PHILIPS

Film capacitors

C22 1986

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Data handbook

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Electronic components and materials

Components and materials

Book C22 1986

Film capacitors

FILM CAPACITORS

DATA HANDBOOK SYSTEM

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

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

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

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

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

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ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks comprises:

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

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

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

T3 **Klystrons**

T4 **Magnetrons for microwave heating**

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

T6 **Geiger-Müller tubes**

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

T9 **Photo and electron multipliers**

T10 **Plumbicon camera tubes and accessories**

T11 **Microwave semiconductors and components**

T12 **Vidicon and Newvicon camera tubes**

T13 **Image intensifiers and infrared detectors**

T15 **Dry reed switches**

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

SEMICONDUCTORS (RED SERIES)

The red series of data handbooks comprises:

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

S2a **Power diodes**

S2b **Thyristors and triacs**

S3 **Small-signal transistors**

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

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

S5 **Field-effect transistors**

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

S7 **Surface mounted semiconductors**

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

S9 **Power MOS transistors**

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

S11 **Microwave transistors**

S12 **Surface acoustic wave devices**

S13 **Semiconductor sensors**

INTEGRATED CIRCUITS (PURPLE SERIES)

The purple series of data handbooks comprises:

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

NEW SERIES

IC01N	**Radio, audio and associated systems** Bipolar, MOS	(published 1985)
IC02Na	**Video and associated systems** Bipolar, MOS Types MAB8031AH to TDA1524A	(published 1985)
IC02Nb	**Video and associated systems** Bipolar, MOS Types TDA2501 to TEA1002	(published 1985)
IC03N	**Integrated circuits for telephony**	(published 1985)
IC04N	**HE4000B logic family** CMOS	
IC05N	**HE4000B logic family — uncased ICs** CMOS	(published 1984)
IC06N*	**High-speed CMOS; PC74HC/HCT/HCU** Logic family	(published 1986)
IC07N	**High-speed CMOS; PC54/74HC/HCT/HCU — uncased ICs** Logic family	
IC08N	**ECL 10K and 100K logic families**	(published 1984)
IC09N	**TTL logic series**	(published 1984)
IC10N	**Memories** MOS, TTL, ECL	
IC11N	**Linear LSI**	(published 1985)
IC12N	**Semi-custom gate arrays & cell libraries** ISL, ECL, CMOS	
IC13N	**Semi-custom** Integrated Fuse Logic	(published 1985)
IC14N	**Microprocessors, microcontrollers & peripherals** Bipolar, MOS	(published 1985)
IC15N	**FAST TTL logic series**	(published 1984)

Note

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

* Supersedes the IC06N edition and the Supplement to IC06N issued Autumn 1985.

COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

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

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

C3 **Loudspeakers**

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

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

C6 **Synchronous motors and gearboxes**

C7 **Variable capacitors**

C8 **Variable mains transformers**

C9 **Piezoelectric quartz devices**

C10 **Connectors**

C11 **Varistors, thermistors and sensors**

C12 **Potentiometers, encoders and switches**

C13 **Fixed resistors**

C14 **Electrolytic and solid capacitors**

C15 **Ceramic capacitors**

C16 **Permanent magnet materials**

C17 **Stepping motors and associated electronics**

C18 **Direct current motors**

C19 **Piezoelectric ceramics**

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

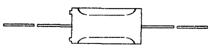
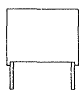
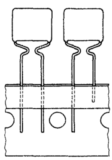
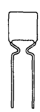
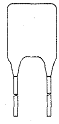
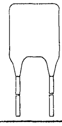
C21* **Assemblies for industrial use**
HNIL FZ/30 series, NORbits 60-, 61-, 90-series, input devices

C22 **Film capacitors**

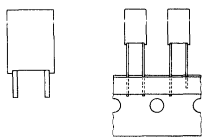
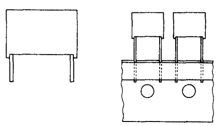
* To be issued shortly.

SELECTION GUIDE

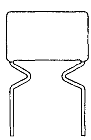
SELECTION GUIDE

style 2222 . . .	type	rated cap. range	rated voltage V	pitch mm	page
METALLIZED POLYETHYLENETEREPHTHALATE FILM CAPACITORS (MKT)					
341	moulded 	0,082 –6,8 μF 0,039 –2,2 μF 0,0082–1,0 μF	100 250 400		9
344	potted 	0,18 –10 μF 0,082 –10 μF 0,039 –2,2 μF 0,010 –1,0 μF	63 100 250 400	10; 15; 22,5; 27,5	21
365	epoxy lacquered 	0,047 –1,0 μF 0,01 –0,10 μF	63 100	5,08	41
		0,12 –1,0 μF 0,039 –0,47 μF 0,018 –0,047 μF 0,0039–0,015 μF	63 100 250 400	5,08*	
366	epoxy lacquered 	0,047 –1,0 μF 0,01 –0,10 μF	63 100	5,08	41
		0,12 –1,0 μF 0,039 –0,47 μF 0,018 –0,047 μF 0,0039–0,015 μF	63 100 250 400	7,62	
367	epoxy lacquered 	0,047 –1,0 μF 0,01 –0,10 μF	63 100	5,08	41
		0,12 –1,0 μF 0,039 –0,47 μF 0,018 –0,047 μF 0,0039–0,015 μF	63 100 250 400	7,62	
368	epoxy lacquered 	0,056 –6,8 μF 0,027 –2,2 μF 0,001 –1,0 μF 0,01 –0,47 μF	100 250 400 630	10,16; 15,24; 22,86; 27,94	41
369	epoxy lacquered 	0,056 –0,22 μF 0,027 –0,10 μF 0,001 –0,033 μF 0,010 –0,022 μF	100 250 400 630	10,16	41

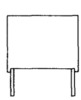
* Original pitch 7,62 mm reduced to 5,08 mm.

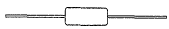
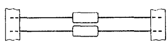
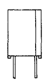
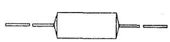
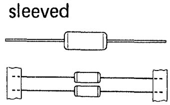
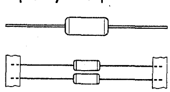
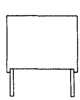
style 2222 . . .	type	rated cap. range	rated voltage V	pitch mm	page
370	potted 	0,039 –1,0 µF 0,0039–0,10 µF	63 100	5,08	21
371	potted 	0,056 –1,0 µF 0,018 –0,47 µF 0,0082–0,10 µF 0,0039–0,010 µF	63 100 250 400	7,62	21

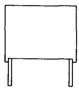
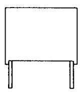
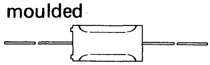
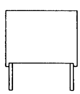
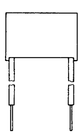
POLYETHYLENETEREPHTHALATE FILM/FOIL CAPACITORS (KT)

style 2222 . . .	type	rated cap. range	rated voltage V	pitch mm	page
347	phenolic lacquered 	0,015 –1,0 µF 0,0082–0,68 µF 0,0047–0,33 µF 0,001 –0,15 µF	100 250 400 630	10,16; 15,24; 22,86; 27,94	95

METALLIZED POLYCARBONATE FILM CAPACITORS (MKC)

style 2222 . . .	type	rated cap. range	rated voltage V	pitch mm	page
341	moulded 	0,082 –6,8 µF 0,039 –2,2 µF 0,0082–1,0 µF 0,0082–0,47 µF 0,0082–0,15 µF	100 250 400 630 1000		117
344	potted 	0,082 –6,8 µF 0,039 –2,2 µF 0,010 –1,0 µF 0,010 –0,47 µF	100 250 400 630	10; 15; 22,5; 27,5	129

style 2222 . . .	type	rated cap. range	rated voltage V	pitch mm	page
POLYSTYRENE FILM/FOIL CAPACITORS (KS)					
424 425 426 427	sleeved 	2 000– 39 000 pF 1 100– 16 000 pF 560– 11 000 pF 51– 5 600 pF	63 160 250 630		165
428 429 430 431		2 000– 39 000 pF 1 100– 16 000 pF 560– 11 000 pF 51– 5 600 pF	63 160 250 630		
443	potted 	100– 34 000 pF	63	2,54; 5,08; 7,62	179
444 445 446 447	wrapped end-filled 	43 000–162 000 pF 18 000– 82 000 pF 12 000– 47 000 pF 6 200– 24 000 pF	63 160 250 630		193
POLYPROPYLENE FILM/FOIL CAPACITORS (KP)					
455 456 457	sleeved 	3 300– 56 000 pF 1 800– 36 000 pF 47– 20 000 pF	63 160 250		241
460 461 462	epoxy lacquered 	6 800– 62 000 pF 3 600– 39 000 pF 47– 22 000 pF	63 160 250		253
357 5....	potted 	0,039–0,82 μF	250	15; 22,5; 27,5	233

style 2222 . . .	type	rated cap. range	rated voltage V	pitch mm	page
A.C. AND PULSE METALLIZED POLYPROPYLENE FILM CAPACITORS					
(KP/MKP) 357 6 . . . . 357 7 . . . . 357 8 . . . . 357 9	potted 	0,047 –0,33 µF 0,016 –0,22 µF 0,0082–0,15 µF 0,001 –0,013 µF	630 1000 1500 2000	22,5; 27,5	289
(KP/MMKP) 376	potted 	0,027 –0,27 µF 0,015 –0,18 µF 0,0068–0,015 µF 0,0010–0,010 µF	630 1000 1500 2000	22,5; 27,5	301
INTERFERENCE SUPPRESSION CAPACITORS (MKT-P)					
330 0	moulded 	0,01 –0,47 µF	250 V~		323
330 4	potted 	0,01 –1,0 µF	250 V~	15; 22,5; 27,5	323
330 8	potted; insulated leads 	0,01 –0,1 µF	250 V~	15	323

METALLIZED POLYETHYLENETHEREPHTHALATE FILM CAPACITORS (MKT)

METALLIZED POLYETHYLENETEREPHTHALATE FILM CAPACITORS

MKT axial moulded type

- Supplied in boxes

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	0,0082 to 6,8 μF
Tolerance on rated capacitance	± 20%, ± 10%, ± 5%
Rated voltage U_R (d.c.)	100 V, 250 V, 400 V
Climatic category	55/100/56
Rated temperature	85 °C
Tangent of loss angle at 10 kHz	100×10^{-4}
Related specification	IEC 384-2
Performance grade	general purpose

STYLE

Style 2222 341; see Tables 1 to 3.

APPLICATION

In electronic circuits for blocking and coupling, bypass and energy reservoir applications.

DESCRIPTION

The capacitors consist of a low-inductance wound cell of metallized polyethyleneterephthalate (PETP) film. The cell is moulded in yellow flame retardent polypropylene. The axial leads are of solder-coated wire. One end of the capacitor is provided with two stand-off ridges to allow removal of solder flux etc., when cleaning the printed-wiring board.

GENERAL DATA

Dimensions in mm

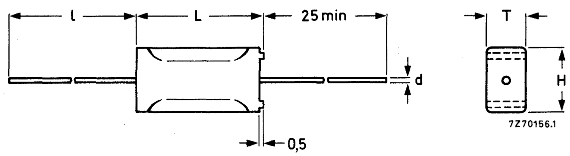


Fig. 1.

Table 1–U_R (d.c.) = 100 V; max. a.c. voltage = 63 V; Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass g	catalogue number 2222 341 . . . . . tol. ± 20%	tol. ± 10%	tol. ± 5%
0,082	5,1	8,8	14,6	0,8	40	1,0	26823	27823	25823
0,10							26104	27104	25104
0,12							26124	27124	25124
0,15							26154	27154	25154
0,18						1,1	26184	27184	25184
0,22						1,4	26224	27224	25224
0,27	5,7	9,5	14,6				26274	27274	25274
0,33	6,6	10,4	18,1			1,7	26334	27334	25334
0,39							26394	27394	25394
0,47						2,0	26474	27474	25474
0,56	7,9	11,5	18,1				26564	27564	25564
0,68	7,8	11,6	23,5			2,5	26684	27684	25684
0,82							26824	27824	25824
1,0	9,2	12,9	23,5			3,2	26105	27105	25105
1,2							26125	27125	25125
1,5	10,8	14,5	23,5			4,0	26155	27155	25155
1,8							26185	27185	25185
2,2	10,7	14,6	31	1	50	5,5	26225	27225	25225
2,7							26275	27275	25275
3,3	12,5	19,5	31			8,0	26335	27335	25335
3,9							26395	27395	25395
4,7							26475	27475	25475
5,6	15,4	22,1	31			10,5	26565	27565	25565
6,8							26685	27685	25685

Table 2-U_R (d.c.) = 250 V; max. a.c. voltage = 160 V; Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass g	catalogue number 2222 341 . . . . . tol. ± 20%	tol. ± 10%	tol. ± 5%
0,039	5,1	8,8	14,6	0,8	40	1,0	88393	89393	87393
0,047							88473	89473	87473
0,056							88563	89563	87563
0,068							88683	89683	87683
0,082	5,7	9,5	14,6			1,1	88823	89823	87823
0,10							88104	89104	87104
0,12	6,6	10,4	18,1			1,7	88124	89124	87124
0,15							88154	89154	87154
0,18							88184	89184	87184
0,22							88224	89224	87224
0,27	7,8	11,6	23,5			2,5	88274	89274	87274
0,33							88334	89334	87334
0,39							88394	89394	87394
0,47							88474	89474	87474
0,56	9,2	12,9	23,5			3,2	88564	89564	87564
0,68							88684	89684	87684
0,82	10,7	14,6	31	1	50	5,5	88824	89824	87824
1,0							88105	89105	87105
1,2							88125	89125	87125
1,5	12,5	19,5	31			8,0	88155	89155	87155
1,8							88185	89185	87185
2,2							88225	89225	87225

Table 3-U_R (d.c.) = 400 V; max. a.c. voltage = 220 V; Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass g	catalogue number 2222 341 ..... tol. ± 20%	tol. ± 10%	tol. ± 5%
0,0082	5,1	8,8	14,6	0,8	40	1,0	54822	55822	53822
0,010							54103	55103	53103
0,012							54123	55123	53123
0,015							54153	55153	53153
0,018							54183	55183	53183
0,022							54223	55223	53223
0,027							54273	55273	53273
0,033							54333	55333	53333
0,039	7	10,6	14,6			1,4	54393	55393	53393
0,047							54473	55473	53473
0,056	6,6	10,4	18,1			1,7	54563	55563	53563
0,068							54683	55683	53683
0,082	7,9	11,5	18,1			2,0	54823	55823	53823
0,10							54104	55104	53104
0,12	7,8	11,6	23,5			2,5	54124	55124	53124
0,15							54154	55154	53154
0,18	9,2	12,9	23,5			3,2	54184	55184	53184
0,22							54224	55224	53224
0,27	10,8	14,5	23,5			4,0	54274	55274	53274
0,33							54334	55334	53334
0,39	10,7	14,6	31	1	50	5,5	54394	55394	53394
0,47							54474	55474	53474
0,56	12,5	19,5	31			8,0	54564	55564	53564
0,68							54684	55684	53684
0,82	15,4	22,1	31			10,5	54824	55824	53824
1,0							54105	55105	53105

Marking

a. Rated capacitance
b. Rated voltage
c. Tolerance on rated capacitance
d. Category voltage
e. Year and month of manufacture
f. Manufacturer's name
g. Climatic category
h. Manufacturer's type designation

The marking is impressed on one side with a, b, c, e and h as follows:

1st line : rated capacitance in pF or μF, tolerance and rated d.c. voltage;

2nd line: 5th, 6th and 7th digits of the catalogue number, code for dielectric material (MKT) and production date code (according to IEC 62, clause 5).

The marking on the other side is impressed with f as follows:

1st line : manufacturer's name;

2nd line: code for factory of origin.

The package containing the capacitors is marked with a to h.

Mounting

The capacitors are for horizontal or vertical mounting on printed-wiring boards and for point to point wiring.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 kHz	see Tables 1 to 3
Tolerance on rated capacitance	see Tables 1 to 3

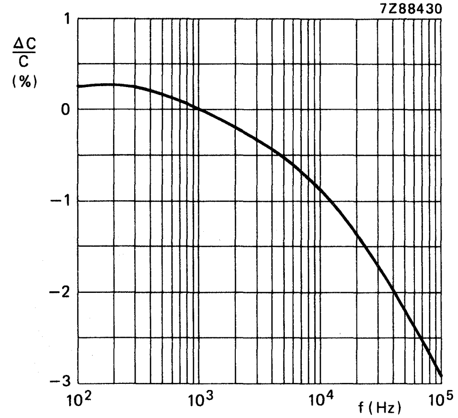


Fig. 2 Capacitance as a function of frequency; typical curve.

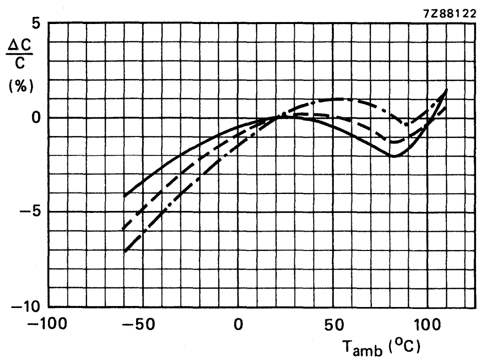


Fig. 3 Capacitance as a function of ambient free air temperature; typical curves.
——— for all capacitance values, measured at 1 kHz, 1 V.
– – – – for capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.
– · – · – for capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Voltage

Rated voltage U_R (d.c.)	See Tables 1 to 3
Category voltage U_C	0,8 x U_R (d.c.)
Maximum a.c. voltage (r.m.s. value), at 50 to 60 Hz	See Tables 1 to 3
Test voltage	
between terminations	1,6 x U_R (d.c.)
between interconnected terminations and case	2 x U_R (d.c.); min. 200 V

Temperature

Climatic category	55/100/56
Rated temperature	85 ^oC
Storage temperature range	−55 to + 100 ^oC

Notes

- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.).
- For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

Maximum pulse load

rated voltage V	maximum pulse load (V/μs)			
	L = 14,5 mm	L = 18 mm	L = 23,5 mm	L = 31 mm
100	24	10	6	3,5
250	35	14	9	5
400	55	22	14	8

The maximum pulse load values in the table are valid for pulse voltages equal to the rated voltage.

For lower pulse voltages the given values may be multiplied by U_R/applied voltage.

Note

If the pulse load requirement is satisfied, a check must be made to ascertain that the maximum dissipation is not exceeded.

Tangent of loss angle

capacitance	tangent of loss angle		
	1 kHz	10 kHz	100 kHz
$C_R \leqslant 0{,}1\ \mu F$	$\leqslant 75 \times 10^{-4}$	$\leqslant 130 \times 10^{-4}$	$\leqslant 250 \times 10^{-4}$
$0{,}1\ \mu F < C_R \leqslant 1\ \mu F$	$\leqslant 75 \times 10^{-4}$	$\leqslant 130 \times 10^{-4}$	
$C_R > 1\ \mu F$	$\leqslant 75 \times 10^{-4}$	$\leqslant 150 \times 10^{-4}$	

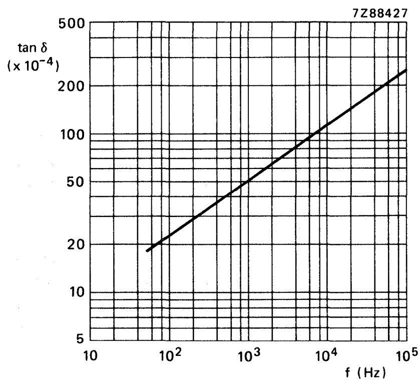


Fig. 4 Tan δ as a function of frequency, typical curve.

Insulation resistance

The insulation resistance is measured after a voltage of 100 ± 15 V has been applied for 1 min ± 5 s, at T_{amb} = 20 °C.

R between terminations, for $C_R \leqslant 0{,}33\ \mu F$

100 V version	> 15 000 MΩ
250 V and 400 V versions	> 30 000 MΩ

RC between terminations, for $C_R > 0{,}33\ \mu F$

100 V version	> 5 000 s
250 V and 400 V versions	> 10 000 s

R between interconnected terminations and case (foil method) > 30 000 MΩ

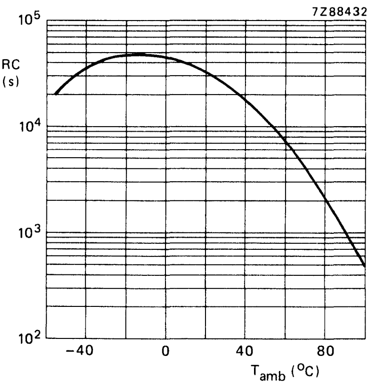


Fig. 5 RC-product as a function of ambient free air temperature; typical curve.

Maximum dissipation

Notes

In applications where voltages higher than 50 V are applied, it is recommended that the power in the capacitor be limited to 2,5 VA in case of capacitor failure.

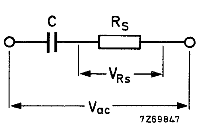
If the requirement for the maximum dissipation is satisfied, a check must be made to ascertain that the maximum pulse load is not exceeded.

The maximum a.c. voltage has been specified for 50 to 60 Hz and at 23 °C. This voltage value must also never be exceeded at other frequencies. This permissible a.c. voltage may further be limited by the following requirements:

1. The power dissipation must not exceed the specified limit P_{max}.
2. The steepness of the a.c. voltage must not exceed the specified limit.

The power dissipated by a capacitor is a function of the voltage across the series resistance (R_s) or of the current through the series resistance and is expressed by

$$P = \frac{V_{R_s}^2}{R_s} = I^2 R_s \qquad (1)$$



$$V_{R_s}^2 = \frac{R_s^2}{R_s^2 + 1/\omega^2 C^2} V_{ac}^2 \qquad (2a)$$

Because for these capacitors $\tan \delta = R_s \omega C = < 0{,}1$, the formula (2a) can be simplified to

$$V_{R_s}^2 = \frac{R_s^2}{1/\omega^2 C^2} V_{ac}^2 = R_s^2 \omega^2 C^2 V_{ac}^2 \qquad (2b)$$

Thus $\quad P = R_s \omega^2 C^2 V_{ac}^2 \qquad (3a)$

or $\quad P = (R_s C)\, C \omega^2 V_{ac}^2 \qquad (3b)$

The term R_sC can be found from Fig. 6, C (in farads), $\omega = 2\pi f$ and V_{ac} are assumed to be known.

The maximum permissible value of power dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be read from Fig. 7.

Thus, when the actual power has been calculated with equation (3b), Fig. 7 gives the minimum size of capacitor which can dissipate this power.

Example of using Figs 6 and 7

A capacitor of 1 μF should be used at an a.c. voltage of 130 V, a frequency of 1 kHz and an ambient free air temperature of 50 ^oC.

The RsC-product is $7{,}1 \times 10^{-7}$ ΩF (from Fig. 6), so that the power to be dissipated is

$$P = (RsC)\, C\omega^2 Vac^2$$
$$= 7{,}1 \cdot 10^{-7} \times 1 \circ 10^{-6} \times (2\pi)^2 \times 10^6 \times 130^2$$
$$= 472 \text{ mW}$$

For a rated voltage of 130 Vac a capacitor of the 250 V range is required at least.

Capacitor 1 μF/160 Vac is satisfactory because of its dimensions 10,7 mm x 14,6 mm x 31 mm and its dissipated power of 595 mW at 50 ^oC.

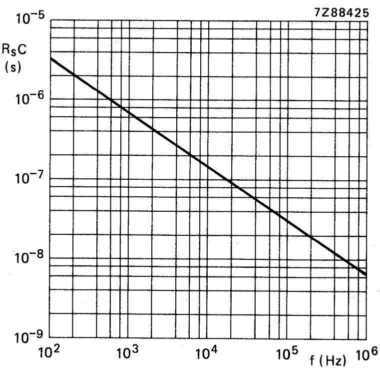


Fig. 6 Maximum product of series resistance and capacitance as a function of frequency.

curve	dimensions (mm)		
	T_{max}	H_{max}	L_{max}
1	5,1	8,8	14,6
2	5,7	9,5	14,6
3	7	10,6	14,6
4	6,6	10,4	18,1
5	7,9	11,5	18,1
6	7,8	11,6	23,5
7	9,2	12,9	23,5
8	10,8	14,5	23,5
9	10,7	14,6	31
10	12,5	19,5	31
11	15,4	22,1	31

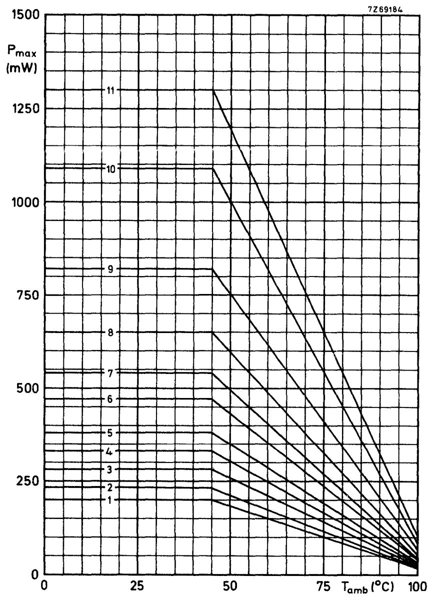


Fig. 7 Maximum dissipation as a function of ambient free air temperature.

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number as shown in Tables 1 to 3.

PACKING

The capacitors are packed in boxes of 250 (for $H_{max} \leqslant 11,6$ mm) and 200 (for $H_{max} > 11,6$ mm).

METALLIZED POLYETHYLENETEREPHTHALATE FILM CAPACITORS

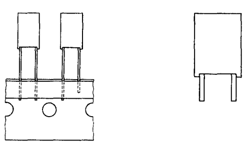
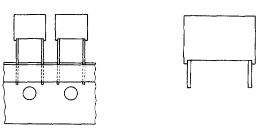
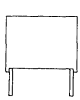
MKT radial potted type

- 5,08 to 27,5 mm pitch
- Supplied on tape or in boxes

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	0,0039 to 10 μF
Tolerance on rated capacitance	± 20%, ± 10%, ± 5%
Rated voltage U_R (d.c.)	63 V, 100 V, 250 V, 400 V
Climatic category	55/100/56
Rated temperature	85 °C
Tangent of the loss angle at 10 kHz	100 x 10^{-4}
Related specification	IEC 384-2
Performance grade	long life
Qualified according to	CECC 30 401-039*

SURVEY OF STYLES

	style	pitch	tables
	2222 370	5,08 mm	1 to 2
	2222 371	7,62 mm	3 to 6
	2222 344	10 to 27,5 mm	7 to 10

APPLICATION

In electronic circuits for blocking and coupling, bypass and energy reservoir applications. Their defined dimensions make them suitable for circuits with high packaging density.

DESCRIPTION

The capacitors consist of a low-inductance wound cell of metallized polyethyleneterephthalate (PETP) film. The cell is potted with epoxy resin in a flame retardent polypropylene case. The radial leads are of solder-coated wire. The capacitors can withstand solvents and rinsing liquids without damage. They have small stand-off pips to allow removal of solder flux etc. during cleaning of the printed-wiring board.

* Except for 63 V version of style 2222 344.

GENERAL DATA

Dimensions in mm

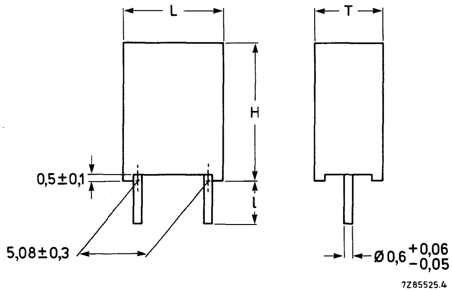


Fig. 1.

In addition to the capacitors quoted in Tables 1 and 2, capacitors with tolerance ± 5% are available. The catalogue number of these capacitors can be found by replacing the 2nd digit in the columns by:
2 for capacitors with l = 4 ± 0,5 mm,
6 for capacitors with l = 26 ± 1 mm,
9 for capacitors on tape;
e.g.: 2222 370 10393 → 2222 370 12393.

Table 1 U_R (d.c.) = 63 V; max. a.c. voltage = 40 V; Fig. 1.

rated capacitance μF	T_{max}	H_{max}	L_{max}	mass g	catalogue number 2222 370							
					packed in boxes				on tape on reel		on tape in ammunition pack	
					l = 4 ± 0,5		l = 26 ± 1					
					tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,039	2,5	6,5	7,2	0,25	10393	11393	14393	15393	17393	18393	77393	78393
0,047					10473	11473	14473	15473	17473	18473	77473	78473
0,056					10563	11563	14563	15563	17563	18563	77563	78563
0,068					10683	11683	14683	15683	17683	18683	77683	78683
0,082					10823	11823	14823	15823	17823	18823	77823	78823
0,10					10104	11104	14104	15104	17104	18104	77104	78104
0,12	3,5	8	7,2	0,35	10124	11124	14124	15124	17124	18124	77124	78124
0,15					10154	11154	14154	15154	17154	18154	77154	78154
0,18					10184	11184	14184	15184	17184	18184	77184	78184
0,22					10224	11224	14224	15224	17224	18224	77224	78224
0,27	4,5	9	7,2	0,45	10274	11274	14274	15274	17274	18274	77274	78274
0,33					10334	11334	14334	15334	17334	18334	77334	78334
0,39	5	10	7,2	0,5	10394	11394	14394	15394	17394	18394	77394	78394
0,47					10474	11474	14474	15474	17474	18474	77474	78474
0,56	6	11	7,2	0,6	10564	11564	14564	15564	17564	18564	77564	78564
0,68					10684	11684	14684	15684	17684	18684	77684	78684
0,82					10824	11824	14824	15824	17824	18824	77824	78824
1,0					10105	11105	14105	15105	17105	18105	77105	78105

Table 2 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V; Fig. 1.

rated capacitance µF	T_{max}	H_{max}	L_{max}	mass g	catalogue number 2222 370							
					packed in boxes				on tape on reel		on tape in ammunition pack	
					l = 4 ± 0,5		l = 26 ± 1					
					tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,0039	2,5	6,5	7,2	0,25	20392	21392	24392	25392	27392	28392	87392	88392
0,0047					20472	21472	24472	25472	27472	28472	87472	88472
0,0056					20562	21562	24562	25562	27562	28562	87562	88562
0,0068					20682	21682	24682	25682	27682	28682	87682	88682
0,0082					20822	21822	24822	25822	27822	28822	87822	88822
0,010					20103	21103	24103	25103	27103	28103	87103	88103
0,012					20123	21123	24123	25123	27123	28123	87123	88123
0,015					20153	21153	24153	25153	27153	28153	87153	88153
0,018					20183	21183	24183	25183	27183	28183	87183	88183
0,022					20223	21223	24223	25223	27223	28223	87223	88223
0,027					20273	21273	24273	25273	27273	28273	87273	88273
0,033					20333	21333	24333	25333	27333	28333	87333	88333
0,039	3,5	8	7,2	0,35	20393	21393	24393	25393	27393	28393	87393	88393
0,047					20473	21473	24473	25473	27473	28473	87473	88473
0,056					20563	21563	24563	25563	27563	28563	87563	88563
0,068					20683	21683	24683	25683	27683	28683	87683	88683
0,082					20823	21823	24823	25823	27823	28823	87823	88823
0,10					20104	21104	24104	25104	27104	28104	87104	88104

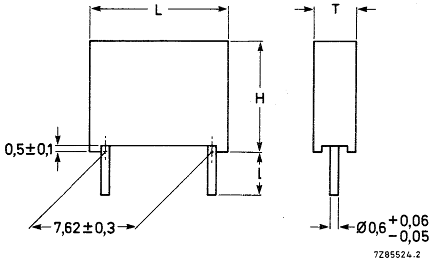


Fig. 2.

In addition to the capacitors quoted in Tables 3 to 6, capacitors with tolerance ± 5% are available. The catalogue number of these capacitors can be found by replacing the 2nd digit in the columns by:
2 for capacitors with l = 4 ± 0,5 mm,
6 for capacitors with l = 26 ± 1 mm,
9 for capacitors on tape;
e.g.: 2222 371 10563 → 2222 371 12563.

Table 3 U_R (d.c.) = 63 V; max. a.c. voltage = 40 V; Fig. 2.

rated capacitance µF	T_{max}	H_{max}	L_{max}	mass g	catalogue number 2222 371					
					l = 4 ± 0,5		l = 26 ± 1		on tape on reel	
					tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,056	2,5	6,5	10	0,3	10563	11563	14563	15563	17563	18563
0,068					10683	11683	14683	15683	17683	18683
0,082					10823	11823	14823	15823	17823	18823
0,10					10104	11104	14104	15104	17104	18104
0,12	3	8	10	0,4	10124	11124	14124	15124	17124	18124
0,15					10154	11154	14154	15154	17154	18154
0,18					10184	11184	14184	15184	17184	18184
0,22					10224	11224	14224	15224	17224	18224
0,27	4	9	10	0,5	10274	11274	14274	15274	17274	18274
0,33					10334	11334	14334	15334	17334	18334
0,39					10394	11394	14394	15394	17394	18394
0,47					10474	11474	14474	15474	17474	18474
0,56	5	10,5	10	0,65	10564	11564	14564	15564	17564	18564
0,68					10684	11684	14684	15684	17684	18684
0,82	6	11,5	10	0,75	10824	11824	14824	15824	17824	18824
1,0					10105	11105	14105	15105	17105	18105

Table 4 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V; Fig. 2

rated capacitance µF	T_{max}	H_{max}	L_{max}	mass g	catalogue number 2222 371					
					l = 4 ± 0,5		l = 26 ± 1		on tape on reel	
					tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,018	2,5	6,5	10	0,3	20183	21183	24183	25183	27183	28183
0,022					20223	21223	24223	25223	27223	28223
0,027					20273	21273	24273	25273	27273	28273
0,033					20333	21333	24333	25333	27333	28333
0,039					20393	21393	24393	25393	27393	28393
0,047					20473	21473	24473	25473	27473	28473
0,056	3	8	10	0,4	20563	21563	24563	25563	27563	28563
0,068					20683	21683	24683	25683	27683	28683
0,082					20823	21823	24823	25823	27823	28823
0,10					20104	21104	24104	25104	27104	28104
0,12	4	9	10	0,5	20124	21124	24124	25124	27124	28124
0,15					20154	21154	24154	25154	27154	28154
0,18					20184	21184	24184	25184	27184	28184
0,22					20224	21224	24224	25224	27224	28224
0,27	5	10,5	10	0,65	20274	21274	24274	25274	27274	28274
0,33					20334	21334	24334	25334	27334	28334
0,39	6	11,5	10	0,75	20394	21394	24394	25394	27394	28394
0,47					20474	21474	24474	25474	27474	28474

Table 5 U_R (d.c.) = 250 V; max. a.c. voltage = 160 V; Fig. 2.

rated capacitance µF	T_{max}	H_{max}	L_{max}	mass g	catalogue number 2222 371					
					l = 4 ± 0,5		l = 26 ± 1		on tape on reel	
					tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,0082	2,5	6,5	10	0,3	40822	41822	44822	45822	47822	48822
0,010					40103	41103	44103	45103	47103	48103
0,012					40123	41123	44123	45123	47123	48123
0,015					40153	41153	44153	45153	47153	48153
0,018	3	8	10	0,4	40183	41183	44183	45183	47183	48183
0,022					40223	41223	44223	45223	47223	48223
0,027					40273	41273	44273	45273	47273	48273
0,033					40333	41333	44333	45333	47333	48333
0,039	4	9	10	0,5	40393	41393	44393	45393	47393	48393
0,047					40473	41473	44473	45473	47473	48473
0,056	5	10,5	10	0,65	40563	41563	44563	45563	47563	48563
0,068					40683	41683	44683	45683	47683	48683
0,082	6	11,5	10	0,75	40823	41823	44823	45823	47823	48823
0,10					40104	41104	44104	45104	47104	48104

Table 6 U_R (d.c.) = 400 V; max. a.c. voltage = 220 V; Fig. 2.

rated capacitance µF	T_{max}	H_{max}	L_{max}	mass g	catalogue number 2222 371					
					l = 4 ± 0,5		l = 26 ± 1		on tape on reel	
					tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,0039	2,5	6,5	10	0,3	50392	51392	54392	55392	57392	58392
0,0047					50472	51472	54472	55472	57472	58472
0,0056					50562	51562	54562	55562	57562	58562
0,0068					50682	51682	54682	55682	57682	58682
0,0082	3	8	10	0,4	50822	51822	54822	55822	57822	58822
0,010					50103	51103	54103	55103	57103	58103

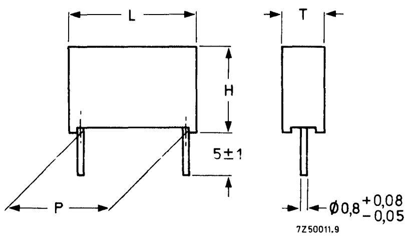


Fig. 3.

In addition to the capacitors quoted in Tables 7 to 10, capacitors with tolerance ± 5% are available. The catalogue number of these capacitors can be found by replacing the 2nd digit in the columns by:
2 for U_R = 250 V,
3 for U_R = 63 V, 100 V and 400 V;
e.g.: 2222 344 14184 → 2222 344 13184.

Table 7 U_R (d.c.) = 63 V; max. a.c. voltage = 40 V; Fig. 3.

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 344 ..... tol. ± 20%	tol. ± 10%
0,18	4,5	10	13	10 ± 0,3	0,7	14184	15184
0,22	4,5	10				14224	15224
0,27	5	11			0,85	14274	15274
0,33	5	11				14334	15334
0,39	6	12			1	14394	15394
0,47	6	12				14474	15474
0,56	6	12	17,5	15 ± 0,3	1,4	14564	15564
0,68	6	12				14684	15684
0,82	7	13			1,8	14824	15824
1,0	7	13				14105	15105
1,2	8,5	14,5			2,55	14125	15125
1,5	8,5	14,5				14155	15155
1,8	6,5	15,5	26	22,5 ± 0,3	2,75	14185	15185
2,2	6,5	15,5				14225	15225
2,7	8,5	17,5			4,3	14275	15275
3,3	8,5	17,5				14335	15335
3,9	9,5	19			5,1	14395	15395
4,7	9,5	19				14475	15475
5,6	11	20	31	27,5 ± 0,3	7,4	14565	15565
6,8	11	20				14685	15685
8,2	13	22,5			10,2	14825	15825
10	13	22,5				14106	15106

Table 8 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V; Fig. 3.

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 344 . . . . . tol. ± 20%	tol. ± 10%
0,082	4,5	10	13	10 ± 0,3	0,7	24823	25823
0,10	4,5	10				24104	25104
0,12	4,5	10				24124	25124
0,15	4,5	10				24154	25154
0,18	4,5	10			0,85	24184	25184
0,22	4,5	10				24224	25224
0,27	5	11	17,5	15 ± 0,3	1,05	24274	25274
0,33	5	11				24334	25334
0,39	5	11			1,4	24394	25394
0,47	5	11				24474	25474
→ 0,56	6	12			1,8	24564	25564
→ 0,68	6	12				24684	25684
0,82	7	13			2,55	24824	25824
1,0	7	13				24105	25105
1,2	6,5	15,5	26	22,5 ± 0,3	2,75	24125	25125
1,5	6,5	15,5				24155	25155
1,8	8,5	17,5			4,3	24185	25185
2,2	8,5	17,5				24225	25225
2,7	9,5	19			5,1	24275	25275
3,3	9,5	19				24335	25335
3,9	11	20	31	27,5 ± 0,3	7,4	24395	25395
4,7	11	20				24475	25475
5,6	13	22,5			10,2	24565	25565
6,8	13	22,5				24685	25685
8,2	15	25			12,8	24825	25825
10	15	25				24106	25106

Table 9 U_R (d.c.) = 250 V; max. a.c. voltage = 160 V; Fig. 3.

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 344 ..... tol. ± 20%	tol. ± 10%
0,039	4,5	10	13	10 ± 0,3	0,7	40393	41393
0,047						40473	41473
0,056						40563	41563
0,068						40683	41683
0,082	5	11	17,5	15 ± 0,3	1,05	40823	41823
0,10	5	11				40104	41104
0,12	5	11				40124	41124
0,15	5	11				40154	41154
0,18	6	12			1,4	40184	41184 ←
0,22	6	12				40224	41224 ←
0,27	7	13			1,8	40274	41274
0,33	7	13				40334	41334
0,39	6,5	15,5	26	22,5 ± 0,3	2,75	40394	41394
0,47	6,5	15,5				40474	41474
0,56	6,5	15,5				40564	41564
0,68	6,5	15,5				40684	41684
0,82	8,5	17,5			4,4	40824	41824
1,0	8,5	17,5				40105	41105
1,2	11	20	31	27,5 ± 0,3	7,4	40125	41125
1,5						40155	41155
1,8						40185	41185
2,2						40225	41225

Table 10 U_R (d.c.) = 400 V; max. a.c. voltage = 220 V; Fig. 3.

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 344 ..... tol. ± 20%	catalogue number 2222 344 ..... tol. ± 10%
0,010	4,5	10	13	10 ± 0,3	0,7	54103	55103
0,012						54123	55123
0,015						54153	55153
0,018						54183	55183
0,022						54223	55223
0,027						54273	55273
0,033						54333	55333
0,039	5	11	17,5	15 ± 0,3	1,05	54393	55393
0,047	5	11				54473	55473
→ 0,056	6	12			1,4	54563	55563
→ 0,068	6	12				54683	55683
0,082	7	13			1,8	54823	55823
0,10	7	13				54104	55104
0,12	8,5	14,5			2,55	54124	55124
0,15	8,5	14,5				54154	55154
0,18	6,5	15,5	26	22,5 ± 0,3	2,75	54184	55184
0,22	6,5	15,5				54224	55224
0,27	7,5	16,5			3,5	54274	55274
0,33	7,5	16,5				54334	55334
0,39	9,5	19			5,1	54394	55394
0,47	9,5	19				54474	55474
0,56	11	20	31	27,5 ± 0,3	7,4	54564	55564
0,68	11	20				54684	55684
0,82	13	22,5			10,2	54824	55824
1,0	13	22,5				54105	55105

Marking

a. Rated capacitance
b. Rated voltage
c. Tolerance on rated capacitance
d. Category voltage
e. Year and month or week of manufacture
f. Manufacturer's name
g. Climatic category
h. Manufacturer's type designation

- Styles 2222 370 and 2222 371:

  The capacitors are laser marked
  – on the top with a and c as follows:
    rated capacitance in nF or μF, and tolerance code (M = ± 20%, K = ± 10%, J = ± 5%).
  – on the side with b, e, f and h as follows:
    1st line : rated d.c. voltage with unit symbol,
    2nd line: code for dielectric material (MKT) and code for factory of origin,
    3rd line : 5th, 6th and 7th digits of the catalogue number, and manufacturer's identification (PH),
    4th line : production date code (year and week).

- Style 2222 344:

  The capacitors are marked on the top by embossed print with a, b, c, f and h as follows:
  1st line : rated capacitance in μF, tolerance and rated d.c. voltage.
  2nd line: code for dielectric material (MKT), 5th, 6th and 7th digits of the catalogue number, and code for factory of origin.

  The manufacturer's identification symbol is indicated at the left of this marking.

Mounting

The capacitors are for printed-wiring applications. The capacitors which are supplied on tape (2222 370, 2222 371) are suitable for mounting on printed-wiring boards by means of automatic insertion machines.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 kHz	see Tables 1 to 10
Tolerance on rated capacitance	see Tables 1 to 10

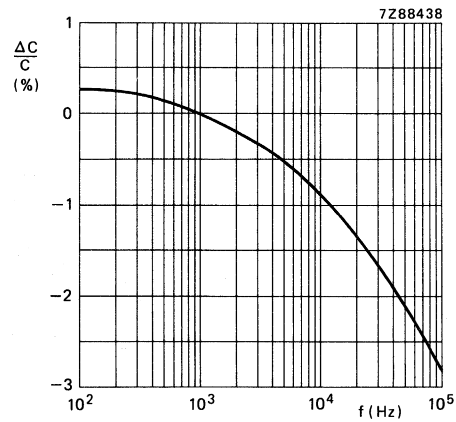


Fig. 4 Capacitance as a function of frequency; typical curve.

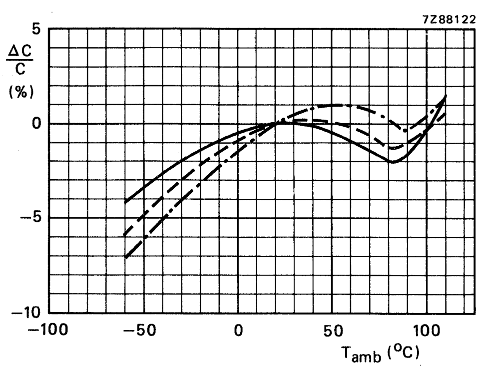


Fig. 5 Capacitance as a function of ambient free air temperature; typical curves.
——— for all capacitance values, measured at 1 kHz, 1 V.
– – – – for capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.
– · – · – for capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Voltage

Rated voltage U_R (d.c.)	See Tables 1 to 10
Category voltage U_C	0,8 x U_R (d.c.)
Maximum a.c. voltage (r.m.s. value), at 50 to 60 Hz	See Tables 1 to 10
Test voltage	
between terminations	1,6 x U_R (d.c.)
between interconnected terminations and case	2 x U_R (d.c.); min. 200 V

Temperature

Climatic category	55/100/56
Rated temperature	85 °C
Storage temperature range	–55 to + 100 °C

Notes

- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.)
- For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

Maximum pulse load

rated voltage V	maximum pulse load (V/μs)					
	L = 7,2 mm	L = 10 mm	L = 13 mm	L = 17,5 mm	L = 26 mm	L = 31 mm
63	55	17	15	6	3	2
100	90	30	24	10	4	3,5
250		60	35	14	6	5
400		95	55	22	10	8

The maximum pulse load values in the table are valid for pulse voltages equal to the rated voltage.

For lower pulse voltages the given values may be multiplied by U_R/applied voltage.

Note

If the pulse load requirement is satisfied, a check must be made to ascertain that the maximum dissipation is not exceeded.

Tangent of loss angle

style	capacitance	tangent of loss angle		
		1 kHz	10 kHz	100 kHz
2222 370 2222 371	$C \leqslant 0{,}1\ \mu F$ $0{,}1\ \mu F < C \leqslant 0{,}47\ \mu F$ $0{,}47\ \mu F < C \leqslant 1\ \mu F$	$\leqslant 75 \times 10^{-4}$ $\leqslant 75 \times 10^{-4}$ $\leqslant 75 \times 10^{-4}$	$\leqslant 130 \times 10^{-4}$ $\leqslant 130 \times 10^{-4}$ $\leqslant 130 \times 10^{-4}$	$\leqslant 200 \times 10^{-4}$ $\leqslant 300 \times 10^{-4}$
2222 344	$C \leqslant 0{,}1\ \mu F$ $0{,}1\ \mu F < C \leqslant 1\ \mu F$ $C > 1\ \mu F$	$\leqslant 75 \times 10^{-4}$ $\leqslant 75 \times 10^{-4}$ $\leqslant 75 \times 10^{-4}$	$\leqslant 130 \times 10^{-4}$ $\leqslant 130 \times 10^{-4}$ $\leqslant 150 \times 10^{-4}$	$\leqslant 250 \times 10^{-4}$

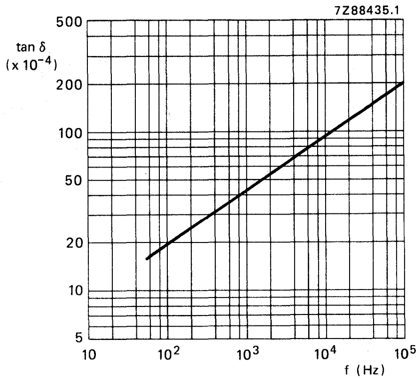


Fig. 6 Tan δ as a function of frequency, typical curve.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 min ± 5 s, the voltage being 10 ± 1 V for the 63 V version and 100 ± 15 V for the 100 V, 250 V and 400 V versions at T_{amb} = 20 °C.

R between terminations, for $C_R \leqslant 0{,}33\ \mu F$	
63 V and 100 V versions	> 15 000 MΩ
250 V and 400 V versions	> 30 000 MΩ
RC between terminations, for $C_R > 0{,}33\ \mu F$	
63 V and 100 V versions	> 5 000 s
250 V and 400 V versions	> 10 000 s
R between interconnected terminations and case (foil method)	> 30 000 MΩ

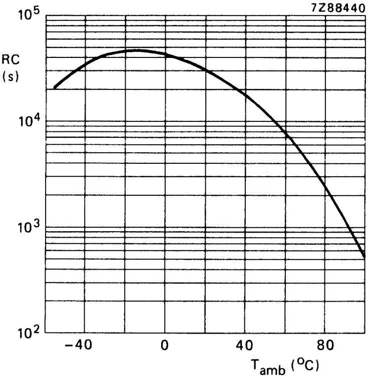


Fig. 7 RC-product as a function of ambient free air temperature; typical curve.

Maximum dissipation

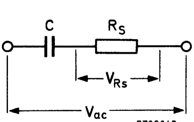
Notes
In applications where voltages higher than 50 V are applied, it is recommended that the power in the capacitor be limited to 2,5 VA in case of capacitor failure.
If the requirement for the maximum permissible power dissipation is satisfied, a check must be made to ascertain that the maximum permissible pulse load is not exceeded.

The maximum a.c. voltage has been specified for 50 to 60 Hz and at 23 °C. This voltage value must also never be exceeded at other frequencies. This permissible a.c. voltage may further be limited by the following requirements:

1. The power dissipation must not exceed the specified limit P_{max}.
2. The steepness of the a.c. voltage must not exceed the specified limit.

The power dissipated by a capacitor is a function of the voltage across the series resistance (R_s) or of the current through the series resistance and is expressed by

$$P = \frac{V_{R_s}{}^2}{R_s} = I^2 R_s \tag{1}$$



$$V_{R_s}{}^2 = \frac{R_s{}^2}{R_s{}^2 + 1/\omega^2 C^2} V_{ac}{}^2 \tag{2a}$$

Because for these capacitors tan $\delta = R_s \omega C = < 0{,}1$, the formula (2a) can be simplified to

$$V_{R_s}{}^2 = \frac{R_s{}^2}{1/\omega^2 C^2} V_{ac}{}^2 = R_s{}^2 \omega^2 C^2 V_{ac}{}^2 \tag{2b}$$

Thus $\quad P = R_s \omega^2 C^2 V_{ac}{}^2 \quad$ (3a)

or $\quad P = (R_s C)\, C \omega^2 V_{ac}{}^2 \quad$ (3b)

The term R_sC can be found from Fig. 8, C (in farads), $\omega = 2\pi f$ and V_{ac} are assumed to be known.

The maximum permissible value of power dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be read from Fig. 9.

Thus, when the actual power has been calculated with equation (3b), Fig. 9 gives the minimum size of capacitor which can dissipate this power.

Example of using Figs 8 and 9

A capacitor of 0,1 μF should be used at an a.c. voltage of 10 V, a frequency of 10 kHz and an ambient temperature of 50 $^{\circ}$C.

The RsC-product is 2×10^{-7} ΩF (from Fig. 8), so that the power to be dissipated is

$$\begin{aligned} P &= (RsC)\ C\omega^2\ Vac^2 \\ &= 2 \cdot 10^{-7} \times 0{,}1 \circ 10^{-6} \times (2\pi)^2 \times 10^8 \times 10^2 W \\ &= 7{,}8\ mW \end{aligned}$$

For a rated voltage of 10 Vac a capacitor of the 63 V version is required at least.

Capacitor 0,1 μF/40 Vac is satisfactory because of its dimensions 2,5 mm x 6 mm x 7,2 mm and its dissipated power of 57 mW at 50 $^{\circ}$C.

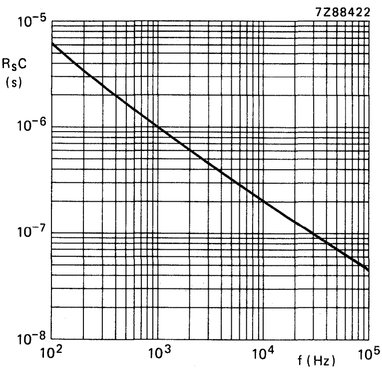


Fig. 8 Maximum product of series resistance and capacitance as a function of frequency.

curve	dimensions (mm)		
	T_{max}	H_{max}	L_{max}
1	2,5	6	7,2
2	2,5	6	10
	3,5	8	7,2
3	3	8	10
4	4,5	9	7,2
5	5	10	7,2
	4	9	10
6	6	11	7,2
	5	10,5	10
7	4,5	10	13
	6	11,5	10
8	5	11	13
9	6	12	13
10	5	11	17,5
11	6	12	17,5
12	7	13	17,5
13	8,5	14,5	17,5
14	6,5	15,5	26
15	7,5	16,5	26
16	8,5	17,5	26
17	9,5	19	26
18	11	20	31
19	13	22,5	31
20	15	25	31

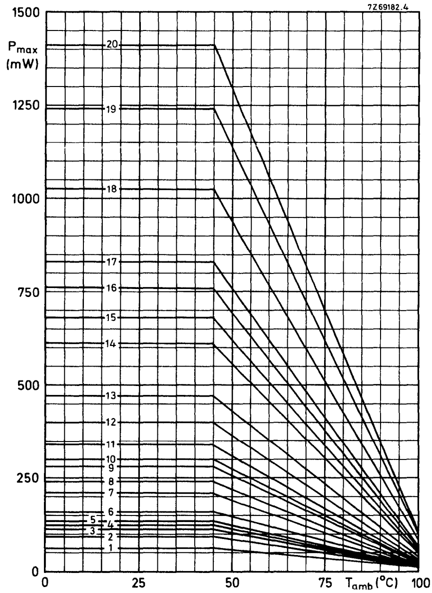


Fig. 9 Maximum dissipation as a function of ambient free air temperature.

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number as shown in Tables 1 to 10.

PACKING

Style 2222 344

The capacitors are supplied in boxes of 1000 (L = 13 or 17,5 mm), 200 (L = 26 mm) or 100 (L = 31 mm).

Style 2222 370

The capacitors are supplied in boxes, and on tape on reel or in ammunition packing.

→ The number of capacitors per box is 2000 for l = 4 ± 0,5 mm, and 1000 for l = 26 ± 1 mm.

The number of capacitors per reel and per ammunition packing is 2000 for T = 2,5 mm, 1500 for T = 3,5 mm, and 1000 for T ⩾ 4,5 mm.

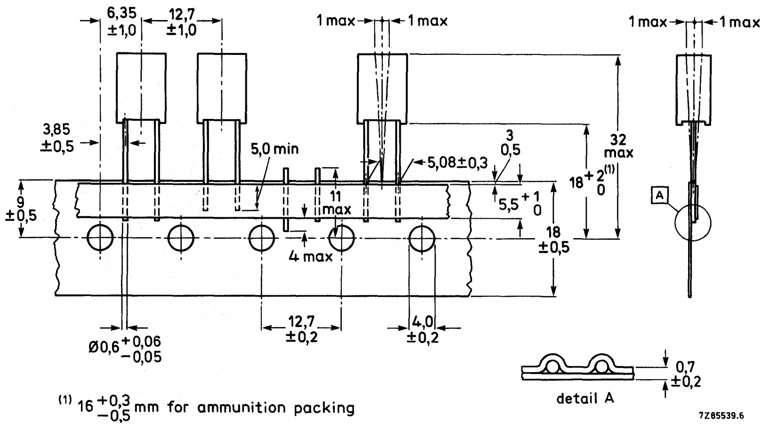


Fig. 10 Capacitors 2222 370 on tape.

Cumulative pitch error: 1,0 mm/20 pitches.
Max. 0,5% of the total number of capacitors per reel may be missing, but no more than 2 consecutive positions may be vacant.

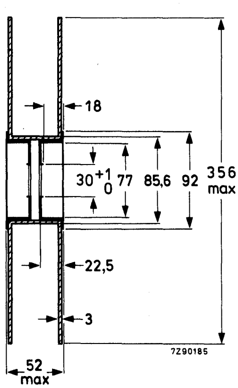


Fig. 11 Reel.

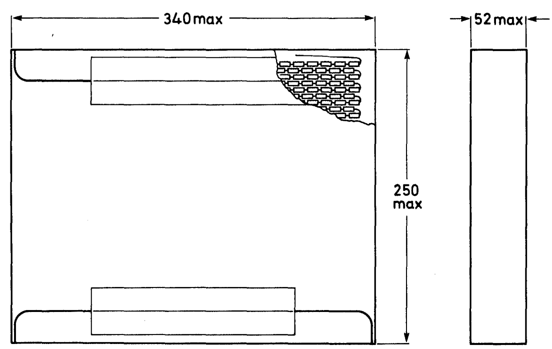
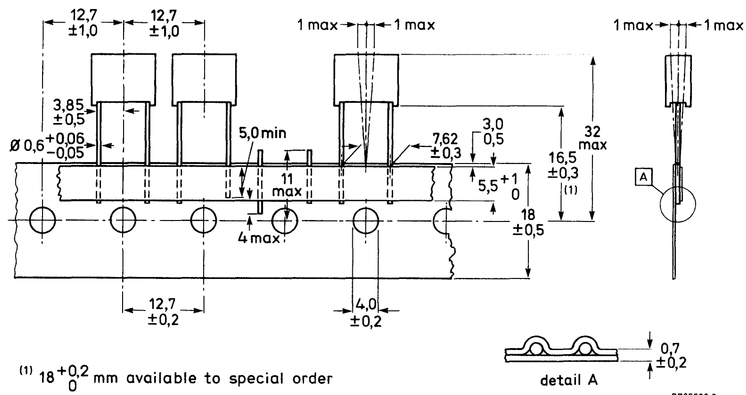


Fig. 12 Capacitors on tape in ammunition packing.

Style 2222 371

The capacitors are supplied in boxes of 1000, and on tape on reels of 1500 for T ⩽ 4 mm, and 1000 for T > 4 mm.



(1) $18^{+0,2}_{0}$ mm available to special order

Fig. 13 Capacitors 2222 371 on tape.
Cumulative pitch error 1,0 mm/20 pitches.
Max. 0,5% of the total number of capacitors per reel may be missing, but no more than 2 consecutive positions may be vacant.

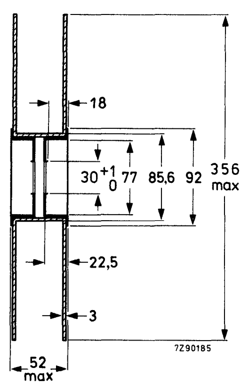


Fig. 14 Reel.

Characteristics concerning taped capacitors:

Pull-out force of the component	$\geqslant$ 5 N
Pull-off force of adhesive tape	$\geqslant$ 6 N
Tearing force of tape	$\geqslant$ 15 N

Storage conditions:

Storage temperature range	−25 to + 40 °C
Relative humidity	$\leqslant$ 80%

METALLIZED POLYETHYLENETEREPHTHALATE FILM CAPACITORS

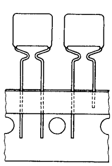
MKT radial epoxy lacquered type

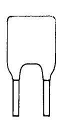
- 5,08 to 27,94 mm pitch
- Supplied on tape or in boxes

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	0,001 to 6,8 μF
Tolerance on rated capacitance	± 20%, ± 10%, ± 5%
Rated voltage U_R (d.c.)	63 V, 100 V, 250 V. 400 V, 630 V
Climatic category	40/100/56
Rated temperature	85 ^{o}C
Tangent of the loss angle at 10 kHz	100×10^{-4}
Related specification	IEC 384-2
Performance grade	long life

SURVEY OF STYLES





style	pitch	tables
2222 365	5,08 mm	1 to 6
2222 366	5,08 mm; 7,62 mm	7 to 12
2222 368	10,16 mm to 27,94 mm	13 to 16
2222 367	5,08 mm; 7,62 mm	17 to 22
2222 369	10,16 mm	23 to 26

APPLICATION

In electronic circuits for blocking and coupling, bypass and energy reservoir applications. Their small dimensions make them suitable for circuits with high packaging density.

DESCRIPTION

The capacitors consist of a low-inductance wound cell of metallized polyethyleneterephthalate film. The cell is protected by a hard, water repellent, solvent resistant epoxy lacquer. The radial leads are of solder-coated wire.

GENERAL DATA

Dimensions in mm

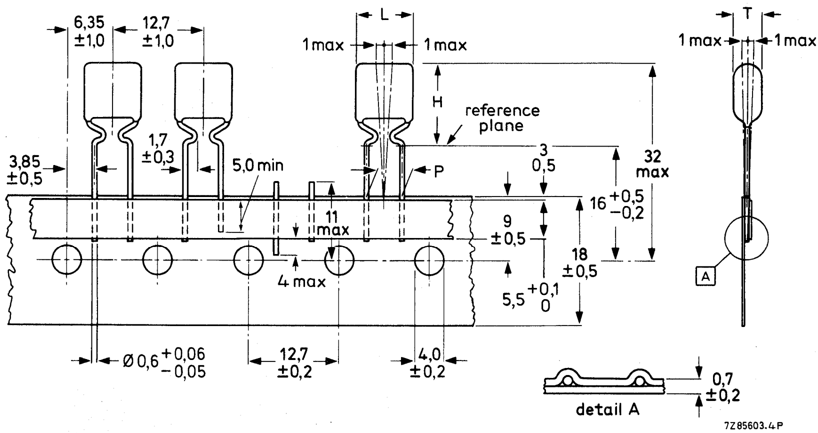


Fig. 1.

→ In addition to the capacitors quoted in Tables 1 to 6, capacitors with tolerance ±5% are available. The catalogue number of these capacitors can be found by replacing the 2nd digit in the columns by: 2 for reel packing, 6 for ammunition packing; e.g.: 2222 365 70473 → 2222 365 72473.

Table 1 U_R (d.c.) = 63 V; max. a.c. voltage = 40 V; Fig. 1; **pitch = 5,08 mm**

rated capacitance	T_{max}	H_{max}	L_{max}	P	mass	catalogue number 2222 365			
						reel packing		ammunition packing	
μF					g	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ±10%
0,047	3,5	12,5	7,5	5,08 ± 0,3	0,3	70473	71473	74473	75473
0,056						70563	71563	74563	75563
0,068						70683	71683	74683	75683
0,082						70823	71823	74823	75823
0,1						70104	71104	74104	75104
0,12						70124	71124	74124	75124
0,15	4	13			0,35	70154	71154	74154	75154
0,18	4,5	13,5				70184	71184	74184	75184
0,22						70224	71224	74224	75224
0,27	5	14			0,45	70274	71274	74274	75274
0,33	5,5	14,5				70334	71334	74334	75334
0,39						70394	71394	74394	75394
0,47	6	15,5				70474	71474	74474	75474
0,56	5,5	14				70564	71564	74564	75564
0,68	5,5	14,5				70684	71684	74684	75684
0,82	6	15			0,5	70824	71824	74824	75824
1,0	6,5	15,5				70105	71105	74105	75105

Table 2 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V; Fig. 1; **pitch = 5,08 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 365 ..... reel packing tol. ± 20%	reel packing tol. ± 10%	ammunition packing tol. ± 20%	ammunition packing tol. ± 10%
0,01						80103	81103	84103	85103
0,012						80123	81123	84123	85123
0,015				5,08		80153	81153	84153	85153
0,018				±		80183	81183	84183	85183
0,022	3,5	12,5		0,3	0,3	80223	81223	84223	85223
0,027						80273	81273	84273	85273
0,033			7,5			80333	81333	84333	85333
0,039						80393	81393	84393	85393
0,047	4	13				80473	81473	84473	85473
0,056						80563	81563	84563	85563
0,068	4,5	13,5			0,35	80683	81683	84683	85683
0,082						80823	81823	84823	85823
0,10						80104	81104	84104	85104

Table 3 U_R (d.c.) = 63 V; max. a.c. voltage = 40 V; Fig. 1; **original pitch 7,62 mm reduced to 5,08 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 365 ..... reel packing tol. ± 20%	reel packing tol. ± 10%	ammunition packing tol. ± 20%	ammunition packing tol. ± 10%
0,12						10124	11124	14124	15124
0,15	4	13,5	10		0,4	10154	11154	14154	15154
0,18						10184	11184	14184	15184
0,22						10224	11224	14224	15224
0,27	4,5	14		5,08	0,5	10274	11274	14274	15274
0,33	5	14,5	10,5	±	0,5	10334	11334	14334	15334
0,39	5	14,5		0,3	0,6	10394	11394	14394	15394
0,47						10474	11474	14474	15474
0,56						10564	11564	14564	15564
0,68	5,5	15			0,7	10684	11684	14684	15684
0,82						10824	11824	14824	15824
1,0						10105	11105	14105	15105

Table 4 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V; Fig. 1; **original pitch 7,62 mm reduced to 5,08 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 365 . . . . . reel packing tol. ± 20%	reel packing tol. ± 10%	ammunition packing tol. ± 20%	ammunition packing tol. ± 10%
0,039	4	13,5	10	5,08 ± 0,3	0,4	20393	21393	24393	25393
0,047						20473	21473	24473	25473
0,056						20563	21563	24563	25563
0,068						20683	21683	24683	25683
0,082						20823	21823	24823	25823
0,10						20104	21104	24104	25104
0,12	4,5	14	10,5		0,5	20124	21124	24124	25124
0,15	5	14,5			0,5	20154	21154	24154	25154
0,18	5	14,5			0,6	20184	21184	24184	25184
0,22	5,5	15			0,7	20224	21224	24224	25224
0,27	6	15,5			0,8	20274	21274	24274	25274
0,33						20334	21334	24334	25334
0,39						20394	21394	24394	25394
0,47						20474	21474	24474	25474

Table 5 U_R (d.c.) = 250 V; max. a.c. voltage = 160 V; Fig. 1; **original pitch 7,62 mm reduced to 5,08 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 365 . . . . . reel packing tol. ± 20%	reel packing tol. ± 10%	ammunition packing tol. ± 20%	ammunition packing tol. ± 10%
0,018	4	13,5	10	5,08 ± 0,3	0,4	40183	41183	44183	45183
0,022						40223	41223	44223	45223
0,027						40273	41273	44273	45273
0,033						40333	41333	44333	45333
0,039						40393	41393	44393	45393
→ 0,047						40473	41473	44473	45473

Table 6 U_R (d.c.) = 400 V; max. a.c. voltage = 220 V; Fig. 1; **original pitch 7,62 mm reduced to 5,08 mm**

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 365 ..... reel packing tol. ± 20%	reel packing tol. ± 10%	ammunition packing tol. ± 20%	ammunition packing tol. ± 10%
0,0039						50392	51392	54392	55392
0,0047						50472	51472	54472	55472
0,0056						50562	51562	54562	55562
0,0068	4	13,5	10	5,08 ± 0,3	0,4	50682	51682	54682	55682
0,0082						50822	51822	54822	55822
0,010						50103	51103	54103	55103
0,012						50123	51123	54123	55123
0,015						50153	51153	54153	55153

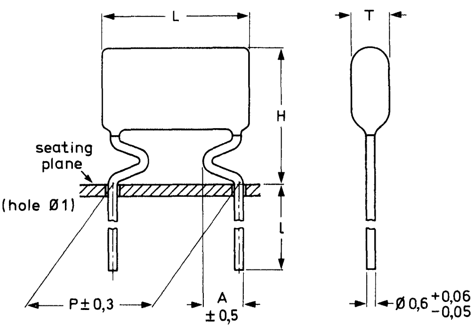


Fig. 2.

In addition to the capacitors quoted in Tables 7 to 12, capacitors with tolerance ± 5% are available. The catalogue number of these capacitors can be found by replacing the 2nd digit in the columns by:
2 for capacitors with ℓ = 17 ± 4 mm,
6 for capacitors with ℓ = 5 ± 1 mm;
e.g.: 2222 366 70473 → 2222 366 72473.

Table 7 U_R (d.c.) = 63 V; max. a.c. voltage = 40 V; Fig. 2; **pitch = 5,08 mm**

rated capacitance μF	T_{max}	H_{max}	L_{max}	A	P	mass g	catalogue number 2222 366 ..... ℓ = 17 ± 4 tol. ± 20%	ℓ = 17 ± 4 tol. ± 10%	ℓ = 5 ± 1 tol. ± 20%	ℓ = 5 ± 1 tol. ± 10%
0,047							70473	71473	74473	75473
0,056							70563	71563	74563	75563
0,068	3,5	12,5				0,3	70683	71683	74683	75683
0,082							70823	71823	74823	75823
0,1							70104	71104	74104	75104
0,12							70124	71124	74124	75124
0,15	4	13					70154	71154	74154	75154
0,18	4,5	13,5				0,35	70184	71184	74184	75184
0,22			7,5				70224	71224	74224	75224
0,27	5	14		1,7 ± 0,3	5,08 ± 0,3		70274	71274	74274	75274
0,33	5,5	14,5					70334	71334	74334	75334
0,39							70394	71394	74394	75394
0,47	6	15,5				0,45	70474	71474	74474	75474
0,56	5,5	14					70564	71564	74564	75564
0,68	5,5	14,5					70684	71684	74684	75684
0,82	6	15				0,5	70824	71824	74824	75824
1,0	6,5	15,5					70105	71105	74105	75105

Table 8 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V; Fig. 2; **pitch = 5,08 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	A	P	mass g	catalogue number 2222 366 ..... ℓ = 17 ± 4 tol. ± 20%	ℓ = 17 ± 4 tol. ± 10%	ℓ = 5 ± 1 tol. ± 20%	ℓ = 5 ± 1 tol. ± 10%
0,01							80103	81103	84103	85103
0,012							80123	81123	84123	85123
0,015							80153	81153	84153	85153
0,018							80183	81183	84183	85183
0,022	3,5	12,5				0,3	80223	81223	84223	85223
0,027				1,7 ± 0,3	5,08 ± 0,3		80273	81273	84273	85273
0,033			7,5				80333	81333	84333	85333
0,039							80393	81393	84393	85393
0,047	4	13					80473	81473	84473	85473
0,056							80563	81563	84563	85563
0,068	4,5	13,5				0,35	80683	81683	84683	85683
0,082							80823	81823	84823	85823
0,10							80104	81104	84104	85104

Table 9 U_R (d.c.) = 63 V; max. a.c. voltage = 40 V; Fig. 2 **pitch = 7,62 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	A	P	mass g	catalogue number 2222 366 ..... ℓ = 17 ± 4 tol. ± 20%	ℓ = 17 ± 4 tol. ± 10%	ℓ = 5 ± 1 tol. ± 20%	ℓ = 5 ± 1 tol. ± 10%
0,12						0,4	10124	11124	14124	15124
0,15	4	12	10				10154	11154	14154	15154
0,18							10184	11184	14184	15184
0,22							10224	11224	14224	15224
0,27	4,5	13				0,5	10274	11274	14274	15274
0,33	5	13,5		2,0 ± 0,5	7,62 ± 0,3		10334	11334	14334	15334
0,39	5	13,5				0,6	10394	11394	14394	15394
0,47	5,5	14	10,5			0,7	10474	11474	14474	15474
0,56							10564	11564	14564	15564
0,68	5,5	14,5				0,8	10684	11684	14684	15684
0,82							10824	11824	14824	15824
1,0							10105	11105	14105	15105

Table 10 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V; Fig. 2; **pitch = 7,62 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	A	P	mass g	catalogue number 2222 366 ..... ℓ = 17 ± 4 tol. ± 20%	ℓ = 17 ± 4 tol. ± 10%	ℓ = 5 ± 1 tol. ± 20%	ℓ = 5 ± 1 tol. ± 10%
0,039							20393	21393	24393	25393
0,047							20473	21473	24473	25473
0,056	4	12	10			0,4	20563	21563	24563	25563
0,068							20683	21683	24683	25683
0,082				2,0	7,62		20823	21823	24823	25823
0,10	4	13		±	±		20104	21104	24104	25104
0,12	4,5	13		0,5	0,3	0,5	20124	21124	24124	25124
0,15	5	13				0,6	20154	21154	24154	25154
0,18	5	13	10,5			0,6	20184	21184	24184	25184
0,22	5,5	13,5				0,7	20224	21224	24224	25224
0,27	6	14				0,7	20274	21274	24274	25274
0,33							20334	21334	24334	25334
0,39	6	15				0,8	20394	21394	24394	25394
0,47							20474	21474	24474	25474

Table 11 U_R (d.c.) = 250 V; max. a.c. voltage = 160 V; Fig. 2; **pitch = 7,62 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	A	P	mass g	catalogue number 2222 366 ..... ℓ = 17 ± 4 tol. ± 20%	ℓ = 17 ± 4 tol. ± 10%	ℓ = 5 ± 1 tol. ± 20%	ℓ = 5 ± 1 tol. ± 10%
0,018							40183	41183	44183	45183
0,022	4	13	10	2,0	7,62	0,4	40223	41223	44223	45223
0,027				±	±		40273	41273	44273	45273
0,033				0,5	0,3		40333	41333	44333	45333
0,039							40393	41393	44393	45393
0,047						0,5	40473	41473	44473	45473

Table 12 U_R (d.c.) = 400 V; max. a.c. voltage = 220 V; Fig. 2; **pitch = 7,62 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	A	P	mass g	catalogue number 2222 366 ..... ℓ = 17 ± 4 tol. ± 20%	ℓ = 17 ± 4 tol. ± 10%	ℓ = 5 ± 1 tol. ± 20%	ℓ = 5 ± 1 tol. ± 10%
0,0039	4	12					50392	51392	54392	55392
0,0047							50472	51472	54472	55472
0,0056							50562	51562	54562	55562
0,0068	4	13	10	2,0	7,62	0,4	50682	51682	54682	55682
0,0082				±	±		50822	51822	54822	55822
0,010				0,5	0,3		50103	51103	54103	55103
0,012							50123	51123	54123	55123
0,015							50153	51153	54153	55153

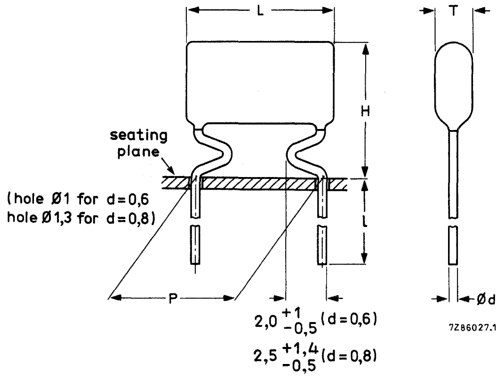


Fig. 3

pitch P	lead length ℓ	
	short leads	5 ± 1
10,16 15,24	long leads	17 ± 4
22,86		25 ± 4
27,94		24 ± 4

Table 13 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V, Fig. 3

rated capaci-tange µF	T_{max}	H_{max}	L_{max}	d	P	mass g	catalogue number 2222 368 . . . . . short leads tol. ± 20%	short leads tol. ± 10%	long leads tol. ± 20%	long leads tol. ± 10%
0,056	4	12	12,5	0,6 + 0,06 −0,05	10,16 ± 0,3	0,4	24563	25563	20563	21563
0,068							24683	25683	20683	21683
0,082							24823	25823	20823	21823
0,10							24104	25104	20104	21104
0,12							24124	25124	20124	21124
0,15							24154	25154	20154	21154
0,18	4,5	12,5				0,45	24184	25184	20184	21184
0,22	5	13				0,5	24224	25224	20224	21224
0,27	5	14	17,5	0,8 + 0,08 −0,05	15,24 ± 0,3	0,5	24274	25274	20274	21274
0,33						0,6	24334	25334	20334	21334
0,39						0,65	24394	25394	20394	21394
0,47	5,5	14,5				0,75	24474	25474	20474	21474
0,56	5,5	14,5				0,85	24564	25564	20564	21564
0,68	6	15				1	24684	25684	20684	21684
0,82	6,5	15,5				1,15	24824	25824	20824	21824
1,0	7,5	16,5				1,35	24105	25105	20105	21105
1,2	6	18	26		22,86 ± 0,3	1,8	24125	25125	20125	21125
1,5						2	24155	25155	20155	21155
1,8						2,3	24185	25185	20185	21185
2,2	6,5	18,5				2,8	24225	25225	20225	21225
2,7	7,5	19,5				3,2	24275	25275	20275	21275
3,3	8,5	20,5				4	24335	25335	20335	21335
3,9	8,5	20,5	30		27,94 ± 0,3	4,5	24395	25395	20395	21395
4,7	9,5	21,5				5,2	24475	25475	20475	21475
5,6	10,5	22,5				6	24565	25565	20565	21565
6,8	11,5	23,5				6,5	24685	25685	20685	21685

In addition to the capacitors quoted in Tables 13 to 16, capacitors with tolerance ± 5% are available. The catalogue number of these capacitors can be found by replacing the 2nd digit in the columns by:
2 for capacitors with long leads,
6 for capacitors with short leads;
e.g.: 2222 368 24563 → 2222 368 26563.

Table 14 U_R (d.c.) = 250 V; max. a.c. voltage = 160 V; Fig. 3

rated capacitance	T_{max}	H_{max}	L_{max}	d	P	mass	catalogue number 2222 368			
							short leads		long leads	
μF						g	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,027							44273	45273	40273	41273
0,033	4	12					44333	45333	40333	41333
0,039					10,16 ± 0,3	0,4	44393	45393	40393	41393
0,047							44473	45473	40473	41473
0,056	4,5	12,5	12,5	0,6 + 0,06 −0,05		0,45	44563	45563	40563	41563
0,068	4,5	12,5					44683	45683	40683	41683
0,082	5	13				0,5	44823	45823	40823	41823
0,10	5	13					44104	45104	40104	41104
0,12	5	14				0,65	44124	45124	40124	41124
0,15	5	14			15,24 ± 0,3	0,7	44154	45154	40154	41154
0,18	5,5	14,5	17,5			0,8	44184	45184	40184	41184
0,22	6	15				0,9	44224	45224	40224	41224
0,27	6,5	15,5				1,1	44274	45274	40274	41274
0,33	7	16				1,3	44334	45334	40334	41334
0,39	5	17				1,8	44394	45394	40394	41394
0,47	5,5	17,5				2,1	44474	45474	40474	41474
0,56	6	18	26		22,86 ± 0,3	2,5	44564	45564	40564	41564
0,68	6,5	18,5		0,8 + 0,08 −0,05		2,9	44684	45684	40684	41684
0,82	7	19				3,3	44824	45824	40824	41824
1,0	7,5	19,5				3,6	44105	45105	40105	41105
1,2	7,5	19,5				4	44125	45125	40125	41125
1,5	8,5	20,5	30		27,94 ± 0,3	5,1	44155	45155	40155	41155
1,8	9,5	21,5				5,9	44185	45185	40185	41185
2,2	10,5	22,5				6,4	44225	45225	40225	41225

Table 15 U_R (d.c.) = 400 V; max. a.c. voltage = 220 V; Fig. 3

rated capacitance	T_{max}	H_{max}	L_{max}	d	P	mass	catalogue number 2222 368			
							short leads		long leads	
μF						g	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,001							54102	55102	50102	51102
0,0012							54122	55122	50122	51122
0,0015							54152	55152	50152	51152
0,0018							54182	55182	50182	51182
0,0022							54222	55222	50222	51222
0,0027							54272	55272	50272	51272
0,0033				0,6	10,16		54332	55332	50332	51332
0,0039	4	12	12,5	+ 0,06	± 0,3		54392	55392	50392	51392
0,0047				−0,05			54472	55472	50472	51472
0,0056							54562	55562	50562	51562
0,0068						0,4	54682	55682	50682	51682
0,0082							54822	55822	50822	51822
0,010							54103	55103	50103	51103
0,012							54123	55123	50123	51123
0,015							54153	55153	50153	51153
0,018							54183	55183	50183	51183
0,022							54223	55223	50223	51223
0,027	4,5	12,5				0,45	54273	55273	50273	51273
0,033							54333	55333	50333	51333
0,039						0,6	54393	55393	50393	51393
0,047	5	14			15,24	0,6	54473	55473	50473	51473
0,056					± 0,3	0,65	54563	55563	50563	51563
0,068			17,5			0,7	54683	55683	50683	51683
0,082	5,5	14,5				0,8	54823	55823	50823	51823
0,10	6	15				0,9	54104	55104	50104	51104
0,12	6,5	15,5				1,1	54124	55124	50124	51124
0,15	7	16				1,3	54154	55154	50154	51154
0,18	5	17		0,8		1,6	54184	55184	50184	51184
0,22	5,5	17,5		+ 0,08	22,86	1,9	54224	55224	50224	51224
0,27	6	18		−0,05	± 0,3	2,3	54274	55274	50274	51274
0,33	6,5	18,5	26			2,6	54334	55334	50334	51334
0,39	7	19				3	54394	55394	50394	51394
0,47	8	20				3,4	54474	55474	50474	51474
0,56	8	20				3,5	54564	55564	50564	51564
0,68	8,5	20,5	30		27,94	4	54684	55684	50684	51684
0,82	9,5	21,5			± 0,3	4,5	54824	55824	50824	51824
1	11	23				5,0	54105	55105	50105	51105

Table 16 U_R (d.c.) = 630 V; max. a.c. voltage = 220 V; Fig. 3

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	P	mass g	catalogue number 2222 368 ..... short leads tol. ± 20%	short leads tol. ± 10%	long leads tol. ± 20%	long leads tol. ± 10%
0,01	4,5	12,5	12,5	0,6 +0,06 −0,05	10,16 ± 0,3	0,45	64103	65103	60103	61103
0,012	5	13				0,5	64123	65123	60123	61123
0,015	5,5	13,5				0,55	64153	65153	60153	61153
0,018	6	14				0,6	64183	65183	60183	61183
0,022	6,5	14,5				0,7	64223	65223	60223	61223
0,027	5,5	14,5	17,5	0,8 +0,08 −0,05	15,24 ± 0,3	0,9	64273	65273	60273	61273
0,033	6	15				1	64333	65333	60333	61333
0,039	6,5	15,5				1,1	64393	65393	60393	61393
0,047	7	16				1,25	64473	65473	60473	61473
0,056	7,5	16,5				1,35	64563	65563	60563	61563
0,068	8	17				1,45	64683	65683	60683	61683
0,082	5,5	17,5	26		22,86 ± 0,3	1,85	64823	65823	60823	61823
0,1	6	18				2,15	64104	65104	60104	61104
0,12	7	19				2,5	64124	65124	60124	61124
0,15	7,5	19,5				2,9	64154	65154	60154	61154
0,18	8,5	20,5				3,2	64184	65184	60184	61184
0,22	9,5	21,5				3,5	64224	65224	60224	61224
0,27	9	21	30		27,94 ± 0,3	4,3	64274	65274	60274	61274
0,33	10	22				5	64334	65334	60334	61334
0,39	11	23				5,65	64394	65394	60394	61394
0,47	12	24				6,5	64474	65474	60474	61474

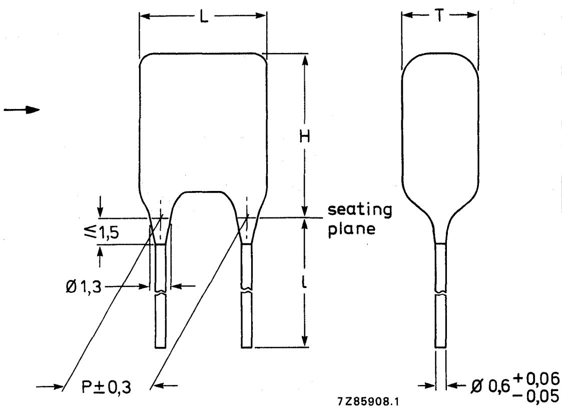


Fig. 4.

In addition to the capacitors quoted in Tables 17 to 22, capacitors with tolerance ± 5% are available. The catalogue number of these capacitors can be found by replacing the 2nd digit in the columns by:
2 for capacitors with ℓ = 22 ± 4 mm.
6 for capacitors with ℓ = 5 ± 1 mm;
e.g.: 2222 367 70473 → 2222 367 72473.

Table 17 U_R (d.c.) = 63 V; max. a.c. voltage = 40 V; Fig. 4; **pitch = 5,08 mm**

rated capacitance	T_{max}	H_{max}	L_{max}	P	mass	catalogue number 2222 367			
						ℓ = 22 ± 4		ℓ = 5 ± 1	
μF					g	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,047						70473	71473	74473	75473
0,056						70563	71563	74563	75563
0,068	3,5	7,5			0,3	70683	71683	74683	75683
0,082						70823	71823	74823	75823
0,1						70104	71104	74104	75104
0,12						70124	71124	74124	75124
0,15	4	8				70154	71154	74154	75154
0,18	4,5	8,5			0,35	70184	71184	74184	75184
0,22			7,5	5,08		70224	71224	74224	75224
0,27	5	9		± 0,3		70274	71274	74274	75274
0,33	5,5	9,5				70334	71334	74334	75334
0,39	5,5	10,5				70394	71394	74394	75394
0,47	6	11,5			0,45	70474	71474	74474	75474
0,56	5,5	10				70564	71564	74564	75564
0,68	5,5	10,5				70684	71684	74684	75684
0,82	6	11			0,5	70824	71824	74824	75824
1,0	6,5	11,5				70105	71105	74105	75105

Table 18 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V; Fig. 4; **pitch = 5,08 mm**

rated capacitance	T_{max}	H_{max}	L_{max}	P	mass	catalogue number 2222 367			
						ℓ = 22 ± 4		ℓ = 5 ± 1	
						tol.	tol.	tol.	tol.
µF					g	± 20%	± 10%	± 20%	± 10%
0,01						80103	81103	84103	85103
0,012						80123	81123	84123	85123
0,015						80153	81153	84153	85153
0,018						80183	81183	84183	85183
0,022	3,5	7,5			0,3	80223	81223	84223	85223
0,027						80273	81273	84273	85273
0,033			7,5	5,08		80333	81333	84333	85333
0,039				± 0,3		80393	81393	84393	85393
0,047						80473	81473	84473	85473
0,056	4	8			0,35	80563	81563	84563	85563
0,068	4,5	8,5				80683	81683	84683	85683
0,082						80823	81823	84823	85823
0,10					0,45	80104	81104	84104	85104

Table 19 U_R (d.c.) = 63 V; max. a.c. voltage = 40 V; Fig. 4; **pitch = 7,62 mm**

rated capacitance	T_{max}	H_{max}	L_{max}	P	mass	catalogue number 2222 367			
						ℓ = 22 ± 4		ℓ = 5 ± 1	
						tol.	tol.	tol.	tol.
µF					g	± 20%	± 10%	± 20%	± 10%
0,12						10124	11124	14124	15124
0,15	4	8	10		0,4	10154	11154	14154	15154
0,18				7,62		10184	11184	14184	15184
0,22				± 0,3		10224	11224	14224	15224
0,27	4,5	8,5			0,5	10274	11274	14274	15274
0,33	5	9				10334	11334	14334	15334
0,39	5	9			0,6	10394	11394	14394	15394
0,47	5,5	9,5			0,7	10474	11474	14474	15474
0,56			10,5			10564	11564	14564	15564
0,68	5,5	10			0,8	10684	11684	14684	15684
0,82						10824	11824	14824	15824
1,0						10105	11105	14105	15105

Table 20 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V; Fig. 4; **pitch = 7,62 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 367 ..... ℓ = 22 ± 4 tol. ± 20%	ℓ = 22 ± 4 tol. ± 10%	ℓ = 5 ± 1 tol. ± 20%	ℓ = 5 ± 1 tol. ± 10%
0,039	4	8	10	7,62 ± 0,3	0,4	20393	21393	24393	25393
0,047	4	8				20473	21473	24473	25473
0,056	4	8				20563	21563	24563	25563
0,068	4	8				20683	21683	24683	25683
0,082	4	8				20823	21823	24823	25823
0,10	4	8,5				20104	21104	24104	25104
0,12	4,5	9	10,5		0,5	20124	21124	24124	25124
0,15	5	9,5			0,6	20154	21154	24154	25154
0,18	5	9,5			0,6	20184	21184	24184	25184
0,22	5,5	10			0,7	20224	21224	24224	25224
0,27	6	10,5			0,8	20274	21274	24274	25274
0,33						20334	21334	24334	25334
0,39						20394	21394	24394	25394
0,47						20474	21474	24474	25474

Table 21 U_R (d.c.) = 250 V; max. a.c. voltage = 160 V; Fig. 4; **pitch = 7,62 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 367 ..... ℓ = 22 ± 4 tol. ± 20%	ℓ = 22 ± 4 tol. ± 10%	ℓ = 5 ± 1 tol. ± 20%	ℓ = 5 ± 1 tol. ± 10%
0,018	4	8,5	10	7,62 ± 0,3	0,4	40183	41183	44183	45183
0,022						40223	41223	44223	45223
0,027						40273	41273	44273	45273
0,033					0,5	40333	41333	44333	45333
→ 0,039						40393	41393	44393	45393
0,047						40473	41473	44473	45473

Table 22 U_R (d.c.) = 400 V; max. a.c. voltage = 220 V; Fig. 4; **pitch = 7,62 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 367 ..... ℓ = 22 ± 4 tol. ± 20%	ℓ = 22 ± 4 tol. ± 10%	ℓ = 5 ± 1 tol. ± 20%	ℓ = 5 ± 1 tol. ± 10%
0,0039	4	8,5	10	7,62 ± 0,3	0,4	50392	51392	54392	55392
0,0047						50472	51472	54472	55472
0,0056						50562	51562	54562	55562
0,0068						50682	51682	54682	55682
0,0082						50822	51822	54822	55822
0,010						50103	51103	54103	55103
0,012						50123	51123	54123	55123
0,015						50153	51153	54153	55153

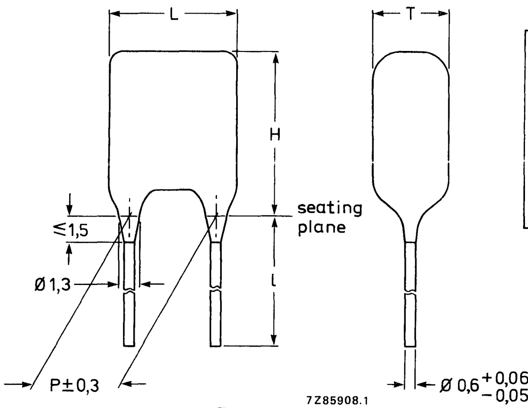


Fig. 5.

In addition to the capacitors quoted in Tables 23 to 26, capacitors with tolerance ± 5% are available. The catalogue number of these capacitors can be found by replacing the 2nd digit in the columns by:
2 for capacitors with ℓ = 22 ± 4 mm,
6 for capacitors with ℓ = 5 ± 1 mm;
e.g.: 2222 369 24563 → 2222 369 26563.

Table 23 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V, Fig. 5

rated capacitance	T_{max}	H_{max}	L_{max}	d	P	mass	catalogue number 2222 369			
							short leads 5 ± 1		long leads 22 ± 4	
μF						g	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,056							24563	25563	20563	21563
0,068							24683	25683	20683	21683
0,082	4	9,5				0,4	24823	25823	20823	21823
0,10				0,6	10,16		24104	25104	20104	21104
0,12			12,5	+0,06	± 0,3		24124	25124	20124	21124
0,15				−0,05			24154	25154	20154	21154
0,18	4,5	10				0,45	24184	25184	20184	21184
0,22	5	10,5				0,5	24224	25224	20224	21224

Table 24 U_R (d.c.) = 250 V; max. a.c. voltage = 160 V; Fig. 5

rated capacitance	T_{max}	H_{max}	L_{max}	d	P	mass	catalogue number 2222 369			
							short leads 5 ± 1		long leads 22 ± 4	
μF						g	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,027							44273	45273	40273	41273
0,033	4	9,5					44333	45333	40333	41333
0,039					10,16	0,4	44393	45393	40393	41393
0,047			12,5		± 0,3		44473	45473	40473	42473
0,056	4,5	10		0,6		0,45	44563	45563	40563	41563
0,068	4,5	10		+0,06			44683	45683	40683	41683
0,082	5	10,5		−0,05		0,5	44823	45823	40823	41823
0,10	5	10,5					44104	45104	40104	41104

Table 25 U_R (d.c.) = 400 V; max. a.c. voltage = 220 V; Fig. 5

rated capaci-tance	T_{max}	H_{max}	L_{max}	d	P	mass	catalogue number 2222 369			
							short leads 5 ± 1		long leads 22 ± 4	
μF						g	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,001							54102	55102	50102	51102
0,0012							54122	55122	50122	51122
0,0015							54152	55152	50152	51152
0,0018							54182	55182	50182	51182
0,0022							54222	55222	50222	51222
0,0027							54272	55272	50272	51272
0,0033							54332	55332	50332	51332
0,0039				0,6	10,16		54392	55392	50392	51392
0,0047	4	9,5	12,5	+0,06	± 0,3		54472	55472	50472	51472
0,0056				−0,05		0,4	54562	55562	50562	51562
0,0068							54682	55682	50682	51682
0,0082							54822	55822	50822	51822
0,010							54103	55103	50103	51103
0,012							54123	55123	50123	51123
0,015							54153	55153	50153	55153
0,018							54183	55183	50183	51183
0,022							54223	55223	50223	51223
0,027	4,5	10	12,5			0,45	54273	55273	50273	51273
0,033	4,5	10	12,5				54333	55333	50333	51333

Table 26 U_R (d.c.) = 630 V; max. a.c. voltage = 220 V; Fig. 5

rated capaci-tance	T_{max}	H_{max}	L_{max}	d	P	mass	catalogue number 2222 369			
							short leads 5 ± 1		long leads 22 ± 4	
μF						g	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,010	4,5	10				0,45	64103	65103	60103	61103
0,012	5	10,5		0,6	10,16	0,5	64123	65123	60123	61123
0,015	5,5	11	12,5	+0,06	± 0,3	0,55	64153	65153	60153	61153
0,018	6	11,5		−0,05		0,6	64183	65183	60183	61183
0,022	6,5	12				0,7	64223	65223	60223	61223

Marking

a. Rated capacitance
b. Rated voltage
c. Tolerance on rated capacitance
d. Category voltage
e. Year and month of manufacture
f. Manufacturer's name
g. Climatic category
h. Manufacturer's type designation

- Styles 2222 365, 2222 366, and 2222 367:

– The capacitors with a pitch of 5,08 mm are marked in black ink on the top with a, b and c as follows:

1st line: rated capacitance in μF without unit symbol;

2nd line: tolerance code (M = ± 20%, K = ± 10%, J = ± 5%),
rated d.c. voltage without unit symbol.

example: 0.047
K 63

– The capacitors with a pitch of 5,08 (7,62) mm or 7,62 mm are marked in black ink on the top with a, b and c as follows:

1st line: rated capacitance in pF or μF without unit symbol,
tolerance code (M = ± 20%, K = ± 10%, J = ± 5%);

2nd line: rated d.c. voltage without unit symbol,
code for dielectric material (MKT)

example: 0,047 K
100 MKT

- Styles 2222 368 and 2222 369:

– The capacitors are marked in black ink on top with a, b, c, f and h as follows:

1st line: rated capacitance in pF or μF,
tolerance (± 20% identified by M or 20%, ± 10% by K or 10% and ± 5% by J or 5%);

2nd line: rated d.c. voltage,
code for dielectric material (MKT).

The manufacturer's name is indicated at the left.
Code for factory of origin is indicated at the right.

The package containing the capacitors is marked with a to h.

Mounting

The capacitors are for printed-wiring applications.
Capacitors of style 2222 365 (supplied on tape on reel or in ammunition packing) are suitable for mounting on printed-wiring boards by means of automatic insertion machines.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 kHz	see Tables 1 to 26
Tolerance on rated capacitance	see Tables 1 to 26

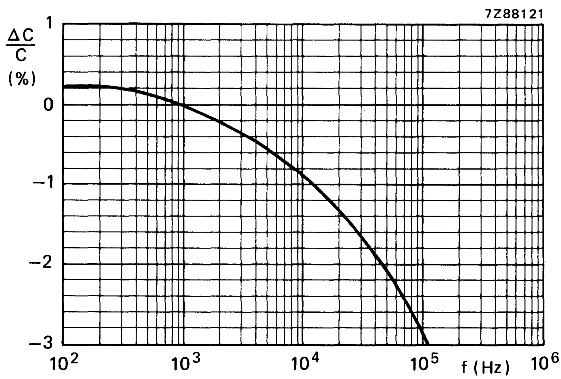


Fig. 6 Capacitance as a function of frequency; typical curve.

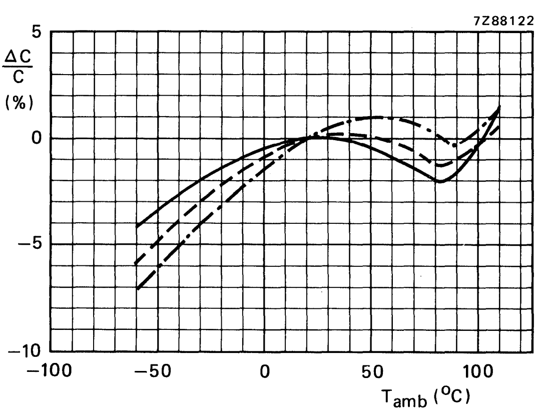


Fig. 7 Capacitance as a function of ambient free air temperature; typical curves.

——— for all capacitance values, measured at 1 kHz, 1 V.

— — — for capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.

—·—·— for capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Voltage

Rated voltage U_R (d.c.)	See Tables 1 to 26
Category voltage U_C	0,8 x U_R (d.c.)
Maximum a.c. voltage (r.m.s. value), at 50 to 60 Hz	see Tables 1 to 26
Test voltage	
between terminations	1,6 x U_R (d.c.)
between interconnected terminations and case	2 x U_R (d.c.); min. 200 V

Temperature

Climatic category	40/100/56
Rated temperature	85 °C
Storage temperature range	−40 to + 100 °C

Notes:
- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.).
- For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

Maximum pulse load

rated voltage V	maximum pulse load V/μs					
	L = 7,5 mm	L = 10 mm	L = 12,5 mm	L = 17,5 mm	L = 26 mm	L = 30 mm
63	55	17				
100	90	30	24	10	4	3,5
250		60	35	14	6	5
400		95	55	22	10	8
630			80	35	14	12

The maximum pulse load values in the table are valid for pulse voltages equal to the rated voltage.
For lower pulse voltages the given values may be multiplied by U_R/applied voltage.

Note:
If the pulse load requirement is satisfied, a check must be made to ascertain that the maximum dissipation is not exceeded.

Tangent of loss angle

capacitance	frequency		
	1 kHz	10 kHz	100 kHz
$C \leqslant 0,1\ \mu F$	$\leqslant 75 \times 10^{-4}$	$\leqslant 130 \times 10^{-4}$	$\leqslant 225 \times 10^{-4}$
$0,1\ \mu F < C \leqslant 0,47\ \mu F$	$\leqslant 75 \times 10^{-4}$	$\leqslant 130 \times 10^{-4}$	$\leqslant 300 \times 10^{-4}$
$0,47\ \mu F < C \leqslant 1\ \mu F$	$\leqslant 75 \times 10^{-4}$	$\leqslant 130 \times 10^{-4}$	
$C > 1\ \mu F$	$\leqslant 75 \times 10^{-4}$	$\leqslant 150 \times 10^{-4}$	

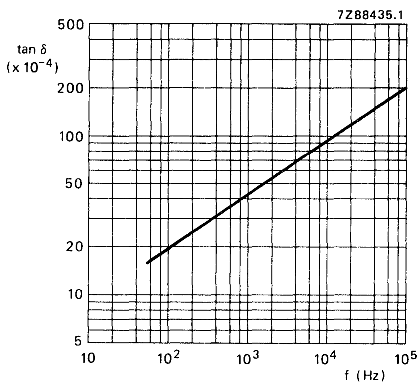


Fig. 8 Tan δ as a function of frequency, typical curve.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 min ± 5 s, the voltage being 10 ± 1 V for the 63 V version, 100 ± 15 V for the 100 V, 250 V and 400 V versions and 500 ± 50 V for the 630 V version at T_{amb} = 20 °C.

R between terminations, for $C_R \leqslant 0,33\ \mu F$	
63 V and 100 V versions	> 15 000 MΩ
250 V, 400 V and 630 V versions	> 30 000 MΩ
RC between terminations, for $C_R > 0,33\ \mu F$	
63 V and 100 V versions	> 5000 s
250 V, 400 V and 630 V versions	> 10 000 s
R between interconnected terminations and case (foil method)	> 30 000 MΩ

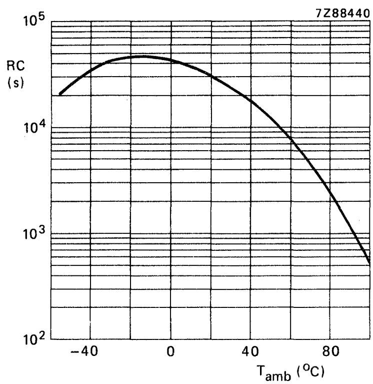


Fig. 9 RC-product as a function of ambient free air temperature; typical curve.

Maximum dissipation

Notes

In applications where voltages higher than 50 V are applied, it is recommended that the power in the capacitor be limited to 2,5 VA in case of capacitor failure.

If the requirement for the maximum permissible power dissipation is satisfied, a check must be made to ascertain that the maximum permissible pulse load is not exceeded.

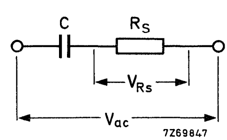
The maximum a.c. voltage has been specified for 50 to 60 Hz and at 23 °C. This voltage value must also never be exceeded at other frequencies. This permissible a.c. voltage may further be limited by the following requirements:

1. The power dissipation must not exceed the specified limit P_{max}.

2. The steepness of the a.c. voltage must not exceed hte specified limit.

The power dissipated by a capacitor is a function of the voltage across the series resistance (R_s) or of the current through the series resistance and is expressed by

$$P = \frac{V_{R_s}^{2}}{R_s} = I^2 R_s \qquad (1)$$



$$V_{R_3}^{2} = \frac{R_s^2}{R_s^2 + 1/\omega^2 C^2} V_{ac}^{2} \qquad (2a)$$

Because forthese capacitors tan d = $R_s \omega C$ = < 0,1, the formula (2a) can be simplified to

$$V_{R_s}{}^2 = \frac{R_s{}^2}{1/\omega^2 C^2} V_{ac}{}^2 = R_s{}^2 \omega^2 C^2 V_{ac}{}^2 \qquad (2b)$$

Thus $P = R_s \omega^2 C^2 V_{ac}{}^2$ (3a)

or $P = (R_s C)\, C \omega^2 V_{ac}{}^2$ (3b)

The term R_sC can be found from Fig. 10, C (in farads), $\omega = 2\pi f$ and V_{ac} are assumed to be known.

The maximum permissible value of power dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be read from Figs 11 and 12.

Thus, when the actual power has been calculated with equation (3b), Figs 11 and 12 give the minimum size of capacitor which can dissipate this power.

Example of using Figs 10, 11 and 12

A capacitor of 0,1 μF should be used at an a.c. voltage of 10 V, a frequency of 10 kHz and an ambient temperature of 50 °C.

The RsC-product is 2 x 10^{-7} ΩF (from Fig. 10), so that the power to be dissipated is

$$P = (RsC)\, C\omega^2\, Vac^2$$
$$= 2 \cdot 10^{-7} \times 0{,}1 \cdot 10^{-6} \times (2\pi)^2 \times 10^8 \times 10^2\, W$$
$$= 7{,}8\ mW$$

For a rated voltage of 10 Vac a capacitor of the 63 V range is required at least.

Capacitor 0,1 μF/63 Vac is satisfactory because of its dimensions 3,5 mm x 12,5 mm x 7,5 mm and its dissipated power of 70 mW at 50 °C.

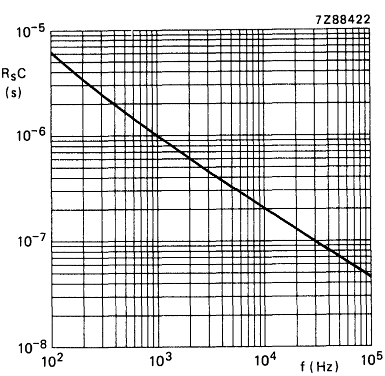


Fig. 10 Maximum product of series resistance and capacitance as a function of frequency.

curve	dimensions (mm) T_{max}	L_{max}
1	3,5	7,5
2	4	7,5
3	4,5	7,5
4	5	7,5
5	5,5	7,5
6	6	7,5
7	4	10
8	4,5	10,5
9	5	10,5
10	5,5	10,5
11	6	10,5

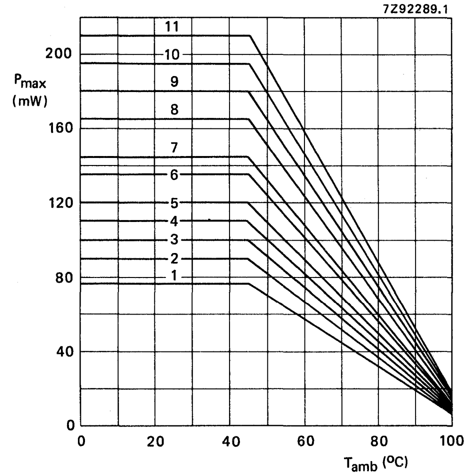


Fig. 11 Maximum dissipation as a function of ambient free air temperature, styles 2222 365, 2222 366 and 2222 367.

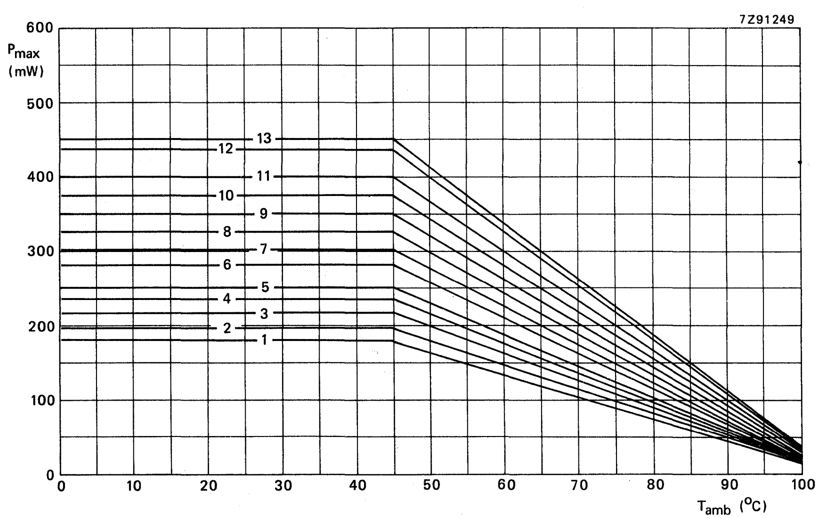


Fig. 12a Maximum dissipation as a function of ambient free air temperature; styles 2222 368 and 2222 369.

curve	dimensions (mm) T_{max}	L_{max}
1	4	12,5
2	4,5	12,5
3	5	12,5
4	5,5	12,5
5	6	12,5
6	6,5	12,5
	5	17,5
7	5,5	17,5
8	6	17,5
9	6,5	17,5
10	7	17,5
11	7,5	17,5
12	8	17,5
13	8,5	17,5
14	5	26
15	5,5	26
16	6	26
17	6,5	26
18	7	26
19	7,5	26
20	8	26
21	8,5	26
22	7,5	30
23	8	30
24	9,5	26
25	8,5	30
26	9	30
27	9,5	30
28	10	30
29	10,5	30
30	11	30
31	11,5	30
32	12	30
33	13	30

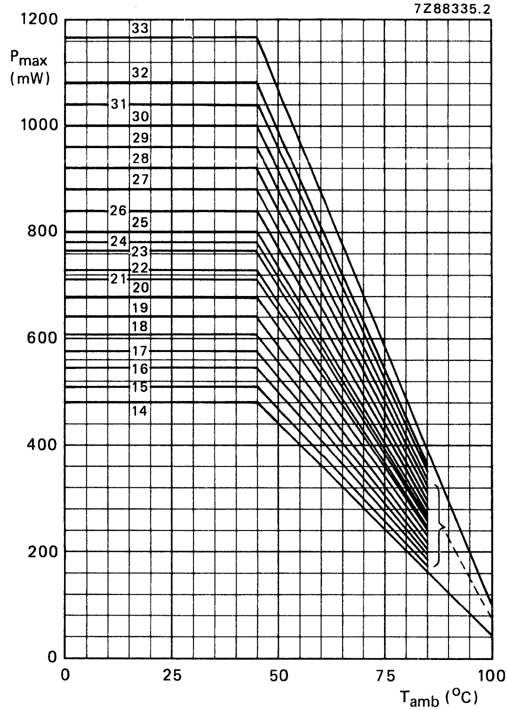


Fig. 12b Maximum dissipation as a function of ambient free air temperature; **styles 2222 368 and 2222 369.**

PACKING

Styles 2222 366, 2222 367, 2222 368 and 2222 369

The capacitors are supplied in boxes; the number per box is given in the table below.

L_{max} mm	T_{max} mm	number of capacitors per box short leads	long leads
7,5 10		1000	1000
12,5 17,5		2000	1000
26	⩽ 7 ⩾ 7,5	1000 1000	1000 500
30	⩽ 9,5 > 9,5	500 500	500 250

Style 2222 365

The capacitors are supplied on tape on reel and in ammunition packing.

The number of capacitors per reel and per pack is given in the table below.

T_{max} mm	number of capacitors per reel or per ammunition packing
4	1500
⩾ 4,5	1000

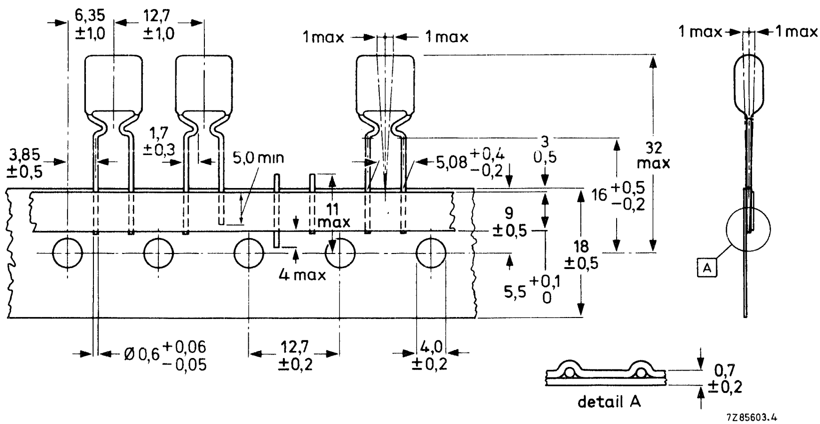


Fig. 13 Capacitors on tape.

Cumulative pitch error: 1,0 mm/20 pitches.
Maximum 0,5% of the total number of capacitors per reel may be missing, but no more than 2 consecutive positions may be vacant.

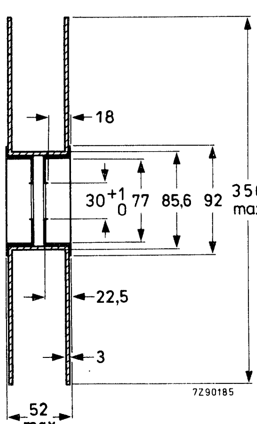


Fig. 14 Reel.

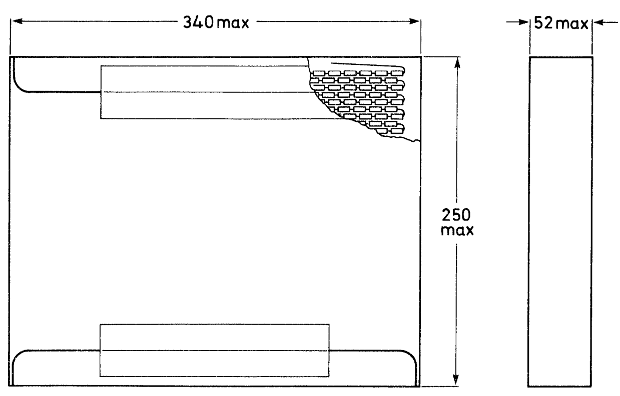


Fig. 15 Capacitors on tape in ammunition packing.

Characteristics concerning taped capacitors:

Pull-out force of the component	$\geqslant$ 5 N
Pull-off force of adhesive tape	$\geqslant$ 6 N
Tearing force of tape	$\geqslant$ 15 N

Storage conditions:

Storage temperature range	−25 to + 40 °C
Relative humidity	$\leqslant$ 80%

INSPECTION REQUIREMENTS

metallized polyethyleneterephthalate film capacitors (MKT)

Note 1
Sub-clause numbers of tests and performance requirements refer to the Sectional Specification, IEC-publication 384-2 and GENERAL DATA of specifications.

Note 2
In this table: D = destructive, ND = non-destructive.

Note 3
For the type ranges with CECC Qualification Approval separate periodic C-tests are carried out as prescribed by the CECC Detail specification.

clause number and test (see Note 1)	D or ND	conditions of test (see Note 1	performance requirements **2222 341**
Group A Inspection (lot-by-lot)			
Sub-group A1	ND		
4.1 Visual examination			– No mechanical failures. – Legible marking and as specified in GENERAL DATA of this specification.
4.2 Dimensions		Gauging	– As specified in Tables in GENERAL DATA.
Sub-group A2			
4.2.1 Voltage proof (Test A)		at 1,6 x U_R (d.c.) for 1 s	– No breakdown or flashover.
4.2.2 Capacitance		at 1 kHz	– Within specified tolerance.
4.2.3 Tangent of loss angle		**Styles 2222 365 to 371:** for $C_R \leqslant 470$ nF at 100 kHz; for $C_R > 470$ nF at 10 kHz. **Styles 2222 341 and 344:** at 10 kHz.	– As in GENERAL DATA of this specification.
4.2.4 Insulation resistance (Test A)		at 10 V for U_R = 63 V, at 100 V for U_R = 100 V, 250 V, 400 V, at 500 V for U_R = 630 V.	– As in GENERAL DATA of this specification.

performance requirements **2222 344-370-371**	performance requirements **2222 365 to 369**
– No mechanical failures. – Legible marking and as specified in GENERAL DATA of this specification. – As specified in Tables in GENERAL DATA.	– No mechanical failures. – Legible marking and as specified in GENERAL DATA of this specification. – As specified in Tables in GENERAL DATA.
– No breakdown or flashover.	– No breakdown or flashover.
– Within specified tolerance. – As in GENERAL DATA of this specification.	– Within specified tolerance. – As in GENERAL DATA of this specification.
– As in GENERAL DATA of this specification.	– As in GENERAL DATA of this specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 341**
Group B Inspection			
Lot-by-lot for CECC assessed types (For the other types periodic tests)			
4.5 Solderability	D	Without ageing Method: 1 Solder bath: 235 °C	Good tinning as evidenced by free flowing of the solder with wetting of the terminations.
Group C Inspection (periodic)			
Sub-group CIA	D		
Part of sample of Sub-group C1			
4.1 Dimensions (detail)			As specified in Tables in GENERAL DATA
4.3.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
4.3 Robustness of terminations		Tensile, bending and torsion	No visible damage.
4.4 Resistance to soldering heat		Method: 1A Solder bath: 260 °C Duration: 10 s	
4.4.2 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 2\%$ of the value measured initially.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF, compared to values measured in 4.3.1.

performance requirements **2222 344-370-371**	performance requirements **2222 365 to 369**
Good tinning as evidenced by free flowing of the solder with wetting of the terminations.	Good tinning as evidenced by free flowing of the solder with wetting of the terminations.
As specified in Tables in GENERAL DATA	As specified in Tables in GENERAL DATA
No visible damage.	No visible damage.
No visible damage. Legible marking. $\Delta C/C \leqslant 1\%$ of the value measured initially. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF, compared to values measured in 4.3.1.	No visible damage. Legible marking. $\Delta C/C \leqslant 2\%$ of the value measured initially. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF, compared to values measured in 4.3.1.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 341**
Sub-group C1B Other part of sample of Sub-group C1	D		
4.6.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
4.6 Rapid change of temperature		θ A = lower cat. temp. θ B = upper cat. temp. 5 cycles, duration t = 30 min. Visual examination	 No visible damage.
4.7 Vibration		Method of mounting see Note below. Procedure B4. Frequency range: 10 to 55 Hz Amplitude: 0,75 mm or acceleration: 98 m/s^2 (whichever is the less severe). Total duration: 6 h	
4.7.2 Final inspection		Visual examination	No visible damage.
4.9 Shock		Method of mounting see Note below. Pulse shape: half sine Acceleration: 490 m/s^2 Duration of pulse: 11 ms	
4.9.3 Final measurements		Visual examination Capacitance Tangent of loss angle	No visible damage. $\Delta C/C \leqslant 3\%$ of the value measured in 4.6.1. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in 4.6.1.
		Insulation resistance	As in GENERAL DATA of this specification.

Note

The capacitor shall be mechanically fixed by the leads and the body (stand-off pips or ridges) shall be in good contact with the printed-wiring board, also the body of capacitors with a mass > 6 g shall be clamped to the printed-wiring board.

performance requirements **2222 344-370-371**	performance requirements **2222 365 to 369**
No visible damage.	No visible damage.
No visible damage.	No visible damage.
No visible damage. $\Delta C/C \leqslant 3\%$ of the value measured in 4.6.1. Increase of tan $\delta \leqslant 0{,}005$ ($\leqslant 0{,}01$ for 2222 370 and 371) for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in 4.6.1	No visible damage. $\Delta C/C \leqslant 3\%$ of the value measured in 4.6.1. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in 4.6.1.
As in GENERAL DATA of this specification.	As in GENERAL DATA of this specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 341**
Sub-group C1	D		
Combined sample of specimens of Sub-groups C1A and C1B			
4.10 Climatic sequence			
4.10.2 Dry heat		Temperature: upper category temperature Duration: 16 h	
4.10.3 Damp heat cyclic, Test Db, first cycle			
4.10.4 Cold		Temperature: lower category temperature Duration: 2 h	
4.10.6 Damp heat cyclic, Test Db, remaining cycles			
4.10.6.2 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 3\%$ of value measured in 4.4.2 or 4.9.3.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}007$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}005$ for $C_R > 470$ nF compared to values measured in 4.3.1 or 4.6.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.

performance requirements **2222 344-370-371**	performance requirements **2222 365 to 369**
No visible damage. Legible marking. $\Delta C/C \leqslant 5\%$ of value measured in 4.4.2 or 4.9.3. Increase of tan $\delta \leqslant 0{,}007$ ($\leqslant 0{,}01$ for 2222 370 and 371) for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}005$ for $C_R > 470$ nF compared to values measured in 4.3.1 or 4.6.1. $\geqslant 50\%$ of values in GENERAL DATA of this specification.	No visible damage. Legible marking. $\Delta C/C \leqslant 5\%$ of value measured in 4.4.2 or 4.9.3. Increase of tan δ $\leqslant 0{,}007$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}005$ for $C_R > 470$ nF compared to values measured in 4.3.1 or 4.6.1. $\geqslant 50\%$ of values in GENERAL DATA of this specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 341**
Sub-group C2	D		
4.11 Damp heat steady state			
4.11.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
4.11.3 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 3\%$ of the value measured in 4.11.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}007$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}005$ for $C_R > 470$ nF compared to values measured in 4.11.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.
Sub-group C3	D		
4.12 Endurance		Duration: 2000 h; 1,25 U_R (d.c.) at 85 °C, 1,25 U_C at 100 °C	
4.12.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	

performance requirements **2222 344-370-371**	performance requirements **2222 365 to 369**
No visible damage. Legible marking $\Delta C/C \leqslant 3\%$ ($\leqslant 5\%$ for 2222 370) of the value measured in 4.11.1. Increase of tan δ $\leqslant 0{,}007$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}005$ for $C_R > 470$ nF compared to values measured in 4.11.1. $\geqslant 50\%$ of values in GENERAL DATA of this specification.	No visible damge. Legible marking. $\Delta C/C \leqslant 5\%$ of the value measured in 4.11.1. Increase of tan δ $\leqslant 0{,}007$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}005$ for $C_R > 470$ nF compared to values measured in 4.11.1. $\geqslant 50\%$ of values in GENERAL DATA of this specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 341**
4.12.5 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C < 5\%$ of value measured in 4.12.1.*
		Tangent of loss angle	Increase of tan δ $\leqslant 0,005$ for $C_R \leqslant 100$ nF, $\leqslant 0,01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0,015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0,003$ for $C_R > 470$ nF compared to values measured in 4.12.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.
Sub-group C4	D		
4.13 Charge and discharge		10 000 cycles (50 c/s) charge to U_R half sine wave Duration: 5 ms, discharge R = $\dfrac{U_R}{C_R \cdot 5 \quad (\frac{dU}{dt})\ R}$ with a min. of 2,2 Ω	
4.13.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
4.13.3 Final measurements		Capacitance	$\Delta C/C \leqslant 3\%$ of value measured in 4.13.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0,005$ for $C_R \leqslant 100$ nF, $\leqslant 0,01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0,015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0,003$ for $C_R > 470$ nF.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.

* $\Delta C/C \leqslant 8\%$ for dimensions 5,1 mm x 8,8 mm x 14,6 mm.

performance requirements **2222 344-370-371**	performance requirements **2222 365 to 369**
No visible damage. Legible marking. $\Delta C/C < 3\%$ of value measured in 4.12.1. Increase of tan $\delta \leqslant 0{,}005$ ($\leqslant 0{,}01$ at 100 °C and $\leqslant 0{,}005$ at 85 °C for 2222 370 and 371) for $C_R < 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R \geqslant 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF, compared to values measured in 4.12.1. $\geqslant 50\%$ of values in GENERAL DATA of this specification.	No visible damage. Legible marking. $\Delta C/C < 5\%$ of value measured in 4.12.1. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in 4.12.1. $\geqslant 50\%$ of values in GENERAL DATA of this specification.
$\Delta C/C \leqslant 3\%$ of value measured in 4.13.1. Increase of tan $\delta \leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF $\leqslant 0{,}003$ for $C_R > 470$ nF. $\geqslant 50\%$ of values in GENERAL DATA of this specification.	$\Delta C/C \leqslant 3\%$ of value measured in 4.13.1. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF. $\geqslant 50\%$ of values in GENERAL DATA of this specification.

additional tests	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD1	D		
A.1 Heat storage		Duration: 2000 h Temperature: upper category temperature	
A.1.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
A.1.2 Final measurements		Capacitance	$\Delta C/C \leqslant 5\%$ of value measured in A.1.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.1.1.
		Insulation resistance	As in GENERAL DATA of this specification.
Sub-group ADD2			
A.2 Endurance for capacitors with max. a.c. voltage $\geqslant 200$ V (r.m.s.)		Duration: 1000 h Temperature: 85 $^{\circ}$C Voltage: 1,25 x max. a.c. voltage (r.m.s. value), 50 Hz	
A.2.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
A.2.2 Final measurements		Capacitance	$\Delta C/C \leqslant 5\%$ of value measured in A.2.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.2.1.
		Insulation resistance	As in GENERAL DATA of this specification.

performance requirements **2222 344-370-371**	performance requirements **2222 365 to 369**
$\Delta C/C \leqslant 3\%$ of value measured in A.1.1. Increase of tan $\delta \leqslant 0{,}005$ ($\leqslant 0{,}01$ for 2222 370 and 371) for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A1.1. As in GENERAL DATA of this specification.	$\Delta C/C \leqslant 3\%$ of value measured in A.1.1. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.1.1. As in GENERAL DATA of this specification.
$\Delta C/C \leqslant 3\%$ ($\leqslant 5\%$ for 2222 370) of value measured in A.2.1. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.2.1. As in GENERAL DATA of this specification.	$\Delta C/C \leqslant 5\%$ of value measured in A.2.1. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.2.1. As in GENERAL DATA of this specification.

additional tests	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD3 A.3 Solvent resistance, Mil STD-202F, method 215 B		**GROUP 1:** **De-ionized water, followed by** mixture of isopropyl alcohol and mineral spirits **GROUP 2:** 1-1-1-Trichloroethane **GROUP 3:** Azeotropic mixture of trichlorotrifluoroethane and methylene chloride Temperature: 25 °C	
A.3.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
A.3.2 Final measurements		Capacitance	$\Delta C/C \leqslant 1\%$ of value measured in A.3.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.3.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.

performance requirements **2222 344-370-371**	performance requirements **2222 365 to 369**
$\Delta C/C \leqslant 1\%$ of value measured in A.3.1. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.3.1. $\geqslant 50\%$ of values in GENERAL DATA of this specification.	$\Delta C/C \leqslant 1\%$ of value measured in A.3.1. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.3.1. $\geqslant 50\%$ of values in GENERAL DATA of this specification.

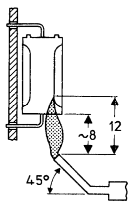
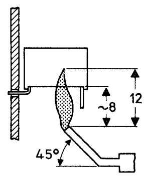
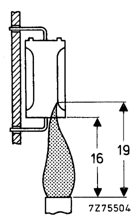
additional tests	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD4			
A.4 Detergent resistance		Density 20g/l dishwasher detergent. Temperature 70 °C, during 3 min. Followed by rinsing in clear water for 1 min. Recovery time > 2 h.	
A.4.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470\,nF$ at 100 kHz, $C_R > 470\,nF$ at 10 kHz	
A.4.2 Final measurements		Capacitance	$\Delta C/C \leqslant 1\%$ of value measured in A.4.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100\,nF$, $\leqslant 0{,}01$ for $C_R > 100\,nF$ and $\leqslant 220\,nF$, $\leqslant 0{,}015$ for $C_R > 220\,nF$ and $\leqslant 470\,nF$, $\leqslant 0{,}003$ for $C_R > 470\,nF$ compared to values measured in A.4.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.

performance requirements **2222 344-370-371**	performance requirments **2222 365 to 369**
$\Delta C/C \leqslant 1\%$ of value measured in A.4.1. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.4.1. $\geqslant 50\%$ of values in GENERAL DATA of this specification.	$\Delta C/C \leqslant 1\%$ of value measured in A.4.1. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.4.1. $\geqslant 50\%$ of values in GENERAL DATA of this specification.

additional tests	D or ND	conditions of tests	performance requirements **2222 341**
Sub-group ADD5	D		
A.5 Resistance to soldering heat with pre-heating		Capacitors mounted on a 1,6 mm board with non-plated holes Body temp.: 80 °C Bath temp.: 260 °C Dwell time: 2 x 5 s with interim free period of 5 s *	
A.5.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
A.5.2 Final measurements		Capacitance	$\Delta C/C \leqslant 2\%$ for $C \leqslant 10$ nF, $\leqslant 1\%$ for $C > 10$ nF of value measured in A.5.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 100$ nF, $\leqslant 0{,}01$ for $C_R > 100$ nF and $\leqslant 220$ nF, $\leqslant 0{,}015$ for $C_R > 220$ nF and $\leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.5.1.

* For style 2222 341: dwell time = 5 s.

performance requirements **2222 344-370-371**	performance requirements **2222 365 to 369**
$\leqslant$ 2% for T_{max} = 2,5 mm, $\leqslant$ 1% for $T_{max} >$ 2,5 mm of value measured in A.5.1. Increase of tan δ $\leqslant$ 0,005 for $C_R \leqslant$ 100 nF, $\leqslant$ 0,01 for $C_R >$ 100 nF and $\leqslant$ 220 nF, $\leqslant$ 0,015 for $C_R >$ 220 nF and $\leqslant$ 470 nF, $\leqslant$ 0,003 for $C_R >$ 470 nF compared to values measured in A.5.1.	$\Delta C/C \leqslant$ 2% for C $\leqslant$ 10 nF, $\leqslant$ 1% for C $>$ 10 nF of value measured in A.5.1. Increase of tan δ $\leqslant$ 0,005 for $C_R \leqslant$ 100 nF, $\leqslant$ 0,01 for $C_R >$ 100 nF and $\leqslant$ 220 nF, $\leqslant$ 0,015 for $C_R >$ 220 nF and $\leqslant$ 470 nF, $\leqslant$ 0,003 for $C_R >$ 470 nF compared to values measured in A.5.1.

additional tests	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD6	D		
A.6.1 Needle flame test, IEC 695-2-2		Bore of gas jet: ϕ 0,5 mm. Fuel: Butane. Test duration: 20 s One flame application. 7Z75503 7Z75502	After removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s, no burning particles must drop from the sample.
A.6.2 Needle flame test, UL 1414		Bore of gas jet: ϕ 10 mm. Fuel: natural gas. Test duration: 3 x 15 s. Time interval between each flame application: 15 s. 7Z75504	Extinguishing time $\leqslant$ 15 s after the first and second flame application, $\leqslant$ 60 s after the third flame application.
Sub-group ADD7			
A.7 Climatic test on taped types		250 h at 40 ± 2 °C R.H. 90 to 95% Recovery time 24 h.	Not applicable.

performance requirements **2222 344-370-371**	performance requirements **2222 365 to 369**
Only applicable to 2222 344 After removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s, no burning particles must drop from the sample.	Not applicable.
Not applicable.	Not applicable.
Only applicable to 2222 370 and 371 Change in position of lead hole over 10 pitch distances $\leqslant$ 0,05 mm. Angle of component $\leqslant 4^{o}$. Pull off, pull out and tearing forces $\geqslant$ 50% of values in GENERAL DATA of this specification.	**Only applicable to 2222 365** Change in position of lead hole over 10 pitch distances $\leqslant$ 0,05 mm. Angle of component $\leqslant 4^{o}$. Pull off, pull out and tearing forces $\geqslant$ 50% of values in GENERAL DATA of this specification.

POLYETHYLENETHEREPHTHALATE FILM/FOIL CAPACITORS (KT)

POLYETHYLENETEREPHTHALATE FILM/FOIL CAPACITORS

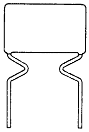
KT radial phenolic lacquered type

- 10,16 to 27,94 mm pitch
- Supplied in boxes

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	0,001 to 1 μF
Tolerance on rated capacitance	± 20%, ± 10%
Rated voltage U_R (d.c.)	100 V, 250 V, 400 V, 630 V
Climatic category, IEC 68	40/100/21
Rated temperature	85 ^oC
Related specification	IEC 384-11

STYLE



Style: 2222 347.
Pitch: 10,16 mm, 15,24 mm, 22,86 mm, 27,94 mm
See Tables 1 to 4.

APPLICATION

For use in wide range of consumer and industrial applications, especially where high currents and/or steep pulses occur. The capacitors are suited for d.c. or a.c. operation.

DESCRIPTION

These capacitors consist of a low-inductance wound cell of metal foil and a polyethyleneterephthalate (PETP) film. The cell is protected by a hard, tan coloured lacquer, which is self-extinguishing. The radial leads are of solder-coated wire.

GENERAL DATA

Dimensions in mm

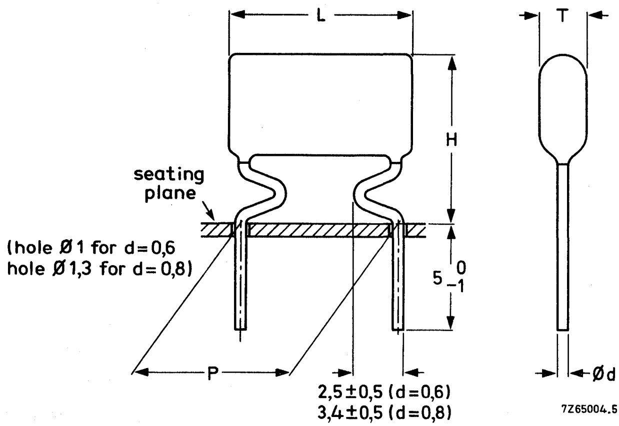


Fig. 1.

Table 1 U_R (d.c.) = 100 V; max. a.c. voltage = 50 V, Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	P	mass g	catalogue number 2222 347 ..... tol. ± 20%	tol. ± 10%
0,015	4,5	12	13,5	0,6 + 0,06 −0,05	10,16 ± 0,3	0,4	20153	21153
0,018	5	12,5				0,5	20183	21183
0,022	5,5	13				0,6	20223	21223
0,027	5,5	13				0,7	20273	21273
0,033	6	13,5				0,7	20333	21333
0,039	6,5	14				0,8	20393	21393
0,047	7	14,5				0,9	20473	21473
0,056	5,5	14	19	0,8 + 0,08 −0,05	15,24 ± 0,3	1,2	20563	21563
0,068	6	14,5				1,3	20683	21683
0,082	6,5	15				1,5	20823	21823
0,10	7	15,5				1,7	20104	21104
0,12	7,5	16				1,9	20124	21124
0,15	8	16,5				2,3	20154	21154
0,18	7,5	18	27		22,86 ± 0,3	2,8	20184	21184
0,22	7,5	18,5				3,2	20224	21224
0,27	8	19,5				3,8	20274	21274
0,33	8,5	20				4,4	20334	21334
0,39	9,5	21				5,1	20394	21394
0,47	10,5	22				6,0	20474	21474
0,56	10	21,5	32		27,94 ± 0,3	7,0	20564	21564
0,68	11	22,5				8,4	20684	21684
0,82	12	23,5				10,2	20824	21824
1	13,5	25				12,5	20105	21105

Table 2 U_R (d.c.) = 250 V; max. a.c. voltage = 80 V, Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	P	mass g	catalogue number 2222 347 ..... tol. ± 20%	tol. ± 10%
0,0082	4,5	12				0,4	40822	41822
0,010	5	12,5				0,5	40103	41103
0,012	5,5	13		0,6	10,16	0,5	40123	41123
0,015	5,5	13	13,5	+ 0,06	± 0,3	0,6	40153	41153
0,018	6	13,5		−0,05		0,7	40183	41183
0,022	6,5	14				0,8	40223	41223
0,027	7	14,5				0,9	40273	41273
0,033	5,5	14				1,1	40333	41333
0,039	6	14,5				1,3	40393	41393
0,047	6,5	15	19		15,24	1,4	40473	41473
0,056	7	15,5			± 0,3	1,6	40563	41563
0,068	7,5	16				1,8	40683	41683
0,082	8	16,5				2,1	40823	41823
0,10	7,5	18				2,7	40104	41104
0,12	7,5	18,5				3,0	40124	41124
0,15	8	19,5	27	0,8	22,86	3,5	40154	41154
0,18	8,5	20		+ 0,08	± 0,3	4,0	40184	41184
0,22	9,5	21		−0,05		4,5	40224	41224
0,27	10,5	22				5,3	40274	41274
0,33	10	21,5				6,3	40334	41334
0,39	11	22,5			27,94	7,6	40394	41394
0,47	12	23,5	32		± 0,3	9,1	40474	41474
0,56	13,5	25				10,8	40564	41564
0,68	15	26,5				13,1	40684	41684

Table 3 U_R (d.c.) = 400 V; max. a.c. voltage = 125 V, Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	P	mass g	catalogue number 2222 347 . . . . . tol. ± 20%	catalogue number 2222 347 . . . . . tol. ± 10%
→ 0,0047	4,5	12,5	13,5	0,6 + 0,06 −0,05	10,16 ± 0,3	0,4	50472	51472
0,0056	5	12,5				0,5	50562	51562
0,0068	5,5	13				0,5	50682	51682
0,0082	5,5	13				0,6	50822	51822
0,010	6	13,5				0,7	50103	51103
0,012	6,5	14				0,8	50123	51123
0,015	7	14,5				0,9	50153	51153
0,018	5,5	14	19	0,8 + 0,08 −0,05	15,24 ± 0,3	1,1	50183	51183
0,022	6	14,5				1,2	50223	51223
0,027	6,5	15				1,4	50273	51273
0,033	7	15,5				1,6	50333	51333
0,039	7,5	16				1,8	50393	51393
0,047	8	16,5				2,1	50473	51473
0,056	7,5	18	27		22,86 ± 0,3	2,5	50563	51563
0,068	7,5	18,5				2,9	50683	51683
0,082	8	19,5				3,2	50823	51823
0,10	8,5	20				3,8	50104	51104
0,12	9,5	21				4,4	50124	51124
0,15	10,5	22				5,2	50154	51154
0,18	10	21,5	32		27,94 ± 0,3	6,0	50184	51184
0,22	11	22,5				6,9	50224	51224
0,27	12	23,5				8,0	50274	51274
0,33	13,5	25				9,5	50334	51334

Table 4 U_R (d.c.) = 630 V; max. a.c. voltage = 200 V, Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	P	mass g	catalogue number 2222 347	
							tol. ± 20%	tol. ± 10%
0,001	5,5	13				0,5	60102	61102
0,0012	5,5	13				0,5	60122	61122
0,0015	5,5	13				0,6	60152	61152
0,0018	5,5	13				0,7	60182	61182
0,0022	5,5	13				0,5	60222	61222
0,0027	5,5	13	13,5	0,6	10,16	0,6	60272	61272
0,0033	5,5	13		+ 0,06	± 0,3	0,5	60332	61332
0,0039	5,5	13		−0,05		0,6	60392	61392
0,0047	6	13				0,7	60472	61472
0,0056	6,5	14				0,8	60562	61562
0,0068	7	14,5				0,9	60682	61682
0,0082	5,5	14				1,1	60822	61822
0,010	6	14,5				1,2	60103	61103
0,012	6,5	15	19		15,24	1,3	60123	61123
0,015	7	15,5			± 0,3	1,5	60153	61153
0,018	7,5	16				1,7	60183	61183
0,022	8	16,5				2,0	60223	61223
0,027	7,5	18				2,5	60273	61273
0,033	7,5	18,5				2,8	60333	61333
0,039	8	19,5	27	0,8	22,86	3,0	60393	61393
0,047	8,5	20		+ 0,08	± 0,3	3,5	60473	61473
0,056	9,5	21		−0,05		3,8	60563	61563
0,068	10,5	22				4,4	60683	61683
0,082	10	21,5				5,2	60823	61823
0,1	11	22,5	32		27,94	6,2	60104	61104
0,12	12	23,5			± 0,3	7,2	60124	61124
0,15	13,5	25				8,7	60154	61154

Marking

a. Rated capacitance
b. Rated voltage
c. Tolerance on rated capacitance
d. Category voltage
e. Year and month of manufacture
f. Manufacturer's name
g. Climatic category
h. Manufacturer's type designation

The capacitors are marked in black ink on top with a, b, c, f and h as follows:

1st line : rated capacitance in pF or μF, tolerance (± 20% indicated by M or 20%, ± 10% indicated by K or 10%);

2nd line : rated d.c. voltage and code for dielectric material (KT)

The manufacturer's name is indicated at the left.
The code for factory of origin is indicated at the right.

The package containing the capacitors is marked with a to h.

Mounting

The capacitors are for printed-wiring applications.

Ratings and characteristics

Unless otherwise specified all electrical values apply at an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 kHz	see Tables 1 to 4
Tolerance on rated capacitance	see Tables 1 to 4

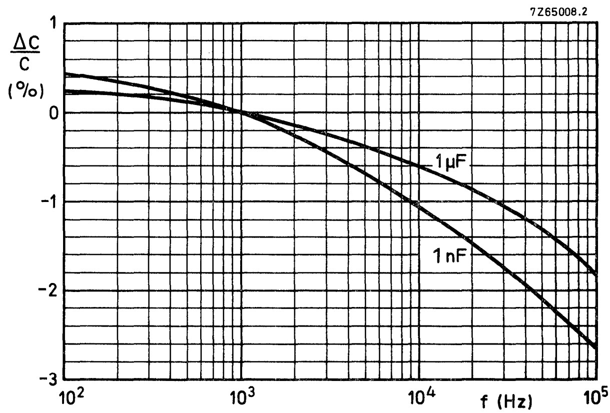


Fig. 2 Capacitance as a function of frequency; typical curves.

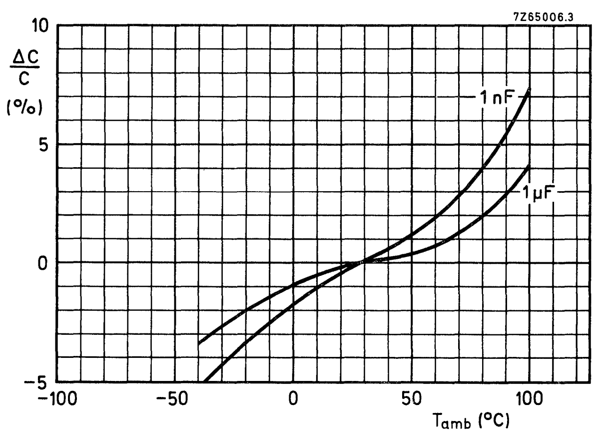


Fig. 3 Capacitance as a function of ambient free air temperature; typical curves.

Voltage

Rated voltage U_R (d.c.)	See Tables 1 to 4
Category voltage U_C	0,8 x U_R (d.c.)
Maximum a.c. voltage (r.m.s. value), at 50 to 60 Hz	See Tables 1 to 4
Test voltage between terminations	2 x U_R (d.c.)

Notes
- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.)
- For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

Temperature

Climatic category	40/100/21
Rated temperature	85 °C
Storage temperature range	–40 to + 100 °C

Tangent of the loss angle

Tan δ at 10 kHz	$\leqslant 110 \times 10^{-4}$
Tan δ at 1 kHz	$\leqslant 60 \times 10^{-4}$

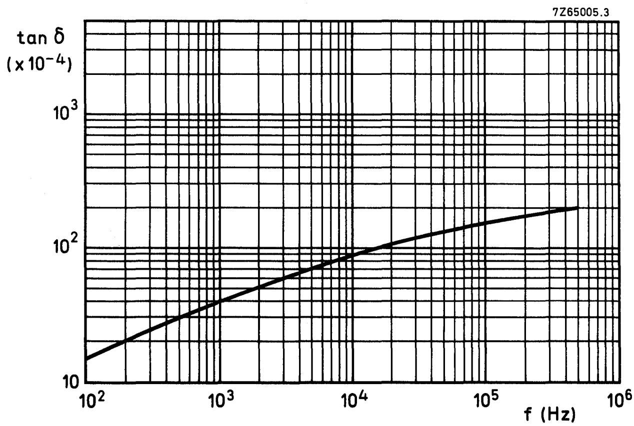


Fig. 4 Tan δ as a function of frequency; typical curve.

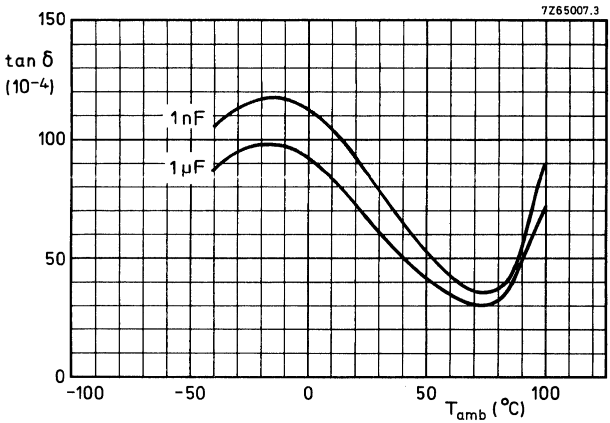


Fig. 5 Tan δ as a function of ambient free air temperature; typical curves.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 min ± 5 s, the voltage being 100 ± 15 V for the 100 V, 250 V and 400 V versions, and 500 ± 50 V for the 630 V version, at T_{amb} = 20 °C.

R between terminations, for $C_R \leqslant 0{,}33\ \mu F$	> 50 000 MΩ
RC between terminations, for $C_R > 0{,}33\ \mu F$	> 16 500 s

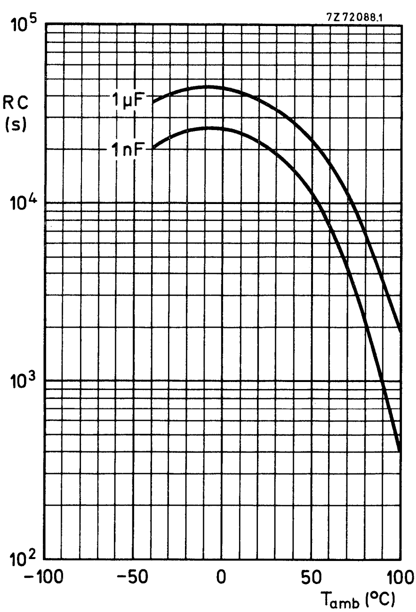


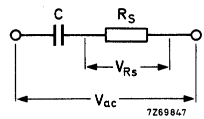
Fig. 6 RC-product as a function of ambient free air temperature; typical curves.

Maximum dissipation

The maximum a.c. voltage has been specified for 50 to 60 Hz and at 23 °C. This voltage must also never be exceeded at other frequencies. This permissible a.c. voltage may further be limited by the maximum power dissipation P_{max}.

The power dissipated by a capacitor is a function of the voltage across the series resistance (R_s) or of the current through the series resistance and is expressed by

$$P = \frac{V_{Rs}^2}{R_s} = I^2 R_s \qquad (1)$$



$$V_{Rs}^2 = \frac{R_s^2}{R_s^2 + 1/\omega^2 C^2} V_{ac}^2 \qquad (2a)$$

Because for these capacitors $\tan \delta = R_s \omega C = < 0{,}1$, the formule (2a) can be simplified to

$$V_{Rs}^2 = \frac{R_s^2}{1/\omega^2 C^2} V_{ac}^2 = R_s^2 \omega^2 C^2 V_{ac}^2 \qquad (2b)$$

Thus $P = R_s \omega^2 C^2 V_{ac}^2$ (3a)

or $P = (R_s C)\, C \omega^2 V_{ac}^2$ (3b)

The term R_sC can be found from Fig. 7; C (in farads), $\omega = 2\pi f$ and V_{ac} are assumed to be known.

The maximum permissible value of power dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be read from Fig. 8.

Thus, when the actual power has been calculated with equation (3b), Fig. 8 gives the minimum size of capacitor which can dissipate this power.

Example of using Fig. 7 and Fig. 8

A capacitor with a value of 0,047 μF should be used at an a.c. voltage of 100 V, a frequency of 10 kHz and an ambient free air temperature of 50 °C. Thus the rated d.c. voltage should be at least 400 V. The R_sC-product is $1{,}35 \times 10^{-7}$ s (from Fig. 7), so that the power to be dissipated is

$$\begin{aligned} P &= (R_s C)\, C \omega^2 V_{ac}^2 \\ &= 1{,}35 \times 10^{-7} \times 0{,}047 \times 10^{-6} \times 4\pi^2 \times 10^8 \times 10^4 = 250 \text{ mW} \end{aligned}$$

For an a.c. voltage of 100 V a capacitor of the 400 V series is required at least.

Capacitor 0,047 μF/125 V(a.c.) is satisfactory because of its dimensions 8 mm x 16,5 mm x 19 mm, and its dissipated power of 400 mW at 50 °C.

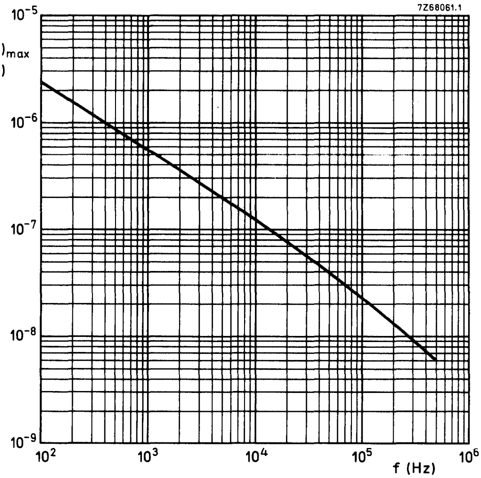


Fig. 7 Maximum product of series resistance and capacitance as a function of frequency.

curve	dimensions in mm		
	T_{max}	H_{max}	L_{max}
1	4,5	12	13,5
2	5	12,5	13,5
3	5,5	13	13,5
4	6	13,5	13,5
5	6,5	14	13,5
6	7	14,5	13,5
7	5,5	14	19
8	6	14,5	19
9	6,5	15	19
10	7	15,5	19
11	7,5	16	19
12	8	16,5	19
13	6,5	18	27
14	7,5	18,5	27
15	8	19,5	27
16	8,5	20	27
17	9,5	21	27
18	10,5	22	27
19	10	21,5	32
20	11	22,5	32
21	12	23,5	32
22	13,5	25	32
23	15	26,5	32

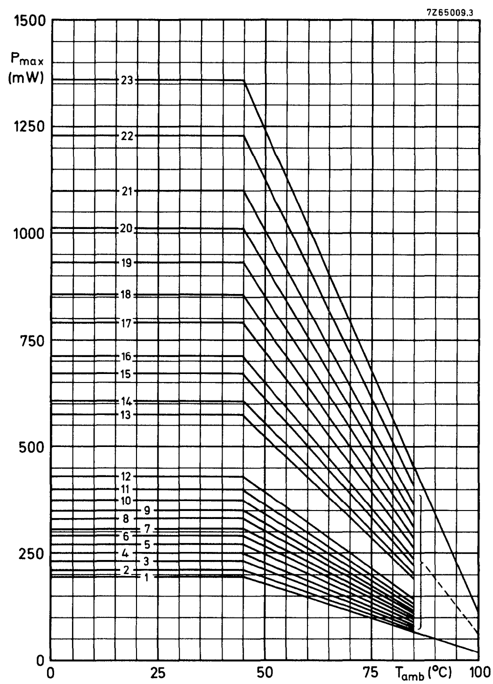


Fig. 8 Maximum dissipation as a function of ambient free air temperature.

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number as shown in Tables 1 to 4.

PACKING

The capacitors are packed in boxes; the number of capacitors per box is given in the table below.

dimensions (mm) T_{max} x H_{max} x L_{max}	number of capacitors per box
$\geq$ 4,5 x 12 x 13,5 and $\leq$ 7,5 x 16 x 19	2000
$>$ 7,5 x 16 x 19 and $\leq$ 7,5 x 18,5 x 27	1000
$>$ 7,5 x 18,5 x 27 and $\leq$ 11 x 22,5 x 32	500
$>$ 11 x 22,5 x 32	250

INSPECTION REQUIREMENTS

polyethyleneterephthalate film/foil capacitors (KT)

Note 1
Sub-clause numbers of tests and performance requirements refer to the Sectional Specification, IEC-publication 384-11 and GENERAL DATA of this specification.

Note 2
In this table: D = destructive, ND = non-destructive.

clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements (see Note 1)
Group A Inspection (lot-by-lot)			
Sub-group A1	ND		
4.1 Visual examination			– No mechanical failures – Legible marking and as specified in GENERAL DATA of this specification.
4.2 Dimensions		Gauging	– As specified in Tables 1 to 4 of this specification.
Sub-group A2	ND		
4.2.1 Voltage proof (Test A)		at 2,2 x U_R (d.c.) for 1 s	– No breakdown or flashover.
4.2.2 Capacitance		at 1 kHz	– Within specified tolerance.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Group B Inspection (periodic)			
4.5 Solderability	D	Without ageing Method: 1 Solder bath: 235 °C Dwell time: 2 s Non-activated colophony flux	Good tinning as evidenced by free flowing of the solder with wetting of the terminations.
Group C Inspection (periodic)			
Sub-group C1A	D		
Part of sample of Sub-group C1			
4.1 Dimensions (detail)			As specified in Tables 1 to 4 of this specification.
4.3.1 Initial measurements		Capacitance at 1 kHz Tangent of loss angle at 10 kHz	
4.3 Robustness of terminations		Tensile and bending	No visible damage.
4.4 Resistance to soldering heat		No pre-drying Method: 1A Solder bath: 260 °C Duration: 10 s	
4.2.2 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 2\%$ of the value measured in 4.3.1.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Sub-group C1B			
Other part of sample of Sub-group C1			
4.6.1 Initial measurements		Capacitance at 1 kHz Tangent of loss angle at 10 kHz	
4.6 Rapid change of temperature		θ A = lower cat. temp. θ B = upper cat. temp. 5 cycles, duration t = 30 min. Visual examination	 No visible damage.
4.7 Vibration		Method of mounting see Note below. Procedure B4. Frequency range: 10 to 55 Hz Pulse shape: half sine Amplitude: 0,75 mm or acceleration: 98 m/s^2 (whichever is the less severe). Total duration: 6 h	
4.7.2 Final inspection		Visual examination	No visible damage.
4.9 Shock		Method of mounting see Note below. Pulse shape: half sine Acceleration: 390 m/s^2 Duration of pulse: 6 ms	
4.9.3 Final measurements		Visual examination Capacitance Tangent of loss angle	No visible damage. $\Delta C/C \leqslant 2\%$ of the value measured in 4.6.1. As in GENERAL DATA of this specification.

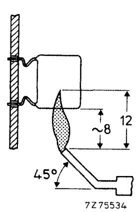
Note:

The capacitors shall be mechanically fixed by the leads and the crimps shall be in good contact with the printed-wiring board, also the body of capacitors with a mass >2 g shall be clamped to the printed-wiring board.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Sub-group C1	D		
Combined sample of specimens of Sub-groups C1A and C1B			
4.10 Climatic sequence			
4.10.2 Dry heat		Temperature: upper category temperature Duration: 16 h	
4.10.3 Damp heat cyclic, Test Db, first cycle			
4.10.4 Cold		Temperature: lower category temperature Duration: 2 h	
4.10.6 Damp heat cyclic, Test Db, remaining cycles			
4.10.6.2 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 5\%$ of value measured in 4.4.2 or 4.9.3.
		Tangent of loss angle	As in GENERAL DATA of this specification.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Sub-group C2	D		
4.11 Damp heat steady state			
4.11.1 Initial measurements		Capacitance at 1 kHz Tangent of loss angle at 10 kHz	
4.11.3 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 5\%$ of the value measured in 4.11.1.
		Tangent of loss angle	As in GENERAL DATA of this specification.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.
Sub-group C3	D		
4.12 Endurance		Duration: 1000 h; 1,5 U_R (d.c.) at 85 °C, 1,5 U_C at 100 °C	
4.12.1 Initial measurements		Capacitance at 1 kHz Tangent of loss angle at 10 kHz	
4.12.5 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 10\%$ of value measured in 4.12.1.
		Tangent of loss angle	As in GENERAL DATA of this specification.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.

additional tests	D or ND	conditions of test	performance requirements
Sub-group ADD1	D		
A.1 Heat storage		Duration: 1000 h Temperature: upper category temperature	
A.1.1 Initial measurements		Capacitance at 1 kHz Tangent of loss angle at 10 kHz	
A.1.2 Final measurements		Capacitance	$\Delta C/C \leqslant 5\%$ of value measured in A.1.1.
		Insulation resistance	As in GENERAL DATA of this specification.
Sub-group ADD2			
A.2 Endurance for capacitors with max. a.c. voltage $\geqslant 200$ V (r.m.s.)		Duration: 1000 h Temperature: 85 ^{o}C Voltage: 1,25 x max. a.c. voltage (r.m.s. value), 50 Hz	
A.2.1 Initial measurements		Capacitance at 1 kHz Tangent of loss angle at 10 kHz	
A.2.2 Final measurements		Capacitance	$\Delta C/C \leqslant 5\%$ of value measured in A.2.1.
		Tangent of loss angle	As in GENERAL DATA of this specification.
		Insulation resistance	As in GENERAL DATA of this specification.

additional tests	D or ND	conditions of tests	performance requirements
Sub-group ADD3	D		
A.3 Resistance to soldering heat with pre-heating		Capacitors mounted on a 1,6 mm board with non-plated holes Body temp.: 80 °C Bath temp.: 260 °C Dwell time: 2 x 5 s, with interim free period of 5 s	
A.3.1 Initial measurements		Capacitance Tangent of loss angle	
A.3.2 Final measurements		Capacitance	ΔC/C ⩽ 2% of value measured in A.3.1.
		Tangent of loss angle	As in GENERAL DATA of this specification.
		Insulation resistance	As in GENERAL DATA of this specification.
Sub-group ADD4	D		
A.4.1 Needle flame test, IEC 695-2-2		Bore of gas jet: ϕ 0,5 mm. Fuel: butane. Test duration: 20 s. One flame application. 	After removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s, no burning particles must drop from the sample.

METALLIZED POLYCARBONATE FILM CAPACITORS (MKC)

METALLIZED POLYCARBONATE FILM CAPACITORS

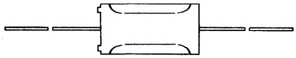
MKC axial moulded type

- Supplied in boxes

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	0,0082 to 6,8 μF
Tolerance on rated capacitance	± 20%, ± 10%, ± 5%
Rated voltage U_R (d.c.)	100 V, 250 V, 400 V, 630 V, 1000 V
Climatic category	55/100/56
Rated temperature	85 ^{o}C
Tangent of loss angle at 10 kHz	20×10^{-4}
Related specification	IEC 384-6
Performance grade	general purpose

STYLE



Style 2222 341; see Tables 1 to 5

APPLICATION

In electronic circuits for blocking and coupling, bypass and energy reservoir applications.

DESCRIPTION

The capacitors consist of a low-inductance wound cell of metallized polycarbonate film. The cell is moulded in yellow flame retardent polypropylene. The axial leads are of solder-coated wire. One end of the capacitor is provided with two stand-off ridges to allow removal of solder flux etc., when cleaning the printed-wiring board.

GENERAL DATA

Dimensions in mm

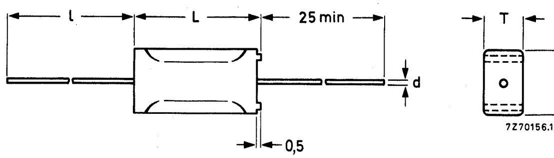


Fig. 1.

Table 1 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V; Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass g	catalogue number 2222 341 . . . . . tol. ± 20%	tol. ± 10%	tol. ± 5%
0,082	5,1	8,8	14,6	0,8	40	1,0	28823	29823	23823
0,10							28104	29104	23104
0,12							28124	29124	23124
0,15							28154	29154	23154
0,18	5,7	9,5	14,6			1,1	28184	29184	23184
0,22	7	10,6	14,6			1,4	28224	29224	23224
0,27							28274	29274	23274
0,33	6,6	10,4	18,1			1,7	28334	29334	23334
0,39							28394	29394	23394
0,47	7,9	11,5	18,1			2,0	28474	29474	23474
0,56							28564	29564	23564
0,68	7,8	11,6	23,5			2,5	28684	29684	23684
0,82							28824	29824	23824
1,0	9,2	12,9	23,5			3,2	28105	29105	23105
1,2							28125	29125	23125
1,5	10,8	14,5	23,5			4,0	28155	29155	23155
1,8							28185	29185	23185
2,2	10,7	14,6	31	1	50	5,5	28225	29225	23225
2,7							28275	29275	23275
3,3	12,5	19,5	31			8,0	28335	29335	23335
3,9							28395	29395	23395
4,7							28475	29475	23475
5,6	15,4	22,1	31			10,5	28565	29565	23565
6,8							28685	29685	23685

Table 2 U_R (d.c.) = 250 V; max. a.c. voltage = 160 V; Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass g	catalogue number 2222 341 ..... tol. ± 20%	tol. ± 10%	tol. ± 5%
0,039	5,1	8,8	14,6	0,8	40	1,0	48393	49393	47393
0,047							48473	49473	47473
0,056							48563	49563	47563
0,068							48683	49683	47683
0,082	5,7	9,5	14,6			1,4	48823	49823	47823
0,10							48104	49104	47104
0,12	6,6	10,4	18,1			1,7	48124	49124	47124
0,15							48154	49154	47154
0,18	7,9	11,5	18,1			2,0	48184	49184	47184
0,22							48224	49224	47224
0,27	7,8	11,6	23,5			2,5	48274	49274	47274
0,33							48334	49334	47334
0,39	9,2	12,9	23,5			3,2	48394	49394	47394
0,47							48474	49474	47474
0,56	10,8	14,5	23,5			4,0	48564	49564	47564
0,68							48684	49684	47684
0,82	10,7	14,6	31	1	50	5,5	48824	49824	47824
1,0							48105	49105	47105
1,2	12,5	19,5	31			8,0	48125	49125	47125
1,5							48155	49155	47155
1,8	15,4	22,1	31			10,5	48185	49185	47185
2,2							48225	49225	47225

Table 3 U_R (d.c.) = 400 V; max. a.c. voltage = 220 V; Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass g	catalogue number 2222 341 . . . . . tol. ± 20%	tol. ± 10%	tol. ± 5%
0,0082							58822	59822	57822
0,010							58103	59103	57103
0,012							58123	59123	57123
0,015	5,1	8,8	14,6			1,0	58153	59153	57153
0,018							58183	59183	57183
0,022							58223	59223	57223
0,027							58273	59273	57273
0,033	5,7	9,5	14,6			1,1	58333	59333	57333
0,039	7	10,6	14,6			1,4	58393	59393	57393
0,047							58473	59473	57473
0,056	6,6	10,4	18,1	0,8	40	1,7	58563	59563	57563
0,068							58683	59683	57683
0,082	7,9	11,5	18,1			2,0	58823	59823	57823
0,10							58104	59104	57104
0,12	7,8	11,6	23,5			2,5	58124	59124	57124
0,15							58154	59154	57154
0,18	9,2	12,9	23,5			3,2	58184	59184	57184
0,22							58224	59224	57224
0,27	10,8	14,5	23,5			4,0	58274	59274	57274
0,33							58334	59334	57334
0,39	10,7	14,6	31			5,5	58394	59394	57394
0,47							58474	59474	57474
0,56	12,5	19,5	31	1	50	8,0	58564	59564	57564
0,68							58684	59684	57684
0,82	15,4	22,1	31			10,5	58824	59824	57824
1,0							58105	59105	57105

Table 4 U_R (d.c.) = 630 V; max. a.c. voltage = 220 V; Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass g	catalogue number 2222 341 ..... tol. ± 20%	tol. ± 10%	tol. ± 5%
0,0082	5,1	8,8	14,6	0,8	40	1,0	60822	61822	62822
0,010							60103	61103	62103
0,012	5,7	9,5	14,6			1,1	60123	61123	62123
0,015							60153	61153	62153
0,018	7	10,6	14,6			1,4	60183	61183	62183
0,022							60223	61223	62223
0,027	6,6	10,4	18,1			1,7	60273	61273	62273
0,033							60333	61333	62333
0,039	7,9	11,5	18,1			2,0	60393	61393	62393
0,047							60473	61473	62473
0,056	7,8	11,6	23,5			2,5	60563	61563	62563
0,068							60683	61683	62683
0,082	9,2	12,9	23,5			3,2	60823	61823	62823
0,10							60104	61104	62104
0,12	10,8	14,5	23,5			4,0	60124	61124	62124
0,15							60154	61154	62154
0,18	10,7	14,6	31	1	50	5,5	60184	61184	62184
0,22							60224	61224	62224
0,27	12,5	19,5	31			8,0	60274	61274	62274
0,33							60334	61334	62334
0,39	15,4	22,1	31			10,5	60394	61394	62394
0,47							60474	61474	62474

Table 5 U_R (d.c.) = 1000 V; max. a.c. voltage = 250 V; Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass g	catalogue number 2222 341 ..... tol. ± 20%	tol. ± 10%
0,0082	6,6	10,4	18,1	0,8	40	1,7	70822	71822
0,010							70103	71103
0,012	7,9	11,5	18,1			2,0	70123	71123
0,015							70153	71153
0,018	7,8	11,6	23,5			2,5	70183	71183
0,022							70223	71223
0,027	9,2	12,9	23,5			3,2	70273	71273
0,033							70333	71333
0,039	10,8	14,5	23,5			4,0	70393	71393
0,047							70473	71473
0,056	10,7	14,6	31	1	50	5,5	70563	71563
0,068							70683	71683
0,082	12,5	19,5	31			8,0	70823	71823
0,10							70104	71104
0,12	15,4	22,1	31			10,5	70124	71124
0,15							70154	71154

Note: Capacitors of the 1000 V range with tolerance ± 5% are available to special order.

Marking

a. Rated capacitance
b. Rated voltage
c. Tolerance on rated capacitance
d. Category voltage
e. Year and month of manufacture
f. Manufacturer's name
g. Climatic category
h. Manufacturer's type designation

The marking is impressed on one side with a, b, c, e and h as follows:

1st line : rated capacitance in pF or μF, tolerance and rated d.c. voltage;

2nd line: 5th, 6th and 7th digits of the catalogue number, code for dielectric material (MKC) and production date code (according to IEC 62, clause 5).

The marking on the other side is impressed with f as follows:

1st line : manufacturer's name;

2nd line: code for factory of origin.

The package containing the capacitors is marked with a to h.

Mounting

The capacitors are for horizontal or vertical mounting on printed-wiring boards and for point to point wiring.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 kHz	see Tables 1 to 5
Tolerance on rated capacitance	see Tables 1 to 5

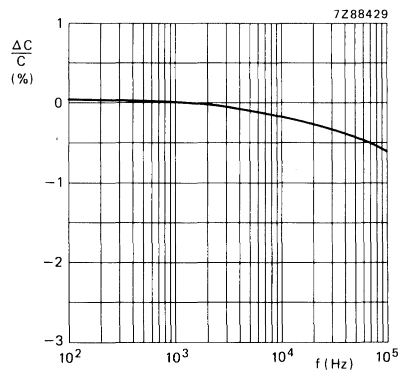


Fig. 2 Capacitance as a function of frequency; typical curve.

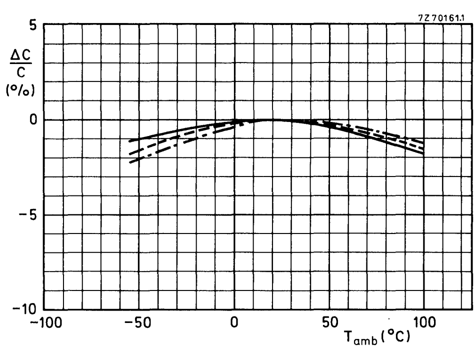


Fig. 3 Capacitance as a function of ambient free air temperature; typical curves.
——— for all capacitance values, measured at 1 kHz, 1 V.
– – – – for capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.
– · – · – for capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Voltage

Rated voltage U_R (d.c.) — See Tables 1 to 5

Category voltage U_C — $0{,}8 \times U_R$ (d.c.)

Maximum a.c. voltage (r.m.s. value), at 50 to 60 Hz — See Tables 1 to 5

Test voltage
- between terminations — $1{,}6 \times U_R$ (d.c.)
- between interconnected terminations and case — $2 \times U_R$ (d.c.); min. 200 V

Temperature

Climatic category — 55/100/56

Rated temperature — 85 °C

Storage temperature range — −55 to + 100 °C

Notes
- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.)
- For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

Maximum pulse load

rated voltage V	maximum pulse load (V/µs)			
	L = 14,5 mm	L = 18 mm	L = 23,5 mm	L = 31 mm
100	30	13	7,5	4,5
250	45	18	12	7
400	70	30	18	11
630	100	45	25	15
1000		45	40	20

The maximum pulse load values in the table are valid for pulse voltages equal to the rated voltage.

For lower pulse voltages the given values may be multiplied by U_R/applied voltage.

Note
If the pulse load requirement is satisfied, a check must be made to ascertain that the maximum dissipation is not exceeded.

Tangent of loss angle

capacitance	tangent of loss angle		
	1 kHz	10 kHz	100 kHz
$C_R \leqslant 0,1\ \mu F$	$\leqslant 30 \times 10^{-4}$	$\leqslant 60 \times 10^{-4}$	$\leqslant 130 \times 10^{-4}$
$0,1\ \mu F < C_R \leqslant 1\ \mu F$	$\leqslant 30 \times 10^{-4}$	$\leqslant 60 \times 10^{-4}$	
$C_R > 1\ \mu F$	$\leqslant 30 \times 10^{-4}$	$\leqslant 75 \times 10^{-4}$	

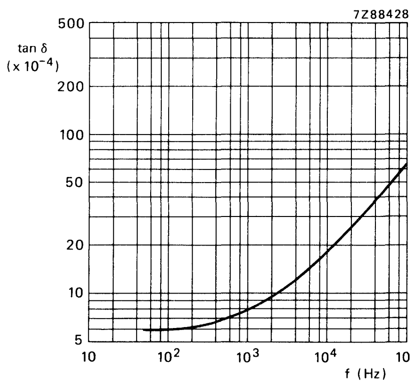


Fig. 4 Tan δ as a function of frequency, typical curve.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 min ± 5 s, the voltage being 100 ± 15 V for the 100 V, 250 V and 400 V versions, and 500 ± 50 V for the 630 V and 1000 V versions, at T_{amb} = 20 °C.

R between terminations, for $C_R \leqslant 0,33\ \mu F$	
100 V version	> 15 000 MΩ
250 V, 400 V 630 V, 1000 V versions	> 30 000 MΩ
RC between terminations, for $C_R > 0,33\ \mu F$	
100 V version	> 5 000 s
250 V, 400 V, 630 V, 1000 V versions	> 10 000 s
R between interconnected terminations and case (foil method)	> 30 000 MΩ

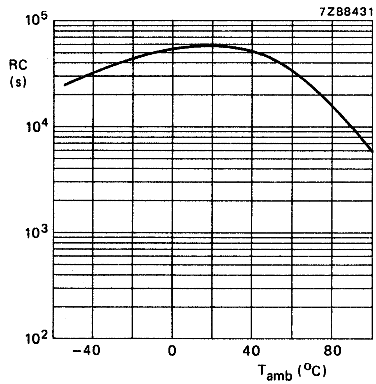


Fig. 5 RC-product as a function of ambient free air temperature; typical curve.

Maximum dissipation

Notes

In applications where voltages higher than 50 V are applied, it is recommended that the power in the capacitor be limited to 2,5 VA in case of capacitor failure.
If the requirement for the maximum dissipation is satisfied, a check must be made to ascertain that the maximum pulse load is not exceeded.

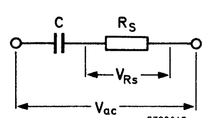
The maximum a.c. voltage has been specified for 50 to 60 Hz and at 23 °C. This voltage value must also never be exceeded at other frequencies. This permissible a.c. voltage may further be limited by the following requirements:

1. The power dissipation must not exceed the specified limit P_{max}.
2. The steepness of the a.c. voltage must not exceed the specified limit.

The power dissipated by a capacitor is a function of the voltage across the series resistance (R_s) or of the current through the series resistance and is expressed by

$$P = \frac{V_{R_s}^2}{R_s} = I^2R_s \qquad (1)$$

$$V_{R_s}^2 = \frac{R_s^2}{R_s^2 + 1/\omega^2C^2} V_{ac}^2 \qquad (2a)$$



Because for these capacitors tan $\delta = R_s\omega C = < 0{,}1$, the formula (2a) can be simplified to

$$V_{R_s}^2 = \frac{R_s^2}{1/\omega^2C^2} V_{ac}^2 = R_s^2\omega^2C^2V_{ac}^2 \qquad (2b)$$

Thus $\quad P = R_s\omega^2C^2V_{ac}^2 \qquad (3a)$

or $\quad P = (R_sC)\, C\omega^2V_{ac}^2 \qquad (3b)$

The term R_sC can be found from Fig. 6, C (in farads), $\omega = 2\pi f$ and V_{ac} are assumed to be known.

The maximum permissible value of power dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be read from Fig. 7.

Thus, when the actual power has been calculated with equation (3b), Fig. 7 gives the minimum size of capacitor which can dissipate this power.

Example of using Figs 6 and 7

A capacitor of 1 μF should be used at an a.c. voltage of 130 V, a frequency of 1 kHz and an ambient free air temperature of 50 °C.

The RsC-product is 1,5 x 10^{-7} ΩF (from Fig. 6), so that the power to be dissipated is

$$P = (RsC)\, C\omega^2 V_{ac}^2$$
$$= 1{,}5 \cdot 10^{-7} \times 1 \cdot 10^{-6} \times (2\pi)^2 \times 10^6 \times 130^2$$
$$= 100 \text{ mW}$$

For a rated voltage of 130 Vac a capacitor of the 250 V version is required at least.

Capacitor 1 μF/160 Vac is satisfactory because of its dimensions 10,7 mm x 14,6 mm x 31 mm and its dissipated power of 595 mW at 50 °C.

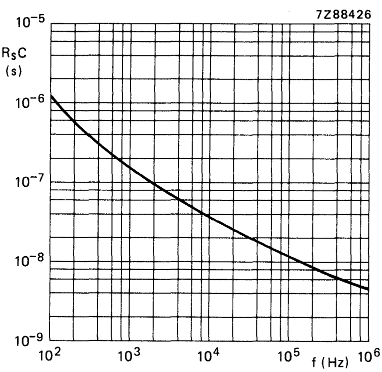


Fig. 6 Maximum product of series resistance and capacitance as a function of frequency.

curve	dimensions (mm)		
	T_{max}	H_{max}	L_{max}
1	5,1	8,8	14,6
2	5,7	9,5	14,6
3	7	10,6	14,6
4	6,6	10,4	18,1
5	7,9	11,5	18,1
6	7,8	11,6	23,5
7	9,2	12,9	23,5
8	10,8	14,5	23,5
9	10,7	14,6	31
10	12,5	19,5	31
11	15,4	22,1	31

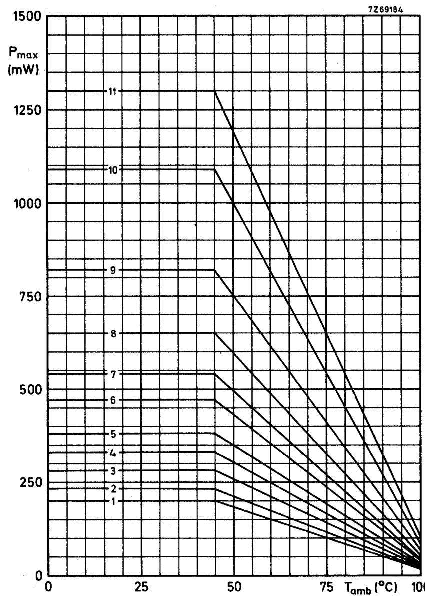


Fig. 7 Maximum dissipation as a function of ambient free air temperature.

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number as shown in Tables 1 to 5.

PACKING

The capacitors are packed in boxes of 250 (for $H_{max} \leqslant 11{,}6$ mm) and 200 (for $H_{max} > 11{,}6$ mm).

METALLIZED POLYCARBONATE FILM CAPACITORS

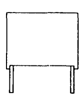
MKC radial potted type

- 10 to 27,5 mm pitch
- Supplied in boxes

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	0,010 to 6,8 μF
Tolerance on rated capacitance	± 20%, ± 10%, ± 5%
Rated voltage U_R (d.c.)	100 V, 250 V, 400 V, 630 V
Climatic category	55/100/56
Rated temperature	85 ^{o}C
Tangent of loss angle at 10 kHz	20 x 10^{-4}
Related specification	IEC 384-6
Performance grade	long life

STYLE



Style: 2222 344.
Pitch: 10 mm, 15 mm, 22,5 mm, 27,5 mm.
See Tables 1 to 4.

APPLICATION

In electronic circuits for blocking and coupling, bypass and energy reservoir applications. Their defined dimensions make them suitable for circuits with high packaging density.

DESCRIPTION

The capacitors consist of a low-inductance wound cell of metallized polycarbonate film. The cell is potted with epoxy resin in a flame retardent polypropylene case. The radial leads are of solder-coated wire. The capacitors can withstand solvents and rinsing liquids without damage. They have small stand-off pips to allow removal of solder flux etc. during cleaning of the printed-wiring board.

GENERAL DATA

Dimensions in mm

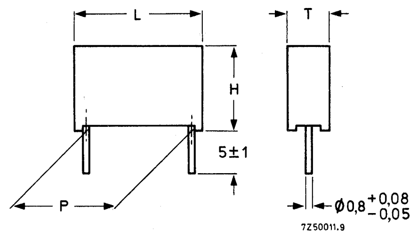


Fig. 1.

Table 1 U_R (d.c.) = 100 V; max. a.c. voltage = 63 V, Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 344 . . . . . tol. ± 20%	tol. ± 10%	tol. ± 5%
0,082	4,5	10	13	10 ± 0,3	0,7	20823	21823	22823
0,10	4,5	10				20104	21104	22104
0,12	4,5	10				20124	21124	22124
0,15	4,5	10				20154	21154	22154
0,18	5	11			0,85	20184	21184	22184
0,22	5	11				20224	21224	22224
0,27	5	11	17,5	15 ± 0,3	1,05	20274	21274	22274
0,33	5	11				20334	21334	22334
0,39	6	12			1,4	20394	21394	22394
0,47	6	12				20474	21474	22474
0,56	7	13			1,8	20564	21564	22564
0,68	7	13				20684	21684	22684
0,82	8,5	14,5			2,55	20824	21824	22824
1,0	8,5	14,5				20105	21105	22105
1,2	6,5	15,5	26	22,5 ± 0,3	2,75	20125	21125	22125
1,5	6,5	15,5				20155	21155	22155
1,8	8,5	17,5			4,3	20185	21185	22185
2,2	8,5	17,5				20225	21225	22225
2,7	9,5	19			5,1	20275	21275	22275
3,3	9,5	19				20335	21335	22335
3,9	11	20	31	27,5 ± 0,3	7,4	20395	21395	22395
4,7	11	20				20475	21475	22475
5,6	13	22,5			10,2	20565	21565	22565
6,8	13	22,5				20685	21685	22685

Table 2 U_R (d.c.) = 250 V; max. a.c. voltage = 160 V, Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 344 . . . . . tol. ± 20%	tol. ± 10%	tol. ± 5%
0,039	4,5	10	13	10 ± 0,3	0,7	44393	45393	43393
0,047	4,5	10				44473	45473	43473
0,056	4,5	10				44563	45563	43563
0,068	4,5	10				44683	45683	43683
0,082	5	11	17,5	15 ± 0,3	1,05	44823	45823	43823
0,10	5	11				44104	45104	43104
0,12	6	12			1,4	44124	45124	43124 ←
0,15	6	12				44154	45154	43154 ←
0,18	7	13			1,8	44184	45184	43184
0,22	7	13				44224	45224	43224
0,27	8,5	14,5			2,55	44274	45274	43274
0,33	8,5	14,5				44334	45334	43334
0,39	6,5	15,5	26	22,5 ± 0,3	2,75	44394	45394	43394
0,47	6,5	15,5				44474	45474	43474
0,56	7,5	16,5			3,5	44564	45564	43564
0,68	7,5	16,5				44684	45684	43684
0,82	9,5	19			5,1	44824	45824	43824
1,0	9,5	19				44105	45105	43105
1,2	11	20	31	27,5 ± 0,3	7,4	44125	45125	43125
1,5	11	20				44155	45155	43155
1,8	13	22,5			10,2	44185	45185	43185
2,2	13	22,5				44225	45225	43225

Table 3 U_R (d.c.) = 400 V; max. a.c. voltage = 220 V, Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 344 . . . . . tol. ± 20%	tol. ± 10%	tol. ± 5%
0,010	4,5	10				50103	51103	52103
0,012	4,5	10				50123	51123	52123
0,015	4,5	10				50153	51153	52153
0,018	4,5	10	13	10 ± 0,3	0,7	50183	51183	52183
0,022	4,5	10				50223	51223	52223
0,027	4,5	10				50273	51273	52273
0,033	4,5	10				50333	51333	52333
0,039	5	11			1,05	50393	51393	52393
0,047	5	11				50473	51473	52473
0,056	6	12			1,4	50563	51563	52563
0,068	6	12				50683	51683	52683
0,082	7	13	17,5	15 ± 0,3	1,8	50823	51823	52823
0,10	7	13				50104	51104	52104
0,12	8,5	14,5			2,55	50124	51124	52124
0,15	8,5	14,5				50154	51154	52154
0,18	6,5	15,5			2,75	50184	51184	52184
0,22	6,5	15,5				50224	51224	52224
0,27	7,5	16,5	26	22,5 ± 0,3	3,5	50274	51274	52274
0,33	7,5	16,5				50334	51334	52334
0,39	9,5	19			5,1	50394	51394	52394
0,47	9,5	19				50474	51474	52474
0,56	11	20			7,4	50564	51564	52564
0,68	11	20	31	27,5 ± 0,3		50684	51684	52684
0,82	13	22,5			10,2	50824	51824	52824
1,0	13	22,5				50105	51105	52105

Table 4 U_R (d.c.) = 630 V; max. a.c. voltage = 220 V, Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 344 ..... tol. ± 20%	tol. ± 10%	tol. ± 5%
0,010	4,5	10	13	10 ± 0,3	0,7	60103	61103	62103
0,012	5	11			0,85	60123	61123	62123
0,015	5	11				60153	61153	62153
0,018	6	12			1	60183	61183	62183
0,022	6	12				60223	61223	62223
0,027	6	12	17,5	15 ± 0,3	1,4	60273	61273	62273 ←
0,033	6	12				60333	61333	62333 ←
0,039	7	13			1,8	60393	61393	62393
0,047	7	13				60473	61473	62473
0,056	8,5	14,5			2,55	60563	61563	62563
0,068	8,5	14,5				60683	61683	62683
0,082	6,5	15,5	26	22,5 ± 0,3	2,75	60823	61823	62823
0,10	6,5	15,5				60104	61104	62104
0,12	7,5	16,5			3,5	60124	61124	62124
0,15	7,5	16,5				60154	61154	62154
0,18	9,5	19			5,1	60184	61184	62184
0,22	9,5	19				60224	61224	62224
0,27	11	20	31	27,5 ± 0,3	7,4	60274	61274	62274
0,33	11	20				60334	61334	62334
0,39	13	22,5			10,2	60394	61394	62394
0,47	13	22,5				60474	61474	62474

Marking

a. Rated capacitance
b. Rated voltage
c. Tolerance on rated capacitance
d. Category voltage
e. Year and month of manufacture
f. Manufacturer's name
g. Climatic category
h. Manufacturer's type designation

The capacitors are marked on the top by embossed print with a, b and c as follows:
1st line : rated capacitance in μF, tolerance and rated d.c. voltage.
2nd line : last eight digits of the catalogue number.

The package containing the capacitors is marked with a to h.

Mounting

The capacitors are for printed-wiring applications.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 kHz	see Tables 1 to 4
Tolerance on rated capacitance	see Tables 1 to 4

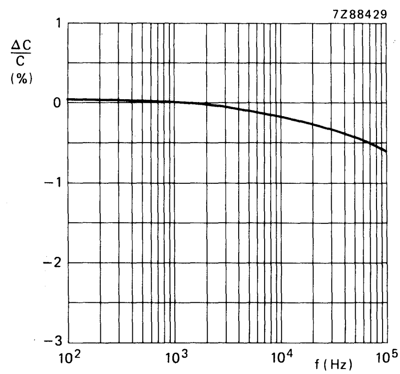


Fig. 2 Capacitance as a function of frequency; typical curve.

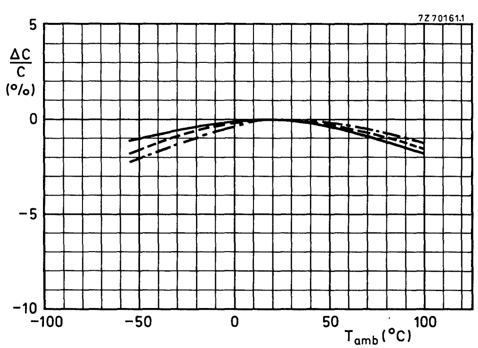


Fig. 3 Capacitance as a function of ambient free air temperature; typical curves.
——— for all capacitance values, measured at 1 kHz, 1 V.
– – – – for capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.
– · – · – for capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Voltage

Rated voltage U_R (d.c.)	See Tables 1 to 4
Category voltage U_C	0,8 x U_R (d.c.)
Maximum a.c. voltage (r.m.s. value), at 50 to 60 Hz	See Tables 1 to 4
Test voltage	
between terminations	1,6 x U_R (d.c.)
between interconnected terminations and case	2 x U_R (d.c.); min. 200 V

Notes

- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.).
- For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

Temperature

Climatic category	55/100/56
Rated temperature	85 °C
Storage temperature range	−55 to + 100 °C

Maximum pulse load

rated voltage V	maximum pulse load (V/μs)			
	L = 13 mm	L = 17,5 mm	L = 26 mm	L = 31 mm
100	30	13	6	4,5
250	45	18	8	7
400	70	30	13	11
630	100	45	18	15

The maximum pulse load values in the table are valid for pulse voltages equal to the rated voltage.

For lower pulse voltages the given values may be multiplied by U_R/applied voltage.

Note

If the pulse load requirement is satisfied, a check must be made to ascertain that the maximum dissipation is not exceeded.

Tangent of loss angle

capacitance	tangent of loss angle		
	1 kHz	10 kHz	100 kHz
$C_R \leqslant 0,1\ \mu F$	$\leqslant 30 \times 10^{-4}$	$\leqslant 60 \times 10^{-4}$	$\leqslant 130 \times 10^{-4}$
$0,1\ \mu F < C_R \leqslant 1\ \mu F$	$\leqslant 30 \times 10^{-4}$	$\leqslant 60 \times 10^{-4}$	
$C_R > 1\ \mu F$	$\leqslant 30 \times 10^{-4}$	$\leqslant 75 \times 10^{-4}$	

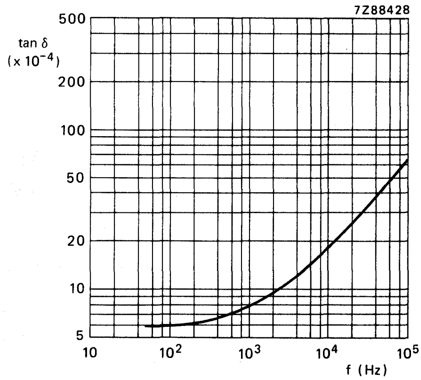


Fig. 4 Tan δ as a function of frequency, typical curve.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 min ± 5 s, the voltage being 100 ± 15 V for the 100 V, 250 V and 400 V versions, and 500 ± 50 V for the 630 V version, at T_{amb} = 20 °C.

R between terminations, for $C_R \leqslant 0,33\ \mu F$	
100 V version	> 15 000 MΩ
250 V, 400 V, 630 V versions	> 30 000 MΩ
RC between terminations, for $C_R > 0,33\ \mu F$	
100 V version	> 5 000 s
250 V, 400 V, 630 V versions	> 10 000 s
R between interconnected terminations and case (foil method)	> 30 000 MΩ

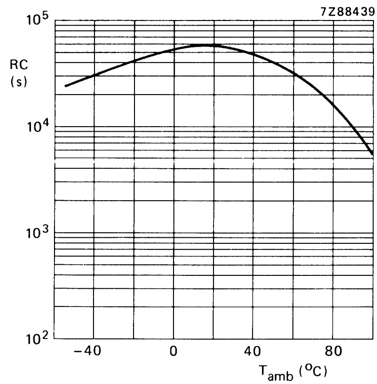


Fig. 5 RC-product as a function of ambient free air temperature; typical curve.

Maximum dissipation

Notes

In applications where voltages higher than 50 V are applied, it is recommended that the power in the capacitor be limited to 2,5 VA in case of capacitor failure.

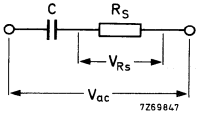
If the requirement for the maximum dissipation is satisfied, a check must be made to ascertain that the maximum pulse load is not exceeded.

The maximum a.c. voltage has been specified for 50 to 60 Hz and at 23 °C. This voltage value must also never be exceeded at other frequencies. This permissible a.c. voltage may further be limited by the following requirements:

1. The power dissipation must not exceed the specified limit P_{max}.
2. The steepness of the a.c. voltage must not exceed the specified limit.

The power dissipated by a capacitor is a function of the voltage across the series resistance (R_s) or of the current through the series resistance and is expressed by

$$P = \frac{V_{R_s}^2}{R_s} = I^2R_s \qquad (1)$$



$$V_{R_s}^2 = \frac{R_s^2}{R_s^2 + 1/\omega^2C^2} V_{ac}^2 \qquad (2a)$$

Because for these capacitors tan $\delta = R_s\omega C = < 0{,}1$, the formula (2a) can be simplified to

$$V_{R_s}^2 = \frac{R_s^2}{1/\omega^2C^2} V_{ac}^2 = R_s^2\omega^2C^2V_{ac}^2 \qquad (2b)$$

Thus $\quad P = R_s\omega^2C^2V_{ac}^2 \qquad (3a)$

or $\quad P = (R_sC)\, C\omega^2V_{ac}^2 \qquad (3b)$

The term R_sC can be found from Fig. 6, C (in farads), $\omega = 2\pi f$ and V_{ac} are assumed to be known.

The maximum permissible value of power dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be read from Fig. 7.

Thus, when the actual power has been calculated with equation (3b), Fig. 7 gives the minimum size of capacitor which can dissipate this power.

Example of using Figs 6 and 7

A capacitor of 1 μF should be used at an a.c. voltage of 130 V, a frequency of 1 kHz and an ambient free air temperature of 50 °C.

The RsC-product is 1,5 x 10^{-7} ΩF (from Fig. 6), so that the power to be dissipated is

$$P = (RsC)\ C\omega^2 V_{ac}^2$$
$$= 1{,}5 \cdot 10^{-7} \times 1 \cdot 10^{-6} \times (2\pi)^2 \times 10^6 \times 130^2$$
$$= 100 \text{ mW}$$

For a rated voltage of 130 Vac a capacitor of the 250 V version is required at least.

Capacitor 1 μF/160 Vac is satisfactory because of its dimensions 9,5 mm x 19 mm x 26 mm and its dissipated power of 755 mW at 50 °C.

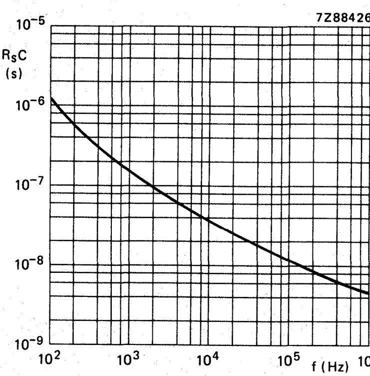


Fig. 6 Maximum product of series resistance and capacitance as a function of frequency.

curve	dimensions (mm)		
	T_{max}	H_{max}	L_{max}
1	4,5	10	13
2	5	11	13
3	6	12	13
4	5	11	17,5
5	6	12	17,5
6	7	13	17,5
7	8,5	14,5	17,5
8	6,5	15,5	26
9	7,5	16,5	26
10	8,5	17,5	26
11	9,5	19	26
12	11	20	31
13	13	22,5	31

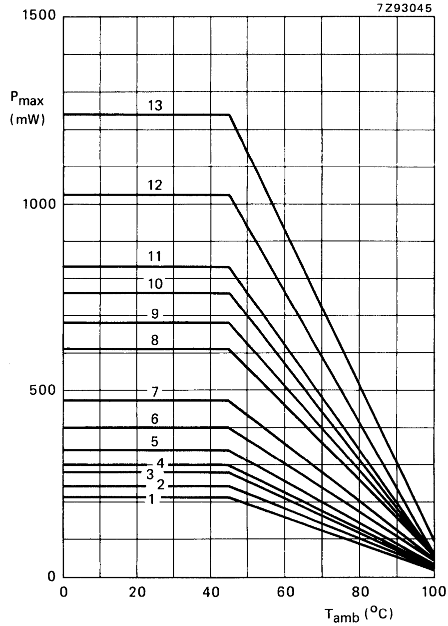


Fig. 7 Maximum dissipation as a function of ambient free air temperature.

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number as shown in Tables 1 to 4.

PACKING

The capacitors are packed in boxes, the number of capacitors per box is given in the table below.

L_{max} mm	number of capacitors per box
13, 17,5	1000
26	200
31	100

INSPECTION REQUIREMENTS

metallized polycarbonate film capacitors (MKC)

Note 1
Sub-clause numbers of tests and performance requirements refer to the Sectional Specification, IEC-publication 384-6 and GENERAL DATA of the specifications.

Note 2
In this table: D = destructive, ND = non-destructive.

clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 341**
Group A Inspection (lot-by-lot)			
Sub-group A1	ND		
4.1 Visual examination			– No mechanical failures – Legible marking and as specified in GENERAL DATA of the specification.
4.2 Dimensions		Gauging	– As specified in the Tables of the specification.
Sub-group A2	ND		
4.2.1 Voltage proof (Test A)		at 1,6 x U_R (d.c.) for 1 s	– No breakdown or flashover.
4.2.2 Capacitance		at 1 kHz	– Within specified tolerance.
4.2.3 Tangent of loss angle		at 10 kHz	– As in GENERAL DATA of the specification.
4.2.4 Insulation resistance (Test A)		at 100 V for U_R = 100 V, 250 V, 400 V; at 500 V for U_R = 630 V, 1000 V	– As in GENERAL DATA of the specification.

performance requirements
2222 344

- No mechanical failures
- Legible marking and as specified in GENERAL DATA of the specification.
- As specified in the Tables of the specification.

- No breakdown or flashover.
- Within specified tolerance.
- As in GENERAL DATA of the specification.
- As in GENERAL DATA of the specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 341**
Group B Inspection (periodic)			
4.5 Solderability	D	Without ageing Method: 1 Solder bath: 235 °C Dwell time: 2 s Non-activated colophony flux	Good tinning as evidenced by free flowing of the solder with wetting of the terminations.
Group C Inspection (periodic)			
Sub-group C1A	D		
Part of sample of Sub-group C1			
4.1 Dimensions (detail)			As specified in the Tables of the specification.
4.3.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
4.3 Robustness of terminations		Tensile, bending and torsion	No visible damage.
4.4 Resistance to soldering heat		Method: 1A Solder bath: 260 °C Duration: 10 s	
4.4.2 Final measurements		Visual examination Capacitance Tangent of loss angle	No visible damage. Legible marking. $\Delta C/C \leqslant 1\%$ of the value measured initially. Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF, compared to values measured in 4.3.1.

performance requirements
2222 344

Good tinning as evidenced by free flowing of the solder with wetting of terminations.

As specified in the Tables of the specification.

No visible damage.

No visible damage.
Legible marking.
$\Delta C/C \leqslant 1\%$ of the value measured initially.
Increase of tan δ
$\leqslant 0{,}005$ for $C_R \leqslant 470$ nF,
$\leqslant 0{,}003$ for $C_R > 470$ nF,
compared to values measured in 4.3.1.

sub-clause number and (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 341**
Sub-group C1B	D		
Other part of sample of Sub-group C1			
4.6.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
4.6 Rapid change of temperature		θ A = lower cat. temp. θ B = upper cat. temp. 5 cycles, duration t = 30 min. Visual examination	No visible damage.
4.7 Vibration		Method of mounting see Note below. Procedure B4. Frequency range: 10 to 55 Hz Amplitude: 0,75 mm or acceleration: 98 m/s^2 (whichever is the less severe). Total duration: 6 h	
4.7.2 Final inspection		Visual examination	No visible damage.
4.9 Shock		Method of mounting see Note below. Pulse shape: half sine Acceleration: 490 m/s^2 Duration of pulse: 11 ms	
4.9.3 Final measurements		Visual examination Capacitance	No visible damage. $\Delta C/C \leqslant 2{,}5\%$ of the value measured in 4.6.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in 4.6.1.
		Insulation resistance	As in GENERAL DATA of the specification.

Note

The capacitor shall be mechanically fixed by the leads and the stand-off pips (ridges) shall be in good contact with the printed-wiring board, also the body of capacitors with a mass > 6 g shall be clamped to the printed-wiring board.

performance requirements
2222 344

No visible damage.

No visible damage.

No visible damage.
$\Delta C/C \leqslant 2{,}5\%$ of the value measured in 4.6.1.
Increase of tan δ
$\leqslant 0{,}005$ for $C_R \leqslant 470$ nF,
$\leqslant 0{,}003$ for $C_R > 470$ nF
compared to values measured in 4.6.1.
As in GENERAL DATA of the specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 341**
Sub-group C1	D		
Combined sample of specimens of Sub-groups C1A and C1B			
4.10 Climatic sequence			
4.10.2 Dry heat		Temperature: upper category temperature Duration: 16 h	
4.10.3 Damp heat cyclic, Test Db, first cycle			
4.10.4 Cold		Temperature: lower category temperature Duration: 2 h	
4.10.6 Damp heat cyclic, Test Db, remaining cycles			
4.10.6.2 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 5\%$ of value measured in 4.4.2 or 4.9.3.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}007$ for $C_R \leqslant 470$ nF, $\leqslant 0{,}005$ for $C_R > 470$ nF compared to values measured in 4.3.1 or 4.6.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.

performance requirements
2222 344

No visible damage.
Legible marking.
$\Delta C/C \leqslant 3\%$ of value measured in 4.4.2 or 4.9.3.
Increase of tan δ
$\leqslant 0{,}007$ for $C_R \leqslant 470$ nF,
$\leqslant 0{,}005$ for $C_R > 470$ nF
compared to values measured in 4.3.1 or 4.6.1.
$\geqslant 50\%$ of values in GENERAL DATA in the specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 341**
Sub-group C2	D		
4.11 Damp heat steady state			
4.11.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
4.11.3 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 3\%$ of the value measured in 4.11.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}007$ for $C_R \leqslant 470$ nF, $\leqslant 0{,}005$ for $C_R > 470$ nF compared to values measured in 4.11.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.
Sub-group C3	D		
4.12 Endurance		Duration: 2000 h; 1,25 U_R (d.c.) at 85 °C, 1,25 U_C at 100 °C	
4.12.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
4.12.5 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 3\%$ of value measured in 4.12.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in 4.12.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.

performance requirements
2222 344

No visible damage.
Legible marking.
$\Delta C/C \leq 3\%$ of the value measured in 4.11.1.
Increase of tan δ
$\leq 0{,}007$ for $C_R \leq 470$ nF,
$\leq 0{,}005$ for $C_R > 470$ nF
compared to values measured in 4.11.1.
$\geq 50\%$ of values in GENERAL DATA of the specification.

No visible damage.
Legible marking.
$\Delta C/C \leq 3\%$ of value measured in 4.12.1.
Increase of tan δ
$\leq 0{,}005$ for $C_R \leq 470$ nF,
$\leq 0{,}003$ for $C_R > 470$ nF
compared to values measured in 4.12.1.
$\geq 50\%$ of values in GENERAL DATA of the specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 341**
Sub-group C4	D		
4.13 Charge and discharge		10 000 cycles (50 c/s) charge to U_R half sine wave Duration: 5 ms, discharge R = $\dfrac{U_R}{C_R \cdot 5 \ (\frac{dU}{dt})\ R}$ with a min. of 2,2 Ω	
4.13.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
4.13.3 Final measurements		Capacitance	$\Delta C/C \leqslant 2\%$ of value measured in 4.13.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.

performance requirements
2222 344

$\Delta C/C \leqslant 2\%$ of value
measured in 4.13.1.
Increase of tan δ
$\leqslant 0{,}005$ for $C_R \leqslant 470$ nF,
$\leqslant 0{,}003$ for $C_R > 470$ nF.
$\geqslant 50\%$ of values in GENERAL
DATA of the specification.

additional test	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD1	D		
A.1 Heat storage		Duration: 2000 h Temperature: upper category temperature	
A.1.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
A.1.2 Final measurements		Capacitance	$\Delta C/C \leqslant 5\%$ of value measured in A.1.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.1.1.
		Insulation resistance	As in GENERAL DATA of the specification.
Sub-group ADD2			
A.2 Endurance for capacitors with max. a.c. voltage $\geqslant 200$ V (r.m.s.)		Duration: 1000 h Temperature: 85 $^{\circ}$C Voltage: 1,25 x max. a.c. voltage (r.m.s. value), 50 Hz	
A.2.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
A.2.2 Final measurements		Capacitance	$\Delta C/C \leqslant 3\%$ of value measured in A.2.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.2.1.
		Insulation resistance	As in GENERAL DATA of the specification.

performance requirements
2222 344

$\Delta C/C \leqslant 3\%$ of value measured in A.1.1.
Increase of tan δ
$\leqslant 0{,}005$ for $C_R \leqslant 470$ nF,
$\leqslant 0{,}003$ for $C_R > 470$ nF
compared to values measured in A.1.1.
As in GENERAL DATA of the specification.

$\Delta C/C \leqslant 3\%$ of value measured in A.2.1.
Increase of tan δ
$\leqslant 0{,}005$ for $C_R \leqslant 470$ nF,
$\leqslant 0{,}003$ for $C_R > 470$ nF
compared to values measured in A.2.1.
As in GENERAL DATA of the specification.

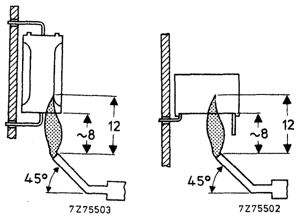
additional test	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD3 A.3 Solvent resistance, Mil STD-202F, method 215 B		**GROUP 1:** **De-ionized water, followed by** mixture of isopropyl alcohol and mineral spirits **GROUP 2:** 1-1-1-Trichloroethane **GROUP 3:** Azeotropic mixture of trichlorotrifluoroethane and methylene chloride Temperature: 25 °C	
A.3.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
A.3.2 Final measurements		Capacitance	$\Delta C/C \leqslant 1\%$ of value measured in A.3.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.3.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.
Sub-group ADD4 A.4 Detergent resistance		Density 20g/l dishwasher detergent Temperature 70 °C, during 3 min. Followed by rinsing in clear water for 1 min. Recovery time > 2 h.	
A.4.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
A.4.2 Final measurements		Capacitance	$\Delta C/C \leqslant 1\%$ of value measured in A.4.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.4.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.

performance requirements
2222 344

$\Delta C/C \leqslant 1\%$ of value measured in A.3.1.
Increase of tan δ
$\leqslant 0{,}005$ for $C_R \leqslant 470$ nF,
$\leqslant 0{,}003$ for $C_R > 470$ nF
compared to values measured in A.3.1.
$\geqslant 50\%$ of values in GENERAL DATA of the specification.

$\Delta C/C \leqslant 1\%$ of value measured in A.4.1.
Increase of tan δ
$\leqslant 0{,}005$ for $C_R \leqslant 470$ nF,
$\leqslant 0{,}003$ for $C_R > 470$ nF
compared to values measured in A.4.1.
$\geqslant 50\%$ of values in GENERAL DATA of the specification.

additional test	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD5	D		
A.5 Resistance to soldering heat with pre-heating		Capacitors mounted on a 1,6 mm board with non-plated holes Body temp.: 80 °C Bath temp.: 260 °C Dwell time: 5 s.	
A.5.1 Initial measurements		Capacitance Tangent of loss angle for $C_R \leqslant 470$ nF at 100 kHz, $C_R > 470$ nF at 10 kHz	
A.5.2 Final measurements		Capacitance	$\Delta C/C \leqslant 2\%$ for $C \leqslant 10$ nF, $\leqslant 1\%$ for $C > 10$ nF of value measured in A.5.1.
		Tangent of loss angle	Increase of tan δ $\leqslant 0{,}005$ for $C_R \leqslant 470$ nF, $\leqslant 0{,}003$ for $C_R > 470$ nF compared to values measured in A.5.1.
Sub-group ADD6	D		
A.6.1 Needle flame test, IEC 695-2-2		Bore of gas jet: ϕ 0,5 mm. Fuel: butane. Test duration: 20 s One flame application.	After removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s, no burning particles must drop from the sample.

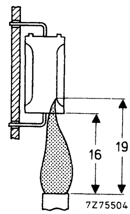


performance requirements
2222 344

$\Delta C/C \leqslant 1\%$ of value measured in A.5.1.

Increase of tan δ
$\leqslant 0{,}005$ for $C_R \leqslant 470$ nF,
$\leqslant 0{,}003$ for $C_R > 470$ nF
compared to values measured in A.5.1.

After removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s, no burning particles must drop from the sample.

additional test	D or ND	conditions of test	performance requirements **2222 341**
A.6.2 Needle flame test, UL 1414		Bore of gas jet: ϕ 10 mm. Fuel: natural gas. Test duration: 3 x 15 s. Time interval between each flame application: 15 s. 	Extinguishing time $\leqslant$ 15 s after the first and second flame application, $\leqslant$ 60 s after the third flame application.

performance requirements
2222 344

Not applicable.

POLYSTYRENE FILM/FOIL CAPACITORS (KS)

POLYSTYRENE FILM/FOIL CAPACITORS

KS axial sleeved type

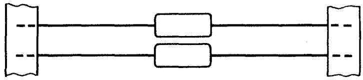
- Supplied on bandoliers on reel or loose in boxes

QUICK REFERENCE DATA

Rated capacitance range	51 to 39 000 pF
Tolerance on rated capacitance	± 5% (E24-series) ± 2% (E24, E48-series) ± 1% (E24, E48, E96-series)
Rated voltage U_R (d.c.)	63 V, 160 V, 250 V, 630 V
Climatic category	
63 V version	40/070/21
160 V, 250 V, 630 V versions	40/085/21
Rated temperature	
63 V version	70 °C
160 V, 250 V, 630 V versions	85 °C
Related specification	IEC 384-7
Stability class	2

SURVEY OF STYLES

Style 2222 424 . . . . . to 427 . . . . .;
See Tables 1 to 4.



Style 2222 428 . . . . . to 431 . . . . .;
See Tables 1 to 4.

APPLICATION

For use in circuits where close tolerance, reliability and low losses are of prime importance, e.g. tuned circuits, filter networks, etc.

DESCRIPTION

The capacitors consist of a low-inductance wound cell of metal foil and a polystyrene film. The cell is covered with a green plastic sleeve. The axial leads are of solder-coated wire.

GENERAL DATA

Dimensions in mm

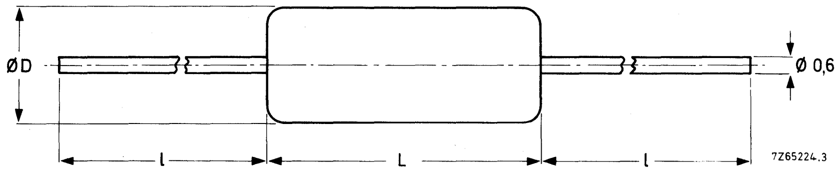


Fig. 1.

Table 1 U_R (d.c.) = 63 V; max. a.c. voltage = 25 V; Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number on bandoliers on reel	catalogue number in box
2 000	3,8	11	30	0,3	2222 428 62002	2222 424 22002
2 200					62202	22202
2 400				0,4	62402	22402
2 700	4,0				62702	22702
3 000					63002	23002
3 300					63302	23302
3 600					63602	23602
3 900					63902	23902
4 300	4,5			0,5	64302	24302
4 700					64702	24702
5 100					65102	25102
5 600					65602	25602
6 200	5,0			0,6	66202	26202
6 800					66802	26802
7 500		15	28		67502	27502
8 200					68202	28202
9 100				0,7	69102	29102
10 000					61003	21003
11 000	5,5			0,8	61103	21103
12 000					61203	21203
13 000				0,9	61303	21303
15 000				1,1	61503	21503
16 000	6,0				61603	21603
18 000					61803	21803
20 000				1,3	62003	22003
22 000	6,5				62203	22203
24 000				1,4	62403	22403
27 000	7,0			1,5	62703	22703
30 000				1,7	63003	23003
33 000	7,5			1,9	63303	23303
36 000					63603	23603
39 000	8,0			2,0	63903	23903

* The capacitance values quoted are also available with a tolerance ± 1% or ± 2%.
Besides the values of the E24-series as quoted, intermediate values of the E48-series (with a tolerance ± 1% or ± 2%) and of the E96-series (with a tolerance ± 1%) are available.

Table 2 U_R (d.c.) = 160 V; max. a.c. voltage = 63 V; Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number on bandoliers on reel	catalogue number in box
1 100	3,8	11	30	0,3	2222 429 61102	2222 425 21102
1 200	4,0				61202	21202
1 300					61302	21302
1 500				0,4	61502	21502
1 600					61602	21602
1 800					61802	21802
2 000	4,5				62002	22002
2 200					62202	22202
2 400				0,5	62402	22402
2 700					62702	22702
3 000	5,0				63002	23002
3 300					63302	23302
3 600				0,6	63602	23602
3 900					63902	23902
4 300		15	28		64302	24302
4 700					64702	24702
5 100					65102	25102
5 600				0,7	65602	25602
6 200					66202	26202
6 800	5,5			0,8	66802	26802
7 500					67502	27502
8 200	6,0			0,9	68202	28202
9 100					69102	29102
10 000				1,1	61003	21003
11 000	6,5				61103	21103
12 000				1,2	61203	21203
13 000				1,3	61303	21303
15 000	7,0			1,4	61503	21503
16 000				1,5	61603	21603

* The capacitance values quoted are also available with a tolerance ± 1% or ± 2%.
Besides the values of the E24-series as quoted, intermediate values of the E48-series (with a tolerance ± 1% or ± 2%) and of the E96-series (with a tolerance ± 1%) are available.

Table 3 U_R (d.c.) = 250 V; max. a.c. voltage = 125 V; Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number on bandoliers on reel	catalogue number in box
560	3,8	11	30	0,3	2222 430 65601	2222 426 25601
620					66201	26201
680					66801	26801
750	4,0				67501	27501
820				0,4	68201	28201
910					69101	29101
1 000					61002	21002
1 100	4,5				61102	21102
1 200				0,5	61202	21202
1 300					61302	21302
1 500					61502	21502
1 600	5,0				61602	21602
1 800					61802	21802
2 000				0,6	62002	22002
2 200					62202	22202
2 400		15	28		62402	22402
2 700					62702	22702
3 000					63002	23002
3 300					63302	23302
3 600				0,7	63602	23602
3 900					63902	23902
4 300					64302	24302
4 700	5,5			0,8	64702	24702
5 100					65102	25102
5 600	6,0			0,9	65602	25602
6 200					66202	26202
6 800	6,5			1,1	66802	26802
7 500					67502	27502
8 200	7,0			1,3	68202	28202
9 100	7,5				69102	29102
10 000				1,5	61003	21003
11 000				1,6	61103	21103

* The capacitance values quoted are also available with a tolerance ± 1% or ± 2%.
Besides the values of the E24-series as quoted, intermediate values of the E48-series (with a tolerance ± 1% or ± 2%) and of the E96-series (with a tolerance ± 1%) are available.

Table 4 U_R (d.c.) = 630 V; max. a.c. voltage = 250 V; Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number on bandoliers on reel	catalogue number in box
51					2222 431 65109	2222 427 25109
56					65609	25609
62					66209	26209
68					66809	26809
75					67509	27509
82					68209	28209
91					69109	29109
100				0,2	61001	21001
110					61101	21101
120	3,8				61201	21201
130					61301	21301
150					61501	21501
160					61601	21601
180					61801	21801
200					62001	22001
220					62201	22201
240		11	30		62401	22401
270					62701	22701
300					63001	23001
330				0,3	63301	23301
360	4,0				63601	23601
390					63901	23901
430					64301	24301
470					64701	24701
510	4,5				65101	25101
560					65601	25601
620				0,4	66201	26201
680					66801	26801
750					67501	27501
820					68201	28201
910					69101	29101
1 000				0,5	61002	21002
1 100	5,0				61102	21102
1 200					61202	21202
1 300				0,6	61302	21302
1 500					61502	21502
1 600				0,7	61602	21602
1 800					61802	21802
2 000	5,5	15	28	0,8	62002	22002
2 200				0,9	62202	22202
2 400				1,1	62402	22402
2 700	6,0				62702	22702

* The capacitance values quoted are also available with a tolerance ± 1% or ± 2%.
Besides the values of the E24-series as quoted, intermediate values of the E48-series (with a tolerance ± 1% or ± 2%) and of the E96-series (with a tolerance ± 1%) are available.

Table 4 (continued) U_R (d.c.) = 630 V; max. a.c. voltage = 250 V; Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number on bandoliers on reel	catalogue number in box
3 000	6,5	15	28	1,1	2222 431 63002	2222 427 23002
3 300				1,4	63302	23302
3 600	7,0				63602	23602
3 900					63902	23902
4 300	7,5			1,7	64302	24302
4 700	8,0				64702	24702
5 100					65102	25102
5 600				2,0	65602	25602

Marking

The capacitors are marked in ink as follows:
1st line : rated capacitance in pF or nF;
2nd line: tolerance code (F = ± 1%, G = ± 2%, J = ± 5%) and rated voltage (d.c.);
3rd line : production date code (according to IEC62, clause 5) and code for dielectric materials (KS = polystyrene film/foil).

Mounting

The capacitors are suited for horizontal or vertical mounting on printed-wiring boards and for point-to-point wiring.

The capacitors packed on bandoliers are for mounting with automatic insertion machines.

When soldering the capacitors, the body temperature shall not exceed 100 °C.

Note: Capacitors mounted vertically on a board without plated-through holes; bodies rest on the board; board thickness: 1,6 mm, hole diameter: 0,8 mm.
Bath temperature 250 °C, dip-solder time 7,5 s
bath temperature 260 °C, dip-solder time 5 s.

Capacitors mounted horizontally on a board with plated-through holes; bodies at least 1 mm from the board.
Bath temperature 260 °C, dip-solder time 5 s.

* The capacitance values quoted are also available with a tolerance ± 1% or ± 2%.
Besides the values of the E24-series as quoted, intermediate values of the E48-series (with a tolerance ± 1% or ± 2%) and of the E96-series (with a tolerance ± 1%) are available.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 MHz ($C_R \leqslant 1000$ pF) at 1 kHz ($C_R > 1000$ pF)	see Tables 1 to 4
Tolerance on rated capacitance	± 5%, ± 2% and ± 1% or 1 pF whichever is greater
Temperature coefficient	−(125 ± 60) 10^{-6}/K
Frequency dependence between 100 Hz and 1 MHz	none

Voltage

Rated voltage U_R (d.c.)	see Tables 1 to 4
Category voltage U_C	U_R (d.c.)
Test voltage between terminations between interconnected terminations and case	 2 x U_R (d.c.) 2 x U_R (d.c.); min. 400 V
Maximum a.c. voltage (r.m.s. value) at 50 to 60 Hz	see Tables 1 to 4

Notes

- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.)
- For other than sinusoidal waveforms, the maximum permissible dissipation must not exceeded.

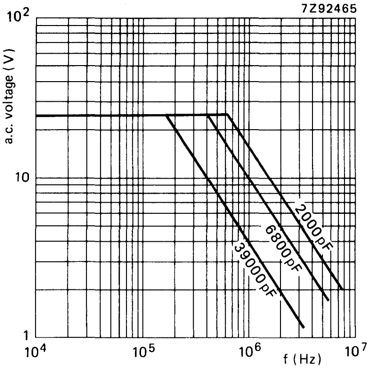


Fig. 2 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 55$ °C, for U_R = 63 V.

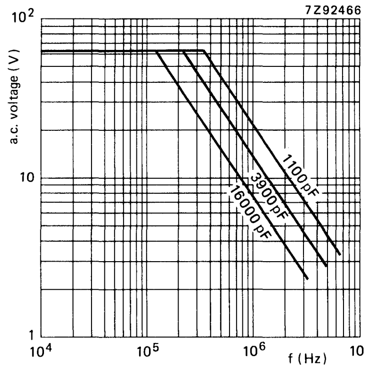


Fig. 3 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70$ °C, for U_R = 160 V.

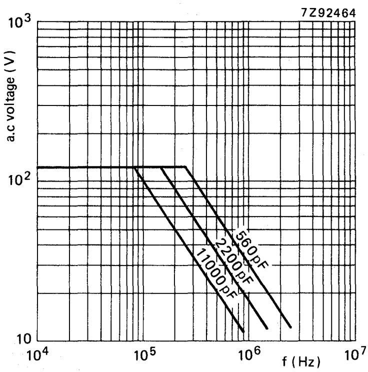


Fig. 4 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leq 70\ ^oC$, for U_R = 250 V.

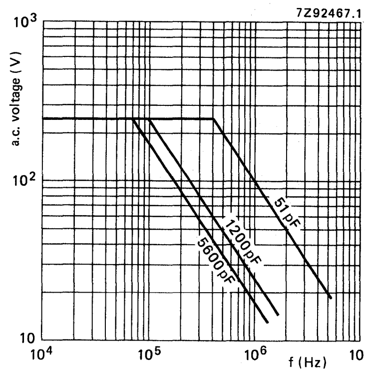


Fig. 5 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leq 70\ ^oC$, for U_R = 630 V.

Temperature

Climatic category	
63 V version	40/070/21
160 V, 250 V, 630 V versions	40/085/21
Rated temperature	
63 V version	70 ^oC
160 V, 250 V, 630 V versions	85 ^oC
Storage temperature range	
63 V version	−40 to + 70 ^oC
160 V, 250 V, 630 V versions	−40 to + 85 ^oC

Tangent of loss angle

Table 5

capacitance	tangent of loss angle at 1 kHz	tangent of loss angle at 100 kHz	tangent of loss angle at 1 MHz
$C_R \leqslant 1000$ pF	$\leqslant 5 \times 10^{-4}$		$\leqslant 10 \times 10^{-4}$
1000 pF $< C_R \leqslant$ 10 000 pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 10 \times 10^{-4}$	
10 000 pF $< C_R \leqslant$ 20 000 pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 15 \times 10^{-4}$	
$C_R >$ 20 000 pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 25 \times 10^{-4}$	

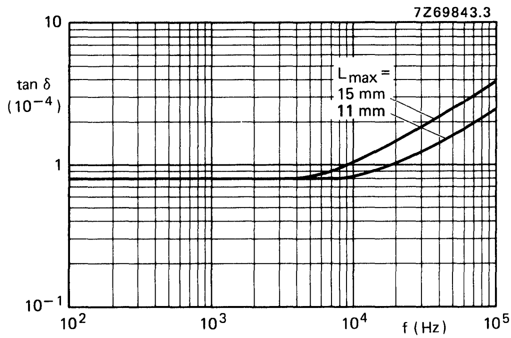


Fig. 6 Tan δ as a function of frequency; typical curves.

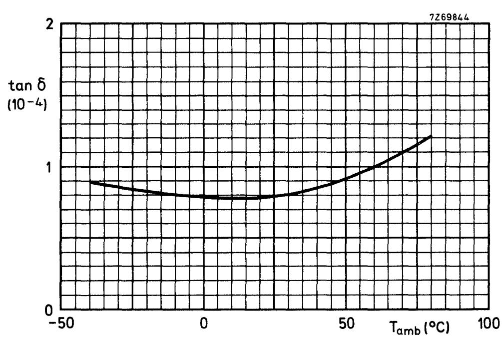


Fig. 7 Tan δ as a function of ambient free air temperature; typical curve.

Insulation resistance at T_{amb} = 20 °C

The insulation resistance is measured after a voltage has been applied for 1 min ± 5 s, the voltage being 10 ± 1 V for the 63 V version, 100 ± 15 V for the 160 V and 250 V versions, and 500 ± 50 V for the 630 V version.

R between terminations	> 100 000 MΩ
R between interconnected terminations and case	> 100 000 MΩ

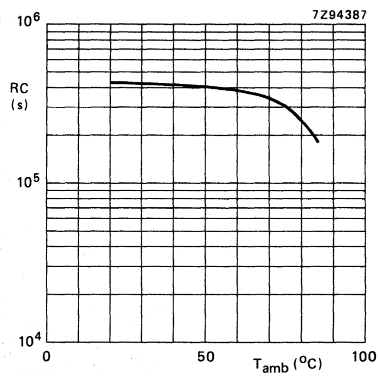


Fig. 8 RC-product as a function of ambient free air temperature; typical curve.

Inductance ⩽ 10 nH/cm lead and capacitor length

Maximum dissipation

The maximum a.c. voltage, which has been specified at 50 to 60 Hz must also never be exceeded at other frequencies.* Moreover this voltage may further be limited by the maximum dissipation (P_{max}).

For a capacitor used with a sinusoidal voltage, the power dissipation is expressed by:

$$P = V_{rms} I_{rms} \cos \varphi. \quad (1)$$

As $I_{rms} = \omega C V_{rms}$, and $\cos \varphi \approx \tan \delta$, equation (1) can be rewritten as:

$$P = V_{rms}^2 \omega C \tan \delta = V_{rms}^2\, 2\pi f C \tan \delta. \quad (2)$$

For capacitors of styles 2222 424 to 2222 431 tan δ is about proportional to the frequency, thus:

$$\tan \delta = \frac{f}{10^5} \tan \delta_{ref}. \quad (3)$$

Tan δ_{ref} is the maximum tan δ at 100 kHz value given under Ratings and characteristics.

Substituting equation (3) in equation (2) gives:

$$P = 2\pi \cdot 10^{-5}\, V_{rms}^2 f^2 C \tan \delta_{ref}. \quad (4)$$

The maximum dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be found from Fig. 9.

* At T_{amb} ⩽ 70 °C (⩽ 55 °C for 63 V version) the maximum permissible sinusoidal voltage can be found in Figs 2 to 5.

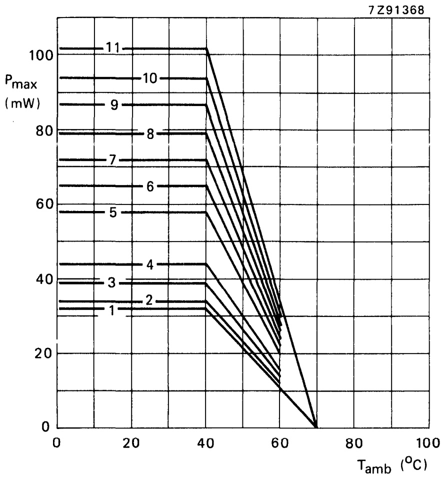


Fig. 9a Maximum dissipation as a function of ambient free air temperature, for U_R = 63 V.

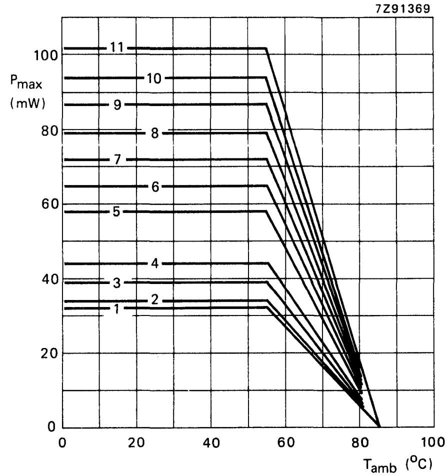


Fig. 9b Maximum dissipation as a function of ambient free air dissipation, for U_R = 160 V, 250 V and 630 V.

Table 6

curve	dimensions (mm)	
	D_{max}	L_{max}
1	3,8	11,0
2	4,0	11,0
3	4,5	11,0
4	5,0	11,0
5	5,0	15,0
6	5,5	15,0

curve	dimensions (mm)	
	D_{max}	L_{max}
7	6,0	15,0
8	6,5	15,0
9	7,0	15,0
10	7,5	15,0
11	8,0	15,0

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number.

Composition of the catalogue number (see Tables 1 to 4).

2222 . . . .

428 = 63 V
429 = 160 V
430 = 250 V
431 = 630 V } packed on bandoliers on reels

6 = ± 5%
7 = ± 2%
8 = ± 1% } packed on bandoliers on reels

code for capacitance, see Tables 1 to 4

424 = 63 V
425 = 160 V
426 = 250 V
427 = 630 V } packed loose in boxes

2 = ± 5%
3 = ± 2%
4 = ± 1% } packed loose in boxes

PACKING

The capacitors are supplied on bandoliers on reels or loose in cardboard boxes.

Packing in cardboard boxes

Table 7

capacitance values (pF) of				number of capacitors per box
63 V version	160 V version	250 V version	630 V version	
2 000– 3 900	1 100– 1 800	560– 1 000	51– 430	400
4 300– 5 600	2 000– 2 700	1 100– 1 500	470– 680	300
6 200– 6 800	3 000– 3 900	1 600– 2 200	750–1 000	250
			1 100–1 200	200
7 500–10 000	4 300– 6 200	2 400– 4 300	1 300–1 500	300
11 000–20 000	6 800–10 000	4 700– 6 200	1 600–2 700	250
22 000–24 000	11 000–13 000	6 800– 7 500	3 000–3 300	200
27 000–39 000	15 000–16 000	8 200–11 000	3 600–5 600	150

Packing on bandoliers on reels

Dimensions in mm

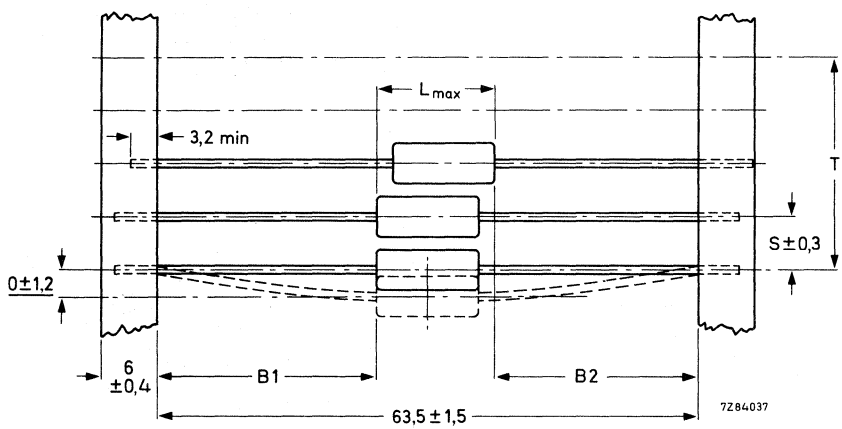


Fig. 10 Capacitors on bandoliers; for dimensions S and T, see Table 8
|B1 - B2| = max. 1,4 mm; for dimension L_{max}, see Tables 1 to 4.

Table 8

capacitance values (pF) of				S	T for number (n) of capacitors	
63 V version	160 V version	250 V version	630 V version		$n < 50$	$50 < n < 100$
2 000– 5 600	1 100– 2 700	560– 1 500	51– 680	5	5(n-1) ± 2	5(n-1) ± 4
6 200–39 000	3 000–16 000	1 600–11 000	750–5 600	10	10(n-1) ± 2	10(n-1) ± 4

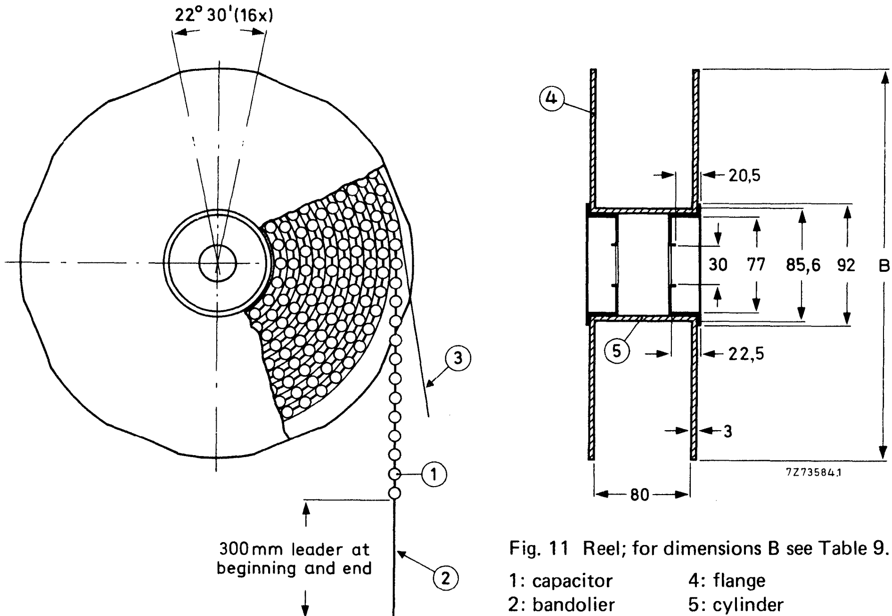


Fig. 11 Reel; for dimensions B see Table 9.

1: capacitor
2: bandolier
3: paper
4: flange
5: cylinder

Table 9

capacitance values (pF) of				B	number of capacitors on one reel
63 V version	160 V version	250 V version	630 V version		
2 000– 2 400	1 100	560– 680	51– 300	305	3 000
2 700– 5 600	1 200– 2 700	750– 1 500	330– 680	305	2 500
6 200–20 000	3 000–10 000	1 600– 6 200	750–2 700	356	1 500
22 000–39 000	11 000–16 000	6 800–11 000	3 000–5 600	356	1 000

Characteristics concerning taped capacitors:

Pull-out force of the component $\geqslant$ 2 N

Tearing force of tape $\geqslant$ 10 N

Storage conditions:

Storage temperature range –25 to + 40 °C

Relative humidity $\leqslant$ 80%

POLYSTYRENE FILM/FOIL CAPACITORS

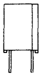
KS radial potted type

- Supplied loose in boxes

QUICK REFERENCE DATA

Rated capacitance range (E96-series)	100 to 34 000 pF
Tolerance on rated capacitance	± 1%
Rated voltage U_R (d.c.)	63 V
Climatic category	
class 1	55/070/56
class 3	55/085/56
Rated temperature	
class 1	70 °C
class 3	85 °C
Related specification	IEC 384-7
Stability class	1 and 3

STYLE



2222 443 . . . . .
Pitch: 2,54 mm, 5,08 mm, 7,62 mm
See Table 1

APPLICATION

For use in LC filters, particularly in telephony equipment, where high requirements are imposed on precision, stability, humidity, dissipation factor and reliability. The dimensions are such that, in combination with currently available ferrites, a high package density is possible.

DESCRIPTION

The capacitors consist of a low-inductance wound cell of polystyrene film and metal foil. The cell is potted with epoxy resin in a yellow flame retardent polypropylene case, which can withstand solvents and rinsing liquids.

The low thermal conductivity of the radial leads provides optimum soldering conditions. The capacitors are provided with stand-off ridges to give a clearance between the capacitors and the printed-wiring board.

GENERAL DATA

Dimensions in mm

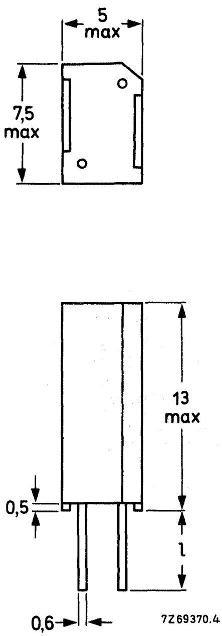


Fig. 1 Capacitors of rated capacitance range 100 to 3920 pF.

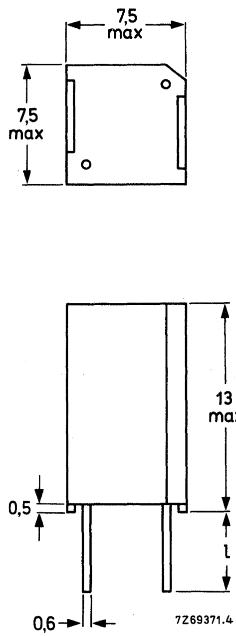


Fig. 2 Capacitors of rated capacitance range 100 to 15 000 pF.

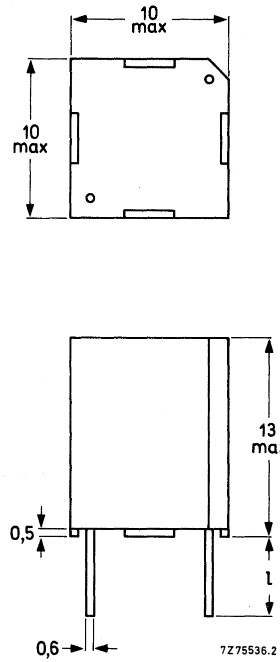


Fig. 3 Capacitors of rated capacitance range 15 400 to 34 000 pF.

Table 1 U_R (d.c.) = 63 V; max. a.c. voltage = 25 V

rated capacitance* (pF)	T_{max} (mm)	L_{max} (mm)	catalogue number 2222 443 . . . . . (ℓ = 3 + 0,4: 6 . . . . ; ℓ = 5 – 1: 4 . . . .)	T_{max} (mm)	L_{max} (mm)	catalogue number 2222 443 . . . . . (ℓ = 3 + 0,4: 7 . . . . ; ℓ = 5 – 1: 8 . . . .)
100			1001			1001
102			1021			1021
105			1051			1051
107			1071			1071
110			1101			1101
113			1131			1131
115			1151			1151
118			1181			1181
121			1211			1211
124			1241			1241
127			1271			1271
130			1301			1301
133			1331			1331
137			1371			1371
140			1401			1401
143			1431			1431
147			1471			1471
150			1501			1501
154			1541			1541
158			1581			1581
162			1621			1621
165	5	7,5	1651	7,5	7,5	1651
169			1691			1691
174			1741			1741
178			1781			1781
182			1821			1821
187			1871			1871
191			1911			1911
196			1961			1961
200			2001			2001
205			2051			2051
210			2101			2101
215			2151			2151
221			2211			2211
226			2261			2261
232			2321			2321
237			2371			2371
243			2431			2431
249			2491			2491
255			2551			2551
261			2611			2611
267			2671			2671

* Besides the values of the E96 series as quoted, intermediate values of the E192 series (with a tolerance ± 1%) are available.

Table 1 (continued) U_R (d.c.) = 63 V; max. a.c. voltage = 25 V

rated capacitance* pF	T_{max} mm	L_{max} mm	catalogue number 2222 443 . . . . . ℓ = 3 + 0,4 6	ℓ = 5 − 1 4	T_{max} mm	L_{max} mm	catalogue number 2222 443 . . . . . ℓ = 3 + 0,4 7	ℓ = 5 − 1 8 . . . .
274	5	7,5	2741		7,5	7,5	2741	
280			2801				2801	
287			2871				2871	
294			2941				2941	
301			3011				3011	
309			3091				3091	
316			3161				3161	
324			3241				3241	
332			3321				3321	
340			3401				3401	
348			3481				3481	
357			3571				3571	
365			3651				3651	
374			3741				3741	
383			3831				3831	
392			3921				3921	
402			4021				4021	
412			4121				4121	
422			4221				4221	
432			4321				4321	
442			4421				4421	
453			4531				4531	
464			4641				4641	
475			4751				4751	
487			4871				4871	
499			4991				4991	
511			5111				5111	
523			5231				5231	
536			5361				5361	
549			5491				5491	
562			5621				5621	
576			5761				5761	
590			5901				5901	
604			6041				6041	
619			6191				6191	
634			6341				6341	
649			6491				6491	
665			6651				6651	
681			6811				6811	
698			6981				6981	
715			7151				7151	
732			7321				7321	

* Besides the values of the E96 series as quoted, intermediate values of the E192 series (with a tolerance ± 1%) are available.

Table 1 (continued) U_R (d.c.) = 63 V; max. a.c. voltage = 25 V

rated capacitance* pF	T_{max} mm	L_{max} mm	catalogue number 2222 443 ..... ℓ = 3 + 0,4: 6 ....; ℓ = 5 − 1: 4	T_{max} mm	L_{max} mm	catalogue number 2222 443 ..... ℓ = 3 + 0,4: 7 ....; ℓ = 5 − 1: 8 ....
750			7501			7501
768			7681			7681
787			7871			7871
806			8061			8061
825			8251			8251
845			8451			8451
866			8661			8661
887			8871			8871
909			9091			9091
931			9311			9311
953			9531			9531
976			9761			9761
1000			1002			1002
1020			1022			1022
1050			1052			1052
1070			1072			1072
1100			1102			1102
1130			1132			1132
1150			1152			1152
1180			1182			1182
1210	5	7,5	1212	7,5	7,5	1212
1240			1242			1242
1270			1272			1272
1300			1302			1302
1330			1332			1332
1370			1372			1372
1400			1402			1402
1430			1432			1432
1470			1472			1472
1500			1502			1502
1540			1542			1542
1580			1582			1582
1620			1622			1622
1650			1652			1652
1690			1692			1692
1740			1742			1742
1780			1782			1782
1820			1822			1822
1870			1872			1872
1910			1912			1912
1960			1962			1962
2000			2002			2002

* Besides the values of the E96 series as quoted, intermediate values of the E192 series (with a tolerance ± 1%) are available.

Table 1 (continued) U_R (d.c.) = 63 V; max. a.c. voltage = 25 V

rated capacitance* pF	T_{max} mm	L_{max} mm	catalogue number 2222 443 ..... $\ell = 3 + 0,4$ 6.... / $\ell = 5 - 1$ 4....	T_{max} mm	L_{max} mm	catalogue number 2222 443 ..... $\ell = 3 + 0,4$ 7.... / $\ell = 5 - 1$ 8....
2050			2052			2052
2100			2102			2102
2150			2152			2152
2210			2212			2212
2260			2262			2262
2320			2322			2322
2370			2372			2372
2430			2432			2432
2490			2492			2492
2550			2552			2552
2610			2612			2612
2670			2672			2672
2740			2742			2742
2800	5	7,5	2802	7,5	7,5	2802
2870			2872			2872
2940			2942			2942
3010			3012			3012
3090			3092			3092
3160			3162			3162
3240			3242			3242
3320			3322			3322
3400			3402			3402
3480			3482			3482
3570			3572			3572
3650			3652			3652
3740			3742			3742
3830			3832			3832
3920			3922			3922
4120			4122			
4220			4222			
4320			4322			
4420			4422			
4530			4532			
4640			4642			
4750	7,5	7,5	4752			
4870			4872			
4990			4992			
5110			5112			
5230			5232			
5360			5362			
5490			5492			
5620			5622			

* Besides the values of the E96 series as quoted, intermediate values of the E192 series (with a tolerance ± 1%) are available.

Table 1 (continued) U_R (d.c.) = 63 V; max. a.c. voltage = 25 V

rated capacitance*	T_{max}	L_{max}	catalogue number 2222 443	
			ℓ = 3 + 0,4 6....	ℓ = 5 − 1 4....
pF	mm	mm		
5760			5762	
5900			5902	
6040			6042	
6190			6192	
6340			6342	
6490			6492	
6650			6652	
6810			6812	
6980			6982	
7150			7152	
7320			7322	
7500			7502	
7680			7682	
7870			7872	
8060			8062	
8250			8252	
8450			8452	
8660			8662	
8870			8872	
9090			9092	
9310	7,5	7,5	9312	
9530			9532	
9760			9762	
10000			1003	
10200			1023	
10500			1053	
10700			1073	
11000			1103	
11300			1133	
11500			1153	
11800			1183	
12100			1213	
12400			1243	
12700			1273	
13000			1303	
13300			1333	
13700			1373	
14000			1403	
14300			1433	
14700			1473	
15000			1503	

* Besides the values of the E96 series as quoted, intermediate values of the E192 series (with a tolerance ± 1%) are available.

Table 1 (continued) U_R (d.c.) = 63 V; max. a.c. voltage = 25 V

rated capacitance*	T_{max}	L_{max}	catalogue number 2222 443	
			ℓ = 3 + 0,4 6	ℓ = 5 − 1 4 . . . .
pF	mm	mm		
15400	10	10	1543	
15800			1583	
16200			1623	
16500			1653	
16900			1693	
17400			1743	
17800			1783	
18200			1823	
18700			1873	
19100			1913	
20000			2003	
21000			2103	
21500			2153	
22100			2213	
22600			2263	
23200			2323	
23700			2373	
24300			2433	
24900			2493	
25500			2553	
26100			2613	
27400			2743	
28000			2803	
28700			2873	
29400			2943	
30100			3013	
30900			3093	
31600			3163	
32400			3243	
33200			3323	
34000			3403	

* Besides the values of the E96 series as quoted, intermediate values of the E192 series (with a tolerance ± 1%)are available.

Marking

a. Rated capacitance
b. Rated voltage
c. Tolerance on rated capacitance
d. Category voltage
e. Year and month of manufacture
f. Manufacturer's name
g. Climatic category
h. Manufacturer's type designation

The capacitors are marked in black ink as follows:

- Capacitors according to Fig. 1 are marked on the top with a, b, c and e:
  1st line: rated capacitance in pF;
  2nd line: tolerance code (F = ± 1%) and rated voltage (d.c.);
  3rd line: production date code according to IEC 62, clause 5, and code for dielectric (KS).

  Note
  The earth side is indicated by a vertical line to the left of the 2nd and 3rd lines of marking, and by the bevelled corner.

- Capacitors according to Figs 2 and 3 are marked on the top with a, b, c, e, f and h:
  1st line: rated capacitance in pF;
  2nd line: tolerance code (F = ± 1%) and rated voltage (d.c.);
  3rd line: 5th, 6th and 7th digits of the catalogue number;
  4th line: production date code according to IEC 62, clause 5, and code for dielectric (KS).

  The manufacturer's identification symbol is indicated to the left of the 2nd and 3rd lines of marking.

  Note
  The earth side is indicated by a vertical line to the left of the 2nd, 3rd and 4th lines of marking, and by the bevelled corner.

The package containing the capacitors is marked with a to h.

Mounting

The capacitors are designed for mounting on printed-wiring boards. The required space on the printed-wiring board for a hole diameter of 1 mm is given in Figs 4, 5 and 6.

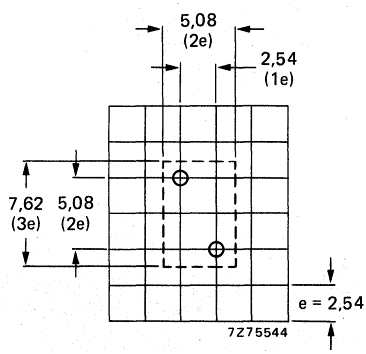


Fig. 4 Required space for capacitors according to Fig. 1.

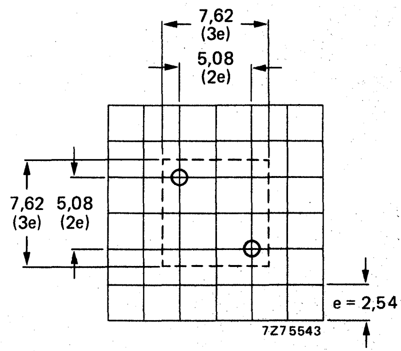


Fig. 5 Required space for capacitors according to Fig. 2.

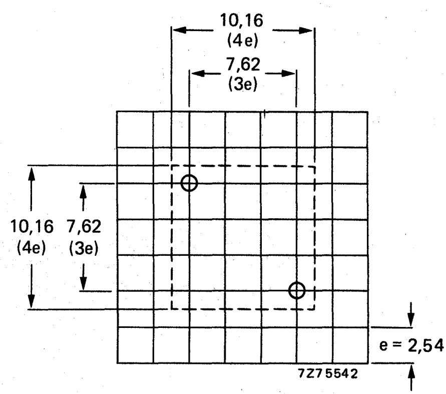


Fig. 6 Required space for capacitors according to Fig. 3.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance at 1 kHz, $C_R > 1000$ pF and at 1 MHz, $C_R \leqslant 1000$ pF	see Table 1
Tolerance on rated capacitance	± 1%
Temperature coefficient $C_R \leqslant 15000$ pF $C_R > 15000$ pF	 $-(125 \pm 30) \times 10^{-6}$/K $-(160 \pm 40) \times 10^{-6}$/K
Frequency dependence between 100 Hz and 1 MHz	none

Voltage

Rated voltage U_R (d.c.)	63 V
Category voltage U_C	U_R (d.c.)
Test voltage between terminations between interconnected terminations and case (foil method)	 2 x U_R (d.c.) 400 V (d.c.)
Maximum a.c. voltage (r.m.s. value) at 50 to 60 Hz	25 V

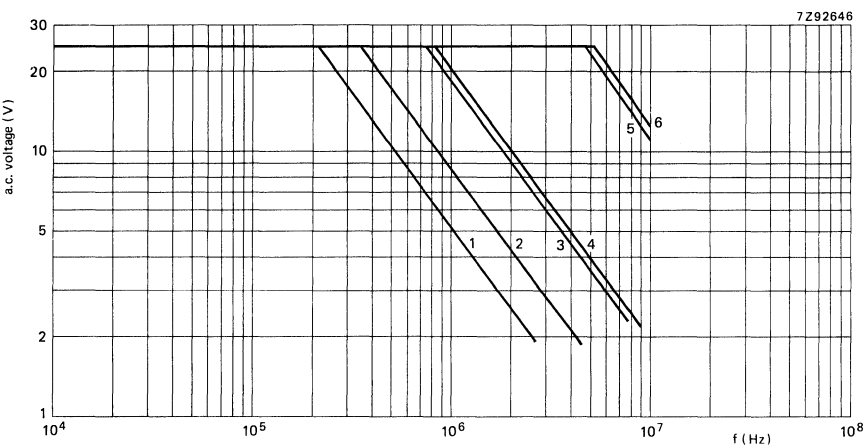


Fig. 7 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 55$ °C.
Curve 1 = 34000 pF; curve 2 = 15000 pF;
curve 3 = 3920 pF, according to Fig. 1; curve 4 = 3920 pF, according to Fig. 2;
curve 5 = 100 pF, according to Fig. 1; curve 6 = 100 pF, according to Fig. 2.

Notes

- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.).
- For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

Temperature

Climatic category

class 1	55/070/56
class 3	55/085/56

Rated temperature

class 1	70 °C
class 3	85 °C

Storage temperature range

class 1	−55 to + 70 °C
class 3	−55 to + 85 °C

Tangent of loss angle

Table 2

capacitance	tangent of loss angle		
	at 1 kHz	at 100 kHz	at 1 MHz
$C_R \leqslant$ 500 pF	$\leqslant 5 \times 10^{-4}$		$\leqslant 5 \times 10^{-4}$
500 pF $< C_R \leqslant$ 1 000 pF	$\leqslant 5 \times 10^{-4}$		$\leqslant 10 \times 10^{-4}$
1 000 pF $< C_R \leqslant$ 10 000 pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 10 \times 10^{-4}$	
10 000 pF $< C_R \leqslant$ 15 000 pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 15 \times 10^{-4}$	
15 000 pF $< C_R \leqslant$ 20 000 pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 25 \times 10^{-4}$	
20 000 pF $< C_R \leqslant$ 30 000 pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 40 \times 10^{-4}$	
$C_R >$ 30 000 pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 60 \times 10^{-4}$	

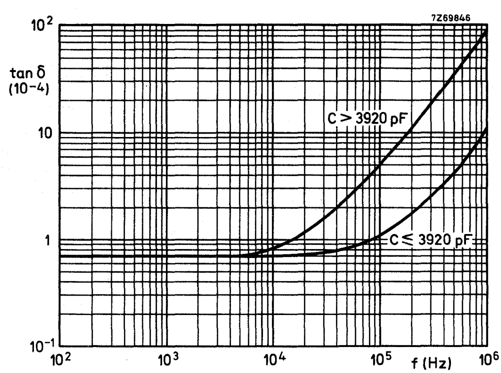


Fig. 8 Tan δ as a function of frequency; typical curve.

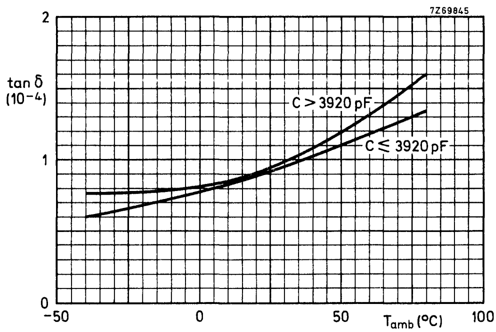


Fig. 9 Tan δ as a function of ambient free air temperature; typical curve.

Insulation resistance

The insulation resistance is measured after a voltage of 10 ± 1 V has been applied for 1 min ± 5 s, at T_{amb} = 20 °C.

R between terminations	> 500 000 MΩ
R between interconnected terminations and case	> 500 000 MΩ

Inductance ≤ 10 nH/cm lead and capacitor length

Maximum dissipation

The maximum a.c. voltage, which has been specified at 50 to 60 Hz must also never be exceeded at other frequencies.* Moreover this voltage may further be limited by the maximum dissipation (P_{max}).

For a capacitor used with a sinusoidal voltage, the power dissipation is expressed by:

$$P = V_{rms} I_{rms} \cos \varphi. \qquad (1)$$

As $I_{rms} = \omega C V_{rms}$, and $\cos \varphi \approx \tan \delta$, equation (1) can be rewritten as:

$$P = V_{rms}^2 \omega C \tan \delta = V_{rms}^2 2\pi f C \tan \delta. \qquad (2)$$

For capacitors of style 2222 443 tan δ is about proportional to the frequency, thus:

$$\tan \delta = \frac{f}{10^5} \tan \delta_{ref}. \qquad (3)$$

Tan δ_{ref} is the maximum tan δ at 100 kHz value given under Ratings and characteristics.

Substituting equation (3) in equation (2) gives:

$$P = 2\pi \cdot 10^{-5}\, V_{rms}^2 f^2 C \tan \delta_{ref}. \qquad (4)$$

The maximum dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be found from Fig. 9.

* At $T_{amb} \leqslant 55$ °C the maximum permissible sinusoidal voltage can be found in Fig. 7.

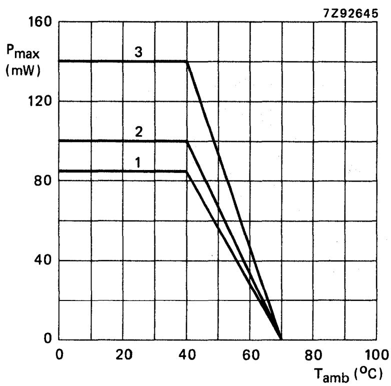


Fig. 10a Maximum dissipation as a function of ambient free air temperature, class 1 capacitors.

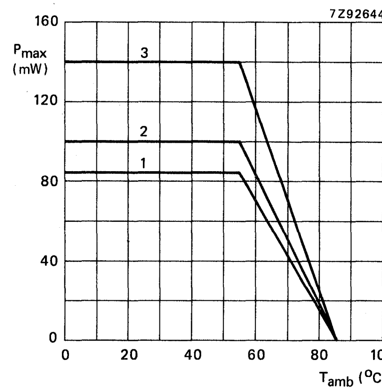


Fig. 10b Maximum dissipation as a function of ambient free air temperature, class 3 capacitors.

Table 3

curve	dimensions (mm)	
	T_{max}	L_{max}
1	5	7,5
2	7,5	7,5
3	10	10

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number as given in Table 1.

PACKING

The capacitors are supplied loose in boxes; the number of capacitors per box is shown in Table 4.

Table 4

capacitors according to	number of capacitors per box
Fig. 1 or Fig. 2	200
Fig. 3	100

POLYSTYRENE FILM/FOIL CAPACITORS

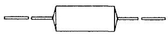
KS axial wrapped end-filled

- Supplied loose in boxes

QUICK REFERENCE DATA

Rated capacitance range	6200 to 162 000 pF
Tolerance on rated capacitance	± 5% (E24-series) ± 2% (E24, E48-series) ± 1% (E24, E48, E96-series)
Rated voltage U_R (d.c.)	63 V, 160 V, 250 V, 630 V
Climatic category	
63 V version	40/070/56
160 V, 250 V, 630 V versions	40/085/56
Rated temperature	
63 V version	70 °C
160 V, 250 V, 630 V versions	85 °C
Related specification	IEC 384-7
Stability class	2

SURVEY OF STYLES



Styles 2222 444 . . . . . to 2222 447 . . . . . .
See Tables 1 to 4.

APPLICATION

For use in circuits where close tolerance, reliability and low losses are of prime importance, e.g. tuned circuits, filter networks, timing network, etc.

DESCRIPTION

The capacitors consist of a low-inductance wound cell of metal foil and a polystyrene film. The cell is wrapped in a polyester film, the ends are filled with epoxy resin. The axial leads are of solder-coated wire.

GENERAL DATA

Dimensions in mm

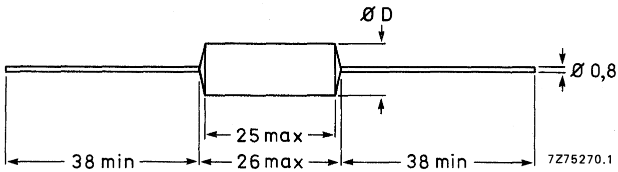


Fig. 1.

Table 1 U_R (d.c.) = 63 V; max. a.c. voltage = 25 V, Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max} mm	approx. mass g	catalogue number
43 000	7,0	3,1	2222 444 24303
47 000	7,5	3,2	24703
51 000	7,5	3,4	25103
56 000	8,0	3,7	25603
62 000	8,5	4,0	26203
68 000	8,5	4,4	26803
75 000	9,0	4,7	27503
82 000	9,5	5,1	28203
91 000	9,5	5,5	29103
100 000	10,0	5,9	21004
110 000	10,5	6,4	21104
120 000	11,0	6,9	21204
130 000	11,5	7,5	21304
150 000	12,0	8,2	21504
160 000	12,5	9,0	21604
162 000	12,5	9,1	21624

* The capacitance values quoted are also available with a tolerance ± 1% or ± 2%.
Besides the values of the E24-series as quoted, intermediate values of the E48-series (with a tolerance ± 1% or ± 2%) and of the E96-series (with a tolerance ± 1%) are available.

Table 2 U_R (d.c.) = 160 V; max. a.c. voltage = 63 V, Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max} mm	approx. mass g	catalogue number
18 000	6,5	2,3	2222 445 21803
20 000	7,0	2,4	22003
22 000	7,0	2,5	22203
24 000	7,5	2,6	22403
27 000	7,5	2,8	22703
30 000	8,0	3,1	23003
33 000	8,5	3,4	23303
36 000	8,5	3,8	23603
39 000	9,0	4,1	23903
43 000	9,5	4,4	24303
47 000	9,5	4,7	24703
51 000	10,0	5,1	25103
56 000	10,5	5,5	25603
62 000	11,0	5,9	26203
68 000	11,5	6,4	26803
75 000	12,0	7,0	27503
82 000	12,5	7,6	28203

Table 3 U_R (d.c.) = 250 V; max. a.c. voltage = 125 V, Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max} mm	approx. mass g	catalogue number
12 000	7,0	2,1	2222 446 21203
13 000	7,0	2,2	21303
15 000	7,5	2,4	21503
16 000	7,5	2,5	21603
18 000	8,0	2,7	21803
20 000	8,0	2,9	22003
22 000	8,5	3,2	22203
24 000	9,0	3,5	22403
27 000	9,5	3,7	22703
30 000	10,0	4,0	23003
33 000	10,5	4,4	23303
36 000	10,5	4,7	23603
39 000	11,0	5,1	23903
43 000	11,5	5,5	24303
47 000	12,0	5,9	24703

* The capacitance values quoted are also available with a tolerance ± 1% or ± 2%.
Besides the values of the E24-series as quoted, intermediate values of the E48-series (with a tolerance ± 1% or ± 2%) and of the E96-series (with a tolerance ± 1%) are available.

Table 4 U_R (d.c.) = 630 V; max. a.c voltage = 250 V, Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max} mm	approx. mass g	catalogue number
6 200	7,5	2,1	2222 447 26202
6 800	7,5	2,2	26802
7 500	8,0	2,4	27502
8 200	8,0	2,6	28202
9 100	8,5	2,8	29102
10 000	9,0	3,0	21003
11 000	9,0	3,3	21103
12 000	9,5	3,6	21203
13 000	10,0	3,9	21303
15 000	10,5	4,2	21503
16 000	11,0	4,6	21603
18 000	11,5	4,9	21803
20 000	12,0	5,3	22003
22 000	12,5	5,8	22203
24 000	12,5	6,2	22403

Marking

The capacitors are marked in ink as follows:
1st line : rated capacitance in pF or nF, and tolerance;
2nd line : rated voltage (d.c.), and code for dielectric material (KS);
3rd line : 5th, 6th and 7th digits of catalogue number, and production date code (according to IEC 62, clause 5).

The outer film connection is identified with a stroke.

Mounting

The capacitors are suited for horizontal or vertical mounting on printed-wiring boards and for point-to-point wiring.

* The capacitance values quoted are also available with a tolerance ± 1% or ± 2%.
Besides the values of the E24-series as quoted, intermediate values of the E48-series (with a tolerance ± 1% or ± 2%) and of the E96-series (with a tolerance ± 1%) are available.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 kHz	see Tables 1 to 4
Tolerance on rated capacitance	± 5%, ± 2% and ± 1%
Temperature coefficient	$-(125 \pm 60)\ 10^{-6}$/K
Frequency dependence between 100 Hz and 1 MHz	none

Voltage

Rated voltage U_R (d.c.)	see Tables 1 to 4
Category voltage U_C	U_R (d.c.)
Test voltage	
between terminations	2 x U_R (d.c.)
between interconnected terminations and case	2 x U_R (d.c.); min. 400 V
Maximum a.c. voltage (r.m.s. value) at 50 to 60 Hz	see Tables 1 to 4

Notes

- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.)
- For other than sinusoidal waveforms, the maximum permissible dissipation must not exceeded.

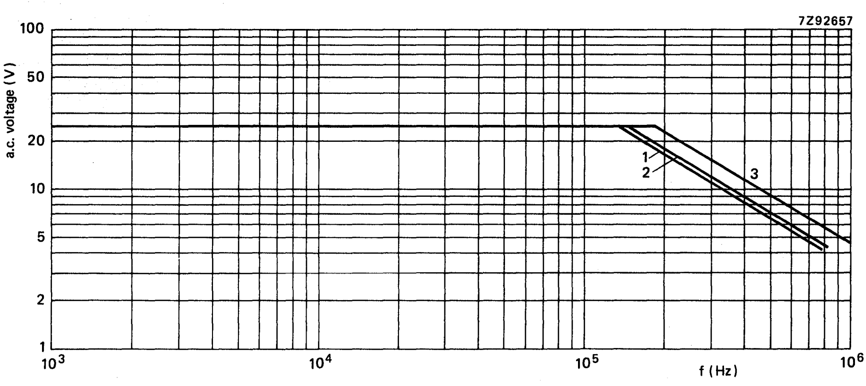


Fig. 2 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 55$ °C, for U_R = 63 V.

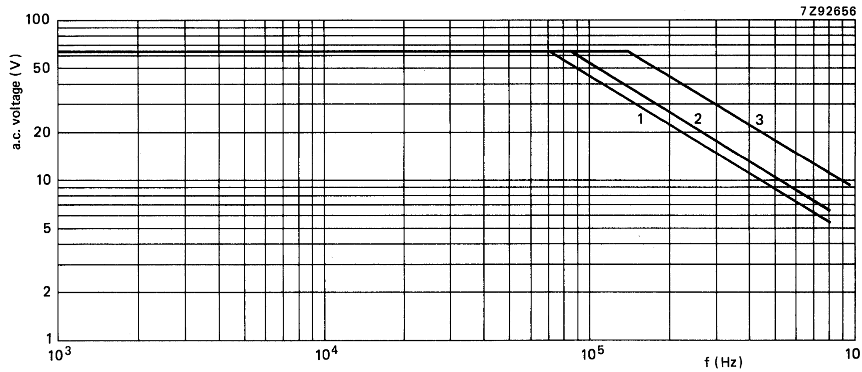


Fig. 3 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^{o}C$, for $U_R = 160$ V.

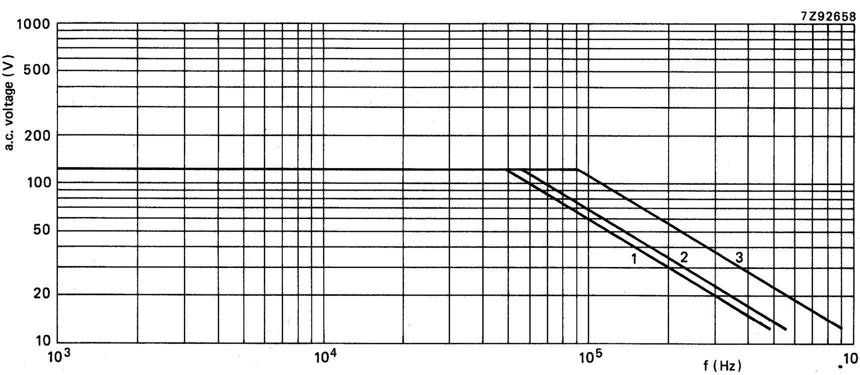


Fig. 4 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^{o}C$, for $U_R = 250$ V.

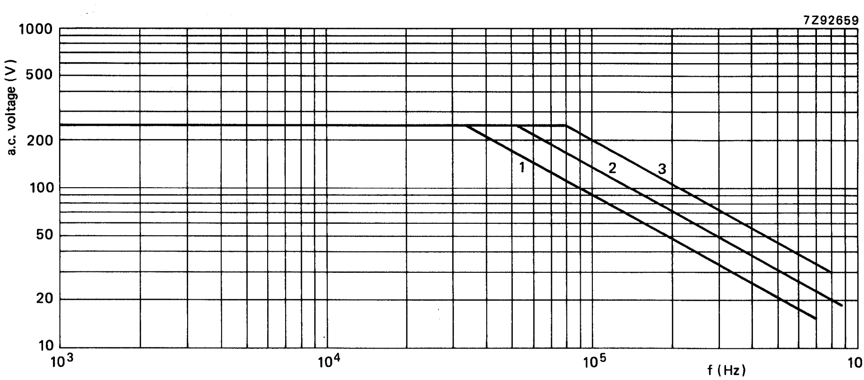


Fig. 5 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^{o}C$, for $U_R = 630$ V.

Temperature

Climatic category
- 63 V version — 40/070/56
- 160 V, 250 V, 630 V versions — 40/085/56

Rated temperature
- 63 V version — 70 °C
- 160 V, 250 V, 630 V versions — 85 °C

Storage temperature range
- 63 V version — −40 to + 70 °C
- 160 V, 250 V, 630 V versions — −40 to + 85 °C

Tangent of loss angle

Table 5

capacitance	tangent of loss angle	
	at 1 kHz	at 100 kHz
6 200 pF $< C_R \leqslant$ 10 000 pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 10 \times 10^{-4}$
10 000 pF $< C_R \leqslant$ 20 000 pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 15 \times 10^{-4}$
$C_R >$ 20 000 pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 25 \times 10^{-4}$

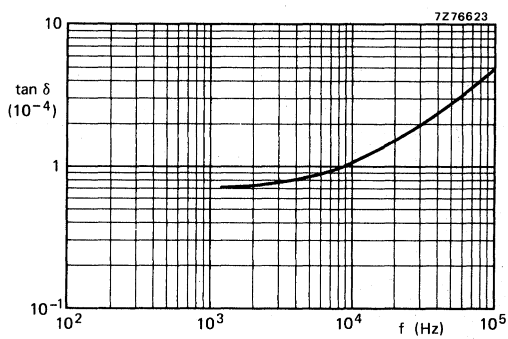


Fig. 6 Tan δ as a function of frequency; typical curve.

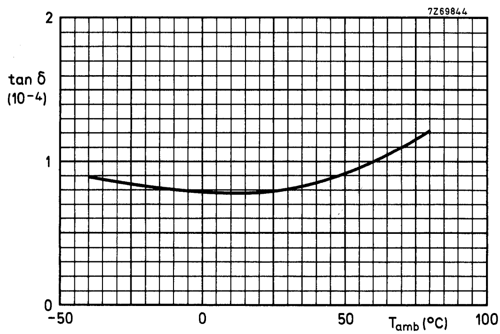


Fig. 7 Tan δ as a function of ambient free air temperature; typical curve.

Insulation resistance at T_{amb} = 20 °C

The insulation resistance is measured after a voltage has been applied for 1 min ± 5 s, the voltage being 10 ± 1 V for the 63 V version, 100 ± 15 V for the 160 V and 250 V versions, and 500 ± 50 V for the 630 V version.

R between terminations	> 500 000 MΩ
R between interconnected terminations and case	> 500 000 MΩ

Inductance $\leqslant$ 10 nH/cm lead and capacitor length

Maximum dissipation

The maximum a.c. voltage, which has been specified at 50 to 60 Hz must also never be exceeded at other frequencies.* Moreover this voltage may further be limited by the maximum dissipation (P_{max}).

For a capacitor used with a sinusoidal voltage, the power dissipation is expressed by:

$$P = V_{rms} I_{rms} \cos\varphi. \quad (1)$$

As $I_{rms} = \omega C V_{rms}$, and $\cos\varphi \approx \tan\delta$, equation (1) can be rewritten as:

$$P = V_{rms}^2 \omega C \tan\delta = V_{rms}^2 2\pi f C \tan\delta. \quad (2)$$

For capacitors of styles 2222 444 to 2222 447 tan δ is about proportional to the frequency, thus:

$$\tan\delta = \frac{f}{10^5} \tan\delta_{ref}. \quad (3)$$

Tan δ_{ref} is the maximum tan δ at 100 kHz value given under Ratings and characteristics.

Substituting equation (3) in equation (2) gives:

$$P = 2\pi \cdot 10^{-5} V_{rms}^2 f^2 C \tan\delta_{ref}. \quad (4)$$

The maximum dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be found from Fig. 8.

* At $T_{amb} \leqslant 70$ °C ($\leqslant 55$ °C for 63 V version) the maximum permissible sinusoidal voltage can be found in Figs 2 to 5.

Table 6

curve	dimensions (mm)	
	D_{max}	L_{max}
1	6,5	25
2	7,0	
3	7,5	
4	8,0	
5	8,5	
6	9,0	
7	9,5	
8	10,0	
9	10,5	
10	11,0	
11	11,5	
12	12,0	
13	12,5	

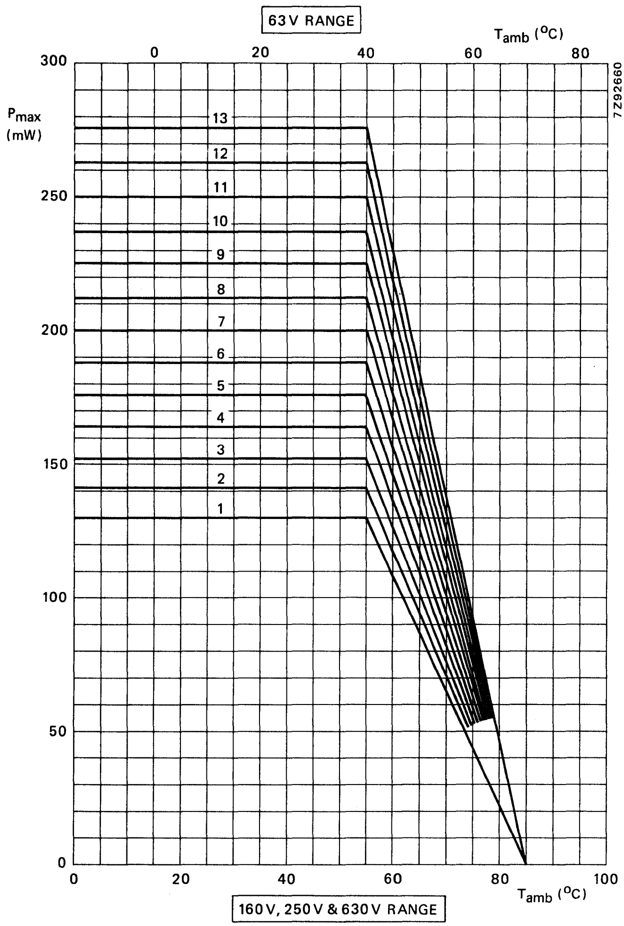


Fig. 8 Maximum dissipation as a function of ambient free air temperature.

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number.

Composition of the catalogue number (see Tables 1 to 4).

2222 . . . .

444 = 63 V
445 = 160 V
446 = 250 V
447 = 630 V

2 = ± 5%
3 = ± 2%
4 = ± 1%

code for capacitance, see Tables 1 to 4

PACKING

The capacitors are supplied loose in cardboard boxes; the number of capacitors per box is given in Table 7.

Table 7

capacitance values (pF) of				number of capacitors per box
63 V version	160 V version	250 V version	630 V version	
43 000- 56 000	18 000-30 000	12 000-18 000	6 200- 8 200	600
62 000- 91 000	33 000-47 000	20 000-27 000	9 100-12 000	500
100 000-130 000	51 000-68 000	30 000-43 000	13 000-18 000	400
150 000-162 000	75 000-82 000	47 000	20 000-24 000	300

INSPECTION REQUIREMENTS

polystyrene film/foil capacitors (KS)

Note 1
Sub-clause numbers of tests and performance requirements refer to the Sectional Specification, IEC-publication 384-7 and GENERAL DATA of the specifications.

Note 2
In this table: D = destructive, ND = non-destructive.

clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
Group A Inspection (lot-by-lot)			
Sub-group A1	ND		
4.1 Visual examination			No mechanical failures. Legible marking and as specified in GENERAL DATA of the specification.
4.2 Dimensions		Gauging	As specified in the Tables of the specification.
Sub-group A2	ND		
4.2.1 Voltage proof (Test A)		at 2 x U_R (d.c.) for 1 s	No breakdown or flashover.
4.2.2 Capacitance		at 1 kHz	Within specified tolerance.
4.2.3 Tangent of loss angle		for $C_R \leqslant 1000$ pF at 1 MHz, for $C_R > 1000$ pF at 100 kHz	As in GENERAL DATA of the specification.

performance requirements **2222 443**	performance requirements **2222 444 to 447**
No mechanical failures. Legible marking and as specified in GENERAL DATA of the specification.	No mechanical failures. Legible marking and as specified in GENERAL DATA of the specification.
As specified in the Table of the specification.	As specified in the Tables of the specification.
No breakdown or flashover.	No breakdown or flashover.
Within specified tolerance.	Within specified tolerance.
As in GENERAL DATA of the specification.	As in GENERAL DATA of the specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
Group B Inspection (periodic)			
4.5 Solderability	D	Without ageing Method: 1 Solder bath: 235 °C Dwell time: 2 s Non-activated colophony flux	Good tinning as evidenced by free flowing of the solder with wetting of the terminations.
Group C Inspection (periodic)			
Sub-group C1A	D		
Part of sample of sub-group C1			
4.1 Dimensions (detail)			As specified in the Tables of the specification.
4.3.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
4.3 Robustness of terminations		Tensile, bending and torsion	No visible damage.
4.4 Resistance to soldering heat		No pre-drying Method: 1A Solder bath: 260 °C Duration: 5 s	
4.4.2 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 1\% + 1$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.3.1.
		Tangent of loss angle	As in GENERAL DATA of the specification.

performance requirements **2222 443**	performance requirements **2222 444 to 447**
Good tinning as evidenced by free flowing of the solder with wetting of the terminations.	Good tinning as evidenced by free flowing of the solder with wetting of the terminations.
As specified in the Table of the specification.	As specified in the Tables of the specification.
No visible damage.	No visible damage.
No visible damage. Legible marking. $\Delta C/C \leqslant 0{,}5\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}5\%$ for $C_R > 1000$ pF of the value measured in 4.3.1. As in GENERAL DATA of the specification.	No visible damage. Legible marking $\Delta C/C \leqslant 0{,}5\%$ of the value measured in 4.3.1. As in GENERAL DATA of the specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
Sub-group C1B	D		
Other part of sample of sub-group C1			
4.6.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
4.6 Rapid change of temperature		θ A = lower cat. temp. θ B = upper cat. temp. 5 cycles, duration t = 30 min. Recovery 1 to 2 h	
4.6.2 Intermediate measurements		Visual examination Capacitance	No visible damage. $\Delta C/C \leqslant 0{,}5\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}5\%$ for $C_R > 1000$ pF of the value measured in 4.6.1.
		Tangent of loss angle	As in GENERAL DATA of the specification.
4.7 Vibration		Method of mounting see Note below. Procedure B4. Frequency range: 10 to 55 Hz Pulse shape: half sine Amplitude: 0,75 mm or acceleration: 98 m/s^2 (whichever is the less severe). Total duration: 6 h	
4.7.2 Final inspection Intermediate measurements		Visual examination Capacitance	No visible damage. $\Delta C/C \leqslant 0{,}5\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}5\%$ for $C_R > 1000$ pF of the value measured in 4.6.2.

Note

The capacitors shall be mechanically fixed by the leads, also the body of capacitors with a mass > 2 g shall be clamped to the printed-wiring board.

performance requirements **2222 443**	performance requirements **2222 444 to 447**
No visible damage. Class 1: $\Delta C/C \leqslant 0{,}3\% + 0{,}3$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}3\%$ for $C_R > 1000$ pF of value measured in 4.6.1. Class 3: $\Delta C/C \leqslant 0{,}75\% + 0{,}75$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}75\%$ for $C_R > 1000$ pF of the value measured in 4.6.1.	No visible damage. $\Delta C/C \leqslant 0{,}5\%$ of the value measured in 4.6.1.
As in GENERAL DATA of the specification.	As in GENERAL DATA of the specification.
No visible damage. $\Delta C/C \leqslant 0{,}1\%$ of the value measured in 4.6.2.	No visible damage. $\Delta C/C \leqslant 0{,}5\%$ of the value measured in 4.6.2.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
4.9 Shock		Method of mounting see Note below. Pulse shape: half sine Acceleration: 490 m/s^2 Duration of pulse: 11 ms	
4.9.3 Final measurements		Visual examination Capacitance	No visible damage. $\Delta C/C \leqslant 0,5\% + 0,5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0,5\%$ for $C_R > 1000$ pF of the value measured in 4.7.2.

Note

The capacitors shall be mechanically fixed by the leads, also the body of capacitors with a mass > 2 g shall be clamped to the printed-wiring board.

performance requirements **2222 443**	performance requirements **2222 444 to 447**
No visible damage. Class 1: $\Delta C/C \leqslant 0{,}5\%$, Class 3: $\Delta C/C \leqslant 1\%$ of the value measured in 4.7.2.	No visible damage. $\Delta C/C \leqslant 0{,}5\%$ of the value measured in 4.7.2.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
Sub-group C1	D		
Combined sample of specimens of Sub-groups C1A and C1B			
4.10 Climatic sequence			
4.10.2 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz Insulation resistance	
4.10.3 Dry heat		Temperature: upper category temperature Duration: 16 h	
4.10.4 Damp heat cyclic, Test Db, first cycle			
4.10.5 Cold		Temperature: lower category temperature Duration: 2 h	
4.10.7 Damp heat cyclic, Test Db remaining cycles		Recovery: 1 to 2 h	
4.10.7 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 1\% + 1$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.10.2.
		Tangent of loss angle	$\leqslant 2$ x values specified in GENERAL DATA of the specification.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.

performance requirements **2222 443**	performance requirements **2222 444 to 447**
No visible damage. Legible marking. Class 1: $\Delta C/C \leqslant 0{,}5\% + 1$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}5\%$ for $C_R > 1000$ pF of the value measured in 4.10.2. Class 3: $\Delta C/C \leqslant 1\% + 1$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.10.2.	No visible damage. Legible marking. $\Delta C/C \leqslant 0{,}5\%$ of the value measured in 4.10.2.
$\leqslant 2$ x values specified in GENERAL DATA of the specification. $\geqslant 20\%$ of values in GENERAL DATA of the specification.	$\leqslant 2$ x values specified in GENERAL DATA of the specification. $\geqslant 20\%$ of values in GENERAL DATA of the specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
Sub-group C2	D		
4.11 Damp heat steady state			
4.11.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
4.11.3 Final measurements		Recovery: 1 to 2 h	
		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 1\% + 1$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.11.1.
		Tangent of loss angle	$\leqslant 2$ x values specified in GENERAL DATA of the specification.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.

performance requirements **2222 443**	performance requirements **2222 444 to 447**
No visible damage. Legible marking $\Delta C/C \leqslant 0{,}5\% + 1$ pF for $C_R \leqslant 1000$ pF $\leqslant 0{,}5\%$ for $C_R > 1000$ pF of the value measured in 4.11.1.	No visible damage. Legible marking. $\Delta C/C \leqslant 0{,}5\%$ of the value measured in 4.11.1.
$\leqslant 2$ x values specified in GENERAL DATA of the specification. $\geqslant 20\%$ of values in GENERAL DATA of the specification.	$\leqslant 2$ x values specified in GENERAL DATA of the specification. $\geqslant 20\%$ of values in GENERAL DATA of the specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
Sub-group C3	D		
4.12 Endurance		**Styles 2222 424 to 431 and 2222 444 to 447:** Duration: 1000 h; 1,5 U_R (d.c.) at 70 °C for 63 V version, at 85 °C for 160 V, 250 V, 630 V versions **Style 2222 443:** Duration: 1000 h; 1,5 U_R (d.c.) at 70 °C for class 1, at 85 °C for class 3	
4.12.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
4.12.5 Final measurements		Visual examination	No visible damage. Legible marking
		Capacitance	$\Delta C/C \leqslant 0{,}3\%$ (63 V version), $\leqslant 0{,}5\% + 0{,}5$ pF (160 V, 250 V, 630 V versions) for $C_R \leqslant 1000$ pF, $\leqslant 0{,}5\%$ for $C_R > 1000$ pF of the value measured in 4.12.1.
		Tangent of loss angle	As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in 4.12.1, whichever is greater.
		Insulation resistance	As in GENERAL DATA of the specification.

performance requirements **2222 443**	performance requirements **2222 444 to 447**
No visible damage. Legible marking. Class 1: $\Delta C/C \leqslant 0,3\% + 0,3$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0,3\%$ for $C_R > 1000$ pF; Class 3: $\Delta C/C \leqslant 0,75\% + 0,75$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0,75\%$ for $C_R > 1000$ pF of the value measured in 4.12.1.	No visible damage Legible marking. $\Delta C/C \leqslant 0,3\%$ (63 V version), $\leqslant 0,5\%$ (160 V, 250 V, 630 V versions) of the value measured in 4.12.1.
As in GENERAL DATA of the specification or $\leqslant 1,4$ x value measured in 4.12.1, whichever is greater.	As in GENERAL DATA of the specification or $\leqslant 1,4$ x value measured in 4.12.1, whichever is greater.
As in GENERAL DATA of the specification.	As in GENERAL DATA of the specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
Sub-group C4	D		
4.2.5 Variation of capacitance with temperature		Static method; capacitors shall be dried. Number of cycles: 1 Capacitance measurements for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz	Temperature coefficient as in GENERAL DATA of the specification. Temperature cyclic drift of capacitance $\Delta C/C \leqslant 0{,}5\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF $\leqslant 0{,}5\%$ for $C_R > 1000$ pF
		Insulation resistance	$\geqslant 10\,000$ MΩ.
4.2.6 Inductance			As in GENERAL DATA of the specification.

performance requirements **2222 443**	performance requirements **2222 444 to 447**
Temperature coefficient as in GENERAL DATA of the specification.	Temperature coefficient as in GENERAL DATA of the specification.
Temperature cyclic drift of capacitance Class 1: $\Delta C/C \leqslant 0{,}3\% + 0{,}3$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}3\%$ for $C_R > 1000$ pF; Class 3: $\Delta C/C \leqslant 0{,}75\% + 0{,}75$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}75\%$ for $C_R > 1000$ pF	Temperature cyclic drift of capacitance $\Delta C/C \leqslant 0{,}5\%$
$\geqslant 10\,000$ MΩ.	$\geqslant 10\,000$ MΩ.
As in GENERAL DATA of the specification.	As in GENERAL DATA of the specification.

additional test	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
Sub-group ADD1	D		
A.1 Heat storage		Duration: 1000 h Temperature: upper category temperature	
A.1.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
A.1.2 Final measurements		Capacitance	$\Delta C/C \leqslant 0{,}3\%$ (63 V version), $\leqslant 0{,}5\% + 0{,}5$ pF (160 V, 250 V, 630 V versions) for $C_R \leqslant 1000$ pF, $\leqslant 0{,}5\%$ for $C_R > 1000$ pF of the value measured in A.1.1.
		Tangent of loss angle	As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in A.1.1, whichever is greater.
		Insulation resistance	As in GENERAL DATA of the specification.

performance requirements **2222 443**	performance requirements **2222 444 to 447**
Class 1: $\Delta C/C \leqslant 0{,}3\% + 0{,}3$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}3\%$ for $C_R > 1000$ pF; Class 3: $\Delta C/C \leqslant 0{,}75\% + 0{,}75$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}75\%$ for $C_R > 1000$ pF of the value measured in A.1.1.	$\Delta C/C \leqslant 0{,}3\%$ (63 V version), $\leqslant 0{,}5\%$ (160 V, 250 V, 630 V versions) of the value measured in A.1.1.
As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in A.1.1, whichever is geater.	As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in A.1.1, whichever is greater.
As in GENERAL DATA of the specification.	As in GENERAL DATA of the specification.

additional test	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
Sub-group ADD2			
A.2 Endurance for capacitors with max. a.c. voltage $\geqslant$ 200 V (r.m.s.)		Duration: 1000 h Temperature: 70 °C for 63 V version, 85 °C for 160 V, 250 V, 630 V versions Voltage: 1,25 x max. a.c. voltage (r.m.s. value), 50 Hz	
A.2.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
A.2.2 Final measurements		Capacitance	For $C_R \leqslant 1000$ pF: $\Delta C/C \leqslant 0{,}3\%$ (63 V version), $\leqslant 0{,}5\% + 0{,}5$ pF (160 V, 250 V, 630 V versions), for $C_R > 1000$ pF: $\Delta C/C \leqslant 0{,}5\%$ of the value measured in A.2.1.
		Tangent of loss angle	As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in A.2.1, whichever is greater.
		Insulation resistance	As in GENERAL DATA of the specification.

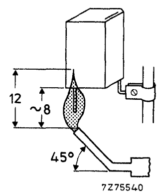
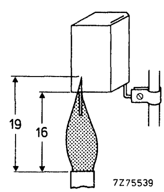
performance requirements **2222 443**	performance requirements **2222 444 to 447**
Not applicable.	$\Delta C/C \leqslant 0{,}5\%$ of the value measured in A.2.1. As in GENERAL DATA of the specification or $\leqslant 1{,}4 \times$ value measured in A.2.1, whichever is greater. As in GENERAL DATA of the specification.

additional test	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
Sub-group ADD3	D		Not applicable.
A.3 Resistance to soldering heat with pre-heating		Capacitors mounted on a 1,6 mm board with non-plated holes Body temp.: 80 °C Bath temp.: 260 °C Dwell time: 5 s	
A.3.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz	
A.3.2 Final measurements		Capacitance	
Sub-group ADD4		**GROUP 1:**	Not applicable.
A.4 Solvent resistance, Mil STD-202F, method 215 B		**De-ionized water, followed by** mixture of isopropyl alcohol and mineral spirits **GROUP 2:** 1-1-1-Trichloroethane **GROUP 3:** Azeotropic mixture of trichlorotrifluoroethane and methylene chloride Temperature: 25 °C	
A.4.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, 1000 pF $< C_R \leqslant$ 15 000 pF at 100 kHz, $C_R >$ 15 000 pF at 10 kHz	
A.4.2 Final measurements		Capacitance Tangent of loss angle Insulation resistance	

performance requirements **2222 443**	performance requirements **2222 444 to 447**
$\Delta C/C \leqslant 0{,}25\%$ of the value measured in A.3.1.	$\Delta C/C \leqslant 0{,}75\%$ of the value measured in A.3.1.
$\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF compared to values measured in A.4.1. As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in A.4.1, whichever is greater. $\geqslant 50\%$ of values in GENERAL DATA of the specification.	Not applicable.

additional test	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
Sub-group ADD5			Not applicable.
A.5 Detergent resistance		Density 20g/l dishwasher detergent Temperature 70 °C, during 3 min. Followed by rinsing in clear water for 1 min. Recovery time > 2 h.	
A.5.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, 1000 pF $< C_R \leqslant$ 15 000 pF at 100 kHz, $C_R >$ 15 000 pF at 10 kHz	
A.5.2 Final measurements		Capacitance Tangent of loss angle Insulation resistance	

performance requirements **2222 443**	performance requirements **2222 444 to 447**
$\Delta C/C \leqslant 1\% + 0,5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF compared to values measured in A.5.1. As in GENERAL DATA of the specification or $\leqslant 1,4$ x value measured in A.5.1, whichever is greater. $\geqslant 50\%$ of values in GENERAL DATA of the specification.	Not applicable.

additional test	D or ND	conditions of test (see Note 1)	performance requirements **2222 424 to 431**
Sub-group ADD6	D		Not applicable.
A.6.1 Needle flame test IEC 695-2-2		Bore of gas jet: ϕ 0,5 mm Fuel: butane Test duration: 20 s One flame application  	
A.6.2 Needle flame test UL 1414		Bore of gas jet: ϕ 10 mm Fuel: natural gas Test duration: 3 x 15 s. Time interval between each flame application: 15 s.  	
Sub-group ADD7			
A.7 Climatic test on taped type		250 h at 40 ± 2 ^{o}C R.H. 90 to 95% Recovery time 24 h.	Deviation of tape on a strip of 250 mm taped products $\leqslant$ 2%. Pull out and tearing forces $\geqslant$ 50% of values in GENERAL DATA of this specification.

performance requirements **2222 443**	performance requirements **2222 444 to 447**
After removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s, no burning particles must drop from the sample. Extinguishing time $\leqslant$ 15 s after the first and second flame application, $\leqslant$ 60 s after the third flame application.	Not applicable.
Not applicable.	Not applicable.

POLYPROPYLENE FILM/FOIL CAPACITORS (KP)

POLYPROPYLENE FILM/FOIL CAPACITORS

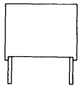
KP radial potted type

- 15, 22,5 and 27,5 mm pitch
- Supplied in boxes

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	0,039 to 0,82 μF
Tolerance on rated capacitance	± 10%, ± 5%
Rated voltage U_R (d.c.)	250 V
Climatic category	55/085/56
Rated temperature	85 °C
Related specification	IEC 384-13
Stability class	3

STYLE



Style 2222 357 5 . . . .; see Table 1.

APPLICATION

These capacitors are for applications where high currents and steep pulses occur. They are mainly used for deflection circuits in television receivers, to operate at high peak currents at line frequency.
When requiring advice, please send oscillograms of current and voltage waveforms.

DESCRIPTION

The capacitors consist of an impregnated, low-inductance wound cell of aluminium foil and polypropylene film. The cell is potted with epoxy resin in a yellow flame-retardent polypropylene case. The radial leads are solder-coated copper wire.

The capacitors can withstand solvents and rinsing liquids without damage. They are provided with small stand-off pips to allow removal of solder flux etc., when cleaning the printed-wiring board.

GENERAL DATA

Dimensions in mm

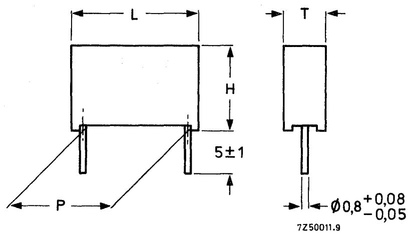


Fig. 1.

Table 1 U_R (d.c.) = 250 V; max. a.c. voltage = 160 V; Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 357 ..... tol. ± 10%	catalogue number 2222 357 ..... tol. ± 5%
0,039	8	15	21,5	15 ± 0,4	3	51393	52393
0,047	8	15			3	51473	52473
0,056	8	15			3	51563	52563
0,068	10	17			4,5	51683	52683
0,082	10	17			4,5	51823	52823
0,10	8,5	18,5	29	22,5 ± 0,4	5,5	51104	52104
0,12	8,5	18,5			5,5	51124	52124
0,15	8,5	18,5			5,5	51154	52154
0,18	8,5	18,5			5,5	51184	52184
0,22	10	20	34	27,5 ± 0,4	8,5	51224	52224
0,27	10	20			8,5	51274	52274
0,33	12	22			11	51334	52334
0,39	12	22			11	51394	52394
0,47	15	25			16	51474	52474
0,56	15	25			16	51564	52564
0,68	15	25			16	51684	52684
0,82	18	28			22	51824	52824

Marking

a. Rated capacitance
b. Rated voltage
c. Tolerance on rated capacitance
d. Category voltage
e. Year and month of manufacture
f. Manufacturer's name
g. Climatic category
h. Manufacturer's type designation

The capacitors are marked on the top by embossed print with a, b, c, e, f and h as follows:

1st line : rated capacitance in μF, tolerance and rated d.c. voltage;

2nd line : code for dielectric material, 5th, 6th and 7th digits of the catalogue number, code for factory of origin, production date code according to IEC 62, clause 5.

The manufacturer's identification symbol is indicated at the left.

The package containing the capacitors is marked with a to h.

Mounting

The capacitors are suited for mounting on printed-wiring boards.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 kHz	see Table 1
Tolerance on rated capacitance	see Table 1
Frequency dependence between 100 Hz and 100 kHz	negligible

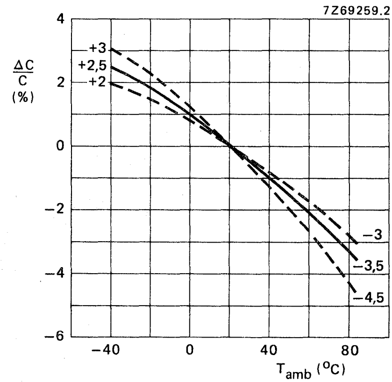


Fig. 2 Capacitance as a function of ambient free air temperature, typical curve.

Voltage

Rated voltage U_R (d.c.)	250 V
Maximum a.c. voltage (r.m.s. value), at 50 to 60 Hz	160 V
Test voltage	
between terminations	2 x U_R (d.c.)
between interconnected terminations and case	1000 V (d.c.)

Notes

- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.).
- For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

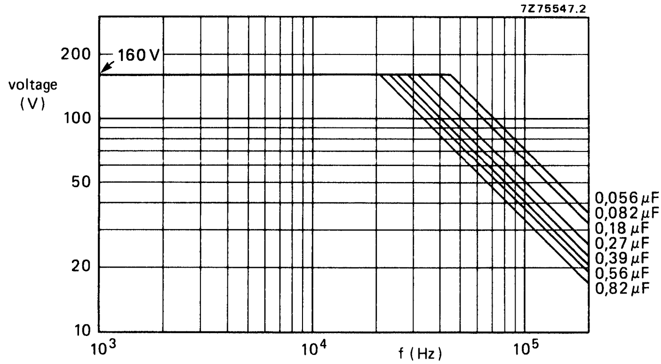


Fig. 3 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 45$ °C.

Temperature

Climatic category	55/085/56
Rated temperature	85 °C
Storage temperature range	−55 to + 85 °C
Rated voltage pulse slope $(\frac{dU}{dt})R$	limited by network conditions
Tangent of loss angle at 100 kHz	
15 and 22,5 mm pitch	$\leqslant 15 \times 10^{-4}$
27,5 mm pitch	
$C_R \leqslant 0{,}33\ \mu F$	$\leqslant 15 \times 10^{-4}$
$0{,}33 < C_R \leqslant 0{,}47\ \mu F$	$\leqslant 20 \times 10^{-4}$
$C_R > 0{,}47\ \mu F$	$\leqslant 25 \times 10^{-4}$

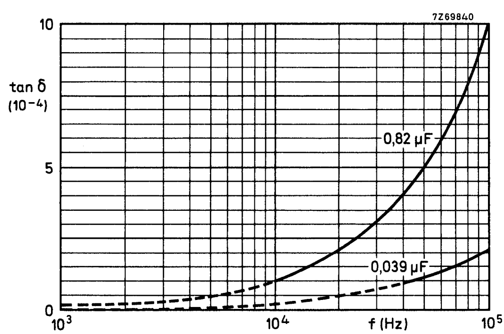


Fig. 4 Tan δ as a function of frequency; typical curves.

Insulation resistance

The insulation resistance is measured after a voltage of 100 ± 15 V has been applied for 1 min ± 5 s, at T_{amb} = 23 °C.

R between termination

$C_R \leqslant 0,1\ \mu F$	> 50 000 MΩ
$C_R > 0,1\ \mu F$	> 5 000 s

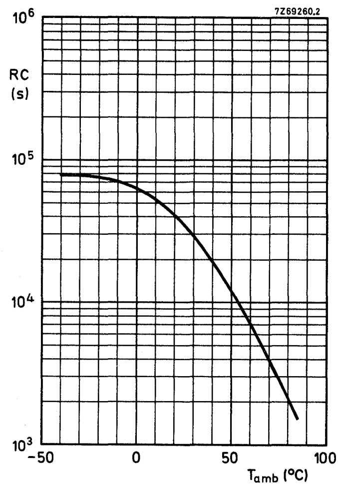


Fig. 5 RC-product as a function of ambient free air temperature; typical curve.

Maximum dissipation

The maximum a.c. voltage, which has been specified at 50 to 60 Hz must also never be exceeded at other frequencies.* Moreover this voltage may further be limited by the maximum dissipation (P_{max}).

For a capacitor used with sinusoidal voltage, the power dissipation is expressed by:

$$P = V_{rms} I_{rms} \cos \varphi \tag{1}$$

As $I_{rms} = \omega C V_{rms}$, and $\cos \varphi \approx \tan \delta$, equation (1) can be rewritten as:

$$P = V_{rms}^2 \omega C \tan \delta = V_{rms}^2\, 2\pi f C \tan \delta. \tag{2}$$

For capacitors of style 2222 357 5 . . . ., tan δ is about proportional to the frequency, thus:

$$\tan \delta = \frac{f}{10^5} \tan \delta_{ref}. \tag{3}$$

Tan δ_{ref} is the maximum tan δ at 100 kHz value given under Ratings and characteristics.

Substituting equation (3) in equation (2) gives:

$$P = 2\pi \cdot 10^{-5}\, V_{rms}^2 f^2 C \tan \delta_{ref}. \tag{4}$$

The maximum dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be found from Fig. 6.

* At $T_{amb} \leqslant 45$ °C the maximum permissible sinusoidal voltage can be found in Fig. 3.

curve	dimensions (mm)		
	T_{max}	H_{max}	L_{max}
1	8	15	21,5
2	10	17	21,5
3	8,5	18,5	29
4	10	20	29
5	10	20	34
6	12	22	34
7	15	25	34
8	18	28	34

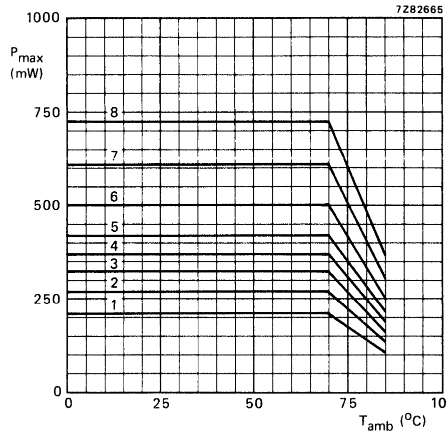


Fig. 6 Maximum dissipation as a function of ambient free air temperature, at various capacitor dimensions.

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number as given in Table 1.

PACKING

The capacitors are supplied in cardboard boxes; the number per box is shown in the table below.

L_{max} mm	number of capacitors per box
21,5 or 29	200
34	100

POLYPROPYLENE FILM/FOIL CAPACITORS

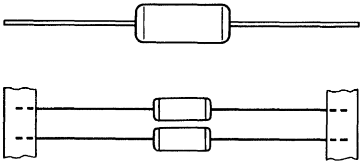
KP axial sleeved type

- Supplied on bandoliers on reel or loose in boxes

QUICK REFERENCE DATA

Rated capacitance range	47 to 56 000 pF
Tolerance on rated capacitance	± 5% (E24-series) ± 2% (E24, E48-series)
Rated voltage U_R (d.c.)	63 V, 160 V, 250 V
Climatic category	40/100/21
Rated temperature	85 °C
Related specification	IEC 384-13
Stability class	1

SURVEY OF STYLES



2222 455 . . . . . to 2222 457 . . . . . ;
see Tables 1 to 3.

APPLICATION

For use in circuits where close tolerance, reliability and low losses are of prime importance, e.g. tuned circuits, filter networks, timing networks, etc.

DESCRIPTION

The capacitors consist of a low-inductance wound cell of metal foil and a polypropylene film. The cell is covered with a blue plastic sleeve. The axial leads are of solder-coated wire.

GENERAL DATA

Dimensions in mm

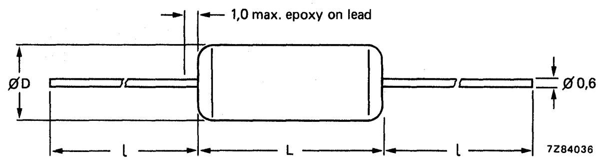


Fig. 1.

→ **Table 1** U_R (d.c.) = 63 V; max. a.c. voltage = 40 V; Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number 2222 455 ..... on bandoliers on reel	in box
3 300	4,0	11,0	30	0,3	63302	23302
3 600					63602	23602
3 900					63902	23902
4 300	4,5				64302	24302
4 700					64702	24702
5 100					65102	25102
5 600					65602	25602
6 200	4,9				66202	26202
6 800				0,4	66802	26802
7 500					67502	27502
8 200					68202	28202
9 100					69102	29102
10 000	4,5	15,0	28	0,5	61003	21003
11 000					61103	21103
12 000					61203	21203
13 000	4,9				61303	21303
15 000					61503	21503
16 000					61603	21603
18 000				0,6	61803	21803
20 000					62003	22003
22 000	5,5				62203	22203
24 000					62403	22403
27 000					62703	22703
30 000	6,0			0,7	63003	23003
33 000					63303	23303
36 000	6,5			0,8	63603	23603
39 000					63903	23903
43 000	7,0			0,9	64303	24303
47 000					64703	24703
51 000	7,5			1,0	65103	25103
56 000					65603	25603

* Besides the values of the E24-series with a tolerance ± 5% as quoted, these values and intermediate values of the E48-series are available with a tolerance ± 2%.

Table 2 U_R (d.c.) = 160 V; max. a.c. voltage = 63 V; Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number 2222 456 . . . . . on bandoliers on reel	in box
1 800	4,0	11,0	30	0,3	61802	21802
2 000					62002	22002
2 200					62202	22202
2 400					62402	22402
2 700					62702	22702
3 000	4,5				63002	23002
3 300					63302	23302
3 600					63602	23602
3 900					63902	23902
4 300	4,9			0,4	64302	24302
4 700					64702	24702
5 100					65102	25102
5 600					65602	25602
6 200	4,5	15,0	28	0,5	66202	26202
6 800					66802	26802
7 500					67502	27502
8 200					68202	28202
9 100					69102	29102
10 000					61003	21003
11 000	4,9			0,6	61103	21103
12 000					61203	21203
13 000					61303	21303
15 000	5,5				61503	21503
16 000					61603	21603
18 000	6,0			0,7	61803	21803
20 000					62003	22003
22 000	6,5			0,8	62203	22203
24 000					62403	22403
27 000	7,0			0,9	62703	22703
30 000					63003	23003
33 000	7,5			1,0	63303	23303
36 000					63603	23603

* Besides the values of the E24-series with a tolerance ± 5% as quoted, these values and intermediate values of the E48-series are available with a tolerance ± 2%.

→ **Table 3** U_R (d.c.) = 250 V; max. a.c. voltage = 125 V; Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number 2222 457 ..... on bandoliers on reel	in box
47	4,0	11,0	30	0,3	64709	24709
51					65109	25109
56					65609	25609
62					66209	26209
68					66809	26809
75					67509	27509
82					68209	28209
91					69109	29109
100					61001	21001
110					61101	21101
120					61201	21201
130					61301	21301
150					61501	21501
160					61601	21601
180					61801	21801
200					62001	22001
220					62201	22201
240					62401	22401
270					62701	22701
300					63001	23001
330					63301	23301
360					63601	23601
390					63901	23901
430					64301	24301
470	4,5				64701	24701
510					65101	25101
560					65601	25601
620					66201	26201
680					66801	26801
750					67501	27501
820					68201	28201
910					69101	29101
1 000					61002	21002
1 100					61102	21102
1 200					61202	21202
1 300					61302	21302
1 500					61502	21502
1 600					61602	21602
1 800					61802	21802
2 000					62002	22002
2 200					62202	22202
2 400	4,9			0,4	62402	22402
2 700					62702	22702
3 000					63002	23002

* Besides the values of the E24-series with a tolerance ± 5% as quoted, these values and intermediate values of the E48-series are available with a tolerance ± 2%.

Table 3 (continued) U_R (d.c.) = 250 V; max. a.c. voltage = 125 V; Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number 2222 457 ..... on bandoliers on reel	catalogue number 2222 457 ..... in box
3 300	4,5	15,0	28	0,4	63302	23302
3 600					63602	23602
3 900					63902	23902
4 300					64302	24302
4 700					64702	24702
5 100	4,9				65102	25102
5 600					65602	25602
6 200				0,5	66202	26202
6 800					66802	26802
7 500	5,5				67502	27502
8 200					68202	28202
9 100					69102	29102
10 000	6,0			0,6	61003	21003
11 000					61103	21103
12 000	6,5			0,7	61203	21203
13 000					61303	21303
15 000	7,0			0,8	61503	21503
16 000					61603	21603
18 000	7,5			0,9	61803	21803
20 000					62003	22003

Marking

The capacitors are marked in black ink as follows:
1st line : rated capacitance in pF or nF;
2nd line: tolerance code (G = ± 2%, J = ± 5%) and rated voltage (d.c.) without unit symbol;
3rd line : code for dielectric material (KP = polypropylene film/foil) and production date code (according to IEC 62, clause 5);
4th line : name of manufacturer.

Mounting

The capacitors are suited for vertical or horizontal mounting on printed-wiring boards and for point-to-point wiring.

The capacitors packed on bandoliers are for mounting with automatic insertion machines.

* Besides the values of the E24-series with a tolerance ± 5% as quoted, these values and intermediate values of the E48-series are available with a tolerance ± 2%.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range	
at 1 MHz ($C_R \leqslant$ 1000 pF)	see Tables 1 to 3
at 1 kHz ($C_R >$ 1000 pF)	see Tables 1 to 3
Tolerance on rated capacitance	± 5%, ± 2% or ± 2 pF*
Temperature coefficient	–(250 ± 120) 10^{-6}/K
Frequency dependence between 100 kHz and 1 MHz	none

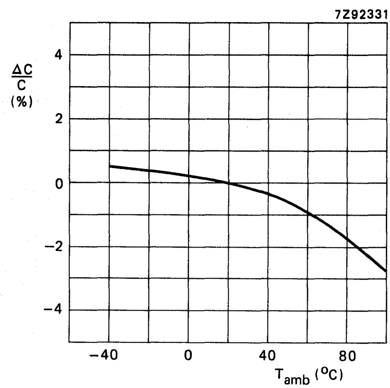


Fig. 2 Capacitance as a function of ambient free air temperature; typical curve.

Voltage

Rated voltage U_R (d.c.)	see Tables 1 to 3
Category voltage U_C	0,8 x U_R (d.c.)
Test voltage	
between terminations	2 x U_R (d.c.)
between interconnected terminations and case	2 x U_R (d.c.); min. 400 V
Maximum a.c. voltage (r.m.s. value) at 50 to 60 Hz	40 V, 63 V, 100 V

Notes

- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.).
- For other than sinusoidal waveforms, the maximum permissible dissipation must not be exceeded.

* Whichever is greater.

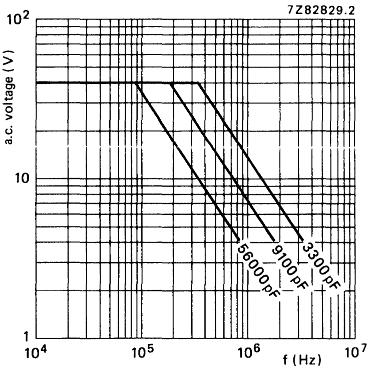


Fig. 3 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^oC$, for $U_R = 63$ V.

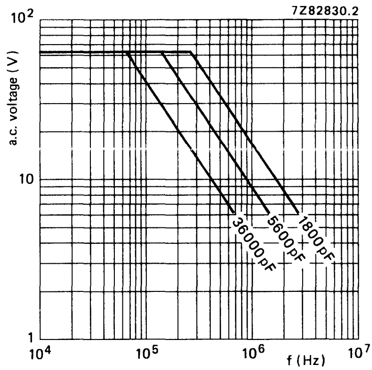


Fig. 4 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^oC$, for $U_R = 160$ V.

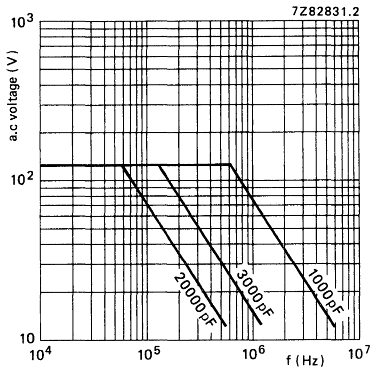


Fig. 5 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^oC$, for $U_R = 250$ V.

Temperature

Climatic category	40/100/21
Rated temperature	85 ^oC
Storage temperature range	–40 to + 100 ^oC

Tangent of loss angle

Table 4

capacitance	tangent of loss angle		
	at 1 kHz	at 100 kHz	at 1 MHz
$C_R \leqslant 1000$ pF	$\leqslant 5 \times 10^{-4}$		$\leqslant 10 \times 10^{-4}$
1000 pF $< C_R \leqslant 5000$ pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 10 \times 10^{-4}$	
5000 pF $< C_R \leqslant 20\,000$ pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 15 \times 10^{-4}$	
$C_R > 20\,000$ pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 25 \times 10^{-4}$	

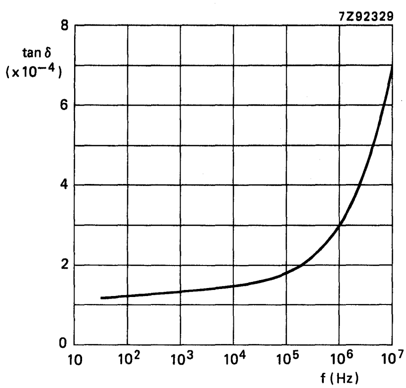


Fig. 6 Tan δ as a function of frequency; typical curve.

Insulation resistance at T_{amb} = 20 °C

The insulation resistance is measured after a voltage has been applied for 1 min ± 5 s, the voltage being 10 ± 1 V for the 63 V version, 100 ± 15 V for the 160 V and 250 V versions.

R between terminations	> 100 000 MΩ
R between interconnected terminations and case	> 100 000 MΩ

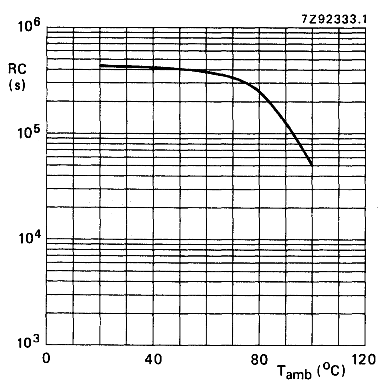


Fig. 7 RC-product as a function of ambient free air temperature; typical curve.

Inductance	≤ 10 nH/cm lead and capacitor length

Maximum dissipation

The maximum a.c. voltage, which has been specified at 50 to 60 Hz must also never be exceeded at other frequencies.* Moreover this voltage may further be limited by the maximum dissipation (P_{max}).

For a capacitor used with a sinusoidal voltage, the power dissipation is expressed by:

$$P = V_{rms} I_{rms} \cos \varphi. \tag{1}$$

As $I_{rms} = \omega C V_{rms}$, and $\cos \varphi \approx \tan \delta$, equation (1) can be rewritten as:

$$P = V_{rms}^2 \omega C \tan \delta = V_{rms}^2 2\pi f C \tan \delta. \tag{2}$$

For capacitors of styles 2222 455, 2222 456 and 2222 457 tan δ is about proportional to the frequency, thus:

$$\tan \delta = \frac{f}{10^5} \tan \delta_{ref} \tag{3}$$

Tan δ_{ref} is the maximum tan δ at 100 kHz value given under Ratings and characteristics.

Substituting equation (3) in equation (2) gives:

$$P = 2\pi \cdot 10^{-5} V_{rms}^2 f^2 C \tan \delta_{ref}. \tag{4}$$

The maximum dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be found from Fig. 8.

Table 5

curve	dimensions (mm) D_{max}	dimensions (mm) L_{max}
1	4,0	11,0
2	4,5	11,0
3	4,9	11,0
4	4,5	15,0
5	4,9	15,0
6	5,5	15,0
7	6,0	15,0
8	6,5	15,0
9	7,0	15,0
10	7,5	15,0

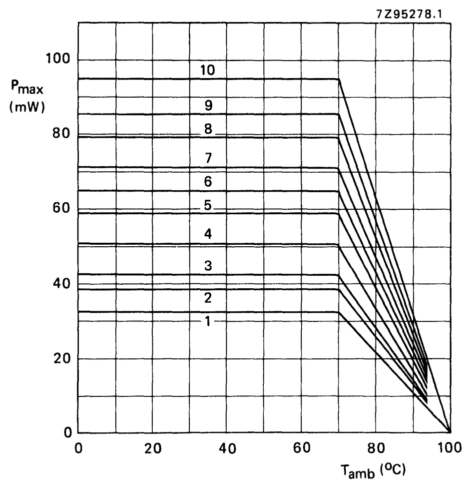


Fig. 8 Maximum dissipation as a function of ambient free air temperature.

* At $T_{amb} \leqslant 70$ °C the maximum permissible sinusoidal voltage can be found in Figs 3, 4 and 5.

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number.

Composition of the catalogue number (see also Tables 1 to 3).

2222 . . . .

455 = 63 V
456 = 160 V
457 = 250 V

6 = ± 5% } packed on bandoliers on reels
7 = ± 2% }

2 = ± 5% } packed loose in boxes
3 = ± 2% }

code for capacitance, see Tables 1 to 3

PACKING

The capacitors are supplied on bandoliers on reels or loose in cardboard boxes.

Packing in cardboard boxes

Table 6

capacitance values (pF) of			number of capacitors per box
63 V version	160 V version	250 V version	
3 300– 4 300	1 800– 2 700	47– 620	400
4 700– 6 200	3 000– 3 900	680– 2 200	300
6 800– 9 100	4 300– 5 600	2 400– 3 000	250
10 000–12 000	6 200– 7 500	3 300– 4 300	400
13 000–16 000	8 200–10 000	4 700– 5 600	300
18 000–27000	11 000–16 000	6 200– 9 100	250
30 000–33 000	18 000–20 000	10 000–11 000	200
36 000–56 000	22 000–36 000	12 000–20 000	150

Packing on bandoliers on reels

Dimensions in mm

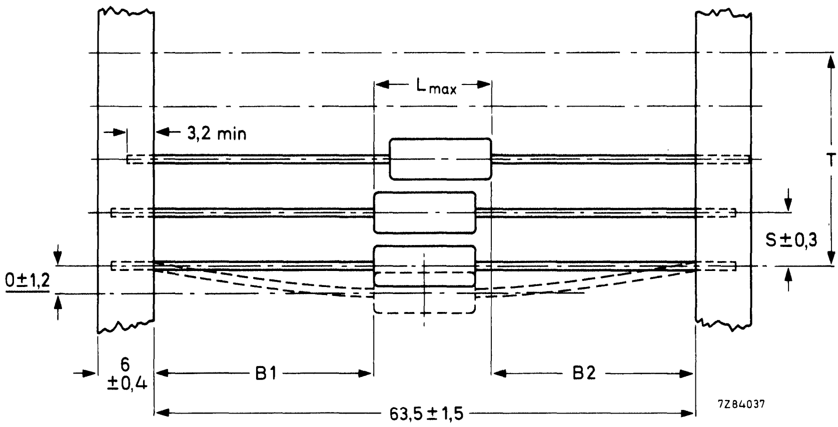


Fig. 9 Capacitors on bandoliers; for dimensions S and T, see Table 7.
|B1 - B2| = max. 1,4 mm; for dimension L_{max}, see Tables 1 to 3.

Table 7

capacitance values (pF) of			S	T for number (n) of capacitors	
63 V version	160 V version	250 V version		n < 50	50 < n < 100
3 300–20 000	1 800–13 000	47– 6 800	5	5(n-1) ± 2	5(n-1) ± 4
22 000–56 000	15 000–36 000	7 500–20 000	10	10(n-1) ± 2	10(n-1) ± 4

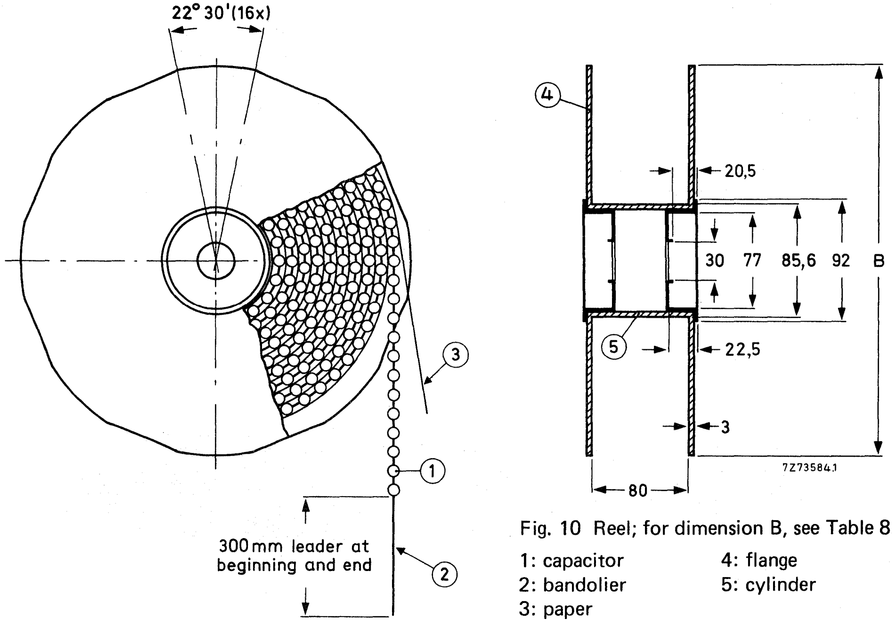


Fig. 10 Reel; for dimension B, see Table 8.

1: capacitor
2: bandolier
3: paper
4: flange
5: cylinder

Table 8

capacitance values (pF) of			B	number of capacitors on one reel
63 V version	160 V version	250 V version		
3 300–20 000	1 800–13 000	47– 6 800	305	2500
22 000–33 000	15 000–20 000	7 500–11 000	356	1500
36 000–56 000	22 000–36 000	12 000–20 000	356	1000

Characteristics concerning taped capacitors:

Pull-out force of the component	⩾ 2 N
Tearing force of tape	⩾ 10 N

Storage conditions:

Storage temperature range	–25 to + 40 °C
Relative humidity	⩽ 80%

POLYPROPYLENE FILM/FOIL CAPACITORS

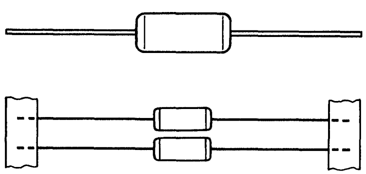
KP axial epoxy lacquered type

- Supplied on bandoliers on reel or loose in boxes

QUICK REFERENCE DATA

Rated capacitance range	47 to 62 000 pF
Tolerance on rated capacitance	± 5% (E24-series) ± 2% (E24, E48-series) ± 1% (E24, E48, E96-series)
Rated voltage U_R (d.c.)	63 V, 160 V, 250 V
Climatic category	40/100/56
Rated temperature	85 ^{o}C
Related specification	IEC 384-13
Stability class	2

SURVEY OF STYLES



2222 460 ..... to 2222 462 .....;
see Tables 1 to 3.

APPLICATION

For use in circuits where close tolerance, reliability and low losses are of prime importance, e.g. tuned circuits, filter networks, timing networks, etc.

DESCRIPTION

The capacitors consist of a low-inductance wound cell of metal foil and a polypropylene film. The cell is protected by a hard water repellant solvent resistant blue epoxy lacquer. The long axial leads of solder-coated wire make the capacitors suitable for vertical or horizontal mounting on printed-wiring boards.

GENERAL DATA

Dimensions in mm

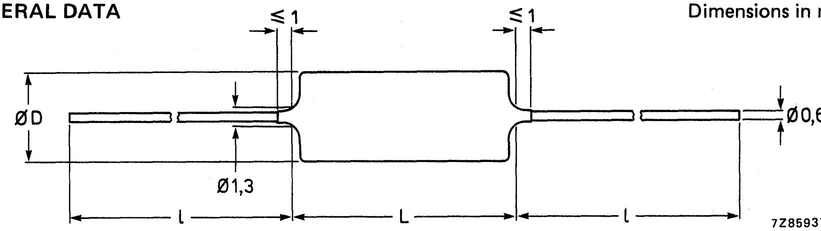


Fig. 1.

Table 1 U_R (d.c.) = 63 V; max. a.c. voltage = 40 V; Fig. 1.

rated capacitance (E24-series, tol. ± 5%) * pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number 2222 460	
					on bandoliers on reel	in box
6 800	5,0	11,0	30	0,5	66802	26802
7 500				0,5	67502	27502
8 200				0,6	68202	28202
9 100				0,6	69102	29102
10 000	5,5	15,0	28	0,6	61003	21003
11 000				0,6	61103	21103
12 000				0,7	61203	21203
13 000				0,8	61303	21303
15 000				0,7	61503	21503
16 000				0,7	61603	21603
18 000				0,8	61803	21803
20 000				0,8	62003	22003
22 000				0,9	62203	22203
24 000	6,0			0,9	62403	22403
27 000				1,0	62703	22703
30 000	6,5			1,1	63003	23003
33 000				1,2	63303	23303
36 000				1,2	63603	23603
39 000	7,0			1,3	63903	23903
43 000				1,4	64303	24303
47 000	7,5			1,5	64703	24703
51 000				1,6	65103	25103
56 000	8,0			1,7	65603	25603
62 000				1,8	66203	26203

* Besides the values of the E24-series as quoted, intermediate values of the E-48-series (with a tolerance ± 1% or ± 2%) and of the E96-series (with a tolerance ± 1%) are available.
See also Ordering information.

Table 2 U_R (d.c.) = 160 V; max. a.c. voltage = 63 V; Fig. 1.

rated capacitance (E24-series, tol. ± 5%) * pF	D_{max}	L_{max}	l_{min}	approx mass g	catalogue number 2222 461 ..... on bandoliers on reel	catalogue number 2222 461 ..... in box
3 600	5,0	11,0	30	0,5	63602	23602
3 900				0,5	63902	23902
4 300				0,5	64302	24302
4 700				0,5	64702	24702
5 100				0,5	65102	25102
5 600				0,5	65602	25602
6 200				0,6	66202	26202
6 800	5,5	15,0	28	0,4	66802	26802
7 500				0,7	67502	27502
8 200				0,6	68202	28202
9 100				0,6	69102	29102
10 000				0,7	61003	21003
11 000				0,7	61103	21103
12 000				0,7	61203	21203
13 000				0,8	61303	21303
15 000				0,8	61503	21503
16 000	6,0			0,9	61603	21603
18 000				0,9	61803	21803
20 000	6,5			1,0	62003	22003
22 000				1,1	62203	22203
24 000				1,1	62403	22403
27 000	7,0			1,2	62703	22703
30 000	7,5			1,3	63003	23003
33 000				1,4	63303	23303
36 000	8,0			1,5	63603	23603
39 000				1,6	63903	23903

* Besides the values of the E24-series as quoted, intermediate values of the E48-series (with a tolerance ± 1% or ± 2%) and of the E96-series (with a tolerance ± 1%) are available.
See also Ordering information.

Table 3 U_R (d.c.) = 250 V; max. a.c. voltage = 125 V; Fig. 1.

rated capacitance (E24-series, tol. ± 5%) * pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number 2222 462 ..... on bandoliers on reel	in box
47	5,0	11,0	30	0,4	64709	24709
51				0,4	65109	25109
56				0,4	65609	25609
62				0,4	66209	26209
68				0,4	66809	26809
75				0,4	67509	27509
82				0,4	68209	28209
91				0,4	69109	29109
100				0,4	61001	21001
110				0,4	61101	21101
120				0,5	61201	21201
130				0,5	61301	21301
150				0,4	61501	21501
160				0,4	61601	21601
180				0,5	61801	21801
200				0,5	62001	22001
220				0,6	62201	22201
240				0,6	62401	22401
270				0,6	62701	22701
300				0,7	63001	23001
330				0,4	63301	23301
360				0,4	63601	23601
390				0,5	63901	23901
430				0,5	64301	24301
470				0,5	64701	24701
510				0,5	65101	25101
560				0,5	65601	25601
620				0,5	66201	26201
680				0,5	66801	26801
750				0,5	67501	27501
820				0,5	68201	28201
910				0,5	69101	29101
1 000				0,5	61002	21002
1 100				0,5	61102	21102
1 200				0,5	61202	21202
1 300				0,5	61302	21302
1 500				0,4	61502	21502
1 600				0,5	61602	21602
1 800				0,6	61802	21802
2 000				0,6	62002	22002

* Besides the values of the E24-series as quoted, intermediate values of the E48-series (with a tolerance ±1% or ±2%) and of the E96-series (with a tolerance ± 1%) are available.
See also Ordering information.

Table 3 (continued) U_R (d.c.) = 250 V; max. a.c. voltage = 125 V; Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number 2222 462 ..... on bandoliers on reel	in box
2 200				0,	62202	22202
2 400				0,5	62402	22402
2 700	5,0	11,0	30	0,5	62702	22702
3 000				0,5	63002	23002
3 300				0,5	63302	23302
3 600				0,5	63602	23602
3 900				0,5	63902	23902
4 300				0,6	64302	24302
4 700				0,6	64702	24702
5 100	5,5			0,6	65102	25102
5 600				0,6	65602	25602
6 200				0,7	66202	26202
6 800				0,7	66802	26802
7 500		15,0	28	0,7	67502	27502
8 200				0,8	68202	28202
9 100	6,0			0,8	69102	29102
10 000				0,9	61003	21003
11 000				0,9	61103	21103
12 000	6,5			1,0	61203	21203
13 000				1,0	61303	21303
15 000	7,0			1,1	61503	21503
16 000				1,2	61603	21603
18 000	7,5			1,3	61803	21803
20 000	8,0			1,4	62003	22003
22 000				1,5	62203	22203

Marking

The capacitors are marked in black ink as follows:
1st line: rated capacitance in pF or nF;
2nd line: tolerance code (F = ± 1%, G = ± 2%, J = ± 5%) and rated voltage (d.c.) without unit symbol;
3rd line: code for dielectric material (KP = polypropylene film/foil) and production date code (according to IEC 62, clause 5);
4th line: name of manufacturer.

Mounting

The capacitors are suited for vertical or horizontal mounting on printed-wiring boards and for point-to-point wiring.

The capacitors packed on bandoliers are for mounting with automatic insertion machines.

* Besides the values of the E24-series as quoted, intermediate values of the E48-series (with a tolerance ± 1% or ± 2%) and of the E96-series (with a tolerance ± 1%) are available.
See also Ordering information.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 MHz ($C_R \leqslant 1000$ pF) at 1 kHz ($C_R > 1000$ pF)	see Tables 1 to 3
Tolerance on rated capacitance	± 5%, ± 2% or 2 pF*, ± 1% or 1 pF*
Temperature coefficient between –40 and + 20 °C between + 20 and + 100 °C	 $-(125 \pm 60)\ 10^{-6}$/K $-(250 \pm 120)\ 10^{-6}$/K
Frequency dependence between 100 kHz and 1 MHz	none

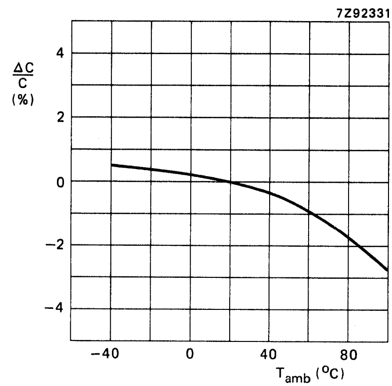


Fig. 2 Capacitance as a function of ambient free air temperature; typical curve.

Voltage

Rated voltage U_R (d.c.)	see Tables 1 to 3
Category voltage U_C	0,8 x U_R (d.c.)
Test voltage between terminations between interconnected terminations and case (foil method)	 2 x U_R (d.c.) 2 x U_R (d.c.); min. 400 V
Maximum a.c. voltage (r.m.s. value) at 50 to 60 Hz	40 V, 63 V, 125 V

Notes

- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.).
- For other than sinusoidal waveforms, the maximum permissible dissipation must not be exceeded.

* Whichever is greater.

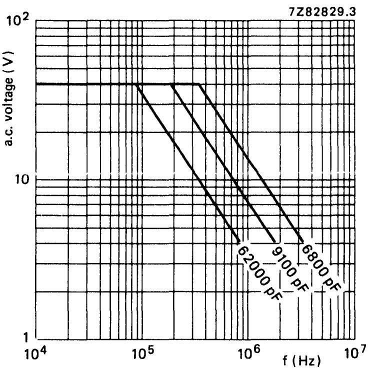


Fig. 3 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^{o}C$, for $U_R = 63$ V.

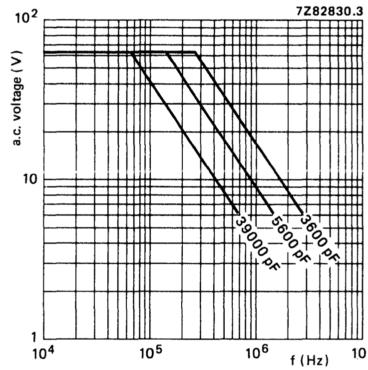


Fig. 4 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^{o}C$, for $U_R = 160$ V.

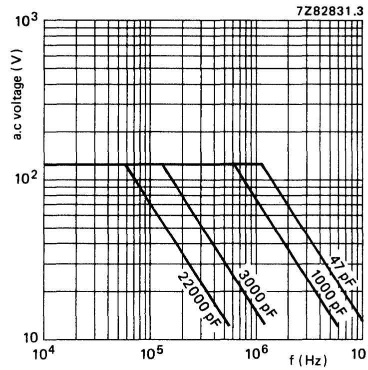


Fig. 5 Maximum a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^{o}C$, for $U_R = 250$ V.

Temperature

Climatic category	40/100/56
Rated temperature	85 ^{o}C
Storage temperature range	–40 to + 100 ^{o}C

Tangent of loss angle

Table 4

capacitance	tangent of loss angle		
	at 1 kHz	at 100 kHz	at 1 MHz
$C_R \leqslant 1000$ pF	$\leqslant 5 \times 10^{-4}$		$\leqslant 10 \times 10^{-4}$
1000 pF $< C_R \leqslant 5000$ pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 10 \times 10^{-4}$	
5000 pF $< C_R \leqslant 20\,000$ pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 15 \times 10^{-4}$	
20 000 pF $< C_R \leqslant 47\,000$ pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 25 \times 10^{-4}$	
$C_R > 47\,000$ pF	$\leqslant 5 \times 10^{-4}$	$\leqslant 40 \times 10^{-4}$	

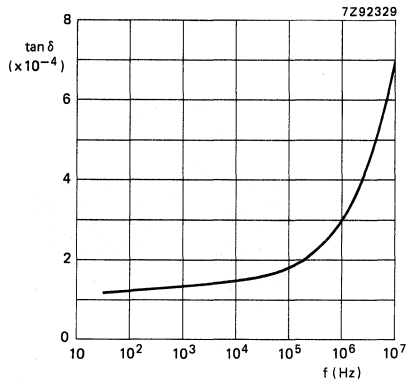


Fig. 6 Tan δ as a function of frequency; typical curve.

Insulation resistance at T_{amb} = 20 °C

The insulation resistance is measured after a voltage has been applied for 1 min ± 5 s, the voltage being 10 ± 1 V for the 63 V version, 100 ± 15 V for the 160 V and 250 V versions.

R between terminations	> 100 000 MΩ
R between interconnected terminations and case	> 100 000 MΩ

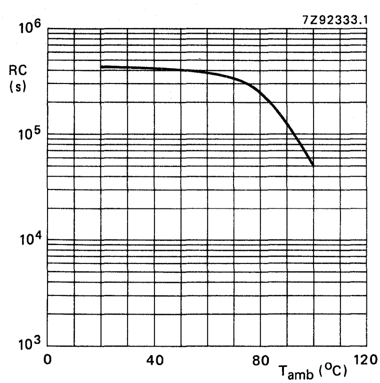


Fig. 7 RC-product as a function of ambient free air temperature; typical curve.

Inductance	$\leqslant$ 10 nH/cm lead and capacitor length

Maximum dissipation

The maximum a.c. voltage, which has been specified at 50 to 60 Hz must also never be exceeded at other frequencies. * Moreover this voltage may further be limited by the maximum dissipation (P_{max}).

For a capacitor used with a sinusoidal voltage, the power dissipation is expressed by:

$$P = V_{rms} I_{rms} \cos \varphi. \qquad (1)$$

As $I_{rms} = \omega C V_{rms}$, and $\cos \varphi \approx \tan \delta$, equation (1) can be rewritten as:

$$P = V_{rms}{}^2 \omega C \tan \delta = V_{rms}{}^2\, 2\pi f C \tan \delta. \qquad (2)$$

For capacitors of styles 2222 460, 2222 461 and 2222 462, tan δ is about proportional to the frequency, thus:

$$\tan \delta = \frac{f}{10^5} \tan \delta_{ref}. \qquad (3)$$

Tan δ_{ref} is the maximum tan δ at 100 kHz value given under Ratings and characteristics.

Substituting equation (3) in equation (2) gives:

$$P = 2\pi \cdot 10^{-5}\, V_{rms}{}^2 f^2 C \tan \delta_{ref}. \qquad (4)$$

The maximum dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be found from Fig. 8.

Table 5

curve	dimensions (mm)	
	D_{max}	L_{max}
1	5,0	11,0
2	5,5	15,0
3	6,0	15,0
4	6,5	15,0
5	7,0	15,0
6	7,5	15,0
7	8,0	15,0

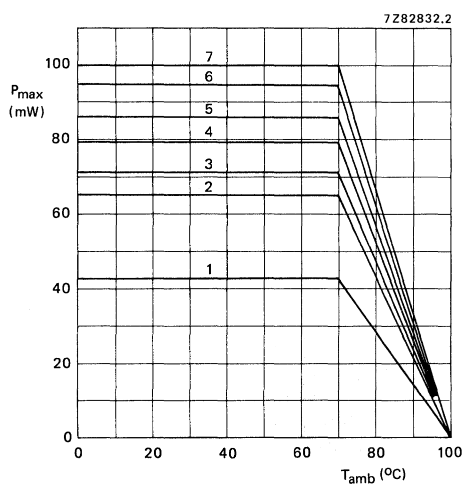


Fig. 8 Maximum dissipation as a function of ambient free air temperature.

* At $T_{amb} \leqslant 70$ °C the maximum permissible sinusoidal voltage can be found in Figs 3, 4 and 5.

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number.

Composition of the catalogue number (see also Tables 1 to 3).

2222 . . . .

460 = 63 V
461 = 160 V
462 = 250 V

6 = ± 5%, 7 = ± 2%, 8 = ± 1% — packed on bandoliers on reels

2 = ± 5%, 3 = ± 2%, 4 = ± 1% — packed in boxes

code for capacitance, see Tables 1 to 3

PACKING

The capacitors are supplied on bandoliers on reels or in cardboard boxes.

Packing in cardboard boxes

Table 6

capacitance values (pF) of 63 V version	160 V version	250 V version	number of capacitors per box
6 800 – 9 100	3 600 – 6 200	47 – 3 300	250
10 000 – 27 000	6 800 – 18 000	3 600 – 10 000	250
30 000 – 36 000	20 000 – 24 000	11 000 – 13 000	200
39 000 – 62 000	27 000 – 39 000	15 000 – 22 000	150

Packing on bandoliers on reels

Dimensions in mm

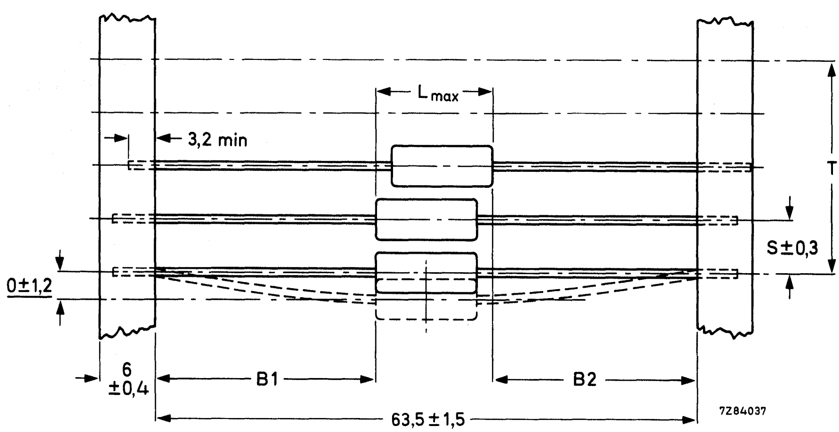


Fig. 9 Capacitors on bandoliers; for dimensions S and T, see Table 7.
|B1 - B2| = max. 1,4 mm; for dimension L_{max}, see Tables 1 to 3;

Table 7

capacitance values (pF) of 63 V version	160 V version	250 V version	S	T for number (n) of capacitors n < 50	50 < n < 100
6 800 – 62 000	3 600 – 39 000	47 – 22 000	10	10 (n - 1) ± 2	10 (n - 1) ± 4

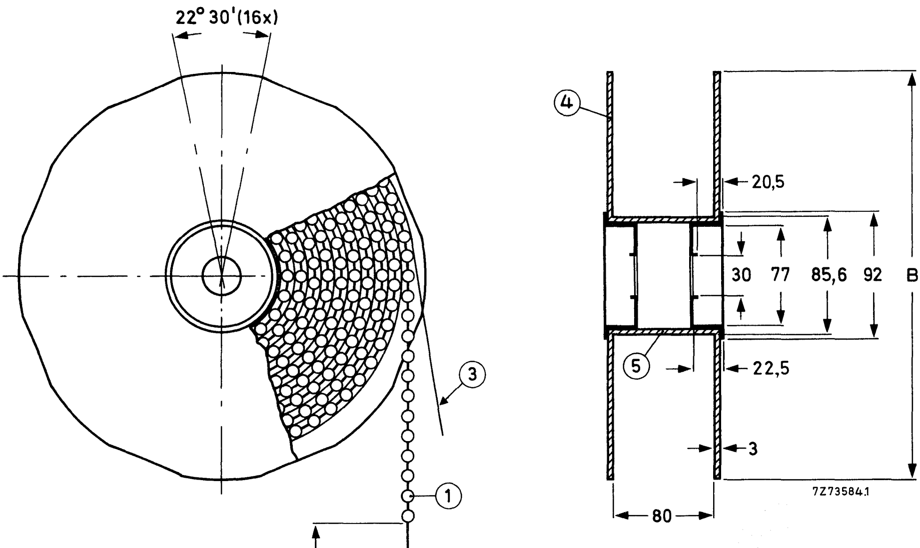


Fig. 10 Reel.

1: capacitor
2: bandolier
3: paper
4: flange
5: cylinder

Table 8

capacitance values (pF) of 63 V version	160 V version	250 V version	B	number of capacitors on one reel
6 800 – 27 000	3 600 – 18 000	47 – 10 000	356	1500
30 000 – 62 000	20 000 – 39 000	11 000 – 22 000	356	1000

Characteristics concerning taped capacitors:

Pull-out force of the component	⩾ 2 N
Tearing force of tape	⩾ 10 N

Storage conditions:

Storage temperature range	–25 to + 40 °C
Relative humidity	⩽ 80%

INSPECTION REQUIREMENTS

polypropylene film/foil capacitors (KP)

Note 1
Sub-clause numbers of tests and performance requirements refer to the Sectional Specification, IEC-publication 384-13 and GENERAL DATA of the specifications.

Note 2
In this table: D = destructive, ND = non-destructive.

Note 3
For the type ranges with CECC Qualification Approval separate periodic C-tests are carried out as prescribed by the CECC Detail specification.

clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 357 5 . . . .**
Group A Inspection (lot-by-lot)			
Sub-group A1	ND		
4.1 Visual examination			No mechanical failures. Legible marking and as specified in GENERAL DATA of the specification.
4.2 Dimensions		Gauging	As specified in the Table in GENERAL DATA.
Sub-group A2	ND		
4.2.1 Voltage proof (Test A)		at 2 x U_R (d.c.) for 1 s	No breakdown or flashover.
4.2.2 Capacitance		at 1 kHz	Within specified tolerance.
4.2.3 Tangent of loss angle		for $C_R \leqslant 1000$ pF at 1 MHz, for $C_R > 1000$ pF at 100 kHz	As in GENERAL DATA of the specification.
4.2.4 Insulation resistance (Test A)		at 100 V	As in GENERAL DATA of the specification.

performance requirements **2222 455 – 457**	performance requirements **2222 460 – 462**
No mechanical failures. Legible marking and as specified in GENERAL DATA of the specification.	No mechanical failures. Legible marking and as specified in GENERAL DATA of the specification.
As specified in the Tables in GENERAL DATA.	As specified in the Tables in GENERAL DATA
No breakdown or flashover.	No breakdown or flashover.
Within specified tolerance.	Within specified tolerance.
As in GENERAL DATA of the specification.	As in GENERAL DATA of the specification.
Not applicable.	Not applicable.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 357 5. . . .**
Group B Inspection (periodic)			
4.5 Solderability	D	Without ageing Method: 1 Non-activated colophony flux Solder bath: 235 °C Dwell time: 2 s	Good tinning as evidenced by free flowing of the solder with wetting of the terminations.
Group C Inspection (periodic)			
Sub-group C1A	D		
Part of sample of Sub-group C1			
4.1 Dimensions (detail)			As specified in Table 1 of the specification.
4.3.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
4.3 Robustness of terminations		Tensile, bending and torsion	No visible damage (torsion not applicable).
4.4 Resistance to soldering heat		No predrying Method: 1A Solder bath: 260 °C Duration: 5 s	
4.4.2 Final measurements		Visual examination Capacitance	No visible damage. Legible marking. $\Delta C/C \leqslant 1\%$ of the value measured in 4.3.1.

performance requirements **2222 455 – 457**	performance requirements **2222 460 – 462**
Good tinning as evidenced by free flowing of the solder with wetting of the terminations.	Good tinning as evidenced by free flowing of the solder with wetting of the terminations.
As specified in Tables 1 to 3 of the specification. No visible damage. No visible damage. Legible marking. $\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.3.1.	As specified in Tables 1 to 3 of the specification. No visible damage. No visible damage. Legible marking. $\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.3.1.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 357 5 . . . .**
Sub-group C1B Other part of sample of sub-group C1	D		
4.6.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
4.6 Rapid change of temperature		θ A = lower cat. temp. θ B = upper cat. temp. 5 cycles, duration t = 30 min. Visual examination	 No visible damage.
4.7 Vibration		Method of mounting see Note below. Procedure B4. Frequency range: 10 to 55 Hz Pulse shape: half sine Amplitude: 0,75 mm or acceleration: 98 m/s^2 (whichever is the less severe) Total duration: 6 h	
4.7.2 Final inspection Intermediate measurements		Visual examination Capacitance	No visible damage. $\Delta C/C \leqslant 1\%$ of the value measured in 4.6.1.
		Tangent of loss angle	As in GENERAL DATA of the specification.
4.9 Shock		Method of mounting see Note below. Pulse shape: half sine Acceleration: 490 m/s^2 Duration of pulse: 11 ms	
4.9.3 Final measurements		Visual examination Capacitance	No visible damage. $\Delta C/C \leqslant 1\%$ of the value measured in 4.6.1.
		Tangent of loss angle	As in GENERAL DATA of the specification.

Note

The capacitor shall be mechanically fixed by the leads and the body (or stand-off pips of style 2222 357 5 . . . .) shall be in good contact with the printed-wiring board, also the body of capacitors with a mass > 6 g shall be clamped to the printed-wiring board.

performance requirements **2222 455 – 457**	performance requirements **2222 460 – 462**
No visible damage.	No visible damage.
No visible damage. $\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.6.1. As in GENERAL DATA of the specification.	No visible damage. $\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.6.1. As in GENERAL DATA of the specification.
No visible damage. $\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.6.1. As in GENERAL DATA of the specification.	No visible damage. $\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.6.1. As in GENERAL DATA of the specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 357 5 . . . .**
Sub-group C1	D		
Combined sample of specimens of Sub-groups C1A and C1B			
4.10 Climatic sequence			
4.10.2 Dry heat		Temperature: upper category temperature Duration: 16 h	
4.10.3 Damp heat cyclic, Test Db, first cycle			
4.10.4 Cold		Temperature: lower category temperature Duration: 2 h	
4.10.6 Damp heat cyclic, Test Db, remaining cycles		Recovery 1 to 2 h	
4.10.6.2 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 1\%$ of value measured in 4.4.2 or 4.9.3.
		Tangent of loss angle	As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in 4.3.1 or 4.6.1 whichever is greater.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.

performance requirements **2222 455 – 457**	performance requirements **2222 460 – 462**
No visible damage. Legible marking. $\Delta C/C \leqslant 0{,}5\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}5\%$ for $C_R > 1000$ pF of the value measured in 4.4.2 ot 4.9.3. As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in 4.3.1 or 4.6.1, whichever is greater. $\geqslant 50\%$ of values in GENERAL DATA of the specification.	No visible damage. Legible marking. $\Delta C/C \leqslant 0{,}5\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}5\%$ for $C_R > 1000$ pF of the value measured in 4.4.2 or 4.9.3. As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in 4.3.1 or 4.6.1, whichever is greater. $\geqslant 50\%$ of values in GENERAL DATA of the specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 357 5 . . . .**
Sub-group C2	D		
4.11 Damp heat steady state			
4.11.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
4.11.3 Final measurements		Recovery: 1 to 2 h	
		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 2\%$ of the value measured in 4.11.1.
		Tangent of loss angle	As in GENERAL DATA of the specification or $\leqslant 1,4$ x value measured in 4.11.1, whichever is greater.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.
Sub-group C3	D		
4.12 Endurance		Duration: 1000 h; 1,50 U_R (d.c.) at 85 °C, 1,50 U_C at 100 °C*	
4.12.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
4.12.5 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 2\%$ of value measured in 4.12.1.
		Tangent of loss angle	As in GENERAL DATA of the specification or $\leqslant 1,4$ x value measured in 4.12.1, whichever is greater.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.

* For styles 2222 455 to 457.

performance requirements **2222 455 – 457**	performance requirements **2222 460 – 462**
No visible damage. Legible marking. $\Delta C/C \leqslant 0{,}5\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 0{,}5\%$ for $C_R > 1000$ pF of the value measured in 4.11.1. As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in 4.11.1, whichever is greater. $\geqslant 50\%$ of values in GENERAL DATA of the specification.	No visible damage. Legible marking. $\Delta C/C \leqslant 1\% + 1$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.11.1. As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in 4.11.1, whichever is greater. $\geqslant 50\%$ of values in GENERAL DATA of the specification.
No visible damage. Legible marking. $\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.12.1. As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in 4.12.1, whichever is greater. $\geqslant 50\%$ of values in GENERAL DATA of the specification.	No visible damage. Legible marking. $\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.12.1. As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in 4.12.1, whichever is greater. $\geqslant 50\%$ of values in GENERAL DATA of the specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 357 5 . . . .**
Sub-group C4	D		Not applicable.
4.2.5 Variation of capacitance with temperature		Static method; capacitors shall be dried. Number of cycles: 1 Capacitance measurements for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz	
		Insulation resistance	
4.2.6 Inductance			

performance requirements **2222 455 – 457**	performance requirements **2222 460 – 462**
Temperature coefficient as in GENERAL DATA of the specification.	Temperature coefficient as in GENERAL DATA of the specification.
Temperature cyclic drift of capacitance $\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.4.2 or 4.9.3.	Temperature cyclic drift of capacitance $\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.4.2 or 4.9.3.
$\geqslant 10\,000$ MΩ.	$\geqslant 10\,000$ MΩ.
As in GENERAL DATA of the specification.	As in GENERAL DATA of the specification.

additional tests	D or ND	conditions of test (see Note 1)	performance requirements **2222 357 5 . . . .**
Sub-group ADD1	D		
A.1 Heat storage		**Style 2222 357 5 . . . .:** Duration: 2000 h, Temperature: upper category temperature **Styles 2222 455 – 457 and 2222 460 – 462** Duration: 1000 h, Temperature: upper category temperature	
A.1.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
A.1.2 Final measurements		Capacitance	$\Delta C/C \leqslant 2\%$ of the value measured in A.1.1.
		Tangent of loss angle	As in GENERAL DATA of the specification or $\leqslant 1,4$ x value measured in A.1.1, whichever is greater.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.

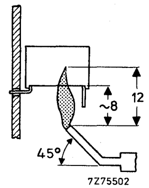
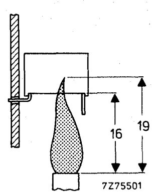
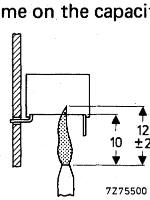
performance requirements **2222 455 – 457**	performance requirements **2222 460 – 462**
$\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in A.1.1. As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in A.1.1, whichever is greater. As in GENERAL DATA of the specification.	$\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in A.1.1. As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in A.1.1, whichever is greater. As in GENERAL DATA of the specification.

additional tests	D or ND	conditions of test (see Note 1)	performance requirements **2222 357 5 . . . .**
Sub-group ADD2			
A.2 Solvent resistance, Mil STD-202F, method 215 B		**GROUP 1: De-ionized water, followed by** mixture of isopropyl alcohol and mineral spirits **GROUP 2:** 1-1-1-Trichloroethane **GROUP 3:** Azeotropic mixture of trichlorotrifluoroethane and methylene chloride. Temperature: 25 °C	
A.2.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
A.2.2 Final measurements		Capacitance	$\Delta C/C \leqslant 1\%$ of value measured in A.2.1.
		Tangent of loss angle	As in GENERAL DATA of the specification or $\leqslant 1,4 \times$ value measured in A.2.1, whichever is greater.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.

performance requirements **2222 455 – 457**	performance requirements **2222 460 – 462**
Not applicable.	$\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\leqslant 1\%$ for $C_R > 1000$ pF of the value measured in A.2.1. As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in A.2.1, whichever is greater. $\geqslant 50\%$ of values in GENERAL DATA of the specification.

additional tests	D or ND	conditions of test	performance requirements **2222 357 5 ....**
Sub-group ADD3	D		
A.3 Detergent resistance		Density 20g/l dishwater detergent Temperature 70 °C, during 3 min. Followed by rinsing in clear water for 1 min. Recovery time > 2 h.	
A.3.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz Tangent of loss angle for $C_R \leqslant 1000$ pF at 1 MHz, $C_R > 1000$ pF at 100 kHz	
A.3.2 Final measurements		Capacitance	$\Delta C/C \leqslant 1\%$ of value measured in A.3.1.
		Tangent of loss angle	As in GENERAL DATA of the specification or $\leqslant 1,4$ x value measured in A.3.1, whichever is greater.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specification.
Sub-group ADD4	D		
A.4 Resistance to soldering heat with pre-heating		Capacitors mounted on a 1,6 mm board with non-plated holes Body temp.: 80 °C Bath temp.: 260 °C Dwell time: 5 s	
A.4.1 Initial measurements		Capacitance for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz	
A.4.2 Final measurements		Capacitance	$\Delta C/C \leqslant 1\%$ of value measured in A.4.1.
Sub-group ADD5			Not applicable.
A.5 Climatic test on taped type		250 h at 40 ± 2 °C R.H. 90 to 95% Recovery time 24 h.	

performance requirements **2222 455 – 457**	performance requirements **2222 460 – 462**
Not applicable.	$\Delta C/C \leq 1\% + 0{,}5$ pF for $C_R \leq 1000$ pF, $\leq 1\%$ for $C_R > 1000$ pF of the value measured in A.3.1. As in GENERAL DATA of the specification or $\leq 1{,}4$ x value measured in A.3.1, whichever is greater. $\geq 50\%$ of values in GENERAL DATA of the specification.
$\Delta C/C \leq 1\% + 0{,}5$ pF for $C_R \leq 1000$ pF, $\leq 1\%$ for $C_R > 1000$ pF of the value measured in A.4.1.	$\Delta C/C \leq 1\% + 0{,}5$ pF for $C_R \leq 1000$ pF, $\leq 1\%$ for $C_R > 1000$ pF of the value measured in A.4.1.
Deviation of tape on a strip of 250 mm taped products $\leq 2\%$. Pull out and tearing forces $\geq 50\%$ of values in GENERAL DATA of the specification.	Deviation of tape on a strip of 250 mm taped products $\leq 2\%$. Pull out and tearing forces $\geq 50\%$ of values in GENERAL DATA of the specification.

additional tests	D or ND	conditions of tests	performance requirements **2222 357 5 . . . .**
Sub-group ADD6	D		
A.6.1 Needle flame test, IEC 695-2-2		Bore of gas jet: ϕ 0,5 mm. Fuel: butane Test duration: 20 s One flame application  	After removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s, no burning particles must drop from the sample.
A.6.2 Needle flame test, UL 1414		Bore of gas jet: ϕ 10 mm. Fuel: natural gas. Test duration: 3 x 15 s. Time interval between each flame application: 15 s.  	Extinguishing time $\leqslant$ 15 s after the first and second flame application, $\leqslant$ 60 s after the third flame application.
A.6.3 Flame test, IEC 65 par. 14.4.1.b (VDE 0860 par. 14.4.1.b)		Bore of gas jet: ϕ 0,5 mm. Fuel: butane. Before testing the capacitors are stored for 2 h at 100 ± 2 °C. Test duration: 1st cycle: 10 s, 2nd cycle: 1 min, 3rd cycle: 2 min. Second and third flame application start directly after extinguishing of the flame on the capacitor.  	Extingusihing time $\leqslant$ 30 s after each flame application. No burning particles must drop from the sample.

performance requirements **2222 455 – 457**	performance requirements **2222 460 – 462**
Not applicable.	Not applicable.

A.C. AND PULSE METALLIZED POLYPROPYLENE FILM CAPACITORS (KP/MKP AND KP/MMKP)

A.C. AND PULSE METALLIZED POLYPROPYLENE FILM CAPACITORS

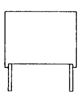
KP/MKP radial potted type

- 22,5 and 27,5 mm pitch
- Supplied in boxes

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	0,001 to 0,33 μF
Tolerance on rated capacitance	± 10%, ± 5%*
Rated voltage U_R (d.c.)	630 V, 1000 V, 1500 V, 2000 V
Rated voltage U_R (a.c.)	300 V, 400 V, 500 V, 600 V
Climatic category	55/085/56
Rated temperature	85 ^{o}C
Related specification	IEC 384-16
Performance grade	long life

STYLE



Style 2222 357 6 . . . . . to 2222 357 9 . . . .; see Tables 1 to 4.

APPLICATION

These capacitors are for applications where high currents and steep pulses occur. They are mainly used for deflection circuits in television receivers, to operate at high peak currents at line frequency.
When requiring advice, please send oscillograms of current and voltage waveforms.

DESCRIPTION

The capacitors consist of a series-constructed, low-inductance wound cell of polypropylene film, aluminium foil and metallized internal electrode. The cell is potted with epoxy resin in a flame retardent polypropylene case. The radial leads are of solder-coated wire.
The capacitors can withstand solvents and rinsing liquids without damage. They are provided with small stand-off pips to allow removal of solder flux etc., when cleaning the printed-wiring board.

* ± 3,5% to special order.

GENERAL DATA

Dimensions in mm

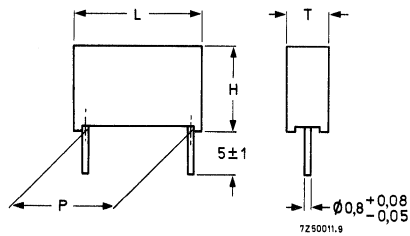


Fig. 1.

Table 1 U_R (d.c.) = 630 V; rated a.c. voltage = 300 V; Fig. 1

rated capacitance* µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 357	
						tol. ± 10%	tol. ± 5%
0,047	8,5	18,5			6	61473	62473
0,056	8,5	18,5			6	61563	62563
0,068	8,5	18,5	29	22,5 ± 0,4	6	61683	62683
0,082	10	20			9	61823	62823
0,10	10	20			9	61104	62104
0,12	10	20			10	61124	62124
0,15	12	22			14	61154	62154
0,18	12	22	34	27,5 ± 0,4	14	61184	62184
0,22	15	25			20	61224	62224
0,27	15	25			20	61274	62274
0,33	18	28			28	61334	62334

* Besides the values of the E12 series as quoted, intermediate values of the E24 series (with a tolerance ± 5%) are available. Other capacitance values and tolerances are available to special order.

Table 2 U_R (d.c.) = 1000 V; rated a.c. voltage = 400 V; Fig. 1

rated capacitance* µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 357 ..... tol. ± 10%	tol. ± 5%
0,016**	8,5	18,5	29	22,5 ± 0,4	6		72163
0,018**	8,5	18,5			6		72183
0,020**	8,5	18,5			6		72203
0,022**	8,5	18,5			6		72223
0,024**	8,5	18,5			6		72243
0,027**	8,5	18,5			6		72273
0,033	8,5	18,5	29	22,5 ± 0,4	6	71333	72333
0,039	8,5	18,5			6	71393	72393
0,047	10	20			9	71473	72473
0,056	10	20			9	71563	72563
0,068	10	20	34	27,5 ± 0,4	10	71683	72683
0,082	12	22			13	71823	72823
0,10	12	22			13	71104	72104
0,12	15	25			18	71124	72124
0,15	15	25			18	71154	72154
0,18	15	25			18	71184	72184
0,22	18	28			26	71224	72224

* Besides the values of the E12 series as quoted, intermediate values of the E24 series (with a tolerance ± 5%) are available. Other capacitance values and tolerances are available to special order.

** Especially suited for fly-back purposes.

Table 3 U_R (d.c.) = 1500 V; rated a.c. voltage = 500 V; Fig. 1

rated capacitance* μF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 357 ..... tol. ± 10%	tol. ± 5%
0,0082**	8,5	18,5	29	22,5 ± 0,4	6		82822
0,0091**	8,5	18,5			6		82912
0,010**	8,5	18,5			6		82103
0,011**	8,5	18,5			6		82113
0,012**	8,5	18,5			6		82123
0,013**	8,5	18,5			6		82133
0,015**	8,5	18,5			6		82153
0,018	8,5	18,5	29	22,5 ± 0,4	6	81183	82183
0,022	8,5	18,5			6	81223	82223
0,024	8,5	18,5			6	81243	82243
0,027	8,5	18,5			6	81273	82273
0,033	10	20			9	81333	82333
0,039	10	20			9	81393	82393
0,047	10	20	34	27,5 ± 0,4	10	81473	82473
0,056	12	22			13	81563	82563
0,068	12	22			13	81683	82683
0,082	15	25			18	81823	82823
0,10	15	25			18	81104	82104
0,12	15	25			18	81124	82124
0,15	18	28			26	81154	82154

* Besides the values of the E12 series as quoted, intermediate values of the E24 series (with tolerance ± 5%) are available. Other capacitance values and tolerances are available to special order.

** Especially suited for fly-back purposes.

Table 4 U_R (d.c.) = 2000 V; rated a.c. voltage = 600 V; Fig. 1. Especially suited for flyback pusposes.

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 357	
						tol. ± 10%	tol. ± 5%
0,0010	8,5	18,5	29	22,5 ± 0,4	6		92102
0,0011	8,5	18,5			6		92112
0,0012	8,5	18,5			6		92122
0,0013	8,5	18,5			6		92132
0,0015	8,5	18,5			6		92152
0,0016	8,5	18,5			6		92162
0,0018	8,5	18,5			6		92182
0,0020	8,5	18,5			6		92202
0,0022	8,5	18,5			6		92222
0,0024	8,5	18,5			6		92242
0,0027	8,5	18,5			6		92272
0,0030	8,5	18,5			6		92302
0,0033	8,5	18,5			6		92332
0,0036	8,5	18,5			6		92362
0,0039	8,5	18,5			6		92392
0,0043	8,5	18,5			6		92432
0,0047	8,5	18,5			6		92472
0,0051	8,5	18,5			6		92512
0,0056	8,5	18,5			6		92562
0,0062	8,5	18,5			6		92622
0,0068	8,5	18,5			6		92682
0,0075	8,5	18,5			6		92752
0,0082	10	20			9		92822
0,0091	10	20			9		92912
0,010	10	20			9		92103
0,011	10	20			9		92113
0,012	10	20			9		92123
0,013	10	20			9		92133

Marking

a. Rated capacitance
b. Rated voltage
c. Tolerance on rated capacitance
d. Category voltage
e. Year and month of manufacture
f. Manufacturer's name
g. Climatic category
h. Manufacturer's type designation

The capacitors are marked on the top by embossed print with a, b, c, e, f and h as follows:

1st line : rated capacitance in pF or μF, tolerance and rated d.c. voltage;

2nd line : code for dielectric material, 5th, 6th and 7th digits of the catalogue number, code for factory of origin, production date code according to IEC 62, clause 5.

The manufacturer's identification symbol is indicated at the left.

The capacitors which are especially suited for flyback purposes are also marked with peak-to-peak voltage and repetition frequency (16 kHz).

The package containing the capacitors is marked with a to h.

Mounting

The capacitors are suited for mounting on printed-wiring boards.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 kHz	see Tables 1 to 4
Tolerance on rated capacitance	see Tables 1 to 4
Frequency dependance between 100 Hz and 100 kHz	negligible

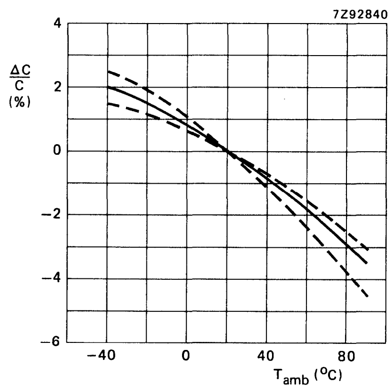


Fig. 2 Capacitance as a function of ambient free air temperature, typical curve.

Voltage

Rated voltage U_R (d.c.)	see Tables 1 to 4
Rated a.c. voltage (r.m.s.), at 50 to 60 Hz	see Tables 1 to 4
Test voltage	
between terminations	1,6 x U_R (d.c.)
between interconnected terminations and case	2840 V (d.c.)

Notes
- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.).
- For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

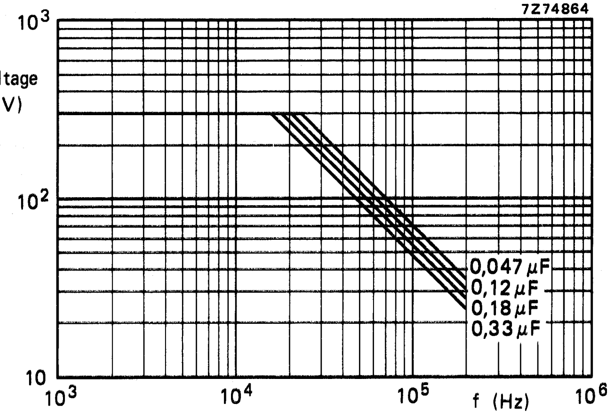


Fig. 3 Rated a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\,^{o}C$, for U_R (d.c.) = 630 V.

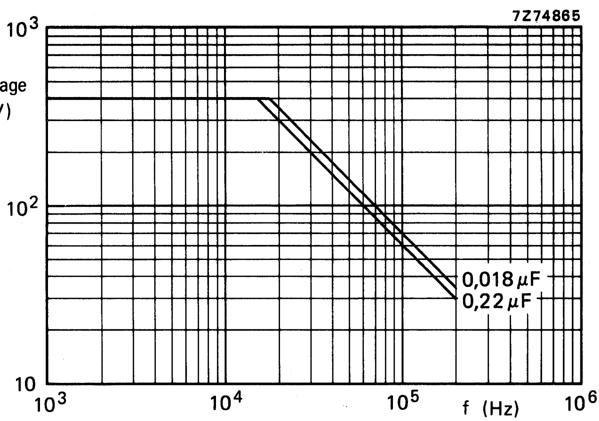


Fig. 4 Rated a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\,^{o}C$, for U_R (d.c.) = 1000 V.

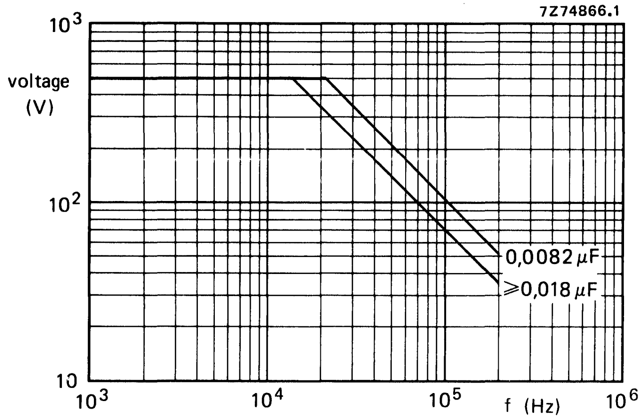


Fig. 5 Rated a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\,^{o}C$, for U_R (d.c.) = 1500 V.

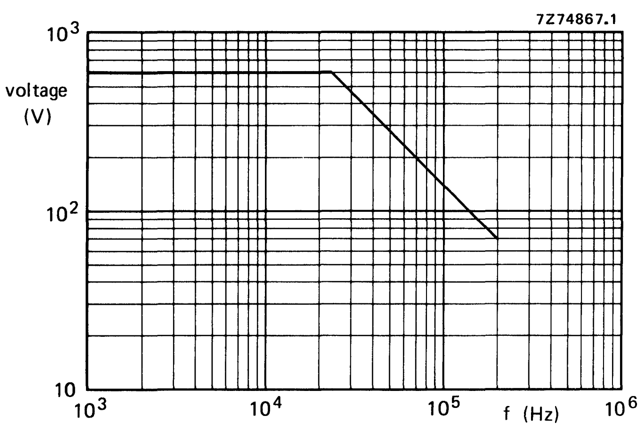


Fig. 6 Rated a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\,^{o}C$, for U_R (d.c.) = 2000 V.

Temperature

Climatic category	55/085/56
Rated temperature	85 °C
Storage temperature range	−55 to + 85 °C

Rated voltage pulse slope $(\frac{dU}{dt})_R$ — limited by network conditions

Tangent of loss angle at 100 kHz

22,5 mm pitch, 630 V version	$\leqslant 15 \times 10^{-4}$
1000 V, 1500 V, 2000 V versions	$\leqslant 10 \times 10^{-4}$
27,5 mm pitch, 630 V version	$\leqslant 20 \times 10^{-4}$
1000 V version	$\leqslant 15 \times 10^{-4}$

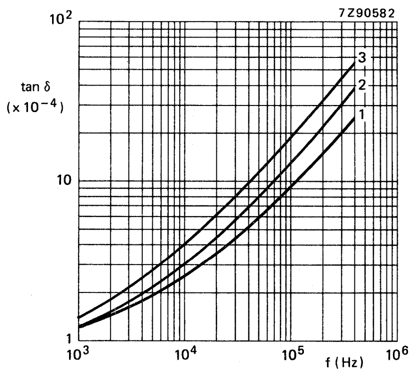


Fig. 7 Maximum tan δ as a function of frequency.

Curve 1 = 22,5 mm pitch, 1000 V, 1500 V and 2000 V versions;

curve 2 = 22,5 mm pitch, 630 V version, 27,5 mm pitch, 1000 V and 1500 V versions;

curve 3 = 27,5 mm pitch, 630 V version.

Insulation resistance

The insulation resistance is measured after a voltage of 500 ± 50 V has been applied for 1 min ± 5 s, at T_{amb} = 23 °C.

R between terminations	> 100 000 MΩ
R between interconnected terminations and case	> 100 000 MΩ

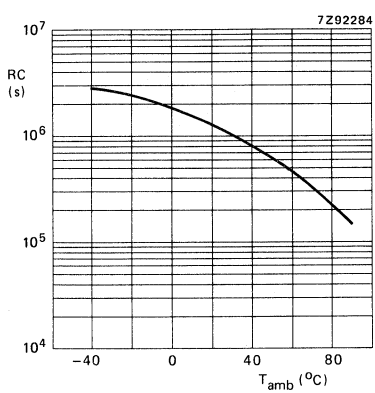


Fig. 8 RC-product as a function of ambient free air temperature; typical curve.

Maximum dissipation

The rated a.c. voltage has been specified for 50 to 60 Hz and at 23 °C. This voltage value must also never be exceeded at other frequencies. This permissible a.c. voltage may further be limited by the following requirements:

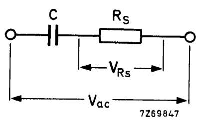
1. The power dissipation must not exceed the specified limit P_{max}.
2. The steepness of the a.c. voltage must not exceed the specified limit.

The power dissipated by a capacitor is a function of the voltage across the series resistance (R_s) or of the current through the series resistance and is expressed by

$$P = \frac{V_{R_s}{}^2}{R_s} = I^2 R_s \qquad (1)$$

$$V_{R_s}{}^2 = \frac{R_s{}^2}{R_s{}^2 + 1/\omega^2 C^2} V_{ac}{}^2 \qquad (2a)$$

Fig. 9.



As for these capacitors $\tan\delta = R_s\omega C < 0,1$, the formula (2a) can be simplified to

$$V_{R_s}{}^2 = \frac{R_s{}^2}{1/\omega^2 C^2} V_{ac}{}^2 = R_s{}^2\omega^2 C^2 V_{ac}{}^2 \qquad (2b)$$

Thus $$P = R_s\omega^2 C^2 V_{ac}{}^2 \qquad (3a)$$

or $$P = \tan\delta\omega C\, V_{ac}{}^2 \qquad (3b)$$

The term $\tan\delta$ can be found from Fig. 7; C (in farads), $\omega = 2\pi f$ and V_{ac} are assumed to be known.

The maximum permissible value of power dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be found from Fig. 11. Thus, when the actual power has been calculated with equation (3b), Fig. 11 gives the minimum size of capacitor which can dissipate this power.

For a capacitor used with a half sinewave pulse, (Fig. 10), V_{rms} can be expressed by

$$V_{rms}{}^2 = \frac{1}{2} V_p{}^2 \frac{T1}{T2}. \qquad (4)$$

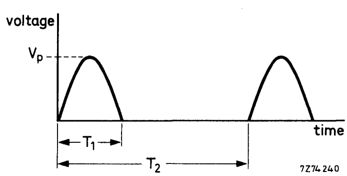
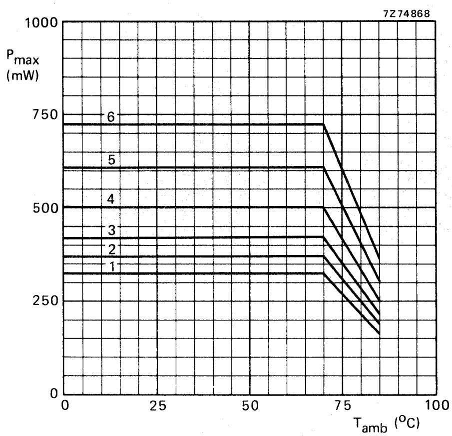


Fig. 10.

Substitution of equation (4) in equation (3b), the maximum power dissipation is

$$P = \frac{1}{2} \cdot \frac{T_1}{T_2} \tan\delta\,\omega C\, V_p{}^2.$$



curve	dimensions (mm)		
	T_{max}	H_{max}	L_{max}
1	8,5	18,5	29
2	10	20	29
3	10	20	34
4	12	22	34
5	15	25	34
6	18	28	34

Fig. 11 Maximum dissipation as a function of ambient free air temperature, at various capacitor dimensions.

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number as given in Tables 1 to 4.

PACKING

The capacitors are supplied in cardboard boxes; the number per box is shown in the table below.

L_{max} mm	number of capacitors per box
29	200
34	100

A.C. AND PULSE METALLIZED POLYPROPYLENE FILM CAPACITORS

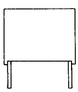
KP/MMKP radial potted type

- 22,5 and 27,5 mm pitch
- Supplied in boxes

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	0,001 to 0,27 μF
Tolerance on rated capacitance	± 10%, ± 5%*
Rated voltage U_R (d.c.)	630 V, 1000 V, 1500 V, 2000 V
Rated voltage U_R (a.c.)	300 V, 400 V, 450 V, 500 V
Climatic category	55/085/56
Rated temperature	85 °C
Related specification	IEC 384-16
Performance grade	long life

STYLE



Style 2222 376; see Tables 1 to 4.

APPLICATION

These capacitors are for applications where high currents and steep pulses occur. They are mainly used for deflection circuits in television receivers, to operate at high peak currents at line frequency.
When requiring advice, please send oscillograms of current and voltage waveforms.

DESCRIPTION

The capacitors consist of a series-constructed, low-inductance wound cell of polypropylene film, aluminium foil and double metallized polyethyleneterephthalate (PETP) film. The cell is potted with epoxy resin in a flame retardent polypropylene case. The radial leads are of solder-coated wire.
The capacitors can withstand solvents and rinsing liquids without damage. They are provided with small stand-off pips to allow removal of solder flux etc., when cleaning the printed-wiring board.

* ± 3,5% to special order.

GENERAL DATA

Dimensions in mm

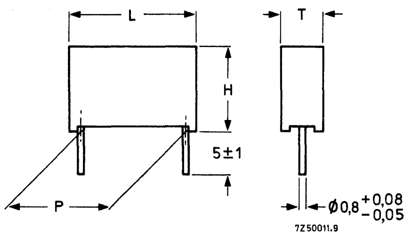


Fig. 1.

Table 1 U_R (d.c.) = 630 V; rated a.c. voltage = 300 V

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 376 ..... tol. ± 10%	tol. ± 5%
0,027	6,5	15	26	22,5 ± 0,3	2,8	61273	62273
0,033	7,5	16			3,5	61333	62333
0,039	7,5	16			3,5	61393	62393
0,047	8,5	17,5			4,4	61473	62473
0,056	9,5	18,5			5,1	61563	62563
0,068	11	20	31	27,5 ± 0,3	7,4	61683	62683
0,082	11	20			7,4	61823	62823
0,10	11	20			7,4	61104	62104
0,12	13	22,5			10,2	61124	62124
0,15	13	22,5			10,2	61154	62154
0,18	15	25			12,8	61184	62184
0,22	18	28			18,2	61224	62224
0,27	18	28			18,2	61274	62274

Table 2 U_R (d.c.) = 1000 V; rated a.c. voltage = 400 V

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 376	
						tol. ± 10%	tol. ± 5%
0,015	6,5	15	26	22,5 ± 0,3	2,8	71153	72153
0,018	7,5	16			3,5	71183	72183
0,022	8,5	17,5			4,4	71223	72223
0,027	8,5	17,5			4,4	71273	72273
0,033	8,5	17,5			4,4	71333	72333
0,039	9,5	18,5			5,1	71393	72393
0,047	11	20	31	27,5 ± 0,3	7,4	71473	72473
0,056	11	20			7,4	71563	72563
0,068	11	20			7,4	71683	72683
0,082	13	22,5			10,2	71823	72823
0,10	13	22,5			10,2	71104	72104
0,12	15	25			12,8	71124	72124
0,15	18	28			18,2	71154	72154
0,18	18	28			18,2	71184	72184

Table 3 U_R (d.c.) = 1500 V; rated a.c. voltage = 450 V

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 376	
						tol. ± 10%	tol. ± 5%
0,0068	6,5	15	26	22,5 ± 0,3	2,8	81682	82682
0,0082	6,5	15			2,8	81822	82822
0,010	7,5	16			3,5	81103	82103
0,012	8,5	17,5			4,4	81123	82123
0,015	9,5	18,5			5,1	81153	82153

Table 4 U_R (d.c.) = 2000 V; rated a.c. voltage = 500 V

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass g	catalogue number 2222 376	
						tol. ± 10%	tol. ± 5%
0,0010	6,5	15			2,8		92102
0,0012	6,5	15			2,8		92122
0,0015	6,5	15			2,8		92152
0,0018	6,5	15			2,8		92182
0,0022	6,5	15			2,8		92222
0,0027	6,5	15			2,8		92272
0,0033	6,5	15	26	22,5 ± 0,3	2,8		92332
0,0039	6,5	15			2,8		92392
0,0047	6,5	15			2,8		92472
0,0056	7,5	16			3,5		92562
0,0068	7,5	16			3,5		92682
0,0082	8,5	17,5			4,4		92822
0,010	9,5	18,5			5,1		92103

Marking

a. Rated capacitance
b. Rated voltage
c. Tolerance on rated capacitance
d. Category voltage
e. Year and month of manufacture
f. Manufacturer's name
g. Climatic category
h. Manufacturer's type designation

The capacitors are marked on the top by embossed print with a, b, c, f and h as follows:

1st line : rated capacitance in µF, tolerance and rated d.c. voltage;

2nd line: code for dielectric material, 5th, 6th and 7th digits of the catalogue number, code for factory of origin,
production date code according to IEC 62, clause 5.

The manufacturer's name is indicated at the left.

The capacitors which are especially suited for flyback purposes are also marked with peak-to-peak voltage and repetition frequency (16 kHz).

The package containing the capacitors is marked with a to h.

Mounting

The capacitors are suited for mounting on printed-wiring boards.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 kHz	see Tables 1 to 4
Tolerance on rated capacitance	see Tables 1 to 4
Frequency dependance between 100 Hz and 100 kHz	negligible

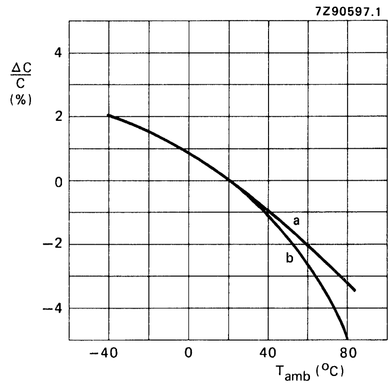


Fig. 2 Capacitance as a function of ambient free air temperature, typical curves.
a = 1500 V and 2000 V versions;
b = 630 V and 1000 V versions.

Voltage

Rated voltage U_R (d.c.)	see Tables 1 to 4
Rated a.c. voltage (r.m.s. value), at 50 to 60 Hz	see Tables 1 to 4
Test voltage	
between terminations	1,6 x U_R (d.c.)
between interconnected terminations and case	2700 V (d.c.)

Notes
- The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.).
- For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

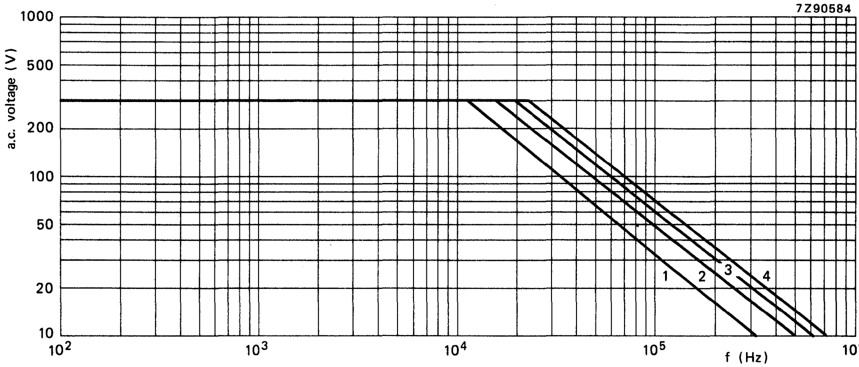


Fig. 3 Rated a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^oC$, for U_R (d.c.) = 630 V.
Curve 1 = 0,27 μF;
curve 2 = 0,12 μF;
curve 3 = 0,056 μF
curve 4 = 0,027 μF.

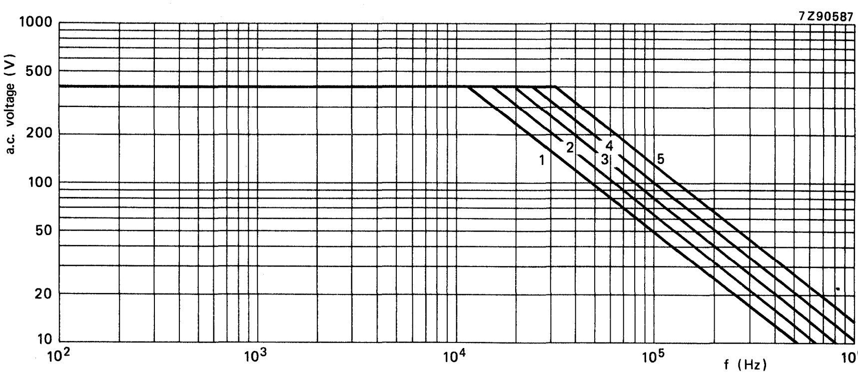


Fig. 4 Rated a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^oC$, for U_R (d.c.) = 1000 V.
Curve 1 = 0,18 μF;
curve 2 = 0,082 μF;
curve 3 = 0,047 μF;
curve 4 = 0,027 μF;
curve 5 = 0,015 μF.

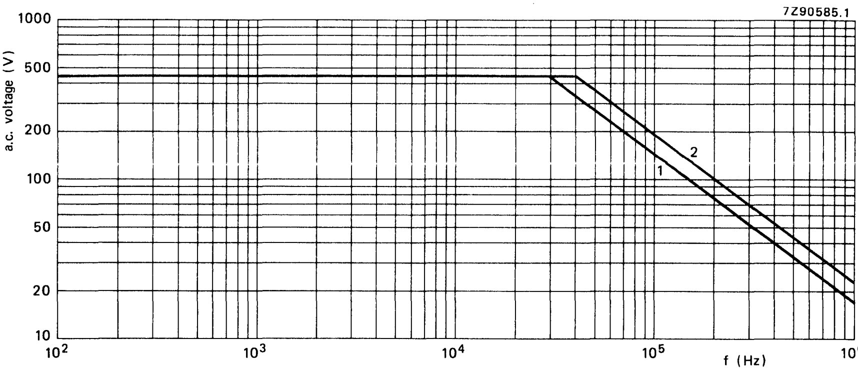


Fig. 5 Rated a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^oC$, for U_R (d.c.) = 1500 V.
Curve 1 = 0,015 μF; curve 2 = 0,0068 μF.

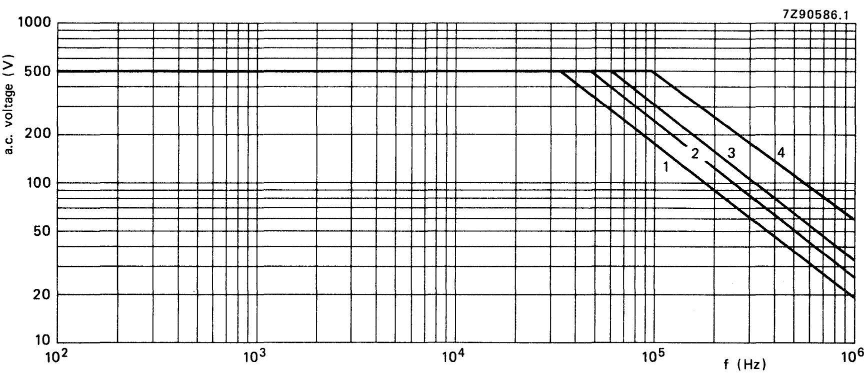


Fig. 6 Rated a.c. voltage (r.m.s. value) as a function of frequency at $T_{amb} \leqslant 70\ ^oC$, for U_R (d.c.) = 2000 V.
Curve 1 = 0,01 μF; curve 3 = 0,0027 μF;
curve 2 = 0,0039 μF; curve 4 = 0,001 μF.

Temperature

Climatic category	55/085/56
Rated temperature	85 °C
Storage temperature range	−55 to + 85 °C

Rated voltage pulse slope, $(\frac{dU}{dt})$ R — limited by network conditions

Tangent of loss angle at 100 kHz

22,5 mm pitch, 630 V version	$\leqslant 15 \times 10^{-4}$
1000 V, 1500 V, 2000 V versions	$\leqslant 10 \times 10^{-4}$
27,5 mm pitch, 630 V version	$\leqslant 20 \times 10^{-4}$
1000 V version	$\leqslant 15 \times 10^{-4}$

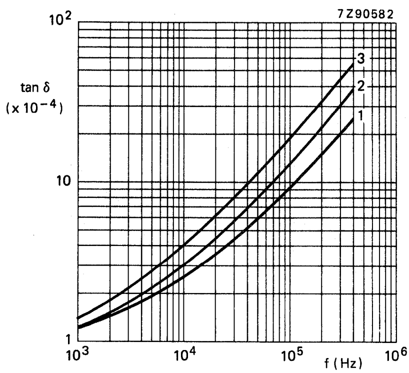


Fig. 7 Maximum tan δ as a function of frequency.

Curve 1 = 22,5 mm pitch, 1000 V, 1500 V and 2000 V versions;

curve 2 = 22,5 mm pitch, 630 V version; 27,5 mm pitch, 1000 V version;

curve 3 = 27,5 mm pitch, 630 V version.

Insulation resistance

The insulation resistance is measured after a voltage of 500 ± 50 V has been applied for 1 min ± 5 s, at T_{amb} = 23 °C.

R between terminations	> 100 000 MΩ
R between interconnected terminations and case	> 100 000 MΩ

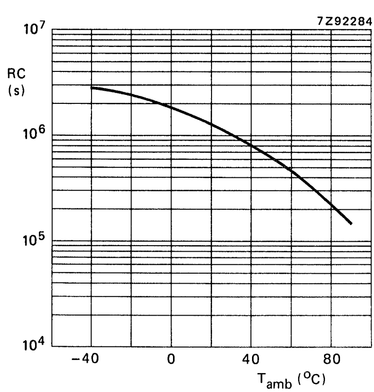


Fig. 8 RC-product as a function of ambient free air temperature; typical curve.

Maximum dissipation

The rated a.c. voltage has been specified for 50 to 60 Hz and at 23 °C. This voltage value must also never be exceeded at other frequencies. This permissible a.c. voltage may further be limited by the following requirements:

1. The power dissipation must not exceed the specified limit P_{max}.
2. The steepness of the a.c. voltage must not exceed the specified limit.

The power dissipated by a capacitor is a function of the voltage across the series resistance (R_s) or of the current through the series resistance and is expressed by

$$P = \frac{V_{R_s}{}^2}{R_s} = I^2 R_s \qquad (1)$$

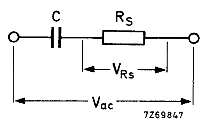


Fig. 9.

$$V_{R_s}{}^2 = \frac{R_s{}^2}{R_s{}^2 + 1/\omega^2 C^2} V_{ac}{}^2 \qquad (2a)$$

As for these capacitors $\tan\delta = R_s\omega C < 0,1$, the formula (2a) can be simplified to

$$V_{R_s}{}^2 = \frac{R_s{}^2}{1/\omega^2 C^2} V_{ac}{}^2 = R_s{}^2\omega^2 C^2 V_{ac}{}^2 \qquad (2b)$$

Thus $$P = R_s\omega^2 C^2 V_{ac}{}^2 \qquad (3a)$$

or $$P = \tan\delta\,\omega C\,V_{ac}{}^2 \qquad (3b)$$

The term $\tan\delta$ can be found from Fig. 7; C (in farads), $\omega = 2\pi f$ and V_{ac} are assumed to be known.

The maximum permissible value of power dissipation (P_{max}), which depends on the dimensions of the capacitor and on the ambient free air temperature, can be found from Fig. 11. Thus, when the actual power has been calculated with equation (3b), Fig. 11 gives the minimum size of capacitor which can dissipate this power.

For a capacitor used with a half sinewave pulse, (Fig. 10), V_{rms} can be expressed by

$$V_{rms}{}^2 = \frac{1}{2} V_p{}^2 \frac{T1}{T2}. \qquad (4)$$

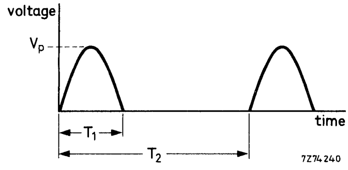
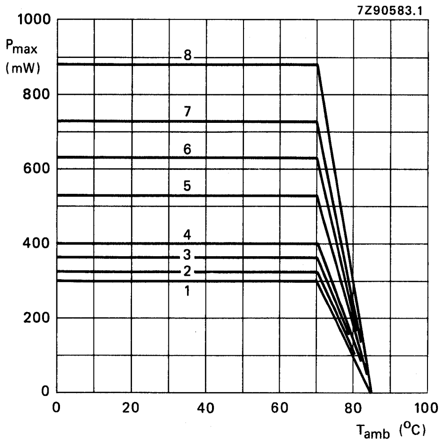


Fig. 10.

Substitution of equation (4) in equation (3b), the maximum power dissipation is

$$P = \frac{1}{2} \cdot \frac{T_1}{T_2} \tan\delta\,\omega C\,V_p{}^2.$$



curve	dimensions (mm)		
	T_{max}	H_{max}	L_{max}
1	6,5	15	26
2	7,5	16	26
3	8,5	17,5	26
4	9,5	18,5	26
5	11	20	31
6	13	22,5	31
7	15	25	31
8	18	28	31

Fig. 11 Maximum dissipation as a function of ambient free air temperature, at various capacitor dimensions.

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number as given in Tables 1 to 4.

PACKING

The capacitors are supplied in cardboard boxes; the number per box is shown in the table below.

L_{max} mm	number of capacitors per box
26	200
31	100

INSPECTION REQUIREMENTS

a.c. and pulse metallized polypropylene film capacitors (KP/MKP and KP/MMKP)

Note 1
Sub-clause numbers of tests and performance requirements refer to the Sectional Specification, IEC-publication 384-16 and GENERAL DATA of the specifications.

Note 2
In this table: D = destructive, ND = non-destructive.

Note 3
For the type ranges with CECC Qualification Approval separate periodic C-tests are carried out as prescribed by the CECC Detail specification.

clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements (see Note 1)
Group A Inspection (lot-by-lot)			
Sub-group A1	ND		
4.1 Visual examination			No mechanical failures. Legible marking and as specified in GENERAL DATA of this specification.
4.2 Dimensions		Gauging	As specified in the Tables of the specifications.
Sub-group A2	ND		
4.2.2 Capacitance		at 1 kHz	Within specified tolerance.
4.2.3 Tangent of loss angle		at 100 kHz	As in GENERAL DATA of the specifications.
4.2.1 Voltage proof (Test A)		at 1,6 x U_R (d.c.) for 1 s	No breakdown or flashover.
4.2.4 Insulation resistance (Test A)		at 500 V	As in GENERAL DATA of the specifications.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Group B Inspection (periodic)			
4.5 Solderability	D	Without ageing Method: 1 Non-activated colophony flux Solder bath: 235 °C Dwell time: 2 s	Good tinning as evidenced by free flowing of the solder with wetting of the terminations.
Group C Inspection (periodic)			
Sub-group C1A	D		
Part of sample of Sub-group C1			
4.1 Dimensions (detail)			As specified in the Tables of the specifications.
4.3.1 Initial measurements		Capacitance Tangent of loss angle	
4.3 Robustness of terminations		Tensile and bending	No visible damage.
4.4 Resistance to soldering heat		Method: 1A Solder bath: 260 °C Duration: 10 s	
4.4.2 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 1\%$ of the value measured initially.
		Tangent of loss angle	increase of tan $\delta \leqslant 0{,}001$. compared to values measured in 4.3.1.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Sub-group C1B	D		
Other part of sample of Sub-group C1			
4.6.1 Initial measurements		Capacitance Tangent of loss angle	
4.6 Rapid change of temperature		θ A = lower cat. temp. θ B = upper cat. temp. 5 cycles, duration t = 30 min. Visual examination	No visible damage.
4.7 Vibration		Method of mounting see Note below. Procedure B4. Frequency range: 10 to 55 Hz Amplitude: 0,75 mm or acceleration: 98 m/s^2 (whichever is the less severe). Total duration: 6 h	
4.7.2 Final inspection		Visual examination	No visible damage.
4.9 Shock		Method of mounting see Note below. Pulse shape: half sine Acceleration: 490 m/s^2 Duration of pulse: 11 ms	
4.9.3 Final measurements		Visual examination Capacitance Tangent of loss angle Insulation resistance	No visible damage. $\Delta C/C \leqslant 2\%$ of the value measured in 4.6.1. Increase of tan $\delta \leqslant 0{,}001$ compared to values measured in 4.6.1. As in GENERAL DATA of the specifications.

Note:

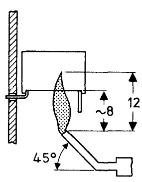
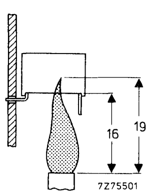
The capacitor shall be mechanically fixed by the leads and the stand-off pips shall be in good contact with the printed-wiring board, also the body of capacitors with a mass > 6 g shall be clamped to the printed-wiring board.

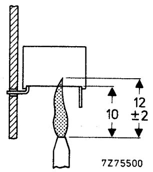
sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Sub-group C1	D		
Combined sample of specimens of Sub-groups C1A and C1B			
4.10 Climatic sequence			
4.10.2 Dry heat		Temperature: upper category temperature Duration: 16 h	
4.10.3 Damp heat cyclic, Test Db, first cycle			
4.10.4 Cold		Temperature: lower category temperature Duration: 2 h	
4.10.6 Damp heat cyclic, Test Db, remaining cycles			
4.10.6.2 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 1\%$ of value measured in 4.4.2 or 4.9.3.
		Tangent of loss angle	Increase of $\tan\delta \leqslant 0{,}002$ compared to values measured in 4.3.1 or 4.6.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specifications.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Sub-group C2	D		
4.11 Damp heat steady state			
4.11.1 Initial measurements		Capacitance Tangent of loss angle	
4.11.3 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 1\%$ of the value measured in 4.11.1.
		Tangent of loss angle	Increase of tan $\delta \leqslant 0{,}002$ compared to values measured in 4.11.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specifications.
Sub-group C3	D		
4.12 Endurance			
4.12.1 Initial measurements		Capacitance Tangent of loss angle	
4.12.2 Endurance, d.c.		Duration: 2000 h; 1,25 U_R (d.c.) at 85 ^{o}C	
4.12.2.4 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	**Style 2222 357 6 . . . . to 2222 357 9 . . . .:** $\Delta C/C \leqslant 2\%$ of the value measured in 4.12.1. **Style 2222 376:** $\Delta C/C \leqslant 3\%$ of the value measured in 4.12.1.
		Tangent of loss angle	Increase of tan $\delta \leqslant 0{,}002$ compared to values measured in 4.12.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specifications.
4.12.3 Endurance, 50 Hz (sub-group C3A)		Duration: 1000 h, 1,25 x rated a.c. voltage (r.m.s. value), 50 Hz, at 85 ^{o}C	
4.12.3.2 Final measurements		Capacitance	$\Delta C/C \leqslant 2\%$ of value measured in 4.12.1.
		Tangent of loss angle	Increase of tan $\delta \leqslant 0{,}004$ compared to values measured in 4.12.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of the specifications.

additional tests	D or ND	conditions of test	performance requirements
Sub-group ADD1	D		
A.1 Heat storage		Duration: 2000 h Temperature: upper category temperature	
A.1.1 Initial measurements		Capacitance Tangent of loss angle	
A.1.2 Final measurements		Capacitance	$\Delta C/C \leqslant 2\%$ of value measured in A.1.1.
		Tangent of loss angle	Increase of $\tan \delta \leqslant 0{,}002$ compared to values measured in A.1.1.
		Insulation resistance	As in GENERAL DATA of the specifications.
Sub-group ADD2			
A.2 Endurance, sinusoidal voltage		Duration: 24 h Temperature: 23 °C Voltage: 1,1 x max. a.c. voltage (r.m.s. value), 20 kHz	
A.2.2 Final measurements		Capacitor body temperature	$\Delta T \leqslant 10$ °C.

additional tests	D or ND	conditions of test	performance requirements
Sub-group ADD3			
A.3 Solvent resistance, Mil STD-202F, method 215 B		**GROUP 1:** **De-ionized water, followed by** mixture of isopropyl alcohol and mineral spirits **GROUP 2:** 1-1-1-Trichloroethane **GROUP 3:** Azeotropic mixture of trichlorotrifluoroethane and methylene chloride Temperature: 25 °C	
A.3.1 Initial measurements		Capacitance Tangent of loss angle	
A.3.2 Final measurements		Capacitance	$\Delta C/C \leqslant$ 1% of value measured in A.3.1.
		Tangent of loss angle	Increase of tan $\delta \leqslant$ 0,001 compared to values measured in A.3.1.
		Insulation resistance	$\geqslant$ 50% of values in GENERAL DATA of the specifications.
Sub-group ADD4			
A.4 Detergent resistance		Density 20g/l dishwasher detergent Temperature 70 °C, during 3 min. Followed by rinsing in clear water for 1 min. Recovery time > 2 h.	
A.4.1 Initial measurements		Capacitance Tangent of loss angle	
A.4.2 Final measurements		Capacitance	$\Delta C/C \leqslant$ 1% of value measured in A.4.1.
		Tangent of loss angle	Increase of tan $\delta \leqslant$ 0,001 compared to values measured in A.4.1.
		Insulation resistance	$\geqslant$ 50% of values in GENERAL DATA of the specifications.

additional tests	D or ND	conditions of tests	performance requirements
Sub-group ADD5	D		
A.5 Resistance to soldering heat with pre-heating		Capacitors mounted on a 1,6 mm board with non-plated holes Body temp.: 80 °C Bath temp.: 260 °C Dwell time: 2 x 5 s with interim free period of 5 s	
A.5.1 Initial measurements		Capacitance Tangent of loss angle	
A.5.2 Final measurements		Capacitance	$\Delta C/C \leqslant$ 1% of value measured in A.5.1.
		Tangent of loss angle	Increase of tan $\delta \leqslant$ 0,001 compared to values measured in A.5.1.
Sub-group ADD6	D		
A.6.1 Needle flame test, IEC 695-2-2		Bore of gas jet: ϕ 0,5 mm. Fuel: butane. Test duration: 20s. One flame application 	After removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s, no burning particles must drop from the sample.
A.6.2 Needle flame test, UL 1414		Bore of gas jet: ϕ 10 mm. Fuel: natural gas. Test duration: 3 x 15 s. Time interval between each flame application: 15 s. 	Extinguishing time $\leqslant$ 15 s after the first and second flame application, $\leqslant$ 60 s after the third flame application.

additional tests	D or ND	conditions of test	performance requirements
A.6.3 Flame test, IEC 65 par. 14.4.1.b (VDE 0860 par. 14.4.1.b)		Bore of gas jet: ϕ 0,5 mm. Fuel: butane. Before testing the capacitors are stored for 2h at 100 ± 2 ^{o}C. Test duration: 1st cycle: 10s, 2nd cycle: 1 min, 3rd cycle: 2 min. Second and third flame application start directly after extinguishing of the flame on the capacitor.  	Extinguishing time ⩽ 30 s after each flame application. No burning particles must drop from the sample.
Sub-group ADD7	D		
A.7 Endurance, 50 Hz		Duration: 1000 h. Temp.: 23 ^{o}C. Voltage: 850 V_{dc} + 550 V_{ac} (for 1500 V version), 1000 V_{dc} + 660 V_{ac} (for 2000 V version).	
A.7.1 Initial measurements		Capacitance	
A.7.2 Final measurements		Capacitance Insulation resistance	No interruption. No short circuit.

INTERFERENCE SUPPRESSION CAPACITORS (MKT-P)

INTERFERENCE SUPPRESSION CAPACITORS

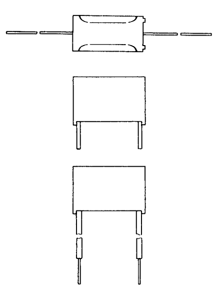
MKT-P radial potted type

- Supplied in boxes

QUICK REFERENCE DATA

Rated capacitance range (E6-series)	0,01 to 1 μF
Tolerance on rated capacitance	± 20%, ± 10%
Rated voltage U_R (a.c.), 50 to 60 Hz	250 V
Climatic category	40/085/21
Application class according to DIN 40040	GPF
Rated temperature	85 ^{o}C
Related specification	IEC 384-14
Performance class	X2
Qualified according to	VDE 565-1 and SEMKO

SURVEY OF STYLES



Style 2222 330 0 . . . ., see Table 1

Style 2222 330 4 . . . ., see Table 2

Style 2222 330 8 . . . ., see Table 3

APPLICATION

For radio interference suppression in:
- small household appliances, e.g. coffee grinders, mixers;
- audio and tv circuits;
- general industrial applications, e.g. test and measuring equipment.

Thanks to the dual dielectric construction any active flammability under fault conditions is prevented.

DESCRIPTION

The capacitors consist of an impregnated low-inductance wound cell of metallized polyethyleneterephthalate (PETP) film and paper film. Three styles are available: with axial leads, with radial leads, and with insulated radial leads.

The cell of the style with axial leads is moulded in yellow flame retardent polypropylene, that of the other styles is potted with epoxy resin in a yellow flame retardent polypropylene case. The leads are solder-coated wire.

The capacitors are provided with stand-off ridges or pips to allow removal of solder flux etc., when cleaning the printed-wiring board.

GENERAL DATA

Dimensions in mm

Style 2222 330 0 . . . .

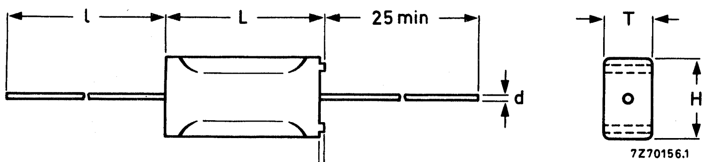


Fig. 1.

Table 1

rated capacitance* μF	T_{max}	H_{max}	L_{max}	d	l_{min}	mass	catalogue number 2222 330 . . . . . tol. ± 20%	tol. ± 10%
0,010	6,6	10,4	18,1	0,8	40	1,8	00103	01103
0,015							00153	01153
0,022							00223	01223
0,033							00333	01333
0,047							00473	01473
0,068	7,9	11,5	18,1			2,1	00683	01683
0,10	7,8	11,6	23,5			2,7	00104	01104
0,15	9,2	12,9	23,5			3,4	00154	01154
0,22	10,8	14,5	23,5			4,2	00224	01224
0,33	12,5	19,5	31	1,0	50	8,0	00334	01334
0,47						8,0	00474	01474

→ * Besides the values of the E6 series as quoted, intermediate values of the E12 series are available to special order.

Style 2222 330 4 . . . .

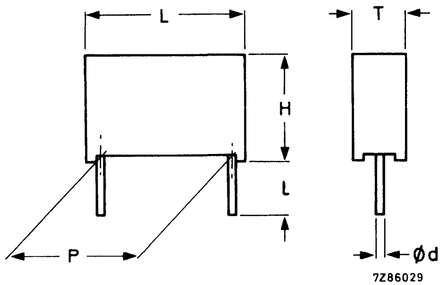


Fig. 2.

Table 2

rated capacitance* μF	T_{max}	H_{max}	L_{max}	d	P	mass g	catalogue number 2222 330 . . . . . l = 5 ± 1 tol. ± 20%	l = 5 ± 1 tol. ± 10%	l = 25 + 2 tol. ± 20%	l = 25 + 2 tol. ± 10%
0,010	5	11	17,5	0,8	15 ± 0,4	1,2	40103	41103	44103	45103
0,015							40153	41153	44153	45153
0,022							40223	41223	44223	45223
0,033							40333	41333	44333	45333
0,047	6	11,5	17,5			1,4	40473	41473	44473	45473
0,068	7	13	17,5			2,0	40683	41683	44683	45683
0,10	8,5	14,5	17,5			2,6	40104	41104	44104	45104
0,15	7	16	26		22,5 ± 0,4	3,0	40154	41154	44154	45154
0,22	8,5	17,5	26			3,7	40224	41224	44224	45224
0,33	10	18,5	26			5,4	40334	41334	44334	45334
0,47	13	22,5	31		27,5 ± 0,4	10,8	40474	41474	44474	45474
0,68	15	25	31			12,9	40684	41684	44684	45684
1,0	18	28	31	1,0		18,2	40105	41105	44105	45105

* Besides the values of the E6 series as quoted, intermediate values of the E12 series are available to special order.

Style 2222 330 8 . . . . .

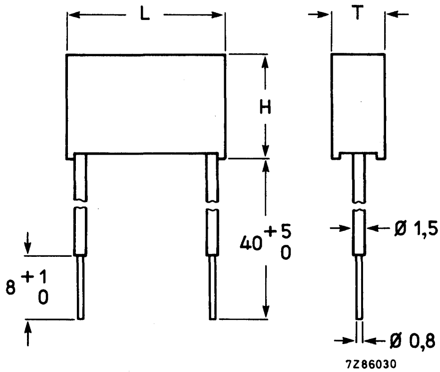


Fig. 3.

Table 3

rated capacitance* μF	T_{max}	H_{max}	L_{max}	mass g	catalogue number 2222 330. . . . . tol. ± 20%	catalogue number 2222 330. . . . . tol. ± 10%
0,010	6	12	17,5	1,8	84103	85103
0,015					84153	85153
0,022					84223	85223
0,033					84333	85333
0,047					84473	85473
0,068	7	13	17,5	2,5	84683	85683
0,10	8,5	14,5	17,5	3,0	84104	85104

→ * Besides the values of the E6 series as quoted, intermediate values of the E12 series are available to special order.

Marking

a. Rated capacitance
b. Rated voltage
c. Tolerance on rated capacitance
d. Category voltage
e. Year and month of manufacture
f. Manufacturer's name
g. Climatic category
h. Manufacturer's type designation
i. Performance class
j. Application class
k. Certification marks

- Style 2222 330 0 . . . .:

  The marking is impressed on one side with a, b, c, e and i as follows:
  1st line: rated capacitance in μF, tolerance (± 10% identified by K, ± 20% not identified), rated voltage and performance class;
  2nd line: last eight digits of the catalogue number, and production date code.*
  On the other side the capacitors are marked with manufacturer's name, application class according to DIN, code for dielectric materials (MKT-P) and approbation symbols.

- Styles 2222 330 4 . . . . and 2222 330 8 . . . .:

  The capacitors are marked on the top by embossed print, with a, b, c, e and i as follows:
  1st line: rated capacitance in μF, tolerance (± 10% identified by K or 10, ± 20% not identified), rated voltage and performance class;
  2nd line: 5th, 6th, 7th, 8th and 9th digits of the catalogue number and code for dielectric materials (MKT-P);
  3rd line: climatic category, production date code,* category according to DIN and SEMKO approbation symbol.
  Manufacturer's identification symbol and VDE approbation symbol are to the left and to the right respectively of the lines of marking.

The package containing the capacitors is marked with a to k.

Mounting

The capacitors are for printed-wiring applications; capacitors of styles 2222 330 0 . . . . and 2222 330 8 . . . . are also suited for point to point wiring.

* According to IEC 62, clause 5.

Ratings and characteristics

Unless otherwise specified all electrical values apply to an ambient free air temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2%.

Capacitance

Rated capacitance range at 1 kHz	see Tables 1 to 3
Tolerance on rated capacitance	see Tables 1 to 3

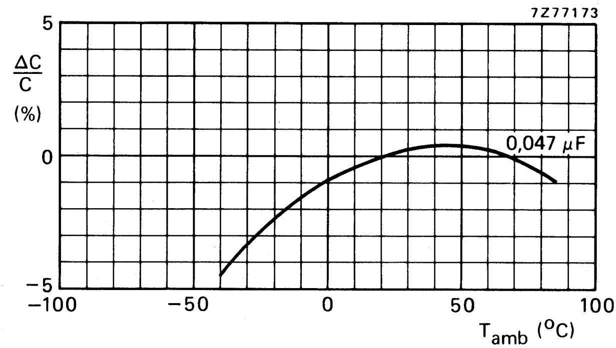


Fig. 4 Capacitance as a function of ambient free air temperature; typical curve.

Voltage

Rated voltage U_R (a.c.) (r.m.s. value), 50 to 60 Hz	250 V
Test voltage	
between terminations	1075 V (d.c.)
between interconnected terminations and case (foil method)	2000 V (a.c.)

Temperature

Climatic category	40/085/21
Rated temperature	85 °C
Storage temperature range	−40 to + 85 °C

Maximum pulse load 100 V/μs

Resonant frequency see Fig. 5

Tangent of loss angle

tan δ at 1 kHz	$\leqslant 75 \times 10^{-4}$
tan δ at 10 kHz	$\leqslant 130 \times 10^{-4}$

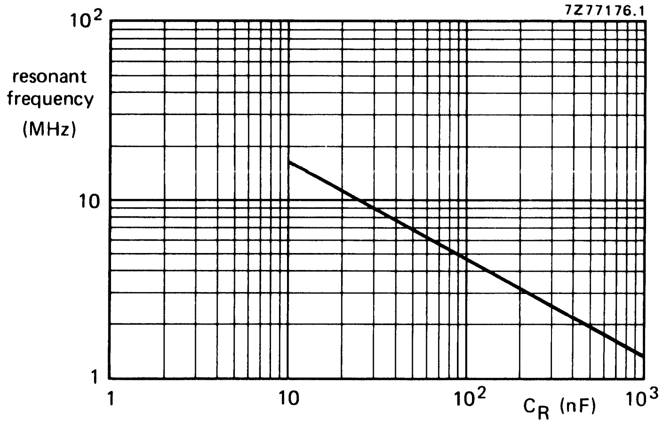


Fig. 5 Resonant frequency as a function of rated capacitance.

Insulation resistance

The insulation resistance is measured after a voltage of 100 ± 15 V has been applied for 1 min ± 5 s, at T_{amb} = 20 °C.

R between terminations, for $C_R \leqslant 0{,}33\ \mu F$	$>$ 15 000 MΩ
RC between terminations, for $C_R > 0{,}33\ \mu F$	$>$ 5000 s
R between interconnected terminations and case (foil method)	$>$ 30 000 MΩ

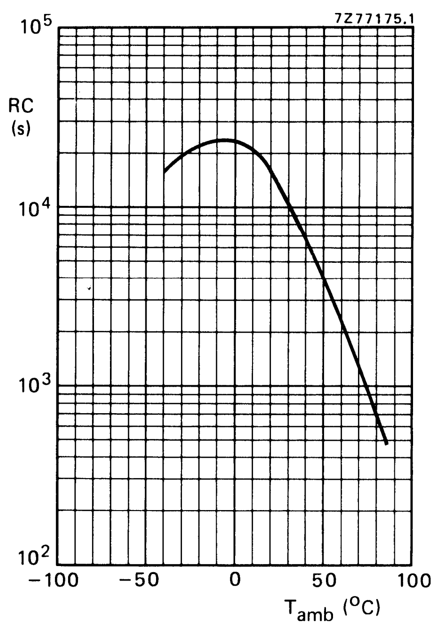


Fig. 6 RC-product as a function of ambient free air temperature; typical curve.

ORDERING INFORMATION

Order the capacitors by quoting the 12-digit catalogue number as shown in Tables 1 to 3.

PACKING

Style 2222 330 0 . . . .

The capacitors are packed in boxes of 1000 (for $L_{max} < 23,5$ mm) and 500 (for $L_{max} \geqslant 23,5$ mm).

Style 2222 330 4 . . . .

The capacitors are packed in boxes; the number per box is given in the table below.

L_{max} mm	T_{max} mm	number of capacitors per box l = 5 ± 1	l = 25 + 2
17,5	$\leqslant 6$	1000	1000
	> 6		500
26		200	100
31		100	125

Style 2222 330 8 . . . .

The capacitors are packed in boxes of 1000.

INSPECTION REQUIREMENTS

interference suppression capacitors (MKT-P)

Note 1
Sub-clause numbers of tests and performance requirements refer to the Sectional Specification, IEC-publication 384-14 and GENERAL DATA of this specification.

Note 2
In this table: D = destructive, ND = non-destructive.

clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements (see Note 1)
Group A Inspection (lot-by-lot)			
Sub-group A1	ND		
4.1 Visual examination			– No mechanical failures. – Legible marking and as specified in GENERAL DATA of this specification.
4.2 Dimensions		Gauging	– As specified in Tables 1 to 3 of this specification.
Sub-group A2	ND		
4.2.2 Capacitance		at 1 kHz	– Within specified tolerance.
4.2.3 Tangent of loss angle		at 10 kHz	– As in GENERAL DATA of this specification.
4.2.1 Voltage proof (Test A)		at 1075 V (d.c.) for 1 s	– No breakdown or flashover.
4.2.2 Insulation resistance (Test A)		at 100 V	– As in GENERAL DATA of this specification.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Group B Inspection (periodic)			
4.5 Solderability	D	Without ageing Method: 1 Non-activated colophony flux Solder bath: 235 °C Dwell time: 2 s	Good tinning as evidenced by free flowing of the solder with wetting of the terminations.
Group C Inspection (periodic)			
Sub-group C1A	D		
Part of sample of Sub-group C1			
4.1 Dimensions (detail)			As specified in Tables 1 to 3 of this specification.
4.3.1 Initial measurements		Capacitance Tangent of loss angle at 10 kHz	
4.3 Robustness of terminations		Tensile, bending and torsion	No visible damage.
4.4 Resistance to soldering heat		Method: 1A Solder bath: 260 °C Duration: 10 s	
4.4.2 Final measurements		Visual examination Capacitance Tangent of loss angle	No visible damage. Legible marking. $\Delta C/C \leqslant 2\%$ of the value measured initially. increase of $\tan \delta \leqslant 0{,}003$ compared to values measured in 4.3.1.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Sub-group C1B Other part of sample of Sub-group C1	D		
4.6.1 Initial measurements		Capacitance Tangent of loss angle at 10 kHz	
4.6 Rapid change of temperature		θ A = lower cat. temp. θ B = upper cat. temp. 5 cycles, duration t = 30 min. Visual examination	No visible damage.
4.7 Vibration		Method of mounting see Note below. Procedure B4. Frequency range: 10 to 55 Hz Amplitude: 0,75 mm or acceleration: 98 m/s^2 (whichever is the less severe) Total duration: 6 h	
4.7.2 Final inspection		Visual examination	No visible damage.
4.9 Shock		Method of mounting see Note below. Pulse shape: half sine Acceleration: 490 m/s^2 Duration of pulse: 11 ms	
4.9.3 Final measurements		Visual examination Capacitance Tangent of loss angle Insulation resistance	No visible damage. $\Delta C/C \leqslant 3\%$ of the value measured in 4.6.1. Increase of tan $\delta \leqslant 0{,}003$ compared to values measured in 4.6.1. As in GENERAL DATA of this specification.

Note:

The capacitor shall be mechanically fixed by the leads and the stand-off pips (ridges) shall be in good contact with the printed-wiring board, also the body of capacitors with a mass > 6 g, and the body of capacitors with insulated leads shall be clamped to the printed-wiring board.

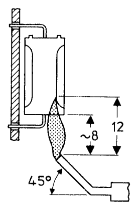
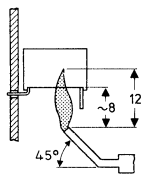
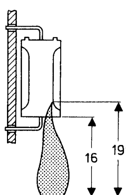
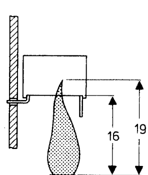
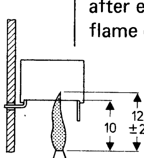
sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Sub-group C1	D		
Combined sample of specimens of Sub-groups C1A and C1B			
4.10 Climatic sequence			
4.10.2 Dry heat		Temperature: upper category temperature Duration: 16 h	
4.10.3 Damp heat cyclic, Test Db, first cycle			
4.10.4 Cold		Temperature: lower category temperature Duration: 2 h	
4.10.6 Damp heat cyclic, Test Db, remaining cycles			
4.10.6.2 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 3\%$ of value measured in 4.4.2 or 4.9.3.
		Tangent of loss angle	Increase of tan $\delta \leqslant 0{,}005$ compared to values measured in 4.3.1 or 4.6.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.
		Voltage proof 710 V (d.c.), 1 min.	No breakdown or flashover.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Sub-group C2	D		
4.11 Damp heat steady state			
4.11.1 Initial measurements		Capacitance Tangent of loss angle at 10 kHz	
4.11.3 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 3\%$ of the value measured in 4.11.1.
		Tangent of loss angle	Increase of tan $\delta \leqslant 0{,}005$ compared to values measured in 4.11.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.
		Voltage proof 710 V (d.c.) for 1 min.	No breakdown or or flashover.
Sub-group C3	D		
4.12 Endurance		Duration: 1000 h 1,25 U_R (a.c.) at 85 °C. Once per hour the voltage is increased to 1000 V (r.m.s.) for 0,1 s, via a resistor of 220 Ω ± 10%	
4.12.1 Initial measurements		Capacitance Tangent of loss angle at 10 kHz	
4.12.5 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C < 10\%$ of value measured in 4.12.1.
		Tangent of loss angle	Increase of tan $\delta \leqslant 0{,}003$ compared to values measured in 4.12.1.
		Insulation resistance	$\geqslant$ 50% of values in GENERAL DATA of this specification.
		Voltage proof 710 V (d.c.) for 1 min.	No breakdown or flashover.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Sub-group C4	D		
4.13 Charge and discharge		10 000 cycles (50 c/s) charge to U_R half sine wave Duration: 5 ms, discharge R = $\dfrac{U_R}{C_R \cdot 5 \left(\frac{dU}{dt}\right)_R}$ with a min. of 2,2 Ω	
4.13.1 Initial measurements		Capacitance Tangent of loss angle at 10 kHz	
4.13.3 Final measurements		Capacitance	$\Delta C/C \leqslant 3\%$ of value measured in 4.13.1.
		Tangent of loss angle	Increase of tan $\delta \leqslant 0{,}003$ compared to values measured in 4.13.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.

additional tests	D or ND	conditions of test	performance requirements
Sub-group ADD1	D		
A.1 Heat storage		Duration: 1000 h Temperature: upper category temperature	
A.1.1 Initial measurements		Capacitance Tangent of loss angle at 10 kHz	
A.1.2 Final measurements		Capacitance	$\Delta C/C \leqslant 10\%$ of value measured in A.1.1.
		Tangent of loss angle	Increase of tan $\delta \leqslant 0{,}003$ compared to values measured in A.1.1.
		Insulation resistance	As in GENERAL DATA of this specification.
Sub-group ADD2		**GROUP 1:** De-ionized water, followed by mixture of isopropyl alcohol and mineral spirits	
A.2 Solvent resistance, Mil STD-202F, method 215 B		**GROUP 2:** 1-1-1-Trichloroethane	
		GROUP 3: Azeotropic mixture of trichlorotrifluoroethane and methylene chloride Temperature: 25 ^{o}C	
A.2.1 Initial measurements		Capacitance Tangent of loss angle at 10 kHz	
A.2.2 Final measurements		Capacitance	$\Delta C/C \leqslant 2\%$ of value measured in A.2.1.
		Tangent of loss angle at 10 kHz	Increase of tan $\delta \leqslant 0{,}003$ compared to values measured in A.2.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.

additional tests	D or ND	conditions of test	performance requirements
Sub-group ADD3			
A.3 Detergent resistance		Density 20g/l dishwasher detergent Temperature 70 °C, during 3 min. Followed by rinsing in clear water for 1 min. Recovery time > 2 h.	
A.3.1 Initial measurements		Capacitance Tangent of loss angle at 10 kHz	
A.3.2 Final measurements		Capacitance	$\Delta C/C \leqslant 2\%$ of value measured in A.3.1
		Tangent of loss angle	Increase of tan $\delta \leqslant 0{,}003$ compared to values measured in A.3.1.
		Insulation resistance	$\geqslant 50\%$ of values in GENERAL DATA of this specification.
Sub-group ADD4 **Not applicable to style 2222 330 8 . . . .**	D		
A.4 Resistance to soldering heat with pre-heating		Capacitors mounted on a 1,6 mm board with non-plated holes Body temp.: 80 °C Bath temp.: 260 °C Dwell time: 2 x 5 s with interim free period of 5 s	
A.4.1 Initial measurements		Capacitance Tangent of loss angle at 10 kHz	
A.4.2 Final measurements		Capacitance	$\Delta C/C \leqslant 2\%$ of value measured in A.4.1.
		Tangent of loss angle	Increase of tan $\delta \leqslant 0{,}003$ compared to values measured in A.4.1.

additional tests	D or ND	conditions of tests	performance requirements
Sub-group ADD5	D		
A.5.1 Needle flame test, IEC 695-2-2		Bore of gas jet: ϕ 0,5 mm. Fuel: butane. Test duration: 20 s. One flame application.	After removing the test flame from the capacitor, the capacitor must not continue to burn for more than 15 s, no burning particles must drop from the sample.
		7Z75503 7Z75502	
A.5.2 Needle flame test, UL1414		Bore of gas jet: ϕ 10 mm. Fuel: natural gas. Test duration; 3 x 15 s. Time interval between each flame application: 15 s.	Extinguishing time $\leqslant$ 15 s after the first and second flame application, $\leqslant$ 60 s after the third flame application.
		7Z75504 7Z75501	
A.5.3 Flame test, IEC 65 par. 14.4.1.b (VDE 0860 par. 14.4.1.b) **Not applicable to style 2222 330 0 . . . . and capacitors with P = 15 mm**		Bore of gas jet: ϕ 0,5 mm. Fuel: butane. Before testing the capacitors are stored for 2h at 100 $\pm$ 2 $^{\circ}$C. Test duration: 1st cycle: 10 s, 2nd cycle: 1 min, 3rd cycle: 2 min. Second and third flame application start directly after extinguishing of the flame on the capacitor.	Extinguishing time $\leqslant$ 30 s after each flame application. No burning particles must drop from the sample.
		7Z75500	

STANDARD SERIES OF VALUES IN A DECADE

for resistances and capacitances

according to IEC publication 63

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

E192	E96	E48
825	825	825
835		
845	845	
856		
866	866	866
876		
887	887	
898		
909	909	909
920		
931	931	
942		
953	953	953
965		
976	976	
988		

E24	E12	E6	E3
10	10	10	10
11			
12	12		
13			
15	15	15	
16			
18	18		
20			
22	22	22	22
24			
27	27		
30			
33	33	33	
36			
39	39		
43			
47	47	47	47
51			
56	56		
62			
68	68	68	
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82	82		
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