PHILIPS

Data handbook

PHILIPS Electronic components and materials

Components and materials

Book C22 1988

Film capacitors

Elcoma – Philips Electronic Components and Materials Division – embraces a world-wide group of companies operating under the following names:

IBRAPE
RTC
Miniwatt
Signetics
Mullard
VALVO
PHILIPS

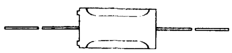
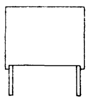
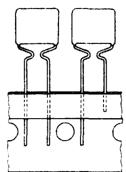
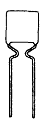
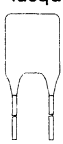
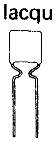
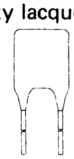
Elcoma offers you a technological partnership in developing your systems to the full. A partnership to which we can bring

- world-wide production and marketing
- know-how
- systems approach
- continuity
- broad product line
- fundamental research
- leading technologies
- applications support
- quality

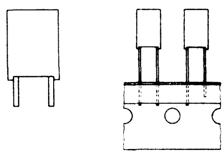
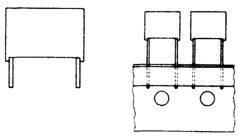
FILM CAPACITORS

SELECTION GUIDE

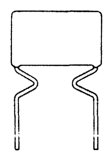
SELECTION GUIDE

style 2222 . . .	type	rated cap. range	rated voltage V	pitch mm	page
METALLIZED POLYETHYLENE-TEREPHTHALATE FILM CAPACITORS (MKT)					
341	moulded 	0,082 –6,8 μF	100		11
		0,039 –2,2 μF	250		
		0,0082–1,0 μF	400		
344	potted 	0,18 –10 μF	63	10; 15; 22,5; 27,5	23
		0,082 –10 μF	100		
		0,039 –2,2 μF	250		
		0,010 –1,0 μF	400		
365	epoxy lacquered 	0,047 –1,0 μF	63	5,08	49
		0,01 –0,10 μF	100		
		0,12 –1,0 μF	63	5,08*	
		0,039 –0,47 μF	100		
		0,018 –0,047 μF	250		
		0,0033–0,015 μF	400		
366	epoxy lacquered 	0,047 –1,0 μF	63	5,08	49
		0,01 –0,10 μF	100		
		0,12 –1,0 μF	63	7,62	
		0,039 –0,47 μF	100		
		0,018 –0,047 μF	250		
		0,0033–0,015 μF	400		
367	epoxy lacquered 	0,047 –1,0 μF	63	5,08	49
		0,01 –0,10 μF	100		
		0,12 –1,0 μF	63	7,62	
		0,039 –0,47 μF	100		
		0,018 –0,047 μF	250		
		0,0033–0,015 μF	400		
368	epoxy lacquered 	0,22 –1,0 μF	63	10,16; 15,24; 22,86; 27,94	49
		0,056 –6,8 μF	100		
		0,027 –2,2 μF	250		
		0,001 –1,0 μF	400		
		0,01 –0,47 μF	630		
369	epoxy lacquered 	0,22 –1,0 μF	63	10,16	49
		0,056 –0,22 μF	100		
		0,027 –0,10 μF	250		
		0,001 –0,033 μF	400		
		0,010 –0,022 μF	630		

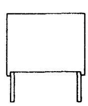
* Original pitch 7,62 mm reduced to 5,08 mm.

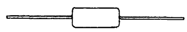
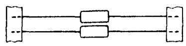
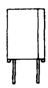
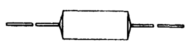
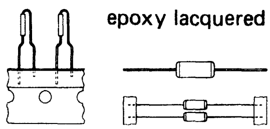
style 2222 . . .	type	rated cap. range	rated voltage V	pitch mm	page
370	potted 	0,056 –1,0 μF 0,0039–0,10 μF	63 100	5,08	23
371	potted 	0,056 –1,0 μF 0,018 –0,47 μF 0,0082–0,10 μF 0,0039–0,010 μF	63 100 250 400	7,62	23

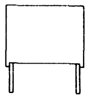
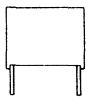
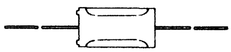
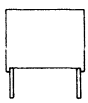
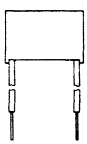
POLYETHYLENE-TEREPHTHALATE FILM/FOIL CAPACITORS (KT)

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	107

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		129
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	141

style 2222 . . .	type	rated cap. range	rated voltage V	pitch mm	page
POLYSTYRENE FILM/FOIL CAPACITORS (KS)					
424	sleeved 	2 000– 39 000 pF	63		177
425		1 100– 16 000 pF	160		
426		560– 11 000 pF	250		
427		47– 5 600 pF	630		
428		2 000– 39 000 pF	63		
429		1 100– 16 000 pF	160		
430		560– 11 000 pF	250		
431		47– 5 600 pF	630		
443	potted 	100– 34 000 pF	63	2,54; 5,08; 7,62	191
444	wrapped end-filled 	43 000–162 000 pF	63		205
445		18 000– 82 000 pF	160		
446		12 000– 47 000 pF	250		
447		6 200– 24 000 pF	630		
POLYPROPYLENE FILM/FOIL CAPACITORS (KP)					
460	epoxy lacquered 	6 800– 62 000 pF	63		245
461		3 600– 39 000 pF	160		
462		1 200– 22 000 pF	250		
463		150– 1 100 pF	400		
464		47– 130 pF	630		

style 2222 . . .	type	rated cap. range	rated voltage V	pitch mm	page
A.C. AND PULSE METALLIZED POLYPROPYLENE FILM CAPACITORS					
(KP/MMKP 376	potted 	0,0068–0,27 µF 0,0047–0,18 µF 0,0018–0,056 µF 0,0010–0,033 µF	630 1000 1600 2000	15; 22,5; 27,5	275
(MKP) 378	potted 	0,33 –3,3 µF 0,18 –1,8 µF 0,056 –0,68 µF 0,012 –0,22 µF 0,0056–0,10 µF 0,0033–0,015 µF	250 400 630 1000 1600 2000	22,5; 27,5	291
INTERFERENCE SUPPRESSION CAPACITORS (MKT-P)					
330 0	moulded 	0,01 –0,47 µF	250 V~		331
330 4	potted 	0,01 –1,0 µF	250 V~	15; 22,5; 27,5	331
330 8	potted; insulated leads 	0,01 –0,1 µF	250 V~	15	331

METALLIZED POLYETHYLENE-TEREPHTHALATE FILM CAPACITORS (MKT)

METALLIZED POLYTHYLENE-TEREPHTHALATE FILM CAPACITORS

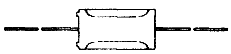
MKT axial moulded type

- 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 (DC)	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 polyethylene-terephthalate (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

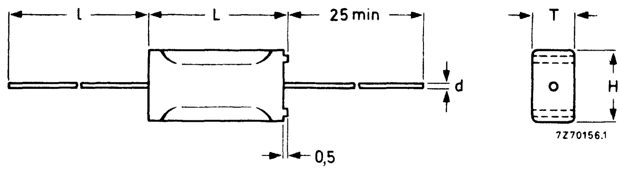


Fig. 1 Capacitors 2222 341.

Table 1–U_R (DC) = 100 V; max. AC voltage = 63 V; Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass grams	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 (DC) = 250 V; max. AC voltage = 160 V; Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass grams	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 (DC) = 400 V; max. AC voltage = 220 V; Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass grams	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

The following information is provided:

- Rated capacitance value
- Rated voltage
- Rated capacitance tolerance
- Category voltage
- Year and month or week of manufacture
- Manufacturer's name
- Climatic category
- Manufacturer's type designation

The capacitors are marked by impression on one side as follows:

line 1: rated capacitance in pF or μF, tolerance and rated DC voltage
line 2: 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 capacitors are also marked by impression on the other side as follows:

line 1: manufacturer's name
line 2: code for factory of origin

The package containing the capacitors is marked with all of the above information.

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 ^{o}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

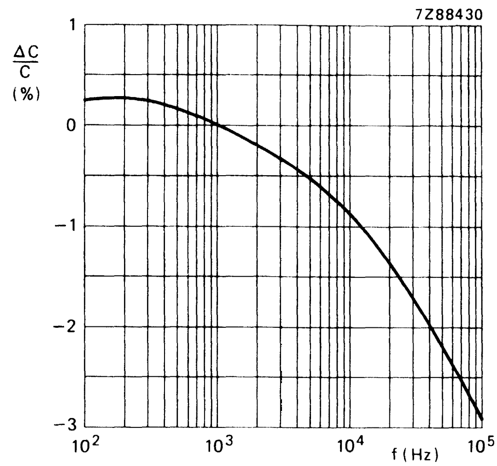


Fig. 2 Capacitance as a function of frequency; typical curve.

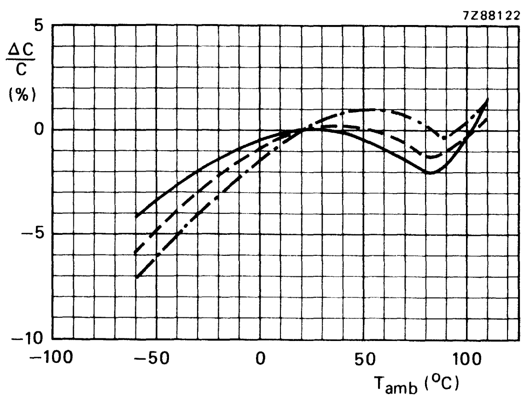


Fig. 3 Capacitance as a function of ambient free air temperature; typical curves.
——— for all capacitance values, measured at 1 kHz, 1 V.
– – – – for capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.
– · – · – for capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Voltage

Rated voltage U_R (DC)	See Tables 1 to 3
Category voltage U_C	0,8 x U_R (DC)
Maximum AC voltage (RMS value), at 50 to 60 Hz	See Tables 1 to 3
Test voltage	
between terminations	1,6 x U_R (DC)
between interconnected terminations and case	2 x U_R (DC); minimum 200 V

Temperature

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

Notes
- The sum of the DC voltage and the peak value of the superimposed AC voltage must be ≤ U_R (DC).
- For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

Maximum pulse load

Table 4 Maximum pulse load per voltage/length

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

Table 5 Tangent of loss angle per range/frequency

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

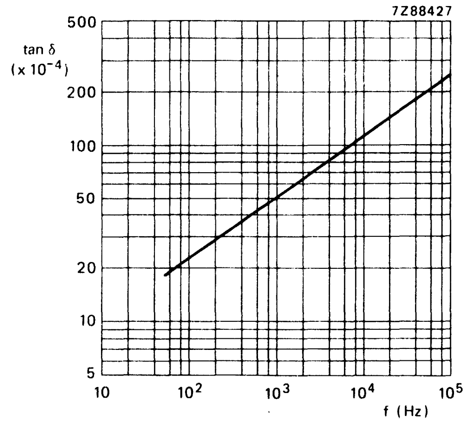


Fig. 4 Tan δ as a function of frequency, typical curve.

Insulation resistance

The insulation resistance is measured after a voltage of 100 ± 15 V has been applied for 1 minute ± 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

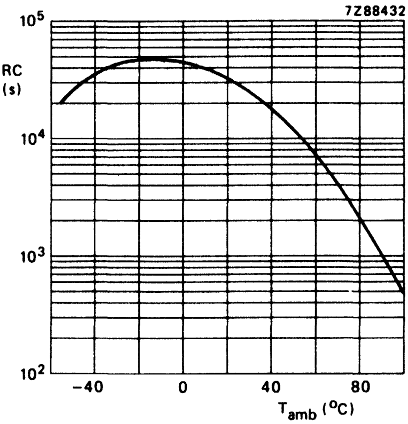


Fig. 5 RC-product as a function of ambient free air temperature; typical curve.

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.

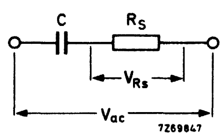
If the requirement for the maximum dissipation is satisfied, a check must be made to ascertain that the maximum pulse load is not exceeded.

The maximum AC 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 AC 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 AC 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 AC voltage of 130 V, a frequency of 1 kHz and an ambient free air temperature of 50 °C.

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

$$
\begin{aligned}
P &= (R_sC)\, C\omega^2 V_{ac}^2 \\
&= 7{,}1 \cdot 10^{-7} \times 1 \cdot 10^{-6} \times (2\pi)^2 \times 10^6 \times 130^2 \\
&= 472 \text{ mW}
\end{aligned}
$$

For a rated voltage of 130 V_{ac} a capacitor of the 250 V range is required.

Capacitor 1 μF/160 V_{ac} 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.

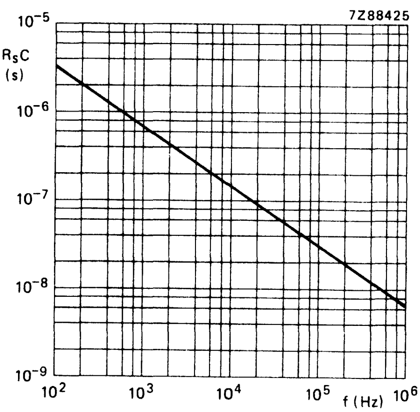


Fig. 6 Maximum product of series resistance and capacitance as a function of frequency.

Table 6 Power dissipation for different dimensions

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

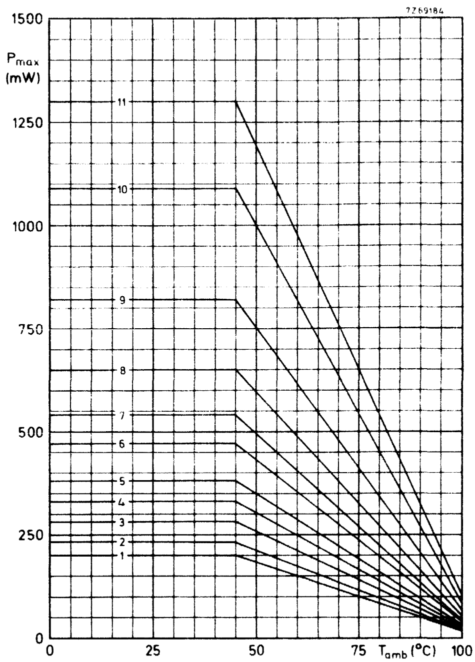


Fig. 7 Maximum dissipation as a function of ambient free air temperature.

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 POLYETHYLENE-TEREPHTHALATE FILM CAPACITORS

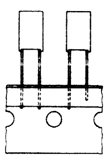
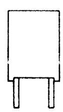
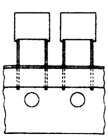
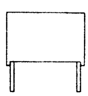
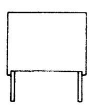
MKT radial potted type

- 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 (DC)	63 V, 100 V, 250 V, 400 V
Climatic category	55/100/56
Rated temperature	85 ^oC
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 2nd edition*

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

Available on tape to special order.

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 polyethylene-terephthalate (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 circuit board.

* Except style 2222 344: 63 V version and 250 V 0,082 and 0,1 μF.

GENERAL DATA

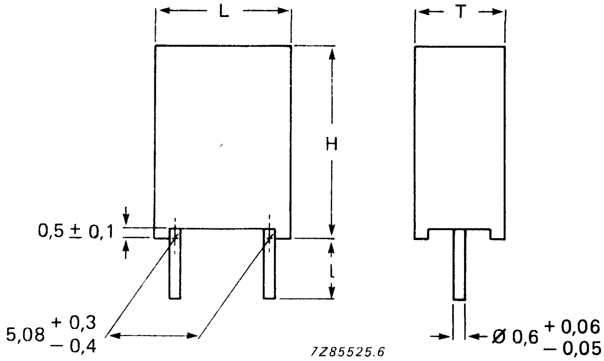


Fig. 1 Physical dimensions; 2222 370 range.

Table 1 U_R(DC) = 63 V; max. AC voltage = 40 V; Fig. 1

rated capacitance μF	T max	H max	L max	mass grams	catalogue number 2222 370 . . . . . packed in boxes l = 4 + 1 − 0,5 tol. ± 20%	tol. ± 10%	tol. ± 5%	l = 26 ± 1 tol. ± 20%	tol. ± 10%	tol. ± 5%
0,056	2,5	6,5	7,2	0,25	10563	11563	12563	14563	15563	16563
0,068					10683	11683	12683	14683	15683	16683
0,082					10823	11823	12823	14823	15823	16823
0,10					10104	11104	12104	14104	15104	16104
0,12	3,5	8	7,2	0,35	10124	11124	12124	14124	15124	16124
0,15					10154	11154	12154	14154	15154	16154
0,18					10184	11184	12184	14184	15184	16184
0,22					10224	11224	12224	14224	15224	16224
0,27	4,5	9	7,2	0,45	10274	11274	12274	14274	15274	16274
0,33					10334	11334	12334	14334	15334	16334
0,39	5	10	7,2	0,5	10394	11394	12394	14394	15394	16394
0,47					10474	11474	12474	14474	15474	16474
0,56	6	11	7,2	0,5	10564	11564	12564	14564	15564	16564
0,68					10684	11684	12684	14684	15684	16684
0,82					10824	11824	12824	14824	15824	16824
1,0					10105	11105	12105	14105	15105	16105

Table 1a U_R(DC) = 63 V; max. AC voltage = 40 V; Fig. 1 and Fig. 10

catalogue number 2222 370									rated capacitance µF
on tape on reel			on tape in ammunition pack						
taping height 18 mm						16 mm			
tol. ± 20%	tol. ± 10%	tol. ± 5%	tol. ± 20%	tol. ± 10%	tol. ± 5%	tol. ± 20%	tol. ± 10%	tol. ± 5%	
17563	18563	19563	74563	75563	76563	77563	78563	79563	0,056
17683	18683	19683	74683	75683	76683	77683	79683	79683	0,068
17823	18823	19823	74823	75823	76823	77823	78823	79823	0,082
17104	18104	19104	74104	75104	76104	77104	78104	79104	0,10
17124	18124	19124	74124	75124	76124	77124	78124	79124	0,12
17154	18154	19154	74154	75154	76154	77154	78154	79154	0,15
17184	18184	19184	74184	75184	76184	77184	78184	79184	0,18
17224	18224	19224	74224	75224	76224	77224	78224	79224	0,22
17274	18274	19274	74274	75274	76274	77274	78274	79274	0,27
17334	18334	19334	74334	75334	76334	77334	78334	79334	0,33
17394	18394	19394	74394	75394	76394	77394	78394	79394	0,39
17474	18474	19474	74474	75474	76474	77474	78474	79474	0,47
17564	18564	19564	74574	75564	76564	77564	78564	79564	0,56
17684	18684	19684	74684	75684	76684	77684	78684	79684	0,68
17824	18824	19824	74824	75824	76824	77824	78824	79824	0,82
17105	18105	19105	74105	75105	76105	77105	78105	79105	1,0

Table 2 U_R(DC) = 100 V; max. AC voltage = 63 V; Fig. 1

rated capacitance µF	T max	H max	L max	mass grams	catalogue number 2222 370 . . . . . packed in boxes					
					l = 4 + 1 – 0,5			l = 26 ± 1		
					tol. ± 20%	tol. ± 10%	tol. ± 5%	tol. ± 20%	tol. ± 10%	tol. ± 5%
0,0039	2,5	6,5	7,2	0,25	20392	21392	22392	14392	15392	26392
0,0047					20472	21472	22472	24472	25472	26472
0,0056					20562	21562	22562	24562	25562	26562
0,0068					20682	21682	22682	24682	25682	26682
0,0082					20822	21822	22822	24822	25822	26822
0,010					20103	21103	22103	24103	25103	26103
0,012					20123	21123	22123	24123	25123	26123
0,015					20153	21153	22153	24153	25153	26153
0,018					20183	21183	22183	24183	25183	26183
0,022					20223	21223	22223	24223	25223	26223
0,027					20273	21273	22273	24273	25273	26273
0,033					20333	21333	22333	24333	25333	26333
0,039					20393	21393	22393	24393	25393	26393
0,047					20473	21473	22473	24473	25473	26473
0,056	3,5	8	7,2	0,35	20563	21563	22563	24563	25563	26563
0,068					20683	21683	22683	24683	25683	26683
0,082					20823	21823	22823	24823	25823	26823
0,10					20104	21104	22104	24104	25104	26104

Table 2a U_R(DC) = 100 V; max. AC voltage = 63 V; Fig. 1 and Fig. 10

catalogue number 2222 370									rated capacitance μF
on tape on reel			on tape in ammunition pack						
taping height 18 mm						16 mm			
tol. ± 20%	tol. ± 10%	tol. ± 5%	tol. ± 20%	tol. ± 10%	tol. ± 5%	tol. ± 20%	tol. ± 10%	tol. ± 5%	
27392	28392	29392	84392	85392	86392	87392	88392	89392	0,0039
27472	28472	29472	84472	85472	86472	87472	88472	89472	0,0047
27562	28562	29562	84562	85562	86562	87562	88562	89562	0,0056
27682	28682	29682	84682	85682	86682	87682	88682	89682	0,0068
27822	28822	29822	84822	85822	86822	87822	88822	89822	0,0082
27103	28103	29103	84103	85103	86103	87103	88103	89103	0,010
27123	28123	29123	84123	85123	86123	87123	88123	89123	0,012
27153	28153	29153	84153	85153	86153	87153	88153	89153	0,015
27183	28183	29183	84183	85183	86183	87183	88183	89183	0,018
27223	28223	29223	84223	85223	86223	87223	88223	89223	0,022
27273	28273	29273	84273	85273	86273	87273	88273	89273	0,027
27333	28333	29333	84333	85333	86333	87333	88333	89333	0,033
27393	28393	29393	84393	85393	86393	87393	88393	89393	0,039
27473	28473	29473	84473	85473	86473	87473	88473	89473	0,047
27563	28563	29563	84563	85563	86563	87563	88563	89563	0,056
27683	28683	29683	84683	85683	86683	87683	88683	89683	0,068
27823	28823	29823	84823	85823	86823	87823	88823	89823	0,082
27104	28104	29104	84104	85104	86104	87104	88104	89104	0,10

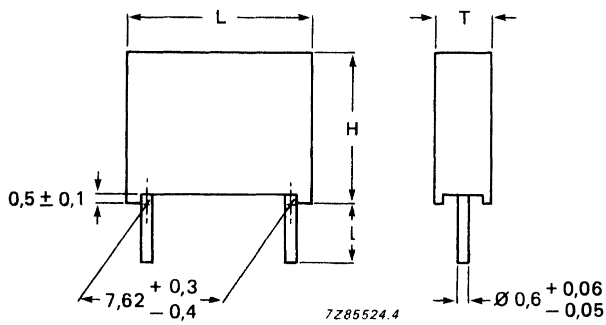


Fig. 2 Physical dimensions; 2222 371 range.

Table 3 U_R(DC) = 63 V; max. AC voltage = 40 V; Fig. 2

rated capacitance μF	T max	H max	L max	mass grams	catalogue number 2222 371 ..... packed in boxes l = 4 + 1 − 0,5 tol. ± 20%	l = 4 + 1 − 0,5 tol. ± 10%	l = 4 + 1 − 0,5 tol. ± 5%	l = 26 ± 1 tol. ± 20%	l = 26 ± 1 tol. ± 10%	l = 26 ± 1 tol. ± 5%
0,056	2,5	6,5	10	0,3	10563	11563	12563	14563	15563	16563
0,068					10683	11683	12683	14683	15683	16683
0,082					10823	11823	12823	14823	15823	16823
0,10					10104	11104	12104	14104	15104	16104
0,12	3	8	10	0,4	10124	11124	12124	14124	15124	16124
0,15					10154	11154	12154	14154	15154	16154
0,18					10184	11184	12184	14184	15184	16184
0,22					10224	11224	12224	14224	15224	16224
0,27	4	9	10	0,5	10274	11274	12274	14274	15274	16274
0,33					10334	11334	12334	14334	15334	16334
0,39					10394	11394	12394	14394	15394	16394
0,47					10474	11474	12474	14474	15474	16474
0,56	5	10,5	10	0,65	10564	11564	12564	14564	15564	16564
0,68					10684	11684	12684	14684	15684	16684
0,82					10824	11824	12824	14824	15824	16824
1,0					10105	11105	12105	14105	15105	16105

Table 3a U_R(DC) = 63 V; max. AC voltage = 40 V; Fig. 2 and Fig. 13

catalogue number 2222 371			rated capacitance μF
on tape on reel			
tol. ± 20%	tol. ± 10%	tol. ± 5%	
17563	18563	19563	0,056
17683	18683	19683	0,068
17823	18823	19823	0,082
17104	18104	19104	0,10
17124	18124	19124	0,12
17154	18154	19154	0,15
17184	18184	19184	0,18
17224	18224	19224	0,22
17274	18274	19274	0,27
17334	18334	19334	0,33
17394	18394	19394	0,39
17474	18474	19474	0,47
17564	18564	19564	0,56
17684	18684	19684	0,68
17824	18824	19824	0,82
17105	18105	19105	1,0

Table 4 U_R(DC) = 100 V; max. AC voltage = 63 V; Fig. 2

rated capacitance µF	T max	H max	L max	mass grams	catalogue number 2222 371 . . . . . packed in boxes l = 4 + 1 − 0,5 tol. ± 20%	l = 4 + 1 − 0,5 tol. ± 10%	l = 4 + 1 − 0,5 tol. ± 5%	l = 26 ± 1 tol. ± 20%	l = 26 ± 1 tol. ± 10%	l = 26 ± 1 tol. ± 5%
0,018	2,5	6,5	10	0,3	20183	21183	22183	24183	25183	26183
0,022					20223	21223	22223	24223	25223	26223
0,027					20273	21273	22273	24273	25273	26273
0,033					20333	21333	22333	24333	25333	26333
0,039					20393	21393	22393	24393	25393	26393
0,047					20473	21473	22473	24473	25473	26473
0,056	3	8	10	0,4	20563	21563	22563	24563	25563	26563
0,068					20683	21683	22683	24683	25683	26683
0,082					20823	21823	22823	24823	25823	26823
0,10					20104	21104	22104	24104	25104	26104
0,12	4	9	10	0,5	20124	21124	22124	24124	25124	26124
0,15					20154	21154	22154	24154	25154	26154
0,18					20184	21184	22184	24184	25184	26184
0,22					20224	21224	22224	24224	25224	26224
0,27	5	10,5	10	0,65	20274	21274	22274	24274	25274	26274
0,33					20334	21334	22334	24334	25334	26334
0,39	6	11,5	10	0,75	20394	21394	22394	24394	25394	26394
0,47					20474	21474	22474	24474	25474	26474

Table 5 U_R(DC) = 250 V; max. AC voltage = 160 V; Fig. 2

rated capacitance µF	T max	H max	L max	mass grams	catalogue number 2222 371 . . . . . l = 4 + 1 − 0,5 tol. ± 20%	l = 4 + 1 − 0,5 tol. ± 10%	l = 4 + 1 − 0,5 tol. ± 5%	l = 26 ± 1 tol. ± 20%	l = 26 ± 1 tol. ± 10%	l = 26 ± 1 tol. ± 5%
0,0082	2,5	6,5	10	0,3	40822	41822	42822	44822	45822	46822
0,010					40103	41103	42103	44103	45103	46103
0,012					40123	41123	42123	44123	45123	46123
0,015					40153	41153	42153	44153	45153	46153
0,018	3	8	10	0,4	40183	41183	42183	44183	45183	46183
0,022					40223	41223	42223	44223	45223	46223
0,027					40273	41273	42273	44273	45273	46273
0,033					40333	41333	42333	44333	45333	46333
0,039	3	8	10		40393	41393	42393	44393	45393	46393
0,047					40473	41473	42473	44473	45473	46473
0,056	4	9	10	9,5	40563	41563	42563	44563	45563	46563
0,068					40683	41683	42683	44683	45683	46683
0,082	5	10,5	10	0,65	40823	41823	42823	44823	45823	46823
0,10					40104	41104	42104	44104	45104	46104

Table 4a U_R(DC) = 100 V; max. AC voltage = 63 V; Fig. 2 and Fig. 13

catalogue number 2222 371 ..... on tape on reel tol. ± 20%	tol. ± 10%	tol. ± 5%	rated capacitance μF
27183	28183	29183	0,018
27223	28223	29223	0,022
27273	28273	29273	0,027
27333	28333	29333	0,033
27393	28393	29393	0,039
27473	28473	29473	0,047
27563	28563	29563	0,056
27683	28683	29683	0,068
27823	28823	29823	0,082
27104	28104	29104	0,10
27124	28124	29124	0,12
27154	28154	29154	0,15
27184	28184	29184	0,18
27224	28224	29224	0,22
27274	28274	29274	0,27
27334	28334	29334	0,33
27394	28394	29394	0,39
27474	28474	29474	0,47

Table 5a U_R(DC) = 250 V; max. AC voltage = 160 V; Fig. 2 and Fig. 13

catalogue number 2222 371 ..... on tape on reel tol. ± 20%	tol. ± 10%	tol. ± 5%	rated capacitance μF
47822	48822	49822	0,0082
47103	48103	49103	0,010
47123	48123	49123	0,012
47153	48153	49153	0,015
47183	48183	49183	0,018
47223	48223	49223	0,022
47273	48273	49273	0,027
47333	48333	49333	0,033
47393	48393	49393	0,039
47473	48473	49473	0,047
47563	48563	49563	0,056
47683	48683	49683	0,068
47823	48823	49823	0,082
47104	48104	49104	0,10

Table 6 U_R(DC) = 400 V; max. AC voltage = 220 V; Fig. 2

rated capacitance µF	T max	H max	L max	mass grams	catalogue number 2222 371					
					l = 4 + 1 – 0,5			l = 26 ± 1		
					tol. ± 20%	tol. ± 10%	tol. ± 5%	tol. ± 20%	tol. ± 10%	tol. ± 5%
0,0039	2,5	6,5	10	0,3	50392	51392	52391	54392	55392	56392
0,0047					50472	51472	52472	54471	55472	56472
0,0056					50562	51562	52562	54562	55562	56562
0,0068					50682	51682	52682	54682	55682	56682
0,0082	3	8	10	0,4	50822	51822	52822	54822	55822	56822
0,010					50103	51103	52103	54103	55103	56103

Table 6a U_R(DC) = 400 V; max. AC voltage = 220 V; Fig. 2 and Fig. 13

catalogue number 2222 371			rated capacitance µF
on tape on reel			
tol. ± 20%	tol. ± 10%	tol. ± 5%	
57392	58392	59392	0,0039
57472	58472	59472	0,0047
57562	58562	59562	0,0056
57682	58682	59682	0,0068
57822	58822	59822	0,0082
57103	58103	59103	0,010

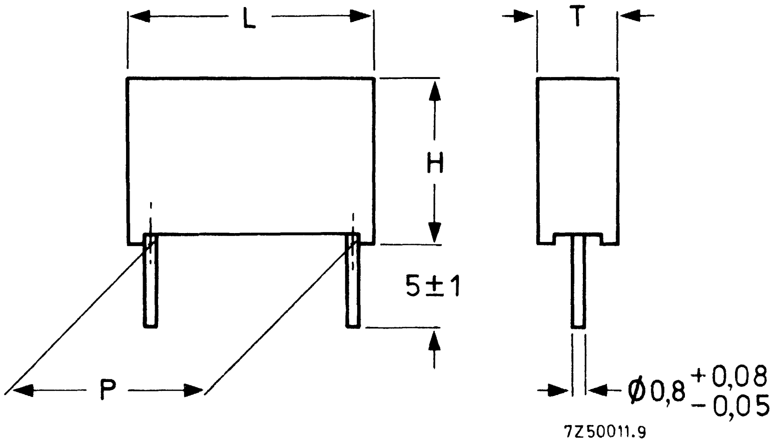


Fig. 3 Physical dimensions; 2222 344 range.

Table 7 U_R(DC) = 63 V; max. AC voltage = 40 V; Fig. 3

rated capacitance μF	T max	H max	L max	P	mass grams	catalogue number 2222 344 . . . . . tol. ± 20%	tol. ± 10%	tol. ± 5%
0,18	4,5	10	13	10 ± 0,3	0,7	14184	15184	13184
0,22	4,5	10				14224	15224	13224
0,27	5	11			0,85	14274	15274	13274
0,33	5	11				14334	15334	13334
0,39	5	11				14394	15394	13394
0,47	5	11				14474	15474	13474
0,56	6	12	17,5	15 ± 0,3	1,4	14564	15564	13564
0,68	6	12				14684	15684	13684
0,82	7	13			1,8	14824	15824	13824
1,0	7	13				14105	15105	13105
1,2	8,5	14,5			2,55	14125	15125	13125
1,5	8,5	14,5				14155	15155	13155
1,8	6,5	15,5	26	22,5 ± 0,3	2,75	14185	15185	13185
2,2	6,5	15,5				14225	15225	13225
2,7	8,5	17,5			4,3	14275	15275	13275
3,3	8,5	17,5				14335	15335	13335
3,9	9,5	19			5,1	14395	15395	13395
4,7	9,5	19				14475	15475	13475
5,6	11	20	31	27,5 ± 0,3	7,4	14565	15565	13565
6,8	11	20				14685	15685	13685
8,2	13	22,5			10,2	14825	15825	13825
10	13	22,5				14106	15106	13106

Table 8 U_R(DC) = 100 V; max. AC voltage = 63 V; Fig. 3

rated capacitance μF	T max	H max	L max	P	mass grams	catalogue number 2222 344 . . . . . tol. ± 20%	tol. ± 10%	tol. ± 5%
0,082	4,5	10	13	10 ± 0,3	0,7	24823	25823	23823
0,10	4,5	10				24104	25104	23104
0,12	4,5	10				24124	25124	23124
0,15	4,5	10				24154	25154	23154
0,18	4,5	10			0,85	24184	25184	23184
0,22	4,5	10				24224	25224	23224
0,27	5	11	17,5	15 ± 0,3	1,05	24274	25274	23274
0,33	5	11				24334	25334	23334
0,39	5	11			1,4	24394	25394	23394
0,47	5	11				24474	25474	23474
0,56	6	12			1,8	24564	25564	23564
0,68	6	12				24684	25684	23684
0,82	7	13			2,55	24824	25824	23824
1,0	7	13				24105	25105	23105
1,2	6,5	15,5	26	22,5 ± 0,3	2,75	24125	25125	23125
1,5	6,5	15,5				24155	25155	23155
1,8	8,5	17,5			4,3	24185	25185	23185
2,2	8,5	17,5				24225	25225	23225
2,7	9,5	19			5,1	24275	25275	23275
3,3	9,5	19				24335	25335	23335
3,9	11	20	31	27,5 ± 0,3	7,4	24395	25395	23395
4,7	11	20				24475	25475	23475
5,6	13	22,5			10,2	24565	25565	23565
6,8	13	22,5				24685	25685	23685
8,2	15	25			12,8	24825	25825	23825
10	15	25				24106	25106	23106

Table 9 U_R(DC) = 250 V; max. AC voltage = 160 V; Fig. 3

rated capacitance μF	T max	H max	L max	P	mass grams	catalogue number 2222 344		
						tol. ± 20%	tol. ± 10%	tol. ± 5%
0,039	4,5	10	13	10 ± 0,3	0,7	40393	41393	42393
0,047						40473	41473	42473
0,056						40563	41563	42563
0,068						40683	41683	42683
0,082	5	11	17,5	15 ± 0,3	1,05	40823	41823	42823
0,10	5	11				40104	41104	42104
0,12	5	11				40124	41124	42124
0,15	5	11				40154	41154	42154
0,18	6	12			1,4	40184	41184	42184
0,22	6	12				40224	41224	42224
0,27	7	13			1,8	40274	41274	42274
0,33	7	13				40334	41334	42334
0,39	6,5	15,5	26	22,5 ± 0,3	2,74	40394	41394	42394
0,47	6,5	15,5				40474	41474	42474
0,56	6,5	15,5				40564	41564	42564
0,68	6,5	15,5				40684	41684	42684
0,82	8,5	17,5			4,4	40824	41824	42824
1,0	8,5	17,5				40105	41105	42105
1,2	11	20	31	27,5 ± 0,3	7,4	40125	41125	42125
1,5						40155	41155	42155
1,8						40185	41185	42185
2,2						40225	41225	42225

Table 10 U_R(DC) = 400 V; max. AC voltage = 220 V; Fig. 3

rated capacitance μF	T max	H max	L max	P	mass grams	catalogue number 2222 344		
						tol. ± 20%	tol. ± 10%	tol. ± 5%
0,010	4,5	10	13	10 ± 0,3	0,7	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	5	11	17,5	15 ± 0,3	1,05	54393	55393	53393
0,047	5	11				54473	55473	53473
0,056	6	12			1,4	54563	55563	53563
0,068	6	12				54683	55683	53683
0,082	7	13			1,8	54823	55823	53823
0,10	7	13				54104	55104	53104
0,12	8,5	14,5			2,55	54124	55124	53124
0,15	8,5	14,5				54154	55154	53154
0,18	6,5	15,5	26	22,5 ± 0,3	2,75	54184	55184	53184
0,22	6,5	15,5				54224	55224	53224
0,27	7,5	16,5			3,5	54274	55274	53274
0,33	7,5	16,5				54334	55334	53334
0,39	9,5	19			5,1	54394	55394	53394
0,47	9,5	19				54474	55474	53474
0,56	11	20	31	27,5 ± 0,3	7,4	54564	55564	53564
0,68	11	20				54684	55684	53684
0,82	13	22,5			10,4	54824	55824	53824
1,0	13	22,5				54105	55105	53105

Marking

The following information is provided:

- Rated capacitance value
- Rated voltage
- Rated capacitance tolerance
- Category voltage
- Year and month or week of manufacture
- Manufacturer's name
- Climatic category
- Manufacturer's type designation
- Styles 2222 370 and 2222 371

  Capacitors within these categories are laser marked. Each device is marked on the top edge and also on one side with the following information:

  Top edge marking –

  rated capacitance in nF or μF
  tolerance code (M = ± 20%; K = ± 10%; J = ± 5%)

  Side marking –

  line 1: rated DC voltage with unit symbol
  line 2: code for dielectric material (MKT) and code for factory of origin
  line 3: 5th, 6th and 7th digits of the catalogue number, and manufacturer's identification (PH)
  line 4: production date code (year and week)

- Style 2222 344

  This category of capacitor is marked on the top edge by embossed print as follows:

  line 1: rated capacitance in μF
  tolerance
  rated DC voltage
  line 2: code for dielectric material (MKT)
  5th, 6th and 7th digits of the catalogue number
  code for factory of origin

  The manufacturer's identification symbol is located to the left of these markings

The package containing the capacitors is marked with all of the above information.

Mounting

The capacitors are for printed-wiring applications. The capacitors which are supplied on tape are suitable for mounting on printed-wiring boards using 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

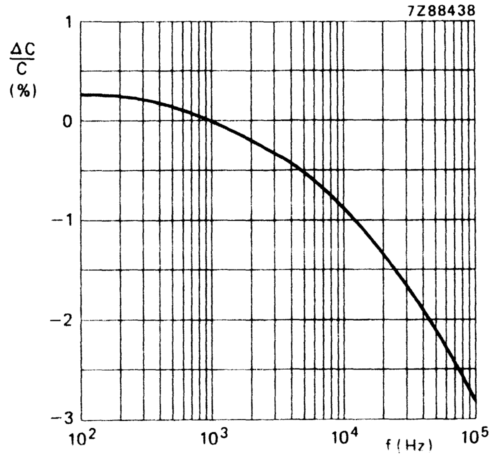


Fig. 4 Capacitance as a function of frequency; typical curve.

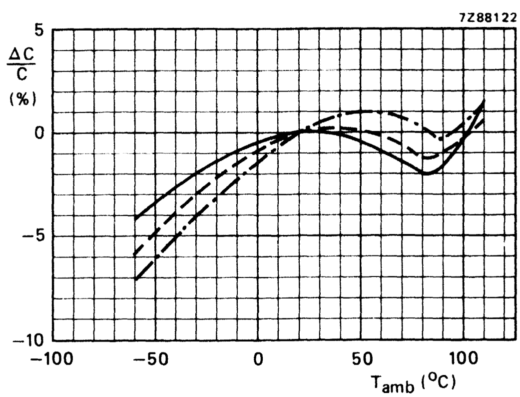


Fig. 5 Capacitance as a function of ambient free air temperature; typical curves.
——— for all capacitance values, measured at 1 kHz, 1 V.
– – – – for capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.
– · – · – for capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Voltage

Rated voltage U_R(DC)	See Tables 1 to 10
Category voltage U_C	0,8 x U_R(DC)
Maximum AC voltage (RMS value) at 50 to 60 Hz	See Tables 1 to 10
Test voltage	
between terminations	1,6 x U_R(DC)
between interconnected terminations and case	2 x U_R(DC); minimum 200 V

Temperature

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

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

Table 11 Maximum pulse load per voltage/length

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	30	9	15	6	3	2
100	55	18	24	10	4	3,5
250		35	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

Table 12 Tangent of loss angle per range/frequency

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	$C \leqslant 0{,}1\ \mu F$ $0{,}1\ \mu F < C \leqslant 1\ \mu F$ $C > 1\ \mu F$	$\leqslant 75 \times 10^{-4}$ $\leqslant 75 \times 10^{-4}$ $\leqslant 75 \times 10^{-4}$	$\leqslant 130 \times 10^{-4}$ $\leqslant 130 \times 10^{-4}$ $\leqslant 150 \times 10^{-4}$	$\leqslant 250 \times 10^{-4}$

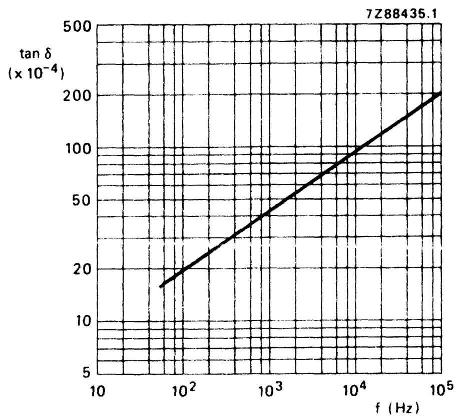


Fig. 6 Tan δ as a function of frequency, typical curve.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 minute ± 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

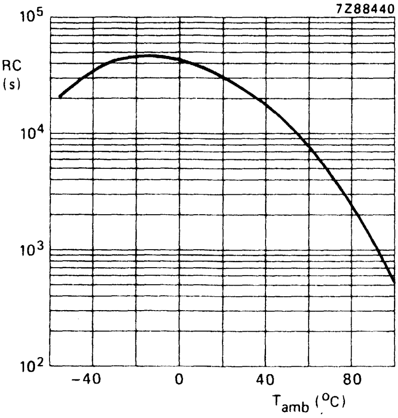


Fig. 7 RC-product as a function of ambient free air temperature; typical curve.

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.

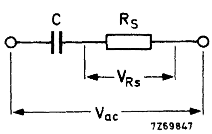
The maximum AC voltage has been specified for 50 to 60 Hz and at 23 °C. This voltage value must also never be exceeded at other frequencies. This permissible AC voltage may further be limited by the following requirements:

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

2. The steepness of the AC 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 $\quad P = (R_sC)\, C\omega^2 V_{ac}^2 \qquad (3b)$

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 AC voltage of 10 V, a frequency of 10 kHz and an ambient temperature of 50 °C.

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

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

For a rated voltage of 10 V_{ac} a capacitor of the 63 V version is required.

Capacitor 0,1 μF/40 V_{ac} 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 °C.

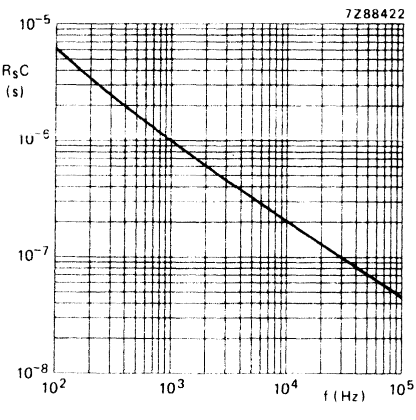


Fig. 8 Maximum product of series resistance and capacitance as a function of frequency.

Table 13 Power dissipation for different dimensions

curve	dimensions (mm)		
	T_{max}	H_{max}	L_{max}
1	2,5	6,5	7,2
2	2,5	6,5	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

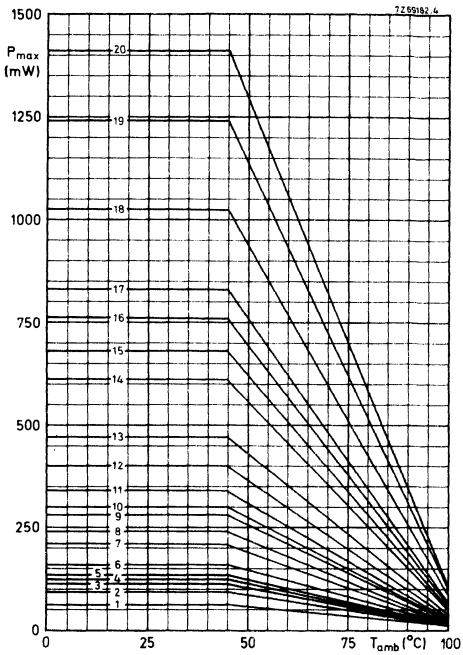


Fig. 9 Maximum dissipation as a function of ambient free air temperature.

ORDERING INFORMATION

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

PACKING

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%

Style 2222 344

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

The capacitors are available on tape to special order.

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 mm and 1000 for l = 26 mm.

Table 14 Number of capacitors per reel and ammunition packing

thickness (T) of capacitors	number of capacitors	
	reel	ammunition pack
2,5 mm	2000	2000
3,5 mm	1500	1500
4,5 mm	1000	1000
5 mm	1000	1000
6 mm	1000	750

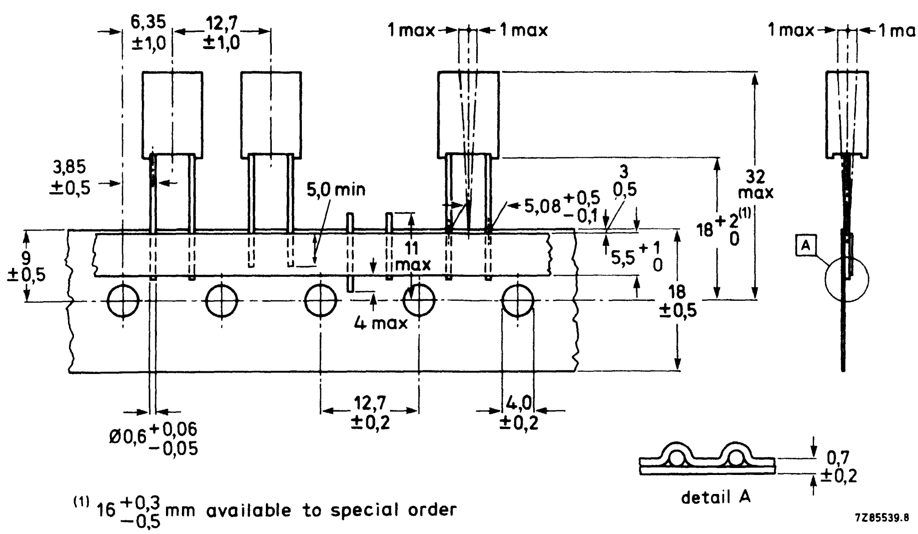


Fig. 10 Capacitors 2222 370 on tape.

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.

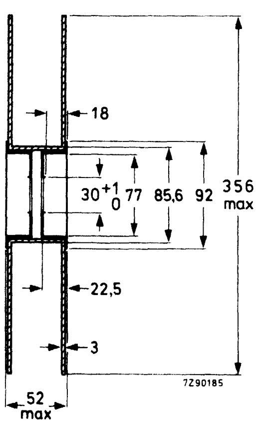


Fig. 11 Reel.

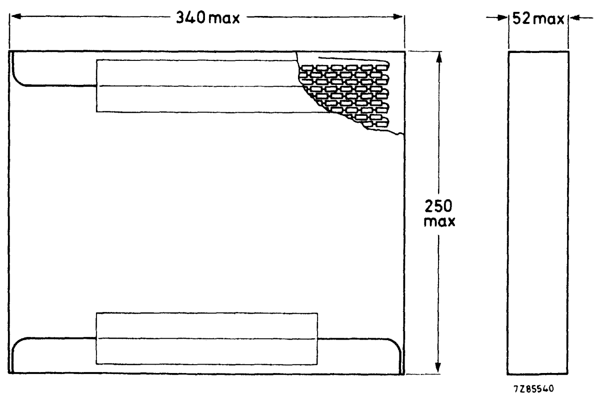


Fig. 12 Capacitors on tape in ammunition packing.

Style 2222 371

The capacitors supplied in boxes of 1000, and on tape on reel of:
2000 for T = 2,5 mm
1500 for T = 3 mm and 4 mm
1000 for T = 5 mm and 6 mm

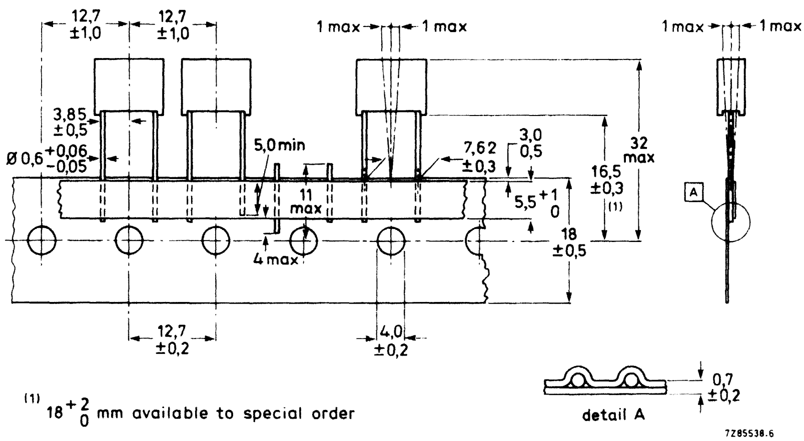


Fig. 13 Capacitors 2222 371 on tape.

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

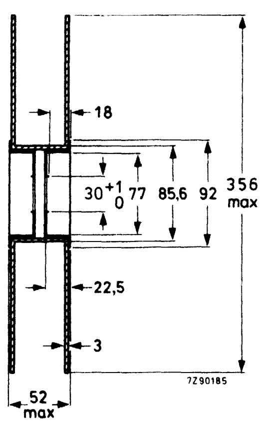


Fig. 14 Reel.

METALLIZED POLYETHYLENE-TEREPHTHALATE FILM CAPACITORS

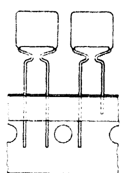
MKT radial epoxy lacquered type

- 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 (DC)	63 V, 100 V, 250 V. 400 V, 630 V
Climatic category	40/100/56
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

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 17
	2222 367	5,08 mm; 7,62 mm	18 to 23
	2222 369	10,16 mm	24 to 28

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

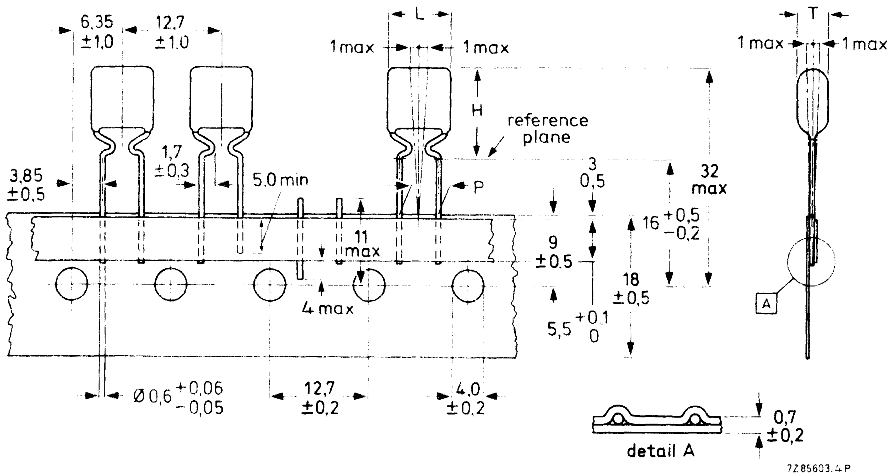


Fig. 1 Capacitors 2222 365 on tape.

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 (DC) = 63 V; max. AC voltage = 40 V; Fig. 1; **pitch = 5,08 mm**

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 365 ..... reel packing tol. ± 20%	reel packing tol. ± 10%	ammunition packing tol. ± 20%	ammunition packing tol. ±10%
0,047	3,5	12,5	7,5	5,08 +0,4 −0,2	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 (DC) = 100 V; max. AC voltage = 63 V; Fig. 1; **pitch = 5,08 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass grams	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						80153	81153	84153	85153
0,018				5,08 +0,4 −0,2		80183	81183	84183	85183
0,022	3,5	12,5			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						80473	81473	84473	85473
0,056						80563	81563	84563	85563
0,068						80683	81683	84683	85683
0,082	4	13			0,35	80823	81823	84823	85823
0,10	4,5	13,5			0,45	80104	81104	84104	85104

Table 3 U_R (DC) = 63 V; max. AC 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 grams	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			0,5	10274	11274	14274	15274
0,33	5	14,5	10,5	5,08 +0,4 −0,2	0,5	10334	11334	14334	15334
0,39	5	14,5			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 (DC) = 100 V; max. AC voltage = 63 V; Fig. 1; **original pitch 7,62 mm reduced to 5,08 mm**

rated capacitance	T_{max}	H_{max}	L_{max}	P	mass	catalogue number 2222 365			
						reel packing		ammunition packing	
μF					grams	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,039	4	13,5	10	5,08 +0,4 −0,2	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 (DC) = 250 V; max. AC voltage = 160 V; Fig. 1; **original pitch 7,62 mm reduced to 5,08 mm**

rated capacitance	T_{max}	H_{max}	L_{max}	P	mass	catalogue number 2222 365			
						reel packing		ammunition packing	
μF					grams	tol. ± 20%	tol. ± 10%	tol. ± 20%	tol. ± 10%
0,018	4	13,5	10	5,08 +0,4 −0,2	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 (DC) = 400 V; max. AC 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 grams	catalogue number 2222 365 ..... reel packing tol. ± 20%	reel packing tol. ± 10%	ammunition packing tol. ± 20%	ammunition packing tol. ± 10%
0,0033						50332	51332	54332	55332
0,0039						50392	51392	54392	55392
0,0047				5,08		50472	51472	54472	55472
0,0056						50562	51562	54562	55562
0,0068	4	13,5	10	+0,4	0,4	50682	51682	54682	55682
0,0082				−0,2		50822	51822	54822	55822
0,010						50103	51103	54103	55103
0,012						50123	51123	54123	55123
0,015						50153	51153	54153	55153

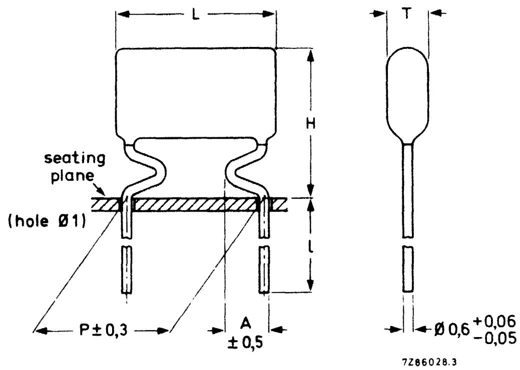


Fig. 2 Capacitors 2222 365.

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 mm
6 for capacitors with ℓ = 4 mm
e.g.: **2222 366 70473 → 2222 366 72473.**

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

rated capacitance μF	T_{max}	H_{max}	L_{max}	A	P	mass grams	catalogue number 2222 366 ..... ℓ = 17 ± 4 tol. ± 20%	ℓ = 17 ± 4 tol. ± 10%	ℓ = 4 + 1 − 0,5 tol. ± 20%	ℓ = 4 + 1 − 0,5 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 (DC) = 100 V; max. AC voltage = 63 V; Fig. 2; **pitch = 5,08 mm**

rated capaci-tance μF	T_{max}	H_{max}	L_{max}	A	P	mass grams	catalogue number 2222 366 ..... ℓ = 17 ± 4 tol. ± 20%	ℓ = 17 ± 4 tol. ± 10%	ℓ = 4 + 1 − 0,5 tol. ± 20%	ℓ = 4 + 1 − 0,5 tol. ± 10%
0,01	3,5	12,5	7,5	1,7 ± 0,3	5,08 ± 0,3		80103	81103	84103	85103
0,012							80123	81123	84123	85123
0,015							80153	81153	84153	85153
0,018							80183	81183	84183	85183
0,022							80223	81223	84223	85223
0,027							80273	81273	84273	85273
0,033							80333	81333	84333	85333
0,039							80393	81393	84393	85393
0,047							80473	81473	84473	85473
0,056							80563	81563	84563	85563
0,068							80683	81683	84683	85683
0,082	4	13				0,35	80823	81823	84823	85823
0,10	4,5	13,5				0,45	80104	81104	84104	85104

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

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

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

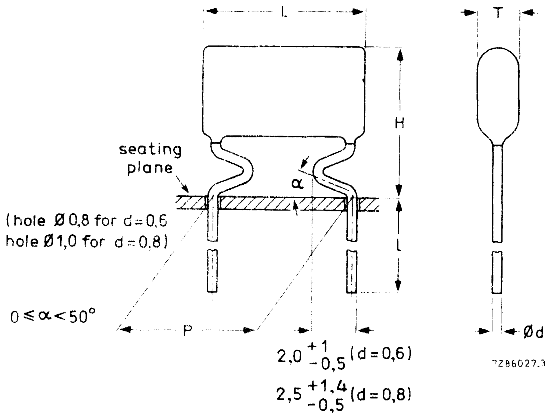
rated capacitance µF	T_{max}	H_{max}	L_{max}	A	P	mass grams	catalogue number 2222 366 ..... ℓ = 17 ± 4 tol. ± 20%	ℓ = 17 ± 4 tol. ± 10%	ℓ = 4 + 1 − 0,5 tol. ± 20%	ℓ = 4 + 1 − 0,5 tol. ± 10%
0,039							20393	21393	24393	25393
0,047							20473	21473	24473	25473
0,056	4	12	10			0,4	20563	21563	24563	25563
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	13,5	10,5			0,6	20184	21184	24184	25184
0,22	5,5	13,5				0,7	20224	21224	24224	25224
0,27	6	14,5				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 (DC) = 250 V; max. AC voltage = 160 V; Fig. 2; **pitch = 7,62 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	A	P	mass grams	catalogue number 2222 366 ..... ℓ = 17 ± 4 tol. ± 20%	ℓ = 17 ± 4 tol. ± 10%	ℓ = 4 + 1 − 0,5 tol. ± 20%	ℓ = 4 + 1 − 0,5 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 (DC) = 400 V; max. AC voltage = 220 V; Fig. 2; **pitch = 7,62 mm**

rated capacitance µF	T_{max}	H_{max}	L_{max}	A	P	mass grams	catalogue number 2222 366 ..... ℓ = 17 ± 4 tol. ± 20%	ℓ = 17 ± 4 tol. ± 10%	ℓ = 4 + 1 − 0,5 tol. ± 20%	ℓ = 4 + 1 − 0,5 tol. ± 10%
0,0033							50332	51332	54332	55332
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



pitch P	lead length ℓ	
	short leads	4 + 1 − 0,5
10,16 15,24	long leads	19 ± 4
22,86		25 ± 4
27,94		24 ± 4

Fig. 3 Capacitors 2222 368

In addition to the capacitors quoted in Tables 13 to 17, 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 2**4**563 → 2222 368 2**6**563.

Table 13 U_R (DC) = 63 V; max. AC voltage = 40 V, Fig. 3

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	P	mass grams	catalogue number 2222 368 ..... short leads tol. ± 20%	short leads tol. ± 10%	long leads tol. ± 20%	long leads tol. ± 10%
0,22	4,5	12,5	12,5	0,6 +0,06 −0,05	10,16 ± 0,3	0,45	14224	15224	10224	11224
0,27							14274	15274	10274	11274
0,33							14334	15334	10334	11334
0,39							14394	15394	10394	11394
0,47	5	13				0,5	14474	15474	10474	11474
0,56	5	13				0,5	14564	15564	10564	11564
0,68	5,5	13,5				0,55	14684	15684	10684	11684
0,82	6	14				0,6	14824	15824	10824	11824
1,0	6,5	14,5				0,7	14105	15105	10105	11105

Table 14 U_R (DC) = 100 V; max. AC voltage = 63 V, Fig. 3

rated capaci-tange µF	T_{max}	H_{max}	L_{max}	d	P	mass grams	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

Table 15 U_R (DC) = 250 V; max AC voltage = 160 V; Fig. 3

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	P	mass grams	catalogue number 2222 368 ..... short leads tol. ± 20%	short leads tol. ± 10%	long leads tol. ± 20%	long leads tol. ± 10%
0,027	4	12	12,5	0,6 + 0,06 −0,05	10,16 ± 0,3	0,4	44273	45273	40273	41273
0,033							44333	45333	40333	41333
0,039							44393	45393	40393	41393
0,047							44473	45473	40473	41473
0,056	4,5	12,5				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	17,5	0,8 + 0,08 −0,05	15,24 ± 0,3	0,65	44124	45124	40124	41124
0,15	5	14				0,7	44154	45154	40154	41154
0,18	5,5	14,5				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	26		22,86 ± 0,3	1,8	44394	45394	40394	41394
0,47	5,5	17,5				2,1	44474	45474	40474	41474
0,56	6	18				2,5	44564	45564	40564	41564
0,68	6,5	18,5				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	30		27,94 ± 0,3	4	44125	45125	40125	41125
1,5	8,5	20,5				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 16 U_R (DC) = 400 V; max. AC 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						grams	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			27,94	4	54684	55684	50684	51684
0,82	9,5	21,5	30		± 0,3	4,5	54824	55824	50824	51824
1	11	23				5,0	54105	55105	50105	51105

Table 17 U_R (DC) = 630 V; max AC voltage = 220 V; Fig. 3

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	P	mass grams	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

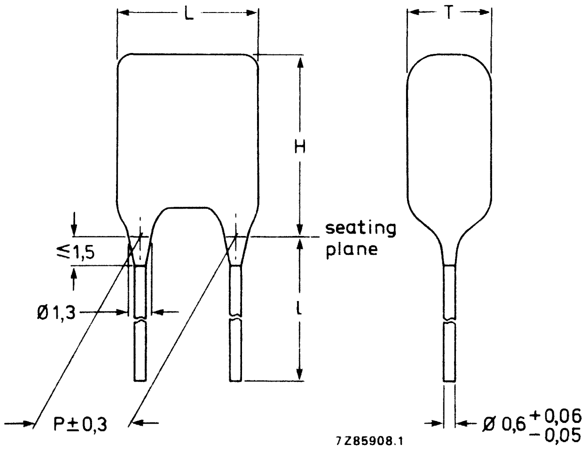


Fig. 4 Capacitors 2222 367.

In addition to the capacitors quoted in Tables 18 to 23, 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 mm
6 for capacitors with ℓ = 4 mm
e.g.: 2222 367 70473 → 2222 367 72473.

Table 18 U_R (DC) = 63 V; max. AC voltage = 40 V; Fig. 4; **pitch = 5,08 mm**

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 367 ..... ℓ = 22 ± 4 tol. ± 20%	ℓ = 22 ± 4 tol. ± 10%	ℓ = 4 + 1 − 0,5 tol. ± 20%	ℓ = 4 + 1 − 0,5 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 19 U_R (DC) = 100 V; max. AC voltage = 63 V; Fig. 4; **pitch = 5,08 mm**

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 367 ..... ℓ = 22 ± 4 tol. ± 20%	ℓ = 22 ± 4 tol. ± 10%	ℓ = 4 + 1 − 0,5 tol. ± 20%	ℓ = 4 + 1 − 0,5 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	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					0,35	80563	81563	84563	85563
→ 0,068						80683	81683	84683	85683
→ 0,082	4	8			0,35	80823	81823	84823	85823
→ 0,10	4,5	8,5			0,45	80104	81104	84104	85104

Table 20 U_R (DC) = 63 V; max. AC voltage = 40 V; Fig. 4; **pitch = 7,62 mm**

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 367 ..... ℓ = 22 ± 4 tol. ± 20%	ℓ = 22 ± 4 tol. ± 10%	ℓ = 4 + 1 − 0,5 tol. ± 20%	ℓ = 4 + 1 − 0,5 tol. ± 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 21 U_R (DC) = 100 V; max. AC voltage = 63 V; Fig. 4; **pitch = 7,62 mm**

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 367 ….. ℓ = 22 ± 4 tol. ± 20%	ℓ = 22 ± 4 tol. ± 10%	ℓ = 4 + 1 − 0,5 tol. ± 20%	ℓ = 4 + 1 − 0,5 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 22 U_R (DC) = 250 V; max. AC voltage = 160 V; Fig. 4; **pitch = 7,62 mm**

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 367 ….. ℓ = 22 ± 4 tol. ± 20%	ℓ = 22 ± 4 tol. ± 10%	ℓ = 4 + 1 − 0,5 tol. ± 20%	ℓ = 4 + 1 − 0,5 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 23 U_R (DC) = 400 V; max. AC voltage = 220 V; Fig. 4; **pitch = 7,62 mm**

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 367 ….. ℓ = 22 ± 4 tol. ± 20%	ℓ = 22 ± 4 tol. ± 10%	ℓ = 4 + 1 − 0,5 tol. ± 20%	ℓ = 4 + 1 − 0,5 tol. ± 10%
0,0033	4	8,5	10	7,62 ± 0,3	0,4	50332	51332	54332	55332
0,0039						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

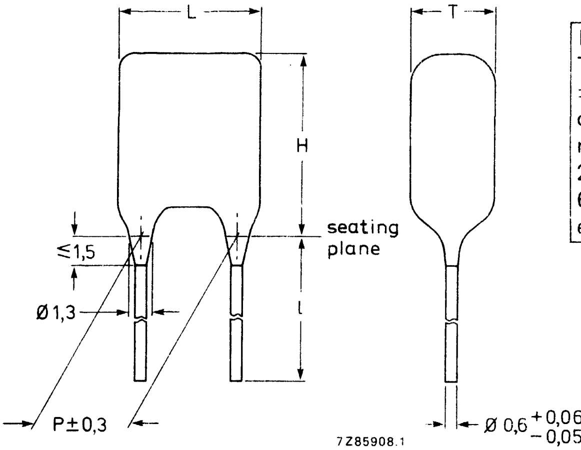


Fig. 5 Capacitors 2222 369.

> In addition to the capacitors quoted in Tables 24 to 28, 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 mm
> 6 for capacitors with ℓ = 4 mm
> e.g.: 2222 369 24563 → 2222 369 26563.

Table 24 U_R (DC) = 63 V; max. AC voltage = 40 V, Fig. 5 (Development data)

→ rated capacitance µF	T_{max}	H_{max}	L_{max}	d	P	mass grams	catalogue number 2222 369 ..... short leads 4 + 1 − 0,5 tol. ± 20%	short leads tol. ± 10%	long leads 22 ± 4 tol. ± 20%	long leads tol. ± 10%
0,22	4,5	10	12,5	0,6 +0,06 −0,05	10,16 ± 0,3	0,45	14224	15224	10224	11224
0,27							14274	15274	10274	11274
0,33							14334	15334	10334	11334
0,39							14394	15394	10394	11394
0,47	5	10,5				0,5	14474	15474	10474	11474
0,56	5	10,5				0,5	14564	15564	10564	11564
0,68	5,5	11				0,55	14684	15684	10684	11684
0,82	6	11,5				0,6	14824	15824	10824	11824
1,0	6,5	12				0,7	14105	15105	10105	11105

Table 25 U_R (DC) = 100 V; max. AC voltage = 63 V, Fig. 5

rated capaci-tance	T_{max}	H_{max}	L_{max}	d	P	mass	catalogue number 2222 369			
							short leads 4 + 1 −0,5		long leads 22 ± 4	
μF						grams	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 26 U_R (DC) = 250 V; max. AC voltage = 160 V; Fig. 5

rated capaci-tance	T_{max}	H_{max}	L_{max}	d	P	mass	catalogue number 2222 369			
							short leads 4 + 1 −0,5		long leads 22 ± 4	
μF						grams	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

*For larger pitches a straight lead version is available to special order.

Table 27 U_R (DC) = 400 V; max. AC voltage = 220 V; Fig 5

rated capaci- tance µF	T_{max}	H_{max}	L_{max}	d	P	mass grams	catalogue number 2222 369 ..... short leads 4 + 1 −0,5 tol. ± 20%	short leads tol. ± 10%	long leads 22 ± 4 tol. ± 20%	long leads 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 28 U_R (DC) = 630 V; max. AC voltage = 220 V; Fig. 5

rated capaci- tance µF	T_{max}	H_{max}	L_{max}	d	P	mass grams	catalogue number 2222 369 ..... short leads 4 + 1 −0,5 tol. ± 20%	short leads tol. ± 10%	long leads 22 ± 4 tol. ± 20%	long leads 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

*For larger pitches a straight lead version is available to special order.

Marking

The following information is provided:

- Rated capacitance value
- Rated voltage
- Rated capacitance tolerance
- Category voltage
- Year and month or week of manufacture
- Manufacturer's name
- Climatic category
- Manufacturer's type designation
- Styles 2222 365, 2222 366 and 2222 367

  Capacitors with a pitch of 5,08 mm are marked in black ink on the top edge as follows:

  line 1: rated capacitance in μF without unit symbol
  line 2: tolerance code (M = ± 20%; K = ± 10%; J = ± 5%)
  rated DC voltage without unit symbol
  example: 0,047
  K 63

  Capacitors with a pitch of 5,08 (7,62) mm or 7,62 mm are marked in black ink on the top edge as follows:

  line 1: rated capacitance in pF or μF without unit symbol tolerance code (M = ± 20%; K = ± 10%; J = ± 5%)
  line 2: rated DC voltage without unit symbol
  code for dielectric material (MKT)
  example: 0,047 K
  100 MKT

- Styles 2222 368 and 2222 369

  Capacitors within these categories are marked in black ink on the top edge as follows:

  line 1: rated capacitance in pF or μF
  tolerance (± 20% identified by M or 20%; ± 10% by K or 10% and ± 5% by J or 5%)
  line 2: rated DC 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 all the above information.

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 28
Tolerance on rated capacitance	see Tables 1 to 28

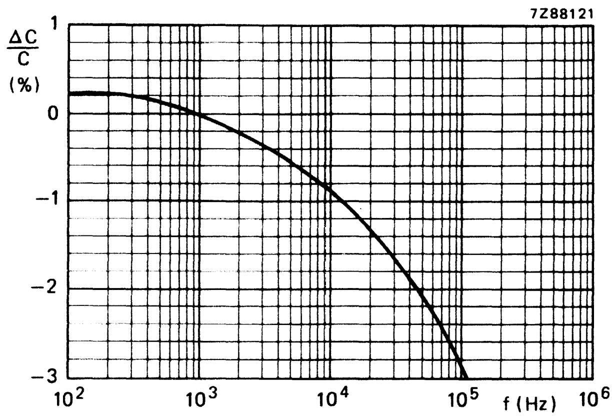


Fig. 6 Capacitance as a function of frequency; typical curve.

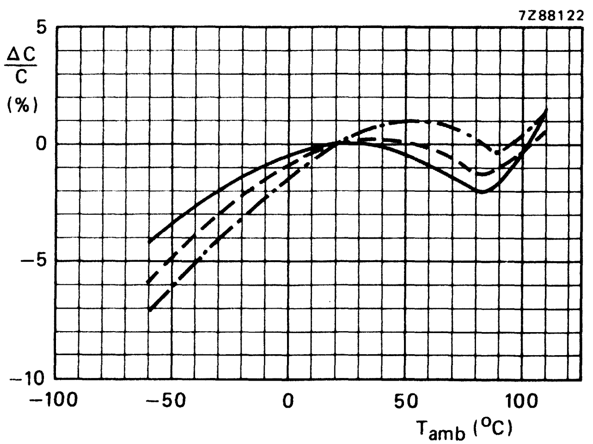


Fig. 7 Capacitance as a function of ambient free air temperature; typical curves.

——— 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 (DC)	See Tables 1 to 28
Category voltage U_C	0,8 x U_R (DC)
Maximum AC voltage (RMS value), at 50 to 60 Hz	see Tables 1 to 28
Test voltage	
between terminations	1,6 x U_R (DC)
between interconnected terminations and case	2 x U_R (DC); 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 DC voltage and the peak value of the superimposed AC voltage must be $\leqslant U_R$ (DC).
- For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

Maximum pulse load

Table 29 Maximum pulse load per voltage/length

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	9	15			
100	55	18	24	10	4	3,5
250		35	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

Table 30 Tangent of loss angle per range/frequency

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

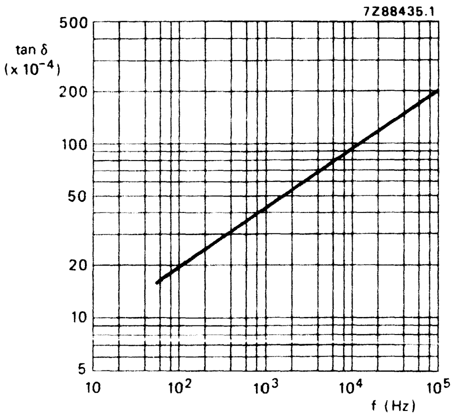


Fig. 8 Tan δ as a function of frequency, typical curve.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 minute ± 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

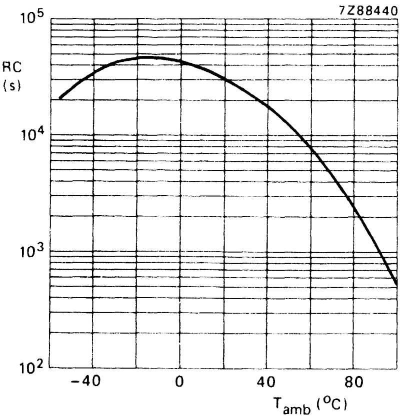


Fig. 9 RC-product as a function of ambient free air temperature; typical curve.

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.

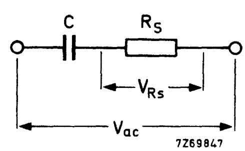
If the requirement for the maximum permissible power dissipation is satisfied, a check must be made to ascertain that the maximum permissible pulse load is not exceeded.

The maximum AC 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 AC 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 AC 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

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



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

As $\tan\delta = R_s\omega C = < 0{,}1$, 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 $P = R_s\omega^2 C^2 V_{ac}{}^2$ (3a)

or $P = (R_sC)\, C\omega^2 V_{ac}{}^2$ (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 AC voltage of 10 V, a frequency of 10 kHz and an ambient temperature of 50 ^{o}C.

The R_sC-product is $2 \times 10^{-7}\,\Omega$F (from Fig. 10), so that the power to be dissipated is

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

For an AC voltage of 10 V a capacitor of the 63 V range is required.

Capacitor 0,1 μF/63 V_{ac} 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 ^{o}C.

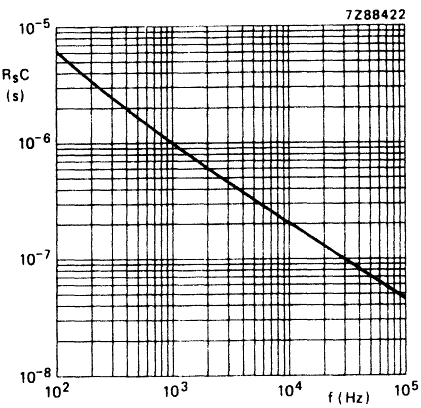


Fig. 10 Maximum product of series resistance and capacitance as a function of frequency.

Table 31 Power dissipation for different dimensions, styles 2222 365, 366 and 367

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

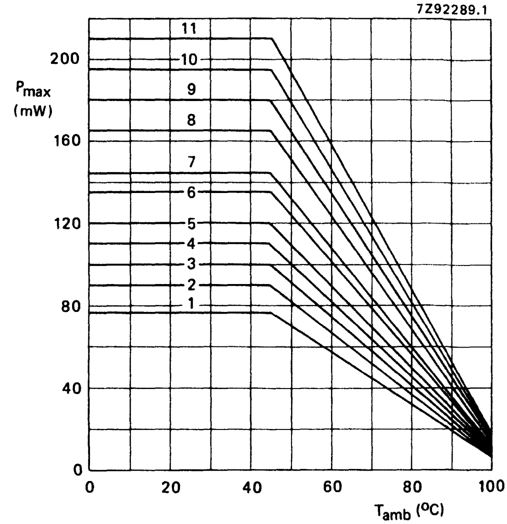


Fig. 11 Maximum dissipation as a function of ambient free air temperature, styles 2222 365, 2222 366 and 2222 367.

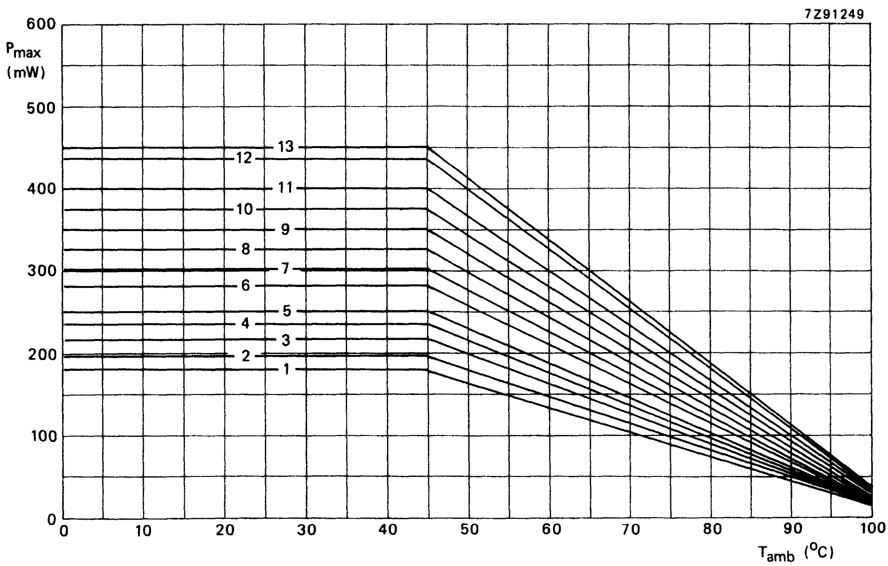


Fig. 12a Maximum dissipation as a function of ambient free air temperature; styles 2222 368 and 2222 369.

Table 32 Power dissipation for different dimensions, styles 2222 368 and 369

curve	dimensions (mm) T_{max}	dimensions (mm) 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

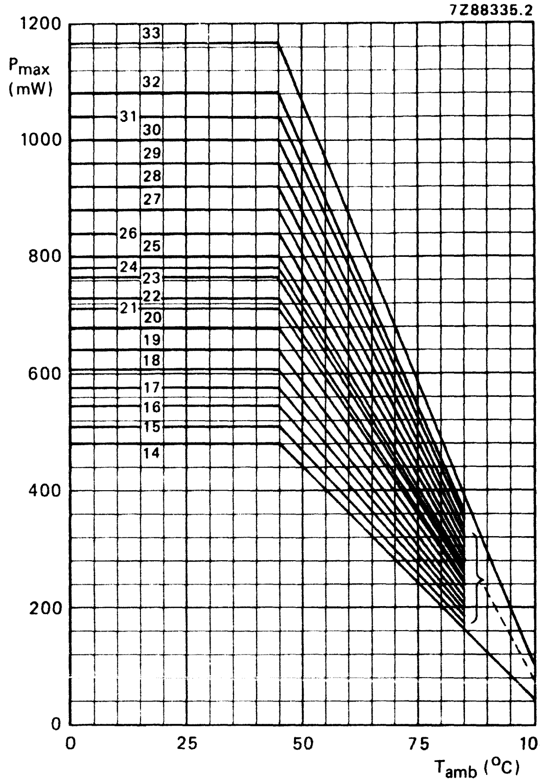


Fig. 12b Maximum dissipation as a function of ambient free air temperature; **styles 2222 368 and 2222 369.**

PACKING

Characteristics concerning taped capacitors:

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

Storage conditions:

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

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.

Table 33 Number of capacitors per box

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	$\leq$ 7 $\geq$ 7,5	1000 1000	1000 500
30	$\leq$ 9,5 $9,5 < T_{max} < 12,0$ $\geq$ 12,0	500 500 250	500 250 250

Style 2222 365

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

Table 34 Number of capacitors on reel or ammunition packing

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

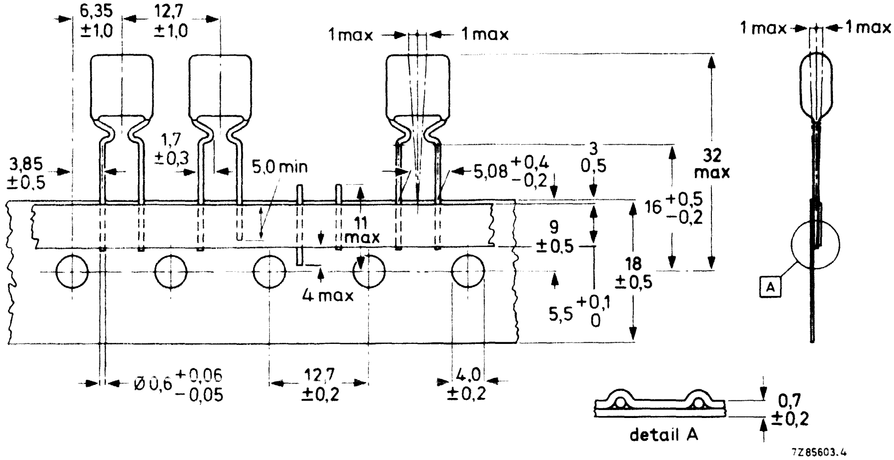


Fig. 13 Capacitors on tape.

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.

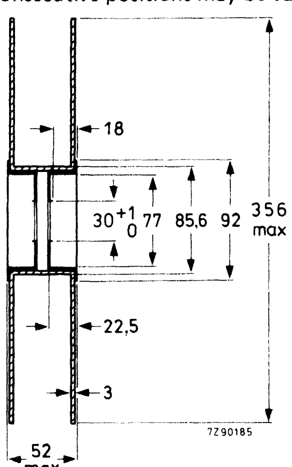


Fig. 14 Reel.

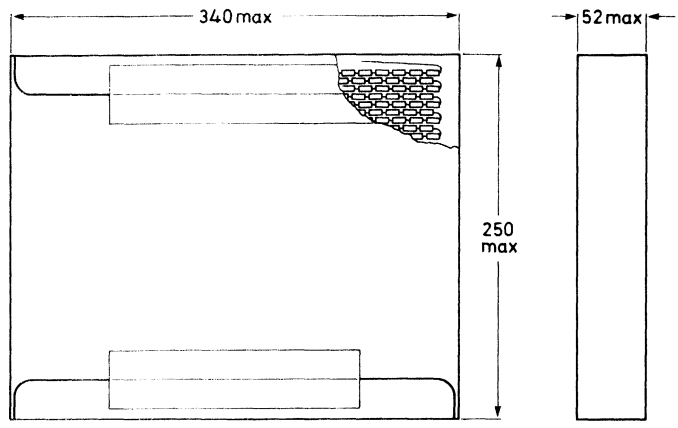


Fig. 15 Capacitors on tape in ammunition packing.

INSPECTION REQUIREMENTS

metallized polyethylene-terephthalate 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 × U_R (DC) 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.	No mechanical failures. Legible marking and as specified in GENERAL DATA of this specification.
As specified in Tables in GENERAL DATA.	As specified in Tables in GENERAL DATA.
No breakdown or flashover.	No breakdown or flashover.
Within specified tolerance.	Within specified tolerance.
As in GENERAL DATA of this specification.	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 C1A Part of sample of Sub-group C1	D		
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	
4.14 Component solvent resistance		Mixture: 1, 1, 2-trichlorotrifluoro-ethane to 2-propanol (isopro-pylalcohol) Temperature: 23 ± 5 °C Method: 2 Immersion time: 5 ± 0,5 minutes	
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 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	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 minutes 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 hours	
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. $\Delta C/C \leqslant 3\%$ of the value measured in 4.6.1.
		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 4.6.1.
		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 grams 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 hours	
4.10.3 Damp heat cyclic, Test Db, first cycle			
4.10.4 Cold		Temperature: lower category temperature Duration: 2 hours	
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 hours; 1,25 U_R (DC) at 85 ^{o}C, 1,25 U_C at 100 ^{o}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 370-371) 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 = $\dfrac{U_R}{C_R \cdot 5 \ (\frac{dU}{dt})\ R}$ 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 Solderability		Without ageing Method 1 Non-activated colophany flux 501 Solder bath: 235 °C Dwell time: 2 s	Good tinning as evidenced by free flowing of the solder with wetting of the terminations (> 95%)
A.1.1 Solvent resistance of the marking		Mixture: 1, 1, 2-trichlorotrifluoro-ethane and 2-propanol (isopropylalcohol) Temperature: 23 ± 5 °C Method 1 Rubbing material: cotton wool Immersion time: 5 ± 0,5 minutes	Legible marking
Sub-group ADD2	D		
A.2 Heat storage		Duration: 2000 hours Temperature: upper category temperature	
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**
Good tinning as evidenced by free flowing of the solder with wetting of the terminations ($>$ 95%)	Good tinning as evidenced by free flowing of the solder with wetting of the terminations ($>$ 95%)
Legible marking	Legible marking
$\Delta C/C \leqslant 3\%$ of value measured in A.2.1. 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 A.2.1.	$\Delta C/C \leqslant 3\%$ 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.	As in GENERAL DATA of this specification.

additional tests	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD3			
A.3 Endurance for capacitors with max. AC voltage $\geqslant$ 200 V (RMS)		Duration: 1000 hours Temperature: 85 °C Voltage: 1,25 x max. AC voltage (RMS value), 50 Hz	
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	$\Delta C/C \leqslant 5\%$ 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	As in GENERAL DATA of this specification.

performance requirements **2222 344-370-371**	performance requirements **2222 365 to 369**
$\Delta C/C \leqslant 3\%$ ($\leqslant 5\%$ for 2222 370) 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. As in GENERAL DATA of this specification.	$\Delta C/C \leqslant 5\%$ 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. As in GENERAL DATA of this specification.

additional tests	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD4		**GROUP 1:**	
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 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 requirements **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.

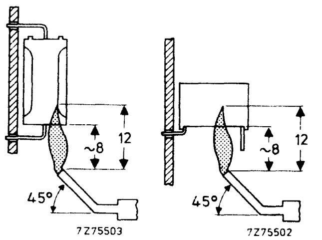
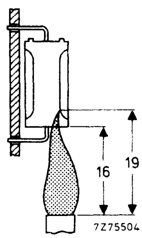
additional tests	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD5			
A.5 Detergent resistance		Density 20g/l dishwasher detergent. Temperature 70 °C, during 3 minutes Followed by rinsing in clear water for 1 minute Recovery time > 2 hours	
A.5.1 Initial measurements		Capacitance 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	$\Delta C/C \leqslant 1\%$ 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.
		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.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. $\geqslant 50\%$ of values in GENERAL DATA of this specification.	$\Delta C/C \leqslant 1\%$ 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. $\geqslant 50\%$ of values in GENERAL DATA of this specification.

additional tests	D or ND	conditions of tests	performance requirements **2222 341**
Sub-group ADD6	D		
A.6 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.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	
A.6.2 Final measurements		Capacitance	$\Delta C/C \leqslant 2\%$ for $C \leqslant 10$ nF, $\leqslant 1\%$ for $C > 10$ nF of value measured in A.6.1.
		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.6.1.

* 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.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 A.6.1.	$\Delta C/C \leqslant$ 2% for $C \leqslant$ 10 nF, $\leqslant$ 1% for $C >$ 10 nF of value measured in A.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 A.6.1.

additional tests	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD7	D		
A.7.1 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.7.2 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.
Sub-group ADD8			
A.8 Climatic test on taped types		250 hours at 40 ± 2 °C R.H. 90 to 95% Recovery time 24 hours	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 ⩽ 0,05 mm. Angle of component ⩽ 4°. Pull off, pull out and tearing forces ⩾ 50% of values in GENERAL DATA of this specification.	**Only applicable to 2222 365** Change in position of lead hole over 10 pitch distances ⩽ 0,05 mm. Angle of component ⩽ 4°. Pull off, pull out and tearing forces ⩾ 50% of values in GENERAL DATA of this specification.

POLYETHYLENE-TEREPHTHALATE FILM/FOIL CAPACITORS (KT)

POLYETHYLENE-TEREPHTHALATE FILM/FOIL CAPACITORS

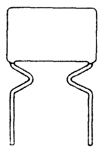
KT radial phenolic lacquered type

- 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 (DC)	100 V, 250 V, 400 V, 630 V
Climatic category, IEC 68	40/100/21
Rated temperature	85 ^{o}C
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 DC or AC operation.

DESCRIPTION

These capacitors consist of a low-inductance wound cell of metal foil and a polyethylene-terephthalate (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

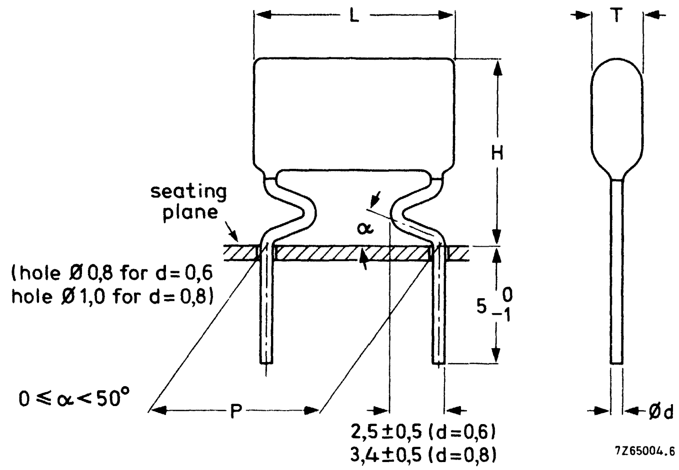


Fig. 1 Capacitors 2222 347.

Table 1 U_R (DC) = 100 V; max. AC voltage = 50 V, Fig. 1

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

Table 2 U_R (DC) = 250 V; max. AC voltage = 80 V, Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	P	mass grams	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 (DC) = 400 V; max. AC voltage = 125 V, Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	P	mass grams	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 (DC) = 630 V; max. AC voltage = 200 V, Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	P	mass grams	catalogue number 2222 347 . . . . . tol. ± 20%	catalogue number 2222 347 . . . . . tol. ± 10%
0,001	5,5	13	13,5	0,6 + 0,06 −0,05	10,16 ± 0,3	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				0,6	60272	61272
0,0033	5,5	13				0,5	60332	61332
0,0039	5,5	13				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	19	0,8 + 0,08 −0,05	15,24 ± 0,3	1,1	60822	61822
0,010	6	14,5				1,2	60103	61103
0,012	6,5	15				1,3	60123	61123
0,015	7	15,5				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	27		22,86 ± 0,3	2,5	60273	61273
0,033	7,5	18,5				2,8	60333	61333
0,039	8	19,5				3,0	60393	61393
0,047	8,5	20				3,5	60473	61473
0,056	9,5	21				3,8	60563	61563
0,068	10,5	22				4,4	60683	61683
0,082	10	21,5	32		27,94 ± 0,3	5,2	60823	61823
0,1	11	22,5				6,2	60104	61104
0,12	12	23,5				7,2	60124	61124
0,15	13,5	25				8,7	60154	61154

Marking

The following information is provided:

- Rated capacitance value
- Rated voltage
- Rated capacitance tolerance
- Category voltage
- Year and month of manufacture
- Manufacturer's name
- Climatic category
- Manufacturer's type designation

The capacitors are marked in black ink on the top edge as follows:

line 1: rated capacitance in pF or μF
tolerance (± 20% indicated by M or 20%, ± 10% by K or 10%)
line 2: rated DC voltage
code for dielectric material (KT)

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 all of the information listed above.

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

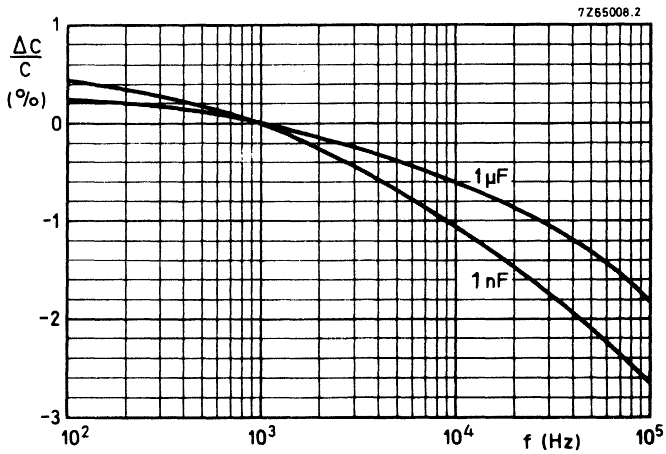


Fig. 2 Capacitance as a function of frequency; typical curves.

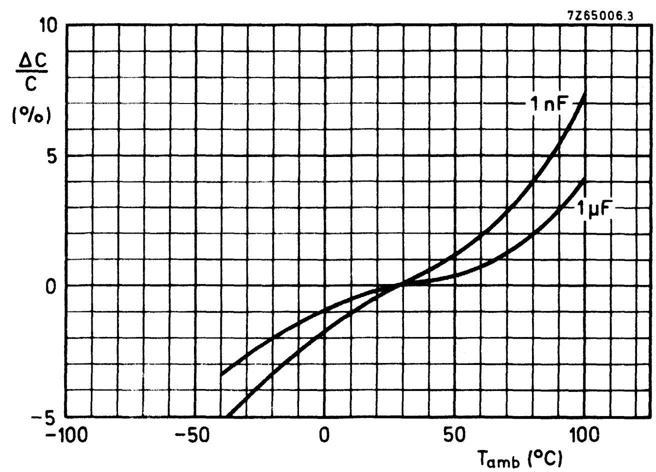


Fig. 3 Capacitance as a function of ambient free air temperature; typical curves.

Voltage

Rated voltage U_R (DC)	See Tables 1 to 4
Category voltage U_C	0,8 x U_R (DC)
Maximum AC voltage (RMS value), at 50 to 60 Hz	See Tables 1 to 4
Test voltage between terminations	2 x U_R (DC)

Notes
- The sum of the DC voltage and the peak value of the superimposed AC voltage must be $\leqslant U_R$ (DC)
- 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 x 10^{-4}
Tan δ at 1 kHz	$\leqslant$ 60 x 10^{-4}

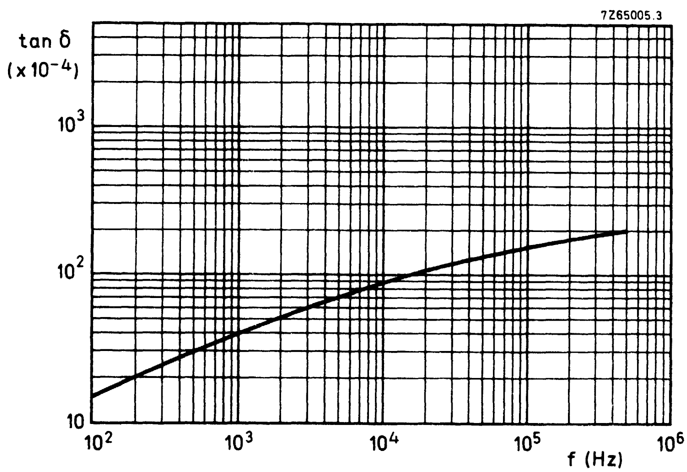


Fig. 4 Tan δ as a function of frequency; typical curve.

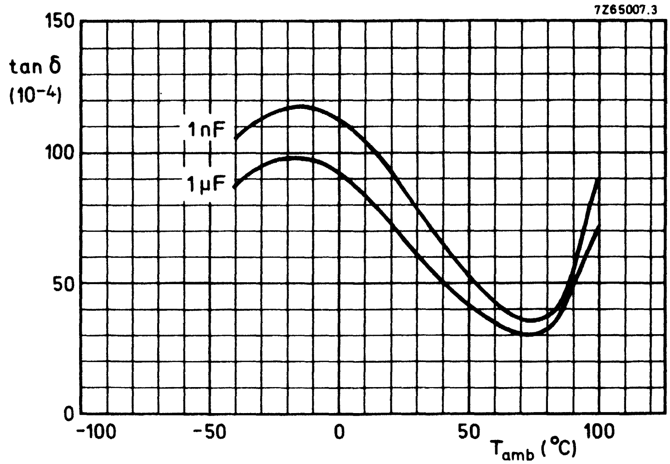


Fig. 5 Tan δ as a function of ambient free air temperature; typical curves.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 minute ± 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

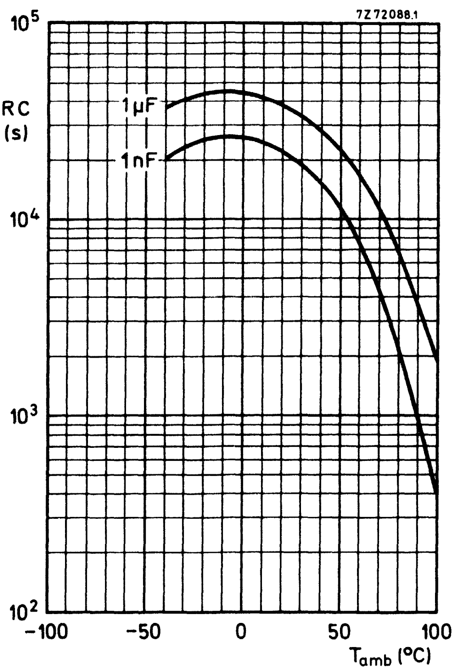
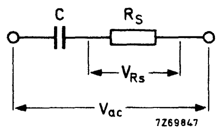


Fig. 6 RC-product as a function of ambient free air temperature; typical curves.

Maximum dissipation

The maximum AC 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 AC 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



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

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

As $\tan \delta = R_s \omega C = < 0{,}1$, the formula (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 AC voltage of 100 V, a frequency of 10 kHz and an ambient free air temperature of 50 °C. Thus the rated DC 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 AC voltage of 100 V a capacitor of the 400 V series is required at least.
Capacitor 0,047 µF/125 V_{ac} 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.

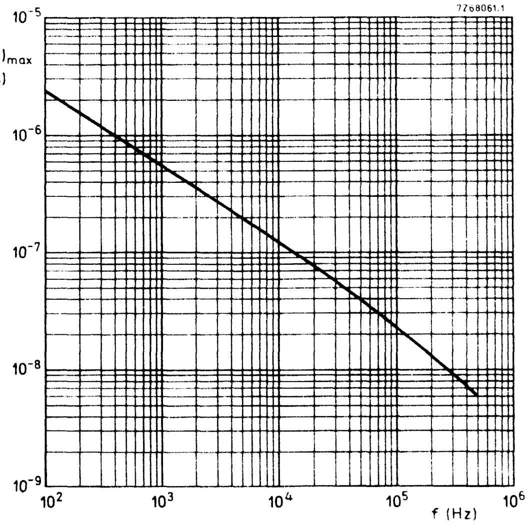


Fig. 7 Maximum product of series resistance and capacitance as a function of frequency.

Table 5 Power dissipation for different dimensions

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

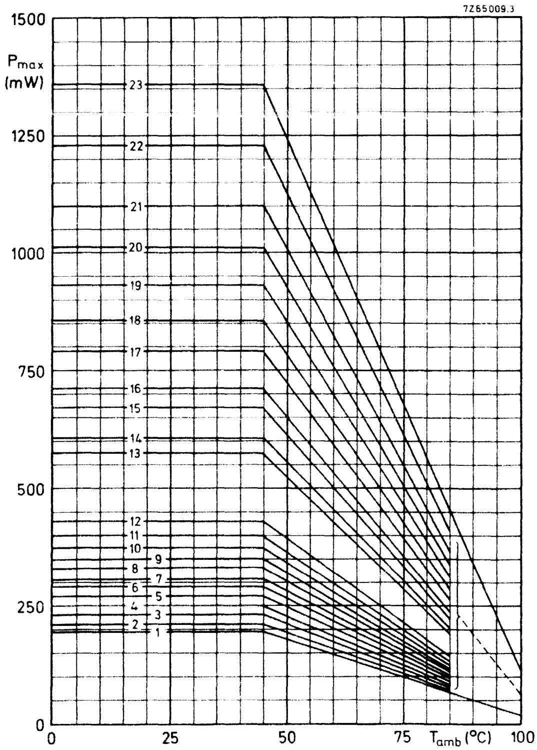


Fig. 8 Maximum dissipation as a function of ambient free air temperature.

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.

Table 6 Number of capacitors per box

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

INSPECTION REQUIREMENTS

polyethylene-terephthalate 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 (DC) 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 Capacitance	No visible damage. Legible marking. $\Delta C/C \leqslant 2\%$ 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 minutes 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 hours	
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.

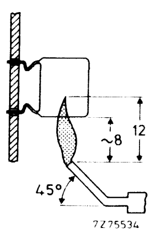
Note:

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 grams 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 hours	
4.10.3 Damp heat cyclic, Test Db, first cycle			
4.10.4 Cold		Temperature: lower category temperature Duration: 2 hours	
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 hours; 1,5 U_R (DC) 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 hours 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. AC voltage $\geqslant$ 200 V (RMS)		Duration: 1000 hours Temperature: 85 ^{o}C Voltage: 1,25 x max. AC voltage (RMS 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	$\Delta C/C \leqslant 2\%$ 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

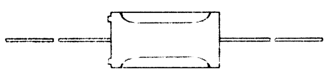
MKC axial moulded type

- 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 (DC)	100 V, 250 V, 400 V, 630 V, 1000 V
Climatic category	55/100/56
Rated temperature	85 °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

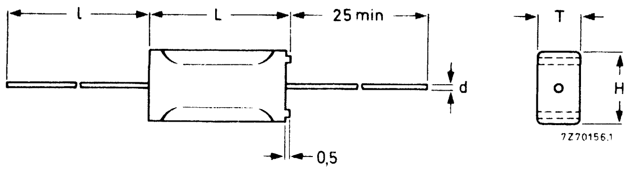


Fig. 1 Capacitors 2222 341.

Table 1 U_R (DC) = 100 V; max. AC voltage = 63 V; Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass grams	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 (DC) = 250 V; max. AC voltage = 160 V; Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass grams	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 (DC) = 400 V; max. AC voltage = 220 V; Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass grams	catalogue number 2222 341		
							tol. ± 20%	tol. ± 10%	tol. ± 5%
0,0082	5,1	8,8	14,6	0,8	40	1,0	58822	59822	57822
0,010							58103	59103	57103
0,012							58123	59123	57123
0,015							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			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	1	50	5,5	58394	59394	57394
0,47							58474	59474	57474
0,56	12,5	19,5	31			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 (DC) = 630 V; max. AC voltage = 220 V; Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass grams	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 (DC) = 1000 V; max. AC voltage = 250 V; Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	d	ℓ min	mass grams	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

The following information is provided:

- Rated capacitance value
- Rated voltage
- Rated capacitance tolerance
- Category voltage
- Year and month of manufacture
- Manufacturer's name
- Climatic category
- Manufacturer's type designation

The capacitors are marked by impression on one side as follows:

line 1: rated capacitance in pF or µF, tolerance and rated DC voltage
line 2: 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 capacitors are also marked by impression on the other side as follows:

line 1: manufacturer's name
line 2: code for factory of origin

The package containing the capacitors is marked with all of the above information.

Mounting

The capacitors are for a horizontal or vertical mounting on printed circuit 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 ^{o}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

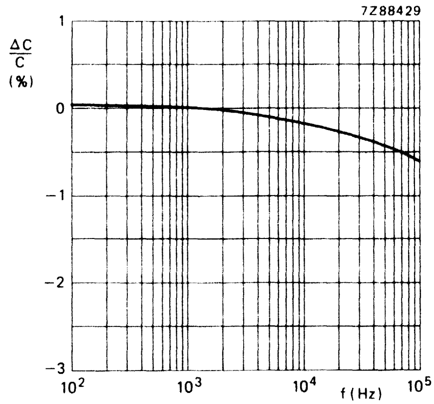


Fig. 2 Capacitance as a function of frequency; typical curve.

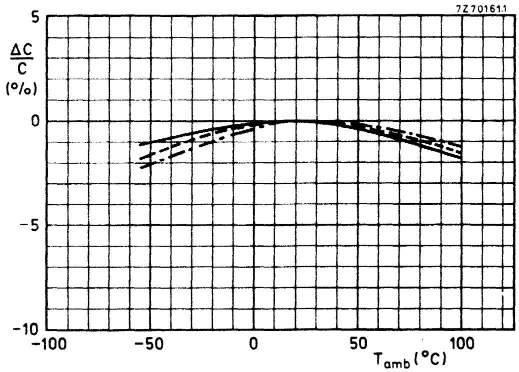


Fig. 3 Capacitance as a function of ambient free air temperature; typical curves.
——— for all capacitance values, measured at 1 kHz, 1 V.
– – – – for capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.
– · – · – for capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Voltage

Rated voltage U_R (DC)	See Tables 1 to 5
Category voltage U_C	0,8 x U_R (DC)
Maximum AC voltage (RMS value), at 50 to 60 Hz	See Tables 1 to 5
Test voltage	
between terminations	1,6 x U_R (DC)
between interconnected terminations and case	2 x U_R (DC) ; minimum 200 V

Temperature

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

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

Maximum pulse load

Table 6 Maximum pulse load per voltage/length

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

Table 7 Tangent of loss angle per range/frequency

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

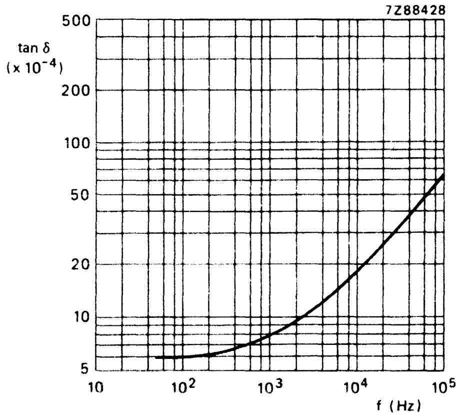


Fig. 4 Tan δ as a function of frequency, typical curve.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 minute ± 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

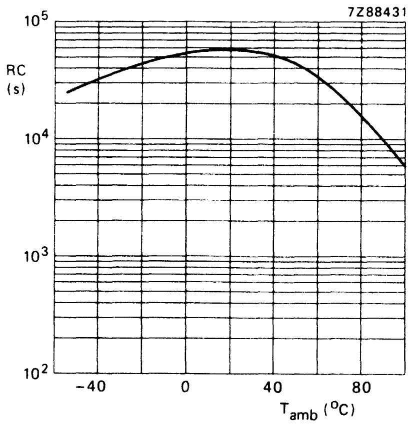


Fig. 5 RC-product as a function of ambient free air temperature; typical curve.

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.

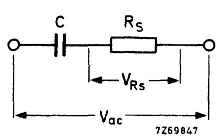
If the requirement for the maximum dissipation is satisfied, a check must be made to ascertain that the maximum pulse load is not exceeded.

The maximum AC 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 AC 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 AC 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

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



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

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

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

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. 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 AC voltage of 130 V, a frequency of 1 kHz and an ambient free air temperature of 50 $^{\circ}$C.

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

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

For an AC voltage of 130 V a capacitor of the 250 V version is required.

Capacitor 1 μF/160 V_{ac} 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 $^{\circ}$C.

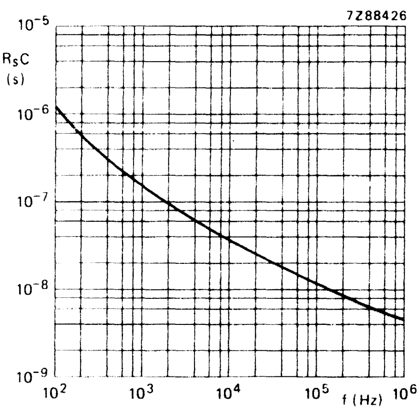


Fig. 6 Maximum product of series resistance and capacitance as a function of frequency.

Table 8 Power dissipation for different dimensions

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

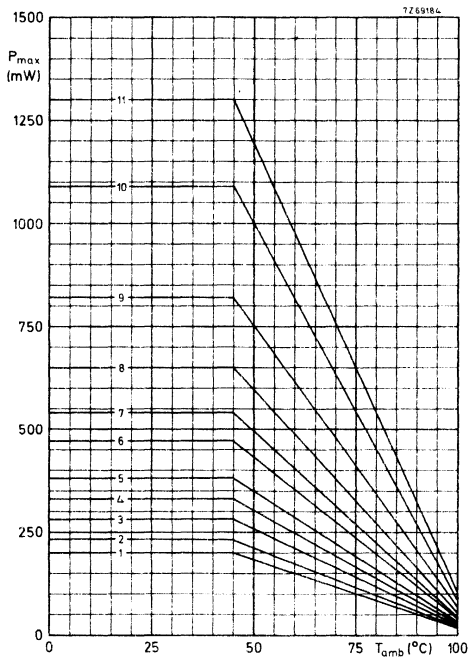


Fig. 7 Maximum dissipation as a function of ambient free air temperature.

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

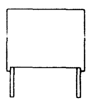
MKC radial potted type

- 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 (DC)	100 V, 250 V, 400 V, 630 V
Climatic category	55/100/56
Rated temperature	85 °C
Tangent of loss angle at 10 kHz	20×10^{-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

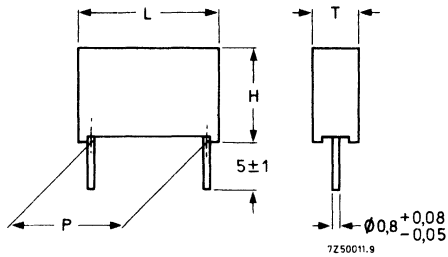


Fig. 1 Capacitors 2222 344.

Table 1 U_R (DC) = 100 V; max. AC voltage = 63 V, Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass grams	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 (DC) = 250 V; max. AC voltage = 160 V, Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass grams	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 (DC) = 400 V; max. AC voltage = 220 V, Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 344		
						tol. ± 20%	tol. ± 10%	tol. ± 5%
0,010	4,5	10	13	10 ± 0,3	0,7	50103	51103	52103
0,012	4,5	10				50123	51123	52123
0,015	4,5	10				50153	51153	52153
0,018	4,5	10				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	17,5	15 ± 0,3	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			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	26	22,5 ± 0,3	2,75	50184	51184	52184
0,22	6,5	15,5				50224	51224	52224
0,27	7,5	16,5			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	31	27,5 ± 0,3	7,4	50564	51564	52564
0,68	11	20				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 (DC) = 630 V; max. AC voltage = 220 V, Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass grams	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

The following information is provided:

- Rated capacitance value
- Rated voltage
- Rated capacitance tolerance
- Category voltage
- Year and month of manufacture
- Manufacturer's name
- Climatic category
- Manufacturer's type designation

The capacitors are marked on the top by embossed print as follows:
line 1: rated capacitance in µF, tolerance and rated DC voltage
line 2: last eight digits of the catalogue number.

The package containing the capacitors is marked with all of the above information.

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

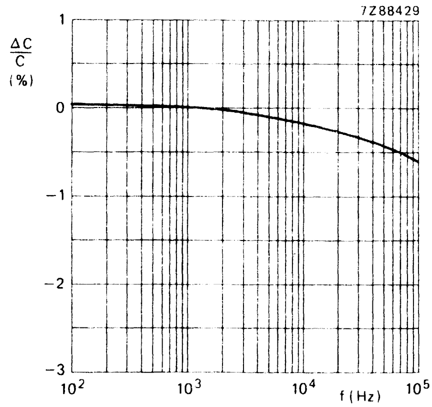


Fig. 2 Capacitance as a function of frequency; typical curve.

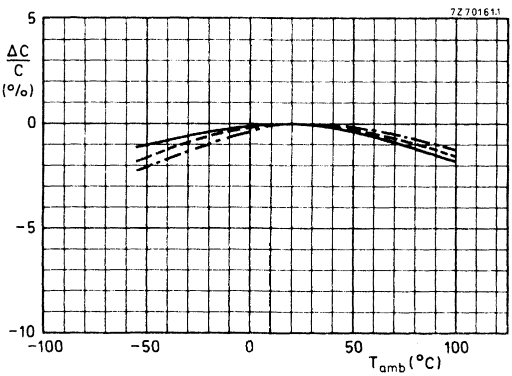


Fig. 3 Capacitance as a function of ambient free air temperature; typical curves.
——— for all capacitance values, measured at 1 kHz, 1 V.
– – – – for capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.
– · – · – for capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Voltage

Rated voltage U_R (DC)	See Tables 1 to 4
Category voltage U_C	0,8 x U_R (DC)
Maximum AC voltage (RMS value), at 50 to 60 Hz	See Tables 1 to 4
Test voltage	
between terminations	1,6 x U_R (DC)
between interconnected terminations and case	2 x U_R (DC); minimum 200 V

Notes
- The sum of the DC voltage and the peak value of the superimposed AC voltage must be $\leqslant U_R$ (DC).
- 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

Table 5 Maximum pulse load per voltage/length

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

Table 6 Tangent of loss angle per range/frequency

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

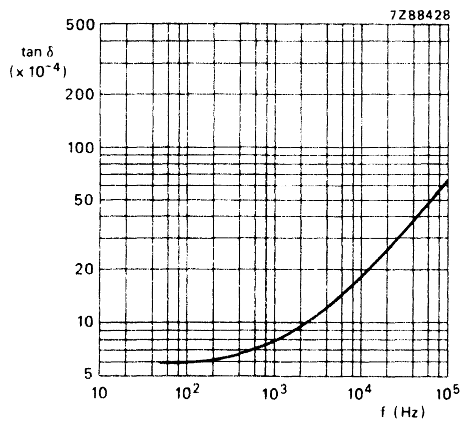


Fig. 4 Tan δ as a function of frequency, typical curve.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 minute ± 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 $T_{amb} = 20\ ^{o}C$.

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

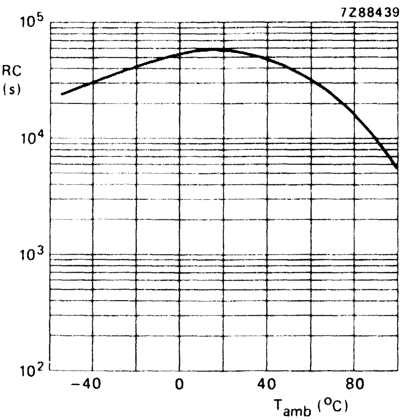


Fig. 5 RC-product as a function of ambient free air temperature; typical curve.

Maximum dissipation

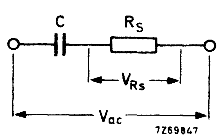
Notes
In applications where voltages higher than 50 V are applied, it is recommended that the power in the capacitor be limited to 2,5 VA in case of capacitor failure.
If the requirement for the maximum dissipation is satisfied, a check must be made to ascertain that the maximum pulse load is not exceeded.

The maximum AC 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 AC 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 AC 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

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



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

As $\tan \delta = R_s \omega C = < 0,1$, 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 $P = R_s \omega^2 C^2 V_{ac}^2$ (3a)

or $P = (R_s C)\, C \omega^2 V_{ac}^2$ (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 AC voltage of 130 V, a frequency of 1 kHz and an ambient free air temperature of 50 °C.

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

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

For an AC voltage of 130 V a capacitor of the 250 V version is required.

Capacitor 1 μF/160 V_{ac} 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.

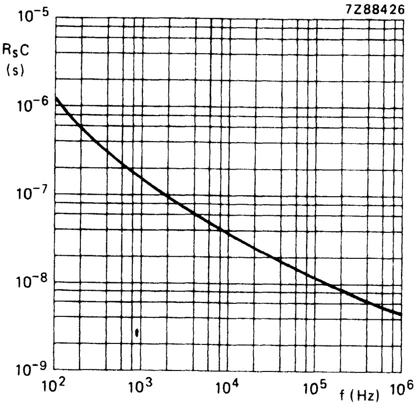


Fig. 6 Maximum product of series resistance and capacitance as a function of frequency.

Table 7 Power dissipation for different dimensions

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

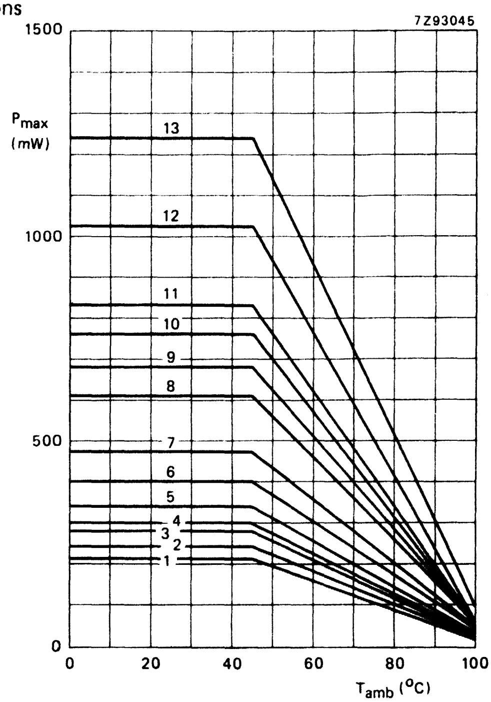


Fig. 7 Maximum dissipation as a function of ambient free air temperature.

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.

Table 8 Number of capacitors per box

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 (DC) 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 minutes 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 hours	
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. $\Delta C/C \leqslant 2{,}5\%$ 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.

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 grams 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 hours	
4.10.3 Damp heat cyclic, Test Db, first cycle			
4.10.4 Cold		Temperature: lower category temperature Duration: 2 hours	
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 hours; 1,25 U_R (DC) 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.
$\Delta C/C \leqslant 3\%$ of the value measured in 4.11.1.
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.
$\geqslant 50\%$ of values in GENERAL DATA of the specification.

No visible damage.
Legible marking.
$\Delta C/C \leqslant 3\%$ of value measured in 4.12.1.
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 4.12.1.
$\geqslant 50\%$ 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 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 = $\frac{U_R}{C_R \cdot 5 \; (\frac{dU}{dt})\,R}$ 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 tests	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD1	D		
A.1 Heat storage		Duration: 2000 hours 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. AC voltage $\geqslant 200$ V (RMS)		Duration: 1000 hours Temperature: 85 $^{\circ}$C Voltage: 1,25 x max. AC voltage (RMS 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.

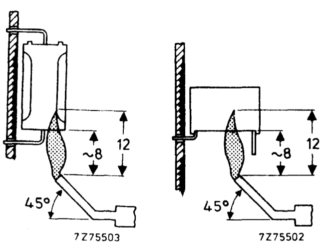
$\Delta C/C \leqslant 3\%$ of value measured in A.2.1.
Increase of tan δ
$\leqslant 0{,}005$ for $C_R \leqslant 470$ nF,
$\leqslant 0{,}003$ for $C_R > 470$ nF
compared to values measured in A.2.1.
As in GENERAL DATA of the specification.

additional 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 $C_R \leqslant 470$ 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 minutes Followed by rinsing in clear water for 1 minute Recovery time > 2 hours	
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.

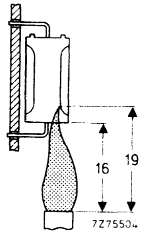
additional tests	D or ND	conditions of test	performance requirements **2222 341**
Sub-group ADD5	D		
A.5 Resistance to soldering heat with pre-heating		Capacitors mounted on a 1,6 mm board with non-plated holes Body temp.: 80 °C Bath temp.: 260 °C Dwell time: 5 s.	
A.5.1 Initial measurements		Capacitance 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 tests	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

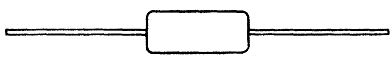
KS axial sleeved type

- Supplied on bandoliers on reel or loose in boxes

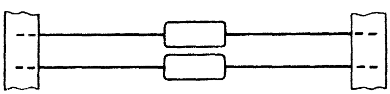
QUICK REFERENCE DATA

Rated capacitance range	47 to 39 000 pF
Tolerance on rated capacitance	± 5% (E24-series) ± 2% (E24, E48-series) ± 1% (E24, E48, E96-series)
Rated voltage U_R (DC)	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

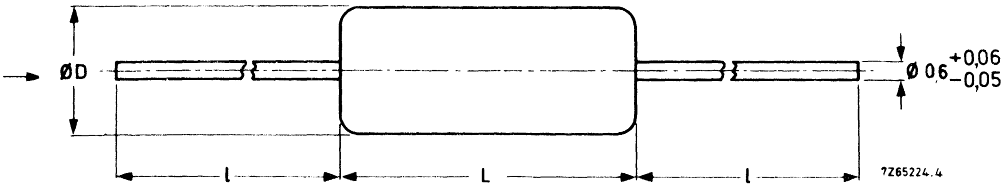


Fig. 1 Capacitors 2222 424 - 431.

Table 1 U_R (DC) = 63 V; max. AC voltage = 25 V; Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass grams	catalogue number	
					on bandoliers on reel	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 (DC) = 160 V; max. AC voltage = 63 V; Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass grams	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 (DC) = 250 V; max. AC voltage = 125 V; Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass grams	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 (DC) = 630 V; max. AC voltage = 250 V; Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass grams	catalogue number on bandoliers on reel	catalogue number in box
47					2222 431 64709	2222 427 24709
51					65109	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					63601	23601
390	4,0				63901	23901
430					64301	24301
470					64701	24701
510					65101	25101
560	4,5				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		15	28	0,8	61802	21802
2 000	5,5				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 (DC) = 630 V; max. AC voltage = 250 V; Fig. 1

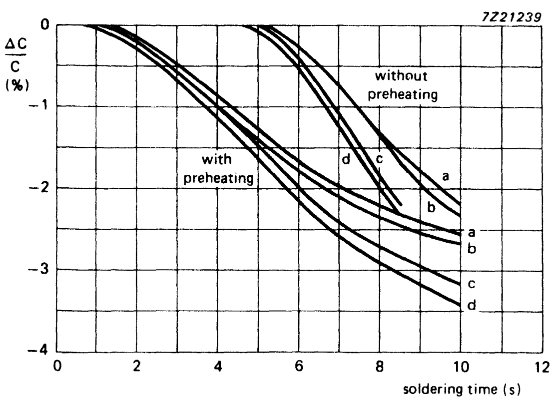
rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass grams	catalogue number on bandoliers on reel	catalogue number in box
3 000	6,5	15	28	1,1	2222 431 63002	2222 427 23002
3 300				1,4	63302	23302
3 600	7,0				63602	23602
3 900					63902	23902
4 300	7,5			1,7	64302	24302
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 (DC);
3rd line : production date code (according to IEC 62, clause 5) and code for dielectric materials (KS = polystyrene film/foil).

Mounting and soldering conditions

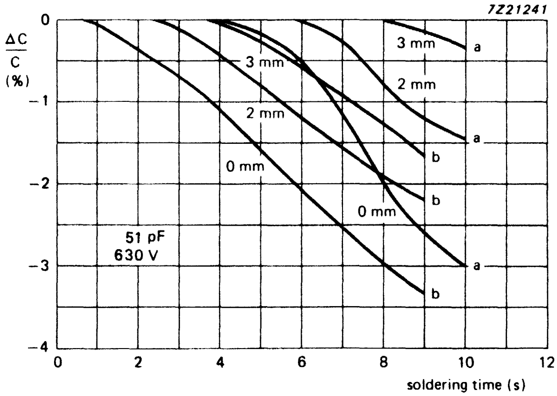
The capacitors are suitable for horizontal or vertical mounting on printed-circuit boards and also for point-to-point wiring.
Capacitors packed on bandoliers are for mounting by automatic insertion machines.
The capacitance stability is dependent on the body dimensions and a function of soldering temperature, soldering time, preheating, mounting method, mounting height and mounting pitch.
In all of the following graphs the solder bath temperature is 260 ± 5 °C.
Fig. 2 shows the typical behaviour of ΔC/C with and without preheating as a function of soldering time. Preheating temperature is 80 °C (duration of 1 hour). Mounting is directly on to the printed circuit board. The leads are to be kept as short as possible (shortest pitch).



a = 1100 pF: 160 V
b = 2000 pF: 63 V
c = 560 pF: 250 V
d = 51 pF: 630 V

Fig. 2 Typical effect on ΔC/C with and without preheating (worst case mounting).

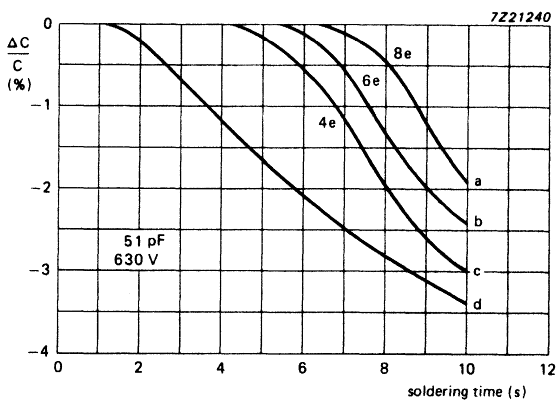
Figure 3 shows the typical effect of higher mounting and minimum pitch, with and without preheating.



a: without preheating b: with preheating

Fig. 3 Typical effect of mounting height with and without preheating.

Figure 4 shows the effect of a wider mounting pitch and close mounting on to the printed circuit board with preheating of the capacitor.



a,b,c : horizontal mounting
d : vertical mounting

Fig. 4 Typical effect of wider mounting pitch and preheating.

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 (DC)	see Tables 1 to 4
Category voltage U_C	U_R (DC)
Test voltage between terminations between interconnected terminations and case	 2 x U_R (DC) 2 x U_R (DC); minimum 400 V
Maximum AC voltage (RMS value) at 50 to 60 Hz	see Tables 1 to 4

Notes

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

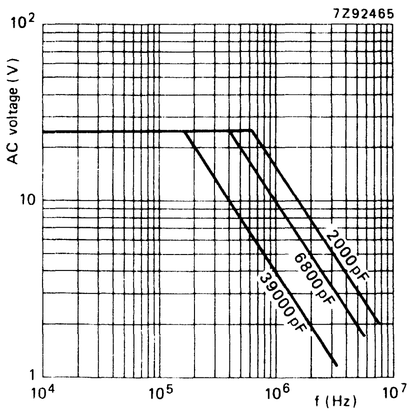


Fig. 5 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant$ 55 °C, for U_R = 63 V.

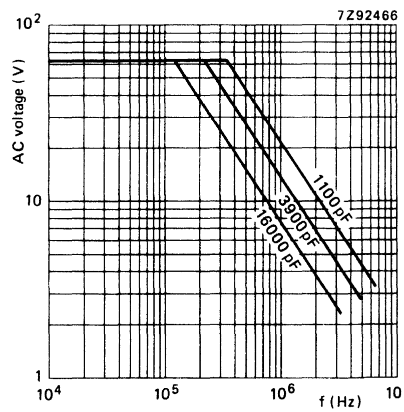


Fig. 6 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant$ 70 °C, for U_R = 160 V.

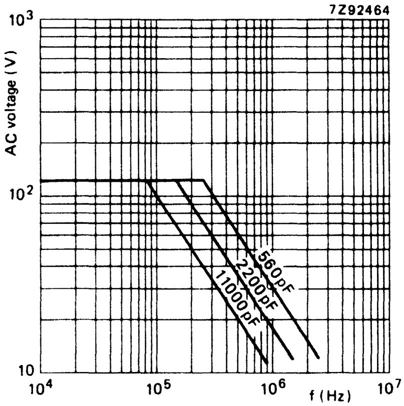


Fig. 7 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 70$ °C, for U_R = 250 V.

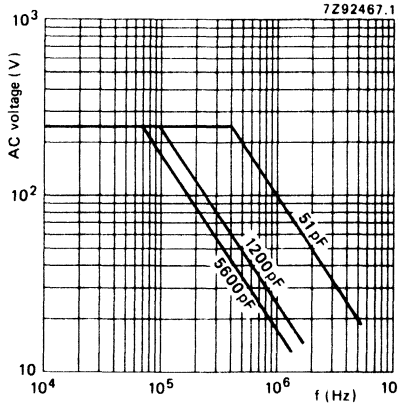


Fig. 8 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 70$ °C, for U_R = 630 V.

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 °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 Tangent of loss langle per range/frequency

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 $< C_R \leqslant$ 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	$\leqslant 5 \times 10^{-4}$	$\leqslant 25 \times 10^{-4}$	

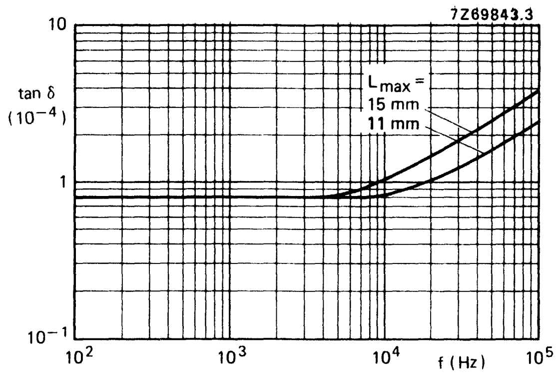


Fig. 9 Tan δ as a function of frequency; typical curves.

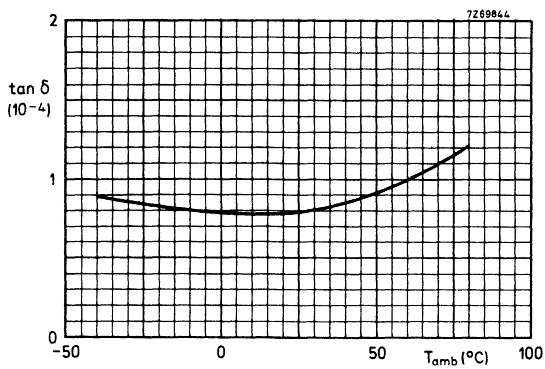


Fig. 10 Tan δ as a function of ambient free air temperature; typical curve.

Insulation resistance at T_{amb} = 20 °C

The insulation resistance is measured after a voltage has been applied for 1 minute ± 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

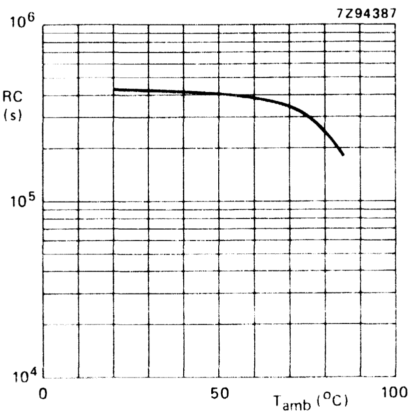


Fig. 11 RC-product as a function of ambient free air temperature; typical curve.

Inductance ≤ 10 nH/cm lead and capacitor length

Maximum dissipation

The maximum AC 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 424 to 2222 431 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. 12.

* At T_{amb} ≤ 70 °C (≤ 55 °C for 63 V version) the maximum permissible sinusoidal voltage can be found in Figs 5 to 8.

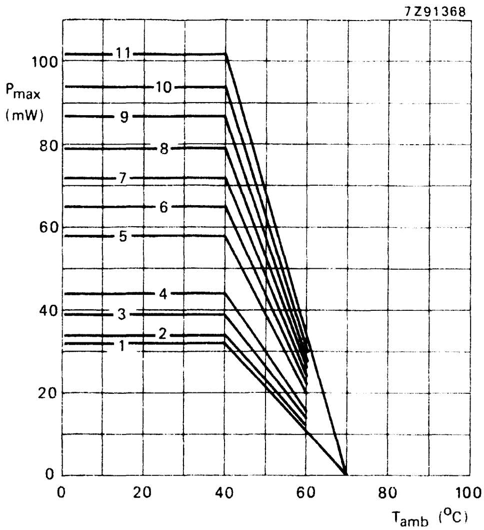


Fig. 12a Maximum dissipation as a function of ambient free air temperature, for U_R = 63 V.

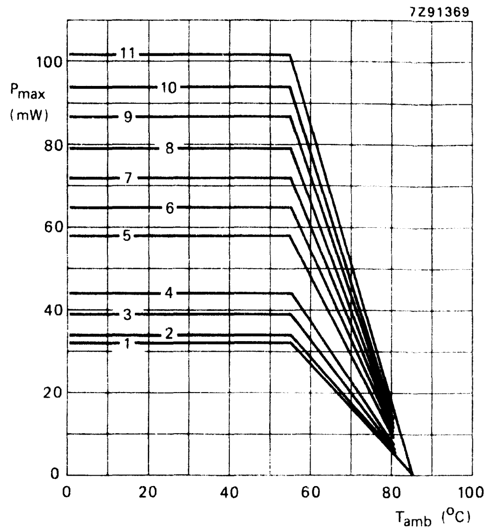


Fig. 12b Maximum dissipation as a function of ambient free air dissipation, for U_R = 160 V, 250 V and 630 V.

Table 6 Power dissipation for different dimensions

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 Packing quantities

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	47– 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

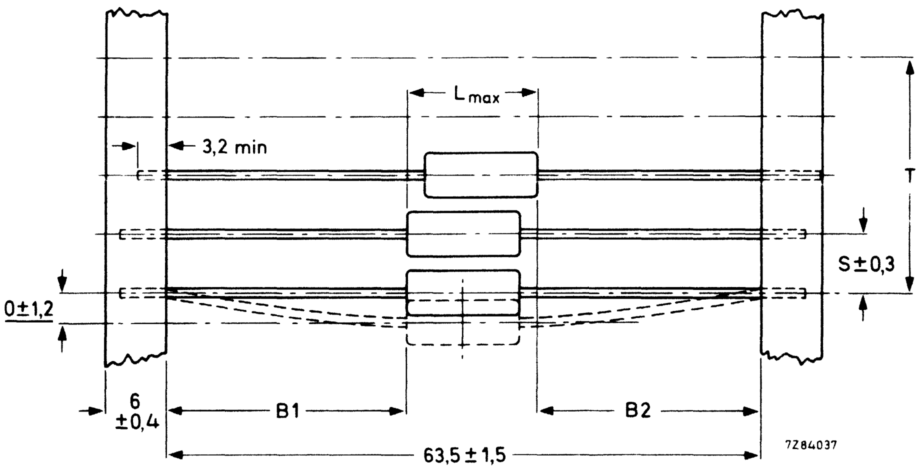
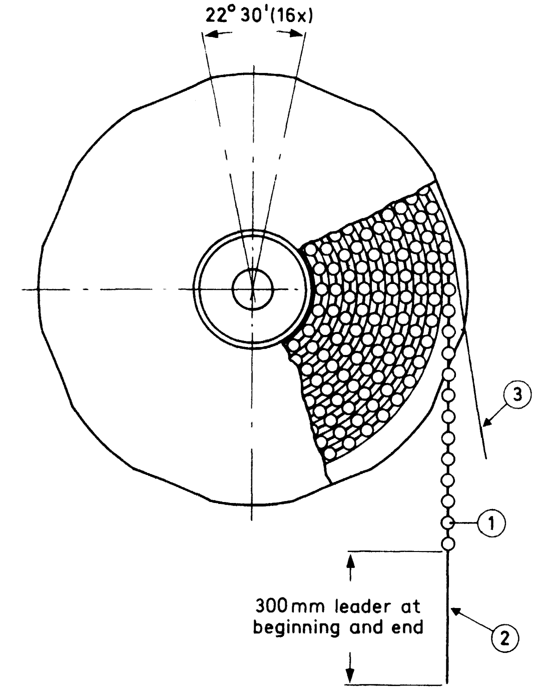


Fig. 13 Capacitors on bandoliers; for dimensions S and T, see Table 8
|B1 - B2| = max. 1,4 mm; for dimension L_{max}, see Tables 1 to 4.

Table 8 Dimensions S and T

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	47– 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



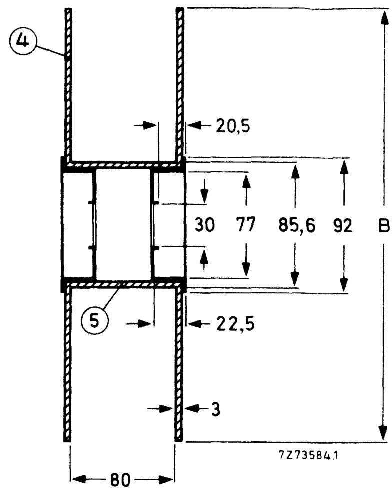


Fig. 14 Reel; for dimension B see Table 9.

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

Table 9 Number of capacitors on tape on reel

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	⩾ 2 N
Tearing force of tape	⩾ 10 N

Storage conditions:

Storage temperature range	–25 to + 40 °C
Relative humidity	⩽ 80%

POLYSTYRENE FILM/FOIL CAPACITORS

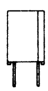
KS radial potted type

- 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 (DC)	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

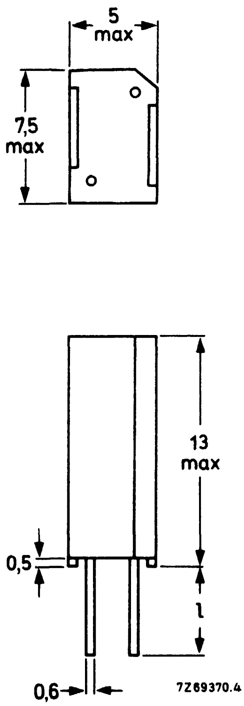


Fig. 1 Capacitors of rated capacitance range 100 to 3920 pF.

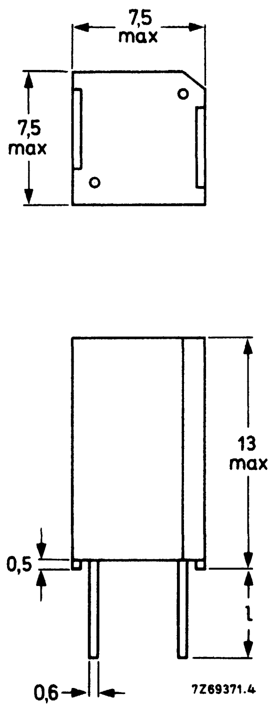


Fig. 2 Capacitors of rated capacitance range 100 to 15 000 pF.

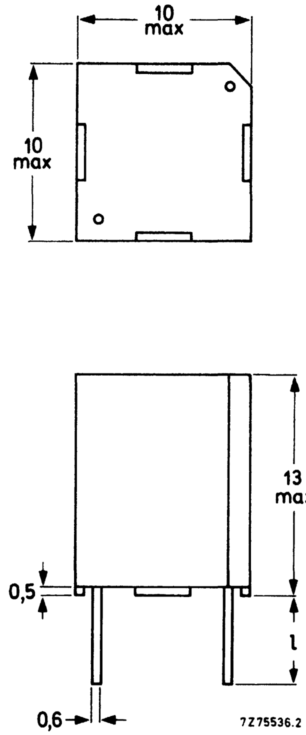


Fig. 3 Capacitors of rated capacitance range 15 400 to 34 000 pF.

Table 1 U_R (DC) = 63 V; max. AC voltage = 25 V

rated capacitance*	T_{max}	L_{max}	catalogue number 2222 443		T_{max}	L_{max}	catalogue number 2222 443	
			ℓ = 3 + 0,4 6	ℓ = 5 − 1 4			ℓ = 3 + 0,4 7	ℓ = 5 − 1 8 . . . .
pF	mm	mm			mm	mm		
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)

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			2741				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	5	7,5	4531		7,5	7,5	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.

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)

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 . . . .
2050	5	7,5	2052		7,5	7,5	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			2802				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	7,5	7,5	4122					
4220			4222					
4320			4322					
4420			4422					
4530			4532					
4640			4642					
4750			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.

rated capacitance* pF	T_{max} mm	L_{max} mm	catalogue number 2222 443 . . . . . ℓ = 3 + 0,4 6	ℓ = 5 − 1 4 . . . .
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)

rated capacitance* pF	T_{max} mm	L_{max} mm	catalogue number 2222 443 . . . . . ℓ = 3 + 0,4 6	ℓ = 5 − 1 4 . . . .
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

The following information is provided:

- Rated capacitance value
- Rated voltage
- Rated capacitance tolerance
- Category voltage
- Year and month of manufacture
- Manufacturer's name
- Climatic category
- Manufacturer's type designation

The package containing the capacitors is marked with all the above information. The capacitors are marked on the top edge in black ink as follows:

Capacitor range as specified at Fig. 1

line 1: rated capacitance in pF
line 2: tolerance code (F = ± 1%) and rated voltage (DC)
line 3: 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 the bevelled corner.

Capacitor range as specified at Figs 2 and 3

line 1: rated capacitance in pF
line 2: tolerance code (F = ± 1%) and rated voltage (DC)
line 3: 5th, 6th and 7th digits of the catalogue number
line 4: production data 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.

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.

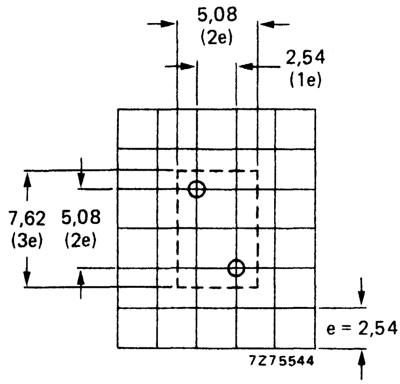


Fig. 4 Required space for capacitors according to Fig. 1.

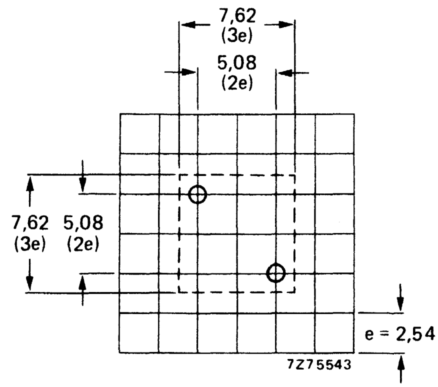


Fig. 5 Required space for capacitors according to Fig. 2.

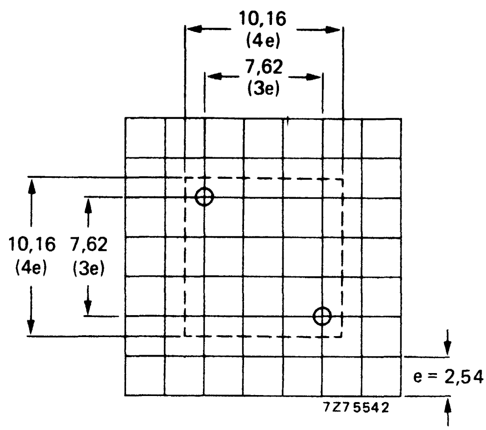


Fig. 6 Required space for capacitors according to Fig. 3.

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 (DC)	63 V
Category voltage U_C	U_R (DC)
Test voltage between terminations between interconnected terminations and case (foil method)	 2 x U_R (DC) 400 V (DC)
Maximum AC voltage (RMS value) at 50 to 60 Hz	25 V

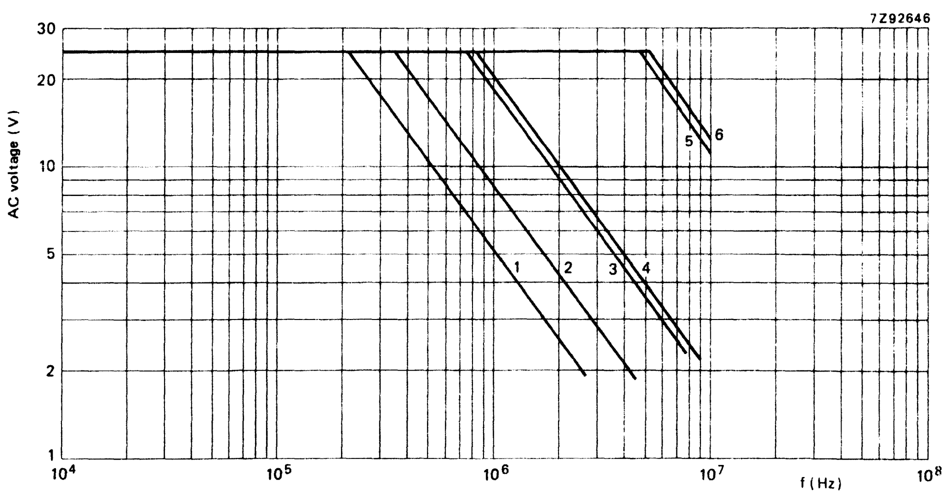


Fig. 7 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 55$ °C.
Curve 1 = 34000 pF; curve 2 = 15000 pF;
curve 3 = 3920 pF, according to Fig. 1; curve 4 = 3920 pF, according to Fig. 2;
curve 5 = 100 pF, according to Fig. 1; curve 6 = 100 pF, according to Fig. 2.

Notes

- The sum of the DC voltage and the peak value of the superimposed AC voltage must be $\leqslant U_R$ (DC).
- 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 5 Tangent of loss angle per range/frequency

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	$\leqslant 5 \times 10^{-4}$	$\leqslant 60 \times 10^{-4}$	

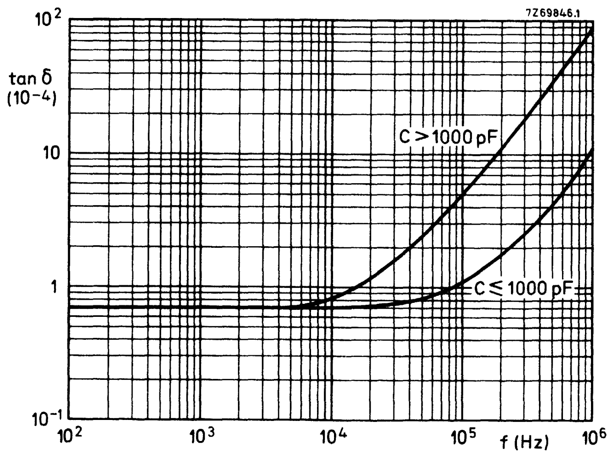


Fig. 8 Tan δ as a function of frequency; typical curve.

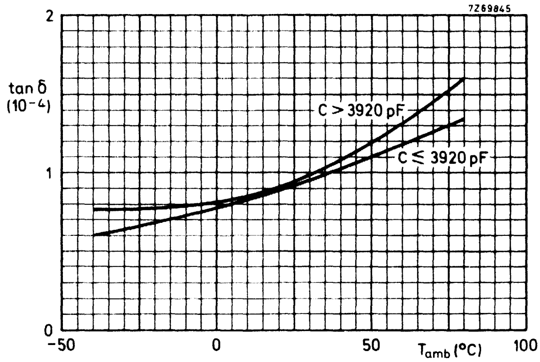


Fig. 9 Tan δ as a function of ambient free air temperature; typical curve.

Insulation resistance

The insulation resistance is measured after a voltage of 10 ± 1 V has been applied for 1 minute ± 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 AC 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 style 2222 443 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. 10.

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

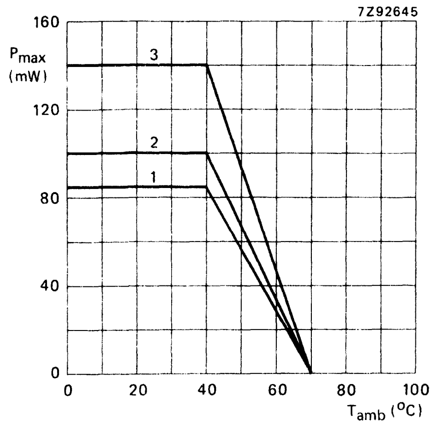


Fig. 10a Maximum dissipation as a function of ambient free air temperature, class 1 capacitors.

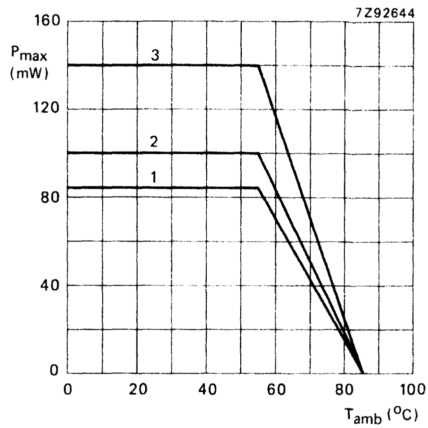


Fig. 10b Maximum dissipation as a function of ambient free air temperature, class 3 capacitors.

Table 3 Power dissipation for different dimensions

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 Number of capacitors per box

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

POLYSTYRENE FILM/FOIL CAPACITORS

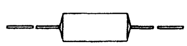
KS axial wrapped end-filled

- 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 (DC)	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

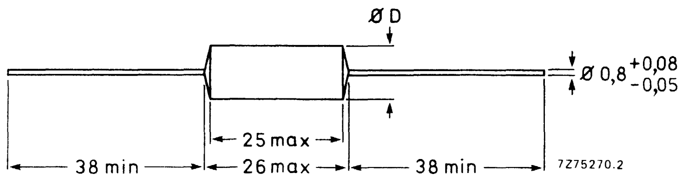


Fig. 1.

Table 1 U_R (DC) = 63 V; max. AC voltage = 25 V, Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max} mm	approx. mass grams	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 (DC) = 160 V; max. AC voltage = 63 V, Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max} mm	approx. mass grams	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 (DC) = 250 V; max. AC voltage = 125 V, Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max} mm	approx. mass grams	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 (DC) = 630 V; max. AC voltage = 250 V, Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max} mm	approx. mass grams	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 (DC), 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 (DC)	see Tables 1 to 4
Category voltage U_C	U_R (DC)
Test voltage	
between terminations	2 x U_R (DC)
between interconnected terminations and case	2 x U_R (DC); min. 400 V
Maximum AC voltage (RMS value) at 50 to 60 Hz	see Tables 1 to 4

Notes

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

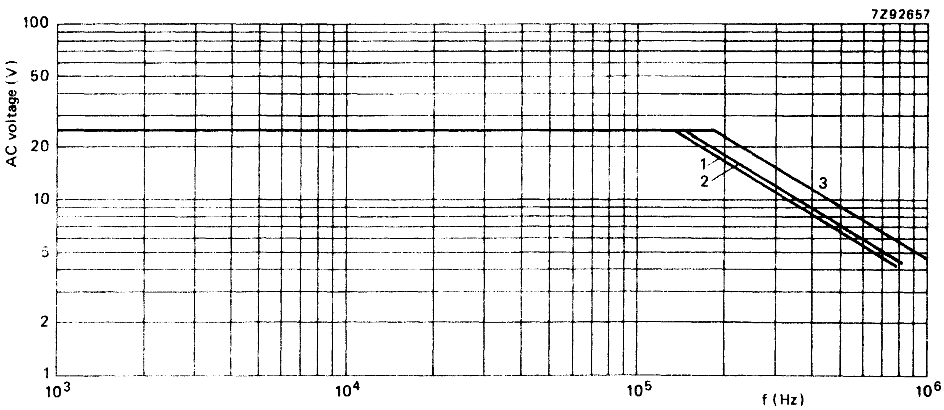


Fig. 2 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 55$ °C, for U_R = 63 V.

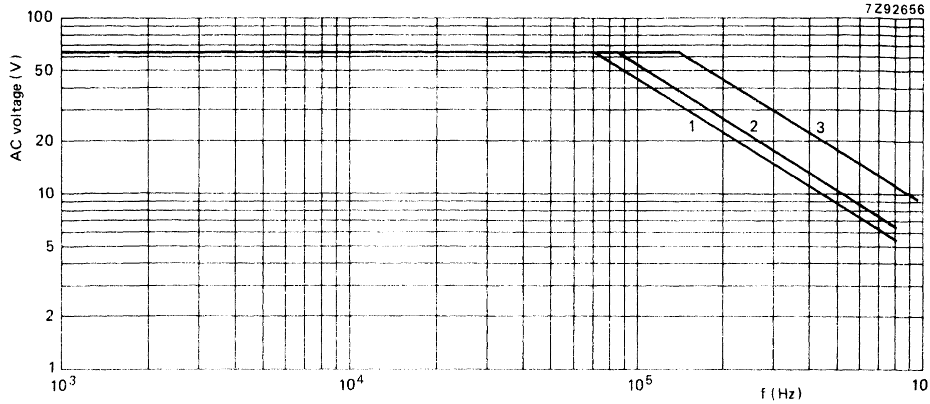


Fig. 3 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 70\,^{o}C$, for $U_R = 160$ V.

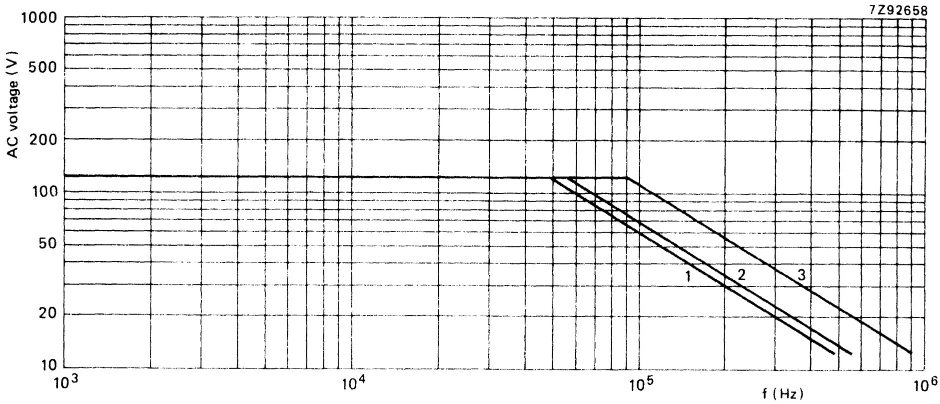


Fig. 4 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 70\,^{o}C$, for $U_R = 250$ V.

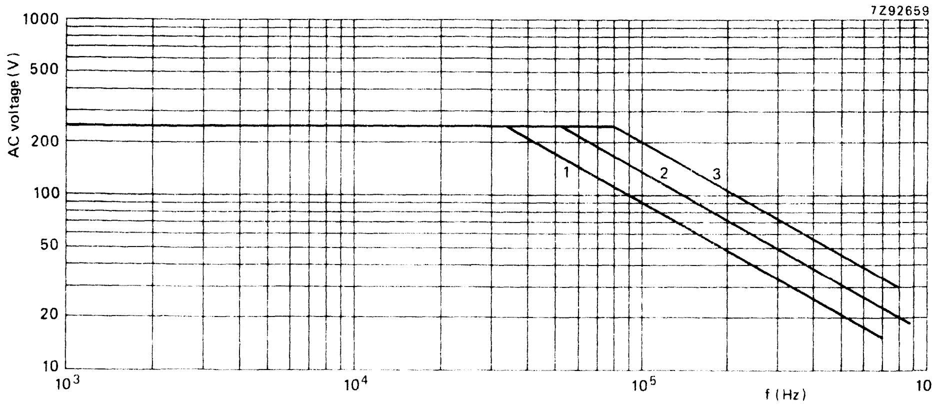


Fig. 5 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 70\,^{o}C$, for $U_R = 630$ V.

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 Tangent of loss angle per range/frequency

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	$\leqslant 5 \times 10^{-4}$	$\leqslant 25 \times 10^{-4}$

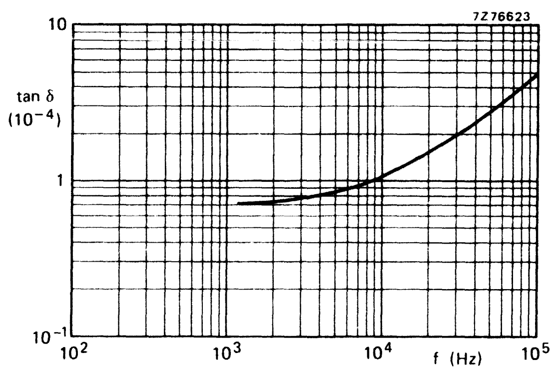


Fig. 6 Tan δ as a function of frequency; typical curve.

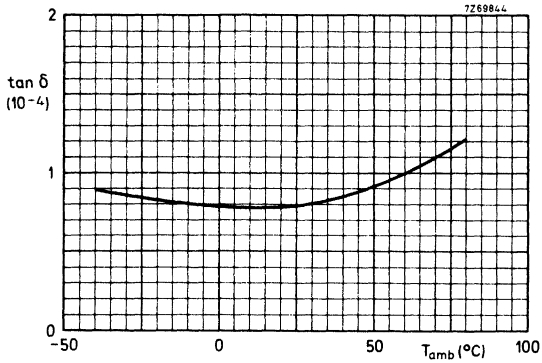


Fig. 7 Tan δ as a function of ambient free air temperature; typical curve.

Insulation resistance at T_{amb} = 20 °C

The insulation resistance is measured after a voltage has been applied for 1 minute ± 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 AC 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 444 to 2222 447 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.

* 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 Power dissipation for different dimensions

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

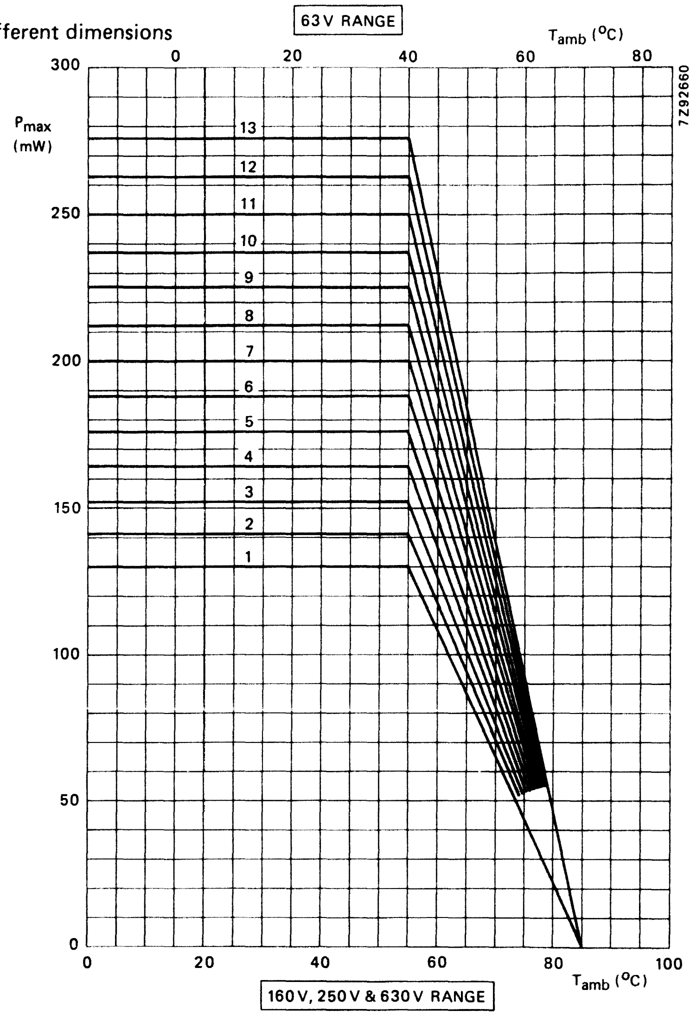


Fig. 8 Maximum dissipation as a function of ambient free air temperature.

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 Number of capacitors per box

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 (DC) 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 minutes Recovery 1 to 2 hours	
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 hours	
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 grams 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. $\Delta C/C \leqslant 0{,}25\%$ 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 grams 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 hours	
4.10.4 Damp heat cyclic, Test Db, first cycle			
4.10.5 Cold		Temperature: lower category temperature Duration: 2 hours	
4.10.7 Damp heat cyclic, Test Db remaining cycles		Recovery: 1 to 2 hours	
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 hours	
		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. $\leqslant 2$ x values specified in GENERAL DATA of the specification. $\geqslant 20\%$ of values in GENERAL DATA of the specification.	No visible damage. Legible marking. $\Delta C/C \leqslant 0,75\%$ 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.

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 hours; 1,5 U_R (DC) at 70 °C for 63 V version, at 85 °C for 160 V, 250 V, 630 V versions **Style 2222 443**: Duration: 1000 hours; 1,5 U_R (DC) 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 tests	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 hours 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 tests	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. AC voltage ⩾ 200 V (RMS)		Duration: 1000 hours Temperature: 70 °C for 63 V version, 85 °C for 160 V, 250 V, 630 V versions Voltage: 1,25 x max. AC voltage (RMS 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 ⩽ 1,4 x value measured in A.2.1, whichever is greater.
		Insulation resistance	As in GENERAL DATA of the specification.

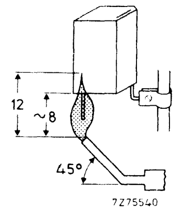
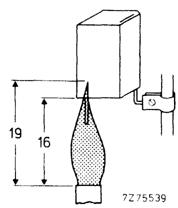
performance requirements **2222 443**	performance requirements **2222 444 to 447**
Not applicable.	$\Delta C/C \leqslant 0{,}5\%$ of the value measured in A.2.1. As in GENERAL DATA of the specification or $\leqslant 1{,}4$ x value measured in A.2.1, whichever is greater. As in GENERAL DATA of the specification.

additional tests	D or ND	conditions of test (see Note 1)	performance requirements **2222 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 tests	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 minutes Followed by rinsing in clear water for 1 minute Recovery time > 2 hours	
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 tests	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	R.H.	10 days at 40 ± 2 °C RH 90 to 95% Recovery time 24 hours	Deviation of tape on a strip of 250 mm taped products ⩽ 2%. Pull out and tearing forces ⩾ 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

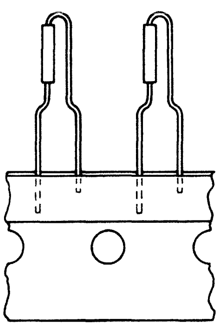
KP Axial epoxy lacquered type

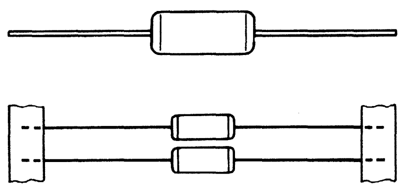
- Supplied in boxes, on bandoliers on reel and single ended

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 (DC)	63 V, 160 V, 250 V, 400 V and 630 V
Climatic category	40/100/56
Rated temperature	85 °C
Related specification	IEC 384-13
Stability class	1 for 63 V, 160 V and 250 V 2 for 400 V and 630 V

SURVEY OF STYLES





2222 460 ..... to 464 .....
see Tables 1 to 5

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-inductive 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

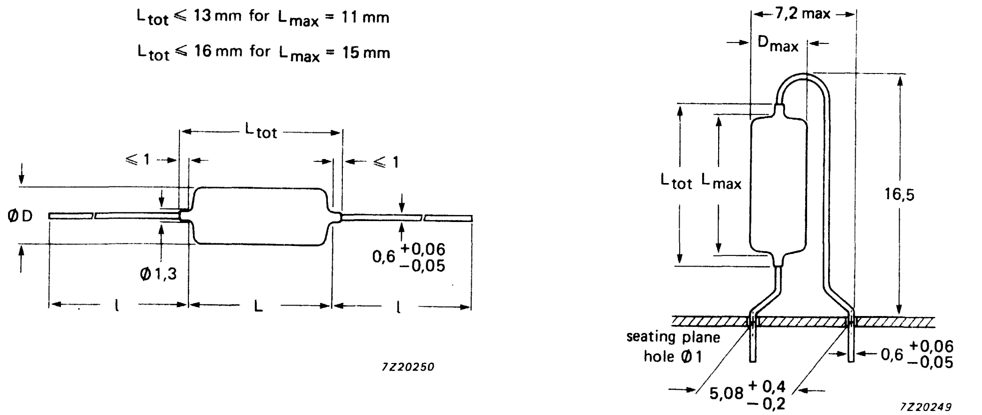


Fig. 1 Capacitors 2222 460 - 2222 464.

Table 1 U_R (DC) = 63 V; max. AC voltage = 40 V, Fig. 1.

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass grams	catalogue number 2222 460 ..... in boxes 2.... / on bandoliers on reel 6....	single ended .....
6 800	5,0	11,0	30	0,5	6802	6802
7 500					7502	7502
8 200				0,6	8202	8202
9 100					9102	9102
10 000	5,5	15,0	28		1003	
11 000					1103	
12 000				0,7	1203	
13 000				0,8	1303	
15 000				0,7	1503	
16 000					1603	
18 000				0,8	1803	
20 000					2003	
22 000				0,9	2203	
24 000	6,0				2403	
27 000				1,0	2703	
30 000	6,5			1,1	3003	
33 000					3303	
36 000				1,2	3603	
39 000	7,0			1,3	3903	
43 000				1,4	4303	
47 000	7,5			1,5	4703	
51 000				1,6	5103	
56 000	8,0			1,7	5603	
62 000				1,8	6203	

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

Table 2 U_R (DC) = 160 V; max. AC voltage = 63 V

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass grams	catalogue number 2222 461 ..... on bandoliers on reel 6.... / in boxes 2....	single ended .....
3 600	5,0	11,0	30	0,5	3602	3602
3 900	5,0	11,0	30	0,5	3902	3902
4 300	5,0	11,0	30	0,5	4302	4302
4 700	5,0	11,0	30	0,5	4702	4702
5 100	5,0	11,0	30	0,5	5102	5102
5 600	5,0	11,0	30	0,5	5602	5602
6 200	5,0	11,0	30	0,6	6202	6202
6 800	5,5	15,0	28	0,4	6802	
7 500	5,5	15,0	28	0,7	7502	
8 200	5,5	15,0	28	0,6	8202	
9 100	5,5	15,0	28	0,6	9102	
10 000	5,5	15,0	28	0,6	1003	
11 000	5,5	15,0	28	0,7	1103	
12 000	5,5	15,0	28	0,7	1203	
13 000	5,5	15,0	28	0,8	1303	
15 000	5,5	15,0	28	0,8	1503	
16 000	6,0	15,0	28	0,9	1603	
18 000	6,0	15,0	28	0,9	1803	
20 000	6,5	15,0	28	1,0	2003	
22 000	6,5	15,0	28	1,1	2203	
24 000	6,5	15,0	28	1,1	2403	
27 000	7,0	15,0	28	1,2	2703	
30 000	7,5	15,0	28	1,3	3003	
33 000	7,5	15,0	28	1,4	3303	
36 000	8,0	15,0	28	1,5	3603	
39 000	8,0	15,0	28	1,6	3903	

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

Table 3 U_R (DC) = 250 V; max. AC voltage = 125 V, Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass grams	catalogue number 2222 462 ..... in boxes 2.... / on bandoliers on reel 6....	single ended .....
1 200				0,5	1202	1202
1 300					1302	1302
1 500				0,4	1502	1502
1 600				0,5	1602	1602
1 800					1802	1802
2 000	5,0	11,0	30	0,6	2002	2002
2 200					2202	2202
2 400					2402	2402
2 700					2702	2702
3 000				0,5	3002	3002
3 300					3302	3302
3 600					3602	
3 900					3902	
4 300					4302	
4 700					4702	
5 100	5,5			0,6	5102	
5 600					5602	
6 200					6202	
6 800				0,7	6802	
7 500					7502	
8 200				0,8	8202	
9 100	6,0	15,0	28		9102	
10 000				0,9	1003	
11 000					1103	
12 000	6,5			1,0	1203	
13 000					1303	
15 000	7,0			1,1	1503	
16 000				1,2	1603	
18 000	7,5			1,3	1803	
20 000	8,0			1,4	2003	
22 000				1,5	2203	

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

Table 4 U_R (DC) = 400 V; max. AC voltage = 160 V, Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass grams	catalogue number 2222 463 ..... in boxes 2.... / on bandoliers on reel 6....	single ended .....
150	5,0	11,0	30	0,4	1501	1501
160					1601	1601
180				0,5	1801	1801
200					2001	2001
220				0,6	2201	2201
240					2401	2401
270					2701	2701
300				0,7	3001	3001
330				0,4	3301	3301
360					3601	3601
390				0,5	3901	3901
430					4301	4301
470					4701	4701
510					5101	5101
560					5601	5601
620					6201	6201
680					6801	6801
750					7501	7501
820					8201	8201
910					9101	9101
1000					1002	1002
1100					1102	1102

Table 5 U_R (DC) = 630 V; max. AC voltage = 200 V, Fig. 1

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass grams	catalogue number 2222 464 ..... in boxes 2.... / on bandoliers on reel 6....	single ended .....
47	5,0	11,0	30	0,4	4709	4709
51					5109	5109
56					5609	5609
62					6209	6209
68					6809	6809
75					7509	7509
82					8209	8209
91					9109	9109
100					1001	1001
110					1101	1101
120				0,5	1201	1201
130					1301	1301

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

Marking

The following information is provided:

- Rated capacitance value
- Rated voltage
- Rated capacitance tolerance
- Category voltage
- Year and month of manufacture
- Manufacturer's name
- Climatic category
- Manufacturer's type designation

The capacitors are marked in black ink as follows:

line 1:	rated capacitance in pF or nF.
line 2:	tolerance code (F = ± 1%, G = ± 2%, J = ± 5%) rated DC voltage without unit symbol.
line 3:	code for dielectric material (KP) production date code according to IEC 62 clause 5.
line 4:	manufacturer's name

Mounting and soldering conditions

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

The capacitors packed on bandoliers are for mounting in printed wiring boards by means of automatic insertion machines.

The capacitance stability is dependent on the maximum temperature the capacitor reaches during soldering.

Figure 2 shows the typical effect of $\Delta C/C$ as a function of soldering time under worst possible mounting conditions (horizontal against the PCB, minimum possible pitch) and with 80 °C preheating.

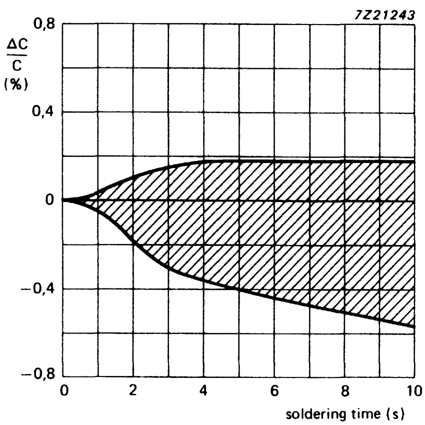


Fig. 2 Typical effect of $\Delta C/C$ as a function of soldering time (boundaries of shaded area are the 2 – sigma limits).

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 for $C_R \leqslant 1000$ pF at 1 kHz for $C_R > 1000$ pF		see Tables 1 to 5
Tolerance on rated capacitance		± 5%, ± 2% or 2 pF* ± 1% or 1 pF*
Temperature coefficient between −40 and + 20 °C	for 400 V - 630 V	$-(125 \pm 125)\ 10^{-6}$/K
	for 63 V - 160 V - 250 V	$-(125 \pm 60)\ 10^{-6}$/K
between + 20 and + 100 °C		$-(250 \pm 120)\ 10^{-6}$/K

Capacitance depends upon
frequency (none between 100 Hz and 1 MHz) and
temperature:

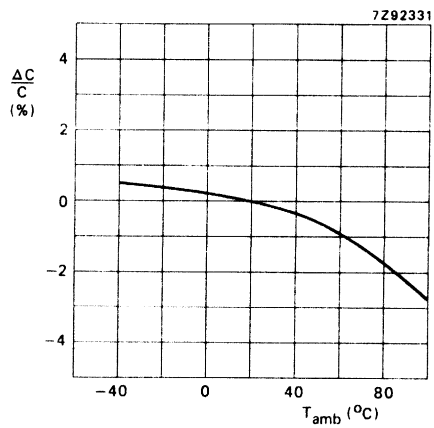


Fig. 3 Capacitance as a function of ambient free air temperature; typical curve.

* Whichever is greater.

Voltage

Rated voltage U_R (DC)	see Tables 1 to 5
Category voltage U_C	0,8 x U_R (DC)
Test voltage	
between terminations	2 x U_R (DC)
between interconnected terminations and case (foil method)	2 x U_R (DC); min. 400 V
Maximum AC voltage (RMS value) at 50 to 60 Hz	40 V, 63 V, 125 V, 160 V, 200 V

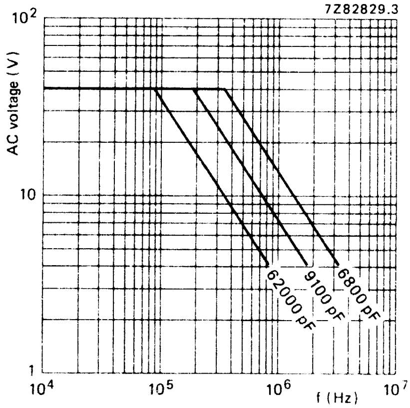


Fig. 4 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 70\ ^{o}C$, for U_R = 63 V.

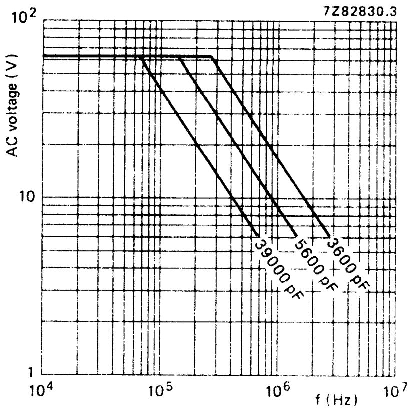


Fig. 5 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 70\ ^{o}C$, for U_R = 160 V.

Notes

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

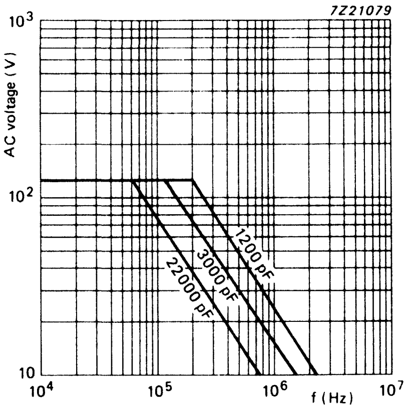


Fig. 6 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 70$ °C, for U_R = 250 V.

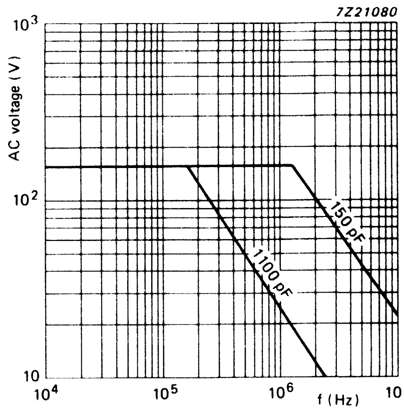


Fig. 7 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 70$ °C, for U_R = 400 V.

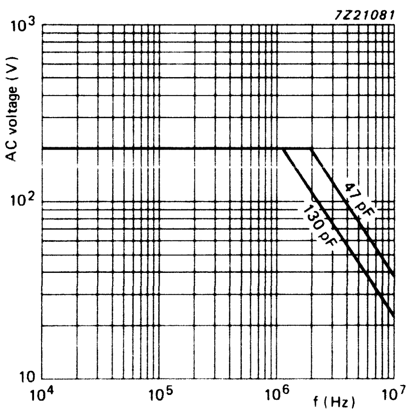


Fig. 8 Maximum AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 70$ °C, for U_R = 630 V.

Temperature

Climatic category	40/100/56
Rated temperature	85 °C
Storage temperature range	−25 to + 40 °C at RH ⩽ 80%. ←

Tangent of loss angle

Table 6 Tangent of loss angle per range/frequency

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	$\leqslant 5 \times 10^{-4}$	$\leqslant 40 \times 10^{-4}$	

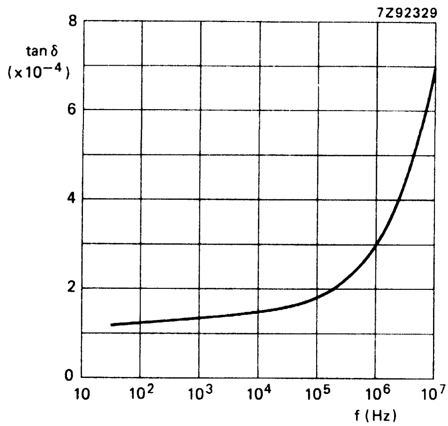


Fig. 9 tan δ as a function of frequency; typical curve.

* Single ended $\leqslant 13 \times 10^{-4}$

Insulation resistance at T_{amb} = 20 °C.

The insulation resistance is measured after a voltage has been applied for 1 minute ± 5 s, the voltage being 10 ± 1 V for the 63 V version and 100 ± 15 V for the 160 V, 250 V, 400 V and 630 V versions.

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

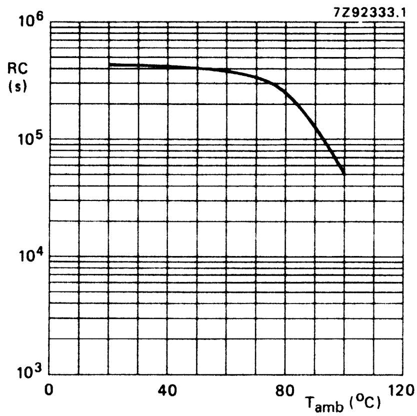


Fig. 10 RC-product as a function of ambient free air temperature; typical curve.

Inductance	≤ 10 nH/cm lead and capacitor length

Maximum dissipation

The maximum AC 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 464 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. 11.

Table 7 Power dissipation for different dimensions

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

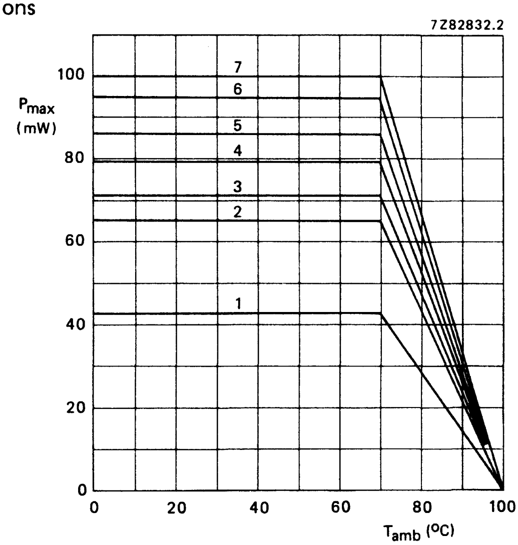


Fig. 11 Maximum dissipation as a function of ambient free air temperature.

* At $T_{amb} \leqslant 70$ °C the maximum permissible sinusoidal voltage can be found in Figs 4, 5, 6, 7 and 8.

ORDERING INFORMATION

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

Composition of the catalogue number

2222 . . . .

code for capacitance, see Tables 1 to 5

460 = 63 V
461 = 160 V
462 = 250 V
463 = 400 V
464 = 630 V

6 = ± 5%	packed on
7 = ± 2%	bandoliers
8 = ± 1%	on reels
2 = ± 5%	packed in
3 = ± 2%	boxes
4 = ± 1%	
0 = ± 2%	single
1 = ± 1%	ended, on tape on reel

PACKING

The capacitors are supplied on bandoliers on reels or in cardboard boxes or single ended on tape on reel.

Packing in cardboard boxes

Table 8 Number of capacitors in cardboard boxes

capacitance values (pF) of			quantity of capacitors per box
63 V version	160 V version	250/400/630 version	
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

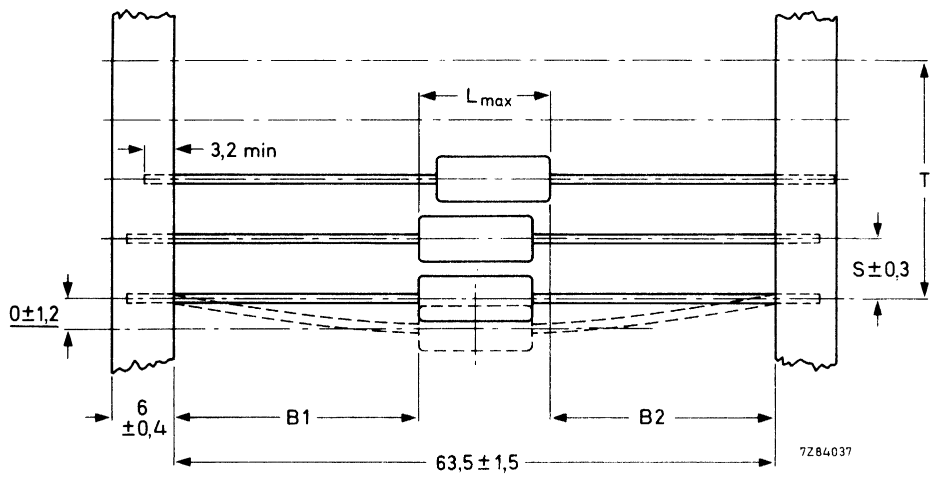
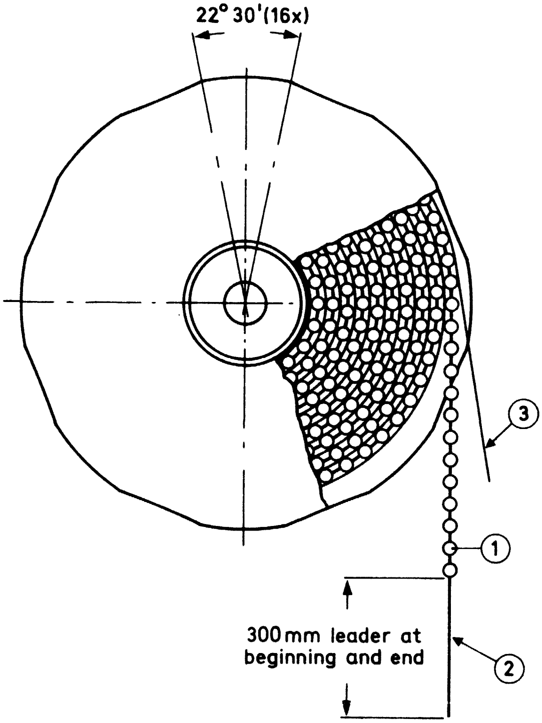


Fig. 12 Capacitors on bandoliers; for dimensions S and T, see Table 9; |B1 - B2| = max. 1,4 mm; for dimensions L_{max}, see Tables 1 to 5.

Table 9 Dimensions of S and T

capacitance values (pF) of			S	T for number (n) of capacitors	
63 V version	160 V version	250/400/630 version		n < 50	50 < n < 100
6 800 – 9 100	3 600 – 6 200	47 – 3 300	5	5 (n - 1) ± 2	5 (n - 1) ± 4
10 000 – 62 000	6 800 – 39 000	3 600 – 22 000	10	10 (n - 1) ± 2	10 (n - 1) ± 4



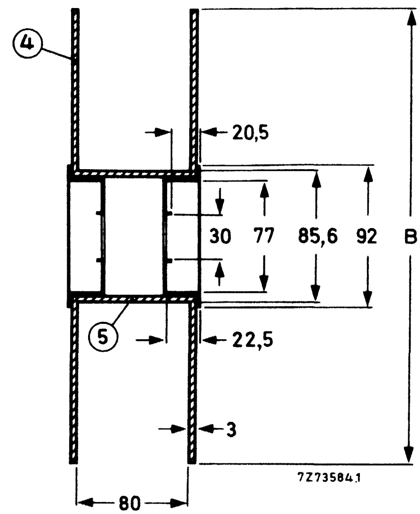


Fig. 13 Reel.

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

Table 10 Number of capacitors on bandoliers on reel

capacitance values (pF) of			B	quantity of capacitors on one reel
63 V version	160 V version	250/400/630 version		
6 800 – 9 100	3 600 – 6 200	47 – 3 300	305	2500
10 000 – 27 000	6 800 – 18 000	3 600 – 10 000	356	1500
30 000 – 62 000	20 000 – 39 000	11 000 – 22 000	356	1000

Packing single ended on tape on reel

Table 11 Number of capacitors on tape on reel

capacitance values (pF) of					B	quantity of capacitors on one reel
63 V version	160 V version	250 V version	400 V version	630 V version		
6 800 – 9 100	3 600 – 6 200	1 200 – 3 300	150 – 1 100	47 – 130	356	1000

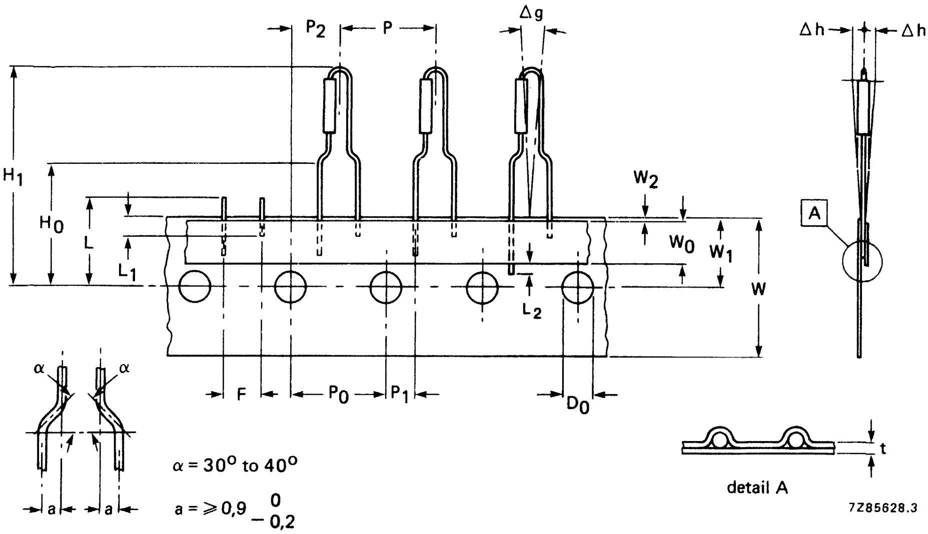
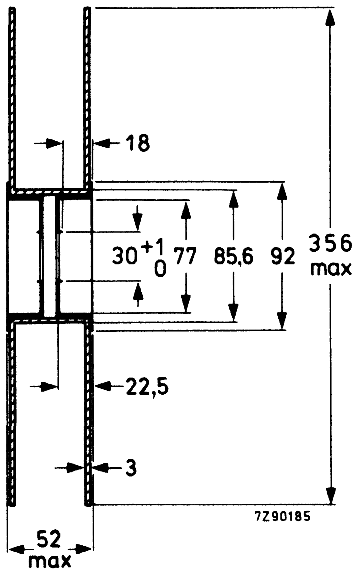


Fig. 14 Single ended on tape on reel.

Pitch of components	P		12,7 ± 1,0
Feed hole pitch	P_0		12,7 ± 0,2
Cumulative pitch error	T		1,0 per 20 spacings 0,5 per 4 spacings
Feed hole centre to lead at topside at the tape	P_1		3,85 ± 0,5
Feed hole centre to body centre	P_2		6,35 ± 1,0
Lead to lead distance	F		5,08 + 0,4 −0,2
Component alignment	Δh		0 ± 1,2
Component alignment	Δg		± 1,0
Tape width	W		18,0 ± 0,5
Hold down tape width	W_0	min.	5,5
Hole position	W_1		9,0 ± 0,5
Hold down tape position	W_2	max.	0,5
Lead wire clinch height	H_0		16,0 ± 0,5
Component height	H_1	max.	32
Feed hole diameter	D_0		4,0 ± 0,2
Total tape thickness	t		0,7 ± 0,2
Length of snipped lead	L	max.	11,0
Lead wire (tape portion) shortest lead	L_1	min.	2,0
Lead wire protrusion	L_2	max.	4



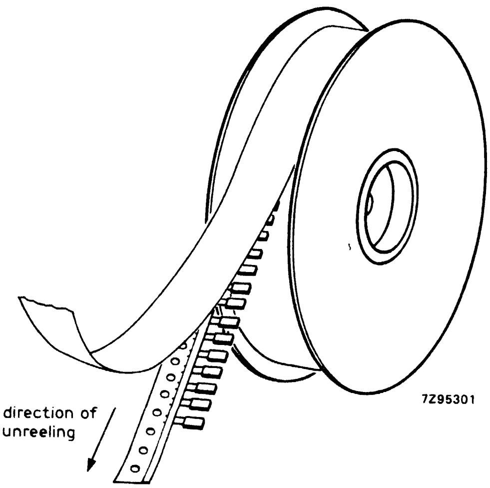


Fig. 15 Reel for single ended version.

Characteristics concerning taped products

For axial leads

Pull-out force of the component	⩾ 2 N
Pull-off force of adhesive tape	⩾ 6 N
Tearing force of tape	⩾ 15 N

For radial leads

Pull-out force of the component	⩾ 5 N
Pull-off force of adhesive tape	⩾ 6 N
Tearing force tape	⩾ 15 N

Storage conditions

Storage temperature range	–25 °C 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.

clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 460 – 464**
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 (DC) 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.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 460 - 464**
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 5 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 predrying Method: 1A Solder bath: 260 °C Duration: 5 s	
4.4.2 Final measurements		Visual examination Capacitance	No visible damage. Legible marking. $\Delta C/C \leqslant 2\% + 1$ pF for $C_R \leqslant 1100$ pF, $\Delta C/C \leqslant 1\%$ for $C_R > 1100$ 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 460 - 464**
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 minutes 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 hours	
4.7.2 Final inspection Intermediate measurements		Visual examination Capacitance Tangent of loss angle	No visible damage. $\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1000$ pF, $\Delta C/C \leqslant 1\%$ for $C_R > 1000$ pF of the value measured in 4.6.1. 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 Tangent of loss angle	No visible damage. $\Delta C/C \leqslant 2\% + 1$ pF for $C_R \leqslant 1100$ pF, $\Delta C/C \leqslant 1\%$ for $C_R > 1100$ pF of the value measured in 4.6.1. As in GENERAL DATA of the specification.

Note

The capacitors shall be mechanically fixed by the leads.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 460 - 464**
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 hours	
4.10.3 Damp heat cyclic, Test Db, first cycle			
4.10.4 Cold		Temperature: lower category temperature Duration: 2 hours	
4.10.6 Damp heat cyclic, Test Db, remaining cycles		Recovery 1 to 2 hours	
4.10.6.2 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 1\% + 1$ pF for $C_R \leqslant 1100$ pF, $\Delta C/C \leqslant 0{,}5\%$ for $C_R > 1100$ pF of the 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.

sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements **2222 460 – 464**
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 hours	
		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 1\% + 1$ pF for $C_R \leqslant 1100$ pF, $\Delta C/C \leqslant 1\%$ for $C_R > 1100$ pF 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 hours; 1,50 U_R (DC) 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	$\Delta C/C \leqslant 2\% + 1$ pF for $C_R \leqslant 1100$ pF, $\Delta C/C \leqslant 1\%$ for $C_R > 1100$ 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	$\geqslant 50\%$ 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 460 – 464**
Sub-group C4	D		
4.2.5 Variation of capacitance with temperature		Static method; capacitors shall be dried.	Temperature coefficient as in GENERAL DATA of the specification.
		Number of cycles: 1	
		Capacitance measurements for $C_R \leqslant 1000$ pF at 100 kHz, $C_R > 1000$ pF at 1 kHz	Temperature cyclic drift of capacitance $\Delta C/C \leqslant 2\% + 1$ pF for $C_R \leqslant 1100$ pF $\Delta C/C \leqslant 1\%$ for $C_R > 1100$ pF of the value measured in 4.4.2 or 4.9.3.
		Insulation resistance	$\geqslant 10\,000$ MΩ.
4.2.6 Inductance			As in GENERAL DATA of the specification.

additional tests	D or ND	conditions of test (see Note 1)	performance requirements **2222 460 – 464**
Sub-group ADD1	D		
A.1 Heat storage		Duration: 1000 hours 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	$\Delta C/C \leqslant 2\% + 1$ pF for $C_R \leqslant 1000$ pF, $\Delta C/C \leqslant 1\%$ 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.

additional tests	D or ND	conditions of test (see Note 1)	performance requirements **2222 460 - 464**
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	$\Delta C/C \leqslant 1\% + 0,5$ pF for $C_R \leqslant 1100$ pF, $\Delta C/C \leqslant 1\%$ for $C_R > 1100$ pF 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	$\geqslant 50\%$ of values in GENERAL DATA of the specification.

additional tests	D or ND	conditions of test	performance requirements **2222 460 – 464**
Sub-group ADD3	D		
A.3 Detergent resistance		Density 20g/l dishwater detergent Temperature 70 °C, during 3 minutes Followed by rinsing in clear water for 1 minute Recovery time > 2 hours	
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	$\Delta C/C \leqslant 1\% + 0{,}5$ pF for $C_R \leqslant 1100$ pF, $\Delta C/C \leqslant 1\%$ for $C_R > 1100$ pF of the 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	$\Delta C/C \leqslant 2\% + 1$ pF for $C_R \leqslant 1100$ pF, $\Delta C/C \leqslant 1\%$ for $C_R > 1100$ pF of the value measured in A.4.1.
Sub-group ADD5			
A.5 Climatic test on taped type		10 days at 40 ± 2 °C R.H. 90 to 95% Recovery time 24 hours	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 the specification.

AC AND PULSE METALLIZED POLYPROPYLENE FILM CAPACITORS (MKP AND KP/MMKP)

AC AND PULSE METALLIZED POLYPROPYLENE FILM CAPACITORS

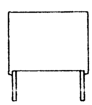
KP/MMKP radial potted type

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

QUICK REFERENCE DATA

Rated capacitance range	0,0018 to 0,27 μF
Tolerance on rated capacitance	± 10%, ± 5%*
Rated voltage U_R (DC)	630 V, 1000 V, 1600 V, 2000 V
Rated voltage U_R (AC)	300 V, 400 V, 500 V, 600 V
Climatic category	55/100/56
Rated temperature	85 °C
Related specifications	IEC 384-16, IEC 384-17**
Performance grade	long life

STYLE



Style 2222 376; Pitch 15 mm, 22,5 mm, 27,5 mm
See Tables 1 to 4

APPLICATION

These capacitors are for use in applications where high currents and steep pulses occur. They are mainly used for deflection circuits in television receivers operating at high peak currents at line frequency, and in switch mode power supplies. When enquiring about use in particular applications, 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 in epoxy resin within a flame retardent polypropylene case, and the radial leads are solder coated. The capacitors are supplied with pips; this ensures that the device stands marginally clear of the printed wiring board, thus allowing the easy removal of solder flux during the cleaning process.

* ± 3,5% to special order
** Formerly IEC-QC40(CO)482

GENERAL DATA

Dimensions

All dimensions in mm

The dimensions of capacitors in each voltage range are detailed in Tables 1 to 4.

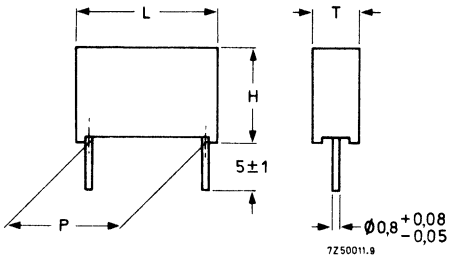


Fig. 1 Component dimensions.

Table 1 U_R (DC) = 630 V; rated AC voltage = 300 V (see Fig. 1)

rated capacitance value µF	$T_{max.}$ mm	$H_{max.}$ mm	$L_{max.}$ mm	P mm	mass grams	catalogue number 2222 376 . . . . . tol. ± 10%	tol. ± 5%
0,0068	5	11	17,5	15 ± 0,3	1,05	61682	62682
0,0075	5	11			1,05	61752	62752
0,0082	5	11			1,05	61822	62822
0,0091	5	11			1,05	61912	62912
0,010	6	12			1,4	61103	62103
0,011	6	12			1,4	61113	62113
0,012	6	12			1,4	61123	62123
0,013	6	12			1,4	61133	62133
0,015	7	13			1,8	61153	62153
0,016	7	13			1,8	61163	62163
0,018	7	13			1,8	61183	62183
0,020	8,5	14,5			2,55	61203	62203
0,022	8,5	14,5			2,55	61223	62223
0,024	6,5	15,5	26	22,5 ± 0,3	2,8	61243	62243
0,027	6,5	15,5			2,8	61273	62273
0,030	7,5	16,5			3,5	61303	62303
0,033	7,5	16,5			3,5	61333	62333
0,036	7,5	16,5			3,5	61363	62363
0,039	7,5	16,5			3,5	61393	62393
0,043	8,5	17,5			4,4	61433	62433
0,047	8,5	17,5			4,4	61473	62473
0,051	8,5	17,5			4,4	61513	62513
0,056	9,5	19			5,1	61563	62563
0,062	11	20	31	27,5 ± 0,3	7,4	61623	62623
0,068	11	20			7,4	61683	62683
0,075	11	20			7,4	61753	62753
0,082	11	20			7,4	61823	62823
0,091	11	20			7,4	61913	62913
0,10	11	20			7,4	61104	62104
0,11	11	20			7,4	61114	62114
0,12	13	22,5			10,2	61124	62124
0,13	13	22,5			10,2	61134	62134
0,15	13	22,5			10,2	61154	62154
0,16	13	22,5			10,2	61164	62164
0,18	15	25			12,8	61184	62184
0,20	15	25			12,8	61204	62204
0,22	18	28			18,2	61224	62224
0,24	18	28			18,2	61244	62244
0,27	18	28			18,2	61274	62274

Table 2 U_R (DC) = 1000 V; rated AC voltage = 400 V (see Fig. 1)

rated capacitance value	$T_{max.}$	$H_{max.}$	$L_{max.}$	P	mass	catalogue number 2222 376	
						tol. ± 10%	tol. ± 5%
μF	mm	mm	mm	mm	grams		
0,0047	5	11			1,05	71472	72472
0,0051	5	11			1,05	71512	72512
0,0056	5	11			1,05	71562	72562
0,0062	6	12			1,4	71622	72622
0,0068	6	12			1,4	71682	72682
0,0075	6	12	17,5	15 ± 0,3	1,4	71752	72752
0,0082	6	12			1,4	71822	72822
0,0091	7	13			1,8	71912	72912
0,010	7	13			1,8	71103	72103
0,011	7	13			1,8	71113	72113
0,012	8,5	14,5			2,55	71123	72123
0,013	6,5	15,5			2,8	71133	72133
0,015	6,5	15,5			2,8	71153	72153
0,016	6,5	15,5			2,8	71163	72163
0,018	7,5	16,5			3,5	71183	72183
0,020	7,5	16,3			3,5	71203	72203
0,022	8,5	17,5	26	22,5 ± 0,3	4,4	71223	72223
0,024	8,5	17,5			4,4	71243	72243
0,027	8,5	17,5			4,4	71273	72273
0,030	8,5	17,5			4,4	71303	72303
0,033	8,5	17,5			4,4	71333	72333
0,036	8,5	17,5			4,4	71363	72363
0,039	9,5	19			5,1	71393	72393
0,043	11	20			7,4	71433	72433
0,047	11	20			7,4	71473	72473
0,051	11	20			7,4	71513	72313
0,056	11	20			7,4	71563	72563
0,062	11	20			7,4	71623	72623
0,068	11	20			7,4	71683	72683
0,075	11	20			7,4	71753	72753
0,082	13	22,5	31	27,5 ± 0,3	10,2	71823	72823
0,091	13	22,5			10,2	71913	72913
0,10	13	22,5			10,2	71104	72104
0,11	15	25			12,8	71114	72114
0,12	15	25			12,8	71124	72124
0,13	15	25			12,8	71134	72134
0,15	18	28			18,2	71154	72154
0,16	18	28			18,2	71164	72164
0,18	18	28			18,2	71184	72184

Table 3 U_R (DC) = 1600 V; rated AC voltage = 500 V (see Fig. 1)

rated capacitance value	$T_{max.}$	$H_{max.}$	$L_{max.}$	P	mass	catalogue number 2222 376	
						tol. ± 10%	tol. ± 5%
μF	mm	mm	mm	mm	grams		
0,0018	5	11	17,5	15 ± 0,3	1,05	81182	82182
0,0020	6	12			1,4	81202	82202
0,0022	6	12			1,4	81222	82222
0,0024	6	12			1,4	81242	82242
0,0027	7	13			1,8	81272	82272
0,0030	7	13			1,8	81302	82302
0,0033	7	13			1,8	81332	82332
0,0036	8,5	14,5			2,55	81362	82362
0,0039	8,5	14,5			2,55	81392	82392
0,0047	8,5	14,5			2,55	81472	82472
0,0051	6,5	15,5	26	22,5 ± 0,3	2,8	81512	82512
0,0056	6,5	15,5			2,8	81562	82562
0,0062	6,5	15,5			2,8	81622	82622
0,0068	6,5	15,5			2,8	81682	82682
0,0075	6,5	15,5			2,8	81752	82752
0,0082	6,5	15,5			2,8	81822	82822
0,0091	7,5	16,5			3,5	81912	82912
0,010	7,5	16,5			3,5	81103	82103
0,011	8,5	17,5			4,4	81113	82113
0,012	8,5	17,5			4,4	81123	82123
0,013	9,5	19			5,1	81133	82133
0,015	9,5	19			5,1	81153	82153
0,016	11	20	31	27,5 ± 0,3		81163	82163
0,018	11	20				81183	82183
0,020	11	20				81203	92203
0,022	11	20				81223	82223
0,024	11	20				81243	82243
0,027	13	22,5				81273	82273
0,030	13	22,5				81303	82303
0,033	13	22,5				81333	82333
0,036	13	22,5				81363	82363
0,039	15	25				81393	82393
0,043	15	25				81433	82433
0,047	18	28				81473	82473
0,051	18	28				81513	82513
0,056	18	28				81563	82563

Table 4 U_R (DC) = 2000 V; rated AC voltage = 600 V (see Fig. 1)

rated capacitance value μF	$T_{max.}$ mm	$H_{max.}$ mm	$L_{max.}$ mm	P mm	mass grams	catalogue number 2222 376 . . . . . tol. ± 10%	 tol. ± 5%
0,0010	5	11	17,5	15 ± 0,3	1,05		92102
0,0011	5	11			1,05		92112
0,0012	6	12			1,4		92122
0,0013	6	12			1,4		92132
0,0015	6	12			1,4		92152
0,0016	6	12			1,4		92162
0,0018	7	13			1,8		92182
0,0020	7	13			1,8		92202
0,0022	8,5	14,5			2,55		92222
0,0024	8,5	14,5			2,55		92242
0,0027	8,5	14,5			2,55		92272
0,0030	8,5	14,5			2,55		92302
0,0033	6,5	15,5	26	22,5 ± 0,3	2,8		92332
0,0036	6,5	15,5			2,8		92362
0,0039	6,5	15,5			2,8		92392
0,0043	6,5	15,5			2,8		92432
0,0047	6,5	15,5			2,8		92472
0,0051	7,5	16,5			3,5		92512
0,0056	7,5	16,5			3,5		92562
0,0062	7,5	16,5			3,5		92622
0,0068	7,5	16,5			3,5		92682
0,0075	8,5	17,5			4,4		92752
0,0082	8,5	17,5			4,4		92822
0,0091	9,5	19			5,1		92912
0,010	9,5	19			5,1		92103
0,011	11	20	31	27,5 ± 0,3			92113
0,012	11	20					92123
0,013	11	20					92133
0,015	11	20					92153
0,016	13	22,5					92163
0,018	13	22,5					92183
0,020	13	22,5					92203
0,022	13	22,5					92223
0,024	15	25					92243
0,027	15	25					92273
0,030	18	28					92303
0,033	18	28					92333

Marking

The capacitors are supplied with the following markings:

- Rated capacitance value
- Rated voltage
- Tolerance of rated capacitor
- Year and month of manufacture
- Manufacturer's name
- Manufacturer's type designation

These marking are embossed on the top edge of the device, in two lines as follows:

First line:
- rated capacitance (in μF)
- capacitor tolerance
- rated DC voltage

Second line:
- code for dielectric material
- 5th, 6th and 7th digits of the catalogue number
- code for factory of origin
- production date (year and month) in accordance with IEC-62 Clause 5

The manufacturer's identification symbol is marked at the left hand side of the data detailed above.

The boxes containing the capacitors are also marked with the information detailed above. In addition, the following information is supplied on the boxes:

- category voltage
- climatic category

Mounting

The capacitors are suitable for mounting on printed wiring boards.

Ratings and characteristics

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

Capacitance

Rated capacitance 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

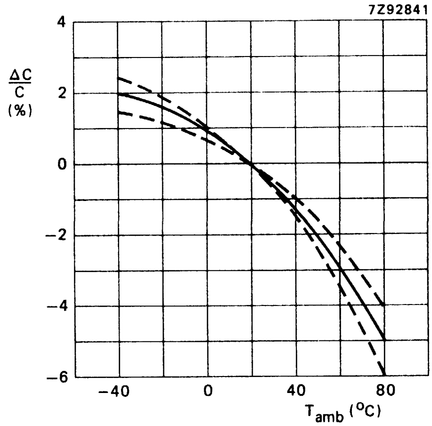


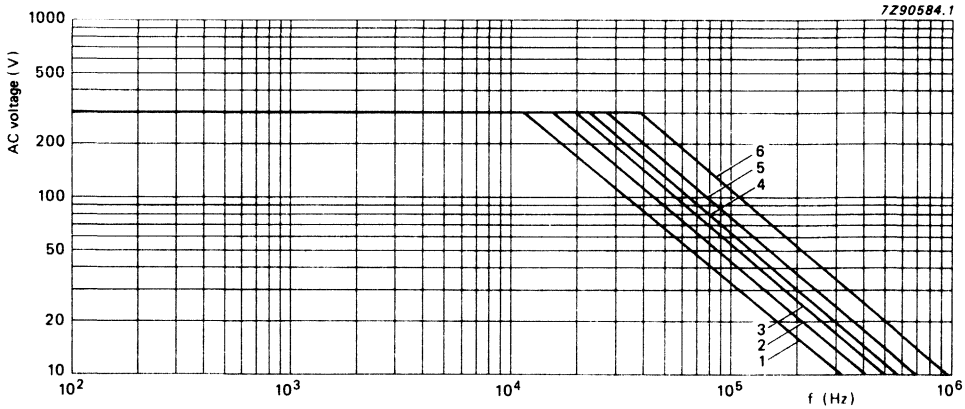
Fig. 2 Capacitance as a function of ambient free air temperature, typical curve.

Voltage

Rated voltage U_R (DC)	see Tables 1 to 4
Rated AC voltage (RMS value) at 50 to 60 Hz	see Tables 1 to 4
Category voltage U_C	0,7 x U_R (DC)
Test voltage	
between terminations	1,6 x U_R (DC)
between interconnected terminations and case (foil method)	2840 V (DC)

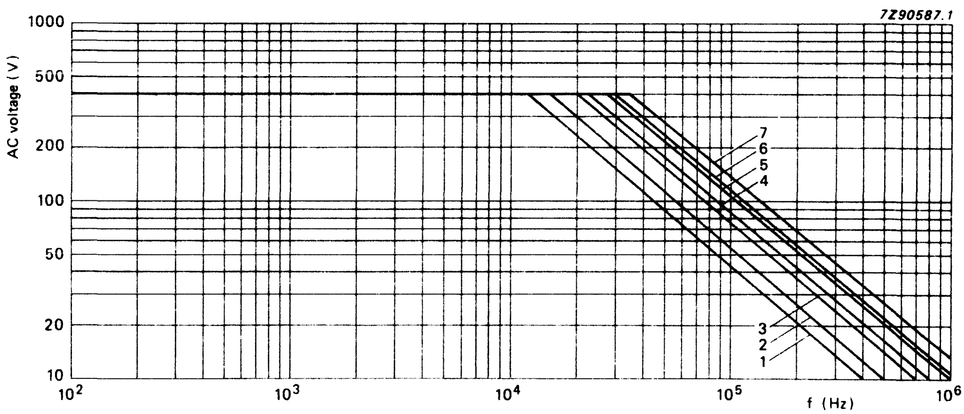
Notes:

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



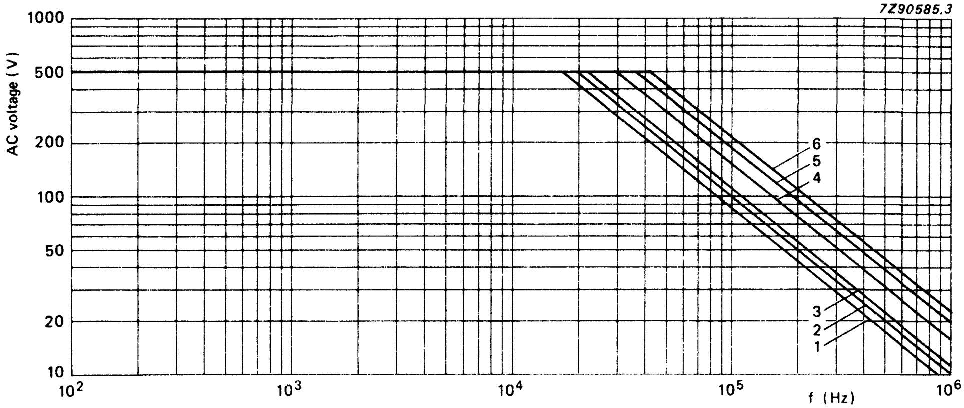
Curve 1: 0,27 μF
Curve 2: 0,12 μF
Curve 3: 0,056 μF
Curve 4: 0,027 μF
Curve 5: 0,022 μF
Curve 6: 0,0068 μF

Fig. 3 Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 85$ °C for U_R (DC) = 630 V.



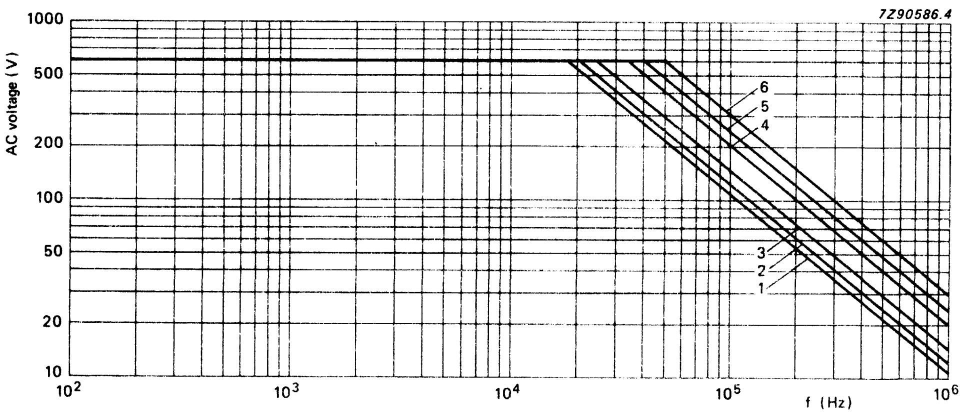
Curve 1: 0,18 μF
Curve 2: 0,082 μF
Curve 3: 0,047 μF
Curve 4: 0,027 μF
Curve 5: 0,015 μF
Curve 6: 0,0082 μF
Curve 7: 0,0047 μF

Fig. 4 Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 85$ °C for U_R (DC) = 1000 V.



Curve 1: 0,056 μF
Curve 2: 0,027 μF
Curve 3: 0,015 μF
Curve 4: 0,0068 μF
Curve 5: 0,0039 μF
Curve 6: 0,0018 μF

Fig. 5 Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 85\ ^{\circ}C$ for U_R (DC) = 1600 V.



Curve 1: 0,033 μF
Curve 2: 0,015 μF
Curve 3: 0,01 μF
Curve 4: 0,0039 μF
Curve 5: 0,0027 μF
Curve 6: 0,001 μF

Fig. 6 Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 85\ ^{\circ}C$ for U_R (DC) = 2000 V.

Temperature

Climatic category 55/100/56

Rated temperature 85 °C

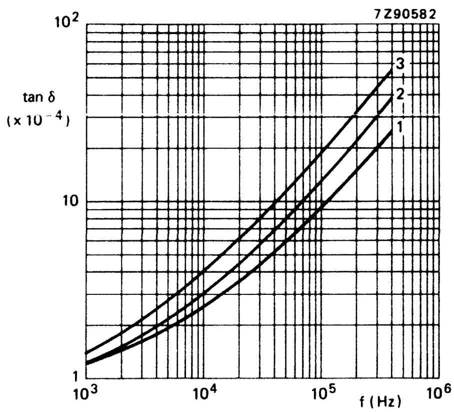
Maximum pulse load

Not applicable, limited by network conditions.

Tangent of loss angle

Table 5 Tangent of loss angle at 100 kHz

Rated voltage V	Capacitors with pitch P 15 mm	22,5 mm	27,5 mm
630	$\leq 10 \times 10^{-4}$	$\leq 15 \times 10^{-4}$	$\leq 20 \times 10^{-4}$
1000	$\leq 10 \times 10^{-4}$	$\leq 10 \times 10^{-4}$	$\leq 15 \times 10^{-4}$
1600	$\leq 10 \times 10^{-4}$	$\leq 10 \times 10^{-4}$	$\leq 15 \times 10^{-4}$
2000	$\leq 10 \times 10^{-4}$	$\leq 10 \times 10^{-4}$	$\leq 15 \times 10^{-4}$



Curve 1 = 15 mm pitch; all series
22,5 mm pitch;
1000 V series
1600 V series
2000 V series

Curve 2 = 22,5 mm pitch;
630 V series
27,5 mm pitch;
1000 V series
1600 V series
2000 V series

Curve 3 = 27,5 mm pitch;
630 V series

Fig. 7 Tangent of loss angle (maximum value) as a function of frequency.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 minute ± 5 s, the voltage being 500 V ± 50 V at T_{amb} = 23 °C

Resistance between terminations for $C_R \leqslant 0,33\ \mu F$:	> 100 000 MΩ
Resistance between interconnected terminations and case:	> 100 000 MΩ

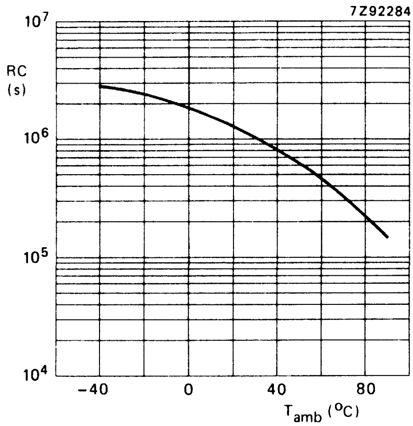


Fig. 8 RC products as a function of ambient free air temperature; typical curve.

Power dissipation

The maximum AC voltage has been specified at between 50 and 60 Hz, and at a temperature of 23 °C. This voltage value must never be exceeded at other frequencies. This permissible AC voltage may further be limited by the following restrictions:

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

– The steepness of the AC 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 (see Fig. 9) and is expressed by:

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

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

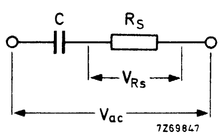


Fig. 9 Power dissipation as a function of the voltage across a series resistance.

Because for these capacitors, tan $\delta = R_s.\omega C = < 0,1$, the formula

$V_{Rs}{}^2 = \dfrac{R_s{}^2}{1/\omega^2.C^2} V_{ac}{}^2$ may be simplified to:

$R_s{}^2.\omega^2.C^2.V_{ac}{}^2$ (equation 3)

Thus $P = R_s.\omega^2.C^2.V_{ac}{}^2$ (equation 4)

or $P = \text{Tan}\ \delta.\omega.C.V_{ac}{}^2$ (equation 5)

The Tan δ value can be found from Fig. 10; $\omega = 2\pi f$ and V_{ac} are assumed as known values

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 using equation 5, Fig. 11 gives the minimum size of capacitor which can be used to dissipate this power.

Note: For a capacitor used with a half sinewave pulse, V_{rms} can be expressed as:

$V_{rms}{}^2 = \dfrac{1}{2} \times Vp^2 \times \dfrac{T1}{T2}$ (equation 6)

Substitution of equation 6 in equation 5 gives the power dissipation as:

$P = \dfrac{1}{2} \times \dfrac{T1}{T2} \times \text{Tan}\ \delta.\omega.C.Vp^2$

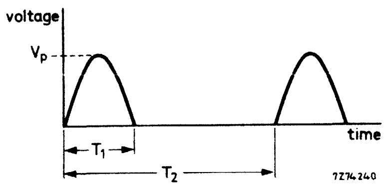


Fig. 10 Half-sinewave pulse.

Table 6 Power dissipation in capacitors of different dimensions (see Fig. 11)

curve	dimensions (mm)		
	$T_{max.}$	$H_{max.}$	$L_{max.}$
1	5	11	17,5
2	6	12	17,5
3	7	13	17,5
4	8,5	14,5	17,5
5	6,5	15,5	26
6	7,5	16,5	26
7	8,5	17,5	26
8	9,5	19	26
9	11	20	31
10	13	22,5	31
11	15	25	31
12	18	28	31

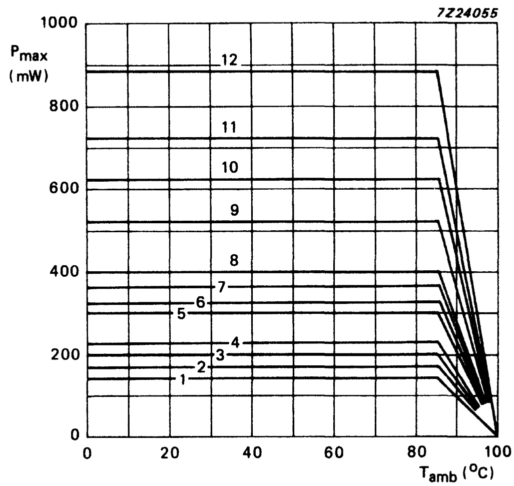


Fig. 11 Maximum dissipation as a function of ambient free air temperature, at various capacitor dimensions.

ORDERING INFORMATION

The capacitors may be ordered by quoting the 12 digit catalogue number (2222 376 xxxxx) as detailed in Tables 1 to 4.

PACKING

The capacitors are supplied in cardboard boxes, as detailed in Table 7 below.

Table 7 Number of capacitors per box

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

AC AND PULSE METALLIZED POLYPROPYLENE FILM CAPACITORS

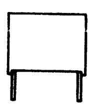
MKP radial potted type

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

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	0,0033 to 3,3 μF
Tolerance on rated capacitance	± 10%, ± 5%
Rated voltage U_R (DC)	250 V, 400 V, 630 V, 1000 V, 1600 V, 2000 V
Rated voltage U_R (AC)	160 V, 200 V, 300 V, 400 V, 500 V, 600 V
Climatic category	55/100/56
Rated temperature	85 °C
Related specification	IEC 384-17*
Performance grade	long life
Stability grade	1

STYLE



Style 2222 378; see Tables 1 to 6.

APPLICATION

These capacitors are for applications where high currents at high frequencies, and steep pulses occur, or high stability is required. Their small dimensions make them suited for circuits with high package density.

DESCRIPTION

The capacitors consist of a low-inductance wound cell of metallized polypropylene film. The cell is potted with epoxy resin in a blue 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.

* IEC40 (CO) 482.

GENERAL DATA

Dimensions in mm

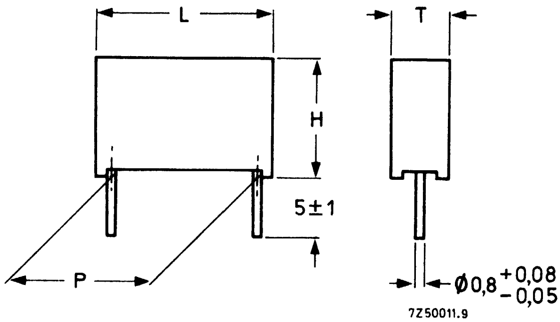


Fig. 1 Capacitors 2222 378.

Table 1 U_R (DC) = 250 V; rated AC voltage = 160 V; Fig. 1

rated capacitance μF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 378	
						tol. ± 10%	tol. ± 5%
0,33	6	15				41334	42334
0,39	7	16				41394	42394
0,47	7	16				41474	42474
0,56	8,5	17,5	26	22,5 ± 0,4		41564	42564
0,68	8,5	17,5				41684	42684
0,82	10	18,5				41824	42824
1	11	20				41105	42105
1,2	11	20				41125	42125
1,5	13	22,5				41155	42155
1,8	13	22,5	31	27,5 ± 0,4		41185	42185
2,2	15	25				41225	42225
2,7	18	28				41275	42275
3,3	18	28				41335	42335

Table 2 U_R (DC) = 400 V; rated AC voltage = 200 V; Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 378 . . . . . tol. ± 10%	tol. ± 5%
0,18	6	16	26	22,5 ± 0,4		51184	52184
0,22	7	16				51224	52224
0,27	7	16				51274	52274
0,33	8,5	17,5				51334	52334
0,39	8,5	17,5				51394	52394
0,47	10	18,5				51474	52474
0,56	10	18,5				51564	52564
0,68	11	20	31	27,5 ± 0,4		51684	52684
0,82	13	22,5				51824	52824
1	13	22,5				51105	52105
1,2	15	25				51125	52125
1,5	18	28				51155	52155
1,8	18	28				51185	52185

Table 3 U_R (DC) = 630 V; rated AC voltage = 300 V; Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 378 . . . . . tol. ± 10%	tol. ± 5%
0,056	6	15	26	22,5 ± 0,4		61563	62563
0,068	6	15				61683	62683
0,082	7	16				61823	62823
0,10	7	16				61104	62104
0,12	8,5	17,5				61124	62124
0,15	8,5	17,5				61154	62154
0,18	10	18,5				61184	62184
0,22	11	20	31	27,5 ± 0,4		61224	62224
0,27	11	20				61274	62274
0,33	13	22,5				61334	62334
0,39	13	22,5				61394	62394
0,47	15	25				61474	62474
0,56	18	28				61564	62564
0,68	18	28				61684	62684

DEVELOPMENT DATA

Table 4 U_R (DC) = 1000 V; rated AC voltage = 400 V; Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 378 ..... tol. ± 10%	tol. ± 5%
0,012	6	15	26	22,5 ± 0,4		71123	72123
0,015	6	15				71153	72153
0,018	6	15				71183	72183
0,022	6	15				71223	72223
0,027	7	16				71273	72273
0,033	8,5	17,5				71333	72333
0,039	8,5	17,5				71393	72393
0,047	10	18,5				71473	72473
0,056	10	18,5				71563	72563
0,068	11	20	31	27,5 ± 0,4		71683	72683
0,082	11	20				71823	72823
0,10	13	22,5				71104	72104
0,12	13	22,5				71124	72124
0,15	15	25				71154	72154
0,18	18	28				71184	72184
0,22	18	28				71224	72224

Table 5 U_R (DC) = 1600 V; rated AC voltage = 500 V; Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 378 ..... tol. ± 10%	tol. ± 5%
0,0056	6	15	26	22,5 ± 0,4		81562	82562
0,0068	6	15				81682	82682
0,0082	6	15				81822	82822
0,010	7	16				81103	82103
0,012	7	16				81123	82123
0,015	8,5	17,5				81153	82153
0,018	8,5	17,5				81183	82183
0,022	10	18,5				81223	82223
0,027	11	20	31	27,5 ± 0,4		81273	82273
0,033	11	20				81333	82333
0,039	11	20				81393	82393
0,047	13	22,5				81473	82473
0,056	15	25				81563	82563
0,068	15	25				81683	82683
0,082	18	28				81823	82823
0,10	18	28				81104	82104

Table 6 U_R (DC) = 2000 V; rated AC voltage = 600 V; Fig. 1

rated capacitance µF	T_{max}	H_{max}	L_{max}	P	mass grams	catalogue number 2222 378 . . . . . tol. ± 10%	catalogue number 2222 378 . . . . . tol. ± 5%
0,0033	6	15	26	22,5 ± 0,4		91332	92332
0,0039	6	15				91392	92392
0,0047	6	15				91472	92472
0,0056	7	16				91562	92562
0,0068	7	16				91682	92682
0,0082	8,5	17,5				91822	92822
0,010	8,5	17,5				91103	92103
0,012	10	18,5				91123	92123
0,015	11	20	31	27,5 ± 0,4		91153	92153

Marking

The following information is provided:

- Rated capacitance value
- Rated voltage
- Rated capacitance tolerance
- Category voltage
- Year and month of manufacture
- Manufacturer's name
- Climatic category
- Manufacturer's type designation

The package containing the capacitors is marked with all the above information. The capacitors are marked on the top edge by embossed print as follows:

line 1: rated capacitance, tolerance and rated DC voltage
line 2: code for dielectric material, 5th, 6th and 7th digits of the catalogue number, code for the factory of origin, production date code according to IEC 62, clause 5.

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

Mounting

The capacitors are suited for mounting on printed circuit 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 6
Tolerance on rated capacitance	see Tables 1 to 6

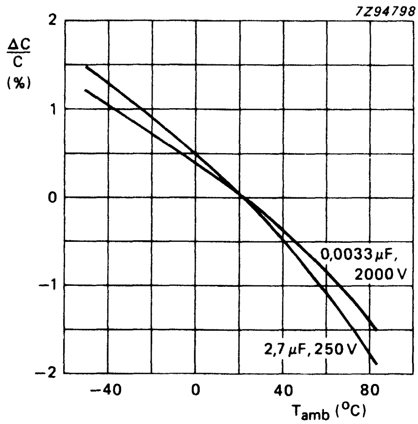


Fig. 2 Capacitance as a function of ambient free air temperature, typical curves.

Voltage

Rated voltage U_R (DC)	see Tables 1 to 6
Rated AC voltage (RMS), at 50 to 60 Hz	see Tables 1 to 6
Category voltage U_c	U_R (DC)
Test voltage	
between terminations	1,6 x U_R (DC)
between interconnected terminations and case	2840 V (DC)

Notes

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

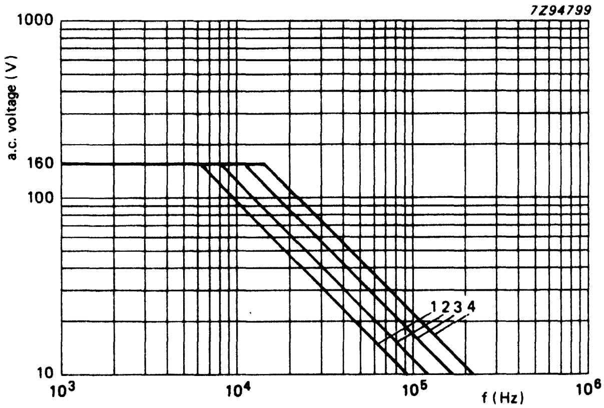


Fig. 3 Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 85\ ^{o}C$, for U_R (DC) = 250 V.

Curve 1 = 3,3 μF; curve 2 = 1,5 μF; curve 3 = 0,68 μF; curve 4 = 0,33 μF.

DEVELOPMENT DATA

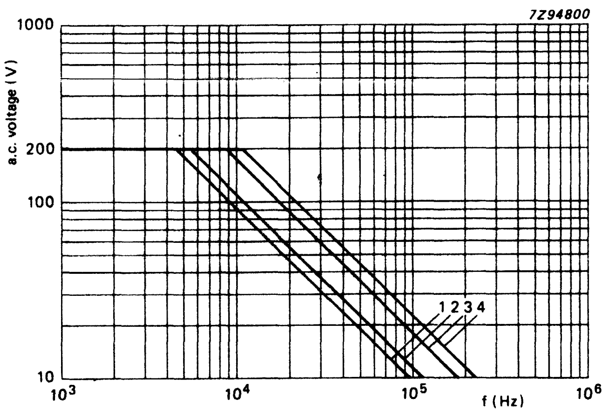


Fig. 4 Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 85\ ^{o}C$, for U_R (DC) = 400 V.

Curve 1 = 1,8 μF; curve 2 = 1 μF; curve 3 = 0,47 μF; curve 4 = 0,18 μF.

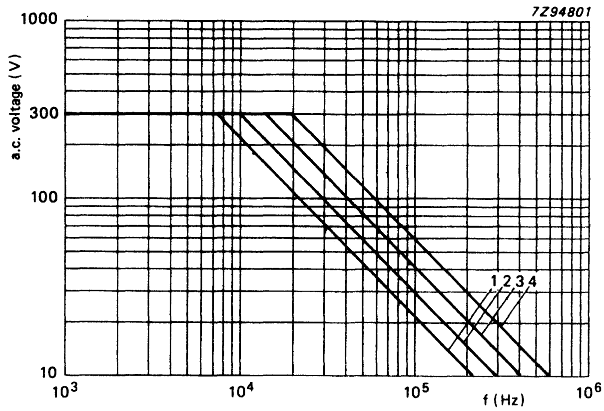


Fig. 5 Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 85\,^{o}C$, for U_R (DC) = 630 V.

Curve 1 = 0,68 μF; curve 2 = 0,33 μF; curve 3 = 0,15 μF; curve 4 = 0,056 μF.

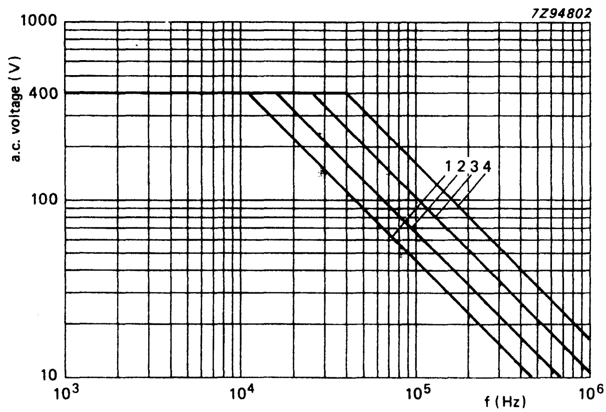


Fig. 6 Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leqslant 85\,^{o}C$, for U_R (DC) = 1000 V.

Curve 1 = 0,22 μF; curve 2 = 0,10 μF; curve 3 = 0,033 μF; curve 4 = 0,012 μF.

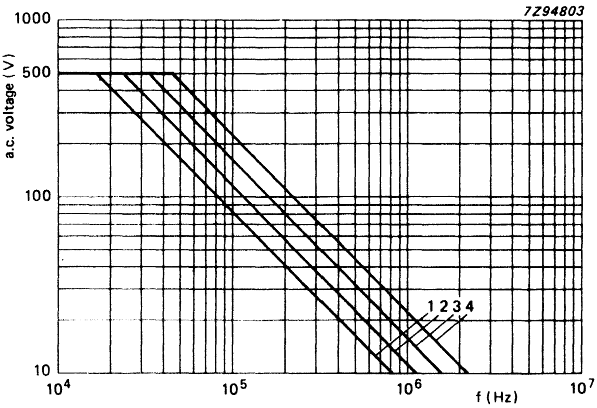


Fig. 7 Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 85$ °C, for U_R (DC) = 1600 V.

Curve 1 = 0,1 μF;
curve 2 = 0,033 μF;
curve 3 = 0,015 μF;
curve 4 = 0,0056 μF.

DEVELOPMENT DATA

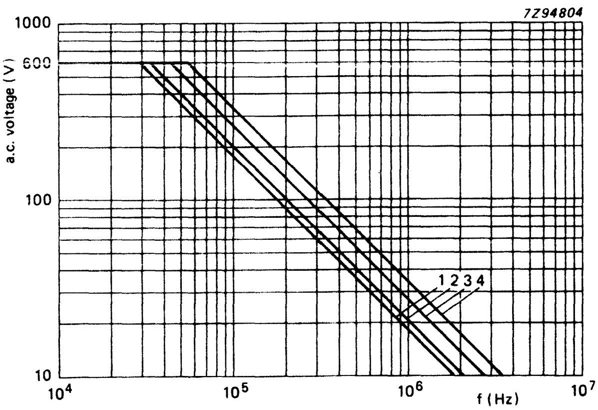


Fig. 8 Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 85$ °C, for U_R (DC) = 2000 V.

Curve 1 = 0,015 μF;
curve 2 = 0,010 μF;
curve 3 = 0,0047 μF;
curve 4 = 0,0033 μF.

Temperature

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

Rated voltage pulse slope $(\frac{dU}{dt})_R$

Table 7 Rated voltage pulse slope

rated voltage V	rated voltage pulse slope (V/µs) L = 26 mm	L = 31 mm
250	80	60
400	120	80
630	600	350
1000	1500	800
1600	2000	1200
2000	2000	1500

The rated voltage pulse slope 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 slope requirement is satisfied, a check must be made to ascertain that the maximum dissipation is not exceeded.

Tangent of loss angle

Table 8 Tangent of loss angle

rated voltage	tangent of loss angle			
	at 10 kHz		at 100 kHz	
V	L = 26 mm	L = 31 mm	L = 26 mm	L = 31 mm
250	$\leqslant 10 \times 10^{-4}$	$\leqslant 20 \times 10^{-4}$	$\leqslant 70 \times 10^{-4}$	
400	$\leqslant 10 \times 10^{-4}$	$\leqslant 15 \times 10^{-4}$	$\leqslant 40 \times 10^{-4}$	$\leqslant 50 \times 10^{-4}$ *
630	$\leqslant 10 \times 10^{-4}$	$\leqslant 10 \times 10^{-4}$	$\leqslant 20 \times 10^{-4}$	$\leqslant 30 \times 10^{-4}$
1000	$\leqslant 8 \times 10^{-4}$	$\leqslant 8 \times 10^{-4}$	$\leqslant 15 \times 10^{-4}$	$\leqslant 20 \times 10^{-4}$
1600	$\leqslant 8 \times 10^{-4}$	$\leqslant 8 \times 10^{-4}$	$\leqslant 10 \times 10^{-4}$	$\leqslant 15 \times 10^{-4}$
2000	$\leqslant 8 \times 10^{-4}$	$\leqslant 8 \times 10^{-4}$	$\leqslant 10 \times 10^{-4}$	$\leqslant 10 \times 10^{-4}$

* Only for $C \leqslant 1$ µF.

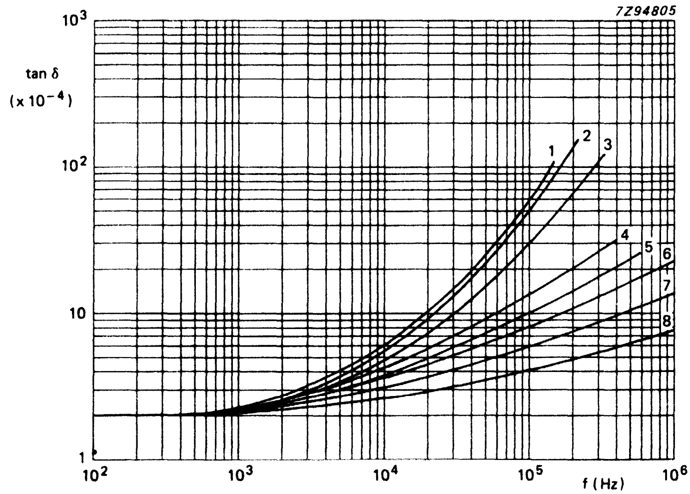


Fig. 9 Tan δ as a function of frequency; typical curves.

Curve 1 = 27,5 mm pitch, 250 V version;
curve 2 = 27,5 mm pitch, 400 V version;
curve 3 = 22,5 mm pitch, 250 V version;
curve 4 = 22,5 mm pitch, 400 V version;
27,5 mm pitch, 630 V version;
curve 5 = 22,5 mm pitch, 630 V version;
curve 6 = 27,5 mm pitch, 1000 V version;
curve 7 = 22,5 mm pitch, 1000 V version;
27,5 mm pitch, 1500 V version;
curve 8 = 22,5 mm pitch, 1500 V and
2000 V versions;
27,5 mm pitch, 2000 V version.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 minute ± 5 s, the voltage being 100 ± 15 V for the 250 V and 400 V versions, and 500 ± 50 V for the 630 V, 1000 V, 1600 V and 2000 V versions.

R between terminations, for $C_R \leqslant 1\ \mu F$	> 100 000 MΩ
RC between terminations, for $C_R > 1\ \mu F$	> 100 000 s
R between interconnected terminations and case	> 30 000 MΩ

Impedance

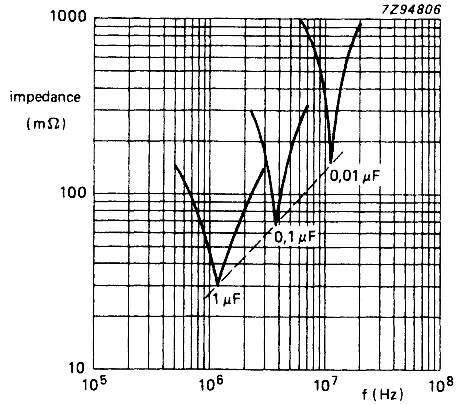


Fig. 10 Impedance as a function of frequency; typical curves.

Maximum dissipation

The rated AC 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 AC 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 AC 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

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

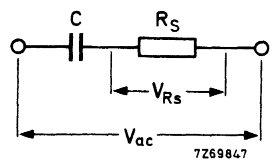


Fig. 11.

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

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

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

The term tan δ can be found from Fig. 9; 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. 12. Thus, when the actual power has been calculated with equation (3b), Fig. 12 gives the minimum size of capacitor which can dissipate this power.

Table 9 Power dissipation for different dimensions

curve	dimensions (mm)		
	T_{max}	H_{max}	L_{max}
1	6	15	26
2	7	16	26
3	8,5	17,5	26
4	10	18,5	26
5	11	20	31
6	13	22,5	31
7	15	25	31
8	18	28	31

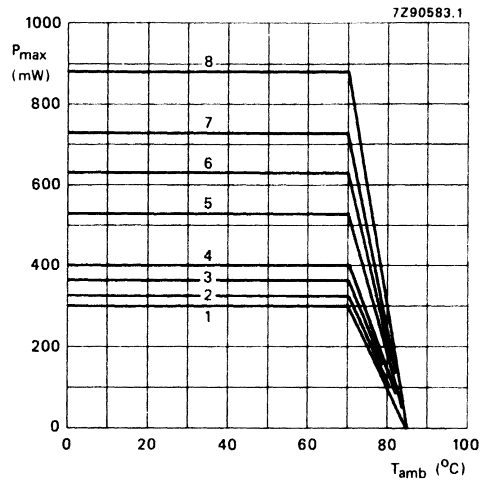


Fig. 12 Maximum dissipation as a function of ambient free air temperature, at various capacitor dimensions.

DEVELOPMENT DATA

ORDENING INFORMATION

Order the capacitors by quoting the 12-digit catalogue numbers as given in Tables 1 to 6.

PACKING

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

Table 10 Number of capacitors per box

L_{max} mm	number of capacitors per box
26	200
31	100

INSPECTION REQUIREMENTS

AC and pulse metallized polypropylene film capacitors (MKP and KP/MMKP)

Note 1
Sub-clause numbers of tests and performance requirements refer to the Sectional Specification, IEC publication 384-16, 384-17 (IEC 40-CO-482) 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 376** (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 for $C_R \leqslant 1\ \mu F$ At 10 kHz for $C_R > 1\ \mu F$	As in GENERAL DATA of the specifications.
4.2.1 Voltage proof (Test A)		at 1,6 x U_R (DC) for 1 s	No breakdown or flashover.
4.2.4 Insulation resistance (Test A)		At 100 V for $U_R < 630$ V At 500 V for $U_R \geqslant 630$ V	As in GENERAL DATA of the specifications.

performance requirements
2222 378 (see Note 1)

No mechanical failures.
Legible marking and as specified in GENERAL DATA of this specification.

As specified in the Tables of the specifications.

Within specified tolerance.

As in GENERAL DATA of the specifications.

No breakdown or flashover.

As in the 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 376**
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.

performance requirements
2222 378

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

As specified in the Tables of the specifications.

No visible damage.

No visible damage.
Legible marking.
$\Delta C/C \leqslant 1\%$ of the value measured initially.
Tan $\delta < 1{,}5$ x the 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 376**
Sub-group C1B	D		
Other part of sample of Sub-group C1			
4.6.1 Initial measurements		Capacitance Tangent of loss angle At 100 kHz for $C_R \leqslant 1\ \mu F$ At 10 kHz for $C_R > 1\ \mu F$	
4.6 Rapid change of temperature		θ A = lower cat. temp. θ B = upper cat. temp. 5 cycles, duration t = 30 minutes 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 hours	
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 grams shall be clamped to the printed-wiring board.

performance requirements
2222 378

No visible damage.

No visible damage.

No visible damage
$\Delta C/C \leqslant 1\%$ of the value measured in 4.6.1.
Tan $\delta < 1{,}5$ x the values measured in 4.6.1.
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 **2222 376**
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 hours	
4.10.3 Damp heat cyclic, Test Db, first cycle			
4.10.4 Cold		Temperature: lower category temperature Duration: 2 hours	
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.

performance requirements
2222 378

No visible damage.
Legible marking.
$\Delta C/C \leqslant 1\%$ of value
measured in 4.4.2 or 4.9.3.
Tan $\delta < 1{,}5$ x the values
measured in 4.3.1 or 4.6.1

$\geqslant 50\%$ 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 **2222 376**
Sub-group C2	D		
4.11 Damp heat steady state			
4.11.1 Initial measurements		Capacitance Tangent of loss angle At 100 kHz for $C_R \leqslant 1\ \mu F$ At 10 kHz for $C_R > 1\ \mu F$	
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 At 100 kHz for $C_R \leqslant 1\ \mu F$ At 10 kHz for $C_R > 1\ \mu F$	
4.12.2 Endurance DC		Duration: 2000 hours 1,25 U_R (DC) at 85 ^oC 1,25 U_C at 100 ^oC	
4.12.2.4 Final measurements		Visual examination	No visible damage. Legible marking.
		Capacitance	$\Delta C/C \leqslant 3\%$ 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 hours; 1,25 x rated AC voltage (RMS value), 50 Hz, at 85 ^oC	
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.

performance requirements
2222 378

No visible damage.
Legible marking.
$\Delta C/C \leqslant 1\%$ of the value measured in 4.11.1.
Tan $\delta < 1{,}5$ x the values measured in 4.11.1.

$\geqslant 50\%$ of values in GENERAL DATA of the specifications.

No visible damage.
Legible marking.
$\Delta C/C \leqslant 1\%$ of the value measured in 4.12.1.
Tan $\delta < 1{,}5$ x the values measured in 4.12.1.

$\geqslant 50\%$ of values in GENERAL DATA of the specifications.

$\Delta C/C \leqslant 5\%$ of value measured in 4.12.1.
Tan $\delta < 1{,}5$ x the values measured in 4.12.1.

$\geqslant 50\%$ of values in GENERAL DATA of the specifications.

sub-clause number and test	D or ND	conditions of test	performance requirements **2222 376**
Sub-group C4	D		
4.13 Charge and discharge $5 \times \left\{ \frac{dU}{dt} \right\} R$		10.000 cycles (50 c/s) charge to U_R half sine wave Duration: 5 ms discharge R = $\frac{U_R}{C_R \cdot 5 \left\{ \frac{dU}{dt} \right\} R}$ with a minimum R of 2,2 Ω	
4.13.1 Initial measurements		Capacitance Tangent of loss angle at 10 kHz for $C_R > 1\ \mu F$ at 100 kHz for $C_R \leqslant 1\ \mu F$	not applicable
4.13.3 Final measurements		Capacitance Tangent of loss angle Insulation resistance	

performance requirements
2222 378

$\Delta C/C \leqslant 1\%$ of the value measured in 4.13.1.
Tan $\delta < 1{,}5$ x the values measured in 4.13.1.

$\geqslant 50\%$ of values in GENERAL DATA of this specification.

additional tests	D or ND	conditions of test	performance requirements **2222 376**
Sub-group ADD1	D		
A.1 Heat storage		Duration: 2000 hours 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 hours Temperature: 23 °C Voltage: 1,1 x max. AC voltage (RMS value), 20 kHz	
A.2.2 Final measurements		Capacitor body temperature	$\Delta T \leqslant 10$ °C.

performance requirements
2222 378

$\Delta C/C \leqslant 1\%$ of value
measured in A.1.1.
Tan $\delta < 1{,}5$ x the values
measured in A.1.1.

As in GENERAL DATA of
the specifications.

$\Delta T \leqslant 10\ ^{o}C$.

additional tests	D or ND	conditions of test	performance requirements **2222 376**
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 Visual inspection	
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 minutes Followed by rinsing in clear water for 1 minute Recovery time > 2 hours	
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.

performance requirements
2222 378

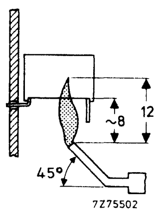
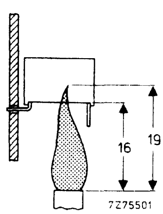
Brush test

$\Delta C/C \leqslant 1\%$ of value measured in A.3.1.
Tan $\delta < 1{,}5$ x the values measured in A.3.1.

$\geqslant 50\%$ of values in GENERAL DATA of the specifications.

$\Delta C/C \leqslant 1\%$ of value measured in A.4.1.
Tan $\delta < 1{,}5$ x the values measured in A.4.1.

$\geqslant 50\%$ of values in GENERAL DATA of the specifications.

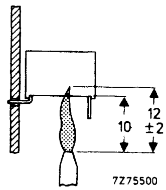
additional tests	D or ND	conditions of tests	performance requirements **2222 376**
Sub-group ADD5	D		
A.5 Resistance to soldering heat with pre-heating		Capacitors mounted on a 1,6 mm board with non-plated holes Body temp.: 80 °C Bath temp.: 260 °C Dwell time: 2 x 5 s with interim free period of 5 s	
A.5.1 Initial measurements		Capacitance Tangent of loss angle	
A.5.2 Final measurements		Capacitance Tangent of loss angle	$\Delta C/C \leqslant 1\%$ of value measured in A.5.1. 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.

performance requirements
2222 378

$\Delta C/C \leqslant 1\%$ of value measured in A.5.1.
Tan $\delta < 1{,}5$ x the 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.

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 **2222 376**
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 hours at 100 ± 2 °C. Test duration: 1st cycle: 10 s, 2nd cycle: 1 minute 3rd cycle: 2 minutes 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 hours Temp.: 23 °C. Voltage: 850 V_{DC} + 550 V_{AC} (for 1600 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.

performance requirements
2222 378

Extinguishing time ≤ 30 s after each flame application. No burning particles must drop from the sample.

Not applicable.

additional tests	D or ND	conditions of test	performance requirements **2222 376**
Sub-group ADD			
A.9 Charge and discharge (high pulse) $5 \times \left\lvert \frac{dU}{dt} \right\rvert_R$		10,000 cycles (1 cycle/sec)	
		charge to $V \leqslant U_R$ (DC) with maximum pulse slope $\leqslant 0{,}01 \left\lvert \frac{dU}{dt} \right\rvert_R$	
		discharge with resistor defined by $R = \dfrac{V^2}{C_R \cdot U_R \cdot \left\lvert \frac{dU}{dt} \right\rvert_R}$	
A.9.1 Initial measurements		Capacitance	
		Tangent of loss angle for $C_R > 1\ \mu F$ at 10 kHz	
A.9.2 Final measurements		Capacitance	
		Tangent of loss angle	
		Insulation resistance	

performance requirements
2222 378

$\Delta C/C \leqslant 1\%$ of value measured in A.8.1.
Tan $\delta < 1{,}5$ x the values measured in A.8.1.

$\geqslant 50\%$ of values in GENERAL DATA of this specification.

INTERFERENCE SUPPRESSION CAPACITORS
(MKT-P)

INTERFERENCE SUPPRESSION CAPACITORS

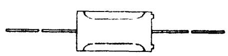
MKT-P radial potted type

- Supplied in boxes

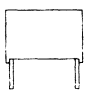
QUICK REFERENCE DATA

Rated capacitance range (E6-series)	0,01 to 1 μF
Tolerance on rated capacitance	± 20%, ± 10%
Rated voltage U_R (AC), 50 to 60 Hz	250 V
Climatic category	40/85/21
Application class according to DIN 40040	GPF
Rated temperature	85 ^{o}C
Related specification	IEC 384-14
Performance class	X2
Qualified according to	VDE565-1, SEMKO, IMQ and UL 1283

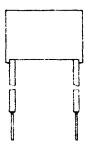
SURVEY OF STYLES



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 polyethylene-terephthalate (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 . . . .

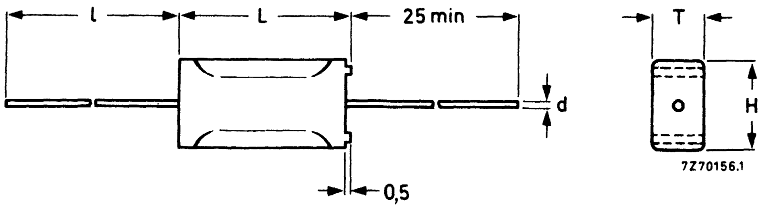


Fig. 1 Capacitors 2222 330 0 . . . .

Table 1 U_R (AC) = 250 V, Fig. 1

rated capacitance* µF	T_{max}	H_{max}	L_{max}	d	l_{min}	mass grams	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 . . . .

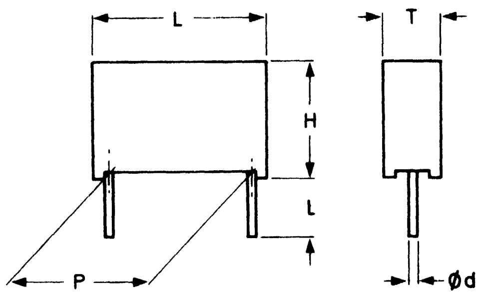


Fig. 2 Capacitors 2222 330 4 . . . .

Table 2 U_R (AC) = 250 V, Fig. 2

rated capacitance* μF	T_{max}	H_{max}	L_{max}	d	P	mass grams	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			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 . . . . .

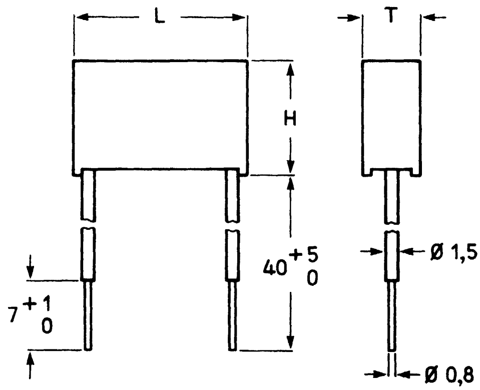


Fig. 3 Capacitors 2222 330 8 . . . .

Table 3 U_R (AC) = 250 V, Fig. 3

rated capacitance* μF	T_{max}	H_{max}	L_{max}	mass grams	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

The following information is provided:

(a) Rated capacitance value
(b) Rated voltage
(c) Rated capacitance tolerance
(d) Category voltage
(e) Year and month of manufacture
(f) Manufacturer's name
(g) Climatic category
(h) Manufacturer's type designation
(j) Performance class
(k) Application class
(l) Certification marks
(m) SH (self-healing metallized product)

- Style 2222 330 0 . . . .

The marking is impressed on one side as follows:

line 1: rated capacitance in μF, tolerance (± 10% identified by K, ± 20% not identified), rated voltage and performance class.

line 2: last eight digits of the catalogue number and production date code (according to IEC 62, clause 5.

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 edge by embossed print as follows:

line 1: rated capacitance in μF, tolerance (± 10% identified by K or 10, ± 20% not identified), rated voltage and performance class.

line 2: 5th, 6th, 7th, 8th and 9th digits of the catalogue number and code for dielectric materials (MKT-P).

line 3: climatic category, production date code (according to IEC 62, clause 5), category according to DIN.
Manufacturer's identification symbol and approbation symbols are to the left and to the right of the lines of marking respectively.

The package containing the capacitors is marked with details a to m listed above.

Mounting

The capacitors are for printed-wiring applications. Capacitors of styles 2222 330 0 . . . . and 2222 330 8 . . . . are also suitable 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

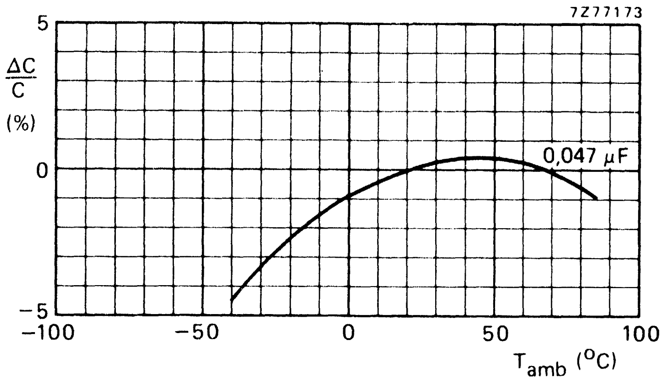


Fig. 4 Capacitance as a function of ambient free air temperature; typical curve.

Voltage

Rated voltage U_R (AC) (RMS value), 50 to 60 Hz	250 V
Test voltage	
between terminations	1075 V (DC)
between interconnected terminations and case (foil method)	2000 V (AC)

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	$\leqslant 130 \times 10^{-4}$

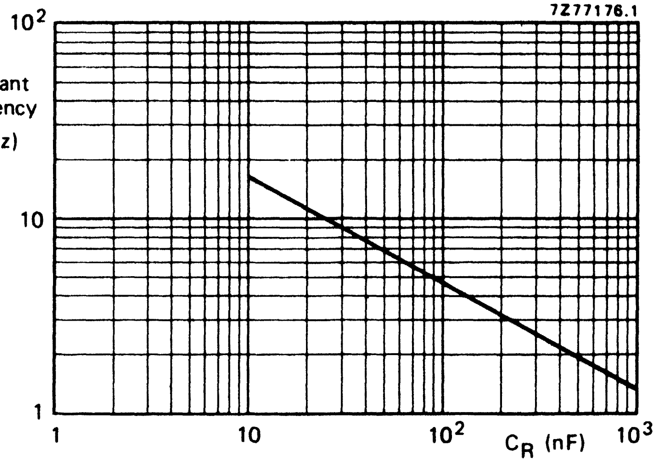


Fig. 5 Resonant frequency as a function of rated capacitance.

Insulation resistance

The insulation resistance is measured after a voltage of 100 ± 15 V has been applied for 1 minute ± 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

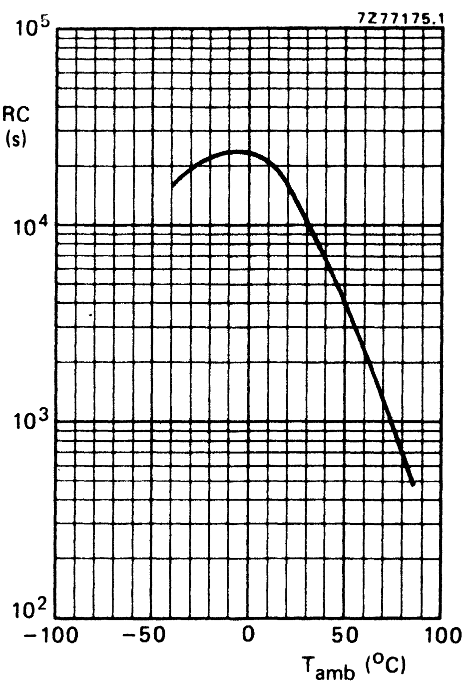


Fig. 6 RC-product as a function of ambient free air temperature; typical curve.

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 $l = 5 \pm 1$	$l = 25 + 2$
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 (DC) 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	D		
Other part of sample of Sub-group C1			
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 minutes 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 hours	
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 grams, and the body of capacitors with insulated leads shall be clamped to the printed-wiring board.

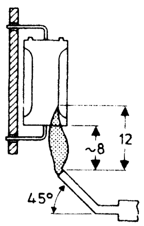
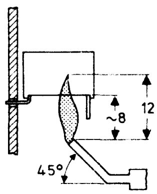
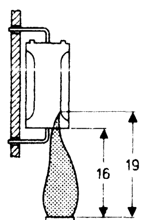
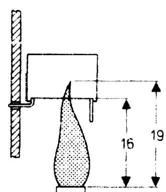
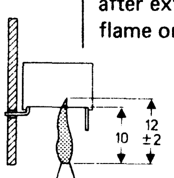
sub-clause number and test (see Note 1)	D or ND	conditions of test (see Note 1)	performance requirements
Sub-group C1	D		
Combined sample of specimens of Sub-groups C1A and C1B			
4.10 Climatic sequence			
4.10.2 Dry heat		Temperature: upper category temperature Duration: 16 hours	
4.10.3 Damp heat cyclic, Test Db, first cycle			
4.10.4 Cold		Temperature: lower category temperature Duration: 2 hours	
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 (DC), 1 minute	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 (DC) for 1 minute	No breakdown or or flashover.
Sub-group C3	D		
4.12 Endurance		Duration: 1000 hours 1,25 U_R (AC) at 85 °C. Once per hour the voltage is in-creased to 1000 V (RMS) 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 (DC) for 1 minute	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 = $\frac{U_R}{C_R \cdot 5 \left(\frac{dU}{dt}\right) R}$ 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 hours 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 °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 ^{o}C, during 3 minute Followed by rinsing in clear water for 1 minute Recovery time > 2 hours	
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 ^{o}C Bath temp.: 260 ^{o}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.  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.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.  7Z75504  7Z75501	Extinguishing time $\leqslant$ 15 s after the first and second flame application, $\leqslant$ 60 s after the third flame application.
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 2 hours at 100 ± 2 °C. Test duration: 1st cycle: 10 s, 2nd cycle: 1 minute 3rd cycle: 2 minute Second and third flame application start directly after extinguishing of the flame on the capacitor.  7Z75500	Extinguishing time $\leqslant$ 30 s after each flame application. No burning particles must drop from the sample.

NOTES

NOTES

NOTES

NOTES

NOTES

NOTES

NOTES

NOTES

NOTES

NOTES

NOTES

DATA HANDBOOK SYSTEM

DATA HANDBOOK SYSTEM

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

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

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

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

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

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

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

ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks comprises:

T1	**Tubes for r.f. heating**
T2a	**Transmitting tubes for communications, glass types**
T2b	**Transmitting tubes for communications, ceramic types**
T3	**Klystrons**
T4	**Magnetrons for microwave heating**
T5	**Cathode-ray tubes** Instrument tubes, monitor and display tubes, C.R. tubes for special applications
T6	**Geiger-Müller tubes**
T8	**Colour display systems** Colour TV picture tubes, colour data graphic display tube assemblies, deflection units
T9	**Photo and electron multipliers**
T10	**Plumbicon camera tubes and accessories**
T11	**Microwave semiconductors and components**
T12	**Vidicon and Newvicon camera tubes**
T13	**Image intensifiers and infrared detectors**
T15	**Dry reed switches**
T16	**Monochrome tubes and deflection units** Black and white TV picture tubes, monochrome data graphic display tubes, deflection units

SEMICONDUCTORS (RED SERIES)

The red series of data handbooks comprises:

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

S2a **Power diodes**

S2b **Thyristors and triacs**

S3 **Small-signal transistors**

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

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

S5 **Field-effect transistors**

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

S7 **Surface mounted semiconductors**

S8a **Light-emitting diodes**

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

S9 **PowerMos transistors**

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

S11 **Microwave transistors**

S12 **Surface acoustic wave devices**

S13 **Semiconductor sensors**

S14 **Liquid Crystal Displays**

INTEGRATED CIRCUITS (PURPLE SERIES)

The purple series of handbooks comprises:

IC01	**Radio, audio and associated systems** Bipolar, MOS	
IC02a/b	**Video and associated systems** Bipolar, MOS	
IC03	**Integrated circuits for telephony** Bipolar, MOS	
IC04	**HE4000B logic family** CMOS	
IC05N	**HE4000B logic family — uncased ICs** CMOS	
IC06N	**High-speed CMOS; PC74HC/HCT/HCU** Logic family	
IC08	**ECL 10K and 100K logic families**	
IC09N	**TTL logic series**	
IC10	**Memories** MOS, TTL, ECL	
IC11	**Linear Products**	
Supplement to IC11	**Linear Products**	
IC12	**I^2C-bus compatible ICs**	
IC13	**Semi-custom** Programmable Logic Devices (PLD)	
IC14	**Microcontrollers and peripherals** Bipolar, MOS	
IC15	**FAST TTL logic series**	
IC16	**CMOS integrated circuits for clocks and watches**	
IC17	**Integrated Services Digital Networks (ISDN)**	not yet issued
IC18	**Microprocessors and peripherals**	

COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

C2	**Television tuners, coaxial aerial input assemblies**
C3	**Loudspeakers**
C4	**Ferroxcube potcores, square cores and cross cores**
C5	**Ferroxcube for power, audio/video and accelerators**
C6	**Synchronous motors and gearboxes**
C7	**Variable capacitors**
C8	**Variable mains transformers**
C9	**Piezoelectric quartz devices**
C11	**Varistors, thermistors and sensors**
C12	**Potentiometers, encoders and switches**
C13	**Fixed resistors**
C14	**Electrolytic and solid capacitors**
C15	**Ceramic capacitors**
C16	**Permanent magnet materials**
C17	**Stepping motors and associated electronics**
C18	**Direct current motors**
C19	**Piezoelectric ceramics**
C20	**Wire-wound components for TVs and monitors**
C22	**Film capacitors**

Argentina: PHILIPS ARGENTINA S.A., Div. Elcoma, Vedia 3892, 1430 BUENOS AIRES, Tel. (01) 541 - 7141 to 7747.
Australia: PHILIPS INDUSTRIES LTD., Elcoma Division, 11 Waltham Street, ARTARMON, N.S.W. 2064, Tel. (02) 439 3322.
Austria: ÖSTERREICHISCHE PHILIPS INDUSTRIE G.m.b.H., UB Bauelemente, Triester Str. 64, 1101 WIEN, Tel. (0222) 60 101-820.
Belgium: N.V. PHILIPS PROF. SYSTEMS – Elcoma Div., 80 Rue Des Deux Gares, B-1070 BRUXELLES, Tel. (02) 52 56 111.
Brazil: CONSTANTA-IBRAPE; (Active Devices): Av. Brigadeiro Faria Lima, 1735-SAO PAULO-SP, Tel. (011) 211-2600.
CONSTANTA-IBRAPE; (Passive Devices & Materials): Av. Francisco Monteiro, 702 – RIBEIRAO PIRES-SP, Tel. (011) 459-8211.
Canada: PHILIPS ELECTRONICS LTD., Elcoma Division, 601 Milner Ave., SCARBOROUGH, Ontario, M1B 1M8, Tel. (416) 292-5161.
Chile: PHILIPS CHILENA S.A., Av. Santa Maria 0760, SANTIAGO, Tel. (02) 77 38 16.
Colombia: IND. PHILIPS DE COLOMBIA S.A., c/o IPRELENSO LTD., Cra. 21, No. 56-17, BOGOTA, D.E., Tel. (01) 249 76 24.
Denmark: MINIWATT A/S, Strandlodsvej 2, P.O. Box 1919, DK 2300 COPENHAGEN S, Tel. (01) 54 11 33.
Finland: OY PHILIPS AB, Elcoma Division, Kaivokatu 8, SF-00100 HELSINKI 10, Tel. (90) 1 72 71.
France: RTC-COMPELEC, 117 Quai du Président Roosevelt, 92134 ISSY-LES-MOULINEAUX Cedex, Tel. (01) 40 93 80 00.
Germany (Fed. Republic): VALVO, UB Bauelemente der Philips G.m.b.H., Valvo Haus, Burchardstrasse 19, D-2 HAMBURG 1, Tel. (040) 3296-0.
Greece: PHILIPS HELLENIQUE S.A., Elcoma Division, No. 15, 25th March Street, GR 17778 TAVROS, Tel. (01) 48 94 339/48 94 911.
Hong Kong: PHILIPS HONG KONG LTD., Elcoma Div., 15/F Philips Ind. Bldg., 24-28 Kung Yip St., KWAI CHUNG, Tel. (0)-24 51 21.
India: PEICO ELECTRONICS & ELECTRICALS LTD., Elcoma Dept., Band Box Building, 254-D Dr. Annie Besant Rd., BOMBAY – 400 025, Tel. (022) 49 30 311/49 30 590.
Indonesia: P.T. PHILIPS-RALIN ELECTRONICS, Elcoma Div., Setiabudi II Building, 6th Fl., Jalan H.R. Rasuna Said (P.O. Box 223/KBY) Kuningan, JAKARTA 12910, Tel. (021) 51 79 95.
Ireland: PHILIPS ELECTRICAL (IRELAND) LTD., Elcoma Division, Newstead, Clonskeagh, DUBLIN 14, Tel. (01) 69 33 55.
Italy: PHILIPS S.p.A., Div. Componenti Elcoma, Piazza IV Novembre 3, I-20124 MILANO, Tel. (02) 6752.1.
Japan: NIHON PHILIPS CORP., Shuwa Shinagawa Bldg., 26-33 Takanawa 3-chome, Minato-ku, TOKYO (108), Tel. (03) 448-5611.
(IC Products) SIGNETICS JAPAN LTD., 8-7 Sanbancho Chiyoda-ku, TOKYO 102, Tel. (03) 230-1521.
Korea (Republic of): PHILIPS ELECTRONICS (KOREA) LTD., Elcoma Div., Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL, Tel. (02) 794-5011.
Malaysia: PHILIPS MALAYSIA SDN BHD, Elcoma Div., 345 Jalan Gelugor, 11700 PULAU PINANG, Tel. (04) 87 00 44.
Mexico: ELECTRONICA, S.A de C.V., Carr. México-Toluca km. 62.5, TOLUCA, Edo. de México 50140, Tel. Toluca 91 (721) 613-00.
Netherlands: PHILIPS NEDERLAND, Marktgroep Elonco, Postbus 90050, 5600 PB EINDHOVEN, Tel. (040) 78 37 49.
New Zealand: PHILIPS NEW ZEALAND LTD., Elcoma Division, 110 Mt. Eden Road, C.P.O. Box 1041, AUCKLAND, Tel. (09) 605-914.
Norway: NORSK A/S PHILIPS, Electronica Dept., Sandstuveien 70, OSLO 6, Tel. (02) 68 02 00.
Pakistan: PHILIPS ELECTRICAL CO. OF PAKISTAN LTD., Philips Markaz, M.A. Jinnah Rd., KARACHI-3, Tel. (021) 72 57 72.
Peru: CADESA, Av. Pardo y Aliaga No. 695, 6th Floor, San Isidro, LIMA 27, Tel. (014) 70 70 80.
Philippines: PHILIPS INDUSTRIAL DEV. INC., 2246 Pasong Tamo, P.O. Box 911, Makati Comm. Centre, MAKATI-RIZAL 3116, Tel. (02) 86 89 51 to 59.
Portugal: PHILIPS PORTUGUESA S.A.R.L., Av. Eng. Duarte Pacheco 6, 1009 LISBOA Codex, Tel. (019) 68 31 21.
Singapore: PHILIPS PROJECT DEV. (Singapore) PTE LTD., Elcoma Div., Lorong 1, Toa Payoh, SINGAPORE 1231, Tel. 35 02 000.
South Africa: S.A. PHILIPS (Pty) LTD., EDAC Div., 3rd Floor Rainer House, Upper Railway Rd. & Ove St., New Doornfontein, JOHANNESBURG 2001, Tel. (011) 402-46 00/07.
Spain: MINIWATT S.A., Balmes 22, 08007 BARCELONA, Tel. (03) 301 63 12.
Sweden: PHILIPS KOMPONENTER A.B., Lidingövägen 50, S-11584 STOCKHOLM, Tel. (08) 78 21 000.
Switzerland: PHILIPS A.G., Elcoma Dept., Allmendstrasse 140-142, CH-8027 ZÜRICH, Tel. (01) 488 22 11.
Taiwan: PHILIPS TAIWAN LTD., 150 Tun Hua North Road, P.O. Box 22978, TAIPEI, Taiwan, Tel. (02) 71 20 500.
Thailand: PHILIPS ELECTRICAL CO. OF THAILAND LTD., 283 Silom Road, P.O. Box 961, BANGKOK, Tel. (02) 233-6330-9.
Turkey: TÜRK PHILIPS TICARET A.S., Elcoma Department, Inönü Cad., No. 78-80, 80090 Ayazpasa ISTANBUL, Tel. (01) 143 59 10.
United Kingdom: MULLARD LTD., Mullard House, Torrington Place, LONDON WC1E 7HD, Tel. (01) 580 6633.
United States: (Active Devices & Materials) AMPEREX SALES CORP., Providence Pike, SLATERSVILLE; R.I. 02876, Tel. (401) 762-9000.
(Colour picture tubes – Monochrome & Colour display tubes) PHILIPS DISPLAY COMPONENTS, 50 Johnston St., SENECA FALLS, N.Y. 13148, Tel. (315) 568-5881.
(IC Products) SIGNETICS CORPORATION, 811 East Arques Avenue, SUNNYVALE, CA 94088-3409, Tel. (408) 991-2000.
(Passive & Electromech. Dev.) MEPCO/CENTRALAB, INC., 2001 West Blue Heron Blvd, RIVIERA BEACH, Florida 33404, Tel. (305) 881-3200.
Uruguay: LUZILECTRON S.A., Avda Uruguay 1287, P.O. Box 907, MONTEVIDEO, Tel. (02) 98 53 95.
Venezuela: IND. VENEZOLANAS PHILIPS S.A., c/o MAGNETICA S.A., Calle 6, Ed. Las Tres Jotas, App. Post. 78117, CARACAS, Tel. (02) 239 39 31.
For all other countries apply to: Philips Components Division, International Business Relations, P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands, Telex 35000 phtcnl

AS58

Printed in The Netherlands

9398 148 00011