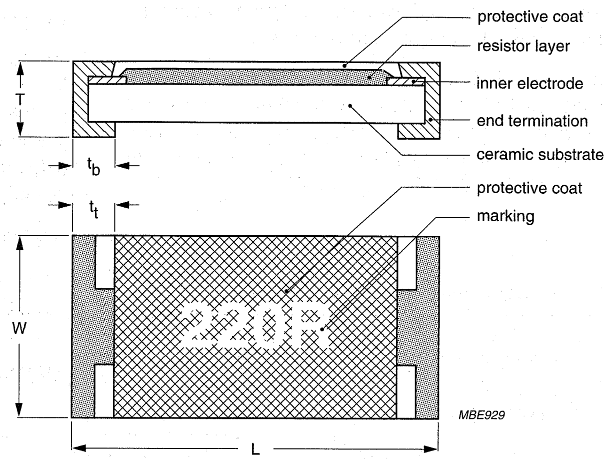
Example

MARKING	RESISTANCE
121R	121 Ω
4021	4.02 kΩ
1503	150 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.5 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.5

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
RC03G	3.20 +0.10/−0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25

High precision chip resistor size 1206 RC03G 0.5%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range −55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	ΔR/R max.: ±(0.25% +0.05 Ω)
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	ΔR/R max.: ±(0.25% +0.05 Ω)
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01P_n; dissipation ≤1 mW	R_{ins} min.: 1000 MΩ ΔR/R max.: ±(1% +0.05 Ω)
4.25.1		endurance	1000 +48/−0 hours; 70 ±2 °C; nominal dissipation; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(0.5% +0.05 Ω)
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 1000 MΩ
4.13		short time overload	room temperature; dissipation 6.25 × P_n; 5 s (voltage not more than 2 × V_{max})	ΔR/R max.: ±(0.25% +0.05 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: R < 250 Ω 250 Ω ≤ R	 ≤±100 × 10^{-6}/K ≤±50 × 10^{-6}/K
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/−0 hours; 125 °C; no load	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)
4.7		voltage proof on insulation	200 V (RMS) during 1 minute	no breakdown

High precision chip resistor size 0805

RC13G 0.5%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Excellent performance at high frequency.

APPLICATIONS

- Power supply in small sized equipment
- Telecommunication
- Medical and Military
- Automotive industry
- Computers.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	90 Ω to 2.74 MΩ
Resistance tolerance and E-series	±0.5%; E24/E96 series
Temperature coefficient	$\leq \pm 50 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70°C	0.125 W
Maximum permissible voltage	150 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	RESISTANCE VALUE	TOL. (%)	ORDERING CODE 2322 738 ..... PAPER TAPE ON REEL 5000 units
RC13G	90 Ω to 2.74 MΩ	±0.5	2 ....

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2338 738.
- The subsequent first digit indicates the resistor type and packaging; see Table 1.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12 NC

RESISTANCE	LAST DIGIT
90 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 Ω	4
1 to 2.74 MΩ	5

ORDERING EXAMPLE

The ordering code of a RC13G resistor, value 10 kΩ, supplied on paper tape of 5000 units per reel is: 2338 738 21003.

High precision chip resistor size 0805

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24/E96 series for resistors with a tolerance of ±5%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
RC13G	150	0.125

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

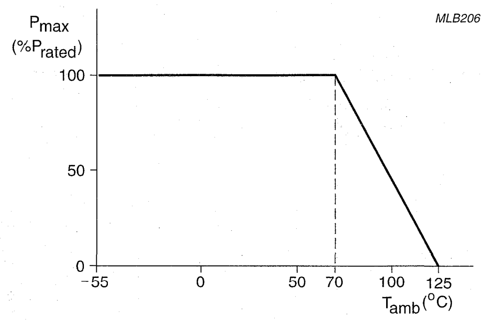


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RC13G	0.55

Marking

Each resistor is marked with a 4-digit code on the protective coating to designate the nominal resistance value.

4-DIGIT MARKING

The R is used as a decimal point.

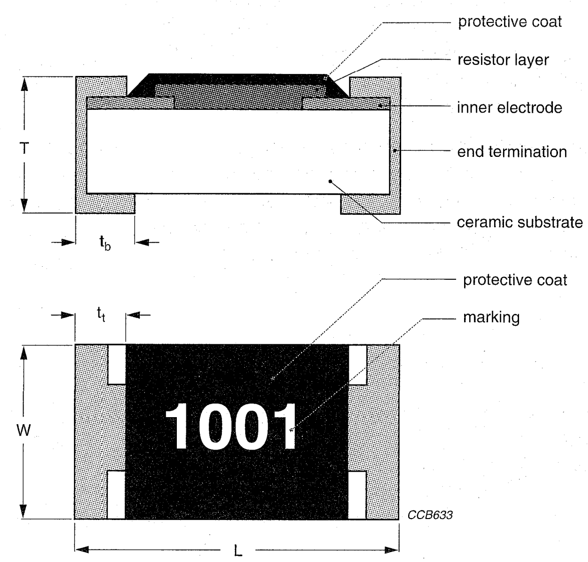
Example

MARKING	RESISTANCE
100R	100 Ω
1001	1 kΩ
1004	1 MΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
RC13G	2.0 ±0.15	1.25 ±0.15	0.55 ±0.10	0.40 ±0.20	0.40 ±0.20

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range −55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	ΔR/R max.: ±(0.25% +0.05 Ω)
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	ΔR/R max.: ±(0.25% +0.05 Ω)
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with $0.01P_n$; dissipation ≤1 mW	R_{ins} min.: 1000 MΩ ΔR/R max.: ±(1% +0.05 Ω)
4.25.1		endurance	1000 +48/−0 hours; 70 ±2 °C; nominal dissipation; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(0.5% +0.05 Ω)
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 1000 MΩ
4.13		short time overload	room temperature; dissipation 6.25 × P_n; 5 s (voltage not more than 2 × V_{max})	ΔR/R max.: ±(0.25% +0.05 Ω)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/−0 hours; 125 °C; no load	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)
4.7		voltage proof on insulation	150 V (RMS) during 1 minute	no breakdown or flashover

Thin film, high precision, high stability, chip resistors

TFR01/11/21/31/41 (1206; 0805; 0603; 0402; 0201)

FEATURES

- High stability and low temperature coefficient
- Low current noise and high linearity
- Low tolerance: 0.5%.

APPLICATIONS

- Audio and video equipment
- Telecommunication equipment
- Computers
- Automotive.

DESCRIPTION

A metal film layer is deposited on a high grade ceramic body (aluminium oxide). This resistive layer is trimmed to its nominal value and on both ends a contact is made which will guarantee optimum solderability. This is achieved by applying several layers and for ease of soldering the outer layer consists of a lead/tin alloy.

The resistive layer is covered with a protective coating.

QUICK REFERENCE DATA

DESCRIPTION	VALUE				
	TFR01	TFR11	TFR21	TFR31	TFR41
Size code	1206 (3216)	0805 (2012)	0603 (1608)	0402 (1005)	0201 (0306)
Resistance range	10 Ω to 1 MΩ	10 Ω to 1 MΩ	10 Ω to 360 kΩ	10 Ω to 100 kΩ	33 Ω to 22 kΩ
Resistance tolerance and series	±0.5%; E24(1)/E96 series				
Temperature coefficient:					
10 Ω to 91 Ω	$\leq 50 \times 10^{-6}$/K	–	–	–	–
10 Ω to 97.6 Ω	–	$\leq 50 \times 10^{-6}$/K	$\leq 50 \times 10^{-6}$/K	$\leq 100 \times 10^{-6}$/K	–
33 Ω to 22 kΩ	–	–	–	–	$\leq 25 \times 10^{-6}$/K
100 Ω to 100 kΩ	–	–	–	$\leq 25 \times 10^{-6}$/K	–
100 Ω to 360 kΩ	–	–	$\leq 25 \times 10^{-6}$/K	–	–
100 Ω to 1 MΩ	$\leq 25 \times 10^{-6}$/K	$\leq 25 \times 10^{-6}$/K	–	–	–
Maximum dissipation at T_{amb} = 70 °C	0.125 W	0.1 W	0.063 W	0.063 W	0.05 W
Maximum permissible voltage (DC or RMS)	150 V	100 V	75 V	25 V	15 V
Climatic category (IEC 60068)	55/125/56				
Basic specification	IEC 60115-8 / JIS C 5202				
Stability after: load, 1000 hours at T_{amb} = 70 °C	ΔR/R: ±(0.5% +0.05 Ω)				

Note

1. Preferred values are E24.

ORDERING INFORMATION

The code number can be logically arranged provided that the resistance value may be expressed in three significant digits and an indication of magnitude. Preferred values are E24, E96 values are available.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350
- The subsequent first 4 digits indicate the resistor type, temperature coefficient and packaging; see Table 1.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 1 Four digits to indicate resistor type and packaging

TYPE	TC	ORDERING CODE 2350 ... . PAPER TAPE ON ∅180 mm REEL	
		5000 units	**10000 units**
TFR01	25	611 6....	–
	50	610 6....	–
TFR11	25	601 6....	–
	50	600 6....	–
TFR21	25	604 6....	–
	50	603 6....	–
TFR31	25	–	607 6....
	100	–	609 6....
TFR41	25	–	614 6....

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
10 Ω ≤ R < 100 Ω	9
100 Ω ≤ R < 1 kΩ	1
1 kΩ ≤ R < 10 kΩ	2
10 kΩ ≤ R < 100 kΩ	3
100 kΩ ≤ R < 1 MΩ	4
R = 1 MΩ	5

ORDERING EXAMPLE

The ordering code of a TFR11 resistor, value 153 Ω, TC25, supplied on paper tape of 5 000 units per reel is: 2350 601 61531.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of ±0.5%. The values of the E24/96 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
TFR01	150	0.125
TFR11	100	0.1
TFR21	75	0.063
TFR31	25	0.063
TFR41	15	0.05

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

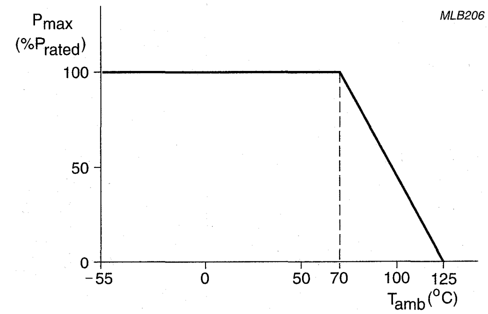


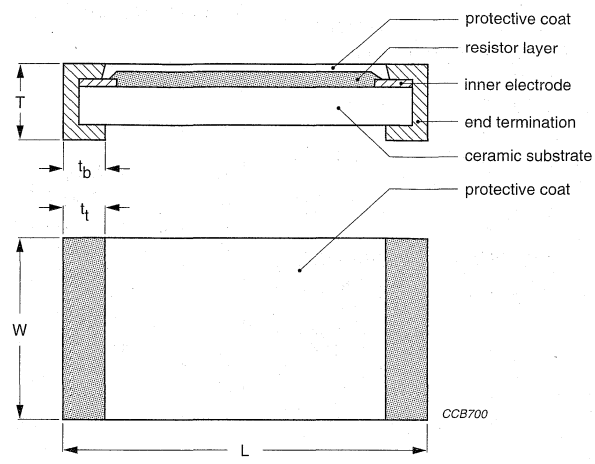
Fig.1 Standard operation; Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Packaging

The packaging of all resistors is marked and includes resistance value, tolerance, TC value, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
TFR01	3.2 ±0.2	1.6 ±0.2	0.4 ±0.1	0.5 ±0.3	0.50 ±0.3
TFR11	2.0 ±0.2	1.25 ±0.2	0.4 ±0.1	0.4 ±0.2	0.4 ±0.2
TFR21	1.6 ±0.2	0.8 ±0.2	0.4 ±0.1	0.3 ±0.2	0.3 ±0.2
TFR31	1.0 ±0.05	0.5 ±0.05	0.35 ±0.05	0.20 ±0.10	0.25 ±0.05
TFR41	0.6 ±0.05	0.3 ±0.05	0.23 ±0.03	0.12 ±0.05	0.12 ±0.05

Marking

Resistors of size 0402 are not marked.

In the E24 series, the rated resistance is marked on the protective coating using three digits, which is based on *"JIS C 5201 4.2.5"*:

- The first two digits shall indicate the significant resistance value.
- The last digit indicates the number of zeros to follow the resistance value.

Example

MARKING	RESISTANCE
510	51 Ω
431	430 Ω
153	15 kΩ

The E96 series is marked with a date code on the protective coating, which is based on *"JIS C 5201 10.1.2.(2).(C)"*.

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"JIS C 5202"*, "Test method of fixed resistors for electronic equipment". The testing also covers the requirements specified by IEC publication 60115-8 and IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"*.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"JIS and IEC"*; a short description of the test procedure is also given.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	TEST METHOD	TEST	PROCEDURE	REQUIREMENTS				
				TFR01	TFR11	TFR21	TFR31	TFR41
Tests in accordance with the schedule of IEC publication 60115-8								
4.4.1		visual examination		no holes; clean surface; no visible damage				
4.4.2		dimensions (outline)	gauge (mm)	see Table 3				
4.5		resistance	applied voltage (+0/–10%): 10 Ω ≤ R < 100 Ω: 0.3 V 100 Ω ≤ R < 1 kΩ: 1 V 1 kΩ ≤ R < 10 kΩ: 3 V 10 kΩ ≤ R < 100 kΩ: 10 V 100 kΩ ≤ R: 25 V	$R - R_{nom}$: ±0.5%				
Short term tests								
4.18	IEC 60068-2-20 JIS C 5202 6.4	resistance to soldering heat	unmounted chips; 10 s; 260 ±5 °C	ΔR/R ≤ ±(0.5% +0.05 Ω)				
4.29	IEC 60068-2-45 JIS C 5202 6.9	component solvent resistance	isopropyl alcohol	marking shall be legible; no visible damage				
4.17	IEC 60068-2-20 JIS C 5202 6.5	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±5 °C	good tinning (≥95% covered); no visible damage				
4.7	JIS C 5202 5.7	voltage proof on insulation	maximum voltage (RMS) during 1 minute metal block method	no breakdown or flashover				

IEC 60115-8 CLAUSE	TEST METHOD	TEST	PROCEDURE	REQUIREMENTS				
				TFR01	TFR11	TFR21	TFR31	TFR41
4.13	JIS C 5202 5.5	short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	$\Delta R/R \leq \pm(0.5\% +0.05\ \Omega)$				
4.33	JIS C 5202 6.1.4.2[(1)]	bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm	no visible damage $\Delta R/R \leq \pm(0.5\% +0.05\ \Omega)$				
4.19	JIS C 5202 7.4	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R \leq \pm(0.5\% +0.05\ \Omega)$				
4.6.11	JIS C 5202 5.6	insulation resistance	voltage (DC) after 1 minute metal block method	$R_{ins} \geq 1000\ M\Omega$				
Long term tests								
4.24.2	JIS C 5202 7.9	damp heat steady state	1000 hours; 60 °C; 90 to 95% RH; loaded with P_n or V_{max} for 1.5 hours on and 0.5 hours off	no visible damage $\Delta R/R \leq \pm(0.5\% +0.05\ \Omega)$				
4.25	IEC 60115-8 4.25.1 JIS C 5202 7.10	endurance at 70 °C	1000 hours; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	no visible damage $\Delta R/R \leq \pm(0.5\% +0.05\ \Omega)$				
4.8.4.2	IEC 60115-8 4.8 JIS C 5202 5.2	temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C ($TC \times 10^{-6}$/K)	should not exceed the temperature coefficient of resistance as specified in “Quick reference data”				

Note

1. Refer to Table 1 for specific ordering information.

Thin film, ultra high precision, high stability, chip resistors

MPC01/11/21 (1206; 0805; 0603)

FEATURES

- High stability and low temperature coefficient
- Excellent pulse stability for single pulse conditions
- Low current noise, high linearity and good high frequency performance
- Low tolerance, ±0.1%.

APPLICATIONS

- Computers
- Telecommunication equipment
- Test and measuring equipment
- Disk drives
- Automotive.

DESCRIPTION

A metal film layer is deposited on a high grade ceramic body (aluminium oxide). This resistive layer is trimmed to its nominal value and on both ends a contact is made which will guarantee optimum solderability. This is achieved by applying several layers and for ease of soldering the outer layer consists of a lead/tin alloy.

The resistive layer is covered with a protective coating.

QUICK REFERENCE DATA

DESCRIPTION	VALUE		
	MPC01	MPC11	MPC21
Size code	1206 (3216)	0805 (2012)	0603 (1608)
Resistance range	10 Ω to 1 MΩ(1)	100 Ω to 1 MΩ(2)	100 Ω to 332 kΩ
Resistance tolerance and series	±0.1%; standard values E24(3) or E96 series		
Temperature coefficient:			
10 Ω to 91 Ω	$\leq \pm 50 \times 10^{-6}$/K	–	–
100 Ω to 249 kΩ	$\leq \pm 10 \times 10^{-6}$/K	–	–
100 Ω to 332 kΩ	–	–	$\leq \pm 25 \times 10^{-6}$/K
100 Ω to 1 MΩ	$\leq \pm 25 \times 10^{-6}$/K	$\leq \pm 25 \times 10^{-6}$/K	–
Absolute maximum dissipation at T_{amb} = 70 °C	0.125 W	0.1 W	0.063 W
Maximum permissible voltage (DC or RMS)	150 V	100 V	75 V
Climatic category (IEC 60068)	55/125/56	55/125/56	55/125/56
Basic specification	IEC 60115-8 / JIS C 5202		
Stability after:			
load, 1000 hours at T_{amb} = 70 °C	$\Delta R/R \leq \pm 0.25\%$	$\Delta R/R \leq \pm 0.5\%$	$\Delta R/R \leq \pm 0.5\%$
climatic tests	$\Delta R/R \leq \pm 0.25\%$	$\Delta R/R \leq \pm 0.5\%$	$\Delta R/R \leq \pm 0.5\%$
short term tests	$\Delta R/R \leq \pm 0.1\%$	$\Delta R/R \leq \pm 0.5\%$	$\Delta R/R \leq \pm 0.5\%$

Notes

1. Resistance values for the range 10 Ω to 91 Ω for MPC01 (TC50), are available on request.
2. Resistance values down to 62 Ω for MPC11, are available on request.
3. Preferred range: E24, TC25 and TC50.

ORDERING INFORMATION

The code number can be logically arranged provided that the resistance value may be expressed in three significant digits and an indication of magnitude. Values which cannot be expressed in this way, are available upon request. Preferred values are E24, E96 values are available.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322
- The subsequent first 4 digits indicate the resistor type, temperature coefficient and packaging; see Table 1.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 1 Four digits to indicate resistor type and packaging

TYPE	TC	ORDERING CODE 2322 ... . PAPER TAPE ON ∅180 mm REEL 5000 units
MPC01	50	740 3....
	25	741 3....
	10	781 3....
MPC11	25	744 3....
MPC21	25	747 3....

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
10 Ω ≤ R < 100 Ω	9
100 Ω ≤ R < 1 kΩ	1
1 kΩ ≤ R < 10 kΩ	2
10 kΩ ≤ R < 100 kΩ	3
100 kΩ ≤ R < 1 MΩ	4
R = 1 MΩ	5

ORDERING EXAMPLE

The ordering code of a MPC01 resistor, value 153 Ω, TC25, supplied on paper tape of 5 000 units per reel is: 2322 741 31531.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of ±0.1%. The values of the E24/E96 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
MPC01	150	0.125
MPC11	100	0.1
MPC21	75	0.063

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

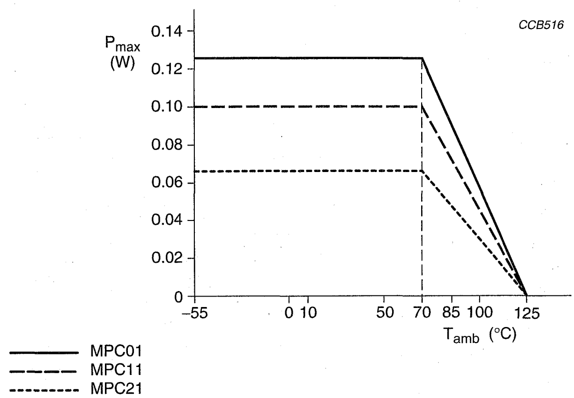
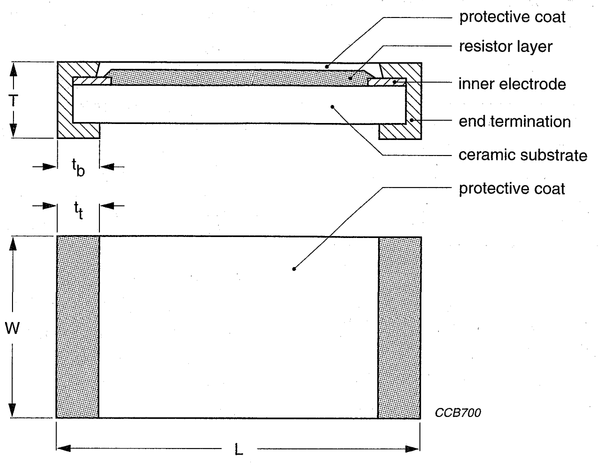


Fig.1 Maximum dissipation (P_{max}) as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
MPC01	3.2 ±0.2	1.6 ±0.2	0.4 ±0.1	0.5 ±0.2	0.5 ±0.2
MPC11	2.0 ±0.2	1.25 ±0.2	0.4 ±0.1	0.4 ±0.25	0.4 ±0.2
MPC21	1.6 ±0.2	0.80 ±0.2	0.4 ±0.1	0.3 ±0.2	0.3 ±0.2

Marking

MPC01

Resistors are marked with four digits representing the nominal resistance value. The first three digits represent the value, and the last digit represents the number of zeros that follow.

Example

MARKING	RESISTANCE
5100	51 Ω
4301	430 Ω
1503	15 kΩ

MPC11

E24 series: Resistors from the E24 series are marked with three digits on the protective coating based on *"JIS C 5201 4.2.5"*. The first two digits represent the value of rated resistance, and the last digit represents the number of zeros that follow.

Example

MARKING	RESISTANCE
510	51 Ω
431	430 Ω
153	15 kΩ

E96 series: Resistors from the E96 series are marked with a four digit code number based on *"JIS C 5201 4.2.5"*. The first three digits represent the value of rated resistance, and the last digit represents the number of zeros to follow. The decimal point is represented by 'R'.

Example: 4 digit marking

MARKING	RESISTANCE
5100	51 Ω
4301	430 Ω
1503	15 kΩ

MPC21

E24 series: Resistors from the E24 series are marked with three digits on the protect coating based on *"JIS C 5201 4.2.5"*. The first two digits represent the value of rated resistance, and the last digit represents the number of zeros that follow.

Example

MARKING	RESISTANCE
510	51 Ω
431	430 Ω
153	15 kΩ

E96 series: Resistors from the E96 series are either marked with a three digit manufacturing date code or with a three digit code number. The first two digits are listed in Table 4 and represent the resistance value. The subsequent digit is listed in Table 5 and represents the number of zeros that follow.

Example

MARKING	RESISTANCE
69R	51.1 Ω
62A	432 Ω
18C	15.0 kΩ

PACKAGE MARKING

The packaging of all resistors is marked and includes type designation, quantity, manufacturing date code, manufacturers name and the country of origin.

Two digit resistance code for E96 series

Table 4 First two digits of the resistance code

VALUE	CODE	VALUE	CODE	VALUE	CODE	VALUE	CODE
100	01	178	25	316	49	562	73
102	02	182	26	324	50	576	74
105	03	187	27	332	51	590	75
107	04	191	28	340	52	604	76
110	05	196	29	348	53	619	77
113	06	200	30	357	54	634	78
115	07	205	31	365	55	649	79
118	08	210	32	374	56	665	80
121	09	215	33	383	57	681	81
124	10	221	34	392	58	698	82
127	11	226	35	402	59	715	83
130	12	232	36	412	60	732	84
133	13	237	37	422	61	750	85
137	14	243	38	432	62	768	86
140	15	249	39	442	63	787	87
143	16	255	40	453	64	806	88
147	17	261	41	464	65	825	89
150	18	267	42	475	66	845	90
154	19	274	43	487	67	866	91
158	20	280	44	499	68	887	92
162	21	287	45	511	69	909	93
165	22	294	46	523	70	931	94
169	23	301	47	536	71	953	95
174	24	309	48	549	72	976	96

Table 5 Multiplier codes; see Table 4

CODE	A	H	C	D	E	F	R	S
Multipliers	1	10^1	10^2	10^3	10^4	10^5	10^{-1}	10^{-2}

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"JIS C 5202"*, "Test method of fixed resistors for electronic equipment". The testing also covers the requirements specified by IEC publication 60115-8 and IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"*.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 6 the tests and requirements are listed with reference to the relevant clauses of *"JIS and IEC"*; a short description of the test procedure is also given.

Table 6 Test procedures and requirements

IEC 60115-8 CLAUSE	TEST METHOD	TEST	PROCEDURE	REQUIREMENTS		
				MPC01	MPC11	MPC21
Tests in accordance with the schedule of IEC publication 60115-8						
4.4.1		visual examination		no holes; clean surface; no visible damage		
4.4.2		dimensions (outline)	gauge (mm)	see Table 3		
4.5		resistance	applied voltage (+0/−10%): 10 Ω ≤ R < 100 Ω: 0.3 V 100 Ω ≤ R < 1 kΩ: 1 V 1 kΩ ≤ R < 10 kΩ: 3 V 10 kΩ ≤ R < 100 kΩ: 10 V 100 kΩ ≤ R: 25 V	$R - R_{nom}$: max. ±0.1% or ±0.5%		
Short term tests						
4.18	IEC 60068-2-20 JIS C 5202 6.4	resistance to soldering heat	unmounted chips; 10 s; 260 ±5 °C	ΔR/R ≤ ±0.1%	ΔR/R ≤ ±0.5%	
4.29	IEC 60068-2-45 JIS C 5202 6.9	component solvent resistance	isopropyl alcohol	marking shall be legible; no visible damage		

Thin film, ultra high precision, high stability, chip resistors

MPC01/11/21 (1206; 0805; 0603)

IEC 60115-8 CLAUSE	TEST METHOD	TEST	PROCEDURE	REQUIREMENTS		
				MPC01	MPC11	MPC21
4.17	IEC 60068-2-20 JIS C 5202 6.5	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±5 °C	good tinning (≥95% covered); no visible damage		
4.7	IEC 60115-8 4.7 JIS C 5202 5.7	voltage proof on insulation	maximum voltage (RMS) during 1 minute metal block method	no breakdown or flashover at 300 V	no breakdown or flashover at 200 V	no breakdown or flashover at 100 V
4.13	IEC 60115-8 4.13 JIS C 5202 5.5	short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	$\Delta R/R \leq \pm 0.1\%$	$\Delta R/R \leq \pm 0.5\%$	
4.33	IEC 60115-8 4.33 JIS C 5202 6.1.4.2[1]	bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm	no visible damage $\Delta R/R \leq \pm 0.1\%$	no visible damage $\Delta R/R \leq \pm 0.5\%$	
4.19	IEC 60115-8 4.19 JIS C 5202 7.4	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R \leq \pm 0.1\%$	no visible damage $\Delta R/R \leq \pm 0.5\%$	
4.6.11	JIS C 5202 5.6	Insulation resistance	voltage (DC) after 1 minute metal block method	$R_{ins} \geq 1000$ MΩ at 300 V	$R_{ins} \geq 1000$ MΩ at 200 V	$R_{ins} \geq 1000$ MΩ at 100 V

IEC 60115-8 CLAUSE	TEST METHOD	TEST	PROCEDURE	REQUIREMENTS		
				MPC01	MPC11	MPC21
Long term tests						
4.24.2	JIS C 5202 7.9	damp heat steady state	1000 hours; 40 °C; 90 to 95% RH; loaded with P_n or V_{max} for 1.5 hours on, 0.5 hours off	$\Delta R/R \leq \pm 0.25\%$	$\Delta R/R \leq \pm 0.5\%$	
4.25	IEC 60115-8 4.25.1 JIS C 5202 7.10	endurance at 70 °C	1000 hours; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	$\Delta R/R \leq \pm 0.25\%$	$\Delta R/R \leq \pm 0.5\%$	
4.23.2	IEC 60115-8 4.25.3 JIS C 5202 7.11	endurance at upper category temperature	1000 hours; no load	$\Delta R/R \leq \pm 0.25\%$	$\Delta R/R \leq \pm 0.5\%$	
4.8.4.2	IEC 60115-8 4.8 JIS C 5202 5.2	temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C (TC × 10^{-6}/K)	should not exceed the temperature coefficient of resistance as specified in “Quick reference data”		

Note

1. Refer to Table 1 for specific ordering information.

Resistor network

RNA310
5%

FEATURES

- 8 resistors in one 1206 package
- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

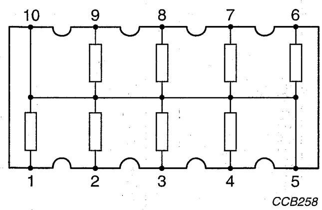
APPLICATIONS

- Motherboards
- Notebook computers
- Printers
- CD-ROM
- PDA
- Camcorders, etc.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.



For dimensions see Fig.3 and Table 3.

Fig.1 Equivalent circuit diagram.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	10 Ω to 100 kΩ; E24 series
Resistance tolerance	±5%
Temperature coefficient:	
10 Ω to 100 Ω	≤250 ±250 × 10^{-6}/K
100 Ω to 100 kΩ	≤±200 × 10^{-6}/K
Absolute maximum dissipation at T_{amb} = 70 °C	1⁄32 W
Maximum permissible voltage	25 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

Resistor network

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	RESISTANCE VALUE	TOL. (%)	ORDERING CODE 2350 230 ..... PAPER TAPE ON REEL 5000 units
RNA310	10 Ω to 100 kΩ	±5	10...
Jumper 0 Ω			
RNA310	–	–	91001

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 230
- The subsequent two digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE	LAST DIGIT
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 kΩ	2
10 to 91 kΩ	3
100 to 910 kΩ	4

ORDERING EXAMPLE

The ordering code of an RNA310 chip resistor, value 47 Ω, supplied on paper tape of 5000 units per reel is: 2350 230 10479.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of ±5%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE[1] (V)	LIMITING POWER (W)
RNA310	25	1⁄32 W

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.2.

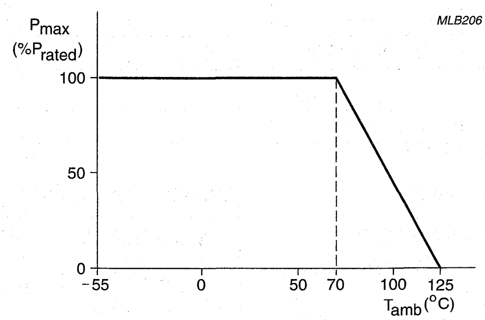


Fig.2 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RNA310	1.0

Marking

Each resistor is marked with a 3-digit code on the protective coat to designate the nominal resistance value.

3-DIGIT MARKING

For values up to 91 Ω the R is used as a decimal point. For values of 100 Ω or greater the first 2 digits apply to the resistance value and the third indicates the number of zeros to follow.

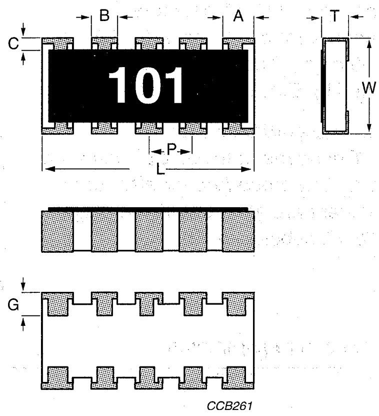
Example

MARKING	RESISTANCE
12R	12 Ω
102	1 kΩ
101	100 Ω

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.3 Outlines.

Table 3 Physical dimensions; see Fig.3

SYMBOL	VALUE	TOL.	UNIT
L	3.30	±0.20	mm
W	1.60	±0.15	mm
T	0.55	±0.10	mm
A	0.50	±0.05	mm
C	0.40	±0.15	mm
P	0.64	±0.05	mm
G	0.40	±0.15	mm
B	0.35	±0.05	mm

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range −55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±(1% +0.05 Ω)
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H_2O followed by brushing in accordance with *"MIL 202 F"*	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
4.7		voltage proof on insulation	25 V (DC or RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	ΔR/R max.: ±(2% +0.1 Ω)
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 5 mm	no visible damage ΔR/R max.: ±(1% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±(2% +0.1 Ω)
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01 P_n	ΔR/R max.: ±(3% +0.1 Ω)
4.25.1		endurance	1000 +48/−0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(3% +0.1 Ω)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/−0 hours; 125 °C; no load	ΔR/R max.: ±(3% +0.1 Ω)

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 10 Ω ≤ R ≤ 100 Ω 100 Ω < R ≤ 100 kΩ	 ≤250 ±250 × 10^{-6}/K ≤±200 × 10^{-6}/K
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.6.1.1		insulation resistance	25 V (DC) after 1 minute	R_{ins} min.: 10^3 MΩ
Other applicable tests				
	(JIS)	resistance to damp heat	1000 +48/−0 hours; 93 +2/−3% RH; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(3% +0.1 Ω)
		leaching	unmounted chips; 60 ±1 s; 260 ±5 °C	good tinning; no leaching

Array chip resistors size 4 × 0603

ARC241/242 ARV241

FEATURES

- 4 × 0603 sized resistors in one 1206-sized package
- Reduced reel exchange time
- Low assembly costs
- Reduced PCB area
- Reduced size of final equipment.

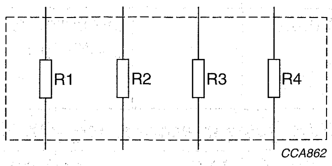
APPLICATIONS

- Computers
- Microcomputer driven applications:
  - Portable radios
  - CD and cassette players
  - Car telephones
  - Camcorders
  - Cordless, cellular phones.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.



R1 = R2 = R3 = R4.
For dimensions see Fig.3 and Table 3.

Fig.1 Equivalent circuit diagram.

QUICK REFERENCE DATA

DESCRIPTION	VALUE		
	ARC241	ARV241	ARC242
Resistance range	10 Ω to 1 MΩ		
Resistance tolerance and E-series	±5%; E24 series		±1%; E96 series
Temperature coefficient	$\leq\pm200 \times 10^{-6}$/K		$\leq\pm100 \times 10^{-6}$/K
Absolute maximum dissipation per resistive element at T_{amb} = 70 °C	0.063 W		
Maximum permissible voltage	50 V (DC or RMS)		
Climatic category (IEC 60068)	55/155/56		
Basic specification	IEC 60115-8		

R-Array overview

TYPE	TERMINATION TECHNOLOGY	SIZE	TOLERANCE (%)
ARC241	concave	4 × 0603	5
ARC242	concave	4 × 0603	1
ARV241	convex	4 × 0603	5

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type

TYPE	ORDERING CODE 2350 0.. .....(1)
	PAPER TAPE ON REEL
	5000 units
ARC241	34 10...
ARV241	35 10...
ARC242	24 1....
Jumper 0 Ω	
ARC241; note 2	34 91001
ARV241; note 2	35 91001

Notes

1. The arrays are supplied in paper tape on reel, 5000 units
2. The jumper has a maximum resistance R_{max} = 50 mΩ and a rated current I_R = 1 A.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 0
- The subsequent three or four digits indicate the resistor termination style, tolerance and packaging; see Table 1.
- The remaining digits indicate the resistance value:
  - The first 2 digits for 5% or 3 digits for 1% tolerance products indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE	LAST DIGIT
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 kΩ	2
10 to 91 kΩ	3
100 to 910 kΩ	4
1 MΩ	5

ORDERING EXAMPLE

The ordering code of an ARC241 resistor, value 100 Ω, supplied on paper tape of 5000 units per reel is: 2350 034 10101.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 or E96 series for resistors with a tolerance of ±5% or ±1%. The values of the E24/E96 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE[(1)] (V)	LIMITING POWER (W)
ARC241 ARC242 ARV241	50	0.063

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating ambient temperature; see Fig.2.

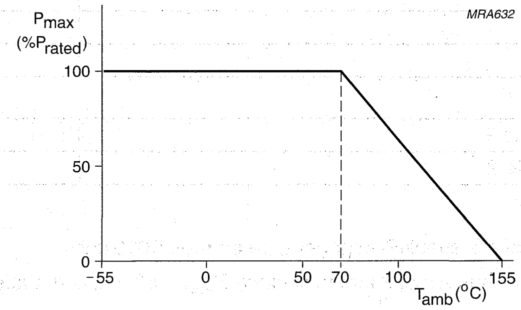


Fig.2 Maximum dissipation (P_{max}) in percentage of rated power as a function of the operating ambient temperature (T_{amb}).

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
All types	1.1

Marking

All resistors within the E24 series are marked with a 3-digit code and a 4-digit code for resistors of the E96 series, on the protective coat to designate the nominal resistance value.

3-DIGIT MARKING

For values up to 91 Ω the R is used as a decimal point. For values of 100 Ω or greater the first 2 digits apply to the resistance value and the third indicates the number of zeros to follow.

Example

MARKING	RESISTANCE
12R	12 Ω
124	120 kΩ
000	jumper

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 K or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

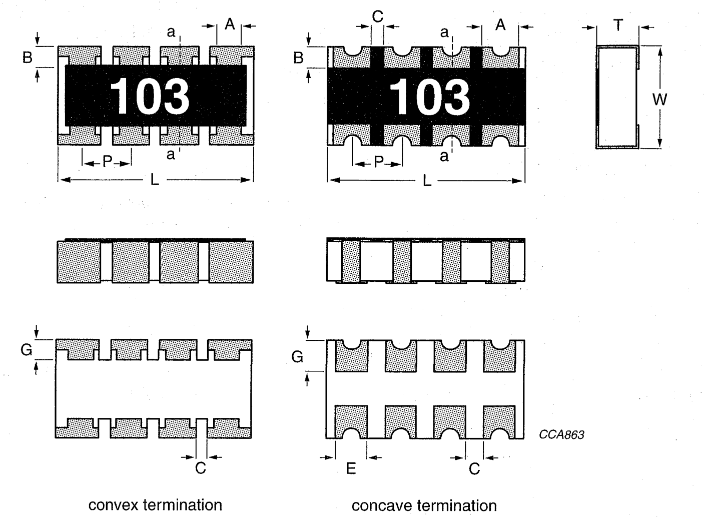
Example

MARKING	RESISTANCE
12R0	12 Ω
1203	120 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



Dimensions in mm.
For dimensions see Table 3.

Fig.3 Outlines.

Table 3 Physical dimensions; see Fig.3

SYMBOL	ARC241/242		ARV241		UNIT
	VALUE	TOL.	VALUE	TOL.	
L	3.20	+0.20/–0.10	3.20	±0.15	mm
W	1.60	+0.20/–0.10	1.60	±0.15	mm
T	0.60	±0.20	0.55	±0.10	mm
A	0.60	±0.15	0.40	±0.15	mm
B	0.35	±0.15	0.30	±0.20	mm
P	0.80	±0.15	0.80	±0.15	mm
E	0.50	±0.15	–	–	mm
G	0.50	±0.15	0.30	±0.15	mm
C	0.10	min.	0.10	min.	mm

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/155/56 (rated temperature range −55 to +155 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given.
In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS		
				ARC241	ARV241	ARC242
Tests in accordance with the schedule of IEC publication 60115-8						
4.4.1		visual examination		no holes; clean surface; no visible damage		
4.4.2		dimensions (outline; see Fig.3)	gauge (mm)	see Table 3		
4.5		resistance	applied voltage (+0/−10%): 10 Ω ≤ R < 100 Ω: 0.3 V 100 Ω ≤ R < 1 kΩ: 1 V 1 kΩ ≤ R < 10 kΩ: 3 V 10 kΩ ≤ R < 100 kΩ: 10 V 100 kΩ ≤ R < 1 MΩ: 25 V R ≥ 1 MΩ: 50 V	$R - R_{nom}$: max. ±5%	$R - R_{nom}$: max. ±5%	$R - R_{nom}$: max. ±1%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)		
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H_2O followed by brushing in accordance with *"MIL 202 F"*	no visible damage		
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage		
4.7		voltage proof on insulation	maximum voltage (RMS) during 1 minute, metal block method	no breakdown or flashover		
4.13		short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	ΔR/R max.: ±(1% +0.05 Ω)		

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS		
				ARC241	ARV241	ARC242
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 5 mm	no visible damage ΔR/R max.: ±(1% +0.05 Ω)		no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)		
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01 P_n	ΔR/R max.: ±(3% +0.1 Ω)		ΔR/R max.: ±(1% +0.05 Ω)
4.25.1		endurance	1000 +48/−0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(2% +0.1 Ω)		ΔR/R max.: ±(1% +0.05 Ω)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/−0 hours; no load	ΔR/R max.: ±(2% +0.1 Ω)		ΔR/R max.: ±(1% +0.05 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	≤±200 × 10^{-6}/K		≤±100 × 10^{-6}/K
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method						
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage		
4.6.1.1		insulation resistance	voltage (DC) after 1 minute, metal block method: 10 V	R_{ins} min.: 10^3 MΩ		
4.12		noise	IEC publication 60195 (measured with Quantech-equipment)			
			R ≤ 100 Ω	max. 0.316 µV/V (−10 dB)		
			100 Ω < R ≤ 1 kΩ	max. 1 µV/V (0 dB)		
			1 kΩ < R ≤ 10 kΩ	max. 3 µV/V (9.54 dB)		
			10 kΩ < R ≤ 100 kΩ	max. 6 µV/V (15.56 dB)		
			100 kΩ < R ≤ 1 MΩ	max. 10 µV/V (20 dB)		

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS		
				ARC241	**ARV241**	**ARC242**
Other applicable tests						
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/−0 hours; 40 ±2 °C; 93 +2/−3% RH; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(3% +0.1 Ω)		ΔR/R max.: ±(2% +0.1 Ω)
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching		

Array chip resistor size 4 × 0402

ARV341 5%

FEATURES

- 4 × 0402 sized resistors in one package
- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Motherboards
- Notebook computers
- Add-on cards
- Mobile phones
- PDA
- Dual In line Memory Module (DIMM).

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating. Finally, external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	10 Ω to 1 MΩ; E24 series
Resistance tolerance	±5%
Temperature coefficient	≤±300 × 10^{-6}/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.063 W
Maximum permissible voltage	50 V (DC or RMS)
Operating temperature range	−55 to +125 °C
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	ORDERING CODE 2350 033 ..... PAPER TAPE ON REEL	
	5000 units	10000 units
ARV341	10...	11...
Jumper 0 Ω		
ARV341; see note 1	91002	91001

Note

1. The jumper has a maximum resistance R_{max} = 50 mΩ and a rated current I_R = 1 A.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 033
- The subsequent two digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE	LAST DIGIT
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 kΩ	2
10 to 91 kΩ	3
100 to 910 kΩ	4
1 MΩ	5

ORDERING EXAMPLE

The ordering code of an ARV341 resistor, value 100 Ω, supplied on paper tape of 5000 units per reel is: 2350 033 10101.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of ±5%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
ARV341	50	0.063

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

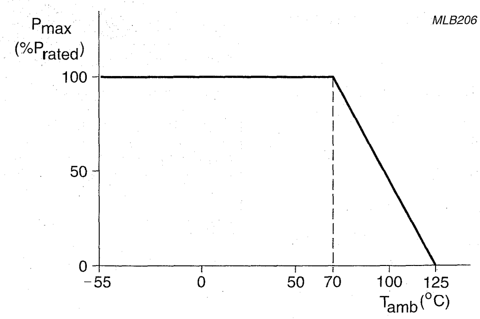


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

Array chip resistor size 4 × 0402

ARV341 5%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
ARV341	0.20

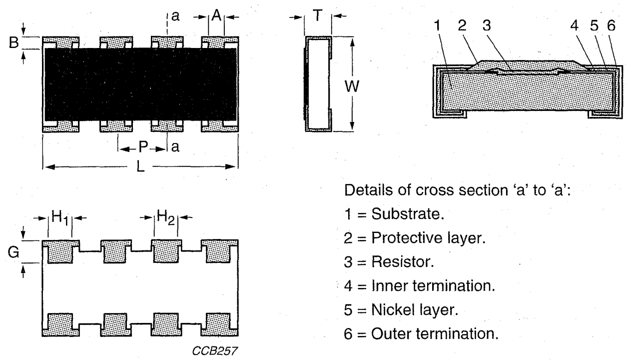
Marking

There is no marking on the product; the product is marked on request.

PACKAGE MARKING

The packaging is marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Physical dimensions; see Fig.2

SYMBOL	VALUE	TOL.	UNIT
L	2.0	±0.10	mm
W	1.0	±0.10	mm
T	0.5	±0.10	mm
A	0.2	±0.15	mm
B	0.2	±0.10	mm
P	0.5	±0.10	mm
G	0.3	±0.10	mm
H_1	0.3	±0.10	mm
H_2	0.2	±0.05	mm

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range −55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±(1% +0.05 Ω)
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H_2O followed by brushing in accordance with *"MIL 202 F"*	no visible damage
4.7		voltage proof on insulation	50 V (DC or RMS) during 1 minute metal block method	no breakdown or flashover
4.13		short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	ΔR/R max.: ±(2% +0.1 Ω)
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 5 mm	no visible damage ΔR/R max.: ±(1% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±(1% +0.05 Ω)
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01 P_n	ΔR/R max.: ±(3% +0.1 Ω)
4.25.1		endurance	1000 +48/−0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(3% +0.1 Ω)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/−0 hours; 125 °C; no load	ΔR/R max.: ±(3% +0.1 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	$\leq \pm 300 \times 10^{-6}$/K

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	16 hours steam or 16 hours 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.6.1.1		insulation resistance	50 V (DC) after 1 minute, metal block method: 10 V	R_{ins} min.: 10^3 MΩ
4.12		noise	IEC publication 60195 (measured with Quantech-equipment):	
			R ≤ 100 Ω	max. 0.316 µV/V (−10 dB)
			100 Ω < R ≤ 1 kΩ	max. 1 µV/V (0 dB)
			1 kΩ < R ≤ 10 kΩ	max. 3 µV/V (9.54 dB)
			10 kΩ < R ≤ 100 kΩ	max. 6 µV/V (15.56 dB)
			100 kΩ < R ≤ 1 MΩ	max. 10 µV/V (20 dB)
Other applicable tests				
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	40 ±2 °C; 93 +2/−3% RH; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(3% +0.1 Ω)
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching

Power chip resistor size 1218

PRC201 5%; 1%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Excellent performance at high frequency.

APPLICATIONS

- Power supplies in small sized equipment
- Camcorders
- Portable radio, CD and cassette players
- Automotive.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. To guarantee optimum solderability the outer layer consists of a lead-tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	0.02 Ω to 1 MΩ
Resistance tolerance and series:	
0.02 Ω ≤ R ≤ 1 MΩ	±5%, E24 series
0.1 Ω ≤ R ≤ 1 MΩ	±1%, E24/E96 series
Temperature coefficient:	
0.020 Ω ≤ R < 0.033 Ω	≤±2000 × 10^{-6}/K
0.033 Ω ≤ R < 0.060 Ω	≤±1000 × 10^{-6}/K
0.060 Ω ≤ R < 0.2 Ω	≤±700 × 10^{-6}/K
0.2 Ω ≤ R < 1 Ω	≤±250 × 10^{-6}/K
1 Ω ≤ R < 10 Ω	≤±200 × 10^{-6}/K
10 Ω ≤ R ≤ 1 MΩ	≤±100 × 10^{-6}/K
Absolute maximum dissipation at T_{amb} = 70 °C	1 W
Maximum permissible voltage	200 V (DC or RMS)
Maximum permissible current	6 A (DC or RMS)
Operating temperature range	–55 °C to +155 °C
Basic specification	IEC 60115-8

Power chip resistor size 1218 | PRC201 5%; 1%

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	TOL. (%)	ORDERING CODE 2322 735 ..... BLISTER TAPE ON REEL 5000 units
PRC201	±5; note 1	60...
	±1	2....
Jumper 0 Ω		
PRC201; note 2	–	90006

Notes

1. Code numbers for values less than 0.1 Ω are available on request
2. The jumper has a maximum resistance R_{max} = 20 mΩ and a rated current I_R = 6 A.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322.
- The subsequent four or five digits indicate the resistor type and packaging; see Table 1.
- The remaining digits indicate the resistance value:
  - The first 2 digits for 5% or 3 digits for 1% tolerance products indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
0.02 to 0.091 Ω	note 1
0.1 to 0.91 Ω	7
1 to 9.1 Ω	8
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 kΩ	2
10 to 91 kΩ	3
100 to 910 kΩ	4
1 MΩ	5

Note

1. Code numbers for values less than 0.1 Ω are available on request.

ORDERING EXAMPLE

The ordering code of a PRC201 resistor, value 470 Ω with 5% tolerance, supplied on blister tape of 5 000 units per reel is: 2322 735 60471.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 or E96 series for resistors with a tolerance of ±5% or ±1%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE[(1)] (V)	LIMITING CURRENT (A)	LIMITING POWER (W)
PRC201	200	6	1

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

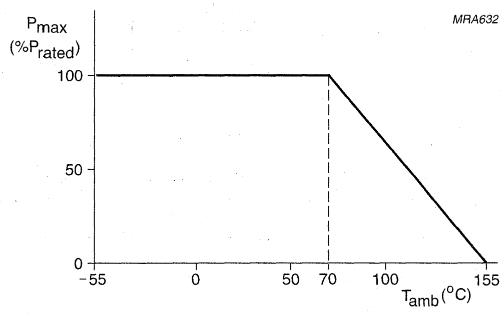
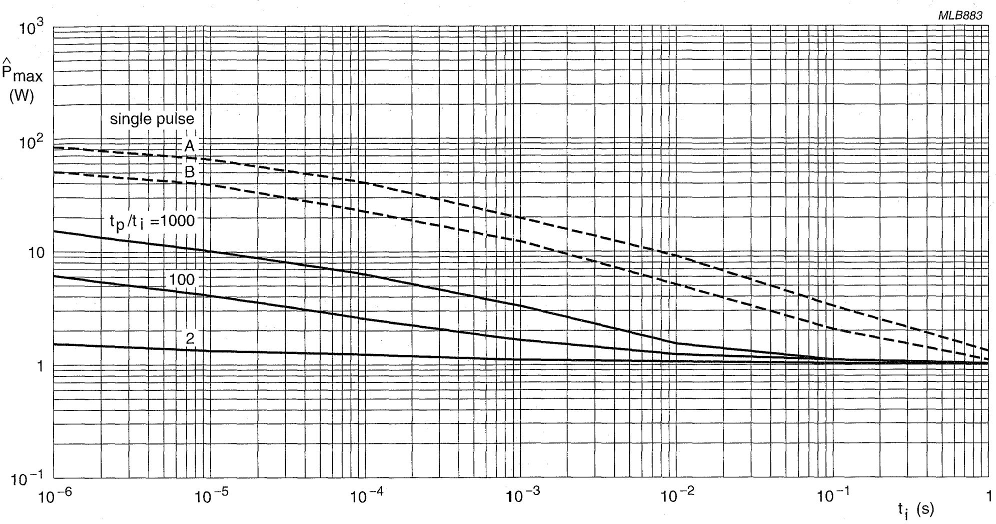


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

PULSE LOADING CAPABILITIES



Single pulse A: $R_n \leq 300\ \Omega$.

Single pulse B: $R_n > 300\ \Omega$.

Fig.2 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for $R \leq 10\ k\Omega$, single pulse and repetitive pulse t_p/t_i.

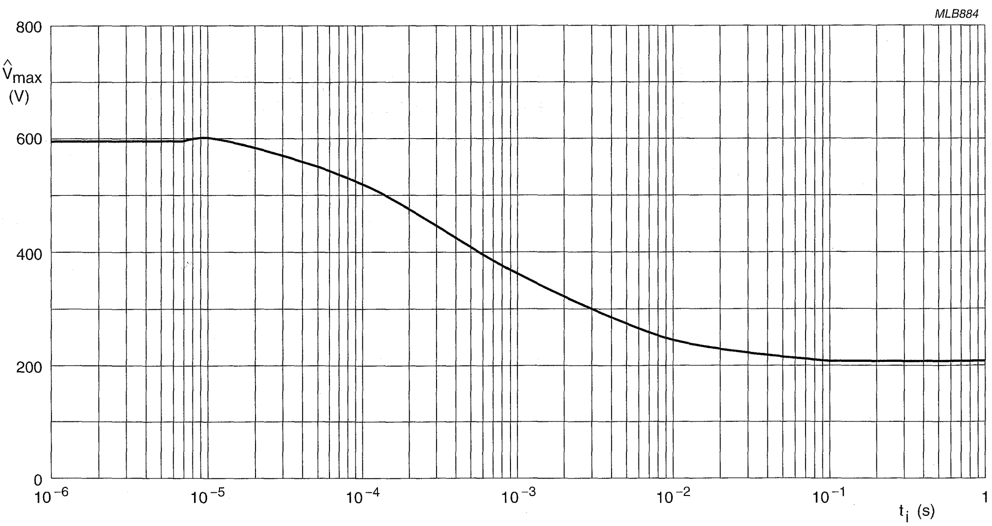
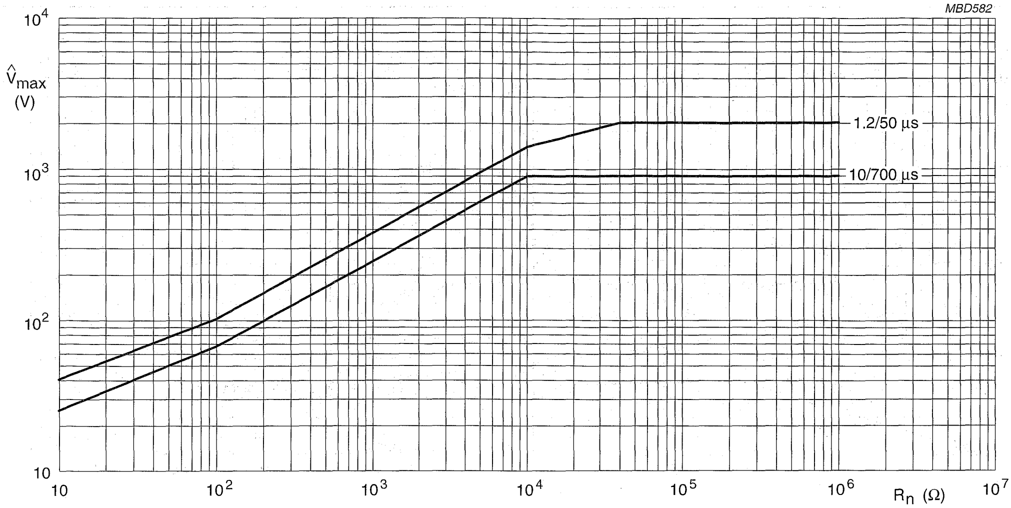


Fig.3 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.



These pulses may not be applied on a regular basis.

Fig.4 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533.

Application information

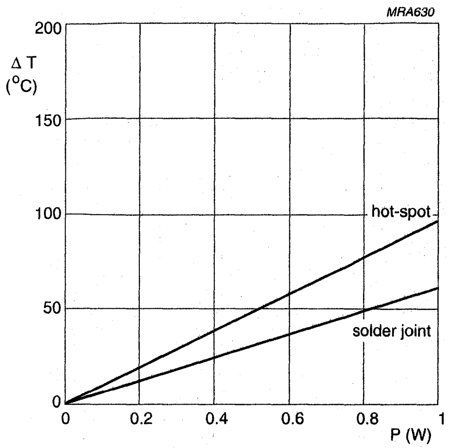


Fig.5 Temperature rise at hot-spot and solder joint as a function of dissipated power, for a resistor mounted horizontally on ceramic PCB.

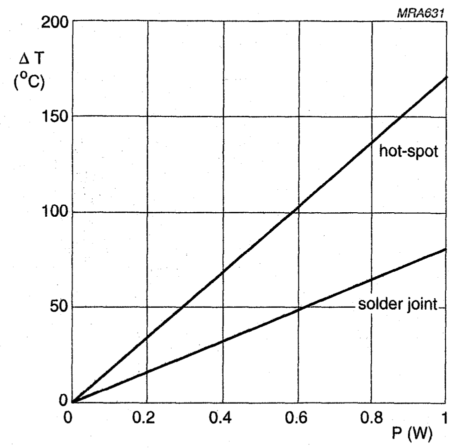


Fig.6 Temperature rise at hot-spot and solder joint as a function of dissipated power, for a resistor mounted horizontally on a FR4 PCB.

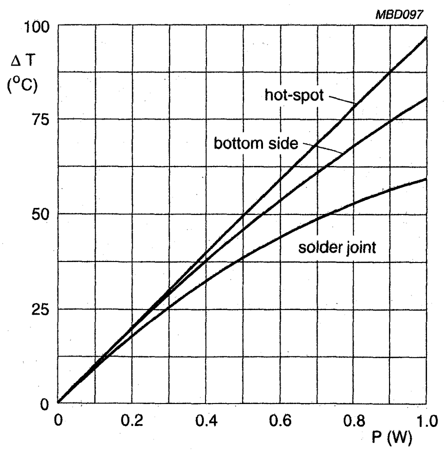
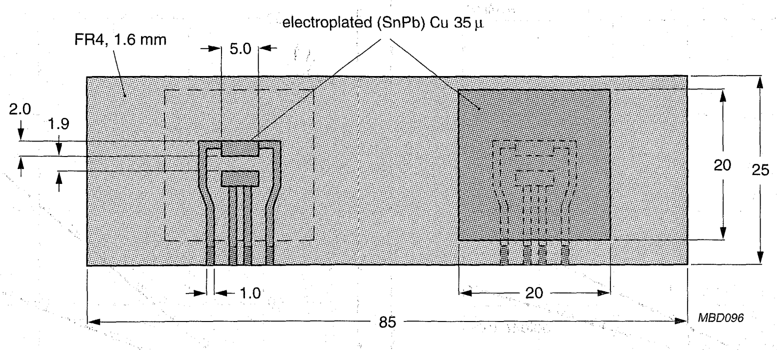


Fig.7 Temperature rise at hot-spot and solder joint as a function of dissipated power, for a resistor horizontally mounted on the test substrate; see Fig.8.

Power chip resistor size 1218

PRC201 5%; 1%



Dimensions in mm.

Fig.8 Test substrate layout. The tracks on the substrate for values below 33 mΩ are wider. With this substrate, the resistance of the tracks becomes significant compared to the resistor tested. Due to the current loading required for resistor testing these tracks may be damaged.

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
PRC201	3

Marking

Each resistor is marked with the nominal resistance value.

4-DIGIT MARKING

For values up to 910 Ω the R is used as a decimal point. For values of 1 kΩ or greater the letter K or M is used as the decimal point for the kΩ or MΩ indication.

Magnitude indicators

RESISTANCE	INDICATOR
0.02 to 910 Ω	R
1 to 910 kΩ	K
1 MΩ	M

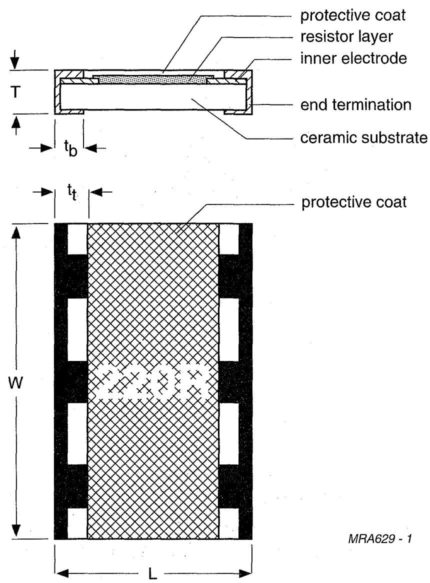
Example

MARKING	RESISTANCE
120R	120 Ω
4K70	4.70 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.9 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.9

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
PRC201	3.05 ±0.15	4.60 ±0.20	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/155/56 (rated temperature range −55 to +155 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions in accordance with *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.4.2		dimensions (outline)	gauge	0.45 mm ≤ T ≤ 0.65 mm 4.4 mm ≤ W ≤ 4.8 mm 2.9 mm ≤ L ≤ 3.2 mm
4.5		resistance	applied voltage (+0/−10%): R < 10 Ω: 0.1 V 10 Ω ≤ R < 100 Ω: 0.3 V 100 Ω ≤ R < 1 kΩ: 1 V 1 kΩ ≤ R < 10 kΩ: 3 V 10 kΩ ≤ R < 100 kΩ: 10 V 100 kΩ ≤ R < 1 MΩ: 25 V 1 MΩ: 50 V	$R - R_{nom}$: max. ±5% or 1%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C: 0.020 Ω ≤ R < 0.1 Ω 0.1 Ω ≤ R ≤ 1 MΩ	 ΔR/R max.: ±(2% +0.1 Ω) ΔR/R max.: ±(1% +0.05 Ω)
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H_2O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.7		voltage proof on insulation	200 V (RMS) during 1 minute	no breakdown or flashover

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: ±(1% +0.05 Ω)
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 2 mm	no damage $\Delta R/R$ max.: ±(1% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: ±(1.0% +0.05 Ω)
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 1000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/–3% RH; loaded with $0.01P_n$	no visible damage $\Delta R/R$ max.: ±(3% +0.1 Ω)
4.25.1		endurance	1000 +48/–0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off: 0.020 Ω ≤ R < 0.1 Ω 0.1 Ω ≤ R ≤ 1 MΩ	no visible damage $\Delta R/R$ max.: ±(5% +0.1 Ω) $\Delta R/R$ max.: ±(3% +0.1 Ω)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/–0 hours; no load	no visible damage $\Delta R/R$ max.: ±(3% +0.1 Ω)
4.8.4.2s‘		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 0.020 Ω ≤ R < 0.033 Ω 0.033 Ω ≤ R < 0.060 Ω 0.060 Ω ≤ R < 0.2 Ω 0.2 Ω ≤ R < 1 Ω 1 Ω ≤ R < 10 Ω 10 Ω ≤ R	 $\Delta R/R$ max.: $\pm 2000 \times 10^{-6}$/K $\Delta R/R$ max.: $\pm 1000 \times 10^{-6}$/K $\Delta R/R$ max.: $\pm 700 \times 10^{-6}$/K $\Delta R/R$ max.: $\pm 250 \times 10^{-6}$/K $\Delta R/R$ max.: $\pm 200 \times 10^{-6}$/K $\Delta R/R$ max.: $\pm 100 \times 10^{-6}$/K
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	16 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching

Power chip resistor size 2010

PRC111 1%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Converters
- Printer equipment
- Computers
- Battery chargers
- Automotive
- Power supplies.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. To guarantee optimum solderability the outer layer consists of a lead-tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 Ω to 10 MΩ, E96 series
Resistance tolerance	±1%
Temperature coefficient:	
1 Ω ≤ R < 4.99 Ω	≤±300 × 10^{-6}/K
5.1 Ω ≤ R < 9.76 Ω	≤±200 × 10^{-6}/K
10 Ω ≤ R < 1 MΩ	≤±100 × 10^{-6}/K
1 MΩ ≤ R < 10 MΩ	≤±200 × 10^{-6}/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.5 W
Maximum permissible voltage	200 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Operating temperature range	−55 °C to +125 °C
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	SERIES	ORDERING CODE 2322 761 .....
				BLISTER TAPE ON REEL
				4000 units
PRC111	1 Ω to 10 MΩ	±1	E96	6....

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322 761; see Table 1.
- The subsequent digit indicates the resistor type and packaging.
- The remaining digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 kΩ	4
1 to 9.76 MΩ	5
10 MΩ	6

ORDERING EXAMPLE

The ordering code of a PRC111 resistor, value 4.02 kΩ with 1% tolerance, supplied on blister tape of 4000 units per reel is:
2322 761 64022.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96 series for resistors with a tolerance of ±1%.
The values of the E96 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
PRC111	200	0.5

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

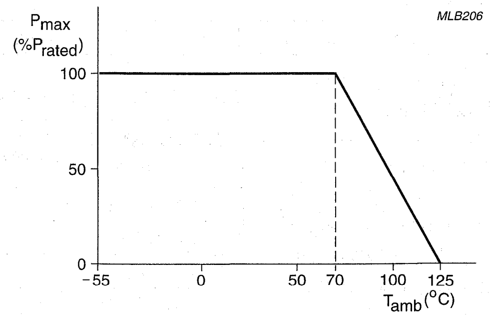


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

Power chip resistor size 2010

PRC111 1%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
PRC111	2.50

Marking

Each resistor is marked with the nominal resistance value.

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

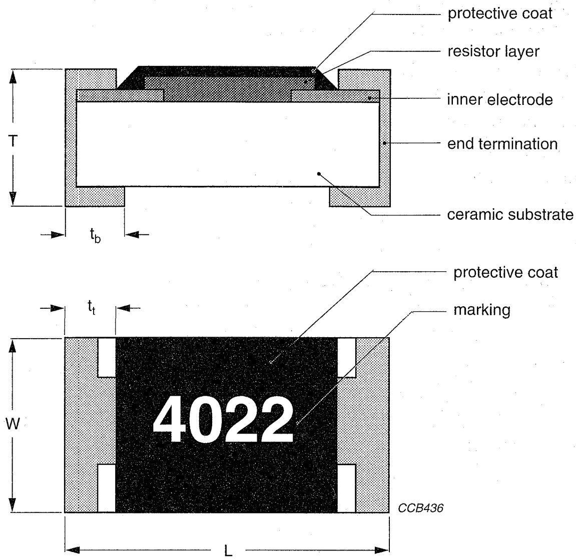
Example

MARKING	RESISTANCE
121R	121 Ω
4021	4.02 kΩ
1503	150 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
PRC111	5.0 ±0.2	2.5 ±0.2	0.55 ±0.10	0.65 ±0.25	0.90 ±0.25

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range –55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions in accordance with *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)
4.13		short time overload	room temperature; dissipation 6.25 × 0.5 W; 5 s (voltage not more than 2 × V_{max})	ΔR/R max.: ±(1% +0.05 Ω)
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 2 mm	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)
4.6.1.1		insulation resistance	200 V (DC) after 1 minute	R_{ins} min.: 10000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/–3% RH; loaded with 0.01 P_n	no visible damage ΔR/R max.: ±(1.5% +0.05 Ω)
4.25.1		endurance	1000 +48/–0 hours; nominal dissipation; 1.5 hours on, 0.5 hour off	no visible damage ΔR/R max.: ±(1.5% +0.05 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 1 Ω ≤ R < 4.99 Ω 5.1 Ω ≤ R < 9.76 Ω 10 Ω ≤ R < 1 MΩ 1 MΩ ≤ R < 10 MΩ	 ΔR/R max.: ±300 × 10^{-6}/K ΔR/R max.: ±200 × 10^{-6}/K ΔR/R max.: ±100 × 10^{-6}/K ΔR/R max.: ±200 × 10^{-6}/K

Power chip resistor size 2010 PRC111 1%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/–0 hours; 40 ±2 °C; 93 +2/–3% RH; loaded with 1 W or V_{max}; 1.5 hours on, 0.5 hour off	no visible damage ΔR/R max.: ±(1% +0.05 Ω)

Power chip resistor size 2010

PRC111 5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Converters
- Printer equipment
- Computers
- Battery chargers
- Automotive
- Power supplies.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. To guarantee optimum solderability the outer layer consists of a lead-tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 Ω to 10 MΩ, jumper; E24 series
Resistance tolerance	±5%; ±2%
Temperature coefficient:	
1 Ω ≤ R < 4.99 Ω	≤±300 × 10^{-6}/K
5.1 Ω ≤ R < 9.76 Ω	≤±200 × 10^{-6}/K
10 Ω ≤ R < 1 MΩ	≤±100 × 10^{-6}/K
1 MΩ ≤ R < 10 MΩ	≤±200 × 10^{-6}/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.5 W
Maximum permissible voltage	200 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Operating temperature range	–55 °C to +125 °C
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	SERIES	ORDERING CODE 2322 760 ..... BLISTER TAPE ON REEL 4000 units
PRC111	1 Ω to 10 MΩ	±5	E24	60...
		±2		80...
Jumper 0 Ω				
PRC111	–	–	–	90003

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322 760; see Table 1.
- The subsequent digit indicates the resistor type and packaging.
- The remaining digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 kΩ	4
1 to 9.76 MΩ	5
10 MΩ	6

ORDERING EXAMPLE

The ordering code of a PRC111 resistor, value 47 Ω with 5% tolerance, supplied on blister tape of 4000 units per reel is: 2322 760 60479.

Power chip resistor size 2010

PRC111 5%; 2%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of ±2% or ±5%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
PRC111	200	0.5

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

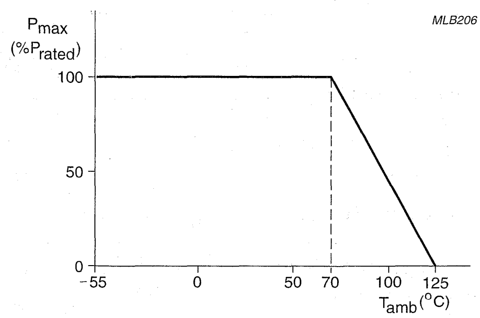


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

Power chip resistor size 2010

PRC111 5%; 2%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
PRC111	2.50

Marking

Each resistor is marked with the nominal resistance value.

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

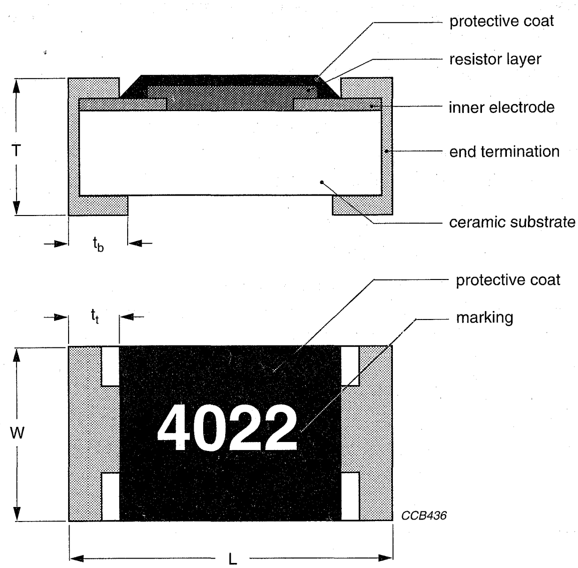
Example

MARKING	RESISTANCE
120R	120 Ω
1202	12 kΩ
1203	120 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
PRC111	5.0 ±0.2	2.5 ±0.2	0.55 ±0.10	0.65 ±0.25	0.90 ±0.25

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range –55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

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Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)
4.13		short time overload	room temperature; dissipation 6.25 × 0.5 W; 5 s (voltage not more than 2 × V_{max})	ΔR/R max.: ±(1% +0.05 Ω)
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 2 mm	no visible damage ΔR/R max.: ±(1.0% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)
4.6.1.1		insulation resistance	200 V (DC) after 1 minute	R_{ins} min.: 10000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/–3% RH; loaded with 0.01 P_n	no visible damage ΔR/R max.: ±(1.5% +0.05 Ω)
4.25.1		endurance	1000 +48/–0 hours; 70 ±2 °C; nominal dissipation; 1.5 hours on, 0.5 hour off	no visible damage ΔR/R max.: ±(1.5% +0.05 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 1 Ω ≤ R < 4.99 Ω 5.1 Ω ≤ R < 9.76 Ω 10 Ω ≤ R < 1 MΩ 1 MΩ ≤ R < 10 MΩ	 ΔR/R max.: ±300 × 10^{-6}/K ΔR/R max.: ±200 × 10^{-6}/K ΔR/R max.: ±100 × 10^{-6}/K ΔR/R max.: ±200 × 10^{-6}/K

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/−0 hours; 40 ±2 °C; 93 +2/−3% RH; loaded with 1 W or V_{max}; 1.5 hours on, 0.5 hour off	no visible damage $\Delta R/R$ max.: ±(1% +0.05 Ω)

Power chip resistor size 2512

PRC221 1%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Power supplies
- Printers
- Computers
- Battery chargers
- Automotive
- Converters
- CD-ROM.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. To guarantee optimum solderability the outer layer consists of a lead-tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 Ω to 10 MΩ; E96 series
Resistance tolerance	±1%
Temperature coefficient:	
$1\ \Omega \leq R < 4.99\ \Omega$	$\leq \pm 300 \times 10^{-6}$/K
$5.1\ \Omega \leq R < 9.76\ \Omega$	$\leq \pm 200 \times 10^{-6}$/K
$10\ \Omega \leq R < 1\ M\Omega$	$\leq \pm 100 \times 10^{-6}$/K
$1\ M\Omega \leq R < 10\ M\Omega$	$\leq \pm 200 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70 °C	1 W
Maximum permissible voltage	250 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Operating temperature range	−55 °C to +125 °C
Basic specification	IEC 60115-8

Power chip resistor size 2512

PRC221 1%

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	TOL. (%)	SERIES	ORDERING CODE 2322 763 ..... BLISTER TAPE ON REEL 4000 units
PRC221	±1	E96	6....

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322 763; see Table 1.
- The subsequent digit indicates the resistor type and packaging.
- The remaining digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 kΩ	4
1 to 9.76 MΩ	5
10 MΩ	6

ORDERING EXAMPLE

The ordering code of a PRC221 resistor, value 4.02 kΩ with 1% tolerance, supplied on blister tape of 4 000 units per reel is: 2322 763 64022.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96 series for resistors with a tolerance of ±1%.
The values of the E96 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
PRC221	250	1

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

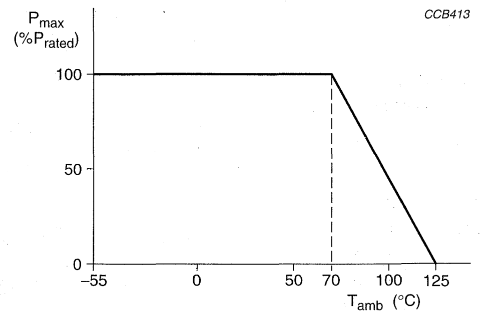


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
PRC221	4.25

Marking

Each resistor is marked with the nominal resistance value.

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

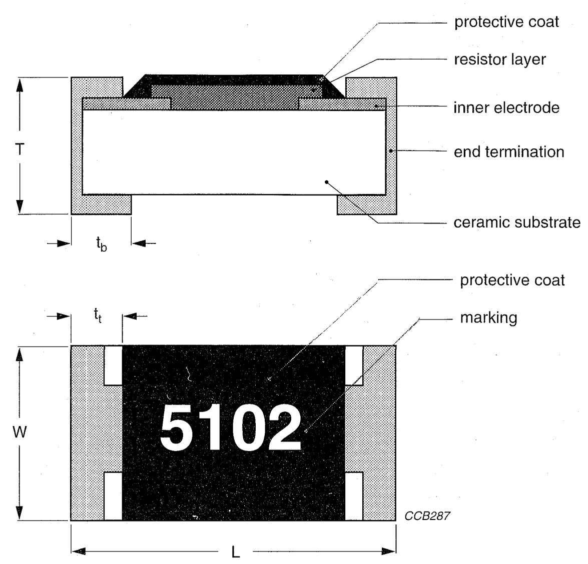
Example

MARKING	RESISTANCE
121R	121 Ω
4021	4.02 kΩ
1503	150 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
PRC221	6.4 ±0.2	3.1 ±0.2	0.55 ±0.10	0.65 ±0.25	1.3 ±0.25

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range −55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions in accordance with *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±(0.5% + 0.05 Ω)
4.13		short time overload	room temperature; dissipation 6.25 × P_n; 5 s (voltage not more than 2 × V_{max})	ΔR/R max.: ±(1% + 0.05 Ω)
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 2 mm	no visible damage ΔR/R max.: ±(0.5% + 0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±(0.5% + 0.05 Ω)
4.6.1.1		insulation resistance	250 V (DC) after 1 minute	R_{ins} min.: 10000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01 P_n	no visible damage ΔR/R max.: ±(1.5% + 0.05 Ω)
4.25.1		endurance	1000 +48/−0 hours; 70 ±2 °C; nominal dissipation; 1.5 hours on, 0.5 hour off	no visible damage ΔR/R max.: ±(1.5% + 0.05 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 1 Ω ≤ R < 4.99 Ω 5.1 Ω ≤ R < 9.76 Ω 10 Ω ≤ R < 1 MΩ 1 MΩ ≤ R < 10 MΩ	 ΔR/R max.: ±300 × 10^{-6}/K ΔR/R max.: ±200 × 10^{-6}/K ΔR/R max.: ±100 × 10^{-6}/K ΔR/R max.: ±200 × 10^{-6}/K

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH loaded with 1 W or V_{max}; 1.5 hours on, 0.5 hour off	no visible damage ΔR/R max.: ±(1% + 0.05 Ω)

Power chip resistor size 2512

PRC221 5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Power supplies
- Printers
- Computers
- Battery chargers
- Automotive
- Converters
- CD-ROM.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. To guarantee optimum solderability the outer layer consists of a lead-tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 Ω to10 MΩ; jumper E24 series
Resistance tolerance	5%; 2%
Temperature coefficient:	
$1\ \Omega \leq R < 4.99\ \Omega$	$\leq\pm300 \times 10^{-6}$/K
$5.1\ \Omega \leq R < 9.76\ \Omega$	$\leq\pm200 \times 10^{-6}$/K
$10\ \Omega \leq R < 1\ M\Omega$	$\leq\pm100 \times 10^{-6}$/K
$1\ M\Omega \leq R < 10\ M\Omega$	$\leq\pm200 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70 °C	1 W
Maximum permissible voltage	250 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Operating temperature range	–55 °C to +125 °C
Basic specification	IEC 60115-8

Power chip resistor size 2512 PRC221 5%; 2%

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	TOL. (%)	SERIES	ORDERING CODE 2322 762 .....
			BLISTER TAPE ON REEL
			4000 units
PRC221	±5	E24	60...
	±2		80...
Jumper			
PRC221	–	–	90000

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322 762; see Table 1.
- The subsequent 2 digits indicates the resistor type and packaging
- The remaining digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.1 Ω	8
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 kΩ	2
10 to 91 kΩ	3
100 to 910 kΩ	4
1 to 9.1 MΩ	5
10 MΩ	6

ORDERING EXAMPLE

The ordering code of a PRC221 resistor, value 47 Ω with 5% tolerance, supplied on blister tape of 4000 units per reel is: 2322 762 60479.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of ±5% and ±2%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
PRC221	250	1

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

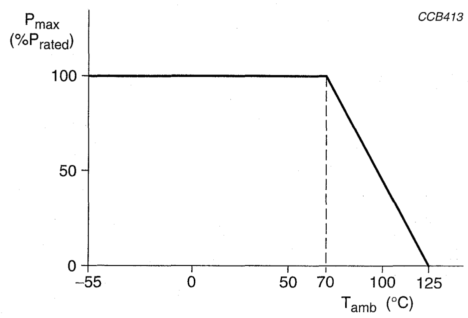


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
PRC221	4.25

Marking

Each resistor is marked with the nominal resistance value.

4-DIGIT MARKING

For values up to 910 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

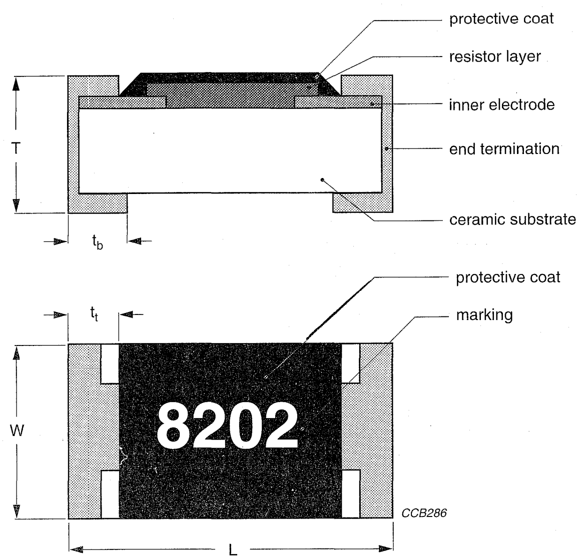
Example

MARKING	RESISTANCE
12R0	12 Ω
8202	82 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
PRC221	6.4 ±0.2	3.1 ±0.2	0.55 ±0.10	0.65 ±0.25	1.3 ±0.25

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range −55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions in accordance with *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±(0.5% + 0.05 Ω)
4.13		short time overload	room temperature; dissipation 6.25 × P_n; 5 s (voltage not more than 2 × V_{max})	ΔR/R max.: ±(1% + 0.05 Ω)
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 2 mm	no visible damage ΔR/R max.: ±(1% + 0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±(0.5% + 0.05 Ω)
4.6.1.1		insulation resistance	250 V (DC) after 1 minute	R_{ins} min.: 10000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01 P_n	no visible damage ΔR/R max.: ±(3% + 0.05 Ω)
4.25.1		endurance	1000 +48/−0 hours; 70 ±2 °C; nominal dissipation; 1.5 hours on, 0.5 hour off	no visible damage ΔR/R max.: ±(3% + 0.05 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 1 Ω ≤ R < 4.99 Ω 5.1 Ω ≤ R < 9.76 Ω 10 Ω ≤ R < 1 MΩ 1 MΩ ≤ R < 10 MΩ	 ΔR/R max.: ±300 × 10^{-6}/K ΔR/R max.: ±200 × 10^{-6}/K ΔR/R max.: ±100 × 10^{-6}/K ΔR/R max.: ±200 × 10^{-6}/K

Power chip resistor size 2512

PRC221 5%; 2%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 1 W or V_{max}; 1.5 hours on, 0.5 hour off	no visible damage ΔR/R max.: ±(2% + 0.05 Ω)

Low ohmic power chip resistors size 2512

PRC221 5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Converters
- Printers
- Computers
- Battery chargers
- Power supplies
- Automotive.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range; note 1	0.01 Ω to 0.99 Ω; E24
Resistance tolerance; note 1	±5%; ±2%
Temperature coefficient:	
$0.01\ \Omega \le R < 0.04\ \Omega$	$\pm 1500 \times 10^{-6}$/K
$0.04\ \Omega \le R < 0.10\ \Omega$	$\pm 600 \times 10^{-6}$/K
$0.10\ \Omega \le R < 0.20\ \Omega$	$\pm 300 \times 10^{-6}$/K
$0.20\ \Omega \le R < 0.50\ \Omega$	$\pm 150 \times 10^{-6}$/K
$0.50\ \Omega \le R < 0.99\ \Omega$	$\pm 75 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70 °C	1 W
Maximum permissible voltage	250 V (DC or RMS)
Operating temperature range	−55 to +125 °C
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

Note

1. Non-E24 values and special tolerances are available on request.

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2322 762 ..... BLISTER TAPE ON REEL 4000 units
PRC221	0.01 to 0.099 Ω	±5	90...
	0.1 to 0.99 Ω		60...
	0.01 to 0.099 Ω	±2	91...
	0.1 to 0.99 Ω		80...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322 762
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
0.01 to 0.099 Ω	0
0.1 to 0.99 Ω	7

ORDERING EXAMPLE

The ordering code of a PRC221 low ohmic power chip resistor, value 0.51 Ω with a tolerance of 5%, supplied on blister tape of 4000 units per reel is: 2322 762 60517.

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24 series for resistors with a tolerance of 5% or 2%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
PRC221	250	1.0

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

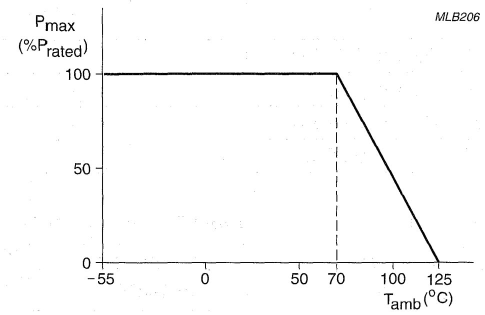


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
PRC221	1.0

Marking

Each resistor is marked with a 4-digit code on the protective coating to designate the nominal resistance value.

4-DIGIT MARKING

The R is used as a decimal point, the other 3 digits are significant

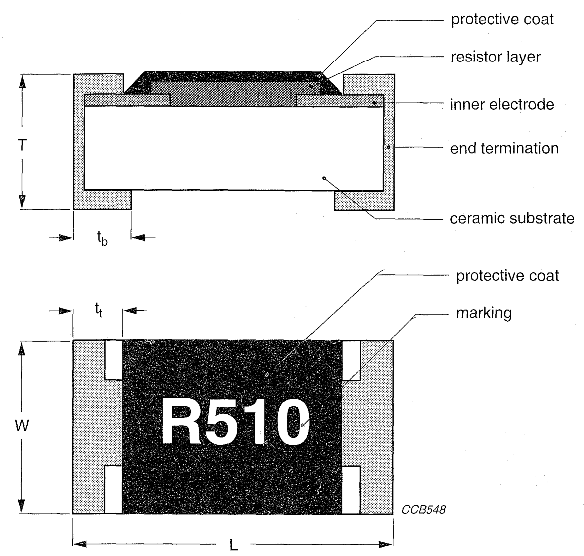
Example

MARKING	RESISTANCE
R010	0.01 Ω
R510	0.51 Ω

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
PRC221	6.4 ±0.20	3.2 ±0.20	0.55 ±0.10	0.65 ±0.25	1.3 ±0.25

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range −55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.5		resistance	applied voltage (+0/−10%): 0.1 V	$R - R_{nom}$: max. ±5%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±1%
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H_2O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.7		voltage proof on insulation	200 V (DC or RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation 6.25 × P_n; 5 s (voltage not more than 2 × V_{max})	ΔR/R max.: ±2%
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 2 mm	no visible damage ΔR/R max.: ±1%
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±1%
4.6.1.1		insulation resistance	250 V (DC) after 1 minute	R_{ins} min.: 10000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01 P_n	no visible damage ΔR/R max.: ±3%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.25.1		endurance	1000 +48/–0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	no visible damage ΔR/R max.: ±3%
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/–0 hours; 125 °C; no load	no visible damage ΔR/R max.: ±3%
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 0.01 Ω ≤ R < 0.04 Ω 0.04 Ω ≤ R < 0.10 Ω 0.10 Ω ≤ R < 0.20 Ω 0.20 Ω ≤ R < 0.50 Ω 0.50 Ω ≤ R < 0.99 Ω	 $\pm1500 \times 10^{-6}$/K $\pm600 \times 10^{-6}$/K $\pm300 \times 10^{-6}$/K $\pm150 \times 10^{-6}$/K $\pm75 \times 10^{-6}$/K
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/–0 hours; 40 ±2 °C; 93 +2/–3% RH; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±3%

Low ohmic chip resistors size 1206

LRC01 5%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Excellent performance at high frequency.

APPLICATIONS

- Battery loaders
- Power supplies in small sized equipment
- Car telephones
- Portable stereo equipment.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range; note 1	0.02 Ω to 0.99 Ω; E24 series
Resistance tolerance	±5%
Temperature coefficient:	
$0.02\ \Omega \leq R < 0.04\ \Omega$	$\leq \pm 1500 \times 10^{-6}$/K
$0.04\ \Omega \leq R < 0.10\ \Omega$	$\leq \pm 600 \times 10^{-6}$/K
$0.10\ \Omega \leq R < 0.20\ \Omega$	$\leq \pm 300 \times 10^{-6}$/K
$0.20\ \Omega \leq R < 0.50\ \Omega$	$\leq \pm 150 \times 10^{-6}$/K
$0.50\ \Omega \leq R < 0.99\ \Omega$	$\leq \pm 75 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.25 W
Maximum permissible voltage	200 V (DC or RMS)
Operating temperature range	−55 to +125 °C
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

Note

1. Non E24 values are available on request.

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 510 ..... PAPER TAPE ON REEL 5000 units
LRC01	20 mΩ to 990 mΩ	±5	10...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 510
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
0.01 to 0.099 Ω	0
0.1 to 0.99 Ω	7

Ordering example

The ordering code of a LRC01 resistor, value 0.47 Ω, supplied on paper tape of 5000 units per reel is: 2350 510 10477.

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24 series for resistors with a tolerance of ±5%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
LRC01	200	0.25

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

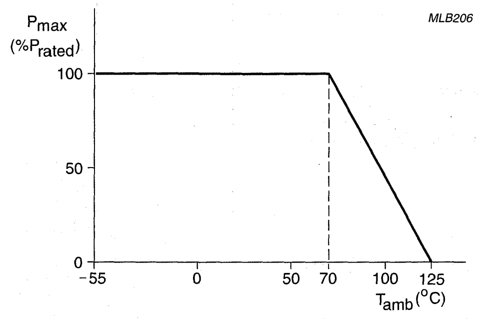


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

Temperature coefficient

Figure 2 shows the typical temperature coefficient of the resistor.

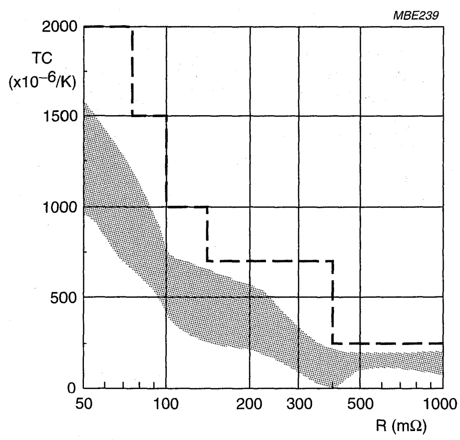


Fig.2 Typical TC as a function of resistance.

Low ohmic chip resistors size 1206 LRC01 5%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
LRC01	1

Marking

Each resistor is marked with a 4-digit code on the protective coating to designate the nominal resistance value.

4-DIGIT MARKING

The R is used as a decimal point.

Magnitude indicators

RESISTANCE	INDICATOR
20 mΩ to 990 mΩ	R

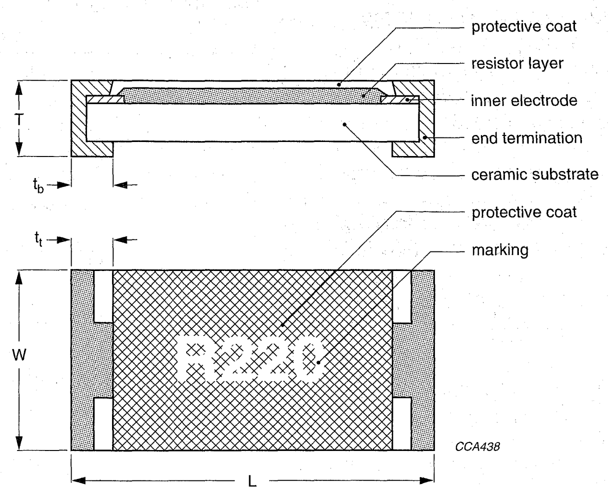
Example

MARKING	RESISTANCE
R210	0.210 Ω
R560	0.560 Ω

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.3 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.3

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
LRC01	3.20 +0.10/−0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range −55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.4.2		dimensions (outline)	gauge	0.45 mm ≤ T ≤ 0.65 mm 1.45 mm ≤ W ≤ 1.75 mm 3.0 mm ≤ L ≤ 3.3 mm
4.5		resistance	applied voltage (+0/−10%): 0.1 V	$R - R_{nom}$: max. ±5%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	ΔR/R max.: ±1%
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H_2O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.7		voltage proof on insulation	200 V (RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation 6.25 × P_n; 5 s (voltage not more than 2 × V_{max})	ΔR/R max.: ±1%
	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage ΔR/R max.: ±1%
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±1%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 1000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/–3% RH; loaded with 0.01 P_n	no visible damage ΔR/R max.: ±3%
4.25.1		endurance	1000 +48/–0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	no visible damage ΔR/R max.: ±3%
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/–0 hours; 125 °C; no load	no visible damage ΔR/R max.: ±3%
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 0.02 Ω ≤ R < 0.04 Ω 0.04 Ω ≤ R < 0.10 Ω 0.10 Ω ≤ R < 0.20 Ω 0.20 Ω ≤ R < 0.50 Ω 0.50 Ω ≤ R < 0.99 Ω	 ≤±1500 × 10^{-6}/K ≤±600 × 10^{-6}/K ≤±300 × 10^{-6}/K ≤±150 × 10^{-6}/K ≤±75 × 10^{-6}/K
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/–0 hours; 40 ±2 °C; 93 +2/–3% RH; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±3%

Low ohmic chip resistors size 1206

LRC02 1%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Low inductance design for current sensing applications.

APPLICATIONS

- Television
- Telecommunication
- Portable computers
- Battery chargers
- Lighting.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	0.02 Ω to 0.99 Ω; E96 series
Resistance tolerance	±1%
Temperature coefficient:	
$0.02\ \Omega \leq R < 0.04\ \Omega$	$\pm 1500 \times 10^{-6}$/K
$0.04\ \Omega \leq R < 0.10\ \Omega$	$\pm 600 \times 10^{-6}$/K
$0.10\ \Omega \leq R < 0.20\ \Omega$	$\pm 300 \times 10^{-6}$/K
$0.20\ \Omega \leq R < 0.50\ \Omega$	$\pm 150 \times 10^{-6}$/K
$0.50\ \Omega \leq R < 0.99\ \Omega$	$\pm 75 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.25 W
Maximum permissible voltage	200 V (DC or RMS)
Operating temperature range	–55 to +125 °C
Climatic category (IEC 60068)	55/155/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 510 ..... PAPER TAPE ON REEL 5000 units
LRC02	0.02 to 0.99 Ω	±1	12...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 510
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
0.02 to 0.099 Ω	0
0.1 to 0.99 Ω	7

Ordering example

The ordering code of a LRC02 resistor, value 0.47 Ω, supplied on paper tape of 5000 units per reel is: 2350 510 12477.

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E96 series for resistors with a tolerance of 1%. The values of the E96 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
LRC02	200	0.25

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

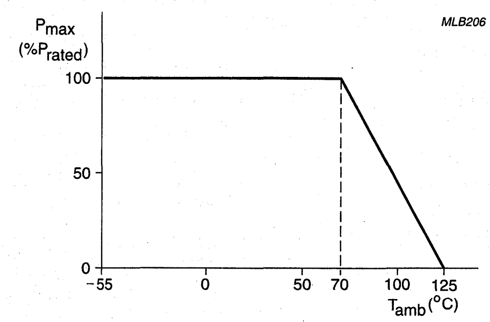


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
LRC02	1.0

Marking

Each resistor is marked with a 4-digit code on the protective coating to designate the nominal resistance value.

4-DIGIT MARKING

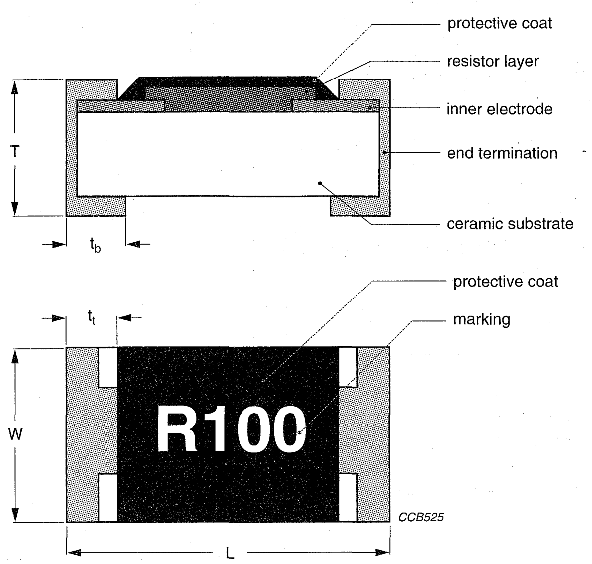
The R is used as a decimal point, the other 3 digits are significant

Example

MARKING	RESISTANCE
R220	0.220 Ω
R100	0.100 Ω
R040	0.040 Ω

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
LRC02	3.2 +0.1/−0.2	1.6 ±0.15	0.60 ±0.10	0.45 ±0.25	0.50 ±0.25

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range −55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.5		resistance	applied voltage (+0/−10%): 0.1 V	$R - R_{nom}$: max. ±5%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±1%
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H_2O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.7		voltage proof on insulation	200 V (DC or RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation 6.25 × P_n; 5 s (voltage not more than 2 × V_{max})	ΔR/R max.: ±1%
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage ΔR/R max.: ±1%
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±1%
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 10000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01 P_n	no visible damage ΔR/R max.: ±3%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.25.1		endurance	1000 +48/–0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	no visible damage ΔR/R max.: ±3%
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/–0 hours; 125 °C; no load	no visible damage ΔR/R max.: ±3%
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 0.02 Ω ≤ R < 0.04 Ω 0.04 Ω ≤ R < 0.10 Ω 0.10 Ω ≤ R < 0.20 Ω 0.20 Ω ≤ R < 0.50 Ω 0.50 Ω ≤ R < 0.99 Ω	 $\pm1500 \times 10^{-6}$/K $\pm600 \times 10^{-6}$/K $\pm300 \times 10^{-6}$/K $\pm150 \times 10^{-6}$/K $\pm75 \times 10^{-6}$/K
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/–0 hours; 40 ±2 °C; 93 +2/–3% RH; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±3%

Low ohmic chip resistors size 0805

LRC11 5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Low inductance design for current sensing applications.

APPLICATIONS

- Television
- Telecommunication equipment
- Portable computers
- Battery chargers
- Lighting.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	0.02 Ω to 0.99 Ω; E24 series
Resistance tolerance	±5%; ±2%
Temperature coefficient:	
$0.02\ \Omega \le R < 0.04\ \Omega$	$\pm 1500 \times 10^{-6}$/K
$0.04\ \Omega \le R < 0.10\ \Omega$	$\pm 600 \times 10^{-6}$/K
$0.10\ \Omega \le R < 0.20\ \Omega$	$\pm 300 \times 10^{-6}$/K
$0.20\ \Omega \le R < 0.50\ \Omega$	$\pm 150 \times 10^{-6}$/K
$0.50\ \Omega \le R < 0.99\ \Omega$	$\pm 75 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.125 W
Maximum permissible voltage	150 V (DC or RMS)
Operating temperature range	−55 to +125 °C
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

Note

1. Non-E24 values and special tolerances are available on request.

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 511 ..... PAPER TAPE ON REEL 5000 units
LRC11	$0.02\ \Omega \le R < 1\ \Omega$	±5	10...
		±2	11...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 511
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
0.020 to 0.099 Ω	0
0.10 to 0.99 Ω	7

Ordering example

The ordering code of a LRC11 low ohmic resistor, value 0.47 Ω with a 2% tolerance, supplied on paper tape of 5000 units per reel is: 2350 511 11477.

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24 series for resistors with a tolerance of ±5% or 2%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
LRC11	150	0.125

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

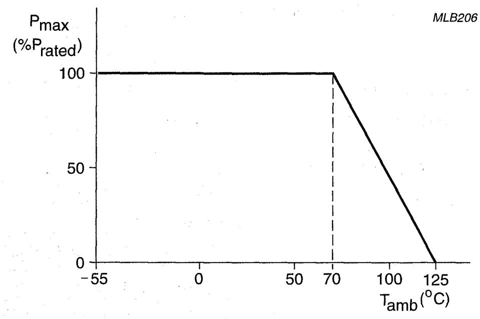


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
LRC01	0.55

Marking

Each resistor is marked with a 4-digit code on the protective coating to designate the nominal resistance value.

4-DIGIT MARKING

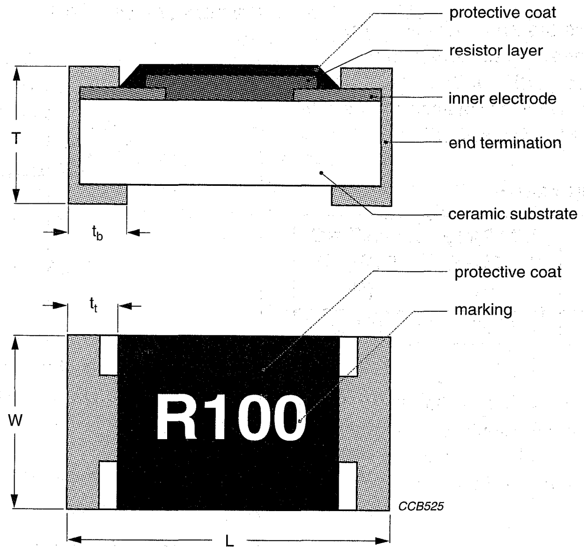
The R is used as a decimal point.

Example

MARKING	RESISTANCE
R220	0.220 Ω
R100	0.100 Ω
R040	0.040 Ω

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
LRC11	2.0 ±0.15	1.25 ±0.15	0.55 ±0.10	0.40 ±0.20	0.40 ±0.20

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range –55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.5		resistance	applied voltage (+0/–10%): 0.1 V	$R - R_{nom}$: max. ±5%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage $\Delta R/R$ max.: ±1%
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H_2O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.7		voltage proof on insulation	150 V (DC or RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: ±1%
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage $\Delta R/R$ max.: ±1%
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: ±1%
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 10000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/–3% RH; loaded with 0.01 P_n	no visible damage $\Delta R/R$ max.: ±3%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.25.1		endurance	1000 +48/−0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	no visible damage $\Delta R/R$ max.: ±3%
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/−0 hours; 125 °C; no load	no visible damage $\Delta R/R$ max.: ±3%
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: $0.02\ \Omega \leq R < 0.04\ \Omega$ $0.04\ \Omega \leq R < 0.10\ \Omega$ $0.10\ \Omega \leq R < 0.20\ \Omega$ $0.20\ \Omega \leq R < 0.50\ \Omega$ $0.50\ \Omega \leq R < 0.99\ \Omega$	 $\pm 1500 \times 10^{-6}$/K $\pm 600 \times 10^{-6}$/K $\pm 300 \times 10^{-6}$/K $\pm 150 \times 10^{-6}$/K $\pm 75 \times 10^{-6}$/K
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching

High ohmic chip resistors size 1206

HRC01 5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- High maximum permissible voltage.

APPLICATIONS

- Measuring equipment
- Telecommunication
- Computers
- Television.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	11 to 100 MΩ; E24 series
Resistance tolerance	±2%; ±5%
Temperature coefficient	$\pm 250 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.25 W
Maximum permissible voltage	200 V (DC or RMS)
Operating temperature range	−55 to +125 °C
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 520 ..... PAPER TAPE ON REEL 5000 units
HRC01	11 to 100 MΩ	±5	10... (91001 for 100 MΩ)
		±2	11... (92001 for 100 MΩ)

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 520
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
11 to 100 MΩ	6

Ordering example

The ordering code of a HRC01 high ohmic resistor, value 30 MΩ, supplied on paper tape of 5000 units per reel is: 2350 520 10306.

High ohmic chip resistors size 1206

HRC01 5%; 2%

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24 series for resistors with a tolerance of 2% or 5%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
HRC01	200	0.25

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

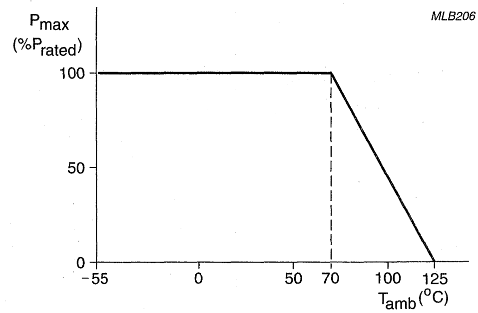


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
HRC01	1.0

Marking

Each resistor is marked with a 3-digit code on the protective coating to designate the nominal resistance value.

3-DIGIT MARKING

For values of 11 MΩ or greater the first 2 digits apply to the resistance value and the third is a 6, as an indication of magnitude.

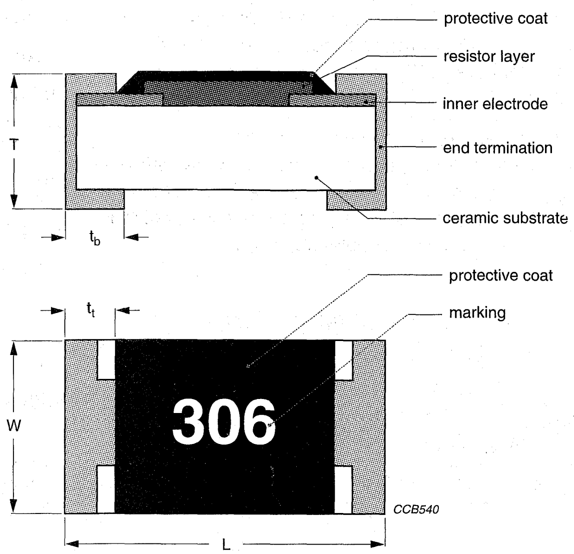
Example

MARKING	RESISTANCE
306	30 MΩ
107	100 MΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
HRC01	3.2 +0.1/−0.2	1.60 ±0.15	0.60 ±0.10	0.45 ±0.25	0.50 ±0.25

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range −55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.5		resistance	applied voltage (+0/−10%): 0.1 V	$R - R_{nom}$: max. ±5%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage $\Delta R/R$ max.: ±(0.2% +0.1 Ω)
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 125 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.7		voltage proof on insulation	500 V (RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation 6.25 × P_n; 5 s (voltage not more than 400 V)	$\Delta R/R$ max.: ±(3% +0.1 Ω)
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 3 mm	no visible damage $\Delta R/R$ max.: ±(1% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: ±(3.0% +0.1 Ω)
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 10000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01 P_n	no visible damage $\Delta R/R$ max.: ±(5% +0.1 Ω)
4.25.1		endurance	1000 +48/−0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: ±(3% +0.1 Ω)

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.23.2	27 (Ba)	endurance at upper category temperature	1 000 +48/–0 hours; 125 °C; no load	no visible damage ΔR/R max.: ±(3% +0.1 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	$\pm 250 \times 10^{-6}$/K
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning (≥95% covered); no leaching

High ohmic chip resistors size 0805

HRC11 5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Power supplies in small equipment
- Digital multimeter
- Telecommunication
- Computers
- Automotive industry
- Medical and military equipment.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	11 to 100 MΩ; E24 series
Resistance tolerance	±5%; ±2%;
Temperature coefficient	$\pm 300 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.125 W
Maximum permissible voltage	150 V (DC or RMS)
Operating temperature range	−55 to +125 °C
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 521 ..... PAPER TAPE ON REEL 5000 units
HRC11	11 to 100 MΩ	±5	10... (91001 for 100 MΩ)
		±2	11... (92001 for 100 MΩ)

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 521
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
11 to 100 MΩ	6

ORDERING EXAMPLE

The ordering code of a HRC11 high ohmic resistor, value 30 MΩ with a tolerance of ±5%, supplied on paper tape of 5000 units per reel is: 2350 521 10306.

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24 series for resistors with a tolerance of 2% or 5%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE[1] (V)	LIMITING POWER (W)
HRC11	150	0.125

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

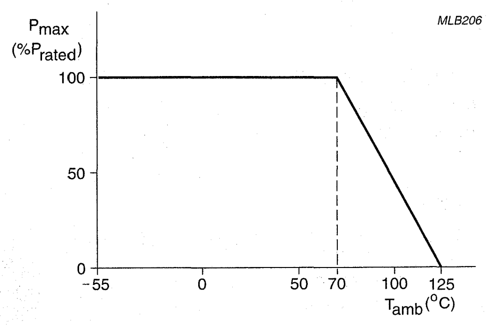


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
HRC11	0.55

Marking

Each resistor is marked with a 3-digit code on the protective coating to designate the nominal resistance value.

3-DIGIT MARKING

For values of 11 MΩ or greater the first 2 digits apply to the resistance value and the third is a 6 or 7, as an indication of magnitude.

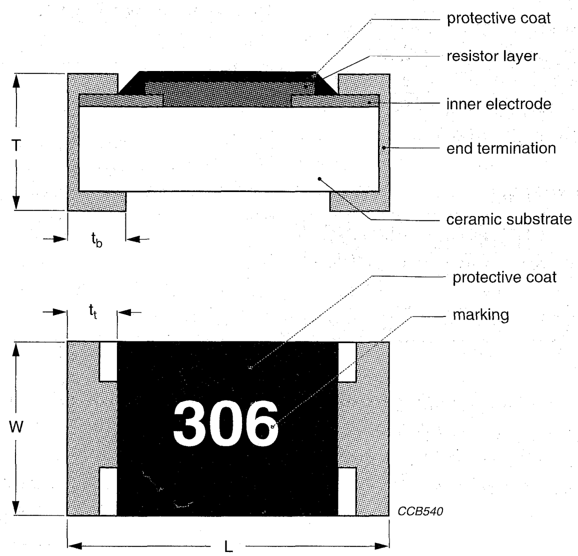
Example

MARKING	RESISTANCE
306	30 MΩ
107	100 MΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
HRC11	2.0 ±0.15	1.25 ±0.15	0.55 ±0.10	0.40 ±0.20	0.40 ±0.20

High ohmic chip resistors size 0805

HRC11 5%; 2%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/125/56 (rated temperature range –55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.5		resistance	applied voltage (+0/–10%): 0.1 V	$R - R_{nom}$: max. ±5%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H_2O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.7		voltage proof on insulation	150 V (RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	ΔR/R max.: ±(1% +0.05 Ω)
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage ΔR/R max.: ±(1% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 10000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/–3% RH; loaded with 0.01 P_n	no visible damage ΔR/R max.: ±(1.5% +0.05 Ω)

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.25.1		endurance	1000 +48/–0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(3% +0.1 Ω)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/–0 hours; 125 °C; no load	no visible damage ΔR/R max.: ±(1.5% +0.05 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	300×10^{-6}/K
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching

High ohmic chip resistors size 0603

HRC21 5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Power supplies in small equipment
- Telecommunication
- Computers
- Automotive industry
- Medical and military equipment.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	11 to 22 MΩ; E24 series
Resistance tolerance	±5%; ±2%
Temperature coefficient	$\pm300 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.063 W
Maximum permissible voltage	50 V (DC or RMS)
Operating temperature range	−55 to +155 °C
Climatic category (IEC 60068)	55/155/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 522 ..... PAPER TAPE ON REEL 5000 units
HRC21	11 to 22 MΩ	±5	10...
		±2	11...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 522
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
11 to 22 MΩ	6

Ordering example

The ordering code of a HRC21 high ohmic resistor, value 12 MΩ, supplied on paper tape of 5000 units per reel is: 2350 522 10126.

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24 series for resistors with a tolerance of 2% or 5%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
HRC21	50	0.063

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

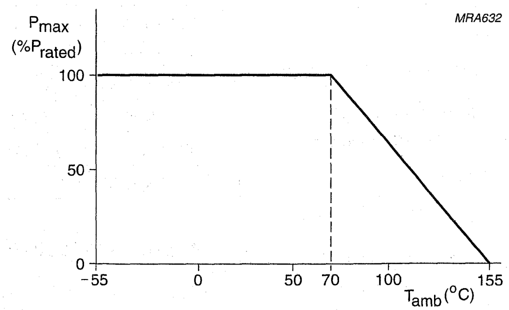


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
HRC21	0.25

Marking

Each resistor is marked with a 3-digit code on the protective coating to designate the nominal resistance value.

3-DIGIT MARKING

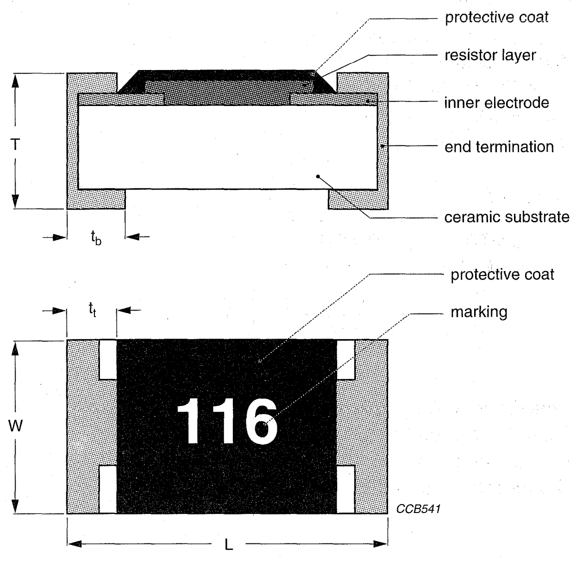
For values of 11 MΩ or greater the first 2 digits apply to the resistance value and the third is a 6, as an indication of magnitude.

Example

MARKING	RESISTANCE
116	11 MΩ
156	15 MΩ

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
HRC21	1.6 ±0.10	0.8 +0.15/−0.05	0.45 ±0.10	0.30 ±0.20	0.30 ±0.20

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/155/56 (rated temperature range –55 to +155 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.5		resistance	applied voltage (+0/–10%): 0.1 V	$R - R_{nom}$: max. ±5%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage $\Delta R/R$ max.: ±(0.5% +0.05 Ω)
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.7		voltage proof on insulation	100 V (RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: ±(1% +0.05 Ω)
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage $\Delta R/R$ max.: ±(1% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: ±(0.5% +0.05 Ω)
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 10000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/–3% RH; loaded with 0.01 P_n	no visible damage $\Delta R/R$ max.: ±(3% +0.1 Ω)
4.25.1		endurance	1000 +48/–0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: ±(3% +0.1 Ω)

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/–0 hours; 155 °C; no load	no visible damage ΔR/R max.: ±(3% +0.1 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	$\pm 300 \times 10^{-6}$/K
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching

Trimmable chip resistors sizes 1206 and 0805

RC02TR RC12TR

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Specific electrical requirements (such as HF characteristics).

APPLICATIONS

This trimmable chip-resistor is suitable for the whole electronic industry and can replace trimmer resistors in several applications.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and a connection is made between them using a resistive metal glaze; the approximate resistor values are dependent on the composition of the glaze.

The resistive layer is covered with a translucent protective coat. Finally, two end electrodes are added, the composition of which has been designed to provide ease of soldering.

QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	RC02TR	RC12TR
Resistance range	1 Ω to 10 MΩ; E24 series	
Resistance tolerance	0/–20% and 0/–30%	
Temperature coefficient:		
$1\ \Omega \leq R < 10\ \Omega$	$\leq 250 \pm 250 \times 10^{-6}$/K	
$10\ \Omega \leq R \leq 1\ M\Omega$	$\leq \pm 100 \times 10^{-6}$/K	
$1\ M\Omega < R$	$\leq \pm 200 \times 10^{-6}$/K	
Absolute maximum dissipation at T_{amb} = 70 °C	0.25 W	0.125 W
Maximum permissible voltage	200 V (RMS)	150 V (RMS)
Climatic category (IEC 60068)	55/155/56	
Basic specification	IEC 60115-8	

ORDERING INFORMATION

Ordering code (12NC)

The resistors have a 12-digit catalogue number starting with 2350 50. The subsequent digits indicate the packaging and resistance value; see Table 1.

Table 1 Ordering code indicating resistor type and packaging

TYPE	TOL. (%)	ORDERING CODE 2350 50. 1....	
		RC02TR	RC12TR
		PAPER TAPE ON REEL	
		5000 units	5000 units
RC02TR/RC12TR	+0/–30	500 11...	501 11...
	+0/–20	500 10...	501 10...

Trimmable chip resistors sizes 1206 and 0805

RC02TR RC12TR

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of 0/–20% and 0/–30%.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
RC02TR	200	0.25
RC12TR	150	0.125

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

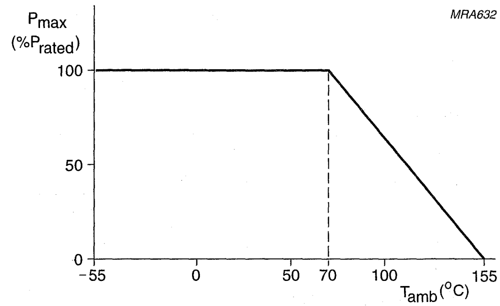


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

Application information

TRIMMING INSTRUCTIONS WITH YAG-LASER

Typical values for:

Cutting speed = 10 to 300 mm/s

Laser power = 1 to 6 W

Maximum trimming length = 60% of resistor film width

Minimum distance between end termination and trimming cut = 0.50 mm.

PROTECTION OF LASER CUT

With epoxy-phenol lacquers, epoxy resins or silicon alkyd-resins.
This is necessary for humidity tests and stability at load.

MECHANICAL DATA

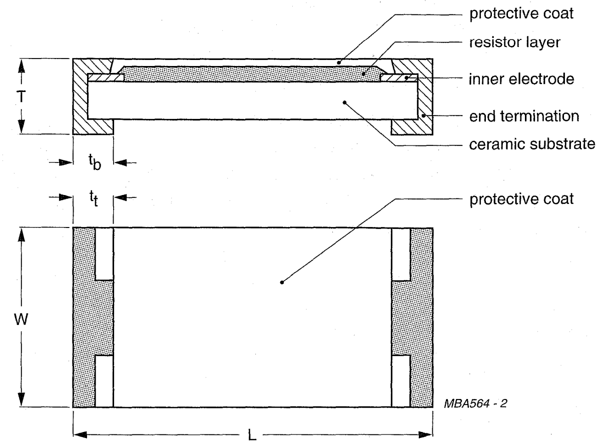
Mass per 100 units

TYPE	MASS (g)
RC02TR	1
RC12TR	0.55

Marking

The resistor is not marked. The packaging is marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 2.

Fig.2 Outlines.

Table 2 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
RC02TR	3.20 +0.10/−0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25
RC12TR	3.20 ±0.15	1.25 ±0.15	0.55 ±0.10	0.45 ±0.20	0.50 ±0.20

Trimmable chip resistors sizes 1206 and 0805 RC02TR RC12TR

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/155/56 (rated temperature range −55 to +155 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions in accordance with *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 3 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 3 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	10 ±1 s; 260 ±5 °C	ΔR/R max.: ±(0.5% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	ΔR/R max.: ±(0.5% +0.05 Ω)
		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm for **RC0TR**, 5 mm for **RC12TR**	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2°C; 93 +2/−3% RH; loaded with 0.01 P_n: R ≤ 1 MΩ R > 1 MΩ	 ΔR/R max.: ±(1.0% +0.05 Ω) ΔR/R max.: ±(1.5% +0.05 Ω)
4.25.1		endurance	1000 +48/−0 hours; 70 ±2 °C; nominal dissipation; 1.5 hours on and 0.5 hours off: R ≤ 1 MΩ R > 1 MΩ	 ΔR/R max.: ±(1% +0.05 Ω) ΔR/R max.: ±(1.5% +0.05 Ω)
4.6.1.1		insulation resistance	100 V (DC) after 1 minute, metal block method	R_{ins} min.: 10^3 MΩ
4.13		short time overload	room temperature; P = 6.25 × P_n; 5 s (V ≤ 2 × V_{max} for **RC02TR**, V ≤ 200 V for **RC12TR**)	ΔR/R max.: ±(1% +0.05 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 1 Ω ≤ R ≤ 10 Ω 10 Ω ≤ R ≤ 1 MΩ 1 MΩ < R	 ≤250 ±250 × 10^{-6}/K ≤±100 × 10^{-6}/K ≤ t±200 × 10^{-6}/K

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.12		noise	IEC publication 60195 (measured with Quantech-equipment):	
			$R \leq 100\ \Omega$	max. 0.316 μV/V (−10 dB)
			$R \leq 1\ k\Omega$	max. 1 μV/V (0 dB)
			$R \leq 10\ k\Omega$	max. 3 μV/V (9.54 dB)
			$R \leq 100\ k\Omega$	max. 6 μV/V (15.56 dB)
			$R \leq 1\ M\Omega$	max. 10 μV/V (20 dB)
			$R \leq 10\ M\Omega$	max. 32 μV/V (30.10 dB)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/−0 hours; no load:	
			$R \leq 1\ M\Omega$	$\Delta R/R$ max.: ±(1% +0.05 Ω)
			$R > 1\ M\Omega$	$\Delta R/R$ max.: ±(1.5% +0.05 Ω)
4.7		voltage proof on insulation	200 V (RMS) during 1 minute	no breakdown

Trimmable chip resistor size 0603

RC22TR

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Improved performance at high frequency
- Low noise, when not trimmed.

APPLICATIONS

- Hand-held measuring equipment
- Mobile phones
- Camcorders
- Portable radios, CD and cassette players
- Tuners
- Photo sensors.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and a connection is made between them using a resistive metal glaze; the approximate resistor values are dependent on the composition of the glaze.

The resistive layer is covered with a translucent protective coat. Finally, two end electrodes are added, the composition of which has been designed to provide ease of soldering.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 Ω to 10 MΩ; E24 series
Resistance tolerance	0/–20% and 0/–30%
Temperature coefficient:	
$R \leq 10\ \Omega$	0 to 500×10^{-6}/K
$10\ \Omega < R \leq 1\ M\Omega$	$\leq \pm 100 \times 10^{-6}$/K
$1\ M\Omega < R$	$\leq \pm 200 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.063 W
Maximum permissible voltage	50 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	TOL. (%)	RESISTANCE VALUE	ORDERING CODE 2350 502 ..... PAPER TAPE ON REEL 5000 units
RC22TR	0/–20	1 Ω to 10 MΩ	11...
	0/–30		10...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 502; see Table 1.
- The subsequent digit indicates the resistor type and packaging.
- The remaining digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.1 Ω	8
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 kΩ	2
10 to 91 kΩ	3
100 to 910 kΩ	4
1 to 9.1 MΩ	5
10 MΩ	6

Ordering example

The ordering code of a RC22TR resistor, value 330 Ω, 0/–30%, supplied on paper tape of 5000 units per reel is: 2350 502 10331

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of 0/–20% and 0/–30%.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
RC22TR	50	0.063

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

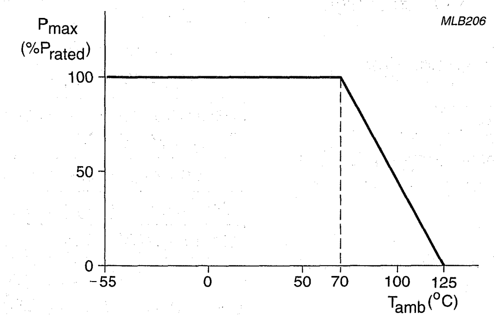


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

Application information

TRIMMING INSTRUCTIONS WITH YAG-LASER

Typical values for:

Cutting speed = 10 to 300 mm/s

Laser power = 1 to 6 W

Maximum trimming length = 60% of resistor film width

Minimum distance between end termination and trimming cut = 0.20 mm.

PROTECTION OF LASER CUT

With epoxy-phenol lacquers, epoxy resins or silicon alkyd-resins.
This is necessary for humidity tests and stability at load.

Trimmable chip resistor size 0603

RC22TR

MECHANICAL DATA

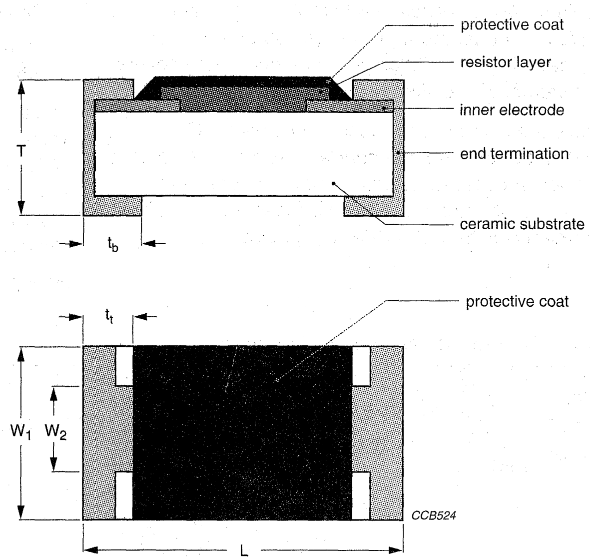
Mass per 100 units

TYPE	MASS (g)
RC22TR	0.25

Marking

The resistor is not marked. The packaging is marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W_1 (mm)	W_2 (mm)	T (mm)	t_t (mm)	t_b (mm)
RC22TR	1.6 ±0.10	0.8 +0.15/−0.05	0.7	0.45 ±0.10	0.30 ±0.15	0.30 ±0.15

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/155/56 (rated temperature range −55 to +155 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions in accordance with *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	ΔR/R max.: ±(1.0% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	ΔR/R max.: ±(1.0% +0.05 Ω)
	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage ΔR/R max.: ±(1.0% +0.05 Ω)
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01 P_n R < 1 MΩ R > 1 MΩ	R_{ins} min.: 10000 MΩ ΔR/R max.: ±(1.0% +0.05 Ω) ΔR/R max.: ±(1.5% +0.05 Ω)
4.25.1		endurance	1000 +48/−0 hours; 70 ±2 °C; nominal dissipation; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(1.0% +0.05 Ω)
4.6.1.1		insulation resistance	50 V (DC) after 1 minute	R_{ins} min.: 10000 MΩ
4.13		short time overload	room temperature; dissipation 6.25 × P_n; 5 s (voltage not more than 2 × V_{max})	ΔR/R max.: ±(1.0% +0.05 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 and 20/UCT/20 R ≤ 10 Ω 10 Ω < R ≤ 1 MΩ 1 MΩ < R	 0 to 500 × 10^{-6}/K ≤±100 × 10^{-6}/K ≤±200 × 10^{-6}/K

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.12		noise	IEC publication 60195 (measured with Quantech-equipment) $R \leq 100\ \Omega$ $100\ \Omega < R \leq 1\ k\Omega$ $1\ k\Omega < R \leq 10\ k\Omega$ $10\ k\Omega < R \leq 100\ k\Omega$ $100\ k\Omega < R \leq 1\ M\Omega$ $1\ M\Omega < R$	 max. 0.316 µV/V (–10 dB) max. 1 µV/V (0 dB) max. 3 µV/V (9.54 dB) max. 6 µV/V (15.56 dB) max. 10 µV/V (20 dB) max. 32 µV/V (30.10 dB)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/–0 hours; 125 °C; no load	no visible damage ΔR/R max.: ±(1.0% +0.05 Ω)
4.7		voltage proof on insulation	50 V (DC or RMS) during 1 minute	no breakdown

Fusible chip resistor size 1206

FRC01 5%

FEATURES

- Overload protection without the risk of fire
- Grey coating for ease of recognition
- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Power supplies in small sized equipment
- Car telephones
- Portable radio, CD and cassette players.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coat and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

To enable recognition of a fusible device, the resistor should be mounted face up.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 to 510 Ω; E24/E96 series
Resistance tolerance	±5%
Temperature coefficient:	
1 to 4.7 Ω	≤±250 × 10^{-6}/K
5.1 to 510 Ω	≤±200 × 10^{-6}/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.125 W
Maximum permissible voltage	200 V (DC or RMS)
Operating temperature range	−55 °C to +125 °C
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	ORDERING CODE 2322 750 ..... PAPER TAPE ON REEL 5000 units
FRC01	6....

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322
- The subsequent 4 digits indicate the resistor type and packaging; see Table 1.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 240 Ω	1

ORDERING EXAMPLE

The ordering code of a FRC01 resistor, value 200 Ω, packed in paper tape and supplied on a reel of 5000 units is: 2322 750 62001.

Fusible chip resistor size 1206

FRC01 5%

FUNCTIONAL DESCRIPTION

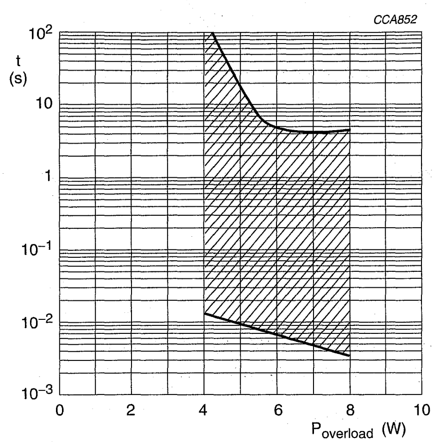
Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of ±5%. The values of the E24/E96 series are in accordance with *"IEC publication 60063"*.

Fusing characteristics

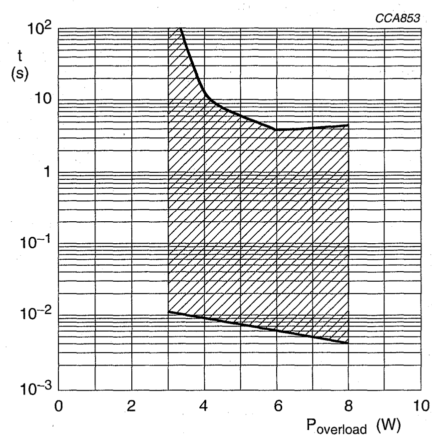
The resistors will fuse without the risk of fire and within an indicated range of overload. Fusing means that the resistive value of the resistor increases at least 100 times; see Figs 1 and 2.

The fusing characteristic is measured under constant voltage with resistors mounted on a ceramic or glass epoxy (FR4) substrate; see Fig.3.



This graph is based on measured data which may deviate according to the application.

Fig.1 Fusing characteristic: 10 Ω ≤ R < 240 Ω, measured using ceramic board material.



This graph is based on measured data which may deviate according to the application.

Fig.2 Fusing characteristic: 1 Ω ≤ R < 240 Ω, measured using glass epoxy (FR4) board material.

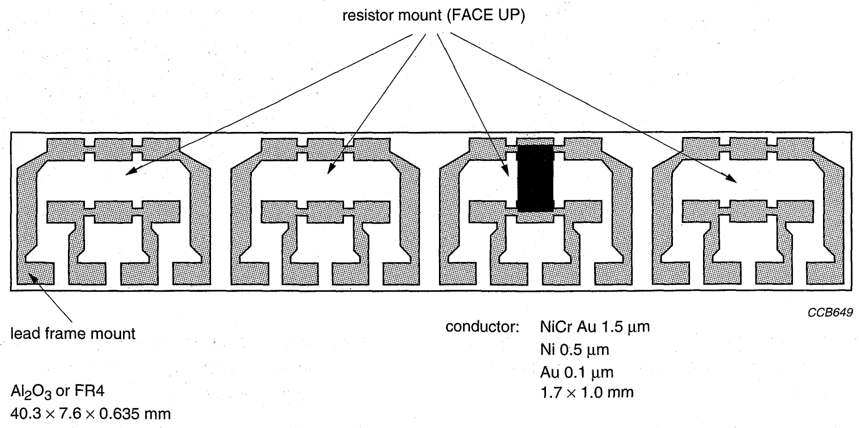


Fig.3 Test substrate layout.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
FRC01	200(2)	0.125

Notes

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.
2. The maximum voltage that may be applied after fusing is shown in Fig.4.

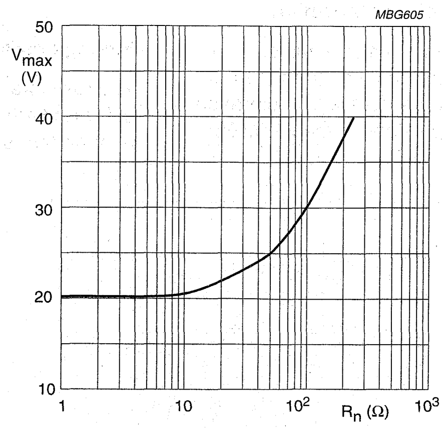


Fig.4 Maximum applied voltage after fusing.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.5.

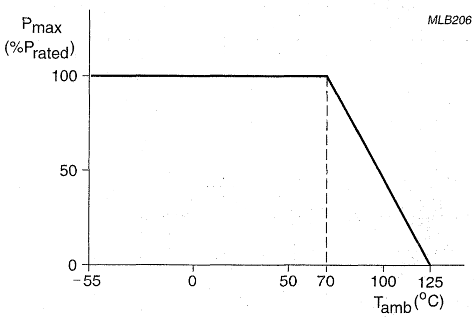
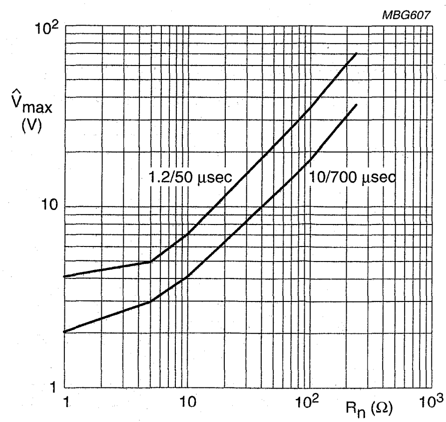


Fig.5 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

PULSE LOADING CAPABILITIES



These pulses may not be applied on a regular basis.

Fig.6 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533.

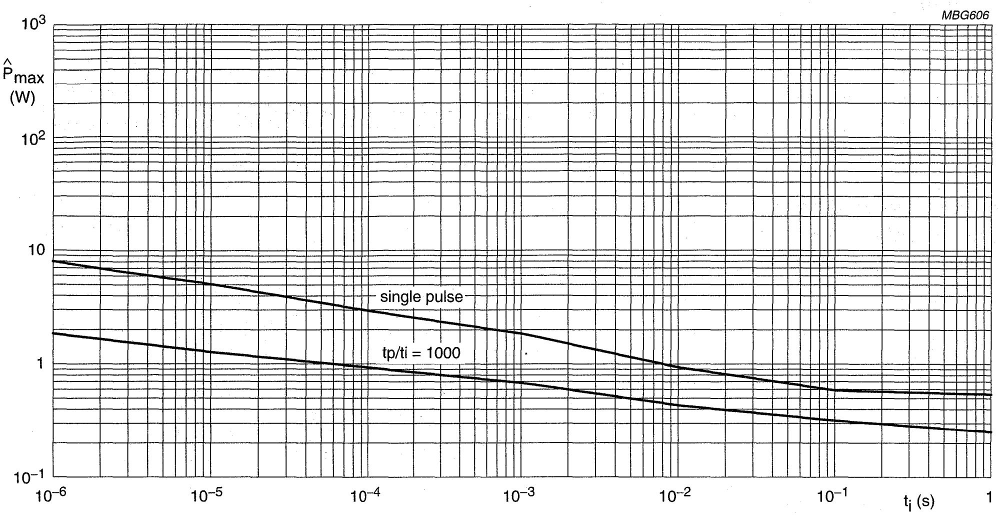


Fig.7 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration, single pulse and repetitive pulse t_p/t_i = 1000.

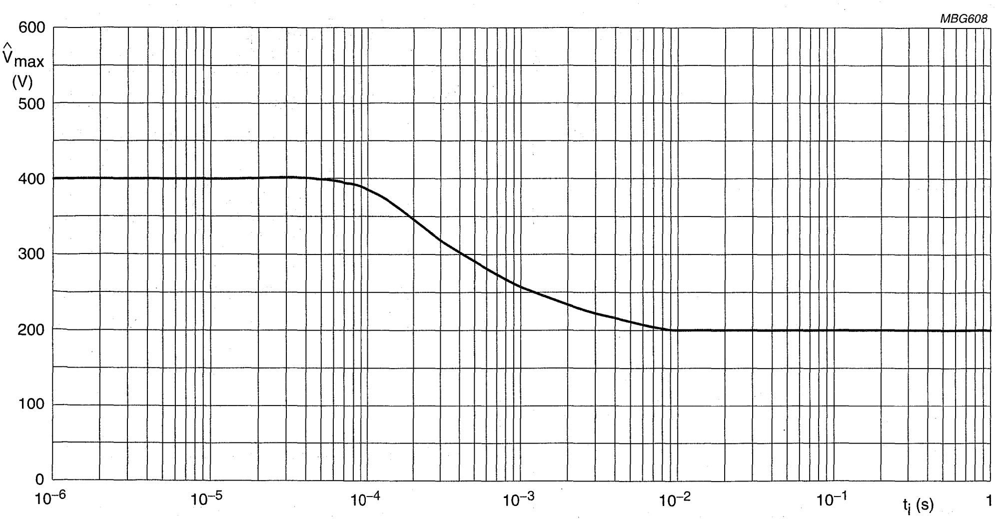


Fig.8 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

Fusible chip resistor size 1206

FRC01 5%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
FRC01	1.0

Marking

All resistors are marked with a four digit code on the protective coat to designate the nominal resistance value.

4-DIGIT MARKING

For all values, the R is used as a decimal point.

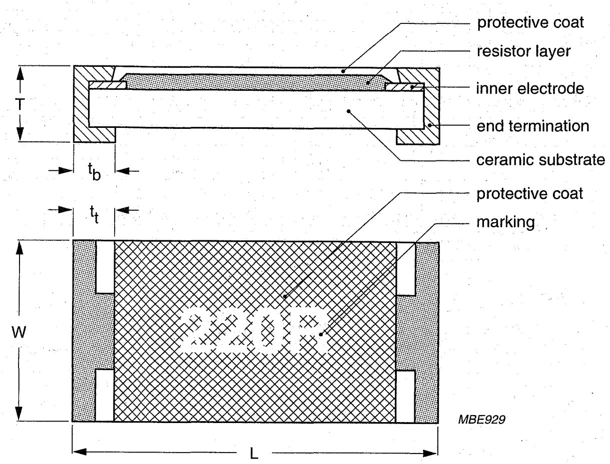
Example

MARKING	RESISTANCE
120R	120 Ω

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.9 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.9

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
FRC01	3.20 +0.10/−0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category **LCT/UCT/56** (rated temperature range: **L**ower **C**ategory **T**emperature, **U**pper **C**ategory **T**emperature; damp heat, long term, **56** days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.4.2		dimensions (outline)	gauge (mm)	$0.45 \leq T \leq 0.65$ $1.45 \leq W \leq 1.75$ $3.0 \leq L \leq 3.3$
4.5		resistance	applied voltage (+0/–10%): $R < 10\ \Omega$: 0.1 V $10\ \Omega \leq R < 100\ \Omega$: 0.3 V $100\ \Omega \leq R < 240\ \Omega$: 1 V	$R - R_{nom}$: max. ±5%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage $\Delta R/R$ max.: ±(1% +0.05 Ω)
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H_2O followed by brushing in accordance with *"MIL 202 F"*	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
4.7		voltage proof on insulation	maximum voltage (RMS) during 1 minute metal block method	no breakdown or flashover
4.13		short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	$\Delta R/R$ max.: ±(1% +0.05 Ω)
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm	no visible damage $\Delta R/R$ max.: ±(1% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: ±(1% +0.05 Ω)
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2°C; 93 +2/–3% RH; loaded with 0.01 P_n	$\Delta R/R$ max.: ±(3% +0.1 Ω)

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.25.1		endurance	1000 +48/–0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(3% +0.1 Ω)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/–0 hours; no load	ΔR/R max.: ±(3% +0.1 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: R < 5 Ω R ≤ 510 Ω	 $\leq \pm 250 \times 10^{-6}$/K $\leq \pm 200 \times 10^{-6}$/K
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.6.1.1		insulation resistance	voltage (DC) after 1 minute, metal block method: 100 V	R_{ins} min.: 10^3 MΩ
4.12		noise	IEC publication 60195 (measured with Quantech-equipment)	max. 2 μV/V
Other applicable tests				
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/–0 hours; 40 ±2 °C; 93 +2/–3% RH; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(5% +0.1 Ω)
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
		trio damp heat test	1000 +48/–0 hours; 85 ±2 °C; 85 ±5% RH; loaded with 0.1 P_n or V_{max}	ΔR/R max.: ±(5% +0.1 Ω)

Surge chip resistor size 1206

SRC01 5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Excellent performance at high frequency.

APPLICATIONS

- Power supply in small sized equipment
- Telecommunication
- Medical and Military
- Automotive industry.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 Ω to 100 kΩ
Resistance tolerance	±5%; ±2% E24 series
Temperature coefficient	$\leq \pm 200 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70°C	0.25 W
Maximum permissible voltage	200 V (DC or RMS)
Climatic category (IEC 60068)	55/155/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 550 ..... PAPER TAPE ON REEL 5000 units
SRC01	1 Ω to 100 kΩ	5	10 ...
		2	11 ...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 550.
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12 NC

RESISTANCE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 kΩ	4

ORDERING EXAMPLE

The ordering code of a SRC01 resistor, value 750 Ω with a tolerance of 5%, supplied on paper tape of 5000 units per reel is: 2350 550 10751.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of ±5% or 2%. The values of the E24 series are in accordance with *"IEC publication 60063"*.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
SRC01	200	0.25

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

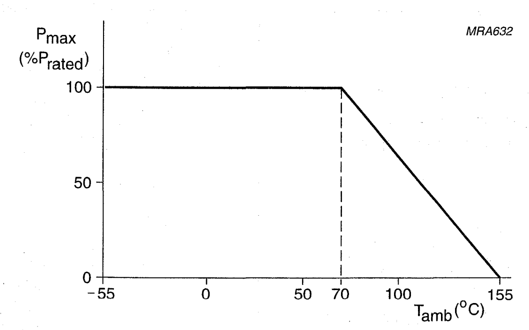


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

PULSE LOADING CAPABILITIES

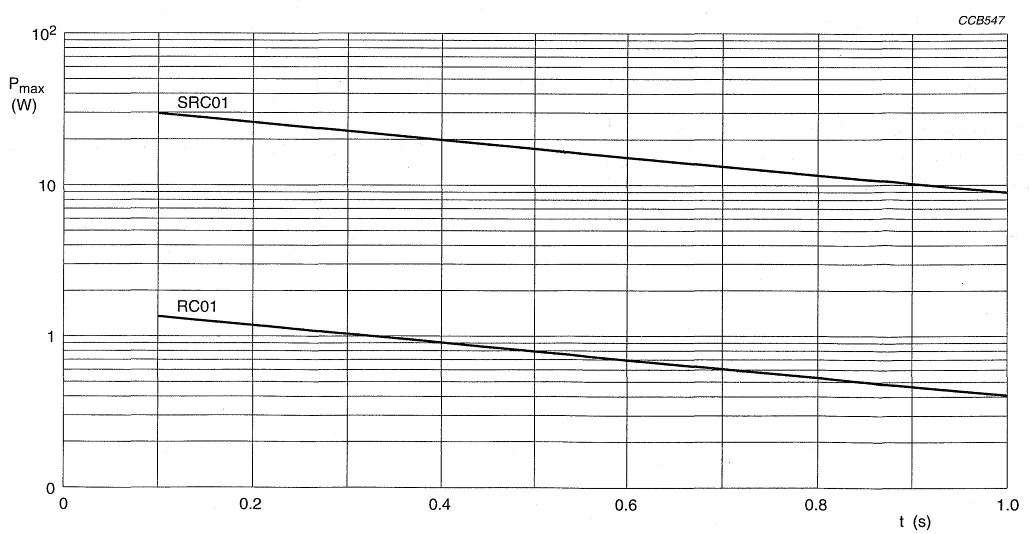


Fig.2 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for R = 1 Ω, single pulse.

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
SRC01	1.0

Marking

All resistors are marked with a 3-digit code on the protective coat to designate the nominal resistance value.

3-DIGIT MARKING

For values up to 1 kΩ the R is used as a decimal point. For values of 1 kΩ or greater the first 2 digits apply to the resistance value and the third indicates the number of zeros to follow.

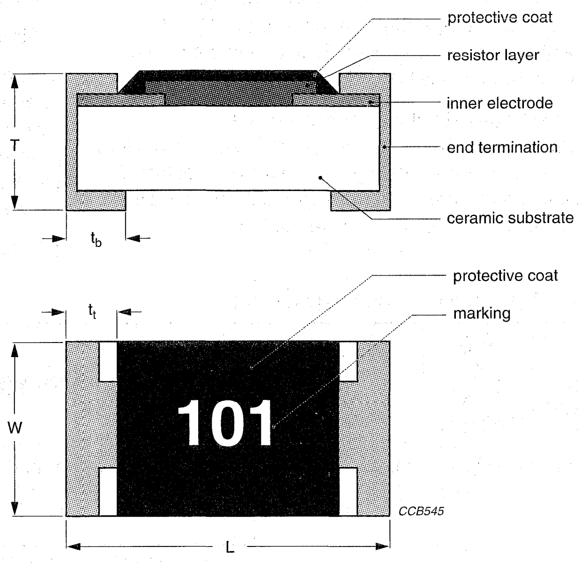
Example

MARKING	RESISTANCE
10R	10 Ω
102	1 kΩ
104	100 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.3 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.3

TYPE	L (mm)	W (mm)	T (mm)	t_t (mm)	t_b (mm)
SRC01	3.20 +0.10/−0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-8"*, category 55/155/56 (rated temperature range −55 to +155 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-8 and 60068"*; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.5		resistance	applied voltage (+0/−10%): 0.1 V	$R - R_{nom}$: max. ±5%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±(1% +0.05 Ω)
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H_2O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.7		voltage proof on insulation	200 V (RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation 6.25 × P_n; 5 s (voltage not more than 2 × V_{max})	ΔR/R max.: ±(2% +0.1 Ω)
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage ΔR/R max.: ±(1.5% +0.05 Ω)
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 1000 MΩ
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/−3% RH; loaded with 0.01 P_n	R_{ins} min.: 1000 MΩ ΔR/R max.: ±(1.5% +0.05 Ω)

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.25.1		endurance	1000 +48/–0 hours; 70 ±2 °C; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(1% +0.05 Ω)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/–0 hours; 155 °C; no load	no visible damage ΔR/R max.: ±(1% +0.05 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	≤±200 × 10^{-6}/K
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/–0 hours; 40 ±2 °C; 93 +2/–3% RH; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±3%

RC NETWORKS PRODUCT DATA

Page

Resistor-Capacitor network size 1608

RCB210

FEATURES

- 4 resistors and 4 capacitors in one package
- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

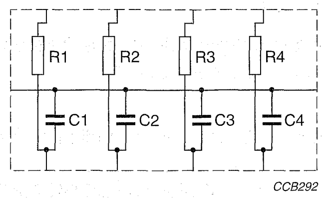
APPLICATIONS

- Motherboards
- Notebook computers
- LCD displays
- Mobile phones.

DESCRIPTION

The components are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the bottom surface of the substrate; a dielectric material is applied to the top surface. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive and dielectric layers are covered with a protective coating and the marking bar is printed on the capacitor side. Finally, external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.



R1 = R2 = R3 = R4
C1 = C2 = C3 = C4
For dimensions see Fig.3 and Table 2.

Fig.1 Equivalent circuit.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance:	
range	10 Ω to 1 kΩ; E6 series
tolerance	±5%
temperature coefficient	$\pm200 \times 10^{-6}$/K
Capacitance:	
range	10 to 180 pF; E3 series
tolerance	+30 to –20%
temperature coefficient	ΔC/C: +20% to –55%
Dissipation factor at 25 °C, 1 kHz, 1 V_{rms}	≤3.0%
Number of:	
resistors	4
capacitors	4
terminals	10
Absolute maximum dissipation at T_{amb} = 70 °C	0.063 W/element
Maximum permissible voltage	25 V (DC or RMS)
Operating temperature range	–25 to +85 °C
Climatic category (IEC 60068)	55/85/56

ORDERING INFORMATION

Ordering code (12NC)

The R-C network has a 12-digit ordering code starting with 2350 321

The last 5 digits indicate the resistance/capacitance combination; see Table 1.

ORDERING EXAMPLE

The ordering code of an RCB210, 1608 concave type R-C network, value 22 Ω/100 pF, supplied on blister tape of 4000 units per reel is: 2350 321 20002.

Table 1 Ordering code indicating network type, packaging and marking code

ORDERING CODE 2350 321			
BLISTER TAPE ON REEL			
4000 units			
R (Ω)	**C (pF)**	**LAST FIVE DIGITS**	**MARKING CODE**
33	180	20001	702
22	100	20002	13
100	47	20003	32
22	10	20004	515
47	22	20005	21
22	22	20006	11
22	47	20007	12
47	47	20008	22
47	100	20009	23
100	22	20010	31
100	100	20011	33
220	22	20012	41
220	47	20013	42
220	100	20014	43
470	22	20015	51
470	47	20016	52
470	100	20017	53
1000	22	20018	61
1000	47	20019	62
1000	100	20020	63
100000	22	20021	502
33	47	20022	503
33	33	20023	504
100	33	20024	505
1000	33	20025	506
47	33	20026	507
2200	47	20027	508

ORDERING CODE 2350 321			
BLISTER TAPE ON REEL			
4000 units			
R (Ω)	**C (pF)**	**LAST FIVE DIGITS**	**MARKING CODE**
82000	33	20028	509
22	33	20029	510
47000	100	20030	511
15000	47	20031	512
33	10	20032	513
47	10	20033	514
330	100	20034	516
10	10	20035	517
15	15	20036	518
10	15	20037	519
15	10	20038	520
27	47	20039	521
33	100	20040	522
100	10	20041	523
10	100	20042	524
10	22	20043	525
10	47	20044	526
1000	10	20045	527
220	10	20046	528
470	10	20047	529
22	180	20048	701
47	180	20049	703
68	180	20050	704
4700	180	20051	705
100	180	20052	706
82	100	20053	530

FUNCTIONAL DESCRIPTION

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
RCB210	25	0.063

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the component can dissipate depends on the operating temperature; see Fig.2.

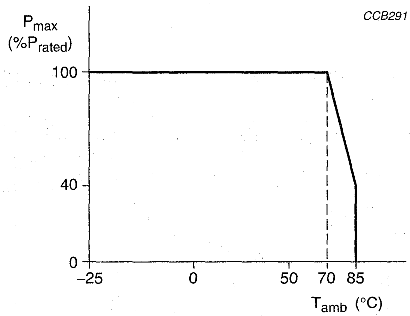


Fig.2 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RCB210	1.8

Marking

Marking codes for capacitance and resistance

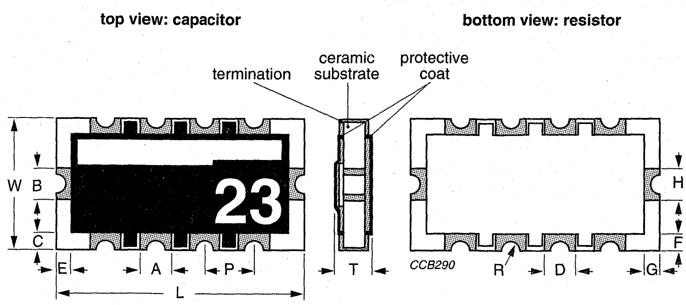
RESISTANCE		CAPACITANCE	
VALUE (Ω)	CODE	VALUE (pF)	CODE
22	1	22	1
47	2	47	2
100	3	100	3
220	4	–	–
470	5	–	–
1000	6	–	–

MARKING EXAMPLES

Typical capacitance/resistance marking codes

C (pF)	R (Ω)			
	22	47	100	220
22	11	21	31	41
47	12	22	32	42
100	13	23	33	43

Outlines



For dimensions see Table 2.

Fig.3 Outlines.

Table 2 Physical dimensions; see Fig.3

SYMBOL	VALUE	TOL.	UNIT
L	4.00	+0.30/–0.10	mm
W	2.10	±0.20	mm
A and B	0.50	±0.20	mm
C and E	0.25	±0.20	mm
H	0.50	±0.20	mm
R	0.15	+0.05/–0.10	mm
T	0.65	+0.20/–0.10	mm
D	0.45	±0.20	mm
F and G	0.40	±0.20	mm
P	0.80	±0.10	mm

Resistor-Capacitor network size 1608

RCB210

HANDLING

Recommended land patterns

The GND pattern should be as large as possible as high frequency noise is removed through this terminal, see Fig.4 and Table 3.

Reflow soldering

SOLDER PASTE

Refer to Fig.5 for pattern.

Thickness: 150 to 200 μm.

FLUX AND SOLDER

Use rosin -based flux only.

Sn/Pb solder composition ratio: 63/37 or 60/40.

Wave soldering

Not recommended.

Component replacement

SOLDERING GUN (<30 W)

The temperature of the tip must be less than 280 °C for a period within 3 seconds and should not come in direct contact with the product.

Substrate

MOUNTING

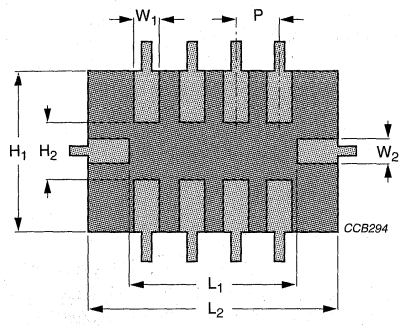
The mounting place on the printed-circuit board (PCB) should be as far as possible from the position which is close to the break line or on the line of large holes.

BENDING

Excessive bending of the PCB after soldering is not recommended. When mounting other components use support pins; see Fig.5.

BREAKING

Any breaking of the PCB should only be done by machine or jig.



For dimensions see Table 3.

Fig.4 Recommended land patterns.

Table 3 Recommended land pattern dimensions; see Fig.4

SYMBOL	SIZE	TOL.	UNIT
H_1	3.10	±0.4	mm
H_2	1.60	±0.5	mm
L_1	3.50	±0.1	mm
L_2	5.10	±0.3	mm
W_1	0.40	±0.05	mm
W_2	0.45	±0.05	mm
P	0.80	±0.05	mm

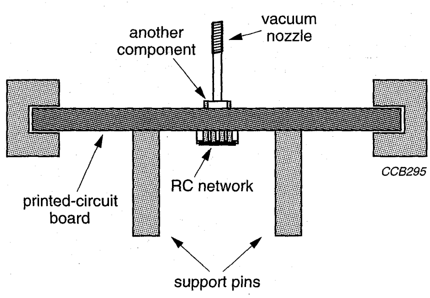


Fig.5 Component installation on PCB.

CAUTION
Rapid heating or cooling will damage this product. Avoid an initial heat shock over 100 °C.
Preheating and gradual cooling is recommended.

TESTS AND REQUIREMENTS

Unless otherwise specified the following values apply:

Temperature: 25 ±2 °C

Relative humidity: 45% to 55%

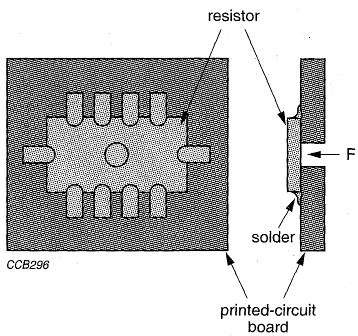
Air pressure: 86 kPa to 107 kPa (860 mbar to 1070 mbar).

In Table 4 the tests and requirements are listed. The description of the test procedure is also given.

All soldering tests are performed with rosin -based flux.

Table 4 Test procedures and requirements

TEST METHOD	PROCEDURE	REQUIREMENTS
Electrical characteristics of resistor		
DC resistance	$R \leq 100\ \Omega$: 0.3 V $100\ \Omega < R \leq 999\ \Omega$: 1 V	within the specified tolerance ±5%
Temperature coefficient	between −55 °C to +125 °C	$\leq \pm 200 \times 10^{-6}$/K
Electrical characteristics of capacitor		
Capacitance	capacitance value shall be measured according to: frequency: 1 kHz ±10% voltage: 1 ±0.2 V_{rms} temperature: 25 ±2 °C	within the specified tolerance +30 to −20%
Dissipation factor	dissipation factor shall be measured according to: frequency: 1 kHz ±10% voltage: 1 ±0.2 V_{rms} temperature: 25 ±2 °C	3.0% max.
Temperature characteristic	between −25 °C to +85 °C	$\Delta C/C$: −55% to +20%
Insulation resistance	25 V (DC) during 1 minute	R_{ins} min.: 1000 MΩ
Withstanding voltage	2.5 × U_R applied between I/O terminal and GND for 1 to 5 s	no mechanical damage, arcing or breakdown
Environmental characteristics of resistor and capacitor		
Temperature cycling	30 minutes at −25 °C 30 minutes at +85 °C; 5 cycles	no mechanical damage $\Delta C/C$: ±20% D_F max.: 5.0% R_{ins} min.: 100 MΩ $\Delta R/R$: ±5.0%
Capacitor load life in humidity	U_R for 500 +24/−0 hours in a controlled humidity test chamber at: 40 ±2 °C and 90 to 95% RH; measurement in 48 ±4 hours at standard condition after test	no mechanical damage $\Delta C/C$: ±20% D_F max.: 5.0% R_{ins} min.: 100 MΩ $\Delta R/R$: ±5.0%
Resistor load life in humidity	U_R for 500 +24/−0 hours (1.5 hours on, 0.5 hours off) in a controlled humidity test chamber at: 40 ±2 °C and 90 to 95% RH; measurement in 48 ±4 hours at standard condition after test	no mechanical damage $\Delta C/C$: ±20% D_F max.: 5.0% R_{ins} min.: 100 MΩ $\Delta R/R$: ±5.0%

TEST METHOD	PROCEDURE	REQUIREMENTS
Capacitor load life	$2 \times U_R$ for 1 000 +24/–0 hours at T_{amb} = 85 ±2 °C; measurement in 48 ±4 hours at standard condition after test	no mechanical damage $\Delta C/C$: ±20% D_F max.: 5.0% R_{ins} min.: 100 MΩ $\Delta R/R$: ±5.0%
Resistor load life	U_R for 1 000 +24/–0 hours at T_{amb} = 70 ±2 °C; measurement in 48 ±4 hours at standard condition after test	no mechanical damage $\Delta C/C$: ±20% D_F max.: 5.0% R_{ins} min.: 100 MΩ $\Delta R/R$: ±5.0%
Resistance to soldering heat	unmounted chips completely immersed for 5 ±1 s in a solder bath at 260 ±5 °C, after 150 ±5 °C preheat for 1 minute; measurement in 48 ±4 hours at standard condition after test	no mechanical damage $\Delta C/C$: ±20% D_F max.: 5.0% R_{ins} min.: 100 MΩ $\Delta R/R$: ±5.0%
Bending	Products shall be soldered to a testing board. The substrate shall be supported at two points 45 mm from its centre. The middle of the substrate shall be pressed by a pressing rod at a rate of 1.0 mm per second until the deflection reaches 3 mm. The pressure shall be maintained for 30 s. Testing board: 100 × 40 × 1.6 mm glass epoxy-rosin printed-circuit board. Pressing rod: 20 × 50 mm wide cylindrical metal rod with a radius of 340 mm.	no mechanical damage $\Delta C/C$: ±20% D_F max.: 5.0% R_{ins} min.: 100 MΩ $\Delta R/R$: ±5.0%
Terminal strength	Products shall be soldered to a testing board, as shown below and a pressing force (9.8 N,1 Kgf) applied in the direction F, for 5 ±1 s. 	no mechanical damage
Terminal solderability	in accordance with *"MIL-STD-202F"* method 208; solder temperature: 230 ±5 °C, during 5 ±0.5 s	95% min. coverage

Capacitor-Resistor network size 1608

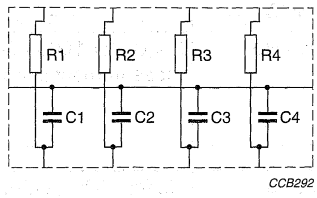
CRB210

FEATURES

- 4 capacitors and 4 resistors in one package
- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Motherboards
- Notebook computers
- LCD displays
- Mobile phones.



R1 = R2 = R3 = R4
C1 = C2 = C3 = C4
For dimensions see Fig.9 and Table 2.

Fig.1 Equivalent circuit.

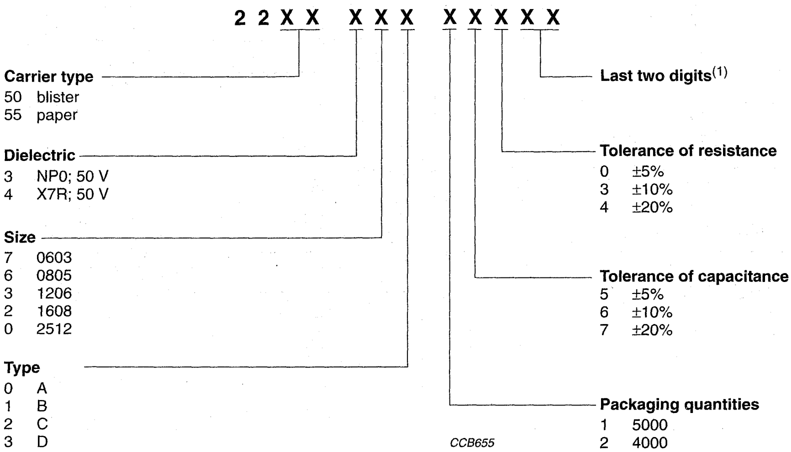
QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	CLASS 1 NP0	CLASS 2 X7R
Capacitance:		
range	15 to 470 pF; E12 series	560 pF to 22 nF; E12 series
tolerance	±5% (J); ±10% (K)	±10% (K); ±20% (M)
Resistance:		
range	10 Ω to 100 kΩ; E12 series	
tolerance	±20%	
temperature coefficient	$\pm 200 \times 10^{-6}$/K	
Absolute maximum dissipation at T_{amb} = 70 °C	0.063 W/element	
Rated voltage	50 V	
Tan δ	≤0.1%	≤2.5%
Number of:		
capacitors	4	
resistors	4	
terminals	10	
Operating temperature range	−55 to +125 °C	

ORDERING INFORMATION

- The C-R network has a 12-digit ordering code starting with 22; see "Ordering code 12NC".
- The last 2 digits indicate the capacitance/resistance combination; see Table 1.

Ordering code 12NC



(1) For the last two digits of the catalogue number, refer to Table 1.

Table 1 Composition of the last two digits of the 12NC

LAST TWO DIGITS OF 12NC	CLASS 1	
	C_R (pF)	RESISTANCE (Ω)
01	180	33
02	100	22
03	47	100
04	10	22
05	22	47
06	22	22
07	47	22
08	47	47
09	100	47
10	22	100
11	100	100
12	22	220
13	47	220
14	100	220
15	22	470
16	47	470
17	100	470
18	22	1000
19	47	1000
20	100	1000
21	22	100000
22	47	33
23	33	33
24	33	100
25	33	1000
26	33	47
27	47	2200
28	33	82000
29	33	22
30	100	47000
31	47	15000
32	10	33
33	10	47
34	100	330
35	10	10
36	15	15
37	15	10
38	10	15
39	47	27
40	100	33
41	10	100
42	100	10
43	22	10
44	47	10
45	10	1000
46	10	220
47	10	470
48	180	22
49	180	47
50	180	68
51	180	4700
52	52	100

ORDERING EXAMPLE

The ordering code of an 1608 type C-R network, NP0 dielectric material, value 180 pF/33 Ω and a 5% tolerance, supplied on blister tape of 4000 units per reel is:
2250 321 25001.

FUNCTIONAL DESCRIPTION

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
CRB210	50	0.063

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-8"*.

DERATING

The power that the component can dissipate depends on the operating temperature; see Fig.2.

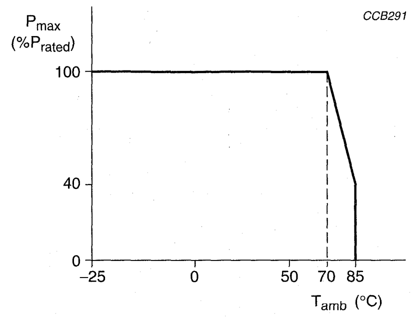


Fig.2 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

ELECTRICAL CHARACTERISTICS

DESCRIPTION	VALUE	
	CLASS 1 NP0	CLASS 2 X7R
Capacitance:		
range	15 to 470 pF; E12 series	560 pF to 22 nF; E12 series
tolerance	±5% (J); ±10% (K)	±10% (K); ±20% (M)
Resistance:		
range	10 Ω to 100 kΩ; E12 series	
tolerance	20%	
temperature coefficient	$\pm 200 \times 10^{-6}$/K	
Absolute maximum dissipation at T_{amb} = 70 °C	0.063 W	
Rated voltage	50 V	
Tan δ	≤0.1%	≤2.5%
Number of:		
capacitors	4	
resistors	4	
terminals	10	
Operating temperature range	−55 to +125 °C	

NP0 capacitor electrical data

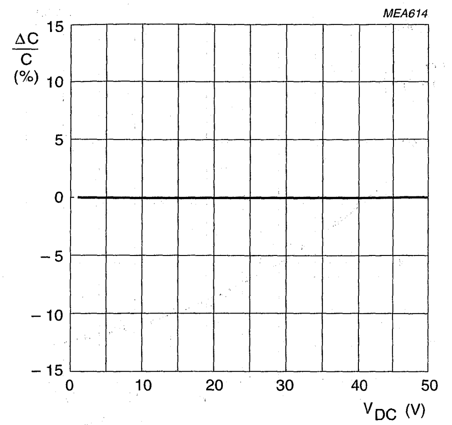


Fig.3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

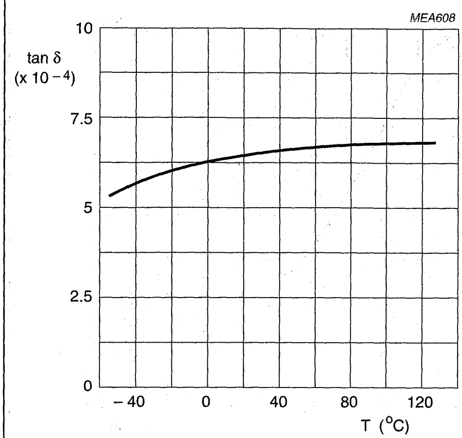
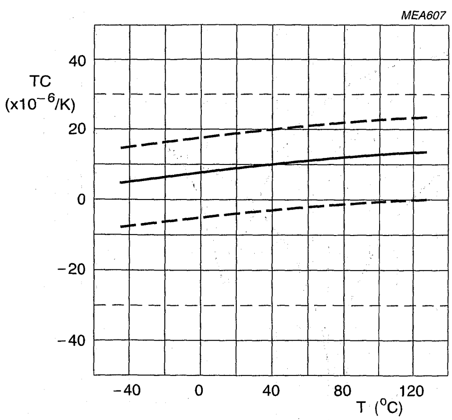


Fig.4 Typical tan δ as a function of temperature.



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

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

X7R capacitor electrical data

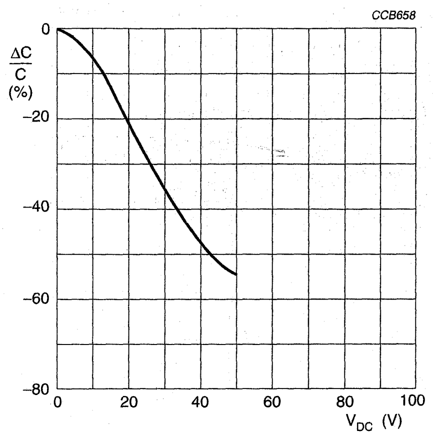


Fig.6 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

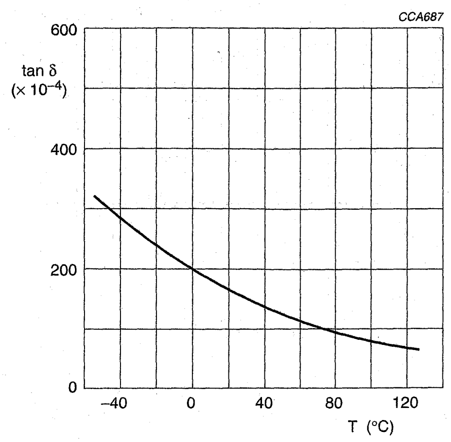


Fig.7 Typical tan δ as a function of temperature.

Attenuation of C-R network: NP0 180 pF/33 Ω and NP0 15 pF/22 Ω

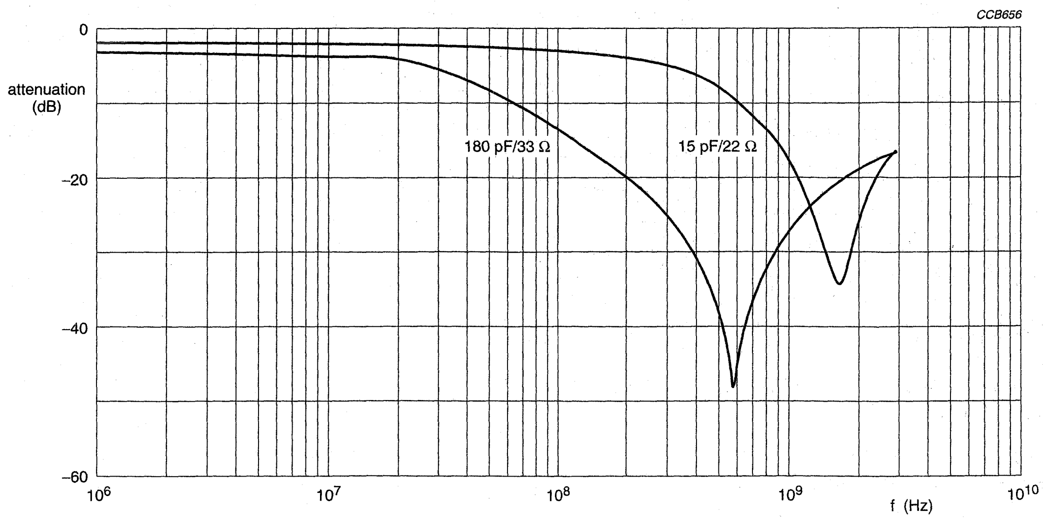


Fig.8 Typical attenuation of C-R network.

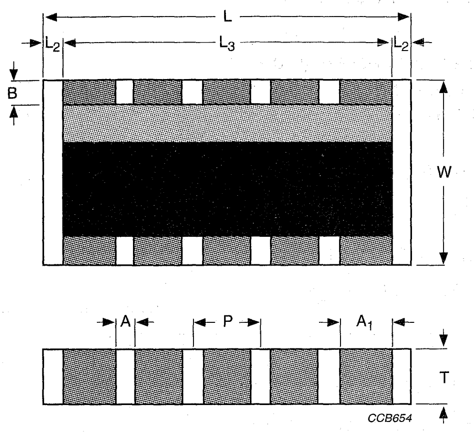
Capacitor-Resistor network size 1608

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
CRB210	≈4

Outlines



For dimensions see Table 2.

Fig.9 Outlines.

Table 2 Physical dimensions; see Fig.9

SYMBOL	VALUE	TOL.	UNIT
L	4.00	±0.20	mm
W	2.10	±0.20	mm
T	0.80	±0.10	mm
L_2	0.20	±0.10	mm
L_3	3.60	±0.20	mm
A	0.40	±0.10	mm
B	0.25	±0.20	mm
P	0.80	±0.10	mm
A_1	0.40	±0.10	mm

HANDLING

Recommended land patterns

The GND pattern should be as large as possible as high frequency noise is removed through this terminal, see Fig.10 and Table 3.

Reflow soldering

SOLDER PASTE

Refer to Fig.10 for pattern.

Thickness: 150 to 200 μm.

FLUX AND SOLDER

Use rosin-based flux only.

Sn/Pb solder composition ratio: 63/37 or 60/40.

Wave soldering

Not recommended.

Component replacement

SOLDERING GUN (<30 W)

The temperature of the tip must be less than 280 °C for a period within 3 seconds and should not come in direct contact with the product.

Substrate

MOUNTING

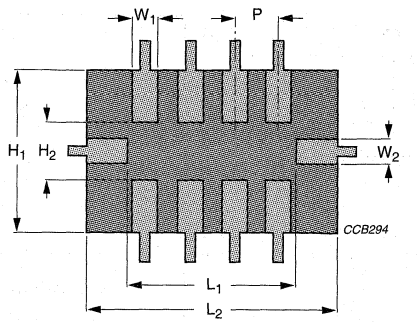
The mounting place on the printed-circuit board (PCB) should be as far as possible from the position which is close to the break line or on the line of large holes.

BENDING

Excessive bending of the PCB after soldering is not recommended. When mounting other components use support pins; see Fig.11.

BREAKING

Any breaking of the PCB should only be done by machine or jig.



For dimensions see Table 3.

Fig.10 Recommended land patterns.

Table 3 Recommended land pattern dimensions; see Fig.10

SYMBOL	SIZE	TOL.	UNIT
H_1	3.10	±0.4	mm
H_2	1.65	±0.05	mm
L_1	3.50	±0.1	mm
L_2	5.10	±0.3	mm
W_1	0.45	±0.05	mm
W_2	0.45	±0.05	mm
P	0.80	±0.05	mm

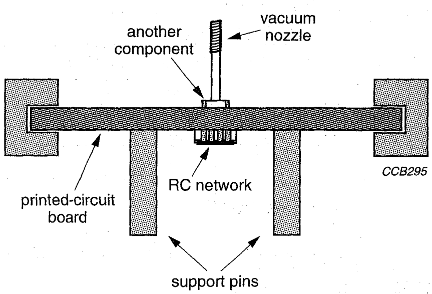


Fig.11 Component installation on PCB.

CAUTION
Rapid heating or cooling will damage this product. Avoid an initial heat shock over 100 °C.
Preheating and gradual cooling is recommended.

TESTS AND REQUIREMENTS

Unless otherwise specified the following values apply:

Temperature: 25 ±2 °C

Relative humidity: 45% to 55%

Air pressure: 86 kPa to 107 kPa (860 mbar to 1070 mbar).

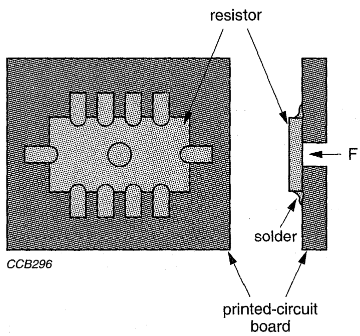
In Table 4 the tests and requirements are listed. The description of the test procedure is also given.

All soldering tests are performed with rosin-based flux.

Table 4 Test procedures and requirements

TEST METHOD	PROCEDURE	REQUIREMENTS
Electrical characteristics of resistor		
DC resistance	$R < 100\ \Omega$: 0.3 V $100\ \Omega \leq R < 1\ k\Omega$: 1 V $1\ k\Omega \leq R < 10\ k\Omega$: 3 V $10\ k\Omega \leq R \leq 100\ k\Omega$: 10 V	within the specified tolerance: 20%
Temperature coefficient	at 20/–55/20 °C and 20/–125/20 °C	$\leq \pm 200 \times 10^{-6}$/K
Electrical characteristics of capacitor		
Capacitance	capacitance value shall be measured as: **NP0**: frequency: 1 MHz voltage: 1 V_{rms} temperature: 20 °C; **X7R**: frequency: 1 kHz voltage: 1 V_{rms} temperature: 20 °C	within the specified tolerance: **NP0**: ±5%; ±10%; **X7R**: ±20%
Dissipation factor	dissipation factor, measured as 6.2.1	**NP0**: 0.1% max. **X7R**: 2.5% max.
Temperature characteristic	$TC = \frac{C_2 - C_1}{C_1} \times 10^2$ C_1 = C at 20 °C C_2 = C at test temperature (–55 to +125 °C)	$\Delta C/C$: **NP0**: $\pm 30 \times 10^{-6}$/K **X7R**: ±15% max.
Insulation resistance	U_R for 1 minute	$\Delta C/C$: **NP0**: $>10^5\ M\Omega$ **X7R**: $C \leq 10$ nF: $>10^5\ M\Omega$; $C > 10$ nF: $R_{ins}\,C > 1000$ s
Withstanding voltage	$2.5 \times U_R$ applied between I/O terminal and GND for 1 minute	no mechanical damage, arcing or breakdown

TEST METHOD	PROCEDURE	REQUIREMENTS
Environmental characteristics of resistor and capacitor		
Rapid change of temperature	preconditioning, class 2 only; NP0/X7R: −55 to +125 °C; 5 cycles	no visible damage after 48 hours recovery ΔC/C: **NP0**: ≤1% or 1 pF **X7R**: ≤15% ΔR/R: **NP0/X7R**: ±5.0%
Capacitor load damp heat	preconditioning class 2 only; 56 days at 40 °C and 90 to 95% RH; U_R applied; measurement after recovery: class 1: 1 to 2 hours class 2: 48 hours	no visible damage ΔC/C: **NP0**: 2% or 1 pF, whichever is greater **X7R**: ≤15% D_F: **NP0**: ≤2 × specified value **X7R**: ≤7% I_R: **NP0**: 2500 MΩ or R_{ins} C ≥ 25 s, whichever is less **X7R**: 1000 MΩ or R_{ins} C ≥ 25 s, whichever is less
Resistor load life in humidity	U_R for 500 +24/−0 hours (1.5 hours on, 0.5 hours off) in a controlled humidity test chamber at: 40 ±2 °C and 90 to 95% RH; measurement in 48 ±4 hours at standard condition after test	no mechanical damage ΔR/R: ±5.0%
Capacitor load endurance	preconditioning class 2 only; 1000 hours, 125 °C at 2 × U_R for U_R = 50 V; measurement after 48 hours recovery	no visible damage ΔC/C: **NP0**: 2% or 1 pF, whichever is greater **X7R**: ≤20% D_F: **NP0**: ≤2 × specified value **X7R**: ≤7% I_R: **NP0**: 4000 MΩ or R_{ins} C ≥ 405 s, whichever is less **X7R**: 2000 MΩ or R_{ins} C≥ 25 s, whichever is less
Resistor load life	U_R for 1000 +24/−0 hours at T_{amb} = 70 ±2 °C; measurement in 48 ±4 hours at standard condition after test	no mechanical damage ΔR/R: ±5.0%

TEST METHOD	PROCEDURE	REQUIREMENTS
Resistance to soldering heat	unmounted chips completely immersed for 10 ±0.5 s in a solder bath at 260 ±5 °C, after 150 ±5 °C preheat for 1 minute; measurement in 48 ±4 hours at standard condition after test	no mechanical damage ΔC/C: **NP0**: ≤0.5% or 0.5 pF, whichever is greater **X7R**: > −5% and ≤10% ΔR/R: ±5.0%
Machinery performance		
Bending	1 mm at a rate of 1 mm/s, radius jig 340 mm.	no visible damage ΔC/C: **NP0**: ≤1% **X7R**: ≤10% ΔR/R: **NP0/X7R**: ±5.0%
Terminal strength	Products shall be soldered to a testing board, as shown below and a pressing force (5 N) applied in the direction F, for 10 s 	no mechanical damage
Terminal solderability	in accordance with *"MIL-STD-202F"* method 208; solder temperature: 215 ±5 °C, during 3 ±0.5 s	95% min. coverage

MULTILAYER SUPPRESSORS AND INDUCTORS PRODUCT DATA

MULTILAYER SUPPRESSORS

Multilayer suppressors are a powerful solution for EMI/RFI attenuation for electronic equipment. Supplied in four standard sizes (0603, 0805, 1206 and 1806), they have impedances between 30 and 1 000 W at 100 MHz.

When installed in series with signal and/or power circuits, high frequency noise is suppressed. There is no need for ground termination, which makes these devices very suitable for circuits with difficult ground. Typical suppression frequencies range from 10 MHz to 1 000 MHz and rated currents are between 0.1 and 0.6 A.

Multilayer suppressors are specially designed to reduce noise in low impedance circuits while keeping the signal free from distortion. This is because at the interfering frequencies these components behave as a resistor. The high frequency noise is converted into heat rather than reflected to the source. This dissipation prevents ringing and parasitic oscillations.

These characteristics can be used for many different purposes:

- Absorption of generated noise.
- Filtering and wave-shape correction of digital signals from high speed clock oscillators.
- Prevention of high frequency interference entering circuit electronics.

Product construction

The use of silver for electrodes and terminations in multilayer suppressors ensures high electrical conductivity, which minimizes heat generation and crosstalk.

The internal construction can be single layer or multilayer, depending on impedance requirements. Single layer products have a ÔmeanderÕ design and are suitable for lower impedances, while multilayer types have alternating layers of ferrite and conductor stacked up to achieve higher impedance levels.

The terminal electrode forms a conductive connection to the circuit. It is formed by three layers:

- Silver: for good conductivity
- Nickel: to protect silver termination against leaching
- Tin-lead: applied to ensure good solderability.

The products are suitable for both reflow and wave soldering.

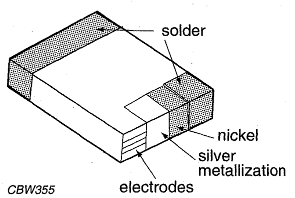


Fig.1 Structure of electrodes.

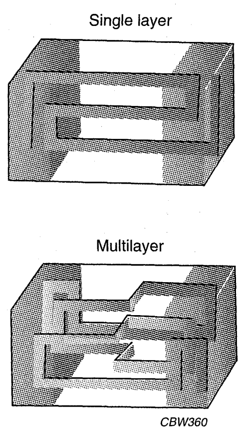


Fig.2 Internal structure of multilayer suppressors..

TYPE NUMBER STRUCTURE

Type numbers for these products consist of the following:

- Product type
- Size
- Material
- Impedance.

Product type

MLS: multilayer suppressor.

Size

0603: 1.6 × 0.80 mm

0805: 2.0 × 1.25 mm

1206: 3.2 × 1.60 mm

1806: 4.5 × 1.60 mm.

Material

4S4

4S7

Impedance value

Expressed in ohms (Ω)

First two digits are significant figures

Last digit is the number of zeros to follow.

EXAMPLES

600: 60 Ω

101: 100 Ω

121: 120 Ω

151: 150 Ω

301: 300 Ω

102: 1000 Ω

Example of the ordering code: MLS0603-4S7-600

TYPE	SIZE	MATERIAL	IMPEDANCE
MLS	0603	4S7	600

Standard products are delivered taped on reel and have a tolerance on impedance of 25%. For different specifications a fifth group is added to the type number.

MULTILAYER SUPPRESSORS MLS0603

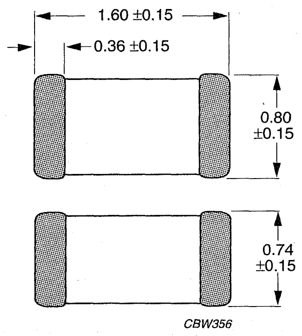


Fig.3 Outline of MLS0603.

Mass

Approximately 5 mg.

Product specifications

GRADE	SIZE	|Z| at 100 MHz (Ω)	R_{DC} MAX. (Ω)	I MAX. (mA)	TYPE NUMBER
4S7	0603	60	0.4	300	MLS0603-4S7-600
		100	0.7	200	MLS0603-4S7-101
		120	0.8	200	MLS0603-4S7-121
		150	0.9	200	MLS0603-4S7-151
		300	1.2	150	MLS0603-4S7-301
		600	1.8	150	MLS0603-4S7-601
		1000	2.0	100	MLS0603-4S7-102

MULTILAYER SUPPRESSORS MLS0805

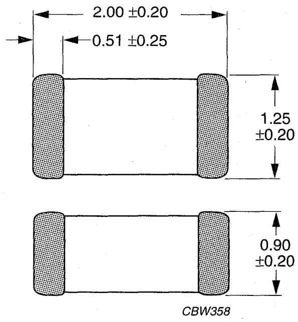


Fig.4 Outline of MLS0805.

Mass

Approximately 11 mg.

Product specifications

GRADE	SIZE	|Z| at 100 MHz (Ω)	R_{DC} MAX. (Ω)	I MAX. (mA)	TYPE NUMBER
4S4	0805	30	0.1	600	MLS0805-4S4-300
		60	0.2	400	MLS0805-4S4-600
4S7	0805	120	0.3	200	MLS0805-4S7-121
		300	0.3	200	MLS0805-4S7-301
		600	0.6	200	MLS0805-4S7-601
		1000	0.8	150	MLS0805-4S7-102

MULTILAYER SUPPRESSORS MLS1206

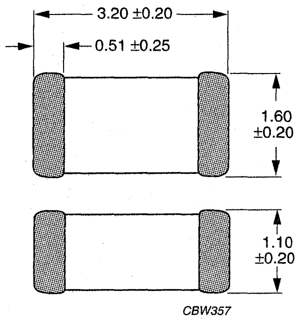


Fig.5 Outline of MLS1206.

Mass

Approximately 28 mg.

Product specifications

GRADE	SIZE	|Z| at 100 MHz (Ω)	R_{DC} MAX. (Ω)	I MAX. (mA)	TYPE NUMBER
4S4	1206	30	0.1	600	MLS1206-4S4-300
		70	0.2	400	MLS1206-4S4-700
		90	0.2	400	MLS1206-4S4-900
		120	0.2	300	MLS1206-4S4-121
		600	0.4	200	MLS1206-4S4-601
4S7	1206	1000	0.6	150	MLS1206-4S7-102

MULTILAYER SUPPRESSORS MLS1806

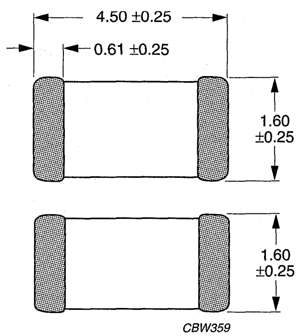


Fig.6 Outline of MLS1806.

Mass

Approximately 55 mg.

Product specifications

GRADE	SIZE	|Z| at 100 MHz (Ω)	R_{DC} MAX. (Ω)	I MAX. (mA)	TYPE NUMBER
4S4	1806	80	0.1	600	MLS1806-4S4-800
		150	0.2	500	MLS1806-4S4-151

Thin film, high frequency inductors | THL (0402; 0603)

FEATURES

- High tolerance, ±0.2 nH and ±2%
- High Q
- High SRF
- Low DC resistance
- Excellent RF stability
- Low profile.

APPLICATIONS

- Cellular handsets
- Cordless telephones
- Base stations
- W-LAN
- GPS
- Tuners
- Satellite TV
- CATV.

DESCRIPTION

The body of the inductor consists of a ceramic substrate on which a low resistive planar inductor is grown. The inductor is patterned very accurately by means of photolithography. Thin-film terminations are added and connected to the inductor.

The terminations are covered with a tin layer for ease of soldering.

QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	THL0603	THL0402
Size code	0603 (1608)	0402 (1005)
Inductance range	1.0 to 100 nH	1.0 to 39 nH
Tolerance on inductance (E12 series):		
$1.0 \leq L \leq 8.2$ nH	±0.2 nH	±0.2 nH
$10 < L \leq 15$ nH	±2%	±2%
$L > 15$ nH	±2%	±3%
Temperature coefficient	0 to $+125 \times 10^{-6}$/K	
Operating temperature	−55 °C to +125 °C	

ORDERING INFORMATION

Components may be ordered by using a simple 13-digit clear text code or Philips unique 12NC.

Clear text code (preferred)

Composition of the clear text code

TYPE	SIZE	VALUE(1)	TOL.	PACKAGING(2)
				PAPER TAPE ON ∅180 mm REEL
THL	0603	1N0 = 1 nH	C = ±0.2 nH	B1 = 5 000 units
	0402		G = ±2%	B2 = 10 000 units
			H = ±3%	

Notes

1. For values up to 8.2 nH the letter N is used as a decimal point. For values of 10 nH or greater the first 2 digits apply to the inductance value and the third indicates the number of zeros to follow.
2. Inductors in size 0603 are available only in quantities of 5000 units per reel. Inductors in size 0402 are available only in quantities of 10000 units per reel.

EXAMPLE

The ordering code of a thin film 0603 inductor, value 4.7 nH with a tolerance of 0.2 nH, supplied on paper tape of 5 000 units per reel is: THL06034N7CB1.

Ordering code (12NC)

The inductors have a 12-digit ordering code that can be logically constructed using Tables 1 and 2. Case size 0603 is only available in 5000 units per reel. Case size 0402 is available in 10000 units per reel.

- The code starts with 9365
- The subsequent 3 digits indicate case size and packaging quantity; see Table 1.
- The following 3 digits are always 122
- The last 2 digits indicate the inductance value in accordance with Table 2.

Table 1 Three digits to indicate case size and packaging quantity

TYPE	ORDERING CODE 9365	
	PAPER TAPE ON ∅180 mm REEL	
	5 000 UNITS	10 000 UNITS
THL0603	006 122..	–
THL0402	–	007 122..

Table 2 Last digits of 12NC

ORDERING CODE 9365			
INDUCTANCE VALUE (nH)	LAST TWO DIGITS	RANGE	
		0603	0402
1.0	11		
1.2	13		
1.5	15		
1.8	17		
2.2	19		
2.7	22		
3.3	24		
3.9	26		
4.7	28		
5.6	31		
6.8	33		
8.2	35	Shaded cells indicate product range.	
10	37		
12	39		
15	42		
18	44		
22	46		
27	48		
33	51		
39	53		
47	55		
56	57		
68	59		
82	62		
100	64		

ORDERING EXAMPLE

The ordering code of a thin film 0603 inductor, value 4.7 nH with a tolerance of 0.2 nH, on paper tape of 5 000 units per reel is: 9365 00 6 122 28.

FUNCTIONAL DESCRIPTION

Product characterization

Table 3 Available range and relevant electrical data for 0603 size

<table>
<tr><th rowspan="2">L
(nH)</th><th rowspan="2">TOL.</th><th colspan="3">Q</th><th>SRF
(GHz)</th><th>R_{DC}
(Ω)</th><th rowspan="2">I_R
(mA)</th></tr>
<tr><th>MIN.
at 300 MHz</th><th>TYPICAL
at 800 MHz</th><th>TYPICAL
at 1.5 GHz</th><th>MIN.</th><th>MIN.</th></tr>
<tr><td>1.0</td><td rowspan="12">±0.2 nH</td><td rowspan="9">20</td><td rowspan="4">34</td><td rowspan="5">38</td><td rowspan="8">6.0</td><td rowspan="3">0.10</td><td rowspan="3">1000</td></tr>
<tr><td>1.2</td></tr>
<tr><td>1.5</td></tr>
<tr><td>1.8</td><td rowspan="3">0.15</td><td rowspan="3">800</td></tr>
<tr><td>2.2</td><td rowspan="11">30</td></tr>
<tr><td>2.7</td><td rowspan="10">35</td></tr>
<tr><td>3.3</td><td rowspan="2">0.20</td><td rowspan="2">700</td></tr>
<tr><td>3.9</td></tr>
<tr><td>4.7</td><td rowspan="3">5.0</td><td>0.25</td><td>600</td></tr>
<tr><td>5.6</td><td rowspan="9">15</td><td rowspan="3">0.50</td><td rowspan="3">400</td></tr>
<tr><td>6.8</td></tr>
<tr><td>8.2</td><td rowspan="2">4.0</td></tr>
<tr><td>10</td><td rowspan="13">±2%</td><td rowspan="3">1.00</td><td rowspan="3">300</td></tr>
<tr><td>12</td><td rowspan="2">3.0</td></tr>
<tr><td>15</td></tr>
<tr><td>18</td><td rowspan="8">25</td><td rowspan="3">30</td><td rowspan="3">2.0</td><td rowspan="2">1.50</td><td rowspan="2">250</td></tr>
<tr><td>22</td></tr>
<tr><td>27</td><td rowspan="2">2.00</td><td rowspan="2">200</td></tr>
<tr><td>33</td><td rowspan="5">15(1)</td><td rowspan="3">–</td><td rowspan="3">1.5</td></tr>
<tr><td>39</td><td rowspan="2">3.00</td><td rowspan="2">180</td></tr>
<tr><td>47</td></tr>
<tr><td>56</td><td rowspan="4">–</td><td rowspan="4">1.0</td><td>4.00</td><td>150</td></tr>
<tr><td>68</td><td>4.50</td><td>140</td></tr>
<tr><td>82</td><td rowspan="2">10(1)</td><td rowspan="2">15</td><td>6.00</td><td>120</td></tr>
<tr><td>100</td><td>8.50</td><td>100</td></tr>
</table>

Note

1. Measured at 200 MHz

Table 4 Available range and relevant electrical data for 0402 size

<table>
<tr><th rowspan="2">L
(nH)</th><th rowspan="2">TOL.</th><th colspan="3">Q</th><th>SRF
(GHz)</th><th>R_{DC}
(Ω)</th><th rowspan="2">I_R
(mA)</th></tr>
<tr><th>MIN.
at 300 MHz</th><th>TYPICAL
at 800 MHz</th><th>TYPICAL
at 1.5 GHz</th><th>MIN.</th><th>MIN.</th></tr>
<tr><td>1.0</td><td rowspan="12">±0.2 nH</td><td rowspan="18">10</td><td rowspan="20">21</td><td rowspan="9">25</td><td rowspan="8">7.0</td><td rowspan="2">0.10</td><td rowspan="2">1200</td></tr>
<tr><td>1.2</td></tr>
<tr><td>1.5</td><td rowspan="2">0.15</td><td>930</td></tr>
<tr><td>1.8</td><td>730</td></tr>
<tr><td>2.2</td><td rowspan="2">0.20</td><td>600</td></tr>
<tr><td>2.7</td><td>580</td></tr>
<tr><td>3.3</td><td>0.30</td><td>500</td></tr>
<tr><td>3.9</td><td>0.40</td><td>420</td></tr>
<tr><td>4.7</td><td rowspan="4">5.5</td><td>0.60</td><td>340</td></tr>
<tr><td>5.6</td><td rowspan="3">22</td><td>0.70</td><td>320</td></tr>
<tr><td>6.8</td><td>0.80</td><td>290</td></tr>
<tr><td>8.2</td><td>1.30</td><td>230</td></tr>
<tr><td>10</td><td rowspan="3">±2%</td><td rowspan="6">20</td><td rowspan="3">4.0</td><td>1.50</td><td>210</td></tr>
<tr><td>12</td><td>1.80</td><td>190</td></tr>
<tr><td>15</td><td rowspan="3">2.55</td><td rowspan="3">160</td></tr>
<tr><td>18</td><td rowspan="5">±3%</td><td rowspan="3">2.0</td></tr>
<tr><td>22</td></tr>
<tr><td>27</td><td>2.70</td><td>150</td></tr>
<tr><td>33</td><td rowspan="2">10(1)</td><td rowspan="2">–</td><td rowspan="2">1.5</td><td>3.60</td><td>130</td></tr>
<tr><td>39</td><td>4.00</td><td>120</td></tr>
</table>

Note

1. Measured at 200 MHz.

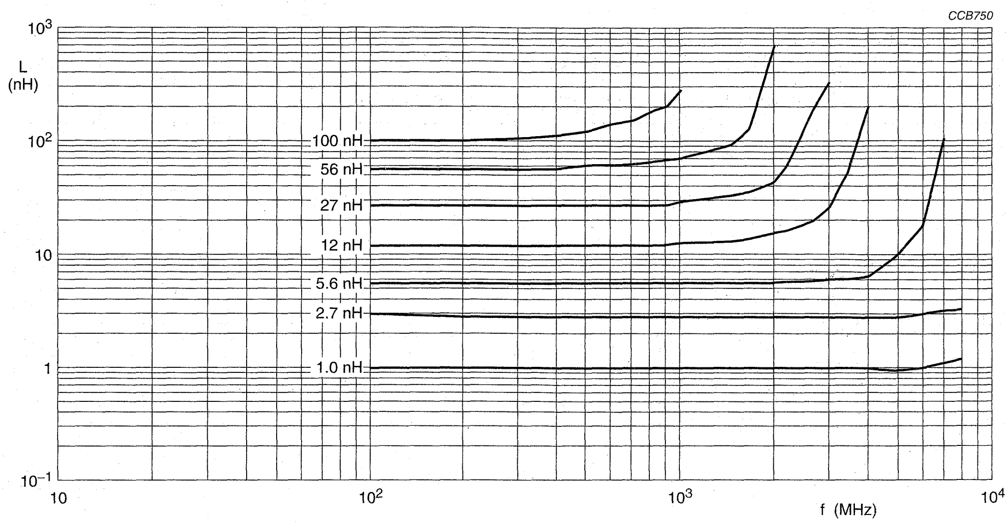


Fig.1 Typical inductance value for 0603 size inductors value as a function of frequency.

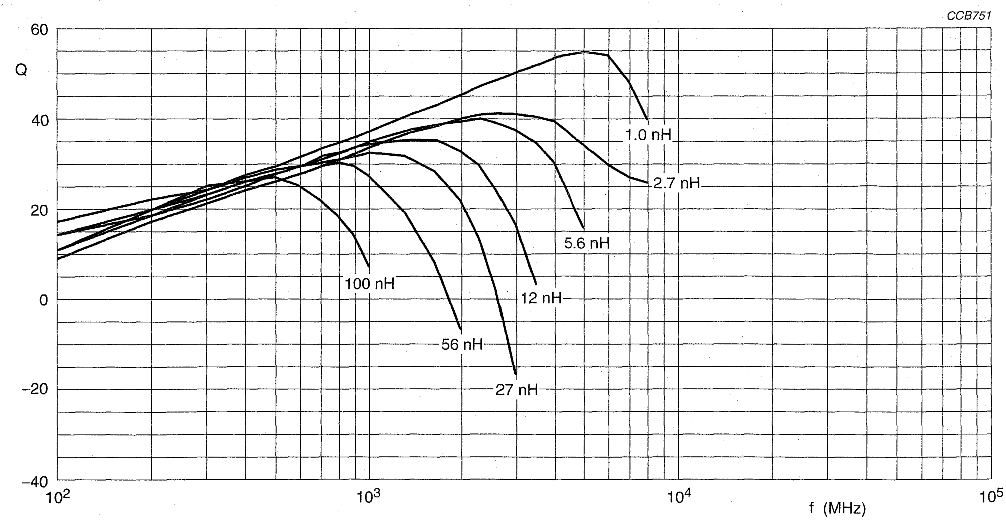


Fig.2 Typical Q for 0603 size inductors as a function of frequency.

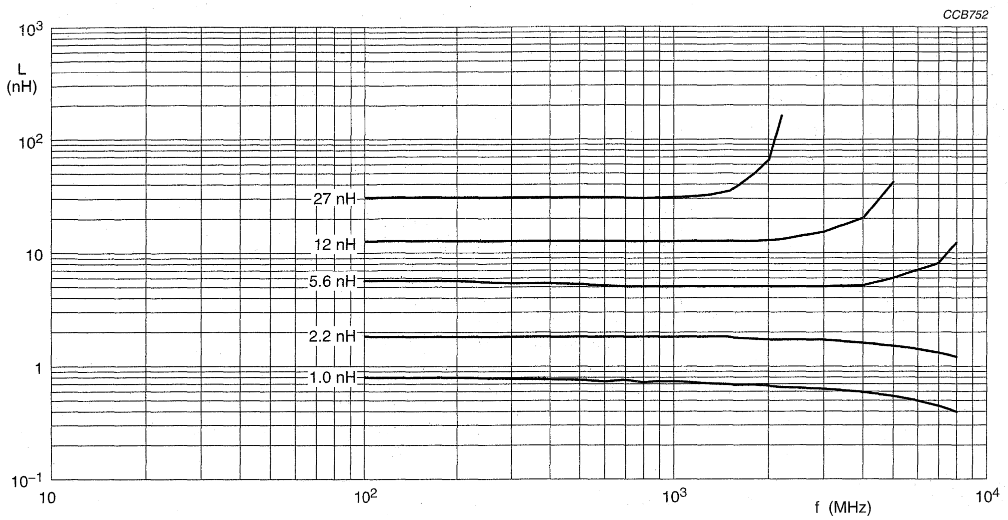


Fig.3 Typical inductance value for 0402 size inductors value as a function of frequency.

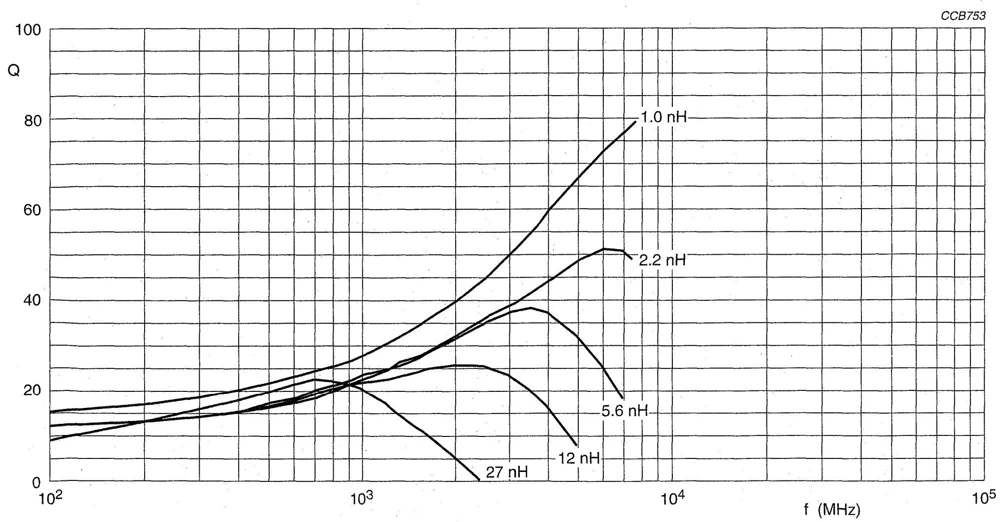


Fig.4 Typical Q for 0402 size inductors value as a function of frequency.

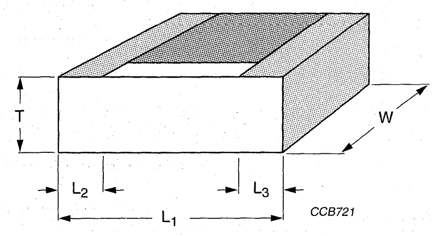
MECHANICAL DATA

Marking

PACKAGE MARKING

The reel and package are marked with inductance value, tolerance, class, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 5.

Fig.5 Component outline.

Table 5 Inductor dimensions; see Fig.5

CASE SIZE	L_1 (mm)	W (mm)	T (mm)	L_2 (mm)	L_3 (mm)
0402	1.0 ±0.1	0.5 ±0.1	0.4 ±0.1	0.25 ±0.05	0.25 ±0.05
0603	1.6 ±0.1	0.8 ±0.1	0.45 ±0.1	0.3 ±0.2	0.3 ±0.2

TESTS AND REQUIREMENTS

Table 6 Test procedures and requirements

TEST	PROCEDURE	REQUIREMENTS
Mounting	the inductors may be mounted on printed-circuit boards (PCBs) or ceramic substrates by applying reflow soldering or conductive adhesive	no visible damage
Visual inspection and dimension check	any applicable method using ×10 magnification	in accordance with specification
Mechanical performance		
Resistance to soldering heat	260 ±5 °C for 10 +0.5 s in a static soldering bath	no visible damage $\Delta L/L_{max.}$: ±5% $\Delta Q/Q_{max.}$: ±10% (L ≥ 10 nH) $\Delta Q/Q_{max.}$: ±20% (L < 10 nH)
Solderability	unmounted chips completely immersed for 2 +0.5 s in a soldering bath at 235 ±5 °C	good tinning (>95% covered), no visible damage
Environmental performance		
Endurance at 70 °C	1000 hours at 70 °C, loaded with I_{rated}, 1.5 hours on, 0.5 hours off	no visible damage $\Delta L/L_{max.}$: ±5% $\Delta Q/Q_{max.}$: ±10% (L ≥ 10 nH) $\Delta Q/Q_{max.}$: ±20% (L < 10 nH)
Rapid change of temperature	−55 to +125 °C, 50 cycles	no visible damage $\Delta L/L_{max.}$: ±5% $\Delta Q/Q_{max.}$: ±10% (L ≥ 10 nH) $\Delta Q/Q_{max.}$: ±20% (L < 10 nH)
Loaded, damp heat, steady state (JIS)	1000 hours at 40 °C; 90 to 95% RH; loaded with I_{rated}, 1.5 hours on, 0.5 hours off	no visible damage $\Delta L/L_{max.}$: ±5% $\Delta Q/Q_{max.}$: ±10% (L ≥ 10 nH) $\Delta Q/Q_{max.}$: ±20% (L < 10 nH)

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Data handbook system

DATA HANDBOOK SYSTEM

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SC06	High-voltage and Switching NPN Power Transistors
SC07	Small-signal Field-effect Transistors
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E192	E96	E48	E192	E96	E48	E192	E96	E48	E192	E96	E48
100	100	100	178	178	178	316	316	316	562	562	562
101			180			320			569		
102	102		182	182		324	324		576	576	
104			184			328			583		
105	105	105	187	187	187	332	332	332	590	590	590
106			189			336			597		
107	107		191	191		340	340		604	604	
109			193			344			612		
110	110	110	196	196	196	348	348	348	619	619	619
111			198			352			626		
113	113		200	200		357	357		634	634	
114			203			361			642		
115	115	115	205	205	205	365	365	365	649	649	649
117			208			370			657		
118	118		210	210		374	374		665	665	
120			213			379			673		
121	121	121	215	215	215	383	383	383	681	681	681
123			218			388			690		
124	124		221	221		392	392		698	698	
126			223			397			706		
127	127	127	226	226	226	402	402	402	715	715	715
129			229			407			723		
130	130		232	232		412	412		732	732	
132			234			417			741		
133	133	133	237	237	237	422	422	422	750	750	750
135			240			427			759		
137	137		243	243		432	432		768	768	
138			246			437			777		
140	140	140	249	249	249	442	442	442	787	787	787
142			252			448			796		
143	143		255	255		453	453		806	806	
145			258			459			816		
147	147	147	261	261	261	464	464	464	825	825	825
149			264			470			835		
150	150		267	267		475	475		845	845	
152			271			481			856		
154	154	154	274	274	274	487	487	487	866	866	866
156			277			493			876		
158	158		280	280		499	499		887	887	
160			284			505			898		
162	162	162	287	287	287	511	511	511	909	909	909
164			291			517			920		
165	165		294	294		523	523		931	931	
167			298			530			942		
169	169	169	301	301	301	536	536	536	953	953	953
172			305			542			965		
174	174		309	309		549	549		976	976	
176			312			556			988		

E24	E12	E6	E3
10	10	10	10
11			
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75			
82	82		
91			

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