PHILIPS

Data handbook

Electronic components and materials

Components and materials

Part 15 May 1980

Film capacitors

Ceramic capacitors

Variable capacitors

COMPONENTS AND MATERIALS

PART 15 — MAY 1980

FILM, CERAMIC AND VARIABLE CAPACITORS

FILM CAPACITORS

CERAMIC CAPACITORS

VARIABLE CAPACITORS

CONTENTS

DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, sub-assemblies and materials; it is made up of three series of handbooks each comprising several parts.

ELECTRON TUBES	BLUE
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COMPONENTS AND MATERIALS	GREEN

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

Where ratings or specifications differ from those published in the preceding edition they are pointed out by arrows. Where application information is given it is advisory and does not form part of the product specification.

If you need confirmation that the published data about any of our products are the latest available, please contact our representative. He is at your service and will be glad to answer your inquiries.

October 1977

ELECTRON TUBES (BLUE SERIES)

Starting in 1980, new part numbers and corresponding codes are being introduced. The former code of the preceding issue is given in brackets under the new code.

Part 1	**February 1980**	**T1 02-80 (ET1a 12-75)**	**Tubes for r.f. heating**
Part 2	**April 1980**	**T2 04-80 (ET1b 08-77)**	**Transmitting tubes for communications**
Part 2a	**November 1977**	**ET2a 11-77**	**Microwave tubes** Communication magnetrons, magnetrons for microwave heating, klystrons, travelling-wave tubes, diodes, triodes T-R switches
Part 2b	**May 1978**	**ET2b 05-78**	**Microwave semiconductors and components** Gunn, Impatt and noise diodes, mixer and detector diodes, backward diodes, varactor diodes, Gunn oscillators, sub-assemblies, circulators and isolators
Part 3	**January 1975**	**ET3 01-75**	**Special Quality tubes, miscellaneous devices**
Part 4	**March 1975**	**ET4 03-75**	**Receiving tubes**
Part 5a	**October 1979**	**ET5a 10-79**	**Cathode-ray tubes** Instrument tubes, monitor and display tubes, C.R. tubes for special applications
Part 5b	**December 1978**	**ET5b 12-78**	**Camera tubes and accessories, image intensifiers**
Part 6	**January 1977**	**ET6 01-77**	**Products for nuclear technology** Channel electron multipliers, neutron tubes, Geiger-Müller tubes
Part 7a	**March 1977**	**ET7a 03-77**	**Gas-filled tubes** Thyratrons, industrial rectifying tubes, ignitrons, high-voltage rectifying tubes
Part 7b	**May 1979**	**ET7b 05-79**	**Gas-filled tubes** Segment indicator tubes, indicator tubes, switching diodes, dry reed contact units
Part 8	**July 1979**	**ET8 07-79**	**Picture tubes and components** Colour TV picture tubes, black and white TV picture tubes, monitor tubes, components for colour television, components for black and white television.
Part 9	**March 1978**	**ET9 03-78**	**Photomultiplier tubes; phototubes**

Starting in 1980, new part numbers and corresponding codes are being introduced. The former code of the preceding issue is given in brackets under the new code.

SEMICONDUCTORS (RED SERIES)

Part 1	**March 1980**	**S1 03-80** **(SC1b 05-77)**	**Diodes** Small-signal germanium diodes, small-signal silicon diodes, special diodes, voltage regulator diodes (< 1,5 W), voltage reference diodes, tuner diodes, rectifier diodes
Part 2	**May 1980**	**S2 05-80** **(SC1a 08-78)**	**Power diodes, thyristors, triacs** Rectifier diodes, voltage regulator diodes (> 1,5 W), rectifier stacks, thyristors, triacs
Part 2	**June 1979**	**SC2 06-79**	**Low-frequency power transistors**
Part 3	**January 1978**	**SC3 01-78**	**High-frequency, switching and field-effect transistors ***
Part 3	**April 1980**	**S3 04-80** **(SC2 11-77, partly)** **(SC3 01-78, partly)**	**Small-signal transistors**
Part 4a	**December 1978**	**SC4a 12-78**	**Transmitting transistors and modules**
Part 4b	**September 1978**	**SC4b 09-78**	**Devices for optoelectronics** Photosensitive diodes and transistors, light-emitting diodes, photocouplers, infrared sensitive devices, photoconductive devices
Part 4c	**July 1978**	**SC4c 07-78**	**Discrete semiconductors for hybrid thick and thin-film circuits**

INTEGRATED CIRCUITS (RED SERIES)

Part 1	**May 1980**	**IC1 04-80** **(SC5b 03-77)**	**Bipolar ICs for radio and audio equipment**
Part 2	**May 1980**	**IC2 04-80** **(SC5b 03-77)**	**Bipolar ICs for video equipment**
Part 5a	**November 1976**	**SC5a 11-76**	**Professional analogue integrated circuits**
Part 6	**October 1977**	**SC6 10-77**	**Digital integrated circuits** LOCMOS HE4000B family
Part 6b	**August 1979**	**SC6b 08-79**	**ICs for digital systems in radio and television receivers**
Signetics integrated circuits			Bipolar and MOS memories 1979 Bipolar and MOS microprocessors 1978 Analogue circuits 1979 Logic - TTL 1978

* Field-effect transistors and wideband transistors will be transferred to S5 and SC3c respectively. The old book SC3 01-78 should be kept until then.

COMPONENTS AND MATERIALS (GREEN SERIES)

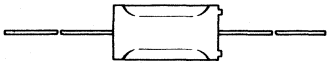
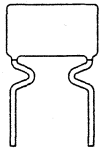
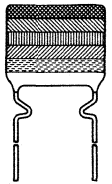
Starting in 1980, new part numbers and corresponding codes are being introduced. The former code of the preceding issue is given in brackets under the new code.

Part 1	**July 1979**	**CM1 07-79**	**Assemblies for industrial use** PLC modules, high noise immunity logic FZ/30 series, NORbits 60-series, 61-series, 90-series, input devices, hybrid integrated circuits, peripheral devices
Part 3a	**September 1978**	**CM3a 09-78**	**FM tuners, television tuners, surface acoustic wave filters**
Part 3b	**October 1978**	**CM3b 10-78**	**Loudspeakers**
Part 4a	**November 1978**	**CM4a 11-78**	**Soft Ferrites** Ferrites for radio, audio and television, beads and chokes, Ferroxcube potcores and square cores, Ferroxcube transformer cores
Part 4b	**February 1979**	**CM4b 02-79**	**Piezoelectric ceramics, permanent magnet materials**
Part 6	**April 1977**	**CM6 04-77**	**Electric motors and accessories** Small synchronous motors, stepper motors, miniature direct current motors
Part 7	**September 1971**	**CM7 09-71**	**Circuit blocks** Circuit blocks 100 kHz-series, circuit blocks 1-series, circuit blocks 10-series, circuit blocks for ferrite core memory drive
Part 7a	**January 1979**	**CM7a 01-79**	**Assemblies** Circuit blocks 40-series and CSA70 (L), counter modules 50-series, input/output devices
Part 8	**June 1979**	**CM8 06-79**	**Variable mains transformers**
Part 9	**August 1979**	**CM9 08-79**	**Piezoelectric quartz devices** Quartz crystal units, temperature compensated crystal oscillators
Part 10	**April 1978**	**CM10 04-78**	**Connectors**
Part 11	**December 1979**	**CM11 12-79**	**Non-linear resistors** Voltage dependent resistors (VDR), light dependant resistors (LDR), negative temperature coefficient thermistors (NTC), positive temperature coefficient thermistors (PTC)
Part 12	**November 1979**	**CM12 11-79**	**Variable resistors and test switches**
Part 13	**December 1979**	**CM13 12-79**	**Fixed resistors**
Part 14	**April 1980**	**C14 04-80 (CM2b 02-78)**	**Electrolytic and solid capacitors**
Part 15	**May 1980**	**C15 05-80 (CM2b 02-78)**	**Film capacitors, ceramic capacitors, variable capacitors**

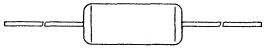
FILM CAPACITORS

SURVEY

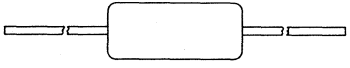
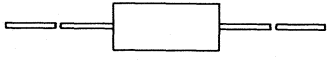
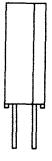
POLYESTER AND POLYCARBONATE CAPACITORS

type	series number 2222 . . .	main application	rated capacitance μF	rated voltage (U_R d.c.) V
Metallized polyester and polycarbonate film capacitors (MKT and MKC); moulded 	341	coupling, decoupling, timing and delay	0,10 to 6,8 0,047 to 2,2 0,010 to 1,0 0,010 to 0,47 0,010 to 0,15	100 250 400 630 } only metallized 1000 } polycarbonate film
Polyester film/foil capacitors (KT); lacquered 	347	coupling, decoupling, high currents, steep pulses	0,015 to 1,0 0,010 to 0,68 0,0047 to 0,33 0,0010 to 0,15	100 250 400 630
Metallized polyester and polycarbonate film capacitors (MKT and MKC); potted 	344	coupling, decoupling, timing and delay	0,15 to 10 0,047 to 10 0,022 to 2,2 0,010 to 1,0 0,0047 to 0,47	63 (only metallized PETP film) 100 250 400 630
Metallized polyester film capacitors (MKT); lacquered 	352	coupling, decoupling timing and delay	0,047 to 6,8 0,001 to 2,2 0,010 to 1,0 0,010 to 0,47	100 250 400 630

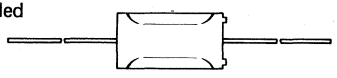
POLYPROPYLENE CAPACITORS

type	series number 2222 . . .	main application	rated capacitance	rated voltage (U_R d.c.) V
Metallized polypropylene film a.c. capacitors (MKP); sealed aluminium case 	328	power factor correction for discharge lighting	3 to 22,5 μF	U_R (a.c.) = 250 V
Polypropylene film/foil capacitors (KP); potted 	357 5....	tv deflection, a.c. motor commutation, high currents, high voltages, steep pulses	0,039 to 0,82 μF	250
Polypropylene capacitors (KP/MKP); series construction 	357 6.... 357 7.... 357 8.... 357 9....		0,047 to 0,33 μF 0,018 to 0,22 μF 0,0082 to 0,15 μF 0,0015 to 0,013 μF	630 1000 1500 2000
Polypropylene film/foil capacitors (KP); axial type 	455 to 458 (development type)	tuning circuits, filter networks, applications with high stability, high precision, low losses	3300 to 56 000 pF 1800 to 36 000 pF 1000 to 20 000 pF 47 to 8 200 pF	63 160 250 630

POLYSTYRENE CAPACITORS

type	series number 2222 . . .	main application	rated capacitance pF	rated voltage (U_R d.c.) V
Polystyrene film/foil capacitors (KS); sleeved 	424 to 431	tuning circuits, filter networks, applications with high stability, high precision, low losses	2000 to 39 000 1100 to 16 000 620 to 11 000 51 to 5 600	63 160 250 630
Polystyrene film/foil capacitors (KS); wrapped end-filled 	444 to 447		43 000 to 162 000 18 000 to 82 000 12 000 to 47 000 6 200 to 24 000	63 160 250 630
Polystyrene film/foil capacitors (KS); potted 	443	LC-filters, tuning circuits, applications with high precision, high stability, high reliability	100 to 34 000	63

DUAL DIELECTRIC CAPACITORS

type	series number 2222 . . .	main application	rated capacitance	rated voltage (U_R)
Metallized polyester/paper film capacitors (MKT-P) for radio interference suppression; moulded 	330 0....	small household appliances, radio and tv	0,01 to 0,22 μF	U_R (a.c.) = 250 V
Metallized polyester/paper film capacitors (MKT-P) for radio interference suppression; potted 	330 4....		0,01 to 0,33 μF	U_R (a.c.) = 250 V

METALLIZED POLYPROPYLENE FILM CAPACITORS

for power factor correction of discharge lighting (MKP)

QUICK REFERENCE DATA

Rated capacitance range	3 to 22,5 μF
Tolerance on rated capacitance	± 10%
Rated voltage U_R (a.c.), 50 to 60 Hz	250 V
Rated temperature	85 °C
Climatic category	
IEC 68	25/085/56
DIN 40040	HPF
Approvals	VDE, CEBEC, KEMA DEMKO, NEMKO, SEMKO

APPLICATION

These capacitors are used for power factor correction in discharge lighting applications, such as fluorescent mercury and sodium vapour discharge lamp circuits.

DESCRIPTION

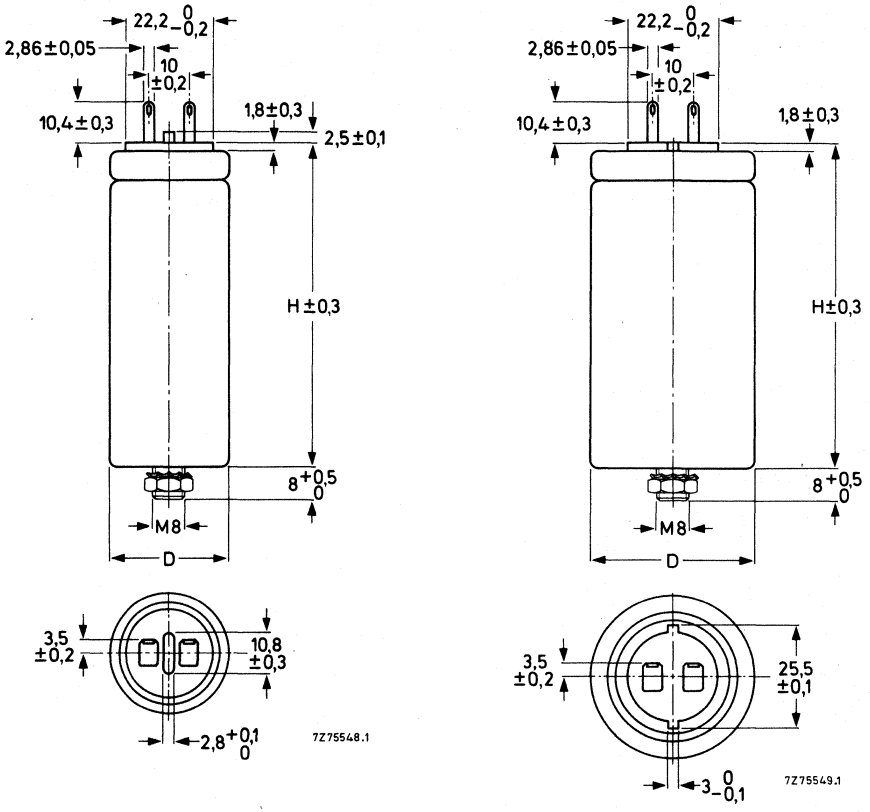
The capacitors consist of a non-inductive wound cell of metallized polypropylene film. The cell is housed in a cylindrical aluminium case which is end-sealed by a disc carrying two solder tags.

In the event of excessive pressure building up inside the case, a safety mechanism will cause the wire leads to the tags to be broken, whereby the risk of fire and explosion is prevented.

The capacitors comply with recommendations laid down in BS 4017 (1973), IEC 68, VDE 0560-6 (FP) and CEE 12.

MECHANICAL DATA

Dimensions in mm



a b

Fig. 1 For dimensions D and H see Table 1.

Marking

The capacitors are marked with:
1st line : catalogue number and manufacturers identification symbol;
2nd line: rated capacitance and tolerance;
3rd line : rated voltage (a.c.), 50 Hz and code for dielectric material (MK = metallized polypropylene film);
4th line : category temperature range and climatic category according to IEC and DIN;
5th line : approbation symbols;
6th line : month and year of manufacture.

Mounting

The capacitors are suited for horizontal or vertical mounting. Capacitors without stud can be fixed with a bracket. The tags are suited for soldering and also for accepting a snap-on connector which may include a discharge resistor.

The capacitors require a minimum clearance of 5 mm between the wall of the mounting space and the top end of the solder tags or snap-on connector. This is to allow for operation of the safety mechanism should there be an excess pressure build-up in the capacitor.

Table 1 U_R (a.c.) = 250 V

rated capacitance	D	H	Fig.	mass approx.	catalogue number of capacitors	
					without stud	with stud
µF				g		
3	30	60,5	1a	35		2222 328 90016
3,5	30	60,5	1a	38	2222 328 51355	55355
4	30	60,5	1a	40	51405	55405
4,2	30	60,5	1a	41	51425	55425
4,5	30	60,5	1a	43	51455	55455
5	30	60,5	1a	45	51505	55505
5,1	35	60,5	1b	47	90014	
5,5	30	75	1a	47	51555	55555
6	30	75	1a	49	51605	55605
6,5	30	75	1a	51	51655	55655
6,9	35	60,5	1b	63	90015	
7	30	75	1a	53	51705	55705
7	35	60,5	1b	64	90011	90005
8	35	75	1b	67	51805	55805
8	40	60,5	1b	67	90001	90003
9	35	75	1b	70	51905	55905
9,5	35	75	1b	72	51955	55955
10	35	75	1b	74	51106	55106
10	40	60,5	1b	71	90002	90004
12	40	75	1b	85	51126	55126
12,5	40	75	1b	89	90007	90006
14	40	75	1b	92	51146	55146
16	40	92	1b	100	51166	55166
18	40	92	1b	108	51186	55186
20	40	104	1b	114	51206	55206
22,5	40	104	1b	123	90009	90008

The capacitors have been approved by VDE, CEBEC, KEMA, DEMKO, NEMKO and SEMKO, see Table 2.

→ Table 2

catalogue number	approved by					
	VDE (FP) 0560-6 (1975)	CEBEC	KEMA	DEMKO	SEMKO	NEMKO
2222 328 51106	x	x	x	x	x	x
51126	x	x				x
51146	x	x				x
51166	x	x				x
51186	x	x				x
51206	x	x				x
51355	x	x	x	x	x	x
51405	x	x	x	x	x	x
51425	x	x	x	x	x	x
51455	x	x	x	x	x	x
51505	x	x	x	x	x	x
51555	x	x	x	x	x	x
51605	x	x	x	x	x	x
51655	x	x	x	x	x	x
51705	x	x	x	x	x	x
51755	x	x	x	x	x	x
51805	x	x	x	x	x	x
51855	x	x	x	x	x	x
51905	x	x	x	x	x	x
51955	x	x	x	x	x	x
2222 328 55106	x	x		x		x
55126	x	x				x
55146	x	x				x
55166	x	x				x
55186	x	x				x
55206	x	x				x
55355	x	x		x		x
55405	x	x		x		x
55425	x	x	x	x	x	x
55455	x	x		x		x
55505	x	x		x		x
55555	x	x		x		x
55605	x	x		x		x
55655	x	x		x		x
55705	x	x		x		x
55755	x	x		x		x
55805	x	x		x		x
55855	x	x		x		x
55905	x	x		x		x
55955	x	x		x		x

Table 2 (continued)

catalogue number	approved by					
	VDE (FP) 0560-6 (1975)	CEBEC	KEMA	DEMKO	SEMKO	NEMKO
2222 328 90001	x	x	x	x	x	x
90002	x	x	x	x	x	x
90003	x	x	x	x	x	x
90004	x	x	x	x	x	x
90005	x	x	x	x		x
90006	x	x				x
90007	x	x				x
90008	x	x				x
90009	x	x				x
90011	x	x	x	x		x
90014				x		
90015				x		
90016				x		

ELECTRICAL DATA

Unless otherwise specified all electrical values apply at an ambient temperature of 25 ± 5 °C, an atmospheric pressure of 860 to 1060 mbar and a relative humidity of 45 to 75%.

Capacitance

Rated capacitance values (C_R) at 50 Hz	see Table 1
Tolerance on rated capacitance	± 10%

Voltage

Rated voltage U_R (a.c.), 50 to 60 Hz	250 V
Test voltage	
between terminals	1,5 x U_R (a.c.) for 10 s
between interconnected terminals and case	2500 V (a.c.) for 1 min

Insulation resistance

The insulation resistance is measured after a voltage of 100 ± 15 V has been applied for 1 min ± 5 s.

R between interconnected terminals and case at 23 °C	> 12 500 MΩ
RC between terminals at 23 °C	> 10 000 s

Tan δ (tangent of the loss angle)

Tan δ at 50 Hz	
$C_R \leqslant 10\ \mu F$	$\leqslant 5 \times 10^{-4}$
$C_R > 10\ \mu F$	$\leqslant 10 \times 10^{-4}$

Temperature

Rated temperature	85 °C
Category temperature range	–25 to + 85 °C
Storage temperature range	–40 to + 85 °C
Climatic category	
IEC 68	25/085/56
DIN 40040	HPF

PACKING

The capacitors are packed in boxes of 50 pieces.
Washers and nuts are supplied in plastic bags of 50 pieces.

TESTS AND REQUIREMENTS

IEC 68-2 test method	name of test	procedure (quick reference)	requirements
Ua1	Tensile strength of tags	Loading force 20 N in axial direction of the tags, 10 s.	No damage.
Ub2	Bending of tags	Two consecutive bends without load.	No damage.
Ud	Torque on threaded stud	Torque of 4 Nm one gradual application.	No damage.
Ta method 2	Solderability	Soldering iron: 350 ± 10 °C, 10 s.	No damage, good tinning.
–	Resistance to soldering heat	Soldering iron: 350 ± 10 °C, 10 s; bit sizes ϕ 8 mm x 32 mm. Solder: Pb/Sn 40/60 with non-activated flux.	Good tinning, no leakage or open circuit.
Na	Rapid change of temperature	5 cycles of 3 h at –25 °C and 3 h at + 85 °C.	No damage, no leakage, $\Delta C/C \leqslant 2\%$. Tan δ and insulation resistance shall meet initial requirements.
Fc	Vibration	10 to 55 Hz, 1,5 mm or 10g (whichever is less), 3 directions, 2 h per direction.	No damage, no open or short-circuit.
Eb	Bumping	40g, 1000 bumps.	No damage, no open or short-circuit.

Additional tests

test method	name of test	procedure (quick reference)	requirements
VDE 0560-6b para. 54C2	Sealing (gas leakage) of dry types	Capacitors in test chamber which accommodates a bath containing de-gassed oil with a viscosity of max. 25 cSt (25×10^{-6} m^2/s) at 20 °C; the oil maintained at 25 ± 5 °C. The air pressure shall be reduced within 1 min to 156 mbar (120 Torr) and maintained at this value for 1 min.	No leakage as evidenced by repetitive bubbling.
IEC 68-2, test Ca	Damp heat, steady state	56 days at 40 °C, R.H. 90 to 95%, no voltage applied.	Insulation resistance > 0,5 x initial requirements, test voltage and tan δ shall meet initial requirements, $\Delta C/C \leqslant 2\%$.
	Endurance (cyclic)	Capacitors in oven, subjected to 84 cycles of 8 h; during first 6 h of each cycle 1,25 x U_R is applied, within 2 h the ambient temperature (25 ± 5 °C) is raised to 85 ± 2 °C. After 6 h period applied voltage is switched off, and capacitors are discharged for 2 h and subjected to forced cooling to 25 ± 5 °C inside oven.	Percentage of failures after 84 cycles shall not exceed 8%. Failure criteria: RC-product at 100 V (d.c.) for 1 min < 5000 s; Δ tan δ at 50 Hz $\geqslant 10 \times 10^{-4}$; $\Delta C/C > 5\%$.
VDE 0560-6b, para. 49	Endurance	Test voltage 1,45 x U_R, for 1100 h, 85 ± 2 °C.	Percentage of failures after 1100 h shall not exceed 3%. Failure criteria: RC-product at 100 V (d.c.) for 1 min < 5000 s; Δ tan δ at 50 Hz $\geqslant 10 \times 10^{-4}$; $\Delta C/C > 10\%$.
CEE 12	Endurance	Capacitors in oven with air circulation, for 500 h, 98 ± 2 °C, test voltage 1,3 x U_R.	No open or short-circuit.

test method	name of test	procedure (quick reference)	requirements
	Destruction	Samples: 15 capacitors having passed endurance test and 15 capacitors having passed initial measurements. Each capacitor enclosed by 4 layers of cotton, in oven heated to 100 ± 2 °C.	
		Step 1: U_R (a.c.) applied for 2 h.	No open or short-circuit.
		Step 2: D.C. voltage applied, which is increased; max. permissible current 50 mA.	Step 2 is terminated when permanent breakdown occurs.
		Step 3: 1,3 U_R (a.c.) applied, increased to 1,8 x U_R (a.c.) at a rate of 1 V/s; 1,8 x U_R (a.c.) maintained for 120 h.	No physical phenomena which could lead to catastrophic failure like fire or explosion; the safety mechanism has become operative (distortion of rill).
		Step 4: 2500 V (a.c.) applied between interconnected tags and case for 1 min.	No flashover over short-circuit.
		The test from step 2 shall be repeated until there is a total of 10 capacitors in which the safety mechanism has become operative.	

Note: Standard atmospheric conditions for referee tests: ambient temperature 23 ± 1°C, atmospheric pressure 86 to 106 kPa and R.H. 50 ± 2%.

INTERFERENCE SUPPRESSION CAPACITORS

dual dielectric (MKT-P)

QUICK REFERENCE DATA

Rated capacitance range (E6 series)	
type with axial leads	0,01 to 0,22 μF
type with radial leads	0,01 to 0,33 μF
Tolerance on rated capacitance	± 10% and ± 20%
Rated voltage U_R (a.c.), 50 to 60 Hz	250 V
Rated temperature	85 °C
Climatic category, IEC 68	40/085/21
Climatic category, DIN 40040	GPF
Approvals	
type with axial leads	VDE0560-7
type with radial leads	VDE0560-7 and SEMKO
Class	X

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-inductive wound cell of metallized polyethyleneterephthalate (PETP) film and paper film. Two types are available: with axial leads and with radial leads.

The cell of the type with axial leads is moulded in yellow flame retardent polypropylene, that of the other type is potted with epoxy resin in a yellow flame retardent polypropylene case. The leads are solder-coated copper wire.

The capacitors are provided with stand-off ridges or pips to allow removal of solder flux etc., when cleaning the printed-wiring board.

MECHANICAL DATA

Dimensions in mm

Type with axial leads

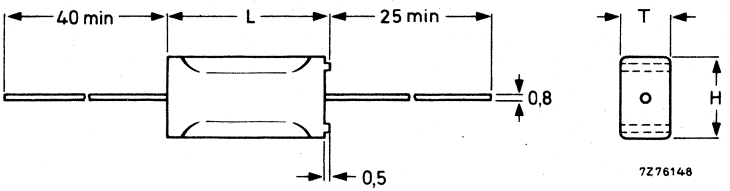


Fig.1 For dimensions T, L and H, see Table 1.

Table 1

rated capacitance µF	T_{max} mm	L_{max} mm	H_{max} mm	mass g	catalogue number 2222 330	
					tol. ± 10%	tol. ± 20%
0,010	6,5	18	10,4	1,8	01103	00103
0,015					01153	00153
0,022					01223	00223
0,033					01333	00333
0,047					01473	00473
0,068	7,6	18	11,5	2,1	01683	00683
0,10	7,4	23,5	11,5	2,7	01104	00104
0,15	8,7	23,5	12,8	3,4	01154	00154
0,22	10,4	23,5	14,4	4,2	01224	00224

Marking

The capacitors are marked on one side as follows:

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

2nd line: last eight digits of the catalogue number, and production date code.*

On the other side the capacitors are marked with manufacturer's identification symbol, category according to DIN, code for dielectric materials (MKT-P) and VDE approbation symbol.

Mounting

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

* According to IEC 62, clause 5.

Type with radial leads

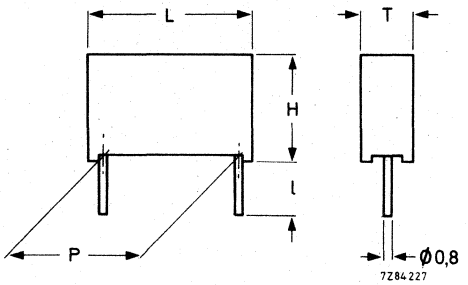


Fig. 2 For dimensions T, L, H, P and l, see Table 2.

Table 2

rated capacitance µF	T_{max} mm	L_{max} mm	H_{max} mm	P mm	mass g	catalogue number 2222 330 . . . . . l = 5–1		l = 25 + 2	
						tol. ± 10%	tol. ± 20%	tol. ± 10%	tol. ± 20%
0,010	5	17,5	11	15 ± 0,4	1,2	41103	40103	45103	44103
0,015						41153	40153	45153	44153
0,022						41223	40223	45223	44223
0,033						41333	30333	45333	44333
0,047	6	17,5	11,5		1,4	41473	40473	45473	44473
0,068	7	17,5	13		2,0	41683	40683	45683	44683
0,10	8,5	17,5	14,5		2,6	41104	40104	45104	44104
0,15	6,5	26	15,5	22,5 ± 0,4	3,0	41154	40154	45154	44154
0,22	7,5	26	16,5		3,7	41224	40224	45224	44224
0,33	9,5	26	19		5,4	41334	40334	45334	44334

Marking

The capacitors are marked on the top face by embossed print, with:
1st line: rated capacitance in µF, tolerance (± 10% identified by K or 10, ± 20% not identified), rated voltage and class;
2nd line: 5th, 6th, 7th, 8th and 9th digits of the catalogue number and code for dielectric materials. (MKT-P).
On the side the capacitors are marked with manufacturer's identification symbol, production date code*, category according to DIN, and VDE and SEMKO approbation symbols.

Mounting

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

* According to IEC 62, clause 5.

ELECTRICAL DATA

Unless otherwise specified all electrical values apply at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Capacitance

Rated capacitance values (C_R) at 1 kHz	see Tables 1 and 2
→ Tolerance on rated capacitance	± 10% and ± 20%

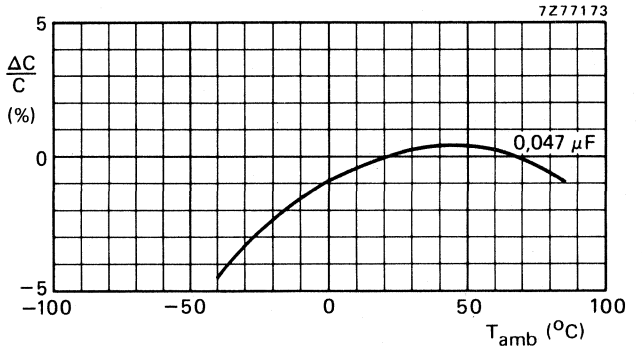


Fig.3 Capacitance as a function of temperature; typical curve, measured at 1 kHz, 0,3 V.

Voltage

Rated voltage U_R (a.c.), 50 to 60 Hz	250 V
→ Test voltage (d.c.) for 1 min, between terminals	
type with axial leads	750 V
type with radial leads	1075 V
Test voltage (a.c.) for 1 min between interconnected terminals and coating	2000 V, 50 Hz

Insulation resistance

The insulation resistance is measured after a voltage of 100 ± 15 V has been applied for 1 min ± 5 s.

R between terminals at T_{amb} = 23 °C	> 15 000 MΩ

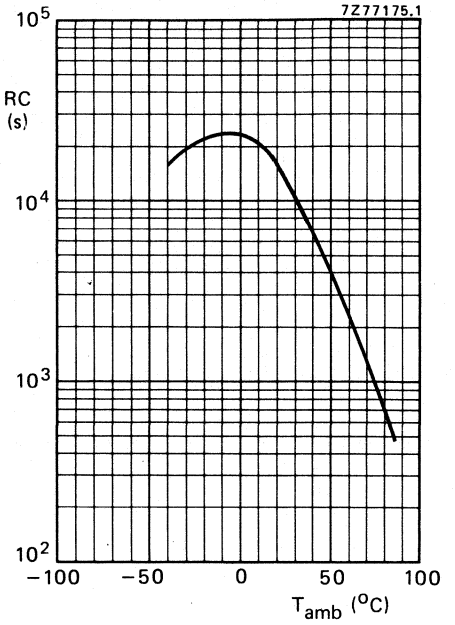


Fig.4 RC-product as a function of temperature; typical curve.

Tan δ (tangent of the loss angle)

Tan δ at 10 kHz $\leqslant 130 \times 10^{-4}$ (typ 90×10^{-4})

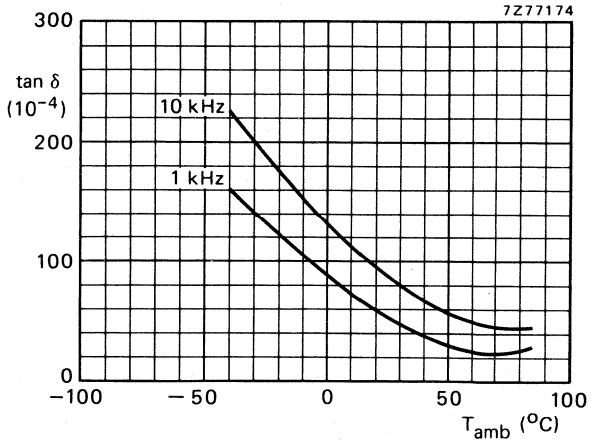


Fig.5 Tan δ as a function of temperature; typical curves, measured at 0,3 V.

Pulse steepness

Maximum pulse steepness	100 V/μs

See also Tests and requirements - charge and discharge test.

Resonant frequency

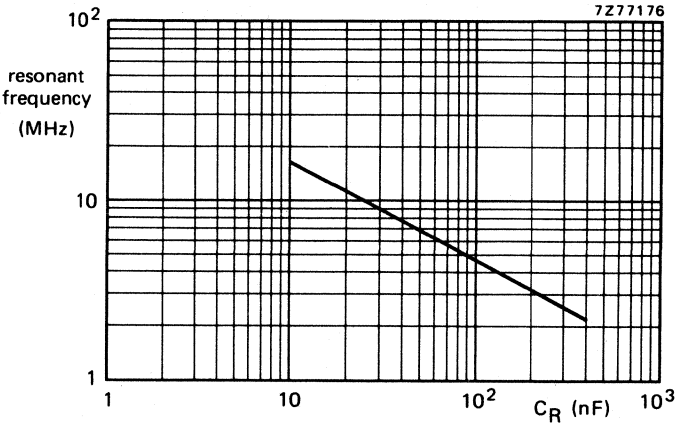


Fig.6 Resonant frequency as a function of rated capacitance.

Temperature

Rated temperature	85 °C
Category temperature range	−40 to +85 °C
Storage temperature range	−55 to +85 °C
Climatic category, IEC 68	40/085/21

PACKING

The capacitors are packed in boxes.

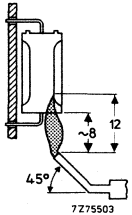
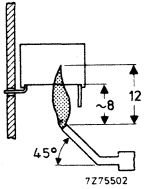
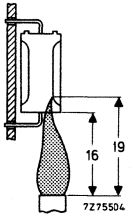
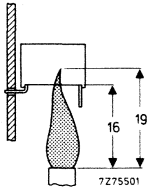
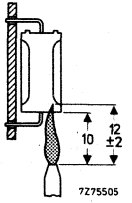
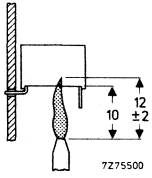
TESTS AND REQUIREMENTS

IEC 68-2 test method	name of test	procedure (quick reference)	requirements
Ua1	Tensile strength of terminations	Loading force 10 N in axial direction of the wires, 10 s.	No damage.
Ub method 1	Bending of terminations	Loading force 5 N, two consecutive bends.	No damage.
Uc (only for axial wires)	Torsion of terminations	Two successive rotations of 180° in opposite directions.	No damage.
Ta 1st part method 1	Solderability	Solder bath: 230 °C, 2 s.	No damage, good tinning.
Tb method 1B	Resistance to soldering heat	Solder bath: 350 °C, 3,5 s.	No damage.
Na	Rapid change of temperature	5 cycles of ½ h at −40 °C and ½ h at +85 °C.	No damage, no leakage; $\Delta C/C \leqslant 5\%$. Tan δ and insulation resistance shall meet initial requirements.
Fc	Vibration	10 to 55 Hz, 0,75 mm or 10g (whichever is less), 3 directions, 2 h per direction.	No damage, no open or short-circuit.
Eb	Bumping	40 g, 4000 bumps.	No damage, no open or short-circuit.

IEC 68-2 test method		name of test	procedure (quick reference)	requirements
Climatic sequence	Ba	Dry heat	16 h at +85 ± 2 °C, no voltage applied.	No damage, no leakage, $\Delta C/C \leqslant 5\%$.
	Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.	
	Aa	Cold	2 h at −40 ± 2 °C; no voltage applied.	
	M	Low air pressure	1 h at 25 ± 5 °C; at an atmospheric pressure of 85 mbar.	During and after the test there shall be no breakdown or flashover.
	Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.	
			Final measurement.	$\Delta C/C \leqslant 5\%$. Tan δ shall meet initial requirements. Insulation resistance $>$ 7500 MΩ.
	Ca	Damp heat, steady state	21 days at 40 °C and R.H. 90 to 95%. a) No voltage applied. b) 250 V (d.c.) applied. Recovery 6 h at 55 °C and R.H. $\leqslant$ 20%, followed by 2 h recovery at 20 °C.	No damage, $\Delta C/C \leqslant 5\%$. Tan δ shall meet initial requirements. Insulation resistance $>$ 7500 MΩ. After test voltage (750 V (d.c.), 1 min): no breakdown or interruption.
	–	Endurance	1000 h at 85 °C, 1,25 x rated a.c. voltage applied, for type with axial leads. 1000 h at 85 °C, 1,5 x rated a.c. voltage applied, for type with radial leads.	Percentage of rejects shall not exceed 5%. Failure criteria: – open or short-circuit; – $\Delta C/C > 10\%$; – insulation resistance $<$ 7500 MΩ; – drops of impregnant.

name of test	procedure (quick reference)	requirements
Additional tests		
Storage	1000 h at 85 °C.	$\Delta C/C \leqslant 5\%$. Tan δ and insulation resistance shall meet initial requirements.
Damp heat, long term exposure	21 days at 40 °C, R.H. 90 to 95%. No voltage applied during the first 10 days; rated a.c. voltage applied for 16 h of every 24 h period during the next 11 days.	Percentage of rejects shall not exceed 5%. Failure criteria: – open or short-circuit; – insulation resistance $< 7500\ M\Omega$.
	21 days at 40 °C, R.H. 90 to 95%. Rated a.c. voltage applied for 16 h of every 24 h period.	
Charge and discharge	10 000 cycles of charge to 350 V (d.c.) and discharge via a resistor of value such that the pulse steepness is 1,5 x specified value. Cycle time: 1 to 150 cycles/s, temperature: 25 °C.	$\Delta \tan \delta \leqslant 20 \times 10^{-4}$ at 10 kHz.

For flammability tests see next page.

name of test	procedure (quick reference)	requirements
Flammability	  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.
→	  Test according to UL1414. Bore of gas jet: ϕ 10 mm. Fuel: natural gas. Test duration: 3 x 15 s. Time interval between each flame application: 15 s.	Extinguishing time $\leqslant$ 15 s after the first and second flame application, $\leqslant$ 60 s after the third flame application.
	  Bore of gas jet: ϕ 0,5 mm. Fuel: butane. Test duration: 3 x 15 s. Second and third flame application starts after extinguishing of the flame on the capacitor. Note: This test is not valid for capacitors with radial leads and 15 mm pitch.	Extinguishing time $\leqslant$ 10 s after each flame application; no burning particles must drop from the sample.

Note

Standard atmospheric conditions for referee tests: ambient temperature 23 ± 1 °C, atmospheric pressure 86 to 106 kPa and R.H. 50 ± 2%.

METALLIZED POLYESTER AND POLYCARBONATE FILM CAPACITORS

moulded type (MKT and MKC)

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	0,01 to 6,8 μF
Tolerance on rated capacitance	± 5%, ± 10%, ± 20%
Rated voltage U_R (d.c.)	100 V, 250 V, 400 V, 630 V, 1000 V
Rated voltage U_R (a.c.), 50 to 60 Hz	63 V, 160 V, 220 V, 220 V, 250 V
Rated temperature	85 °C
Climatic category, IEC 68	55/100/56
Basic specification	IEC 384-2

APPLICATION

For general purpose and industrial use in electronic equipment, e.g. for coupling and decoupling applications.

DESCRIPTION

The capacitors consist of a low-inductive wound cell of metallized polyethyleneterephthalate (PETP) or polycarbonate film. The cell is moulded in yellow flame retardent polypropylene. The axial leads are solder coated copper 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.

MECHANICAL DATA

Dimensions in mm

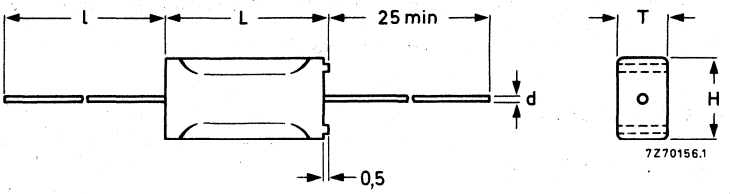


Fig. 1 For dimensions T, L, H, d and l, see tables below.

Table 1 U_R (d.c.) = 100 V; U_R (a.c. = 63 V)
Dielectric: metallized polycarbonate film

rated capacitance* µF	T_{max}	L_{max}	H_{max}	d	l_{min}	mass g	catalogue number 2222 341		
							tol. ±5%	tol. ±10%	tol. ±20%
0,10	4,7	14,5	8,7	0,8	40	1,0	23104	29104	28104
0,15	4,7	14,5	8,7			1,0	23154	29154	28154
0,22	6,5	14,5	10,4			1,4	23224	29224	28224
0,33	6,5	18	10,4			1,7	23334	29334	28334
0,47	7,6	18	11,5			2,0	23474	29474	28474
0,68	7,4	23,5	11,5			2,5	23684	29684	28684
1,0	8,7	23,5	12,8			3,2	23105	29105	28105
1,5	10,4	23,5	14,4			4,0	23155	29155	28155
2,2	10,4	31	14,6	1	50	5,5	23225	29225	28225
3,3	12,4	31	19,5			8,0	23335	29335	28335
4,7	12,4	31	19,5			10,5	23475	29475	28475
6,8	15	31	22			10,5	23685	29685	28685

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

Table 2 U_R (d.c.) = 100 V; U_R (a.c.) = 63 V

Dielectric: metallized PETP film

rated capacitance* µF	T_{max}	L_{max}	H_{max}	d	l_{min}	mass g	catalogue number 2222 341		
							tol. ±5%	tol. ±10%	tol. ±20%
0,10	4,7	14,5	8,7	0,8	40	1,0	25104	27104	26104
0,15	4,7	14,5	8,7			1,0	25154	27154	26154
0,22	6,5	14,5	10,4			1,4	25224	27224	26224
0,33	6,5	18	10,4			1,7	25334	27334	26334
0,47	7,6	18	11,5			2,0	25474	27474	26474
0,68	7,4	23,5	11,5			2,5	25684	27684	26684
1,0	8,7	23,5	12,8			3,2	25105	27105	26105
1,5	10,4	23,5	14,4			4,0	25155	27155	26155
2,2	10,4	31	14,6	1	50	5,5	25225	27225	26225
3,3	12,4	31	19,5			8,0	25335	27335	26335
4,7	12,4	31	19,5			10,5	25475	27475	26475
6,8	15	31	22			10,5	25685	27685	26685

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

Table 3 U_R (d.c.) = 250 V; U_R (a.c.) = 160 V
Dielectric: metallized polycarbonate film

rated capacitance* μF	T_{max}	L_{max}	H_{max}	d	l_{min}	mass g	catalogue number 2222 341		
							tol. ±5%	tol. ±10%	tol. ±20%
0,047	4,7	14,5	8,7	0,8	40	1,0	47473	49473	48473
0,068	4,7	14,5	8,7			1,0	47683	49683	48683
0,10	5,5	14,5	9,4			1,4	47104	49104	48104
0,15	6,5	18	10,4			1,7	47154	49154	48154
0,22	7,6	18	11,5			2,0	47224	49224	48224
0,33	7,4	23,5	11,5			2,5	47334	49334	48334
0,47	8,7	23,5	12,8			3,2	47474	49474	48474
0,68	10,4	23,5	14,4			4,0	47684	49684	48684
1,0	10,4	31	14,6	1	50	5,5	47105	49105	48105
1,5	12,4	31	19,5			8,0	47155	49155	48155
2,2	15	31	22			10,5	47225	49225	48225

Table 4 U_R (d.c.) = 250 V; U_R (a.c.) = 160 V
Dielectric: metallized PETP film

rated capacitance* μF	T_{max}	L_{max}	H_{max}	d	l_{min}	mass g	catalogue number 2222 341		
							tol. ±5%	tol. ±10%	tol. ±20%
0,047	4,7	14,5	8,7	0,8	40	1,0	87473	89473	88473
0,068	4,7	14,5	8,7			1,0	87683	89683	88683
0,10	5,5	14,5	9,4			1,1	87104	89104	88104
0,15	6,5	18	10,4			1,7	87154	89154	88154
0,22	6,5	18	10,4			1,7	87224	89224	88224
0,33	7,4	23,5	11,5			2,5	87334	89334	88334
0,47	7,4	23,5	11,5			2,5	87474	89474	88474
0,68	8,7	23,5	12,8			3,2	87684	89684	88684
1,0	10,4	31	14,6	1	50	5,5	87105	89105	88105
1,5	12,4	31	19,5			8,0	87155	89155	88155
2,2	12,4	31	19,5			8,0	87225	89225	88225

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

Table 5 U_R (d.c.) = 400 V; U_R (a.c.) = 220 V

Dielectric: metallized polycarbonate film

rated capacitance* μF	T_{max}	L_{max}	H_{max}	d	l_{min}	mass g	catalogue number 2222 341		
							tol. ±5%	tol. ±10%	tol. ±20%
0,010	4,7	14,5	8,7	0,8	40	1,0	57103	59103	58103
0,015	4,7	14,5	8,7			1,0	57153	59153	58153
0,022	4,7	14,5	8,7			1,0	57223	59223	58223
0,033	4,7	14,5	8,7			1,0	57333	59333	58333
0,047	6,5	14,5	10,4			1,4	57473	59473	58473
0,068	6,5	18	10,4			1,7	57683	59683	58683
0,10	7,6	18	11,5			2,0	57104	59104	58104
0,15	7,4	23,5	11,5			2,5	57154	59154	58154
0,22	8,7	23,5	12,8			3,2	57224	59224	58224
0,33	10,4	23,5	14,4			4,0	57334	59334	58334
0,47	10,4	31	14,6	1,0	50	5,5	57474	59474	58474
0,68	12,4	31	19,5			8,0	57684	59684	58684
1,0	15	31	22			10,5	57105	59105	58105

Table 6 U_R (d.c.) = 400 V; U_R (a.c.) = 220 V

Dielectric: metallized PETP film

rated capacitance* μF	T_{max}	L_{max}	H_{max}	d	l_{min}	mass g	catalogue number 2222 341		
							tol. ±5%	tol. ±10%	tol. ±20%
0,010	4,7	14,5	8,7	0,8	40	1,0	53103	55103	54103
0,015	4,7	14,5	8,7			1,0	53153	55153	54153
0,022	4,7	14,5	8,7			1,0	53223	55223	54223
0,033	4,7	14,5	8,7			1,0	53333	55333	54333
0,047	6,5	14,5	10,4			1,4	53473	55473	54473
0,068	6,5	18	10,4			1,7	53683	55683	54683
0,10	7,6	18	11,5			2,0	53104	55104	54104
0,15	7,4	23,5	11,5			2,5	53154	55154	54154
0,22	8,7	23,5	12,8			3,2	53224	55224	54224
0,33	10,4	23,5	14,4			4,0	53334	55334	54334
0,47	10,4	31	14,6	1,0	50	5,5	53474	55474	54474
0,68	12,4	31	19,5			8,0	53684	55684	54684
1,0	15	31	22			10,5	53105	55105	54105

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

Table 7 U_R (d.c.) = 630 V; U_R (a.c.) = 220 V

Dielectric: metallized polycarbonate film

rated capacitance* μF	T_{max}	L_{max}	H_{max}	d	l_{min}	mass g	catalogue number 2222 341		
							tol. ±5%	tol. ±10%	tol. ±20%
0,010	4,7	14,5	8,7	0,8	40	1,0	62103	61103	60103
0,015	5,5	14,5	9,4			1,1	62153	61153	60153
0,022	6,5	14,5	10,4			1,4	62223	61223	60223
0,033	6,5	18	10,4			1,7	62333	61333	60333
0,047	7,6	18	11,5			2,0	62473	61473	60473
0,068	7,4	23,5	11,5			2,5	62683	61683	60683
0,10	8,7	23,5	12,8			3,2	62104	61104	60104
0,15	10,4	23,5	14,4			4,0	62154	61154	60154
0,22	10,4	31	14,6	1,0	50	5,5	62224	61224	60224
0,33	12,4	31	19,5			8,0	62334	61334	60334
0,47	15	31	22			10,5	62474	61474	60474

Table 8 U_R (d.c.) = 1000 V; U_R (a.c.) = 250 V

Dielectric: metallized polycarbonate film

rated capacitance* μF	T_{max}	L_{max}	H_{max}	d	l_{min}	mass g	catalogue number 2222 341	
							tol. ±10%	tol. ±20%
0,010	6,5	18	10,4	0,8	40	1,7	71103	70103
0,015	7,6	18	11,5			2,0	71153	70153
0,022	7,4	23,5	11,5			2,5	71223	70223
0,033	8,7	23,5	12,8			3,2	71333	70333
0,047	10,4	23,5	14,4			4,0	71473	70473
0,068	10,4	31	14,6	1,0	50	5,5	71683	70683
0,10	12,4	31	19,5			8,0	71104	70104
0,15	15	31	22			10,5	71154	70154

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

Marking

The marking is impressed on one side:

1st line: rated capacitance, tolerance and rated d.c. voltage;
2nd line: code for dielectric, and 5th, 6th and 7th digits of the catalogue number.

On the other side is impressed: code for factory of origin, production date code (three-month period and year) and manufacturer's identification symbol.

The rated capacitance is marked in μF (without the μF unit symbol) for C $\geqslant$ 0,010 and $<$ 1 μF, and in μF (with the μF unit symbol) for C $\geqslant$ 1 μF.

Tolerance marking is 5 or J for ±5%, 10 or K for ±10%, and 20 or M for ±20%.

The code for the dielectric is MKT for metallized PETP, and MKC for metallized polycarbonate.

Mounting

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

ELECTRICAL DATA

Unless otherwise specified all electrical values apply at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Capacitance

Rated capacitance values (C_R) at 1 kHz	see Tables 1 to 8
Tolerance on rated capacitance	± 5%*, ± 10% and ± 20%

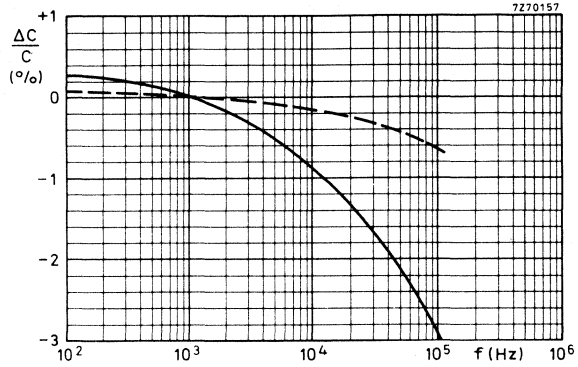


Fig. 2 Capacitance as a function of frequency; typical curves.
—— Metallized PETP film dielectric.
- - - - Metallized polycarbonate film dielectric.
From 100 Hz to 1 kHz the curve is valid for all capacitance values (measuring voltage 1 V). From 1 to 10 kHz the curve is valid for capacitance values ⩽ 1 μF (measuring voltage 1 V). From 10 to 100 kHz the curve is valid for capacitance values ⩽ 0,1 μF (measuring voltage 0,3 V).

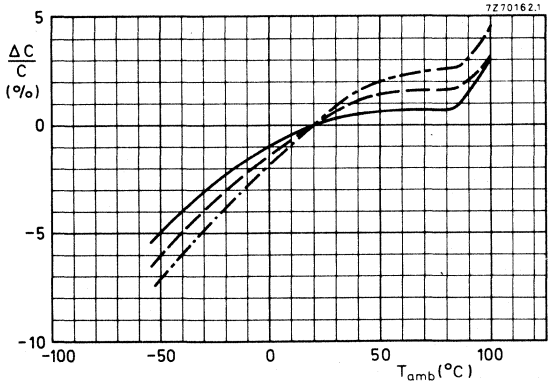


Fig. 3 Capacitance as a function of temperature; typical curves. Metallized PETP film dielectric.
—— For all capacitance values, measured at 1 kHz, 1 V.
- - - - For capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.
—.— For capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

* Only for 100 V, 250 V, 400 V and 630 V versions.

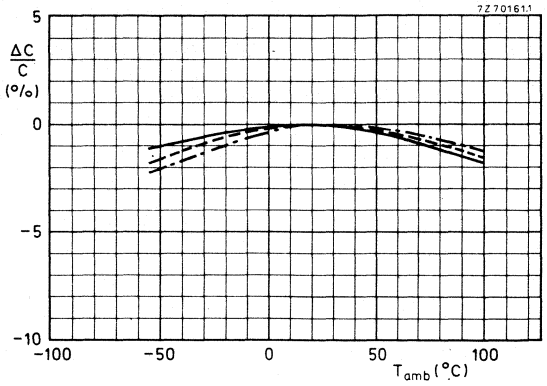


Fig. 4 Capacitance as a function of temperature; typical curves. Metallized polycarbonate film dielectric.
—— For all capacitance values, measured at 1 kHz, 1 V.
- - - For capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.
—.— For capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Voltage

Rated voltage U_R (d.c.)	100 V, 250 V, 400 V, 630 V, 1000 V
Rated voltage U_R (a.c.), 50 to 60 Hz*	
100 V version	63 V
250 V version	160 V
400 V and 630 V versions	220 V
1000 V version	250 V
Category voltage U_C	0,8 x U_R (d.c.)
Test voltage for 1 min	
between terminals	1,6 x U_R (d.c.)
between interconnected terminals and coating	2 x U_R (d.c.) (minimum 1000 V)

Note

The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be ⩽ U_R (d.c.).

* For higher frequencies see Additional information.

Insulation resistance

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

	ambient temperature	
	23 °C	100 °C
R between terminations for $C_R \leqslant 0{,}33\ \mu F$		
100 V version	> 15 000 MΩ	> 50 MΩ
250 V to 1000 V versions	> 30 000 MΩ	> 100 MΩ
RC between terminations for $C_R > 0{,}33\ \mu F$		
100 V version	> 5 000 s	> 16 s
250 V to 1000 V versions	> 10 000 s	> 33 s

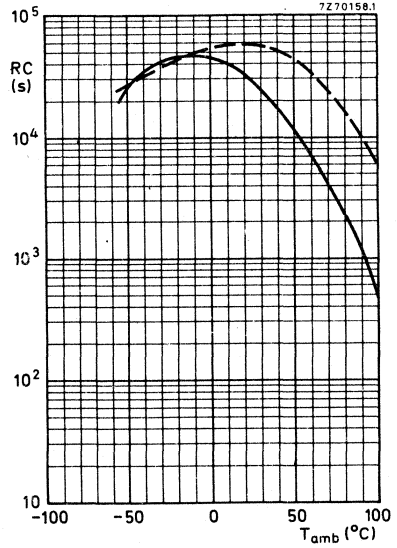


Fig. 5 RC-product as a function of temperature; typical curves.
—— Metallized PETP film dielectric.
- - - Metallized polycarbonate film dielectric.

Tan δ (tangent of the loss angle)

Tan δ at 10 kHz

metallized PETP film dielectric	$\leqslant 150 \times 10^{-4}$ (typ. 100×10^{-4})
metallized polycarbonate film dielectric	$\leqslant 75 \times 10^{-4}$ (typ. 20×10^{-4})

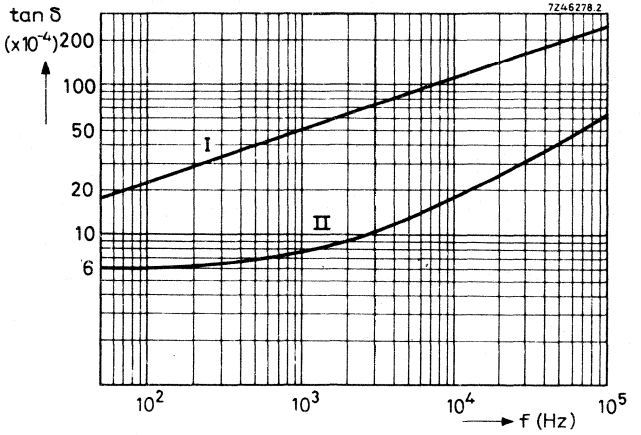


Fig. 6 Tan δ as a function of frequency; typical curves.
I = Metallized PETP film dielectric.
II = Metallized polycarbonate film dielectric.

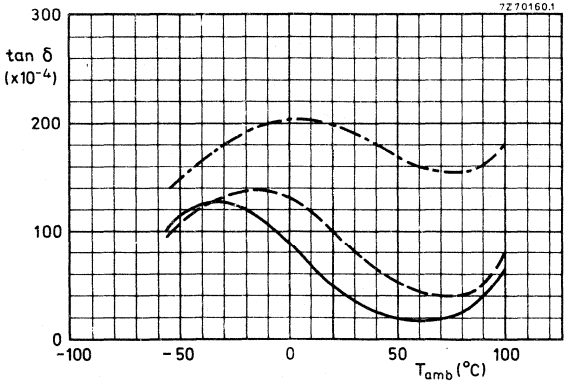


Fig. 7 Tan δ as a function of temperature; typical curves.
Metallized PETP film dielectric.
—— For all capacitance values, measured at 1 kHz, 1 V.
- - - For capacitance values $\leqslant 1\ \mu F$, measured at 10 kHz, 1 V.
- . - For capacitance values $\leqslant 0{,}1\ \mu F$, measured at 100 kHz, 0,3 V.

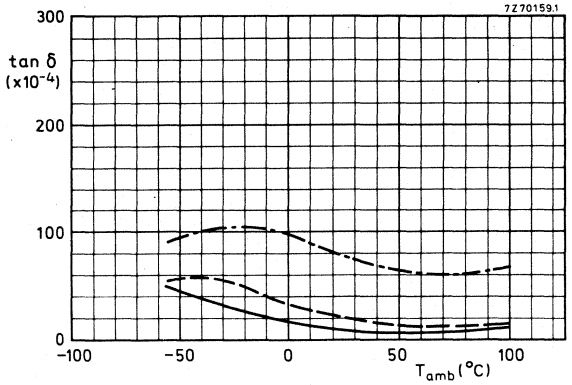


Fig. 8 Tan δ as a function of temperature; typical curves.
Metallized polycarbonate film dielectric.
—— For all capacitance values, measured at 1 kHz, 1 V.
--- For capacitance values $\leqslant$ 1 μF, measured at 10 kHz, 1 V.
-.- For capacitance values $\leqslant$ 0,1 μF, measured at 100 kHz, 0,3 V.

Power dissipation

Maximum permissible power dissipation — see Additional information

Notes
In applications where voltages higher than 50 V are applied, it is recommended that the power in the capacitor is 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 steepness is not exceeded.

→ **Pulse steepness**

rated voltage	max. pulse steepness (V/μs)			
V	L = 14,5 mm	L = 18 mm	L = 23,5 mm	L = 31 mm
100	9	5,6	4	3
250	25	14	10	7,5
400	40	22	16	12
630	70	37	26	19
1000		50	40	35

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

Temperature	
Rated temperature	85 °C
Category temperature range	−55 to + 100 °C
Storage temperature range	−55 to+ 100 °C
Climatic category, IEC 68	55/100/56

PACKING

250 pieces per box, for capacitors with $H_{max} \leqslant 11{,}5$ mm.
200 pieces per box, for capacitors with $H_{max} > 11{,}5$ mm.

TESTS AND REQUIREMENTS

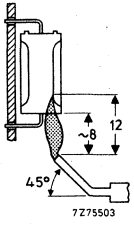
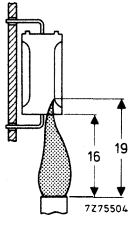
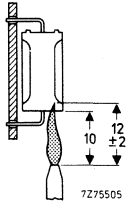
IEC 68-2 method	name of test	procedure (quick reference)	requirements
Ua1	Tensile strength of terminations	Loading force in axial direction of the wires: 10 N, 10 s for d = 0,8 mm; 20 N, 10 s for d = 1 mm.	No damage.
		Loading force in radial direction of the wires: 5 N, 10 s for d = 0,8 mm; 10 N, 10 s for d = 1 mm.	No damage.
Ub (method 1)	Bending of terminations	Loading force 5 N for d = 0,8 mm; 10 N for d = 1 mm; two consecutive bends.	No damage.
Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. 235 °C, dwell time 2 s.	Good tinning.
Tb (method 1B)	Resistance to soldering heat	Solder bath: 350 °C, 3,5 s.	No damage; $\Delta C/C \leqslant 1\%$.
Na	Rapid change of temperature	5 cycles of ½ h at −55 °C and ½ h at + 100 °C	No damage; no leakage; $\Delta C/C \leqslant 2\%$. Tan δ and insulation resistance shall meet initial requirements.
Fc	Vibration	10 to 55 Hz, 0,75 mm or 10g (whichever is less), 3 directions, 2 h per direction.	No damage, no open or short-circuit. $\Delta C/C \leqslant 0{,}5\%$.
Eb	Bumping	40 g, 4000 bumps.	No damage, no open or short-circuit. $\Delta C/C \leqslant 0{,}5\%$.

IEC 68-2 test method		name of test	procedure (quick reference)	requirements	
Climatic sequence	Ba	Dry heat	16 h at + 100 ± 2 °C, no voltage applied.	No damage, no leakage; $\Delta C/C \leqslant 3\%$. (polycarbonate), $\leqslant 7\%$ (PETP) at 100 °C. Insulation resistance at 100 °C for $C_R \leqslant 0{,}33\ \mu F$: $> 50\ M\Omega$ (100 V version), $> 100\ M\Omega$ (other versions); for $C_R > 0{,}33\ \mu F$: RC > 16 s (100 V version), > 33 s (other versions).	
	Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.		
	Aa	Cold	2 h at −55 ± 3 °C; no voltage applied.	$\Delta C/C \leqslant -3\%$ (polycarbonate), $\leqslant -8\%$ (PETP) at −55 °C.	
	M	Low air pressure	1 h at 25 ± 5 °C; at an atmospheric pressure of 8,5 kPa..	During and after the test there shall be no breakdown or flashover.	
	Db	Damp heat, cyclic	5 cycles of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.		
			Final measurement.	$\Delta C/C \leqslant 3\%$. Tan δ shall meet initial requirements. Insulation resistance > 0,5 x initial requirements.	
	Ca	Damp heat, steady state	56 days at 40 °C and R.H. 90 to 95%; 6 V (d.c.) applied continuously.	$\Delta C/C \leqslant 3\%$. Tan δ shall meet initial requirements. Insulation resistance $\geqslant$ 0,5 x initial requirements.	
	—	Endurance	1000 h at 85 °C, 1,5 x U_R (d.c.) (U_R (d.c.) $\leqslant$ 630 V) or 1,2 x U_R (d.c.) (U_R (d.c.) > 630 V) applied.	$\Delta C/C \leqslant 3\%$	$\Delta \tan\delta \leqslant 30 \times 10^{-4}$ at 10 kHz. Insulation resistance shall meet initial requirements.
			1000 h at 100 °C, 1,5 x U_c applied (U_R (d.c.) $\leqslant$ 630 V) or 1,2 x U_c (U_R (d.c.) > 630 V).	$\Delta C/C \leqslant 5\%$	
			1000 h at 85 °C, U_R (a.c.), 50 Hz applied.	$\Delta C/C \leqslant 15\%$ (L = 14,5 mm) $\leqslant 10\%$ (L = 18 mm) $\leqslant 7\%$ (L = 23,5 mm) $\leqslant 5\%$ (L = 31 mm)	

Additional tests

name of test	procedure (quick reference)	requirements
Solvent resistance	According to MIL-STD-202 E, method 215.	No damage.
Storage	1000 h at 100 °C	$\Delta C/C \leqslant 3\%$. Tan δ and insulation resistance (at $\leqslant$ 10 V d.c.) shall meet initial requirements.
	10 000 h at 25 °C	$\Delta C/C \leqslant 1\%$. Tan δ and insulation resistance (at $\leqslant$ 10 V d.c.) shall meet initial requirements.
Charge and discharge	10 000 cycles of charge to U_R (d.c.) and discharge via a resistor of value such that the pulse steepness is 1,5 x specified value. Cycle time: 1 to 150 cycles/s, temperature: 25 °C.	$\Delta \tan \delta \leqslant 20 \times 10^{-4}$ at 10 kHz.

For flammability tests see next page.

name		requirements
Flammability	 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.
	 Test according to UL1414. Bore of gas jet: ϕ 10 mm. Fuel: natural gas. Test duration: 3 x 15 s. Time interval between each flame application: 15 s.	Extinguishing time $\leqslant$ 15 s after the first and second flame application, $\leqslant$ 60 s after the third flame application.
	 Bore of gas jet: ϕ 0,5 mm. Fuel: butane. Test duration: 3 x 15 s. Second and third flame application starts after extinguishing of the flame on the capacitor.	Extinguishing time $\leqslant$ 10 s after each flame application; no burning particles must drop from the sample.

Note

Standard atmospheric conditions for referee tests: ambient temperature 23 ± 1 °C, atmospheric pressure 86 to 106 kPa and R.H. 50 ± 2%.

ADDITIONAL INFORMATION

Power dissipation

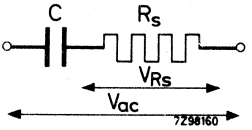
The rated a.c. voltage has been specified for 50 Hz and at 20 °C. This voltage value must also never be exceeded at other frequencies. This permissible a.c. voltage may further be limited by the following requirements:

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

Ad 1.

The power dissipated by a capacitor is a function of the voltage over 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 for these capacitors $\tan \delta = R_S \omega C$ = always $< 0{,}1$, 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

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

or

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

The term $R_S C$ 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 temperature, can be found from Fig. 10. Thus, when the actual power has been calculated with formula (3b), Fig. 10 gives the minimum size of capacitor which can dissipate this power.

May be two or three capacitors having this size can be chosen, namely with different rated voltages.

Example of using Fig. 9 and Fig. 10

A capacitor with a dielectric of metallized PETP film and a value of 1 μF should be used at an a.c. voltage of 130 V, a frequency of 1 kHz and an ambient temperature of 50 °C. The R_sC-product is $7{,}5 \times 10^{-7}$ ΩF (from Fig. 9), so that the power to be dissipated

$$P = (R_sC)\, C\omega^2\, V_{ac}^2$$
$$= 7{,}5 \times 10^{-7} \times 10^{-6} \times 4\,\pi^2 \times 1000^2 \times 130^2 = 500 \text{ mW}.$$

Fig. 10 shows that at 50 °C capacitors with curve numbers 8 to 11 can be used, thus a minimum size of 10,4 x 23,5 x 14,4 mm. It can be seen from the tables that the 1 μF/250 V capacitor can be chosen.

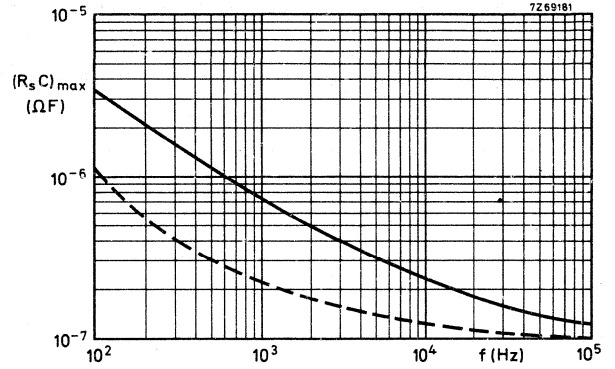


Fig. 9 Maximum product of series resistance and capacitance as a function of frequency.
—— metallized PETP film dielectric;
—— metallized polycarbonate film dielectric.

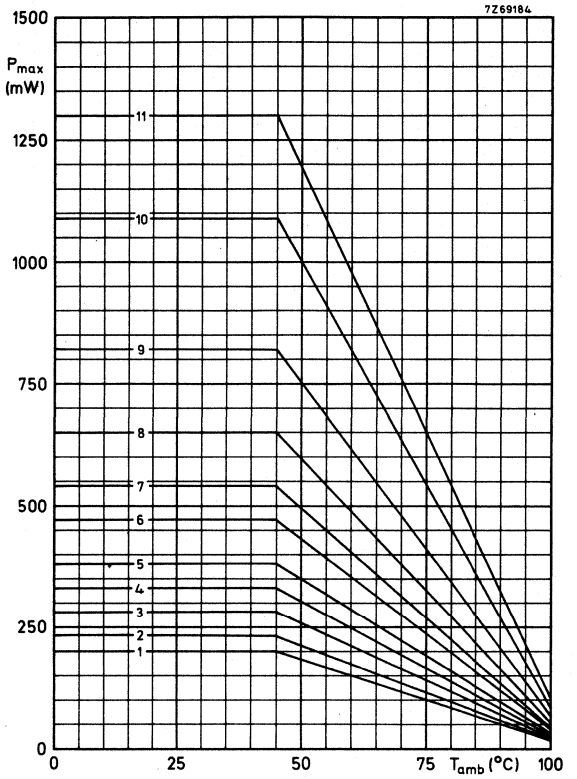


Fig. 10 Maximum permissible power dissipation as a function of temperature.

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

METALLIZED POLYESTER OR POLYCARBONATE FILM CAPACITORS

potted type (MKT and MKC)

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	3900 pF to 10 μF				
Tolerance on rated capacitance	± 5%, ± 10%, ± 20%				
Rated voltage U_R (d.c.)	63 V	100 V	250 V	400 V	630 V
Rated voltage U_R (a.c.), 50 to 60 Hz	40 V	63 V	160 V	220 V	220 V
Rated temperature	85 °C				
Climatic category, IEC 68	55/100/56				
Basic specification	IEC 384-2				

APPLICATION

For general purpose and industrial use in electronic equipment, e.g. for coupling and decoupling applications.

DESCRIPTION

The capacitors consist of a low-inductive wound cell of metallized polyethyleneterephthalate (PETP) or polycarbonate film. The cell is potted with epoxy resin in a yellow flame retardent polypropylene case. The radial leads are solder-coated copper wire. The capacitors are provided with small pips to allow removal of solder flux etc., when cleaning the printed-wiring board.

MECHANICAL DATA

Dimensions in mm

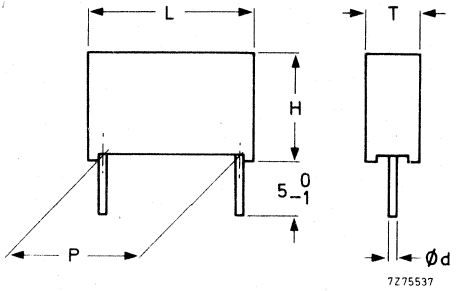


Fig. 1 For dimensions T, L, H, P and d, see tables below.

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

Dielectric: metallized PETP film

rated capacitance* µF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 344	
							tol. ± 10%	tol. ± 20%
0,15	4,5	10,5	10	7,5 ± 0,4	0,6	0,8	17154	16154
0,22	4,5	13	10	10 ± 0,4	0,8	0,7	15224	14224
0,33	5	13	11			0,9	15334	14334
0,47	6	13	12			1	15474	14474
0,68	6	17,5	11,5	15 ± 0,4		1,4	15684	14684
1,0	7	17,5	13			1,8	15105	14105
1,5	8,5	17,5	14,5			2,6	15155	14155
2,2	6,5	26	15,5	22,5 ± 0,4		2,8	15225	14225
3,3	8,5	26	18			4,3	15335	14335
4,7	9,5	26	19			5,1	15475	14475
6,8	11	30	20,5	27,5 ± 0,4		7,4	15685	14685
10	13,5	30	23			10,2	15106	14106

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

Table 2 U_R (d.c.) = 100 V; U_R (a.c.) = 63 V

Dielectric: metallized polycarbonate film

rated capacitance* µF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 344		
							tol. ± 5%	tol. ± 10%	tol. ± 20%
0,10	4,5	13	10	10 ± 0,4	0,8	0,7	22104	21104	20104
0,15	4,5	13	10			0,7	22154	21154	20154
0,22	5	13	11			0,9	22224	21224	20224
0,33	5	17,5	11	15 ± 0,4		1,1	22334	21334	20334
0,47	6	17,5	11,5			1,4	22474	21474	20474
0,68	7	17,5	13			1,8	22684	21684	20684
1,0	8,5	17,5	14,5			2,6	22105	21105	20105
1,5	6,5	26	15,5	22,5 ± 0,4		2,8	22155	21155	20155
2,2	8,5	26	18			4,3	22225	21225	20225
3,3	9,5	26	19			5,1	22335	21335	20335
4,7	11	30	20,5	27,5 ± 0,4		7,4	22475	21475	20475
6,8	13,5	30	23			10,2	22685	21685	20685

Table 3 U_R (d.c.) = 100 V; U_R (a.c.) = 63 V

Dielectric: metallized PETP film

rated capacitance* µF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 344		
							tol. ± 5%	tol. ± 10%	tol. ± 20%
0,047	4,5	10,5	10	7,5 ± 0,4	0,6	0,8		27473	26473
0,068	4,5	10,5	10			0,8		27683	26683
0,10	4,5	10,5	10			0,8		27104	26104
0,10	4,5	13	10	10 ± 0,4	0,8	0,7	23104	25104	24104
0,15	4,5	13	10			0,7	23154	25154	24154
0,22	5	13	11			0,9	23224	25224	24224
0,33	5	17,5	11	15 ± 0,4		1,1	23334	25334	24334
0,47	6	17,5	11,5			1,4	23474	25474	24474
0,68	7	17,5	13			1,8	23684	25684	24684
1,0	8,5	17,5	14,5			2,6	23105	25105	24105
1,5	6,5	26	15,5	22,5 ± 0,4		2,8	23155	25155	24155
2,2	8,5	26	18			4,3	23225	25225	24225
3,3	9,5	26	19			5,1	23335	25335	24335
4,7	11	30	20,5	27,5 ± 0,4		7,4	23475	25475	24475
6,8	13,5	30	23			10,2	23685	25685	24685
10	15	30	25		1,0	12,8	23106	25106	24106

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

Table 4 U_R (d.c.) = 250 V; U_R (a.c.) = 160 V — Dielectric: metallized polycarbonate film

rated capacitance* µF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 344		
							tol. ± 5%	tol. ± 10%	tol. ± 20%
0,047	4,5	13	10	10 ± 0,4	0,8	0,7	43473	45473	44473
0,068	4,5	13	10			0,7	43683	45683	44683
0,10	5	17,5	11	15 ± 0,4		1,1	43104	45104	44104
0,15	6	17,5	11,5			1,4	43154	45154	44154
0,22	7	17,5	13			1,8	43224	45224	44224
0,33	8,5	17,5	14,5			2,6	43334	45334	44334
0,47	6,5	26	15,5	22,5 ± 0,4		2,8	43474	45474	44474
0,68	7,5	26	16,5			3,5	43684	45684	44684
1,0	9,5	26	19			5,1	43105	45105	44105
1,5	11	30	20,5	27,5 ± 0,4		7,4	43155	45155	44155
2,2	13,5	30	23			10,2	43225	45225	44225

Table 5 U_R (d.c.) = 250 V; U_R (a.c.) = 160 V — Dielectric: metallized PETP film

rated capacitance* µF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 344		
							tol. ± 5%	tol. ± 10%	tol. ± 20%
0,022	4,5	10,5	10	7,5 ± 0,4	0,6	0,8		47223	46223
0,033	4,5	10,5	10			0,8		47333	46333
0,047	4,5	13	10	10 ± 0,4	0,8	0,7	42473	41473	40473
0,068	4,5	13	10			0,7	42683	41683	40683
0,10	5	17,5	11	15 ± 0,4		1,1	42104	41104	40104
0,15	5	17,5	11			1,1	42154	41154	40154
0,22	6	17,5	11,5			1,4	42224	41224	40224
0,33	7	17,5	13			1,8	42334	41334	40334
0,47	6,5	26	15,5	22,5 ± 0,4		2,8	42474	41474	40474
0,68	6,5	26	15,5			2,8	42684	41684	40684
1,0	8,5	26	18			4,4	42105	41105	40105
1,5	11	30	20,5	27,5 ± 0,4		7,4	42155	41155	40155
2,2	11	30	20,5			7,4	42225	41225	40225

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

Table 6 U_R (d.c.) = 400 V; U_R (a.c.) = 220 V — Dielectric: metallized polycarbonate film

rated capacitance* µF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 344		
							tol. ± 5%	tol. ± 10%	tol. ± 20%
0,010	4,5	13	10	10 ± 0,4	0,8	0,7	52103	51103	50103
0,015	4,5	13	10			0,7	52153	51153	50153
0,022	4,5	13	10			0,7	52223	51223	50223
0,033	4,5	13	10			0,7	52333	51333	50333
0,047	5	17,5	11	15 ± 0,4		1,1	52473	51473	50473
0,068	6	17,5	11,5			1,4	52683	51683	50683
0,10	7	17,5	13			1,8	52104	51104	50104
0,15	8,5	17,5	14,5			2,6	52154	51154	50154
0,22	6,5	26	15,5	22,5 ± 0,4		2,8	52224	51224	50224
0,33	7,5	26	16,5			3,5	52334	51334	50334
0,47	9,5	26	19			5,1	52474	51474	50474
0,68	11	30	20,5	27,5 ± 0,4		7,4	52684	51684	50684
1,0	13,5	30	23			10,2	52105	51105	50105

Table 7 U_R (d.c.) = 400 V; U_R (a.c.) = 220 V — Dielectric: metallized PETP film

rated capacitance* µF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 344		
							tol. ± 5%	tol. ± 10%	tol. ± 20%
0,010	4,5	10,5	10	7,5 ± 0,4	0,6	0,8		57103	56103
0,015	4,5	10,5	10			0,8		57153	56153
0,010	4,5	13	10	10 ± 0,4	0,8	0,7	53103	55103	54103
0,015	4,5	13	10			0,7	53153	55153	54153
0,022	4,5	13	10			0,7	53223	55223	54223
0,033	4,5	13	10			0,7	53333	55333	54333
0,047	5	17,5	11	15 ± 0,4		1,1	53473	55473	54473
0,068	6	17,5	11,5			1,4	53683	55683	54683
0,10	7	17,5	13			1,8	53104	55104	54104
0,15	8,5	17,5	14,5			2,6	53154	55154	54154
0,22	6,5	26	15,5	22,5 ± 0,4		2,8	53224	55224	54224
0,33	7,5	26	16,5			3,5	53334	55334	54334
0,47	9,5	26	19			5,1	53474	55474	54474
0,68	11	30	20,5	27,5 ± 0,4		7,4	53684	55684	54684
1,0	13,5	30	23			10,2	53105	55105	54105

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

Table 8 U_R (d.c.) = 630 V; U_R (a.c.) = 220 V — Dielectric: metallized polycarbonate film

rated capacitance* µF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 344		
							tol. ± 5%	tol. ± 10%	tol. ± 20%
0,010	4,5	13	10	10 ± 0,4	0,8	0,7	62103	61103	60103
0,015	5	13	11			0,9	62153	61153	60153
0,022	6	13	12			1,0	62223	61223	60223
0,033	6	17,5	11,5	15 ± 0,4		1,4	62333	61333	60333
0,047	7	17,5	13			1,8	62473	61473	60473
0,068	8,5	17,5	14,5			2,6	62683	61683	60683
0,10	6,5	26	15,5	22,5 ± 0,4		2,8	62104	61104	60104
0,15	7,5	26	16,5			3,5	62154	61154	60154
0,22	9,5	26	19			5,1	62224	61224	60224
0,33	11	30	20,5	27,5 ± 0,4		7,4	62334	61334	60334
0,47	13,5	30	23			10,2	62474	61474	60474

Table 9 U_R (d.c.) = 630 V; U_R (a.c.) = 220 V — Dielectric: metallized PETP film

rated capacitance* µF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 344	
							tol. ± 10%	tol. ± 20%
0,0047	4,5	10,5	10	7,5 ± 0,4	0,6	0,8	67472	66472
0,0068	4,5	10,5	10	7,5 ± 0,4	0,6	0,8	67682	66682

Marking

The capacitors are marked on the top face by embossed printed with:

1st line: rated capacitance in µF, tolerance and rated d.c. voltage;
2nd line: last eight digits of the catalogue number.

The capacitors with pitch P = 7,5 mm are marked on the top face by embossed print with:

1st line: rated capacitance in pF or µF and tolerance;
2nd line: rated d.c. voltage, code for dielectric (MKT = metallized PETP film) and code for factory of origin.

Mounting

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

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

ELECTRICAL DATA

Unless otherwise specified all electrical values apply at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Capacitance

Rated capacitance values (C_R) at 1 kHz	see Tables 1 to 8
Tolerance on rated capacitance	± 5%*, ± 10% and ± 20%

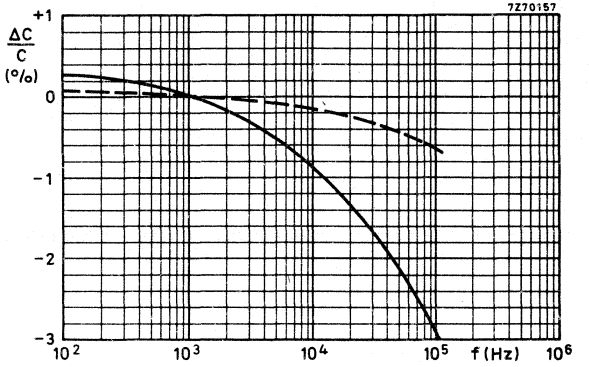


Fig. 2 Capacitance as a function of frequency; typical curves.
—— Metallized PETP film dielectric.
- - - - Metallized polycarbonate film dielectric.
From 100 Hz to 1 kHz the curve is valid for all capacitance values (measuring voltage 1 V). From 1 to 10 kHz the curve is valid for capacitance values ⩽ 1 μF (measuring voltage 1 V). From 10 to 100 kHz the curve is valid for capacitance values ⩽ 0,1 μF (measuring voltage 0,3 V).

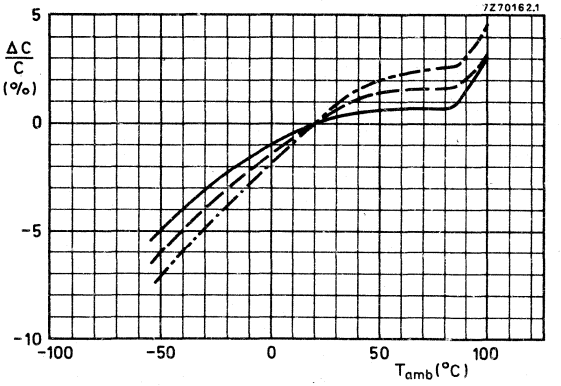


Fig. 3 Capacitance as a function of temperature; typical curves. Metallized PETP film dielectric.
—— For all capacitance values, measured at 1 kHz, 1 V.
- - - - For capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.
—.— For capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

* Not for 63 V version.

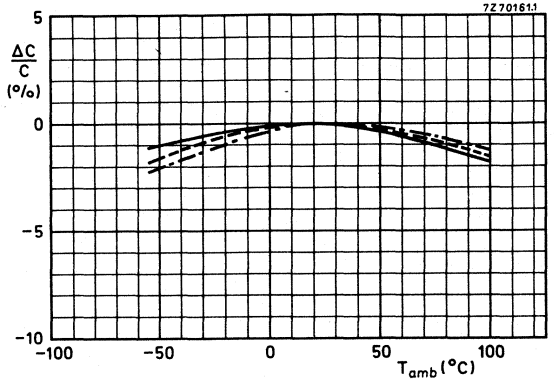


Fig. 4 Capacitance as a function of temperature; typical curves. Metallized polycarbonate film dielectric.
—— For all capacitance values, measured at 1 kHz, 1 V.
- - - For capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V.
—.— For capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Voltage

Rated voltage U_R (d.c.)	63 V, 100 V, 250 V, 400 V, 630 V
Rated voltage U_R (a.c.), 50 to 60 Hz*	
63 V version	40 V
100 V version	63 V
250 V version	160 V
400 V and 630 V versions	220 V
Category voltage U_C	0,8 x U_R (d.c.)
Test voltage for 1 min	
between terminals	1,6 x U_R (d.c.)
between interconnected terminals and coating	2 x U_R (d.c.) (minimum 1000 V)

Note

The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be ⩽ U_R (d.c.).

* For higher frequencies see Additional information.

Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 min ± 5 s, the voltage being 100 ± 15 V for the 63 V, 100 V, 250 V and 400 V versions and 500 ± 50 V for the 630 V version.

	ambient temperature	
	23 °C	100 °C
R between terminations for $C_R \leqslant 0{,}33\ \mu F$		
63 V and 100 V versions	> 15 000 MΩ	> 50 MΩ ←
250 V, 400 V and 630 V versions	> 30 000 MΩ	> 100 MΩ
RC between terminations for $C_R > 0{,}33\ \mu F$		
63 V and 100 V versions	> 5 000 s	> 16 s ←
250 V, 400 V and 630 V versions	> 10 000 s	> 33 s

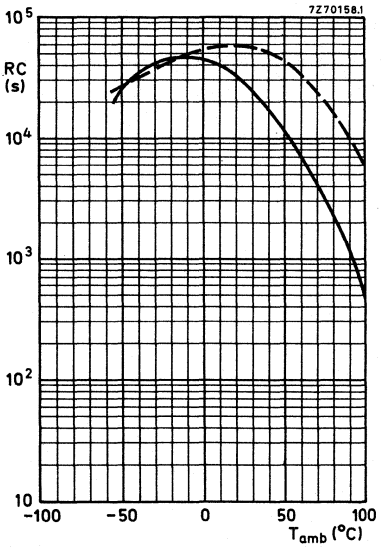


Fig. 5 RC-product as a function of temperature; typical curves.
—— Metallized PETP film dielectric.
- - - Metallized polycarbonate film dielectric.

Tan δ (tangent of the loss angle)

Tan δ at 10 kHz

metallized PETP film dielectric	$\leqslant 150 \times 10^{-4}$ (typ. 100×10^{-4})
metallized polycarbonate film dielectric	$\leqslant 75 \times 10^{-4}$ (typ. 20×10^{-4})

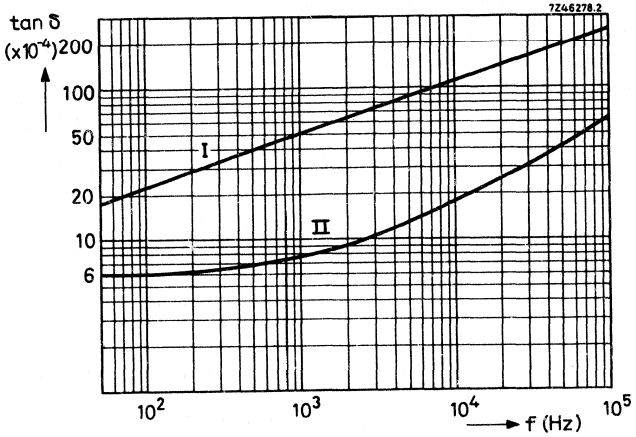


Fig. 6 Tan δ as a function of frequency; typical curves.
I = Metallized PETP film dielectric.
II = Metallized polycarbonate film dielectric.

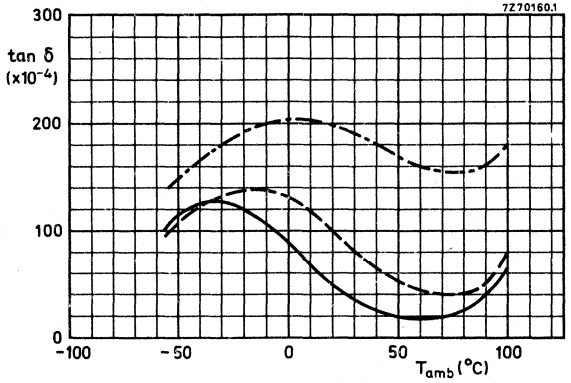


Fig. 7 Tan δ as a function of temperature; typical curves.
Metallized PETP film dielectric.
—— For all capacitance values, measured at 1 kHz, 1 V.
- - - For capacitance values $\leqslant 1\ \mu F$, measured at 10 kHz, 1 V.
-.- For capacitance values $\leqslant 0{,}1\ \mu F$, measured at 100 kHz, 0,3 V.

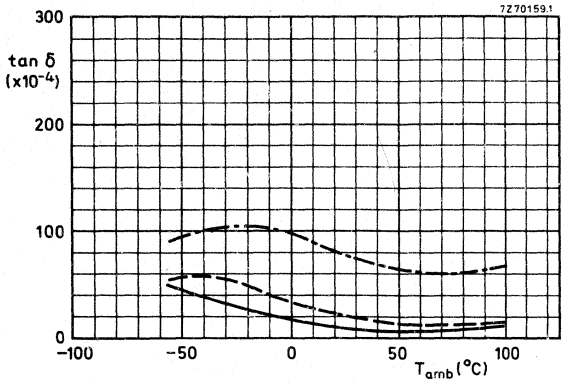


Fig. 8 Tan δ as a function of temperature; typical curves.
Metallized polycarbonate film dielectric.
—— For all capacitance values, measured at 1 kHz, 1 V.
- - - For capacitance values $\leqslant$ 1 μF, measured at 10 kHz, 1 V.
- . - For capacitance values $\leqslant$ 0,1 μF, measured at 100 kHz, 0,3 V.

Power dissipation

Maximum permissible power dissipation — see Additional information

Notes

In applications where voltages higher than 50 V are applied, it is recommended that the power in the capacitor is 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 steepness is not exceeded.

Pulse steepness

rated voltage	max. pulse steepness (V/μs)				
V	L = 10,5 mm	L = 13 mm	L = 17,5 mm	L = 26 mm	L = 30 mm
63	6,3	4,2	2,6	1,7	1,4
100	12,5	9	5,6	3,5	3
250	42	25	14	9	7,5
400	67	40	22	14	12
630	125	70	37	23	19

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

Temperature

Rated temperature	85 °C
Category temperature range	−55 to + 100 °C
Storage temperature range	−55 to + 100 °C
Climatic category, IEC68	55/100/56

→ **PACKING**

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

capacitance values (μF)					number of capacitors per box
63 V version	100 V version	250 V version	400 V version	630 V version	
0,18 - 0,47	0,047 - 0,22	0,047 - 0,068	0,010 - 0,033	0,010 - 0,033	250
	0,27 - 0,33	0,082 - 0,15	0,039 - 0,047	0,039 - 0,047	200
0,56 - 0,68	0,39 - 0,47	0,18 - 0,22	0,056 - 0,068	0,056 - 0,068	150
0,82 - 1,0	0,56 - 0,68	0,27 - 0,33	0,082 - 0,1	0,082 - 1,0	125
1,2 - 1,5	0,82 - 1,0		0,12 - 0,15	0,12 - 0,15	100
1,8 - 4,7	1,2 - 3,3	0,39 - 1,0	0,18 - 0,47	0,18 - 0,47	200
5,6 - 10,0	3,9 - 6,8	1,2 - 2,2	0,56 - 1,0	0,56 - 1,0	100

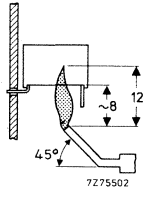
The miniature types are packed in boxes of 250 pieces.

TESTS AND REQUIREMENTS

IEC68-2 method	name of test	procedure (quick reference)	requirements
Ua1	Tensile strength of terminations	Loading force in axial direction of the wires: 10 N, 10 s.	No damage.
		Loading force in radial direction of the wires; 5 N, 10 s.	No damage.
Ub (method 1)	Bending of terminations	Loading force 5 N, two consecutive bends.	No damage.
Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. 235 °C, dwell time 2 s.	Good tinning.
Tb (method 1B)	Resistance to soldering heat	Solder bath: 350 °C, 3,5 s.	No damage; $\Delta C/C \leqslant 1\%$.
Na	Rapid change of temperature	5 cycles of ½ h at −55 °C and ½ h at + 100 °C	No damage; no leakage; $\Delta C/C \leqslant 2\%$. Tan δ and insulation resistance shall meet initial requirements.
Fc	Vibration	10 to 55 Hz, 0,75 mm or 10g (whichever is less), 3 directions, 2 h per direction.	No damage, no open or short-circuit. $\Delta C/C \leqslant 0{,}5\%$.
Eb	Bumping	40g, 4000 bumps.	No damage, no open or short-circuit. $\Delta C/C \leqslant 0{,}5\%$.

IEC68-2 test method		name of test	procedure (quick reference)	requirements	
Climatic sequence	Ba	Dry heat	16 h at + 100 ± 2 °C, no voltage applied.	No damage, no leakage; $\Delta C/C \leqslant -3\%$ (polycarbonate), $\leqslant +7\%$ (PETP) at 100 °C. Insulation resistance at 100 °C for $C_R \leqslant 0{,}33\ \mu F$: $> 50\ M\Omega$ (63 V and 100 V versions), $> 100\ M\Omega$ (other versions); for $C_R > 0{,}33\ \mu F$: RC > 16 s (63 V and 100 V versions), > 33 s (other versions).	
	Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.		
	Aa	Cold	2 h at −55 ± 3 °C; no voltage applied.	$\Delta C/C \leqslant -3\%$ (polycarbonate), $\leqslant -8\%$ (PETP) at −55 °C.	
	M	Low air pressure	1 h at 25 ± 5 °C; at an atmospheric pressure of 85 mbar.	During and after the test there shall be no breakdown or flashover.	
	Db	Damp heat, cyclic	5 cycles of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.		
			Final measurement	$\Delta C/C \leqslant 3\%$. Tan δ shall meet initial requirements. Insulation resistance > 0,5 x initial requirements.	
	Ca	Damp heat, steady state	56 days at 40 °C and R.H. 90 to 95%; 6 V (d.c.) applied continuously.	$\Delta C/C \leqslant 3\%$. Tan δ shall meet initial requirements. Insulation resistance $\geqslant$ 0,5 x initial requirements.	
	–	Endurance	1000 h at 85 °C, 1,5 x U_R (d.c.) applied.	$\Delta C/C \leqslant 3\%$.	$\Delta \tan\delta \leqslant 30 \times 10^{-4}$ at 10 kHz. Insulation resistance shall meet initial requirements.
			1000 h at 100 °C, 1,5 x U_C applied	$\Delta C/C \leqslant 5\%$	
			1000 h at 85 °C, U_R (a.c.), 50 Hz applied.	$\Delta C/C \leqslant 20\%$ (L = 10,5 mm) $\leqslant 15\%$ (L = 13 mm) $\leqslant 10\%$ (L = 17,5 mm) $\leqslant 7\%$ (L = 26 mm) $\leqslant 5\%$ (L = 30 mm)	

Additional tests

name of test	procedure (quick reference)	requirements
Solvent resistance	According to MIL-STD-202 E, method 215.	No damage.
Storage	1000 h at 100 °C	$\Delta C/C \leqslant 3\%$. Tan δ and insulation resistance (at $\leqslant$ 10 V d.c.) shall meet initial requirements.
	10 000 h at 25 °C	$\Delta C/C \leqslant 1\%$. Tan δ and insulation resistance (at $\leqslant$ 10 V d.c.) shall meet initial requirements.
Charge and discharge	10 000 cycles of charge to U_R (d.c.) and discharge via a resistor of value such that the pulse steepness is 1,5 x specified value. Cycle time: 1 to 150 cycles/s, temperature: 25 °C.	$\Delta \tan \delta \leqslant 20 \times 10^{-4}$ at 10 kHz.
Flammability	 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.

Note

Standard atmospheric conditions for referee tests: ambient temperature 23 ± 1 °C, atmospheric pressure 86 to 106 kPa and R.H. 50 ± 2%.

ADDITIONAL INFORMATION

Power dissipation

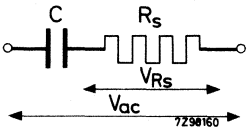
The rated a.c. voltage has been specified for 50 Hz and at 20 °C. This voltage value must also never be exceeded at other frequencies. This permissible a.c. voltage may further be limited by the following requirements:

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

Ad. 1

The power dissipated by a capacitor is a function of the voltage over 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 for these capacitors $\tan \delta = R_S \omega C$ = always < 0,1, the formula (2a) can be simplified to

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

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

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

The term $R_S C$ 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 temperature, can be found from Fig. 10. Thus, when the actual power has been calculated with formula (3b), Fig. 10 gives the minimum size of capacitor which can dissipate this power.

May be two or three capacitors having this size can be chosen, namely with different rated voltages.

Example of using Fig. 9 and Fig. 10

A capacitor with a dielectric of metallised PETP film and a value of 1 μF should be used at an a.c. voltage of 130 V, a frequency of 1 kHz and an ambient temperature of 50 °C. The R_sC-product is $7,5 \times 10^{-7}$ ΩF (from Fig. 9), so that the power to be dissipated

$$P = (R_sC)\, C\omega^2\, V_{ac}^2$$
$$= 7,5 \times 10^{-7} \times 10^{-6} \times 4\pi^2 \times 1000^2 \times 130^2 = 500 \text{ mW}$$

Fig. 10 shows that at 50 °C capacitors with curve numbers 9 to 14 can be used, thus a minimum size of 6,5 x 26 x 15,5 mm. It can be seen from the tables that a choice can be made between the 250 V and 400 V capacitors of 1 μF.

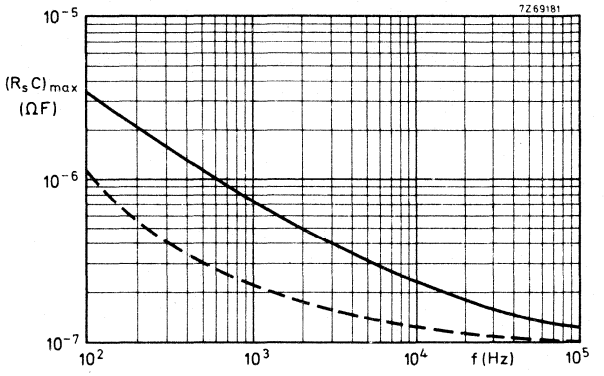


Fig. 9. Maximum product of series resistance and capacitance as a function of frequency
—— metallised PETP film dielectric
---- metallised polycarbonate film dielectric

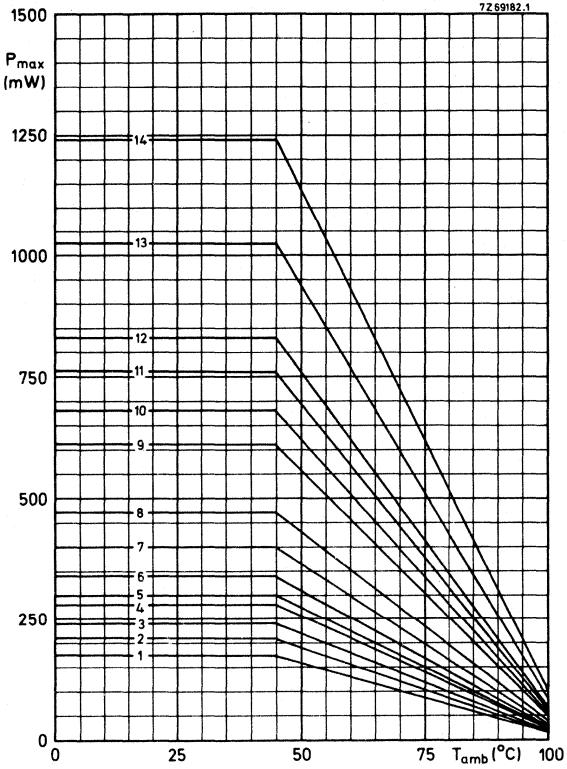


Fig. 10. Maximum permissible power dissipation as a function of temperature.

curve	dimensions (mm)		
	T_{max}	L_{max}	H_{max}
1	4,5	10,5	10
2	4,5	13	10
3	5	13	11
4	6	13	12
5	5	17,5	11
6	6	17,5	11,5
7	7	17,5	13
8	8,5	17,5	14,5
9	6,5	26	15,5
10	7,5	26	16,5
11	8,5	26	18
12	9,5	26	19
13	11	30	20,5
14	13,5	30	23

POLYESTER FILM/FOIL CAPACITORS

flat type (KT)

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	1 nF to 1 μF
Tolerance on rated capacitance	± 10% and ± 20%
Rated voltage U_R (d.c.)	100 V, 250 V, 400 V, 630 V
Rated voltage U_R (a.c.), 50 to 60 Hz	50 V, 80 V, 125 V, 200 V
Rated temperature	85 °C
Climatic category, IEC 68	40/100/21
Basic specification	IEC 384-11

APPLICATION

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

DESCRIPTION

These capacitors consist of a low-inductive wound cell of aluminium foil with a polyethyleneterephthalate (PETP) film. The cell is protected by a hard, tan coloured lacquer, which is water repellent and self-extinguishing. The radial leads are of solder-coated copper wire, which are crimped to provide optimum soldering conditions.

MECHANICAL DATA

Dimensions in mm

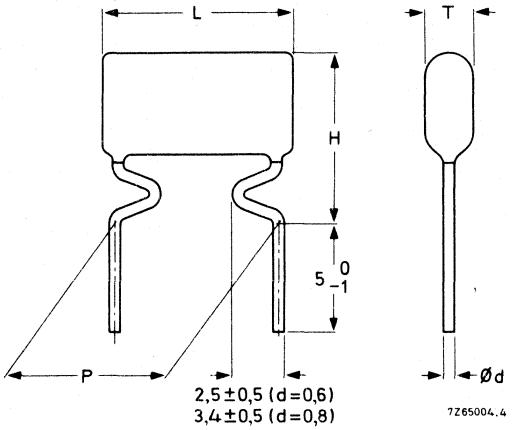


Fig. 1 For dimensions T, L, H, P and d, see tables below.

Table 1 U_R (d.c.) = 100 V; U_R (a.c.) = 50 V

capacitance* µF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 347	
							tol. ±10%	tol. ±20%
0,015	4,5	13,5	12	10,16 ± 0,3 (4e)**	0,6	0,4	21153	20153
0,022	5,5	13,5	13			0,6	21223	20223
0,033	6	13,5	13,5			0,7	21333	20333
0,047	7	13,5	14,5			0,9	21473	20473
0,068	6	19	14,5	15,24 ± 0,3 (6e)**	0,8	1,3	21683	20683
0,10	7	19	15,5			1,7	21104	20104
0,15	8	19	16,5			2,3	21154	20154
0,22	7	27	18,5	22,86 ± 0,3 (9e)**		3,2	21224	20224
0,33	8,5	27	20			4,4	21334	20334
0,47	10,5	27	22			6,0	21474	20474
0,68	11	32	22,5	27,94 ± 0,3 (11e)**		8,4	21684	20684
1,0	13,5	32	25			12,5	21105	20105

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

** e = 2,54 mm (0,1 in).

Table 2 U_R (d.c.) = 250 V; U_R (a.c.) = 80 V

capacitance* μF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 347	
							tol. ±10%	tol. ±20%
0,010	5	13,5	12,5	10,16 ± 0,3 (4e)**	0,6	0,5	41103	40103
0,015	5,5	13,5	13			0,6	41153	40153
0,022	6,5	13,5	14			0,8	41223	40223
0,033	5,5	19	14	15,24 ± 0,3 (6e)**		1,1	41333	40333
0,047	6,5	19	15			1,4	41473	40473
0,068	7,5	19	16			1,8	41683	40683
0,10	6,5	27	18	22,86 ± 0,3 (9e)**	0,8	2,7	41104	40104
0,15	8	27	19,5			3,5	41154	40154
0,22	9,5	27	21			4,5	41224	40224
0,33	10	32	21,5	27,94 ± 0,3 (11e)**		6,3	41334	40334
0,47	12	32	23,5			9,1	41474	40474
0,68	15	32	26,5			13,1	41684	40684

Table 3 U_R (d.c.) = 400 V; U_R (a.c.) = 125 V

capacitance* μF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 347	
							tol. ±10%	tol. ±20%
0,0047	4,5	13,5	12	10,16 ± 0,3 (4e)**	0,6	0,4	51472	50472
0,0068	5,5	13,5	13			0,5	51682	50682
0,010	6	13,5	13,5			0,7	51103	50103
0,015	7	13,5	14,5			0,9	51153	50153
0,022	6	19	14,5	15,24 ± 0,3 (6e)**		1,2	51223	50223
0,033	7	19	15,5			1,6	51333	50333
0,047	8	19	16,5			2,1	51473	50473
0,068	7	27	18,5	22,86 ± 0,3 (9e)**	0,8	2,9	51683	50683
0,10	8,5	27	20			3,8	51104	50104
0,15	10,5	27	22			5,2	51154	50154
0,22	11	32	22,5	27,94 ± 0,3 (11e)**		6,9	51224	50224
0,33	13,5	32	25			9,5	51334	50334

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

** e = 2,54 mm (0,1 in).

Table 4 U_R (d.c.) = 630 V; U_R (a.c.) = 200 V

capacitance* µF	T_{max}	L_{max}	H_{max}	P	d	mass g	catalogue number 2222 347	
							tol. ±10%	tol. ±20%
0,0010	5,5	13,5	13	10,16 ± 0,3 (4e)**	0,6	0,5	61102	60102
0,0015	5,5	13,5	13			0,6	61152	60152
0,0022	4,5	13,5	12			0,5	61222	60222
0,0033	5,5	13,5	13			0,6	61332	60332
0,0047	6	13,5	13,5			0,7	61472	60472
0,0068	7	13,5	14,5			0,9	61682	60682
0,010	6	19	14,5	15,24 ± 0,3 (6e)**	0,8	1,2	61103	60103
0,015	7	19	15,5			1,5	61153	60153
0,022	8	19	16,5			2,0	61223	60223
0,033	7	27	18,5	22,86 ± 0,3 (9e)**		2,8	61333	60333
0,047	8,5	27	20			3,4	61473	60473
0,068	10,5	27	22			4,4	61683	60683
0,10	11	32	22,5	27,94 ± 0,3 (11e)**		6,2	61104	60104
0,15	13,5	32	25			8,7	61154	60154

Marking

The capacitors are marked as follows:

1st line: rated capacitance and tolerance (± 10% indicated by 10 or K, ± 20% indicated by 20 or M);
2nd line: rated voltage, code for dielectric (KT = non-metallized PETP film), code for factory of origin.
The manufacturer's name is at the left of this marking.

Mounting

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

* Capacitance values of the E6 series as quoted are preferred; intermediate capacitance values of the E12 series are available to special order.

** e = 2,54 mm (0,1 in).

ELECTRICAL DATA

Unless otherwise specified all electrical values apply at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Capacitance

Rated capacitance values (C_R) at 1 kHz	see Tables 1 to 4
Tolerance on rated capacitance	± 10% and ± 20%

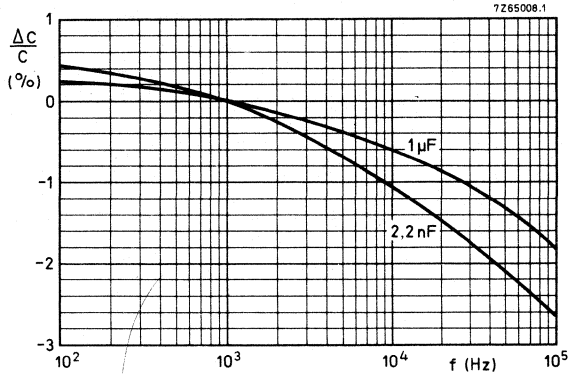


Fig. 2 Capacitance as a function of frequency; typical curves. Measuring voltage is 1 V for frequencies from 100 Hz to 10 kHz and 0,3 V for frequencies from 10 to 100 kHz.

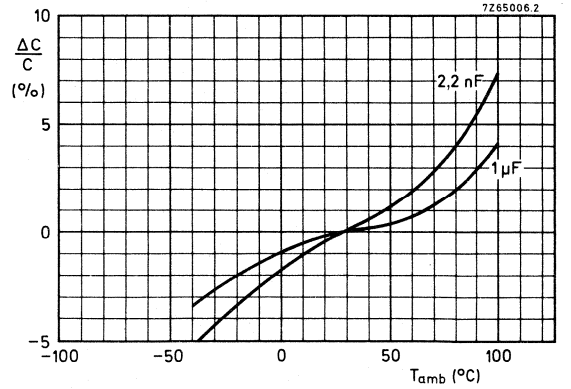


Fig. 3 Capacitance as a function of temperature; typical curves. Measuring frequencies from 1 to 100 kHz for capacitance values from 0,0022 to 0,1 μF and 1 to 10 kHz for capacitance values from 0,1 to 1 μF.

Voltage

Rated voltage U_R (d.c.)	100 V, 250 V, 400 V, 630 V
Rated voltage U_R (a.c.), 50 to 60 Hz*	
100 V version	50 V
250 V version	80 V
400 V version	125 V
630 V version	200 V
Category voltage U_C	0,8 x U_R
→ Test voltage for 1 min between terminals	2 x U_R (d.c.) (minimum 400 V)

Insulation resistance

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

	ambient temperature 23 °C	100 °C
R between terminations, for $C_R \leqslant 0{,}33\ \mu F$	> 50 000 MΩ	> 200 MΩ
RC between terminations, for $C_R > 0{,}33\ \mu F$	> 16 500 s	> 65 s

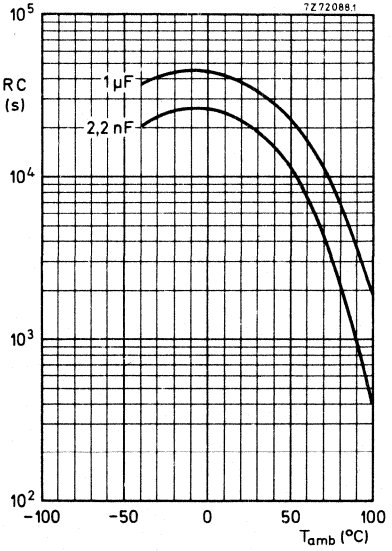


Fig. 4 RC-product as a function of temperature; typical curves.

* For higher frequencies see Additional information.

Tan δ (tangent of the loss angle)

Tan δ at 10 kHz	$\leqslant 110 \times 10^{-4}$ (typ. 85×10^{-4})
Tan δ at 1 kHz	$\leqslant 60 \times 10^{-4}$ (typ. 40×10^{-4})

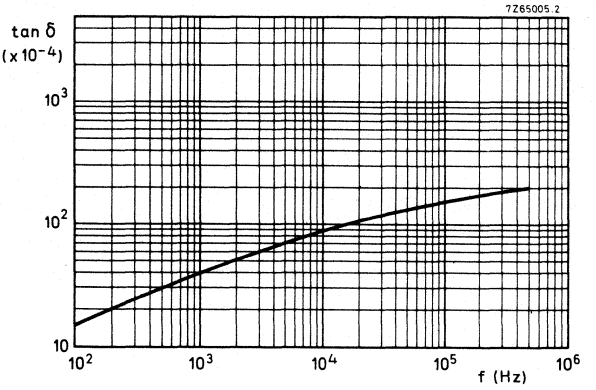


Fig. 5 Tan δ as a function of frequency; typical curve.

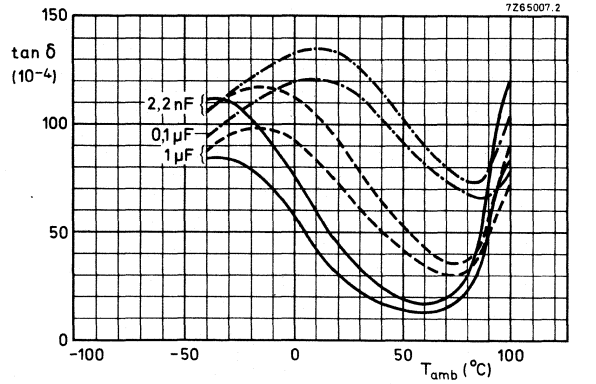


Fig. 6 Tan δ as a function of temperature; typical curves.

———— Measured at 1 V, 1 kHz;
– – – – – Measured at 1 V, 10 kHz;
–.–.–.– Measured at 0,3 V, 100 kHz.

Power dissipation

Maximum permissible power dissipation	see Additional information

Pulse steepness

	limited by network conditions, not by capacitor construction

Temperature

Rated temperature	85 °C
Category temperature range	−40 to +100 °C
Storage temperature range	−55 to +100 °C
Climatic category, IEC 68	40/100/21

PACKING

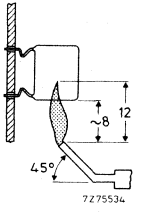
dimensions (mm) $T_{max} \times L_{max} \times H_{max}$	number of pieces per box
$\leqslant$ 5,5 x 13,5 x 13	2000 or 16000
$>$ 5,5 x 13,5 x 13 and $\leqslant$ 8 x 19 x 16,5	2000 or 8000
$>$ 8 x 19 x 16,5 and $\leqslant$ 8,5 x 27 x 20	1000 or 4000
$>$ 8,5 x 27 x 20 and $\leqslant$ 12 x 32 x 23,5	500 or 2000
$>$ 12 x 32 x 23,5	250 or 1000

TESTS AND REQUIREMENTS

IEC 68-2 test method	name of test	procedure (quick reference)	requirements
Ua1	Tensile strength of terminations	Loading force 10 N in axial direction of the wires, 10 s.	No damage.
		Loading force 5 N in radial direction of the wires, 10 s.	No damage.
Ub (method 1)	Bending of terminations	Loading force 5 N, two consecutive bends.	No damage.
Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. 235 °C, dwell time 2 s.	Good tinning.
Tb (method 1B)	Resistance to soldering heat	Solder bath: 350 °C, 3,5 s.	No damage; $\Delta C/C \leqslant 0{,}5\%$.
Na	Rapid change of temperature	5 cycles of ½ h at −40 °C and ½ h at +100 °C.	No damage; $\Delta C/C \leqslant 2\%$. Tan δ and insulation resistance shall meet initial requirements.

IEC 68-2 test method		name of test	procedure (quick reference)	requirements
Climatic sequence	Ba	Dry heat	16 h at +100 ± 2 °C, no voltage applied.	No damage, $\Delta C/C \leqslant 5\%$ at 100 °C. For capacitors $\leqslant 0{,}33\ \mu F$, insulation resistance $> 500\ M\Omega$ at 100 °C; for capacitors $> 0{,}33\ \mu F$, RC > 165 s at 100 °C.
	Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.	
	Aa	Cold	2 h at −40 ± 3 °C; no voltage applied.	$\Delta C/C \leqslant 7\%$ at −40 °C.
	M	Low air pressure	1 h at 25 ± 5 °C; at an atmospheric pressure of 85 mbar.	During and after the test there shall be no breakdown or flashover.
	Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied. Final measurement.	$\Delta C/C \leqslant 5\%$. Tan δ shall meet initial requirements. Insulation resistance > 0,5 x initial requirements.
	Ca	Damp heat, steady state	21 days at 40 °C and R.H. 90 to 95%; no voltage applied.	$\Delta C/C \leqslant 5\%$. Tan δ shall meet initial requirements. Insulation resistance > 0,5 x initial requirements.
	–	Endurance	1000 h at 85 °C, 1,5 x U_R (d.c.) applied. 1000 h at 85 °C, U_R (a.c.), 50 Hz applied. 1000 h at 100 °C, 1,5 x U_C applied.	No damage, no short circuit. $\Delta C/C \leqslant 5\%$; tan δ and insulation resistance shall meet initial requirements.

Additional tests

name of test	procedure (quick reference)	requirements
Solvent resistance	According to MIL-STD-202 E, method 215.	No damage.
Damp heat, long term exposure (IEC 68-2, test Ca)	21 days at 40 ± 2 °C, R.H. 90 to 95%; U_R (a.c.) applied for 16 h per 24 h.	No damage; $\Delta C/C \leqslant 5\%$. Tan δ shall not exceed initial requirements. Insulation resistance $\geqslant$ 50 % of initial requirements.
Flammability	 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.

Note: Standard atmospheric conditions for referee tests: ambient temperature 23 ± 1 °C, atmospheric pressure 86 to 106 kPa and R.H. 50 ± 2%.

ADDITIONAL INFORMATION

Power dissipation

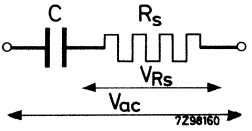
The rated a.c. voltage has been specified for 50 Hz and at 20 °C. This voltage value must also never be exceeded at other frequencies. This permissible a.c. voltage may further be limited by the following requirements:

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

Ad 1.

The power dissipated by a capacitor is a function of the voltage over 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 for these capacitors $\tan \delta = R_S \omega C$ = always < 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 $R_S C$ 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 temperature, can be found from Fig. 8. Thus, when the actual power has been calculated with formula (3b), Fig. 8 gives the minimum size of capacitor which can dissipate this power.

May be two or three capacitors having this size can be chosen, namely with different rated voltages.

Example of using Fig.7 and Fig.8

A capacitor with a value of 0,047 μF should be used at an a.c. voltage of 100 V, a frequency of 10 kHz and an ambient temperature of 60 °C. Thus the rated d.c. voltage should be at least 400 V.
The maximum R_sC-product is $1,35 \times 10^{-7}$ ΩF (from Fig.7), so that the power to be dissipated

$$P = (RsC)\, C\omega^2\, V_{ac}^2$$

$$= 1,35 \times 10^{-7} \times 0,047 \times 10^{-6} \times 4\pi^2 \times 10^8 \times 10^4 = 250 \text{ mW}$$

Fig. 8 shows that at 60 °C capacitors with curve numbers 9 to 23 can be used, thus a minimum size of 6,5 x 19 x 15 mm. It can be seen from table 3 a 400 V capacitor can be used.

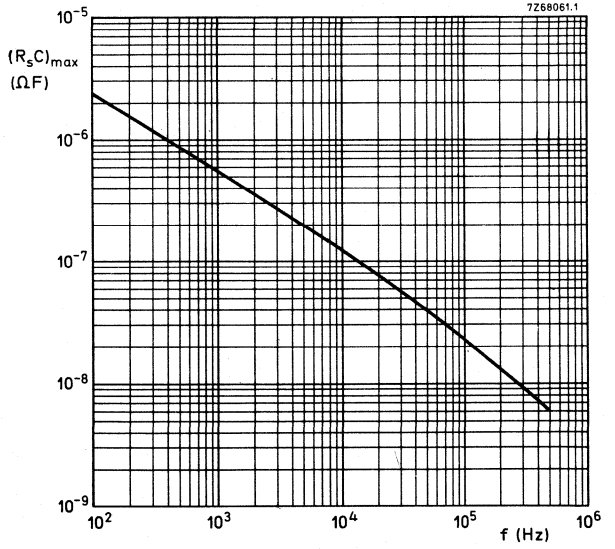


Fig. 7. Maximum product of series resistance and capacitance as a function of frequency.

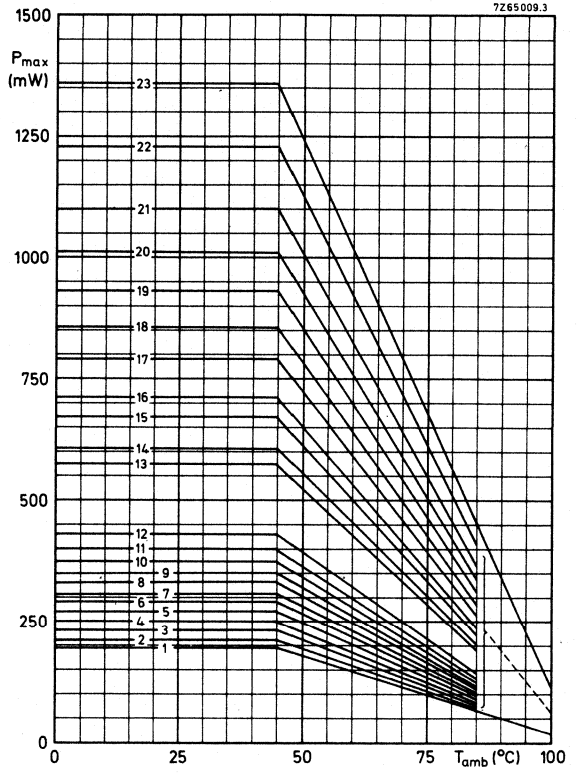


Fig. 8. Maximum permissible power dissipation as a function of temperature.

curve	dimensions in mm		
	T_{max}	L_{max}	H_{max}
1	4,5	13,5	12
2	5	13,5	12,5
3	5,5	13,5	13
4	6	13,5	13,5
5	6,5	13,5	14
6	7	13,5	14,5
7	5,5	19	14
8	6	19	14,5
9	6,5	19	15
10	7	19	15,5
11	7,5	19	16

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

METALLIZED POLYESTER FILM CAPACITORS

lacquered type (MKT)

QUICK REFERENCE DATA

Rated capacitance range (E12-series)	1 nF to 6,8 μF
Tolerance on rated capacitance	± 10% and ± 20%
Rated voltage U_R (d.c.)	100 V, 250 V, 400 V, 630 V
Rated voltage U_R (a.c.), 50 to 60 Hz	63 V, 160 V, 220 V, 220 V
Rated temperature	85 °C
Climatic category, IEC 68	40/100/21
Basic specification	IEC 384-2, grade 2

APPLICATION

For general purpose and industrial use in electronic equipment, e.g. for coupling and decoupling applications.

DESCRIPTION

The capacitors consist of a low-inductive wound cell of metallized polyethyleneterephthalate (PETP) film. The cell is protected by a hard, water repellent lacquer. The radial leads are solder coated copper wire and are crimped to provide optimum soldering conditions. The capacitors are available with short or long leads.

Composition of the catalogue number

2222 352 . . . . .

code for rated voltage, capacitance tolerance and lead length — code for capacitance, see Tables 1 to 4

24 = 100 V; ± 20%	long leads	27 = 100 V; ± 20%	short leads (l = 5 – 1 mm)
25 = 100 V; ± 10%		28 = 100 V; ± 10%	
44 = 250 V; ± 20%		47 = 250 V; ± 20%	
45 = 250 V; ± 10%		48 = 250 V; ± 10%	
54 = 400 V; ± 20%		57 = 400 V; ± 20%	
55 = 400 V; ± 10%		58 = 400 V; ± 10%	
64 = 630 V; ± 20%		67 = 630 V; ± 20%	
65 = 630 V; ± 10%		68 = 630 V; ± 10%	

For ordering purposes please quote the 12-digit catalogue number.

MECHANICAL DATA

Dimensions in mm

Fig. 1 For dimensions T, L, H, P, d and l, see tables below.

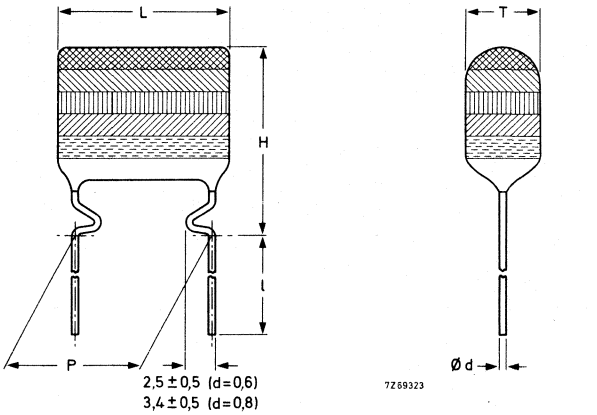


Table 1 U_R (d.c.) = 100 V; U_R (a.c.) = 63 V
The capacitors mentioned in this table are also available with lead length l = 5 – 1 mm.

rated capacitance µF	T_{max}	L_{max}	H_{max}	P	d	l_{min}	mass g	capacitance code
0,047	4,5	12,5	12,5	10,16 ± 0,3 (4e) *	0,6	13	0,6	473
0,056	4,5		12,5				0,6	563
0,068	4,5		12,5				0,6	683
0,082	4,5		12,5				0,6	823
0,10	4,5		12,5				0,6	104
0,12	4,5		12,5				0,6	124
0,15	5		13				0,6	154
0,18	5,5		13,5				0,6	184
0,22	6		14				0,7	224
0,27	6,5		14,5				0,8	274
0,33	5,5	17,5	14,5	15,24 ± 0,3 (6e) *	0,8		1,0	334
0,39	6		15				1,1	394
0,47	6,5		15,5				1,2	474
0,56	7		16				1,3	564
0,68	6	22,5	15	20,32 ± 0,3 (8e) *		21	1,5	684
0,82	6,5		15,5				1,7	824
1,0	7		16				2,0	105
1,2	7,5		16,5				2,3	125
1,5	8,5		17,5				2,6	155
1,8	9,5		18,5				3,1	185
2,2	8,5	30	17,5	27,94 ± 0,3 (11e) *		19	3,4	225
2,7	9,5		18,5				4,0	275
3,3	9		21				4,6	335
3,9	10		22				5,3	395
4,7	11,5		23,5				6,0	475
5,6	12,5		24,5				6,9	565
6,8	14		26				8,0	685

* e = 2,54 mm (0,1 in).

Table 2 U_R (d.c.) = 250 V; U_R (a.c.) = 160 V

The capacitors mentioned in this table are also available with lead length l = 5 – 1 mm.

rated capacitance µF	T_{max}	L_{max}	H_{max}	P	d	l_{min}	mass g	capacitance code
0,0010	4,5		12,5				0,5	102
0,0012	4,5		12,5				0,5	122
0,0015	4,5		12,5				0,5	152
0,0018	4,5		12,5				0,5	182
0,0022	4,5		12,5				0,5	222
0,0027	4,5		12,5				0,5	272
0,0033	4,5		12,5				0,5	332
0,0039	4,5		12,5				0,5	392
0,0047	4,5		12,5				0,5	472
0,0056	4,5		12,5				0,5	562
0,0068	4,5		12,5				0,5	682
0,0082	4,5		12,5				0,5	822
0,010	4	12,5	12	10,16 ± 0,3 (4e) *	0,6		0,5	103
0,012	4		12				0,5	123
0,015	4		12			13	0,5	153
0,018	4		12				0,5	183
0,022	4		12				0,5	223
0,027	4		12				0,5	273
0,033	4		12				0,5	333
0,039	4		12				0,5	393
0,047	4		12				0,5	473
0,056	4,5		12,5				0,5	563
0,068	4,5		12,5				0,6	683
0,082	4,5		12,5				0,6	823
0,10	5		13				0,7	104
0,12	5,5	17,5	14,5	15,24 ± 0,3 (6e) *	0,8		0,9	124
0,15	6		15				1,0	154
0,18	6,5		15,5				1,1	184
0,22	7		16				1,3	224
0,27	6	22,5	15	20,32 ± 0,3 (8e) *		21	1,4	274
0,33	6,5		15,5				1,6	334
0,39	7		16				1,8	394
0,47	7,5		16,5				2,1	474
0,56	8		17				2,4	564
0,68	9		18				2,8	684
0,82	8	30	17	27,94 ± 0,3 (11e) *		19	3,1	824
1,0	9		18				3,6	105
1,2	8,5		20,5				4,2	125
1,5	9,5		21,5				5,0	155
1,8	10,5		22,5				5,7	185
2,2	11,5		23,5				6,5	225

* e = 2,54 mm (0,1 in).

Table 3 U_R (d.c.) = 400 V; U_R (a.c.) = 220 V

The capacitors mentioned in this table are also available with lead length l = 5 – 1 mm.

rated capacitance µF	T_{max}	L_{max}	H_{max}	P	d	l_{min}	mass g	capacitance code
0,010	4,5	12,5	12,5	10,16 ± 0,3 (4e) *	0,6	13	0,5	103
0,012	4,5		12,5				0,5	123
0,015	4,5		12,5				0,5	153
0,018	4,5		12,5				0,5	183
0,022	4,5		12,5				0,5	223
0,027	5		13				0,5	273
0,033	5,5		13,5				0,6	333
0,039	6		14				0,6	393
0,047	6,5		14,5				0,7	473
0,056	5,5	17,5	14,5	15,24 ± 0,3 (6e) *	0,8		0,9	563
0,068	6		15				1,0	683
0,082	6,5		15,5				1,1	823
0,10	7		16				1,3	104
0,12	6	22,5	15	20,32 ± 0,3 (8e) *		21	1,4	124
0,15	6,5		15,5				1,6	154
0,18	7		16				1,9	184
0,22	7,5		16,5				2,2	224
0,27	8,5		17,5				2,5	274
0,33	9,5		18,5				2,9	334
0,39	8,5	30	17,5	27,94 ± 0,3 (11e) *		19	3,2	394
0,47	9,5		18,5				3,7	474
0,56	9		21				4,3	564
0,68	10		22				5,0	684
0,82	11		23				5,7	824
1,0	12		24				6,5	105

* e = 2,54 mm (0,1 in).

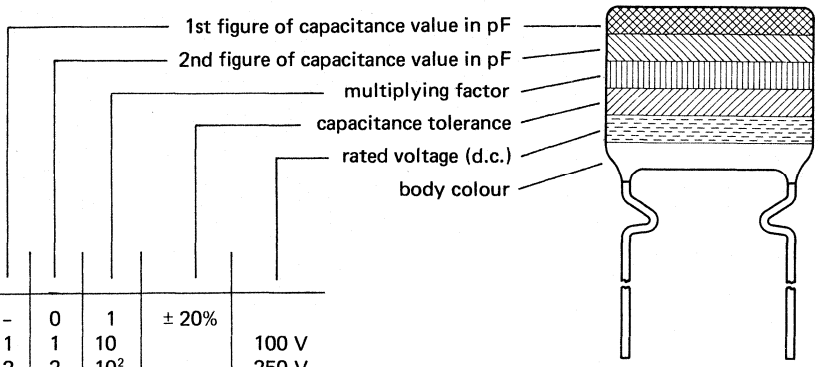
Table 4 U_R (d.c.) = 630 V; U_R (a.c.) = 220 V

The capacitors mentioned in this table are also available with lead length l = 5 – 1 mm.

rated capacitance µF	T_{max}	L_{max}	H_{max}	P	d	l_{min}	mass g	capacitance code
0,010	4,5	12,5	12,5	10,16 ± 0,3 (4e) *	0,6	13	0,5	103
0,012	5		13				0,5	123
0,015	5,5		13,5				0,6	153
0,018	6		14				0,6	183
0,022	6,5		14,5				0,7	223
0,027	5,5	17,5	14,5	15,24 ± 0,3 (6e) *	0,8		0,9	273
0,033	6		15				1,0	333
0,039	6,5		15,5				1,1	393
0,047	7		16				1,3	473
0,056	6	22,5	15	20,32 ± 0,3 (8e) *		21	1,4	563
0,068	6,5		15,5				1,6	683
0,082	7		16				1,9	823
0,10	7,5		16,5				2,2	104
0,12	8,5		17,5				2,5	124
0,15	9,5		18,5				2,9	154
0,18	8,5	30	17,5	27,94 ± 0,3 (11e) *		19	3,2	184
0,22	9,5		18,5				3,7	224
0,27	9		21				4,3	274
0,33	10		22				5,0	334
0,39	11		23				5,7	394
0,47	12		24				6,5	474

* e = 2,54 mm (0,1 in).

Marking



colour					
black	–	0	1	± 20%	
brown	1	1	10		100 V
red	2	2	10^2		250 V
orange	3	3	10^3		
yellow	4	4	10^4		400 V
green	5	5	10^5		
blue	6	6			630 V
violet	7	7			
grey	8	8			
white	9	9		± 10%	

Mounting

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

ELECTRICAL DATA

Unless otherwise specified all electrical values apply at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Capacitance

Rated capacitance values (C_R) at 1 kHz	see Tables 1 to 4
Tolerance on rated capacitance	± 10% and ± 20%

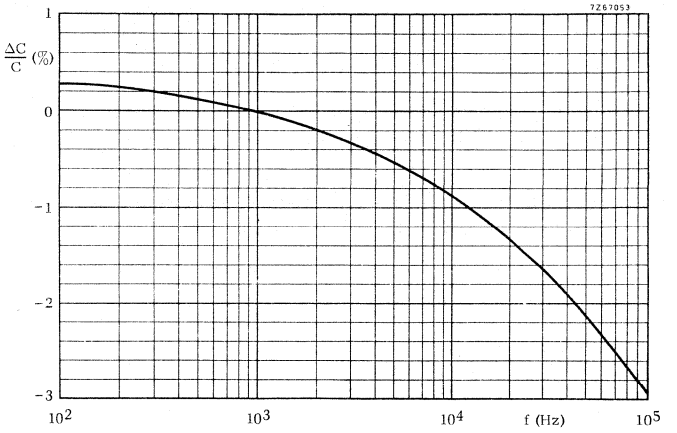


Fig. 2 Capacitance as a function of frequency; typical curve.

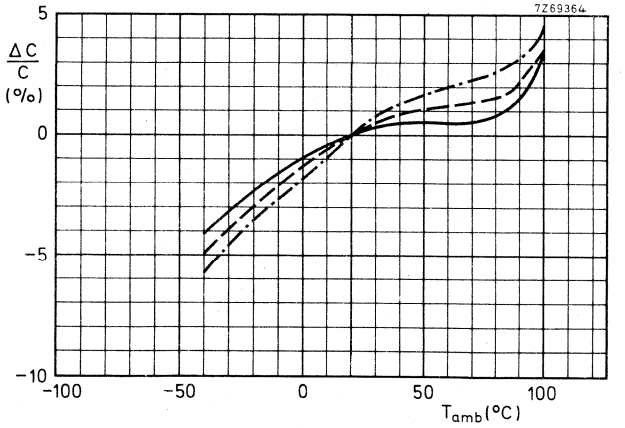


Fig. 3 Capacitance as a function of temperature; typical curves.

——— For all capacitance values, measured at 1 kHz, 1 V;

– – – For capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V;

–.–.– For capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Voltage

Rated voltage U_R (d.c.)	100 V, 250 V, 400 V, 630 V
Rated voltage U_R (a.c.), 50 to 60 Hz	
100 V version	63 V
250 V version	160 V
400 V version	220 V
630 V version	220 V
Category voltage U_C	0,8 x U_R (d.c.)
Test voltage for 1 min	
between terminals	1,6 x U_R (d.c.)
between interconnected terminals and coating	2 x U_R (d.c.) (minimum 200 V)

Note
The sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be $\leqslant U_R$ (d.c.).

Insulation resistance

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

	ambient temperature 23 °C	100 °C
R between terminations for $C_R \leqslant 0{,}33\ \mu F$		
100 V version	> 15 000 MΩ	> 50 MΩ
250 V, 400 V, 630 V versions	> 30 000 MΩ	> 100 MΩ
RC between terminations for $C_R > 0{,}33\ \mu F$		
100 V version	> 5 000 s	> 16 s
250 V, 400 V, 630 V versions	> 10 000 s	> 33 s

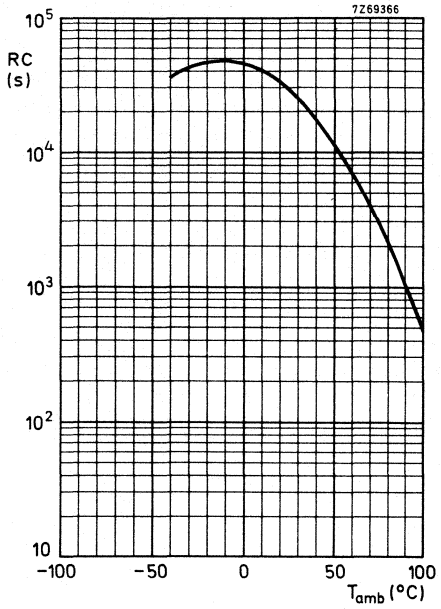


Fig. 4 RC-product as a function of temperature; typical curve.

Tan δ (tangent of the loss angle)

Tan δ at 10 kHz $\leqslant 150 \times 10^{-4}$ (typ. 90×10^{-4})

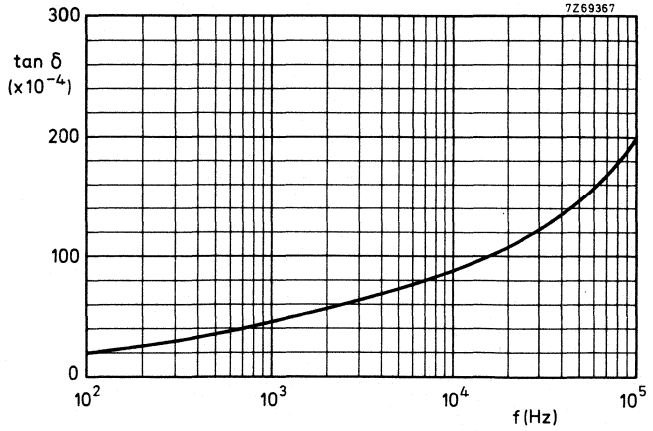


Fig. 5 Tan δ as a function of frequency; typical curve.

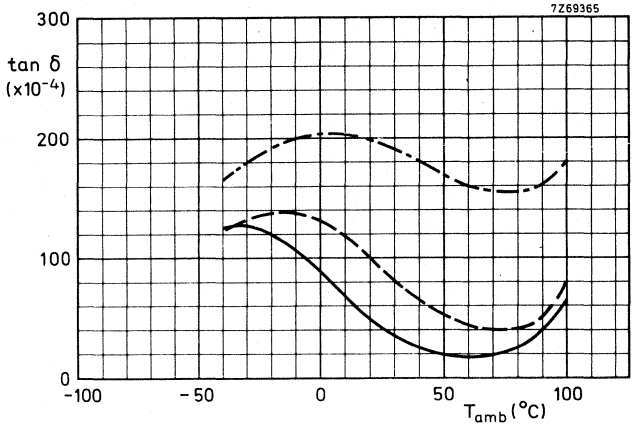


Fig. 6 Tan δ as a function of temperature; typical curves.
——— For all capacitance values, measured at 1 kHz, 1 V;
– – – For capacitance values ⩽ 1 μF, measured at 10 kHz, 1 V;
–.–.– For capacitance values ⩽ 0,1 μF, measured at 100 kHz, 0,3 V.

Power dissipation

Maximum permissible power dissipation — see Additional information

Notes

In applications where voltages higher than 50 V are applied, it is recommended that the power in the capacitor is 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 steepness is not exceeded.

→ **Pulse steepness**

rated voltage V	maximum pulse steepness (V/μs)			
	L = 12,5 mm	L = 17,5 mm	L = 22,5 mm	L = 30 mm
100	9	5,6	4	3
250	25	14	10	7,5
400	40	22	16	12
630	70	37	26	19

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

Temperature

Rated temperature	85 °C
Category temperature range	−40 to + 100 °C
Storage temperature range	−40 to + 100 °C
Climatic category, IEC 68	40/100/21

PACKING

500 pieces per box, for capacitors with $L_{max} = 30$ mm
1000 pieces per box, for capacitors with $L_{max} < 30$ mm

TESTS AND REQUIREMENTS

IEC 384–2 clause	IEC 68–2 test method	name of test	procedure (quick reference)	requirements
17	Ua1	Tensile strength of terminations	Loading force 10 N in axial direction of the wires, 10 s.	No damage.
			Loading force 3,5 N (d = 0,6 mm) or 5 N (d = 0,8 mm) in radial direction of the wires, 10 s.	No damage.
	Ub (method 1)	Bending of terminations	Loading force 3,5 N (d = 0,6 mm) or 5 N (d = 0,8 mm), two consecutive bends.	No damage.
18	Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. 235 °C, dwell time 2 s.	Good tinning.
	Tb (method 1B)	Resistance to soldering heat	Solder bath: 350 °C, 3,5 s.	No damage; $\Delta C/C \leqslant 1\%$.
19	Na	Rapid change of temperature	5 cycles of ½ h at −40 °C and ½ h at + 100 °C.	No damage, no leakage, $\Delta C/C \leqslant 2\%$. Tan δ and insulation resistance shall meet initial requirements.

IEC 384–2 clause	IEC 68–2 test method		name of test	procedure (quick reference)	requirements	
22.2	Climatic sequence	Ba	Dry heat	16 h at + 100 ± 2 °C, no voltage applied.	No damage, no leakage; $\Delta C/C \leqslant 7\%$ at 100 °C. Insulation resistance at 100 °C, for $C_R \leqslant 0{,}33\ \mu F$: $> 50\ M\Omega$ (100 V version), $> 100\ M\Omega$ (250 V, 400 V, 630 V versions); for $C_R > 0{,}33\ \mu F$: > 16 s (100 V version), > 33 s (250 V, 400 V, 630 V version).	
22.3		Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.		
22.4		Aa	Cold	2 h at −40 ± 3 °C; no voltage applied.	$\Delta C/C \leqslant -7\%$ at −40 °C.	
22.5		M	Low air pressure	1 h at 25 ± 5 °C, at atmospheric pressure of 85 mbar.	During and after the test there shall be no breakdown or flashover.	
22.6		Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.		
				Final measurement.	$\Delta C/C \leqslant 5\%$. Tan δ shall meet initial requirements. Insulation resistance $\geqslant 0{,}5$ x initial requirements.	
23		Ca	Damp heat, steady state	21 days at 40 ± 2 °C, R.H. 90 to 95%; 6 V continuously applied.	$\Delta C/C \leqslant 5\%$. Tan δ shall meet initial requirements. Insulation resistance $\geqslant 0{,}5$ x initial requirements.	
24			Endurance	1000 h at 85 °C, 1,5 x U_R (d.c.) applied.	$\Delta C/C \leqslant$ 5%.	Tan δ and insulation resistance shall meet initial requirements.
				1000 h at 100 °C, 1,2 x U_R (d.c.) applied.	$\Delta C/C \leqslant$ 5%.	
				1000 h at 85 °C, U_R (a.c.), 50 Hz applied.	$\Delta C/C \leqslant 15\%$ (L = 12,5 mm) $\Delta C/C \leqslant 10\%$ (L = 17,5 mm) $\Delta C/C \leqslant$ 7% (L = 22,5 mm) $\Delta C/C \leqslant$ 5% (L = 30 mm)	

Additional tests

name of test	procedure (quick reference)	requirements
Storage	1000 h at 100 °C.	$\Delta C/C \leqslant 3\%$. Tan δ and insulation resistance shall meet initial requirements.
Damp heat, long-term exposure	21 days at 40 ± 2 °C and R.H. 90 to 95%, U_R (a.c.) applied for 16 h per 24 h.	No damage.
Charge and discharge	10 000 cycles of charge to U_R (d.c.) and discharge via a resistor of value such that the pulse steepness is 1,5 x initial requirement. Cycle time: 1 to 150 cycles/s, temperature: 25 °C.	$\Delta \tan \delta \leqslant 20 \times 10^{-4}$ at 10 kHz.

Note

Standard atmospheric conditions for referee tests: ambient temperature 23 ± 1 °C, atmospheric pressure 86 to 106 kPa and 50 ± 2%.

ADDITIONAL INFORMATION

Power dissipation

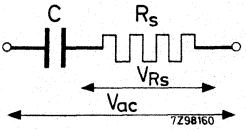
The rated a.c. voltage has been specified for 50 to 60 Hz and at 20 °C. This voltage value must also never be exceeded at other frequencies. This permissible a.c. voltage may further be limited by the following requirements:

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

Ad 1.

The power dissipated by a capacitor is a function of the voltage over 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 for these capacitors $\tan\delta = R_S\omega C$ = always < 0,1, the formula (2a) can be simplified to

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

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

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

The term $R_S C$ 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 temperature, can be found from Fig. 8. Thus, when the actual power has been calculated with formula (3b), Fig. 8 gives the minimum size of capacitor which can dissipate this power.

May be two or three capacitors having this size can be chosen, namely with different rated voltages.

Example of using Fig. 7 and Fig. 8

A capacitor of 0,68 μF should be used at an a.c. voltage of 130 V, a frequency of 1 kHz and an ambient temperature of 50 °C.
The R_sC-product is $7,1 \times 10^{-7}$ ΩF (from Fig. 7), so that the power to be dissipated is

$$P = (R_sC)\, C\omega^2\, V_{ac}^2$$

$$= 7,1 \times 10^{-7} \times 0,68 \times 10^{-6} \times 4\pi^2 \times 1000^2 \times 130^2 = 322 \text{ mW}$$

Fig. 8 shows that at 50 °C capacitors with curve numbers 8 to 31 can be used, thus a minimum size of 6,5 x 17,5 x 15,5 mm. It can be seen from the tables that a 0,68 μF/250 V or 0,68 μF/400 V capacitor can be chosen.

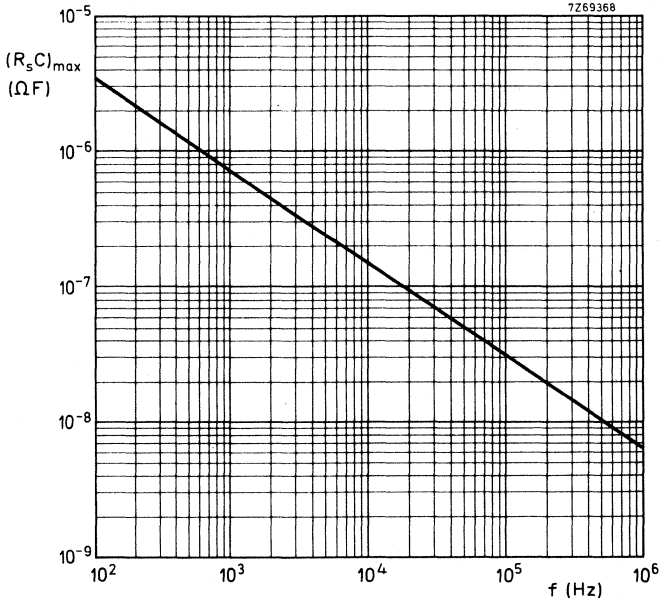
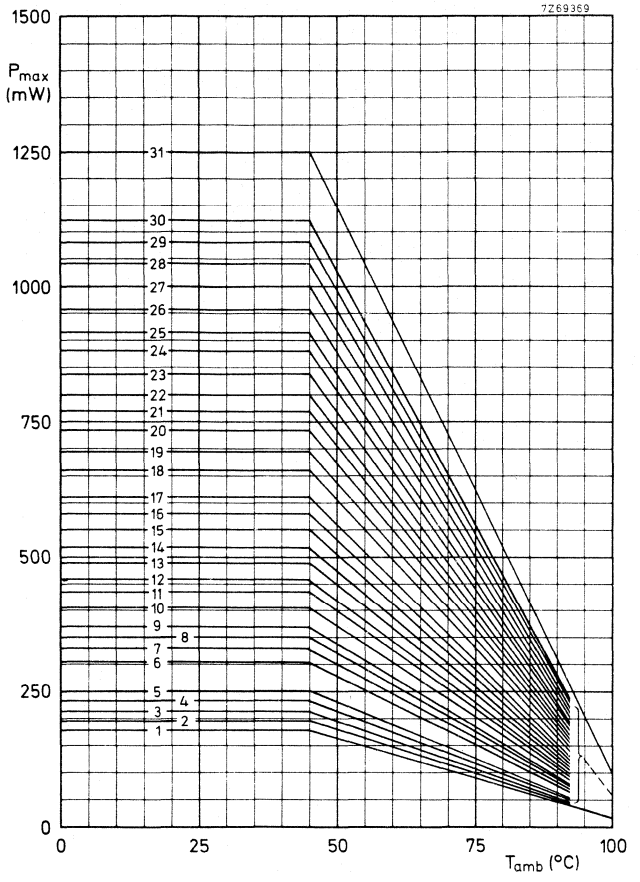


Fig. 7 Maximum product of series resistance and capacitance as a function frequency



curve	dimensions (mm)		
	T_{max}	L_{max}	H_{max}
1	4,5	12,5	12,5
2	5	12,5	13
3	5,5	12,5	13,5
4	6	12,5	14
5	6,5	12,5	14,5
6	5,5	17,5	14,5
7	6	17,5	15
8	6,5	17,5	15,5
9	7	17,5	16
10	6	22,5	15
11	6,5	22,5	15,5
12	7	22,5	16
13	7,5	22,5	16,5
14	8	22,5	17
15	8,5	22,5	17,5
16	9	22,5	18
17	9,5	22,5	18.5
18	8	30	17
19	8,5	30	17,5
20	9	30	18
21	9,5	30	18,5
22	8,5	30	20,5
23	9	30	21
24	9,5	30	21,5
25	10	30	22
26	10,5	30	22,5
27	11	30	23
28	11,5	30	23,5
29	12	30	24
30	12,5	30	24,5
31	14	30	26

Fig. 8 Maximum permissible power dissipation as a function of temperature

POLYPROPYLENE FILM/FOIL CAPACITORS

potted type (KP)

QUICK REFERENCE DATA

Rated capacitance range (E12 series)	0,039 to 0,82 μF
Tolerance on rated capacitance	± 5% and ± 10%
Rated voltage U_R (d.c.)	250 V
Rated voltage U_R (a.c.), 50 to 60 Hz	160 V
Rated temperature	85 °C
Climatic category, IEC 68	40/085/56

APPLICATION

These capacitors are intended for applications where high currents and steep pulses occur. They are mainly used for deflection circuits in television receivers, to operate at high peak currents at line frequency.

When requiring advice, please send oscillograms of current and voltage waveforms.

DESCRIPTION

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

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

MECHANICAL DATA

Dimensions in mm

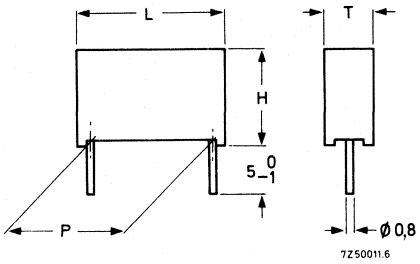


Fig. 1 For dimensions T, L, H and P, see Table 1.

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

rated capacitance µF	T_{max}	L_{max}	H_{max}	P	mass g	catalogue number 2222 357 . . . . . tol. ± 5%	tol. ± 10%
0,039	8	21,5	15	15 ± 0,4	3	52393	51393
0,047	8	21,5	15		3	52473	51473
0,056	8	21,5	15		3	52563	51563
0,068	10	21,5	17		4,5	52683	51683
0,082	10	21,5	17		4,5	52823	51823
0,10	8,5	29	18,5	22,5 ± 0,4	5,5	52104	51104
0,12	8,5	29	18,5		5,5	52124	51124
0,15	8,5	29	18,5		5,5	52154	51154
0,18	10	29	20		7,5	52184	51184
0,22	10	34	20	27,5 ± 0,4	8,5	52224	51224
0,27	10	34	20		8,5	52274	51274
0,33	12	34	22		11	52334	51334
0,39	12	34	22		11	52394	51394
0,47	15	34	25		16	52474	51474
0,56	15	34	25		16	52564	51564
0,68	18	34	28		22	52684	51684
0,82	18	34	28		22	52824	51824

Marking

The capacitors are marked on the top face by embossed print, with:

- rated capacitance in µF, tolerance and rated d.c. voltage, without unit symbols;
- code for dielectric materials (KP), 5th, 6th and 7th digits of the catalogue number, code for factory of origin and production date code (according to IEC 62, clause 5);
- manufacturer's identification symbol.

Mounting

The capacitors are suited for mounting on printed-wiring boards. When a number of capacitors are connected to form a capacitor bank, their mounting proximity should allow a free circulation of ait.

ELECTRICAL DATA

Unless otherwise specified all electrical values apply at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Capacitance

Rated capacitance values (C_R) at 1 kHz	see Table 1
Tolerance on rated capacitance	± 5% or ± 10%
Temperature coefficient at T_{amb} = 20 °C	typ. −550 ± 50 ppm/°C

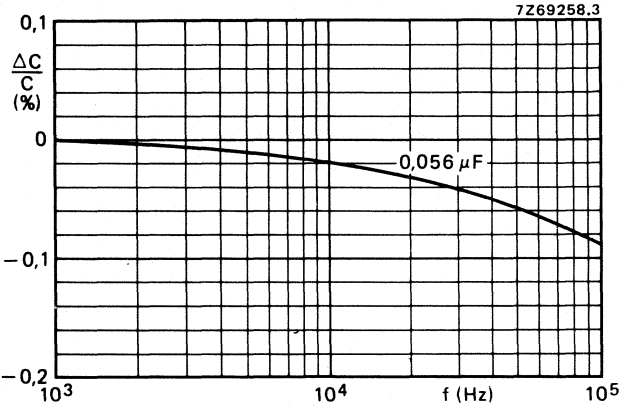


Fig. 2 Capacitance as a function of frequency; typical curve. Measuring voltage is 0,3 V.

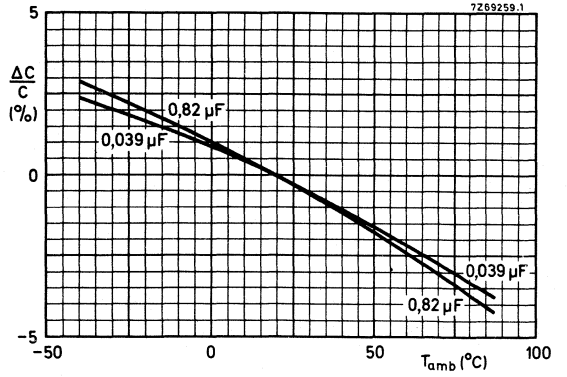


Fig. 3 Capacitance as a function of temperature; typical curves. Measuring voltage is 0,3 V, measuring frequency is 10 kHz.

Voltage

Rated voltage U_R (d.c.)	250 V
Rated voltage U_R (a.c.), 50 to 60 Hz	160 V
Test voltage for 1 min	
between terminals	2 x U_R (d.c.)
between interconnected terminals and case	1000 V (d.c.)

Note
The following two requirements must be satisfied:
the peak value of the a.c. voltage must be ⩽ rated a.c. voltage x $\sqrt{2}$;
the sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be ⩽ rated d.c. voltage

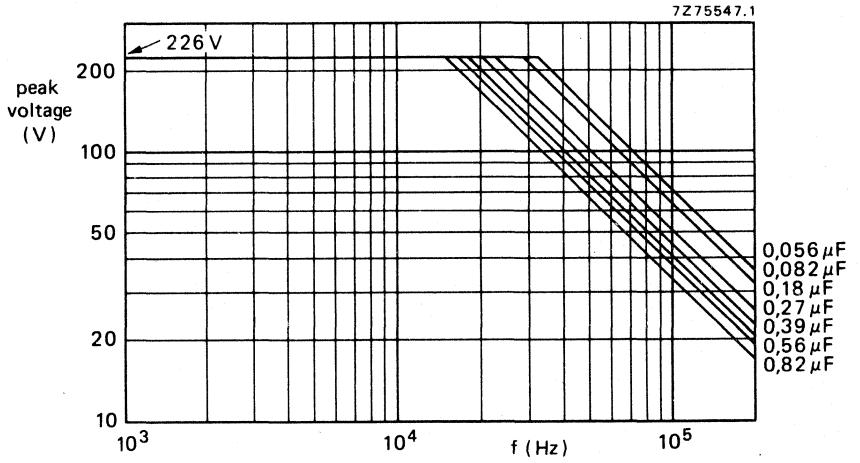


Fig. 4 Maximum permissible peak value of sinusoidal voltages as a function of frequency at $T_{amb} \leqslant 45$ °C.

Insulation resistance

The insulation resistance is measured after a voltage of 100 ± 15 V has been applied for 1 min ± 5 s.

	ambient temperature 23 °C	85 °C
R between terminations, for $C_R \leqslant 0{,}1$ µF	> 50 000 MΩ	> 500 MΩ
RC between terminations, for $C_R > 0{,}1$ µF	> 5 000 s	> 50 s

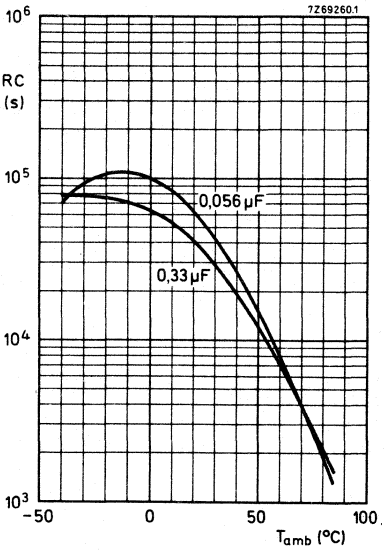


Fig. 5 RC-product as a function of temperature; typical curves.

Tan δ (tangent of the loss angle)

Tan δ at 100 kHz

for capacitors with pitch P = 15 or 22,5 mm	$\leqslant 10 \times 10^{-4}$
for capacitors with pitch P = 27,5 mm	
$C_R \leqslant 0{,}33\ \mu F$	$\leqslant 15 \times 10^{-4}$
$0{,}33\ \mu F < C_R \leqslant 0{,}47\ \mu F$	$\leqslant 20 \times 10^{-4}$
$C_R > 0{,}47\ \mu F$	$\leqslant 25 \times 10^{-4}$

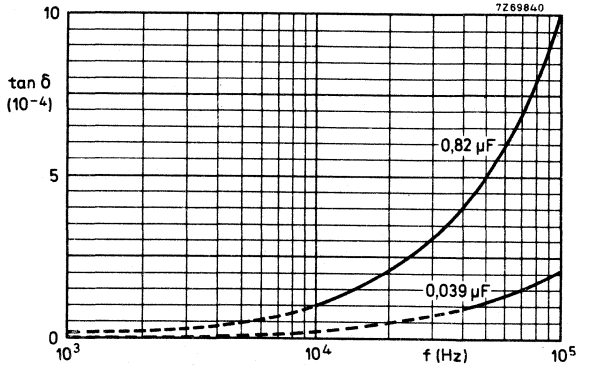


Fig. 6 Tan δ as a function of frequency; typical curves.

Temperature dependence at 100 Hz, 1 kHz, 10 kHz and 100 kHz — none

Power dissipation	
Maximum permissible power dissipation	see Additional information
Pulse steepness	limited by network conditions not by capacitor construction
Temperature	
Rated temperature	85 °C
Category temperature range	−40 to + 85 °C
Storage temperature range	−55 to + 85 °C
Climatic category, IEC 68	40/085/56

PACKING

The capacitors are packed in cardboard boxes. The number per box is 1000 for capacitors with L_{max} = 21,5 mm or 29 mm, and 500 for capacitors with L_{max} = 34 mm.

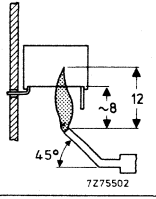
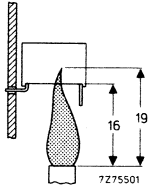
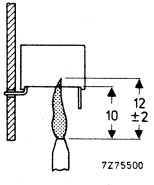
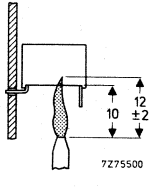
TESTS AND REQUIREMENTS

IEC 68–2 test method	name of test	procedure (quick reference)	requirements
Ua1	Tensile strength of terminations	Loading force 10 N in axial direction of the wires, 10 s.	No damage.
		Loading force 5 N in radial direction of the wires, 10 s.	
Ub (method 1)	Bending of terminations	Loading force 5 N, two consecutive bends.	No damage.
Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. 235 °C, dwell time 2 s.	Good tinning.
Tb (method 1B)	Resistance to soldering heat	Solder bath: 350 °C, 3,5 s.	No damage; $\Delta C/C \leqslant 1\%$.
Na	Rapid change of temperature	5 cycles of ½ h at −40 °C and ½ h at + 85 °C.	No damage, no leakage, $\Delta C/C \leqslant 2\%$. Tan δ and insulation resistance shall meet initial requirements.
Fc	Vibration	10 to 55 Hz, 0,75 mm or 10g (whichever is less), 3 directions, 2 h per direction.	No damage, no open or short-circuit; $\Delta C/C \leqslant 0{,}5\%$.
Eb	Bumping	40g, 4000 bumps.	No damage, no open or short-circuit; $\Delta C/C \leqslant 0{,}5\%$.

IEC 68–2 test method		name of test	procedure (quick reference)	requirements
Climatic sequence	Ba	Dry heat	16 h at + 85 ± 2 °C, no voltage applied.	No damage, no leakage, $\Delta C/C \leqslant 5\%$ at 85 °C. Insulation resistance shall meet initial requirements.
	Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.	
	Aa	Cold	2 h at −40 ± 3 °C; no voltage applied.	$\Delta C/C \leqslant 5\%$ at −40 °C.
	M	Low air pressure	1 h at 25 ± 5 °C, at atmospheric pressure of 85 mbar. During the last 5 min. of the test U_R (d.c.) shall be applied.	During and after the test there shall be no breakdown or flashover.
	Db	Damp heat, cyclic	5 cycles of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied. Within 15 min. after the test U_R (d.c.) has to be applied for 1 min.	
			Final measurement.	$\Delta C/C \leqslant 1\%$. Tan δ shall meet initial requirements. Insulation resistance $\geqslant$ 0,5 x initial requirements.
Ca		Damp heat, steady state	56 days at 40 ± 2 °C, R.H. 90 to 95%; no voltage applied. Within 15 min. after the test U_R (d.c.) has to be applied for 1 min.	No damage, $\Delta C/C \leqslant 2\%$. Tan δ shall meet initial requirements. Insulation resistance $\geqslant$ 0,5 x initial requirements.
–		Endurance	1000 h at 85 °C, 1,5 x U_R (d.c.) applied.	$\Delta C/C \leqslant 1\%$. Tan δ shall meet initial requirements; insulation resistance $\geqslant$ 0,5 x initial requirements.
			1000 h at 85 °C, 1,5 x U_R (a.c.) 50 Hz applied	
			1000 h at 25 °C, 20 kHz voltage of 1,25 x max. permissible voltage (Fig. 4) applied.	

name of test	procedure (quick reference)	requirements
Additional tests		
Solvent resistance	MIL-STD-202E, method 215.	No damage.
Damp heat, long term exposure	56 days at 40 ± 2 °C, R.H. 90 to 95%; U_R (a.c.) applied for 16 h per 24 h.	$\Delta C/C \leqslant 2\%$. Tan δ shall meet initial requirements. Insulation resistance $\geqslant$ 0,5 x initial requirements.
Discharge	10 000 cycles of charge to U_R (d.c.) via a resistor (RC $\leqslant$ 0,5 s) and discharge via a resistor of max. 10 mΩ at 25 °C. Cycle time: approx. 1 cycle/2 s.	$\Delta \tan \delta \leqslant 2 \times 10^{-4}$ at 10 kHz.

For flammability tests see next page.

name of test	procedure (quick reference)	requirements
Flammability	 Bore of gas jet: ϕ 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.
	 Test according to UL1414 Bore of gas jet: ϕ 10 mm. Fuel: natural gas. Test duration: 3 x 15 s. Time interval between each application: 15 s.	Extinguishing time $\leqslant$ 15 s after the first and second flame application, $\leqslant$ 60 s after the third flame application.
	 Bore of gas jet: ϕ 0,5 mm. Fuel: butane. Test duration: 3 x 15 s. Second and third flame application start after extinguishing of the flame on the capacitor.	Extinguishing time $\leqslant$ 10 s after each flame application. No burning particles must drop from the sample.
	 Test according to VDE0860, part 1. Bore of gas jet: ϕ 0,5 mm. Fuel: butane. Before testing the capacitors are stored for 2 h at 100 ± 2 °C. Test duration 1st cycle : 10 s, 2nd cycle : 1 min, 3rd cycle : 2 min. Second and third flame application start directly after extinguishing of the flame on the capacitor.	Extinguishing time $\leqslant$ 30 s after each flame application. No burning particles must drop from the sample.

Note

ADDITIONAL INFORMATION

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

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

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

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

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

For capacitors of the 357 series, tan δ is about proportional to the frequency, thus:

$$\tan\delta = \frac{f}{10^5}\ \tan\delta_{100\ kHz}. \quad (3)$$

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

$$P = 2\pi.10^{-5}\ V_{rms}^2 f^2 C \tan\delta_{100\ kHz}. \quad (4)$$

For capacitors with a pitch of 15 or 22,5 mm the maximum tan δ at 100 kHz is 10^{-3}, thus:

$$P = 2\pi.10^{-8} V_{rms}^2 f^2 C. \quad (5)$$

For capacitors with a pitch of 27,5 mm the maximum tan δ at 100 kHz is:

$1{,}5 \times 10^{-3}$ for $C \leqslant 0{,}33\ \mu F$ thus $P = 3\pi.10^{-8} V_{rms}^2 f^2 C$, (6)
$2{,}0 \times 10^{-3}$ for $0{,}33\ \mu F < C \leqslant 0{,}47\ \mu F$, thus $P = 4\pi.10^{-8}\ V_{rms}^2 f^2 C$, (7)
$2{,}5 \times 10^{-3}$ for $C > 0{,}47\ \mu F$, thus $P = 5\pi.10^{-8} V_{rms}^2 f^2 C$. (8)

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

curve	dimensions (mm)		
	T_{max}	L_{max}	H_{max}
1	8	21,5	15
2	10	21,5	17
3	8,5	29	18,5
4	10	29	20
5	10	34	20
6	12	34	22
7	15	34	25
8	18	34	28

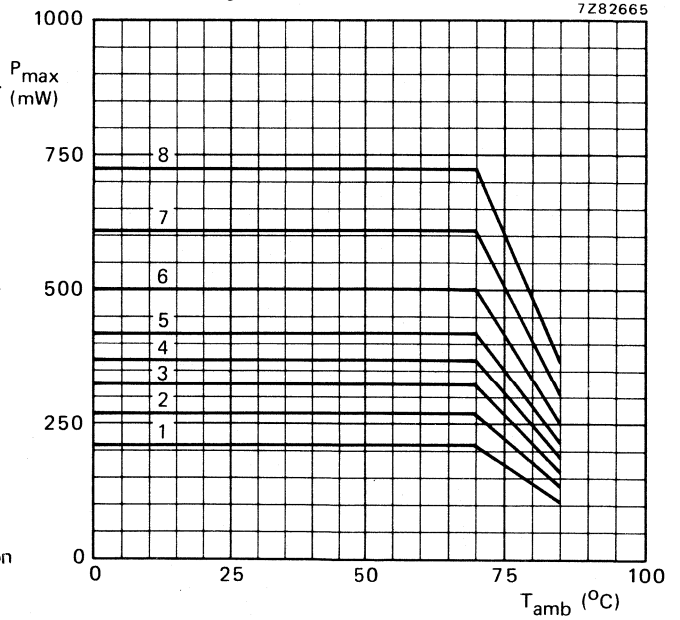


Fig. 7 Maximum permissible power dissipation as a function of temperature.

* At $T_{amb} \leqslant 45$ °C the maximum permissible sinusoidal voltage can be found in Fig. 4.

Example 1

A capacitor of 0,82 μF (27,5 mm pitch) is to be used at a 20 kHz sinusoidal voltage of 100 V and an ambient temperature of 75 °C. The power to be dissipated is

$$P = 5\pi.10^{-8}\ V_{rms}{}^2 f^2 C$$
$$= 5 \times 3{,}14 \times 10^{-8} \times 100^2 \times 20\,000^2 \times 0{,}82 \times 10^{-6}\ W$$
$$P = 515\ mW.$$

Fig. 7 shows that at 75 °C, capacitors with curve number 8 can be used, thus a size of 18 mm x 34 mm x 28 mm.

Example 2

For a capacitor used with a half sinewave pulse, (Fig. 8), V_{rms} can be expressed by

$$V_{rms}{}^2 = \frac{1}{2}\ V_p{}^2\ \frac{T1}{T2}\ . \qquad (9)$$

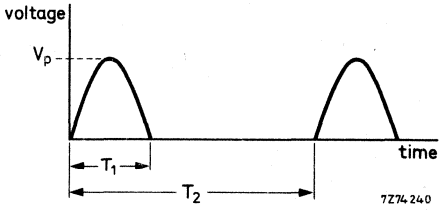


Fig. 8.

With $f = \frac{1}{2T_1}$, and substitution of equation (9) in equation (5), the maximum power dissipation for a capacitor with a pitch of 22,5 mm is

$$P = \frac{\pi}{4}.10^{-8} V_p{}^2\ \frac{1}{T_1.T_2}\ C. \qquad (8)$$

A capacitor of 0,056 μF is to be used with a half sinewave pulse (pulse duration 12 μs, repetition time 60 μs), peak value 200 V at an ambient temperature of 80 °C.

The maximum dissipated power is

$$P = \frac{\pi}{4} \times 10^{-8} \times 200^2 \times \frac{1}{12 \times 60 \times 10^{-12}} \times 0{,}056 \times 10^{-6}\ W$$

$$P = 24{,}4\ mW.$$

From Fig. 7 it can be seen that this power value is permitted for all capacitor sizes.

POLYPROPYLENE CAPACITORS

series construction (KP/MKP)

QUICK REFERENCE DATA

Rated capacitance range (E12 series)	1500 pF to 0,33 μF
Tolerance on rated capacitance	± 5% and ± 10%
Rated voltage U_R (d.c.)	630 V, 1000 V, 1500 V, 2000 V
Rated voltage U_R (a.c.), 50 to 60 Hz	300 V, 400 V, 600 V, 700 V
Rated temperature	85 °C
Climatic catagory, IEC 68	40/085/56

APPLICATION

These capacitors are intended for applications where high currents, high voltages and steep pulses occur. They are mainly used for deflection circuits in television receivers (e.g. flyback), for commutation in thyristor circuits (e.g. motor control) and pulse steepness suppression networks.

When requiring advice,please send oscillograms of current and voltage waveforms.

DESCRIPTION

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

The capacitors are flame retardent and 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.

MECHANICAL DATA

Dimensions in mm

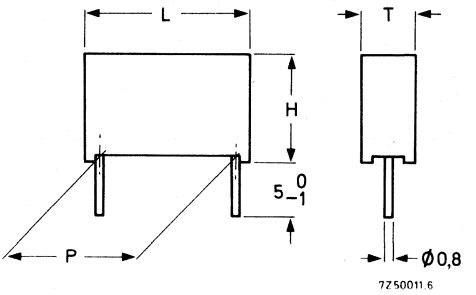


Fig. 1 For dimensions T, L, H and P, see Tables 1 to 4.

Table 1 U_R (d.c.) = 630 V; U_R (a.c.) = 300 V

rated capacitance * μF	T_{max}	L_{max}	H_{max}	P	mass g	catalogue number 2222 357 . . . . . tol. ± 5%	tol. ± 10%
0,047	8,5	29	18,5	22,5 ± 0,4	6	62473	61473
0,056	8,5	29	18,5		6	62563	61563
0,068	10	29	20		9	62683	61683
0,082	10	29	20		9	62823	61823
0,10	10	29	20		9	62104	61104
0,12	10	34	20	27,5 ± 0,4	10	62124	61124
0,15	12	34	22		14	62154	61154
0,18	12	34	22		14	62184	61184
0,22	15	34	25		20	62224	61224
0,27	18	34	28		28	62274	61274
0,33	18	34	28		28	62334	61334

* Besides the values of the E12 series as quoted, intermediate values of the E24 series (with a tolerance ± 5%) are available. Other capacitance values and tolerances are available to special order.

Table 2 U_R (d.c.) = 1000 V; U_R (a.c.) = 400 V

rated capacitance* µF	T_{max}	L_{max}	H_{max}	P	mass g	catalogue number 2222 357 . . . . . tol. ± 5%	tol. ± 10%
0,018**	8,5	29	18,5		6	72183	
0,022**	8,5	29	18,5	22,5 ± 0,4	6	72223	
0,027**	8,5	29	18,5		6	72273	
0,033	8,5	29	18,5		6	72333	71333
0,039	8,5	29	18,5	22,5 ± 0,4	6	72393	71393
0,047	10	29	20		9	72473	71473
0,056	10	29	20		9	72563	71563
0,068	10	34	20		10	72683	71683
0,082	12	34	22		13	72823	71823
0,10	12	34	22		13	72104	71104
0,12	15	34	25	27,5 ± 0,4	18	72124	71124
0,15	18	34	28		26	72154	71154
0,18	18	34	28		26	72184	71184
0,22	18	34	28		26	72224	71224

Table 3 U_R (d.c.) = 1500 V; U_R (a.c.) = 600 V

rated capacitance* µF	T_{max}	L_{max}	H_{max}	P	mass g	catalogue number 2222 357 . . . . . tol. ± 5%	tol. ± 10%
0,0082**	8,5	29	18,5		6	82822	
0,010**	8,5	29	18,5	22,5 ± 0,4	6	82103	
0,012**	8,5	29	18,5		6	82123	
0,015**	8,5	29	18,5		6	82153	
0,018	8,5	29	18,5		6	82183	81183
0,022	8,5	29	18,5		6	82223	81223
0,027	8,5	29	18,5	22,5 ± 0,4	6	82273	81273
0,033	10	29	20		9	82333	81333
0,039	10	29	20		9	82393	81393
0,047	10	34	20		10	82473	81473
0,056	12	34	22		13	82563	81563
0,068	12	34	22		13	82683	81683
0,082	15	34	25	27,5 ± 0,4	18	82823	81823
0,10	15	34	25		18	82104	81104
0,12	18	34	28		26	82124	81124
0,15	18	34	28		26	82154	81154

* Besides the values of the E12 series as quoted, intermediate values of the E24 series (with a tolerance ± 5%) are available. Other capacitance values and tolerances are available to special order.

** Especially suited for fly-back purposes.

→ Table 4 U_R (d.c.) = 2000 V; U_R (a.c.) = 700 V

rated capacitance* µF	T_{max}	L_{max}	H_{max}	P	mass g	catalogue number 2222 357 . . . . . tol. ± 5%	tol. ± 10%
0,0015**	8,5	29	18,5	22,5 ± 0,4	6	92152	
0,0018**						92182	
0,0022**						92222	
0,0027**						92272	
0,0033**						92332	
0,0039**						92392	
0,0047**						92472	
0,0056**						92562	
0,0068**						92682	
0,0075**						92752	
0,0082**	10		20		9	92822	
0,010 **						92103	
0,012 **						92123	
0,013 **						92133	

Marking

The capacitors are marked on the top face by embossed print, with:
- rated capacitance in pF or µF, tolerance and rated d.c. voltage, without unit symbols;
- 5th, 6th and 7th digits of the catalogue number, code for dielectric materials (KP/MKP), code for factory of origin and production date code (according to IEC 62, clause 5);
- manufacturer's identification symbol.

The capacitors which are especially suited for flyback purposes are also marked with peak-to-peak voltage and repetition frequency (16 kHz).

Mounting

The capacitors are suited for mounting on printed-wiring boards. When a number of capacitors are connected to form a capacitor bank, and considerable power dissipation is expected, their mounting proximity should allow a free circulation of air.

* Besides the values of the E12 series as quoted, intermediate values of the E24 series (with a tolerance ± 5%) are available. Other capacitance values and tolerances are available to special order.

** Especially suited for flyback purposes.

ELECTRICAL DATA

Unless otherwise specified all electrical values apply at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Capacitance

Rated capacitance values (C_R) at 1 kHz	see Tables 1 to 4
Tolerance on rated capacitance	± 5% or ± 10%
Temperature coefficient at T_{amb} = 20 °C	−400 ± 50 ppm/°C
Frequency dependence between 100 Hz and 100 kHz	negligible

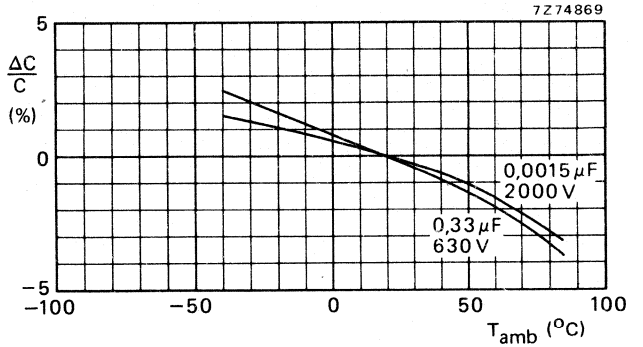


Fig. 2 Capacitance as a function of temperature; typical curves. Measuring voltage is 0,3 V, measuring frequency is 1 kHz.

Voltage

Rated voltage U_R (d.c.)	630 V, 1000 V, 1500 V, 2000 V
Rated voltage U_R (a.c.), 50 to 60 Hz	
630 V version	300 V
1000 V version	400 V
1500 V version	600 V
2000 V version	700 V
Maximum permissible peak-to-peak voltage for flyback capacitors, pulse duration 10 to 14 μs, repetition frequency 15 to 20 kHz	
1000 V version	1000 V (p-p)
1500 V version	1500 V (p-p)
2000 V version	2000 V (p-p)
Test voltage for 1 min	
between terminals	1,6 x U_R (d.c.)
between interconnected terminals and case	2 x U_R (d.c.)

Notes

The following requirements must be satisfied:

- the sum of the d.c. voltage and the peak value of the superimposed a.c. voltage must be ⩽ rated d.c. voltage;
- the peak-to-peak value of the a.c. voltage must be ⩽ maximum permissible a.c. voltage x 2V2;
- for other than sinusoidal waveforms, the maximum permissible dissipation must not be exceeded.

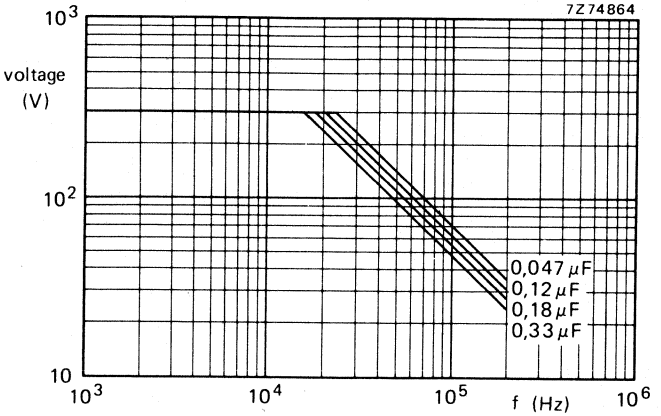


Fig. 3 Maximum permissible r.m.s. value of sinusoidal voltages as a function of frequency at $T_{amb} \leqslant 70\ ^{o}C$, for 630 V version.

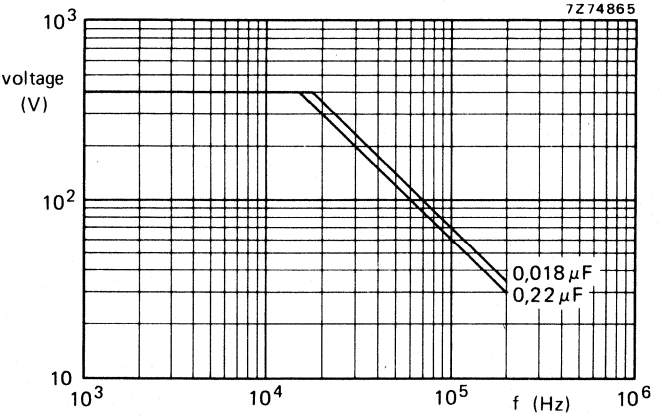


Fig. 4 Maximum permissible r.m.s. value of sinusoidal voltages as a function of frequency at $T_{amb} \leqslant 70\ ^{o}C$, for 1000 V version.

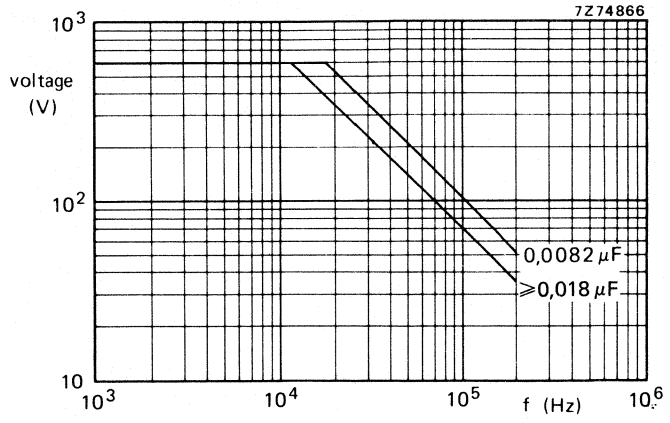


Fig. 5 Maximum permissible r.m.s. value of sinusoidal voltages as a function of frequency at $T_{amb} \leqslant 70\ ^{o}C$, for 1500 V version.

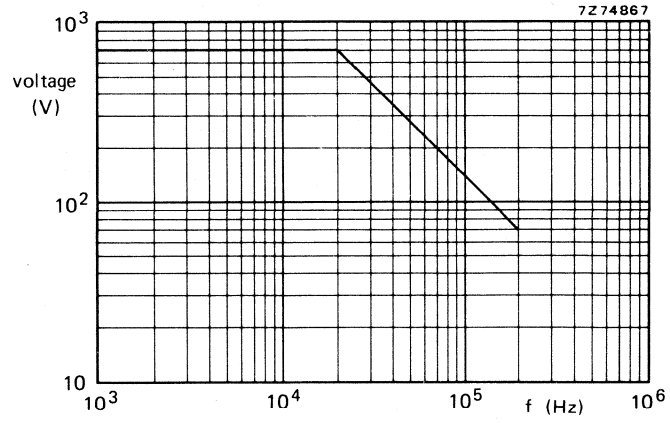


Fig. 6 Maximum permissible r.m.s. value of sinusoidal voltages as a function of frequency at $T_{amb} \leqslant 70\ ^{o}C$, for 2000 V version.

Insulation resistance

The insulation resistance is measured after a voltage of 500 ± 50 V has been applied for 1 min ± 5 s.

	ambient temperature	
	23 °C	85 °C
R between terminations, for $C_R \leqslant 0{,}1\ \mu F$	$> 50\,000\ M\Omega$	$> 500\ M\Omega$
RC between terminations, for $C_R > 0{,}1\ \mu F$	$> 5\,000$ s	> 50 s

Tan δ (tangent of the loss angle)

Tan δ at 100 kHz	
for capacitors with pitch P = 22,5 mm	$\leqslant 10 \times 10^{-4}$
for capacitors with pitch P = 27,5 mm	$\leqslant 15 \times 10^{-4}$

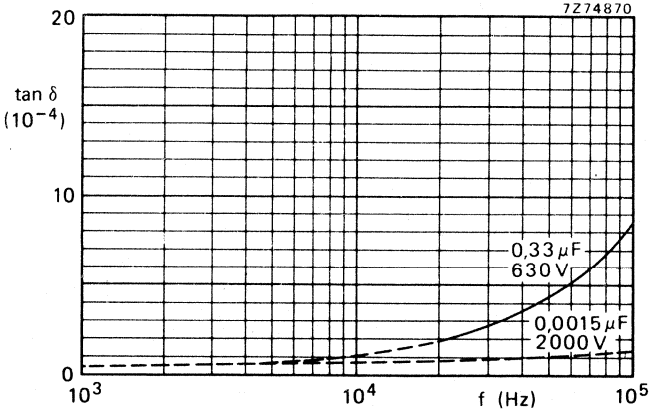


Fig. 7 Tan δ as a function of frequency; typical curves.

Temperature dependence at 100 Hz, 1 kHz, 10 kHz and 100 kHz	negligible
Power dissipation	
Maximum permissible power dissipation	see Additional information
Pulse steepness	limited by network conditions
Temperature	
Rated temperature	85 °C
Category temperature range	−40 to + 85 °C
Storage temperature range	−55 to + 85 °C
Climatic category, IEC 68	40/085/56

PACKING

The capacitors are packed in cardboard boxes. The number per box is 1000 for capacitors with L_{max} = 29 mm, and 500 for capacitors with L_{max} = 34 mm.

TESTS AND REQUIREMENTS

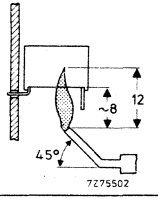
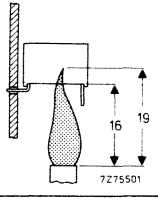
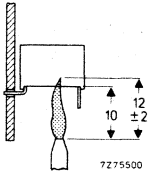
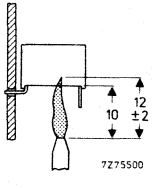
IEC 68-2 test method	name of test	procedure (quick reference)	requirements
Ua1	Tensile strength of terminations	Loading force 10 N in axial direction of the wires, 10 s.	No damage.
		Loading force 5 N in radial direction of the wires, 10 s.	
Ub (method 1)	Bending of terminations	Loading force 5 N, two consecutive bends.	No damage.
Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. 235 °C, dwell time 2 s.	Good tinning.
Tb (method 1B)	Resistance to soldering heat	Solder bath: 350 °C, 3,5 s.	No damage; $\Delta C/C \leqslant 1\%$.
Na	Rapid change of temperature	5 cycles of ½ h at –40 °C and ½ h at + 85 °C.	No damage, no leakage, $\Delta C/C \leqslant 2\%$. Tan δ and insulation resistance shall meet initial requirements.
Fc	Vibration	10 to 55 Hz, 0,75 mm ot 10g (whichever is less), 3 directions, 2 h per direction.	No damage, no open or short-circuit; $\Delta C/C \leqslant 0{,}5\%$.
Eb	Bumping	40g, 4000 bumps.	No damage, no open or short-circuit; $\Delta C/C \leqslant 0{,}5\%$.

IEC 68-2 test method	name of test	procedure (quick reference)	requirements
Ba	Dry heat	16 h at + 85 ± 2 °C, no voltage applied.	No damage, no leakage, $\Delta C/C \leqslant 5\%$ at 85 °C. Insulation resistance shall meet initial requirements.
Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.	
Aa	Cold	2 h at −40 ± 3 °C; no voltage applied.	$\Delta C/C \leqslant 5\%$ at −40 °C.
M	Low air pressure	1 h at 25 ± 5 °C, at atmospheric pressure of 85 mbar. During the last 5 min of the test U_R (d.c.) shall be applied.	During and after the test there shall be no breakdown or flashover.
Db	Damp heat, cyclic	5 cycles of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied. Within 15 min after the test U_R (d.c.) has to be applied for 1 min.	
		Final measurement.	$\Delta C/C \leqslant 1\%$. Tan δ shall meet initial requirements. Insulation resistance $\geqslant$ 0,5 x initial requirements.
Ca	Damp heat, steady state	56 days at 40 ± 2 °C, R.H. 90 to 95%; no voltage applied. Within 15 min after the test U_R (d.c.) has to be applied for 1 min.	$\Delta C/C \leqslant 2\%$. Tan δ shall meet initial requirements. Insulation resistance $\geqslant$ 0,5 x initial requirements.

IEC 68-2 test method	name of test	procedure (quick reference)	requirements
–	Endurance	2000 h at 85 °C, 1,5 x U_R (d.c.) applied.	$\Delta C/C \leqslant 2\%$. Tan δ and insulation resistance shall meet initial requirements.
		2000 h at 85 °C, 1,25 x U_R (a.c.) 50 Hz applied.	
		1000 h at 25 °C, 20 kHz voltage of 1,25 x max. permissible voltage (Figs 3 to 6) applied.	

Additional tests

	Solvent resistance	MIL-STD-202E, method 215.	No damage. Insulation resistance $\geqslant$ 0,5 x initial requirements.
	Damp heat, long term exposure	56 days at 40 ± 2 °C, R.H. 90 to 95%; U_R (a.c.) applied for 16 h per 24 h.	$\Delta C/C \leqslant 2\%$. Tan δ shall meet initial requirements. Insulation resistance $\geqslant$ 0,5 x initial requirements.
	Discharge	10 000 cycles of charge to U_R (d.c.) via a resistor (RC $\leqslant$ 0,5 s) and discharge via a resistor of max. 10 mΩ at 25 °C. Cycle time: approx. 1 cycle/2 s.	$\Delta \tan \delta \leqslant 2 \times 10^{-4}$ at 10 kHz.
	Endurance (only for capacitors suited for fly-back purposes)	1000 h at 25 °C, 800 V (d.c.) + 500 V (a.c.) applied for 1000 V version, 1200 V (d.c.) + 800 V (a.c.) applied for 1500 V version, 1500 V (d.c.) + 1000 V (a.c.) applied for 2000 V version.	No short-circuit or interruption.
		1000 h at 85 °C, same voltages applied as mentioned above.	No short-circuit or interruption.

name of test	procedure (quick reference)	requirements
Flammability	 Bore of gas jet: ϕ0,5 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 drop from the sample.
	 Test according to UL1414. Bore of gas jet: ϕ10 mm. Fuel: methane. Test duration: 3 x 15 s. Time interval between each application: 15 s.	Extinguishing time $\leqslant$ 15 s after the first and second flame application, $\leqslant$ 60 s after the third flame application.
	 Bore of gas jet: ϕ0,5 mm. Fuel: butane. Test duration: 3 x 15 s. Second and third flame application start after extinguishing of the flame on the capacitor.	Extinguishing time $\leqslant$ 10 s after each flame application. No burning particles must drop from the sample.
	 Test according to VDE0860, part 1. Bore of gas jet: ϕ0,5 mm. Fuel: butane. Before testing the capacitors are stored for 2 h at 100 ± 2 °C. Test duration 1st cycle : 10 s, 2nd cycle : 1 min, 3rd cycle : 2 min. Second and third flame application start directly after extinguishing of the flame on the capacitor.	Extinguishing time $\leqslant$ 30 s after each flame application. No burning particles must drop from the sample.

→ Note

Standard atmospheric conditions for referee tests: ambient temperature 23 ± 1 °C, atmospheric pressure 86 to 106 kPa and R.H. 50 ± 2%

ADDITIONAL INFORMATION

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

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

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

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

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

For capacitors of the 357 series, tan δ is about proportional to the frequency, thus:

$$\tan\delta = \frac{f}{10^5} \tan\delta_{100kHz}. \quad (3)$$

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

$$P = 2\pi.10^{-5}\ V^2_{rms} f^2 C \tan\delta_{100kHz}. \quad (4)$$

For capacitors with a pitch of 22,5 mm the maximum tan δ at 100 kHz is 10^{-3}, thus:

$$P = 2\pi.10^{-8} V^2_{rms} f^2 C. \quad (5)$$

For capacitors with a pitch of 27,5 mm the maximum tan δ at 100 kHz is 1,5 x 10^{-3}, thus:

$$P = 3\pi.10^{-8} V^2_{rms} f^2 C. \quad (6)$$

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

	dimensions (mm)		
curve	T_{max}	L_{max}	H_{max}
1	8,5	29	18,5
2	10	29	20
3	10	34	20
4	12	34	22
5	15	34	25
6	18	34	28

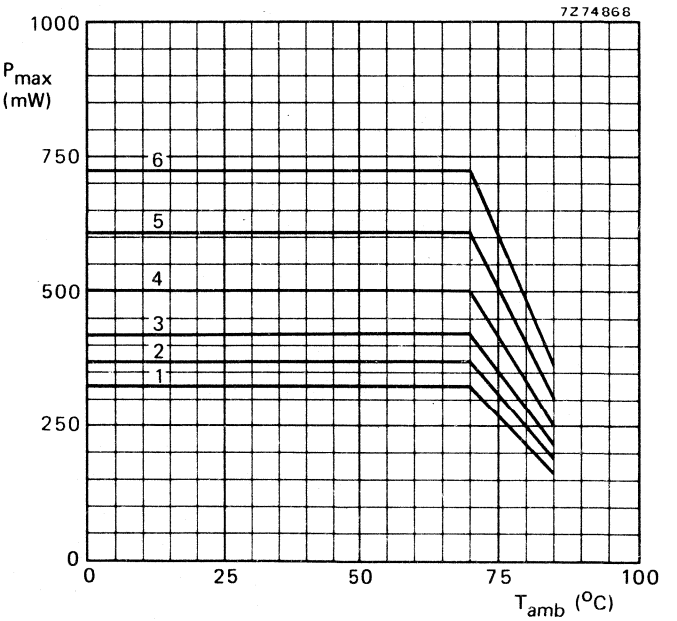


Fig. 8 Maximum permissible power dissipation as a function of temperature.

* At $T_{amb} \leqslant 70$ °C the maximum permissible sinusoidal voltage can be found in Figs 3 to 6.

Example 1

A capacitor of 0,12 μF (27,5 mm pitch) is to be used at a 20 kHz sinusoidal voltage of 300 V and an ambient temperature of 80 °C. The power to be dissipated is

$$P = 3\pi.10^{-8}\ V_{rms}^2\ f^2\ C$$
$$= 3 \times 3{,}14 \times 10^{-8} \times 300^2 \times 20\,000^2 \times 0{,}12 \times 10^{-6} W$$
$$P = 407\ mW.$$

Fig. 8 shows that at 80 °C, capacitors with curve number 5 can be used, thus a size of 15 mm x 34 mm x 25 mm. It can be seen from Tables 1 to 4 that a 0,12 μF/1000 V capacitor must be chosen.

Example 2

For a capacitor used with a half sinewave pulse, (Fig. 9), V_{rms} can be expressed by

$$V_{rms}^2 = \frac{1}{2} V_p^2 \frac{T1}{T2}. \qquad (7)$$

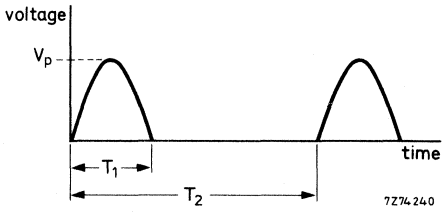


Fig. 9.

With $f = \frac{1}{2T_1}$, and substitution of equation (7) in equation (5), the maximum power dissipation for a capacitor with a pitch of 22,5 mm is

$$P = \frac{\pi}{4}.10^{-8} V_p^2 \frac{1}{T_1.T_2} C. \qquad (8)$$

A capacitor of 0,0075 μF is to be used with a half sinewave pulse (pulse duration 12 μs, repetition time 60 μs), peak value 1500 V at an ambient temperature of 80 °C.

The maximum dissipated power is

$$P = \frac{\pi}{4} \times 10^{-8} \times 1500^2 \times \frac{1}{12 \times 60 \times 10^{-12}} \times 0{,}0075 \times 10^{-6}\ W$$
$$P = 184\ mW$$

From Fig. 8 it can be seen that this power value is permitted for all capacitor sizes.

POLYSTYRENE FILM/FOIL CAPACITORS

axial type (KS)

QUICK REFERENCE DATA

Rated capacitance range	51 to 39 000 pF
Tolerance on rated capacitance	± 5% (E24-series) ± 2% (E24, E48-series) ← ± 1% (E24, E48, E96-series) ←
Rated voltage U_R (d.c.)	63 V, 160 V, 250 V, 630 V
Rated voltage U_R (a.c.), 50 to 60 Hz	25 V, 63 V, 125 V, 250 V
Rated temperature	
63 V version	70 °C
160 V, 250 V, 630 V versions	85 °C
Climatic category, IEC 68	
63 V version	40/070/21
160 V, 250 V, 630 V versions	40/085/21
Basic specification	IEC 384-7 ←

APPLICATION

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

DESCRIPTION

The capacitors consist of a low-inductive wound cell of tin-lead foil with a polystyrene film. The cell is covered with a green plastic film. The long, axial leads of solder-coated wire make the capacitor suitable for vertical or horizontal mounting on printed-wiring boards and also for point-to-point wiring.

Composition of the catalogue number

2222 . . . . . .

424 = 63 V 425 = 160 V 426 = 250 V 427 = 630 V	packed in boxes	2 = ± 5% 3 = ± 2% 4 = ± 1%
428 = 63 V 429 = 160 V 430 = 250 V 431 = 630 V	packed on bandoliers on reels	6 = ± 5% 7 = ± 2% 8 = ± 1%

code for capacitance, see Tables 1 to 4

MECHANICAL DATA

Dimensions in mm

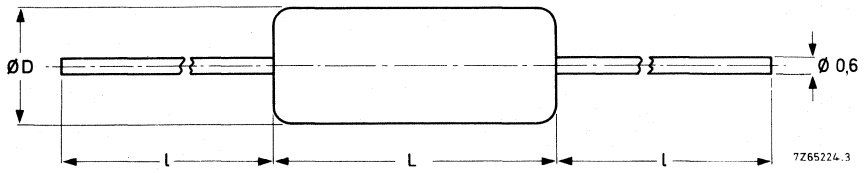


Fig. 1 For dimensions D, L and l see tables below.

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

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number (capacitors packed in boxes)
2 000	3,8	10,9	30	0,3	2222 424 22002
2 200					22202
2 400	4,0			0,4	22402
2 700					22702
3 000					23002
3 300					23302
3 600					23602
3 900					23902
4 300	4,5			0,5	24302
4 700					24702
5 100					25102
5 600					25602
6 200	5,0			0,6	26202
6 800					26802
7 500		15	28		27502
8 200					28202
9 100				0,7	29102
10 000					21003
11 000	5,5			0,8	21103
12 000					21203
13 000				0,9	21303
15 000				1,1	21503

* 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 1 U_R (d.c.) = 63 V; U_R (a.c.) = 25 V (continued)

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number (capacitors packed in boxes)
16 000	6,0	15	28	1,1	2222 424 21603
18 000					21803
20 000	6,5			1,3	22003
22 000					22203
24 000				1,4	22403
27 000	7,0			1,5	22703
30 000				1,7	23003
33 000	7,5			1,9	23303
36 000					23603
39 000	8,0			2,0	23903

Table 2 U_R (d.c.) = 160 V; U_R (a.c.) = 63 V

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number (capacitors packed in boxes)
1 100	3,8	10,9	30	0,3	2222 425 21102
1 200	4,0				21202
1 300					21302
1 500				0,4	21502
1 600					21602
1 800					21802
2 000	4,5				22002
2 200					22202
2 400				0,5	22402
2 700					22702
3 000	5,0				23002
3 300					23302
3 600				0,6	23602
3 900					23902
4 300		15	28		24302
4 700					24702
5 100					25102
5 600				0,7	25602
6 200					26202

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

Table 2 U_R (d.c.) = 160 V; U_R (a.c.) = 63 V (continued)

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number (capacitors packed in boxes)
6 800	5,5	15	28	0,8	2222 425 26802
7 500					27502
8 200	6,0			0,9	28202
9 100					29102
10 000				1,1	21003
11 000	6,5				21103
12 000				1,2	21203
13 000				1,3	21303
15 000	7,0			1,4	21503
16 000				1,5	21603

Table 3 U_R (d.c.) = 250 V; U_R (a.c.) = 125 V

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number (capacitors packed in boxes)
560	3,8	10,9	30	0,3	2222 426 25601
620					26201
680					26801
750	4,0			0,4	27501
820					28201
910					29101
1 000					21002
1 100	4,5				21102
1 200				0,5	21202
1 300					21302
1 500					21502
1 600	5,0				21602
1 800					21802
2 000				0,6	22002
2 200					22202
2 400		15	28	0,5	22402
2 700				0,6	22702
3 000					23002
3 300					23302
3 600				0,7	23602
3 900					23902
4 300					24302

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

Table 3 U_R (d.c.) = 250 V; U_R (a.c.) = 125 V (continued)

rated capacitance (E24-series, tol. ± 5%) * pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number (capacitors packed in boxes)
4 700	5,5	15	28	0,8	2222 426 24702
5 100					25102
5 600	6,0			0,9	25602
6 200					26202
6 800	6,5			1,1	26802
7 500					27502
8 200	7,0			1,3	28202
9 100	7,5				29102
10 000				1,5	21003
11 000				1,6	21103

Table 4 U_R (d.c.) = 630 V; U_R (a.c.) = 250 V

rated capacitance (E24-series, tol. ± 5%) * pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number (capacitors packed in boxes)
51	3,8	10,9	30	0,2	2222 427 25109
56					25609
62					26209
68					26809
75					27509
82					28209
91					29109
100					21001
110					21101
120					21201
130					21301
150					21501
160					21601
180					21801
200					22001
220					22201
240				0,3	22401
270					22701
300					23001
330	4,0				23301
360					23601
390					23901
430					24301
470	4,5				24701
510				0,4	25101
560					25601

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

Table 4 U_R (d.c.) = 630 V; U_R (a.c.) = 250 V (continued)

rated capacitance (E24-series, tol. ± 5%) * pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number (capacitors packed in boxes)
620	4,5	10,9	30	0,4	2222 427 26201
680					26801
750	5,0				27501
820					28201
910				0,5	29101
1 000					21002
1 100					21102
1 200					21202
1 300		15	28	0,6	21302
1 500					21502
1 600				0,7	21602
1 800	5,5			0,8	21802
2 000					22002
2 200				0,9	22202
2 400				1,1	22402
2 700	6,0				22702
3 000	6,5				23002
3 300				1,4	23302
3 600	7,0				23602
3 900					23902
4 300	7,5			1,7	24302
4 700	8,0				24702
5 100					25102
5 600				2,0	25602

Marking

The capacitors are marked in ink as follows:
1st line: rated capacitance in pF or nF;
2nd line: tolerance code (F = ± 1%, G = ± 2%, J = ± 5%) and rated voltage (d.c.);
→ 3rd line: production date code (according to IEC 62, clause 5) and code for dielectric material (KS = polystyrene film/foil).

Mounting

The capacitors are suited for horizontal or vertical mounting on printed-wiring boards and for point-to-point wiring. When bending, cutting or flattening the leads, one should relieve them of the applied
→ load at the capacitor body.

* 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.

ELECTRICAL DATA

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

Capacitance

Rated capacitance values (C_R) at 1 kHz	see Tables 1 to 4
Tolerance on rated capacitance	± 5%, ± 2% and ± 1% or 1 pF whichever is greater
Temperature coefficient	−125 ± 60 ppm/°C
Frequency dependence between 100 Hz and 1 MHz	none

Voltage

Rated voltage U_R (d.c.)	63 V, 160 V, 250 V, 630 V
Rated voltage U_R (a.c.), 50 to 60 Hz	
63 V version	25 V
160 V version	63 V
250 V version	125 V
630 V version	250 V
Category voltage U_C	1 x U_R (d.c.)
Test voltage for 1 min	
between terminals	2 x U_R (d.c.)
between interconnected terminals and coating	2 x U_R (d.c.) (minimum 400 V)

Insulation resistance

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

	ambient temperature	
	23 °C	70 °C
R between terminals	> 100 000 MΩ	> 100 000 MΩ
R between interconnected terminals and coating	> 500 000 MΩ	> 100 000 MΩ

→ **Tan δ (tangent of the loss angle)**

Tan δ at 10 kHz, for $C > 20\,000$ pF	$\leqslant 10 \times 10^{-4}$
Tan δ at 100 kHz, for $10\,000$ pF $< C \leqslant 20\,000$ pF	$\leqslant 15 \times 10^{-4}$
Tan δ at 100 kHz, for 1000 pF $< C \leqslant 10\,000$ pF	$\leqslant 10 \times 10^{-4}$
Tan δ at 1 MHz, for $C \leqslant 1000$ pF	$\leqslant 10 \times 10^{-4}$

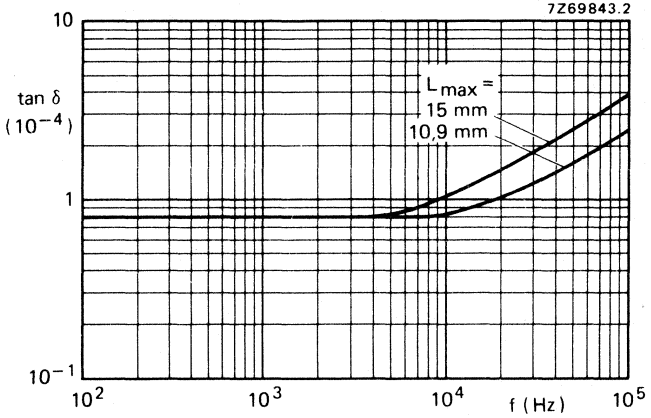


Fig. 2 Tan δ as a function of frequency; typical curves.

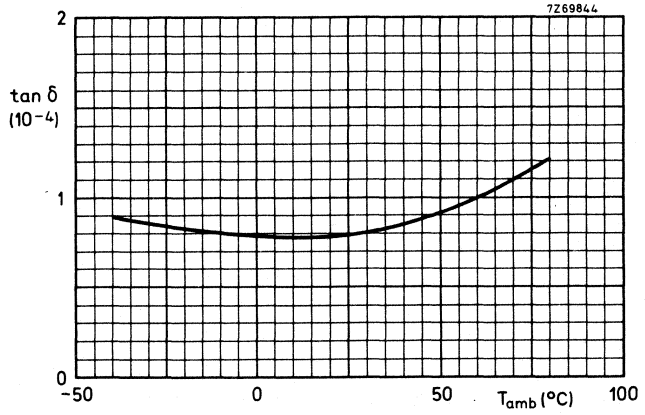


Fig. 3 Tan δ as a function of temperature; typical curve.

Resonant frequency

Resonant frequency		
length between soldering points 20 mm	$1126/\sqrt{C}$ MHz	C in pF
length between soldering points 30 mm	$919/\sqrt{C}$ MHz	C in pF
length between soldering points 40 mm	$796/\sqrt{C}$ MHz	C in pF

Temperature

Rated temperature	
63 V version	70 °C
160 V, 250 V and 630 V versions	85 °C
Category temperature range	
63 V version	−40 to + 70 °C
160 V, 250 V and 630 V versions	−40 to + 85 °C
Storage temperature range	
63 V version	−55 to + 70 °C
160 V, 250 V and 630 V versions	−55 to + 85 °C
Climatic category, IEC 68	
63 V version	40/070/21
160 V, 250 V and 630 V versions	40/085/21

PACKING

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

Packing in cardboard boxes

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

Packing on bandoliers on reels

Dimensions in mm

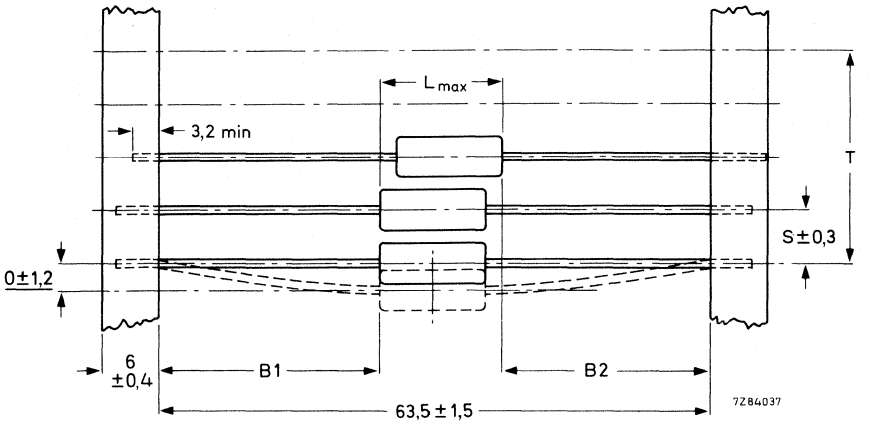


Fig. 4 | B1-B2 | = max. 1,4 mm; for dimension L max, see Tables 1 to 4.

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

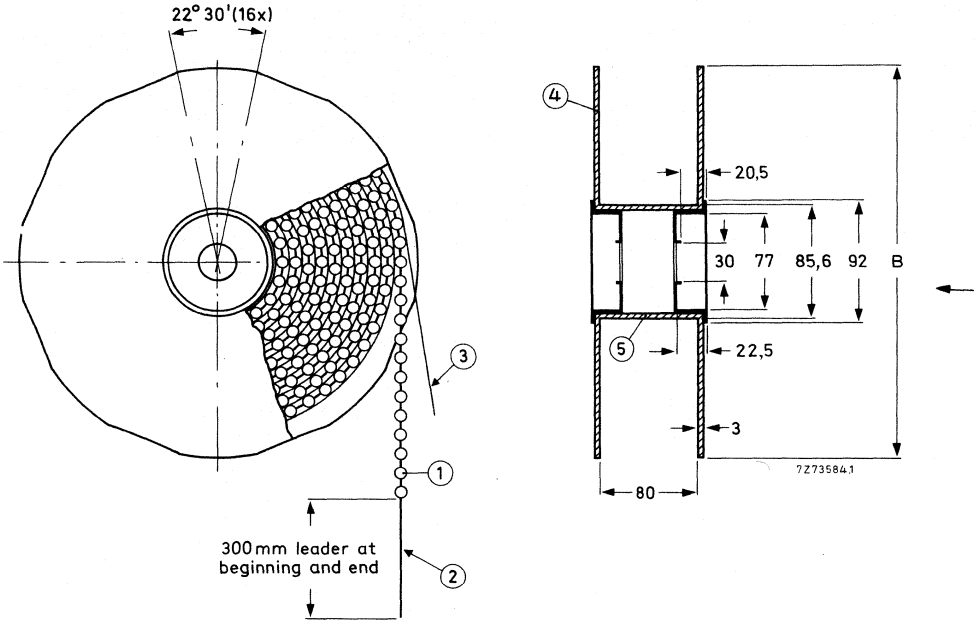


Fig. 5.

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

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

TESTS AND REQUIREMENTS

IEC 384–7 clause	IEC 68–2 test method	name of test	procedure (quick reference)	requirements
12.1	Ua1	Tensile strength of terminations	Loading force 10 N in axial direction of the wires, 10 s.	No damage.
	Ub (method 1)	Bending of terminations	Loading force 5 N, two consecutive bends.	No damage.
	Uc	Torsion of terminations	Two successive rotations of 180° in opposite directions.	No damage.
12.2	Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. 235 °C, dwell time 2 s.	Good tinning.
	Tb (method 1 B)	Resistance to soldering heat	Solder bath: 350 °C, 3,5 s	No damage; $\Delta C/C \leqslant 1\%$.
12.3	Na	Rapid change of temperature	5 cycles of ½ h at –40 °C and ½ h at + 70 °C (63 V version) or + 85 °C (other versions).	No damage, no leakage; $\Delta C/C \leqslant 0{,}5\% + 0{,}5$ pF. Tan δ and insulation resistance shall meet initial requirements.
12.4	Fc	Vibration	10 to 55 Hz, 0,75 mm or 10g (whichever is the less), 3 directions, 2 h per direction.	No damage.

IEC 384–7 clause		IEC 68–2 test method	name of test	procedure (quick reference)	requirements
Climatic sequence	12.7	Ba	Dry heat	16 h at + 70 ± 2 °C (63 V version) or 16 h at + 85 ± 2 °C (160 V, 250 V, 630 V versions); no voltage applied.	No damage, no leakage.
		Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.	
		Aa	Cold	2 h at −40 ± 3 °C; no voltage applied.	
		M	Low air pressure	1 h at 25 ± 5 °C, at atmospheric pressure of 30 kPa.	During and after the test there shall be no breakdown or flashover.
		Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.	
				Final measurement.	$\Delta C/C \leqslant 1\%$ ($C \geqslant 500$ pF), $\leqslant 1{,}5\%$ or 1 pF, whichever is greater ($C < 500$ pF). Tan $\delta \leqslant 2$ x initial requirements; insulation resistance $> 0{,}5$ x initial requirements.
	12.8	Ca	Damp heat, steady state	21 days at 40 ± 2 °C and R.H. 90 to 95%; 6 V applied continuously.	$\Delta C/C \leqslant 1\%$ ($C \geqslant 500$ pF), $\leqslant 1{,}5\%$ or 1 pF, whichever is greater ($C < 500$ pF). Tan $\delta \leqslant 2$ x initial requirements; insulation resistance $> 0{,}5$ x initial requirements.

IEC 384–7 clause	IEC 68–2 test method	name of test	procedure (quick reference)	requirements
12.9		Endurance	1000 h at 70 °C (63 V version) or at 85 °C (160 V, 250 V, 630 V versions); 1,5 x U_R (d.c.) applied.	$\Delta C/C \leqslant 0{,}3\%$ (63 V version), $\leqslant 0{,}5\% + 0{,}5$ pF (other versions). Tan $\delta \leqslant$ initial requirements or $\leqslant 1{,}4$ x initial measurements. Insulation resistance meets initial requirements.
12.10	Hb	Storage at low temperature	72 h at –55 °C.	No breakdown; $\Delta C/C \leqslant 0{,}25\%$ ($C > 500$ pF), $\leqslant 0{,}4\%$ ($C \leqslant 500$ pF).
Additional tests				
Solderability of leads (globule method, IEC 68, test T3.2)			16 h at 155 ± 2 °C.	Good tinning, 4 s yield point.
Soldering test for mounting on printed-wiring boards			Capacitors mounted vertically on a board without plated-through holes; bodies rest on the board; board thickness: 1,6 mm, hole diameter; 0,8 mm. Bath temp. 250 °C, dip-solder time 7,5 s bath temp. 260 °C, dip-solder time 5 s Capacitors mounted horizontally on a board with plated-through holes; bodies at least 1 mm from the board. Bath temp. 260 °C, dip-solder time 5 s	 $\Delta C/C \leqslant 1\%$ $\Delta C/C \leqslant 0{,}75\%$ $\Delta C/C \leqslant 1\%$. Forced cooling of the component side of the board gives less capacitance drift.

Note – Standard atmospheric conditions for referee tests: ambient temperature 23 ± 1 °C, atmospheric pressure 86 to 106 kPa and R.H. 50 ± 2%.

POLYSTYRENE FILM/FOIL CAPACITORS

potted type (KS)

QUICK REFERENCE DATA

Rated capacitance range (E96-series)	100 to 34 000 pF
Tolerance on rated capacitance	± 1%
Rated voltage U_R (d.c.)	63 V
Rated voltage U_R (a.c.), 50 to 60 Hz	25 V
Rated temperature	70 °C (class 1*) 85 °C (class 3*)
Climatic category, IEC 68	40/070/56 (class 1*) 55/085/56 (class 3*)
Basic specification	IEC 384–7

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-inductive wound cell of polystyrene film and tin/lead 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 capacitor and the printed-wiring board.

Composition of the catalogue number

2222 443 . . . . .

4 = capacitors ≤ 3 920 pF, according to Fig. 1, or
capacitors > 3 920 pF, according to Fig. 2, or
capacitors > 15 000 pF, according to Fig. 3
8 = capacitors ≤ 3 920 pF, according to Fig. 2

multiplying factor
1 = 1x
2 = 10x
3 = 100x

first three figures of capacitance value in pF

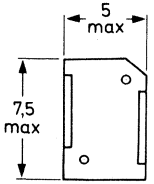
For ordering purposes please quote the catalogue number.

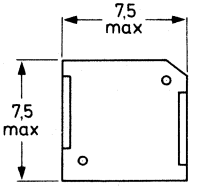
Examples
A capacitor of 4750 pF should be ordered as 2222 443 44752.
A capacitor of 121 pF according to Fig. 2, should be ordered as 2222 443 81211.
A capacitor of 12 100 pF should be ordered as 2222 443 41213.

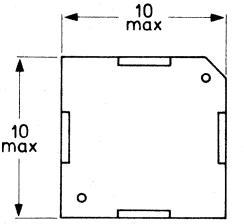
* According to IEC 384–7.

MECHANICAL DATA

Dimensions in mm







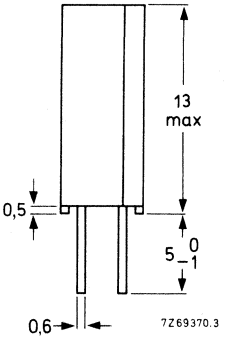


Fig. 1 Capacitors of rated capacitance range 100 to 3920 pF.

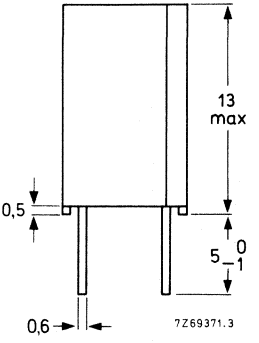


Fig. 2 Capacitors of rated capacitance range 100 to 15 000 pF.

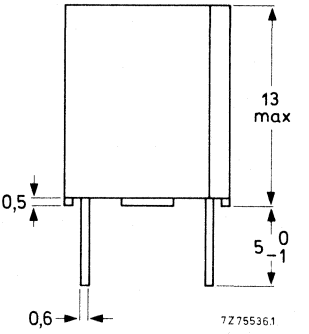


Fig. 3 Capacitors of rated capacitance range 15 400 to 34 000 pF.

Marking

Capacitors according to Fig. 1 are marked in ink on the top with:
1st line: rated capacitance in pF (without the pF unit symbol);
2nd line: tolerance code (F = ± 1%) and rated voltage (d.c.);
3rd line: production date code according to IEC 62, clause 5, and code for dielectric (KS = polystyrene).

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

Capacitors according to Figs 2 and 3 are marked in ink on the top with:
1st line: rated capacitance in pF (without the pF unit symbol);
2nd line: tolerance code (F = ± 1%) and rated voltage (d.c.);
3rd line: 5th, 6th and 7th digits of the catalogue number;
4th line: production date code according to IEC 62, clause 5, and code for dielectric (KS = polystyrene).

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.

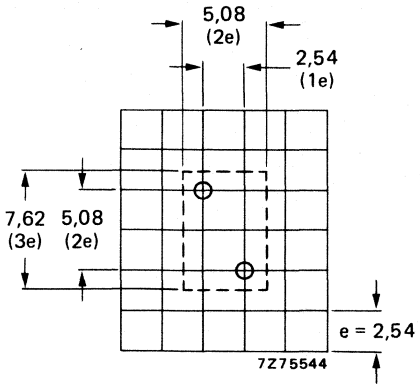


Fig. 4 Required space for capacitors according to Fig. 1.

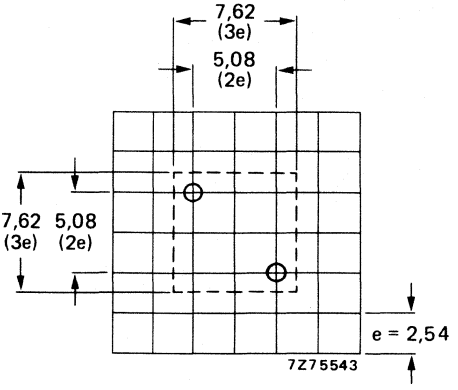


Fig. 5 Required space for capacitors according to Fig. 2.

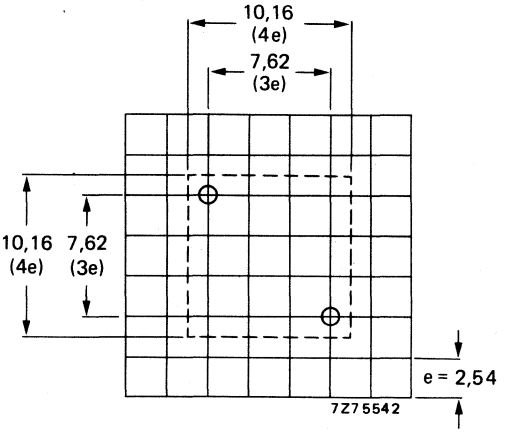


Fig. 6 Required space for capacitors according to Fig. 3.

ELECTRICAL DATA

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

Capacitance

Rated capacitance values (C_R) at 1 kHz, $C_R > 1000$ pF and at 1 MHz, $C_R \leqslant 1000$ pF	100 to 34 000 pF (E96-series)
Tolerance on rated capacitance	± 1%
Temperature coefficient $C_R \leqslant 6000$ pF $C_R > 6000$ pF	 −(95 to 155) ppm/°C −(120 to 185) ppm/°C
Frequency dependence between 100 Hz and 1 MHz	none

Voltage

Rated voltage U_R (d.c.)	63 V
Rated voltage U_R (a.c.), 50 to 60 Hz	25 V
Test voltage for 1 min between terminals between interconnected terminals and case	 2 x U_R (d.c.) 400 V (d.c.)

Insulation resistance

The insulation resistance is measured after a voltage of 10 ± 1 V has been applied for 1 min ± 5 s.

	ambient temperature	
	23 °C	70 °C
R between terminals	> 500 000 MΩ	> 100 000 MΩ
R between interconnected terminals and case	> 500 000 MΩ	> 100 000 MΩ

Tan δ (tangent of the loss angle)

→ Tan δ	
at 1 MHz, $C_R \leqslant 500$ pF	$\leqslant 5 \times 10^{-4}$
at 1 MHz, 500 pF $< C_R \leqslant 1000$ pF	$\leqslant 10 \times 10^{-4}$
at 100 kHz, for 1000 pF $< C \leqslant$ 10 000 pF	$\leqslant 10 \times 10^{-4}$
at 100 kHz, for 10 000 pF $< C \leqslant$ 15 000 pF	$\leqslant 15 \times 10^{-4}$
at 10 kHz, for $C >$ 15 000 pF	$\leqslant 10 \times 10^{-4}$

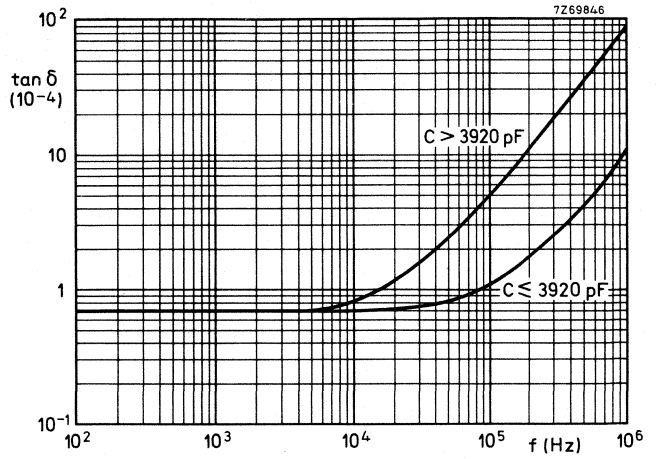


Fig. 7 Tan δ as a function of frequency; typical curves.

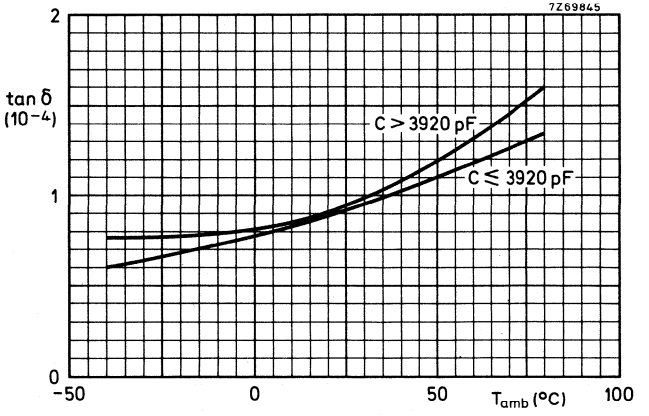


Fig. 8 Tan δ as a function of temperature; typical curves.

Resonant frequency

Resonant frequency, total lead length 2 x 1 mm $\geqslant \frac{8{,}5 \times 10^2}{\sqrt{C}}$ MHz (C in pF)

→ **Temperature**

For general applications

Rated temperature	85 °C (IEC 384–7, class 3)
Category temperature range	–55 to + 85 °C
Storage temperature range	–55 to + 85 °C
Climatic category, IEC 68	55/085/56

For long-life applications

Rated temperature	70 °C (IEC 384–7, class 1)
Category temperature range	–40 to + 70 °C
Storage temperature range	–55 to + 70 °C
Climatic category, IEC 68	40/070/56

PACKING

The capacitors are packed in boxes.
Capacitors according to Figs 1 and 2: 200 pieces per box;
Capacitors according to Fig. 3: 100 pieces per box.

TESTS AND REQUIREMENTS

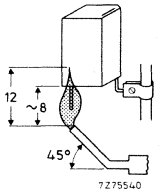
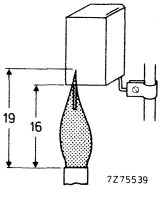
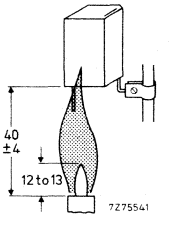
IEC 384–7 clause	IEC 68–2 test method	name of test	procedure (quick reference)	requirements	
12.1	Ua1	Tensile strength of terminations	Loading force 10 N in axial direction of the wires, 10 s.	No damage.	
12.2	Ta	Soldering	Solder bath, non-activated colophony flux solder temp. 235 °C, dwell time 2 s.	Good tinning.	
	Tb (method 1B)	Resistance to soldering heat	Solder bath: 350 °C, 3,5 s.	No damage; $\Delta C/C \leqslant 0{,}5\%$.	
12.3	Na	Rapid change of temperature	5 cycles of ½ h at –40 °C and ½ h at + 70 °C.	$\Delta C/C \leqslant 0{,}2\%$	No damage. Tan δ and insulation resistance shall meet initial requirements.
			5 cycles of ½ h at –40 °C and ½ h at + 85 °C.	$\Delta C/C \leqslant 0{,}5\%$	
12.4	Fc	Vibration	10 to 55 Hz, 0,75 mm or 10g (whichever is the less), 3 direction, 2 h per direction.	No damage, no open or short-circuit; $\Delta C/C \leqslant 0{,}1\%$.	
12.5	Eb	Bumping	40g, 4000 bumps.	No damage, no open or short-circuit; $\Delta C/C \leqslant 0{,}1\%$.	

IEC 384–7 clause		IEC 68–2 test method	name of test	procedure (quick reference)	requirements
Climatic sequence	12.7	Ba	Dry heat	16 h at + 85 ± 2 °C, no voltage applied.	No damage, no leakage
		Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.	
		Aa	Cold	2 h at −40 ± 3 °C; no voltage applied.	
		M	Low air pressure	1 h at 25 ± 5 °C, at atmospheric pressure of 8,5 kPa.	During and after the test there shall be no breakdown or flashover.
		Db	Damp heat, cyclic	5 cycles of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.	
				Final measurement.	$\Delta C/C \leqslant 0{,}5\% + 0{,}5$ pF. Tan $\delta \leqslant 1{,}2$ x initial requirements; insulation resistance $> 5 \times 10^5$ MΩ
	12.8	Ca	Damp heat, steady state	56 days at 40 ± 2 °C and R.H. 90 to 95%; 6 V applied continuously.	$\Delta C/C \leqslant 0{,}75\% + 0{,}5$ pF. Tan $\delta \leqslant 1{,}2$ x initial requirements; insulation resistance $> 5 \times 10^5$ MΩ

IEC 384–7 clause	IEC 68–2 test method	name of test	procedure (quick reference)	requirements	
12.9		Endurance	1000 h at 70 °C, 1,5 x U_R (d.c.) applied.	$\Delta C/C \leqslant 0{,}3\%$ + 0,3 pF	Tan $\delta \leqslant 1{,}4$ x initial requirements; insulation resistance $> 5 \times 10^5$ MΩ.
			1000 h at 85 °C, 1,5 x U_R (d.c.) applied.	$\Delta C/C \leqslant 0{,}75\%$ + 0,75 pF	
12.10	Hb	Storage at low temperature	72 h at −55 °C.	No breakdown; $\Delta C/C \leqslant 0{,}25\%$ or 1 pF, whichever is greater.	

Additional tests

		Long term stability	10 000 h at 55 °C, 25 V (d.c.) applied.	$\Delta C/C \leqslant 0{,}3\%$ + 0,3 pF.
		Endurance	2000 h at 70 °C, 1,5 x U_R (d.c.) applied.	$\Delta C/C \leqslant 0{,}3\%$ + 0,3 pF.
		Solderability of leads solder bath method, IEC 68, test Ta)	16 h at 155 ± 2 °C.	Good tinning.
		Soldering test for mounting on printed-wiring boards	Board thickness: 1,6 mm, hole diameter: 0,8 mm; plated-through holes. Bath temp.: 250 ± 10 °C; dip-solder time: 7,5 ± 0,5 s. Bath temp.: 260 ± 10 °C; dip-solder time: 5 ± 0,5 s.	$\Delta C/C \leqslant 0{,}5\%$ or 1 pF whichever is greater.
		Voltage test (destructive test)	5 x U_R (d.c.) between terminals for 1 s.	No breakdown.

name of test	procedure (quick reference)	requirements
Flammability	 Bore of gas jet: ϕ0,5 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 10 s. No burning particles must drop from the sample.
	 Test according to UL1414 Bore of gas jet: ϕ 10 mm. Fuel: natural gas. Test duration: 3 x 15 s. Time interval between each application: 15 s.	Extinguishing time $\leqslant$ 15 s after the first and second flame application, $\leqslant$ 60 s after the third flame application.
	 Bore of gas jet: ϕ14 to ϕ15 mm. Fuel: propane. Test duration: 15 s. One flame application.	After removing the test flame from the capacitor, the capacitor must not continue to burn for more than 5 s. No burning particles must drop from the sample.

Note – Standard atmospheric conditions for referee tests: ambient temperature 23 ± 1 °C, atmospheric pressure 86 to 106 kPa and R.H. 50 ± 2%.

POLYSTYRENE FILM/FOIL CAPACITORS

wrapped end-filled type (KS)

QUICK REFERENCE DATA

Rated capacitance range	6200 to 162 000 pF
Tolerance on rated capacitance	±5% (E24-series) ±2% (E48-series) ±1% (E96-series)
Rated voltage U_R (d.c.)	63 V, 160 V, 250 V and 630 V
Rated voltage U_R (a.c.), 50 to 60 Hz	25 V, 63 V, 125 V and 250 V
Rated temperature	
63 V version	70 °C
160 V, 250 V, 630 V versions	85 °C
Climatic category, IEC 68	
63 V version	40/070/56
160 V, 250 V, 630 V versions	40/085/56
Basic specification	IEC 384-7

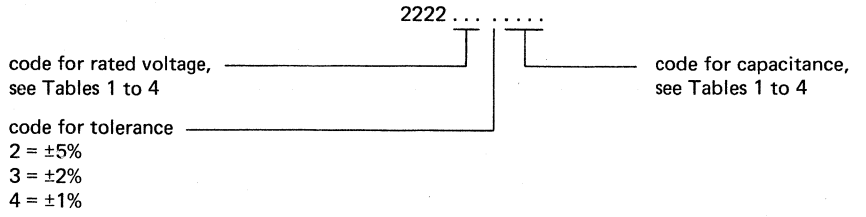
APPLICATION

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

DESCRIPTION

These capacitors consist of a low-inductive wound cell of tin-lead foil with a polystyrene film. The cell is wrapped in a polyester film, the ends are filled with epoxy resin. The axial leads are solder-coated.

Composition of the catalogue number



MECHANICAL DATA

Dimensions in mm

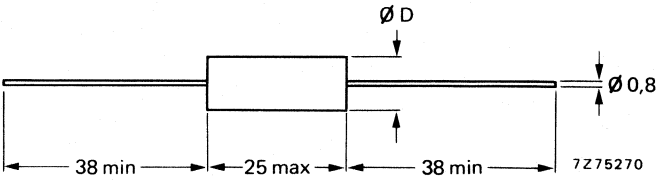


Fig.1 For dimension D see tables below.

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

rated capacitance (E24-series, tol. ±5%)* pF	D_{max} mm	approx. mass g	catalogue number
43000	7,0	3,1	2222 444 24303
47000	7,5	3,2	24703
51000	7,5	3,4	25103
56000	8,0	3,7	25603
62000	8,5	4,0	26203
68000	8,5	4,4	26803
75000	9,0	4,7	27503
82000	9,5	5,1	28203
91000	9,5	5,5	29103
100000	10,0	5,9	21004
110000	10,5	6,4	21104
120000	11,0	6,9	21204
130000	11,5	7,5	21304
150000	12,0	8,2	21504
160000	12,5	9,0	21604
162000	12,5	9,1	21624

* Besides the values of the E24 series as quoted (with a tolerance ±5%), intermediate values of the E48 series (with a tolerance ±2%) and of the E96 series (with a tolerance ±1%) are available.

Table 2 U_R (d.c.) = 160 V; U_R (a.c.) = 63 V

rated capacitance (E24-series, tol. ±5%)* pF	D_{max} mm	approx. mass g	catalogue number
18000	6,5	2,3	2222 445 21803
20000	7,0	2,4	22003
22000	7,0	2,5	22203
24000	7,5	2,6	22403
27000	7,5	2,8	22703
30000	8,0	3,1	23003
33000	8,5	3,4	23303
36000	8,5	3,8	23603
39000	9,0	4,1	23903
43000	9,5	4,4	24303
47000	9,5	4,7	24703
51000	10,0	5,1	25103
56000	10,5	5,5	25603
62000	11,0	5,9	26203
68000	11,5	6,4	26803
75000	12,0	7,0	27503
82000	12,5	7,6	28203

Table 3 U_R (d.c.) = 250 V; U_R (a.c.) = 125 V

rated capacitance (E24-series, tol. ±5%)* pF	D_{max} mm	approx. mass g	catalogue number
12000	7,0	2,1	2222 446 21203
13000	7,0	2,2	21303
15000	7,5	2,4	21503
16000	7,5	2,5	21603
18000	8,0	2,7	21803
20000	8,5	2,9	22003
22000	8,5	3,2	22203
24000	9,0	3,5	22403
27000	9,5	3,7	22703
30000	10,0	4,0	23003
33000	10,5	4,4	23303
36000	10,5	4,7	23603
39000	11,0	5,1	23903
43000	11,5	5,5	24303
47000	12,0	5,9	24703

* Besides the values of the E24 series as quoted (with a tolerance ±5%), intermediate values of the E48 series (with a tolerance ±2%) and of the E96 series (with a tolerance ±1%) are available.

Table 4 U_R (d.c.) = 630 V; U_R (a.c.) = 250 V

rated capacitance (E24-series, tol. ±5%)* pF	D_{max} mm	approx. mass g	catalogue number
6200	7,5	2,1	2222 447 26202
6800	7,5	2,2	26802
7500	8,0	2,4	27502
8200	8,0	2,6	28202
9100	8,5	2,8	29102
10000	9,0	3,0	21003
11000	9,0	3,3	21103
12000	9,5	3,6	21203
13000	10,0	3,9	21303
15000	10,5	4,2	21503
16000	11,0	4,6	21603
18000	11,5	4,9	21803
20000	12,0	5,3	22003
22000	12,5	5,8	22203
24000	12,5	6,2	22403

Marking

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

* Besides the values of the E24 series as quoted (with a tolerance ± 5%), intermediate values of the E48 series (with a tolerance ± 2%) and of the E96 series (with a tolerance ± 1%) are available.
** According to IEC 62, clause 5.

ELECTRICAL DATA

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

Capacitance

Rated capacitance values (C_R) at 1 kHz	see Table 1 to 4
Tolerance on rated capacitance	±5%, ±2% and ±1%
Temperature coefficient	−125 ± 60 ppm/°C
Frequency dependence between 100 Hz and 1 MHz	none

Voltage

Rated voltage U_R (d.c.)	63 V, 160 V, 250 V, 630 V
Rated voltage U_R (a.c.), 50 to 60 Hz	
63 V version	25 V
160 V version	63 V
250 V version	125 V
630 V version	250 V
Category voltage U_C	1 x U_R (d.c.)
Test voltage for 1 min	
between terminals	2 x U_R (d.c.)
between interconnected terminals and case	2 x U_R (d.c.) (minimum 400 V)

Insulation resistance

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

	ambient temperature	
	23 °C	85 °C *
R between terminals, for C ⩽ 100 000 pF	> 500 000 MΩ	> 100 000 MΩ
RC between terminals, for C > 100 000 pF	> 50 000 s	> 10 000 s
R between interconnected terminals and case	> 500 000 MΩ	> 100 000 MΩ

* 70 °C for 63 V version.

Tan δ (tangent of the loss angle)

Tan δ at 10 kHz, for $C_R > 20\,000$ pF	$\leqslant 5 \times 10^{-4}$
Tan δ at 100 kHz, for $C \leqslant 20\,000$ pF	$\leqslant 5 \times 10^{-4}$

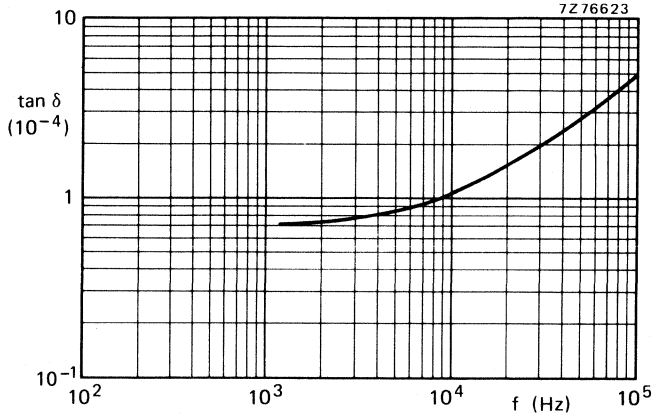


Fig.2 Tan δ as a function of frequency; typical curve.

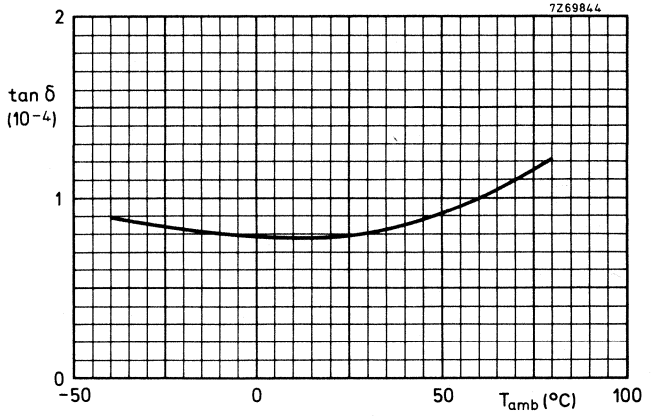


Fig.3 Tan δ as a function of temperature; typical curve.

Resonant frequency

Resonant frequency		
length between soldering points 30 mm	$\frac{919}{\sqrt{C}}$ MHz	C in pF
length between soldering points 40 mm	$\frac{796}{\sqrt{C}}$ MHz	C in pF

Temperature

Rated temperature	
63 V version	70 °C
160 V, 250 V and 630 V versions	85 °C
Category temperature range	
63 V version	−40 to +70 °C
160 V, 250 V and 630 V versions	−40 to +85 °C
Storage temperature range	
63 V version	−55 to +70 °C
160 V, 250 V and 630 V versions	−55 to +85 °C
Climatic category, IEC 68	
63 V version	40/070/56
160 V, 250 V and 630 V versions	40/085/56

PACKING

The capacitors are supplied in cardboard boxes; the number of capacitors per box is given in Table 5.

Table 5

capacitance values (pF) of				number of capacitors per box
63 V version	160 V version	250 V version	630 V version	
43000-56000	18000-30000	12000-18000	6200-8200	600
62000-91000	33000-47000	20000-27000	9100-12000	500
100000-130000	51000-68000	30000-43000	13000-18000	400
150000-162000	75000-82000	47000	20000-24000	300

TESTS AND REQUIREMENTS

IEC 384-7 clause	IEC 68–2 test method	name of test	procedure (quick reference)	requirements
12.1	Ua1	Tensile strength	Loading force 10 N in axial direction of the wires, 10 s.	No damage. Tan δ shall meet initial requirements.
	Ub (method 1)	Bending of terminations	Loading force 5 N, two consecutive bends.	
	Uc	Torsion of terminations	Two successive rotations of 180° in opposite directions.	
12.2	Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. 235 °C, dwell time 2 s.	Good tinning.
	Tb method 1A	Resistance to soldering heat	Solder bath: 260 °C, 10 s.	$\Delta C/C \leqslant 0{,}5\%$; tan δ shall meet initial requirements.
12.3	Na	Rapid change of temperature	5 cycles of ½ h at −40 °C and ½ h at +70 °C (63 V version) or +85 °C (other versions).	No damage; $\Delta C/C \leqslant 0{,}5\%$. Tan δ shall meet initial requirements.
12.4	Fc	Vibration	10 to 55 Hz, 0,75 mm or 10g (whichever is the less), 3 directions, 2 h per direction.	No damage.

IEC 384-7 clause		IEC 68–2 test method	name of test	procedure (quick reference)	requirements
Climatic sequence	12.7	Ba	Dry heat	16 h at +70 ± 2 °C (63 V version) or 16 h at +85 ± 2 °C (160 V, 250 V, 630 V versions); no voltage applied.	No damage.
		Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.	
		Aa	Cold	2 h at −40 ± 3 °C; no voltage applied.	
		M	Low air pressure	1 h at 25 ± 5 °C, at atmospheric pressure of 8,5 kPa	During and after the test there shall be no breakdown or flashover.
		Db	Damp heat, cyclic	5 cycles of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied. Within 15 min after removal from the test, the rated voltage shall be applied for 1 min.	
				Final measurement.	$\Delta C/C \leqslant 0{,}5\%$. Tan $\delta \leqslant 2$ x initial requirements. Insulation resistance $> 0{,}2$ x initial requirements.
	12.8	Ca	Damp heat, steady state	56 days at 40 ± 2 °C and R.H. 90 to 95%; no voltage applied. Within 15 min after removal from the test, the rated voltage shall be applied for 1 min.	$\Delta C/C \leqslant 0{,}75\%$. Tan $\delta \leqslant 2$ x initial requirements. Insulation resistance $> 0{,}2$ x initial requirements.

IEC 384-7 clause	IEC 68–2 test method	name of test	procedure (quick reference)	requirements
12.9		Endurance	1000 h at 70 °C (63 V version) or at 85 °C (160 V, 250 V, 630 V versions); 1,5 x U_R (d.c.) applied.	$\Delta C/C \leqslant 0{,}3\%$ (63 V version), $\leqslant 0{,}5\%$ (other versions). Tan $\delta \leqslant$ initial requirements or $\leqslant 1{,}4$ x initial measurements. Insulation resistance meets initial requirements.
12.10	Hb	Storage at low temperature	72 h at –55 °C.	No breakdown; $\Delta C/C \leqslant 0{,}25\%$.

→

Note
Standard atmospheric conditions for referee tests: ambient temperature 23 ± 1 °C, atmospheric pressure 86 to 106 kPa and R.H. 50 ± 2%.

POLYPROPYLENE FILM/FOIL CAPACITORS

axial type (KP)

QUICK REFERENCE DATA

Rated capacitance range	47 to 56 000 pF
Tolerance on rated capacitance	± 5% (E24-series) ± 2% (E24-series and E48-series)
Rated voltage U_R (d.c.)	63 V, 160 V, 250 V, 630 V
Rated voltage U_R (a.c.), 50 to 60 Hz	25 V, 63 V, 125 V, 200 V
Rated temperature	85 °C
Climatic category, IEC 68	40/100/21

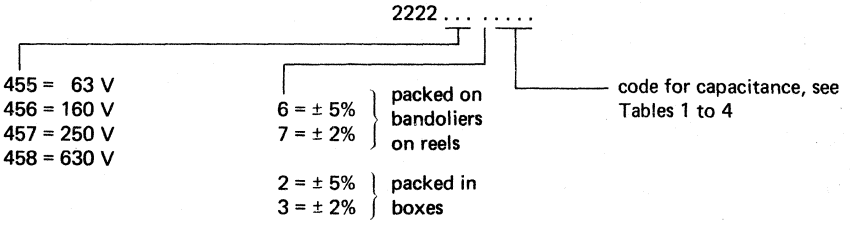
APPLICATION

For use in circuits where precision, 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 aluminium foil with a polypropylene film. The cell is covered with a blue plastic film. The long, axial leads of solder-coated wire make the capacitor suitable for vertical or horizontal mounting on printed-wiring boards.

Composition of the catalogue number



MECHANICAL DATA

Dimensions in mm

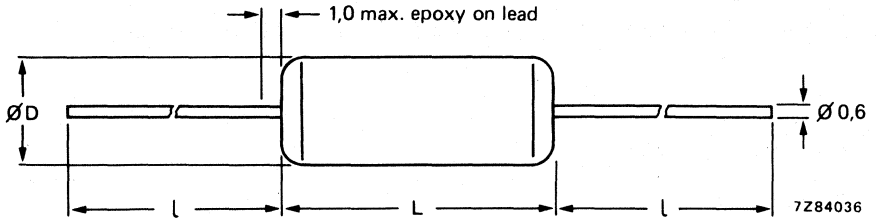


Fig. 1 For dimensions D, L and l see tables below.

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

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number (packed on bandoliers on reels)
3 300	4,0	11,0	30	0,3	2222 455 63302
3 600					63602
3 900					63902
4 300					64302
4 700	4,5				64702
5 100					65102
5 600					65602
6 200					66202
6 800	5,0			0,4	66802
7 500					67502
8 200					68202
9 100					69102
10 000	4,5	15,0	28	0,5	61003
11 000					61103
12 000					61203
13 000	5,0				61303
15 000					61503
16 000					61603
18 000	5,5			0,6	61803
20 000					62003
22 000					62203
24 000	6,0				62403
27 000					62703
30 000	6,5			0,7	63003
33 000					63303
36 000	7,0			0,8	63603
39 000					63903
43 000	7,5			0,9	64303
47 000					64703
51 000	8,0			1,0	65103
56 000					65603

* Besides the values of the E24-series with a tolerance ± 5% as quoted, these values and intermediate values of the E48-series are available with a tolerance ± 2%.

Table 2 U_R (d.c.) = 160 V; U_R (a.c.) = 63 V

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number (packed on bandoliers on reels)
1 800	4,0	11,0	30	0,3	2222 456 61802
2 000					62002
2 200					62202
2 400					62402
2 700					62702
3 000	4,5				63002
3 300					63302
3 600					63602
3 900					63902
4 300	5,0			0,4	64302
4 700					64702
5 100					65102
5 600					65602
6 200	4,5	15,0	28	0,5	66202
6 800					66802
7 500					67502
8 200	5,0				68202
9 100					69102
10 000					61003
11 000	5,5			0,6	61103
12 000					61203
13 000					61303
15 000	6,0				61503
16 000					61603
18 000	6,5			0,7	61803
20 000					62003
22 000	7,0			0,8	62203
24 000					62403
27 000	7,5			0,9	62703
30 000					63003
33 000	8,0			1,0	63303
36 000					63603

* Besides the values of the E24-series with a tolerance ± 5% as quoted, these values and intermediate values of the E48-series are available with a tolerance ± 2%.

Table 3 U_R (d.c.) = 250 V; U_R (a.c.) = 125 V

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number (packed on bandoliers on reels)
1 000	4,0	11,0	30	0,3	2222 457 61002
1 100					61102
1 200					61202
1 300					61302
1 500					61502
1 600	4,5				61602
1 800					61802
2 000					62002
2 200					62202
2 400	5,0			0,4	62402
2 700					62702
3 000					63002
3 300	4,5	15,0	28		63302
3 600					63602
3 900					63902
4 300					64302
4 700	5,0				64702
5 100					65102
5 600					65602
6 200	5,5			0,5	66202
6 800					66802
7 500					67502
8 200	6,0				68202
9 100					69102
10 000	6,5			0,6	61003
11 000					61103
12 000	7,0			0,7	61203
13 000					61303
15 000	7,5			0,8	61503
16 000					61603
18 000	8,0			0,9	61803
20 000					62003

* Besides the values of the E24-series with a tolerance ± 5% as quoted, these values and intermediate values of the E48-series are available with a tolerance ± 2%.

Table 4 U_R (d.c.) = 630 V; U_R (a.c.) = 200 V

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	I_{min}	approx. mass g	catalogue number (packed on bandoliers on reels)
47	4,0	11,0	30	0,3	2222 458 64709
51					65109
56					65609
62					66209
68					66809
75					67509
82					68209
91					69109
100					61001
110					61101
120					61201
130					61301
150					61501
160					61601
180					61801
200					62001
220					62201
240					62401
270					62701
300					63001
330					63301
360					63601
390					63901
430					64301
470					64701
510					65101
560					65601
620					66201
680	4,5				66801
750					67501
820					68201
910					69101
1 000	5,0			0,4	61002
1 100					61102
1 200					61202
1 300	4,5	15,0	28		61302
1 500					61502
1 600					61602
1 800					61802

* Besides the values of the E24-series with a tolerance ± 5% as quoted, these values and intermediate values of the E48-series are available with a tolerance ± 2%.

Table 4 U_R (d.c.) = 630 V; U_R (a.c.) = 200 V (continued)

rated capacitance (E24-series, tol. ± 5%)* pF	D_{max}	L_{max}	l_{min}	approx. mass g	catalogue number (packed on bandoliers on reels)
2 000	5,0	15,0	28	0,4	2222 458 62002
2 200					62202
2 400					62402
2 700	5,5			0,5	62702
3 000					63002
3 300					63302
3 600	6,0				63602
3 900					63902
4 300	6,5			0,6	64302
4 700					64702
5 100	7,0				65102
5 600					65602
6 200	7,5			0,7	66202
6 800					66802
7 500	8,0			0,8	67502
8 200					68202

Marking

The capacitors are marked as follows:
1st line: rated capacitance code;
2nd line: tolerance code (G = ± 2%, J = ± 5%) and rated voltage (d.c.);
3rd line: production date code and code for dielectric material (KP = polypropylene film/foil);
4th line: name of manufacturer.

Note: rated capacitance, tolerance, and production date code are according to IEC 62.

Mounting

The capacitors are suited for horizontal or vertical mounting on printed-wiring boards. When mounting vertically on boards with plated-through holes, the capacitors must be mounted with a minimum height of 1 mm above the board.

* Besides the values of the E24-series with a tolerance ± 5% as quoted, these values and intermediate values of the E48-series are available with a tolerance ± 2%.

DEVELOPMENT SAMPLE DATA

ELECTRICAL DATA

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

Capacitance

Rated capacitance values (C_R) at 1 kHz	see Tables 1 to 4
Tolerance on rated capacitance	± 5% and ± 2%
Temperature coefficient	−125 ± 60 ppm/°C

Voltage

Rated voltage U_R (d.c.)	63 V, 160 V, 250 V, 630 V
Rated voltage U_R (a.c.), 50 to 60 Hz	
63 V version	25 V
160 V version	63 V
250 V version	125 V
630 V version	200 V
Category voltage U_C	0,8 x U_R (d.c.)
Test voltage for 1 min	
between terminals	2 x U_R (d.c.)
between interconnected terminals and coating	2 x U_R (d.c.) (minimum 400 V)

Insulation resistance

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

	ambient temperature	
	23 °C	85 °C
R between terminals	> 100 000 MΩ	> 100 000 MΩ

Tan δ (tangent of the loss angle)

Tan δ at 1 MHz, for $C_R \leqslant 1000$ pF	$\leqslant 10 \times 10^{-4}$
Tan δ at 100 kHz,	
for 1000 pF < $C_R \leqslant$ 5000 pF	$\leqslant 10 \times 10^{-4}$
for 5000 pF < $C_R \leqslant$ 20 000 pF	$\leqslant 15 \times 10^{-4}$
Tan δ at 10 kHz for $C_R >$ 20 000 pF	$\leqslant 10 \times 10^{-4}$

Induction

Maximum induction	10 nH/cm lead and capacitor length

Temperature

Rated temperature	85 °C
Category temperature range	−40 to + 100 °C
Storage temperature range	−40 to + 100 °C
Climatic category, IEC 68	40/100/21

PACKING

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

Packing on bandoliers on reels

Dimensions in mm

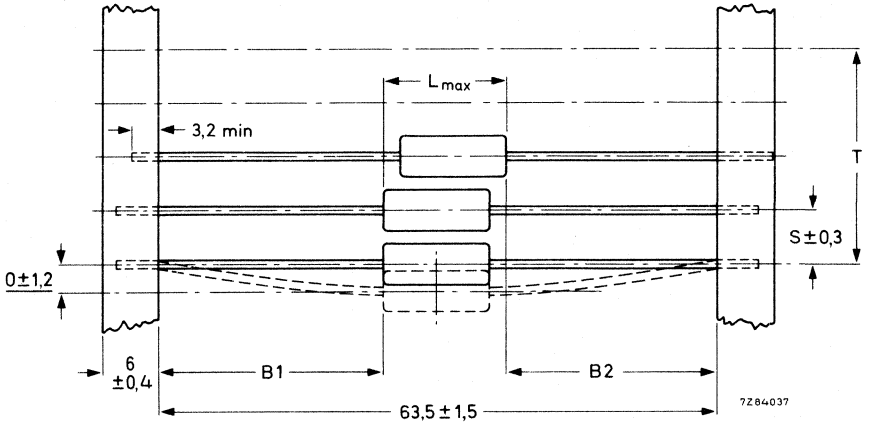
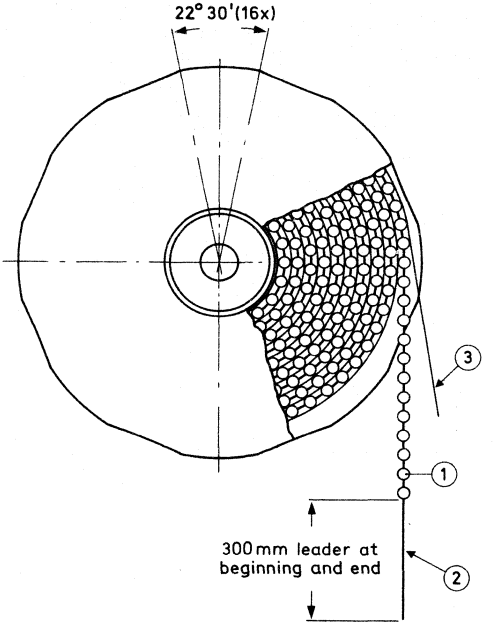


Fig. 2 |B1−B2| = max. 1,4; for dimension L_{max} see Tables 1 to 4.

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
3300– 6 200	1800– 3 900	1000– 2 200	47–910	5	5(n - 1) ± 2	5(n - 1) ± 4
6800–56 000	4300–36 000	2400–20 000	1000–8200	10	10(n - 1) ± 2	10(n - 1) ± 4



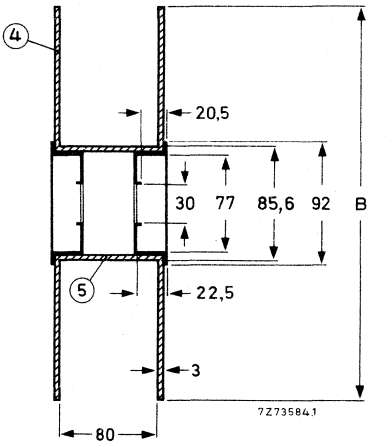


Fig. 3 1: capacitor 4: flange
2: bandolier 5: cylinder
3: paper

capacitance values (pF) of				B	number of capacitors on one reel
63 V version	160 V version	250 V version	630 V version		
3 300– 6 200	1 800– 3 900	1 000– 2 200	47–910	305	2500
6 800– 9 100	4 300– 5 600	2 400– 3 000	1000–1200	356	1500
10 000–12 000	6 300– 7 500	3 300– 4 300	1300–1800	305	2500
13 000–27 000	8 200–16 000	4 700– 9 100	2000–3900	356	1500
30 000–56 000	18 000–36 000	10 000–20 000	4300–8200	356	1000

Packing in cardboard boxes

capacitance values (pF) of				number of capacitors per box
63 V version	160 V version	250 V version	630 V version	
3 300– 4 300	1 800– 2 700	1 000– 1 500	47–620	400
4 700– 6 200	3 000– 3 900	1 600– 2 200	680–910	300
6 800– 9 100	4 300– 5 600	2 400– 3 000	1000–1200	250
10 000–12 000	6 200– 7 500	3 300– 4 300	1300–1800	400
13 000–16 000	8 200–10 000	4 700– 5 600	2000–2400	300
18 000–27 000	11 000–16 000	6 200– 9 100	2700–3900	250
30 000–33 000	18 000–20 000	10 000–11000	4300–4700	200
36 000–56 000	22 000–36 000	12 000–20 000	5100–8200	150

TESTS AND REQUIREMENTS

IEC 68–2 test method	name of test	procedure (quick reference)	requirements
Ua1	Tensile strength of terminations	Loading force 10 N in axial direction of the wires, 10 s.	No damage.
Ub (method 1)	Bending of terminations	Loading force 5 N, two consecutive bends.	No damage.
Uc	Torsion of terminations	Two successive rotations of 180° in opposite directions.	No damage.
Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. 235 °C, dwell time 2 s.	Good tinning
Tb (method 1A)	Resistance to soldering heat	Solder bath, 260 °C, 5 s.	No damage; $\Delta C/C \leqslant 1\%$.
Na	Rapid change of temperature	5 cycles of ½ h at −40 °C and ½ h at + 85 °C.	No damage, no leakage; $\Delta C/C \leqslant 1\%$. Tan δ and insulation resistance shall meet initial requirements.
		5 cycles of ½ h at −40 °C and ½ h at + 100 °C.	$\Delta C/C \leqslant 1{,}5\%$. Tan δ and insulation resistance shall meet initial requirements.

IEC 68–2 test method		name of test	procedure (quick reference)	requirements	
Climatic sequence	Ba	Dry heat	16 h at 100 ± 2 °C; no voltage applied.		
	Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.		
	Aa	Cold	2 h at −40 ± 3 °C; no voltage applied.		
	Db	Damp heat, cyclic	1 cycle of 24 h, upper temperature 55 ± 2 °C, R.H. 93 ± 3%; no voltage applied.		
			Final measurement.	No damage, no leakage; $\Delta C/C \leqslant 0{,}5\%$. Tan $\delta \leqslant 2$ x initial requirements; insulation resistance $> 0{,}5$ x initial requirements.	
Ca		Damp heat, steady state	21 days at 40 ± 2 °C and R.H. 90 to 95%; 6 V applied continuously.	$\Delta C/C \leqslant 0{,}5\%$. Tan $\delta \leqslant 2$ x initial requirements; insulation resistance $> 0{,}5$ x initial requirements.	
		Endurance	1000 h at 85 °C; 1,5 x U_R (d.c.) applied. 1000 h at 85 °C; 1,25 x U_R (a.c.) applied.	$\Delta C/C \leqslant 0{,}5\%$.	Tan $\delta \leqslant 1{,}4$ x initial requirements; insulation resistance $\geqslant$ inital requirements.
			1000 h at 100 °C; 1,5 x U_R (d.c.) applied.	$\Delta C/C < 1\%$	
Hb		Storage	72 h at −55 °C.	$\Delta C/C \leqslant 0{,}5\%$.	
			1000 h at 100 °C.	$\Delta C/C \leqslant 1\%$.	

Additional test

name of test	procedure (quick reference)	requirements
Soldering test for mounting on printed-wiring boards	Capacitors mounted horizontally on a 1,6 mm board, with non-plated-through holes; bodies rest on the board; without forced cooling. Body temperature: 70 ± 5 °C, bath temperature: 250 ± 10 °C, dwell time: 5 ± 0,5 s.	No damage; $\Delta C/C \leqslant 1\%$.

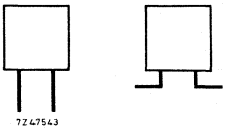
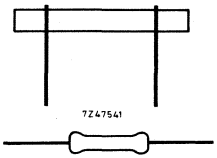
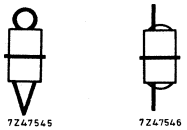
Note

Standard atmospheric conditions for referee tests: ambient temperature 23 ± 1 °C, atmospheric pressure 86 to 106 kPa and R.H. 50 ± 2%.

CERAMIC CAPACITORS

SURVEY

Application type 1 — for tuning and other applications where low losses and a linear temperature dependence are required.
Application type 2 and 3 — for all coupling and decoupling purposes.

version	application	capacitance range pF	rated d.c. voltage V	capacitor series	page
plate 	type 1	0,56– 560	100	2222 631, 632 2222 638, 665 2222 641–643	83
	type 1	0,47– 270	500	2222 650	101
		1 000– 22 000	63	2222 629	
	type 2	180– 4 700	100	2222 630	
		1 000– 10 000	100	2222 640	69
	type 2	100– 2 700	500	2222 655	111
tubular 	type 1	1– 560	500	2222 555	57
	type 2	680– 10 000	500	2222 552	53
	safety	22– 4 700	400 (a.c.)	2212 619	21
	type 1	1– 180	50		
	type 2	150– 1 500	50	2020 561	9
	type 3	1 500– 22 000	50, 25 or 16		
disc 	type 1	0,47– 47	400	2222 625 2222 626	61
	type 2	27– 3 900	400	2222 627	65
	type 2	1,5– 4 700	500	2212 657	27
	pulse voltages	33– 560	2 000	2212 659	35
	interference suppression	220– 2 200	250 (a.c.)	2212 660	41
	safety	33– 1 000	400 (a.c.)	2212 661	47
feed-through 	type 2	2,5– 2 200	400	2222 700*	
		2,5– 4 700	400	2222 702*	119
chip 	type 1	10– 33 000	50	2222 851–856	123
	type 2	180–470 000	50		

* Obsolescent.

MARKING

Colour code

	temperature coefficient	capacitance value: first digit	capacitance value: second digit	capacitance value: multiplier for the capacitance	tolerance on capacitance: C ≤ 10 pF (pF)	tolerance on capacitance: C > 10 pF (%)
red/violet	P100					
black	NP0		0	1		±20
brown	N033	1	1	10	±0,1	±1
red	N075	2	2	10^2	±0,25	±2
orange	N150	3	3	10^3		
yellow	N220	4	4	10^4		
green	N330	5	5		±0,5	±5
blue	N470	6	6			
violet	N750	7	7			
grey		8	8	10^{-2}		
white		9	9	10^{-1}	±1	±10
orange/orange	N1500					

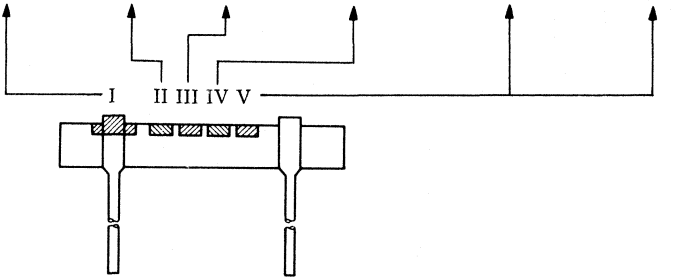
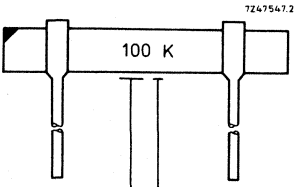


Figure code



colour code for temp. coefficient, see Table above

capacitance value in pF, using K for the thousands

code for tolerance on capacitance:

C ≤ 10 pF		C > 10 pF	
tol (pF)	code	tol (%)	code
±0,25	C	±1	F
±0,5	D	±2	G
±1	F	±5	J
		±10	K
		±20	M
		-20/+50	S

INTRODUCTION

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

Ceramic capacitors can be divided into three classes:

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

Type 2 These capacitors show higher losses and have non-linear temperature characteristics ($\epsilon_r > 250$). They are used in all kinds of electronic circuits for coupling and decoupling purposes.

The survey below shows the various materials we use with their basic chemical composition.

TYPE 1 ϵ_r = 6 up to 250 T.C. types			TYPE 2 ϵ_r > 250 high-K types
P100	(+100 ppm/°C)	$MgTiO_3$, Mg_2SiO_4	ϵ_r = 2000 $BaTiO_3$
NP0	(0 ,, ,,)	$MgTiO_3$	ϵ_r = 5000 (Ba, Ca)(Ti, Zr)O_3 + add.
N075	(-75 ,, ,,)	$Ba_2Ti_9O_{20}+TiO_2$	ϵ_r = 16000 (Ba, Ca)(Ti, Zr)O_3 + add.
N150	(-150 ,, ,,)		
N220	(-220 ,, ,,)		
N330	(-330 ,, ,,)		
N470	(-470 ,, ,,)		
N750	(-750 ,, ,,)	TiO_2+additions	
N1500	(-1500 ,, ,,)	$CaTiO_3$ + additions	

CONSTRUCTION

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

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

The working voltage is dependent on the dielectric thickness.

Several constructions are shown in the figures below:

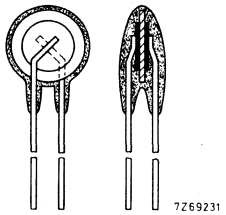


Fig. 1 Disc capacitor.

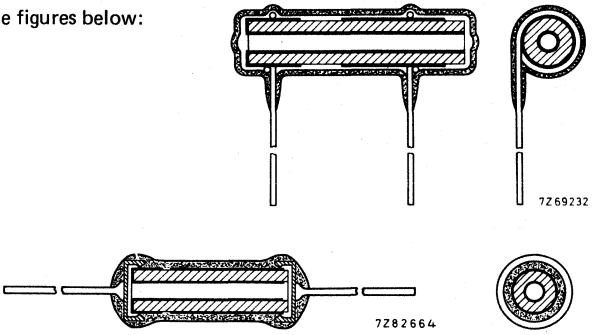


Fig. 2 Tubular capacitors.

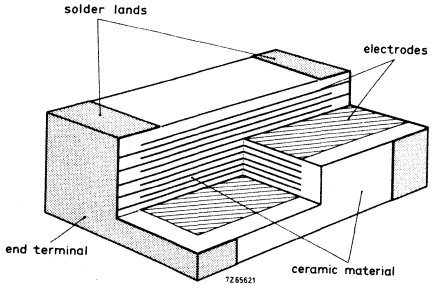


Fig. 3 Cross-section of a chip capacitor.

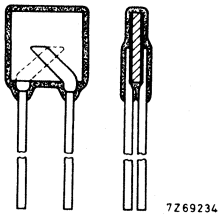


Fig. 4 Plate capacitor.

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

The dielectric material

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

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

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

The capacitance value is marked on the body in clear text or in colour code (see Marking). The temperature coefficient or temperature dependence are indicated by colour coding in accordance with international standards.

EQUIVALENT CIRCUIT

Fig. 5 shows the equivalent circuit of a capacitor.

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

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

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

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

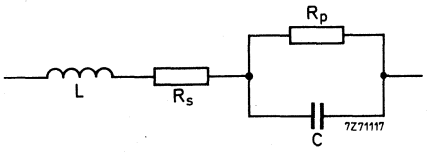


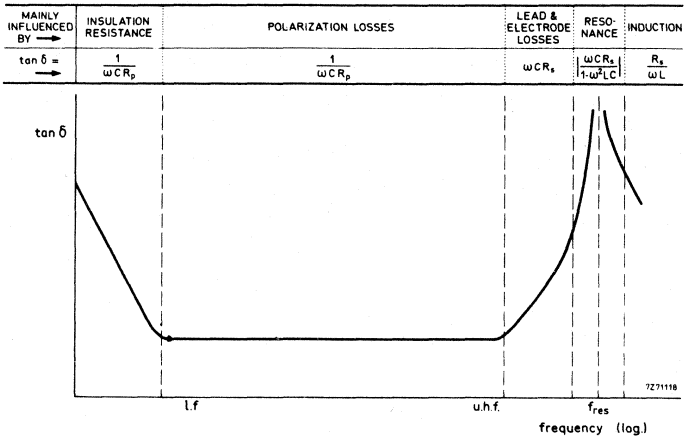
Fig. 5

TANGENT OF THE LOSS ANGLE

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

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

From this formula, tan δ can be derived for different frequency ranges as shown diagrammatically in the graph of Fig. 6.



RELIABILITY *)

The following reliability data on our ceramic capacitors are available

range		F.R. in 10^{-6}/h			
		catastrophic + degradation		catastrophic	
		test	normalized	test	normalized
Tubular capacitors	2222 552	2,4	0,09	2,4	0,09
	2222 555	2,1	0,09	0,8	0,03
Plate capacitors	2222 629	1,5	0,09	0,33	0,02
	2222 630	0,4	0,01	0,4	0,01
	2222 631-2222 643	2	0,04	1,4	0,03
	2222 650	0,96	0,02	0,37	0,01
	2222 655	1,2	0,03	1,2	0,03

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

Catastrophic failures are open and short circuits and insulation resistance too low.
The degradation failures include
tan δ > 2 x requirement after 1000 h
R_{ins} < 0,1 x requirement after 1000 h

The Failure Rate has a confidence level of 60%.

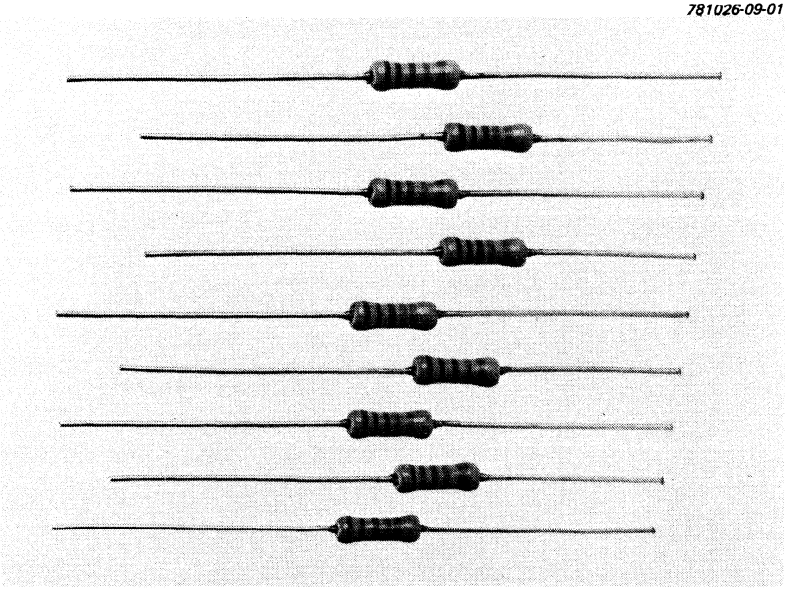
*) Detailed information is given in our Product Informations 30 and 39.

TUBULAR CERAMIC CAPACITORS

QUICK REFERENCE DATA

Capacitance range	1 pF to 22 000 pF
Rated d.c. voltage	
1 to 10 000 pF (types UP125, UP250)	50 V
6800 to 22 000 pF (types TP125, TP250)	25 V
22 000 pF (type EP125)	16 V
Type 1	NP0, N30, N80, N150, N220, N330, N470, N750, SL
Type 2	SB (2B4), SD (2E4)
Type 3	V (3B4), X (3C4), Y (3D4)

781026-09-01



APPLICATION

Axial-lead tubular ceramic capacitors are developed for automatic insertion into printed circuits.

DESCRIPTION

The capacitors consist of a ceramic tube, internally and partly externally metallized. Contact caps of special alloy are pressed onto the ends of the tube and tinned copper connecting wires are welded to these caps. A coating protects the capacitors against atmospheric influences.

MECHANICAL DATA

Dimensions in mm

Outlines

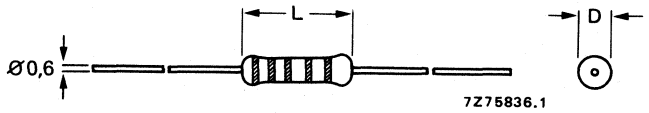


Fig. 1.

Configuration of tape

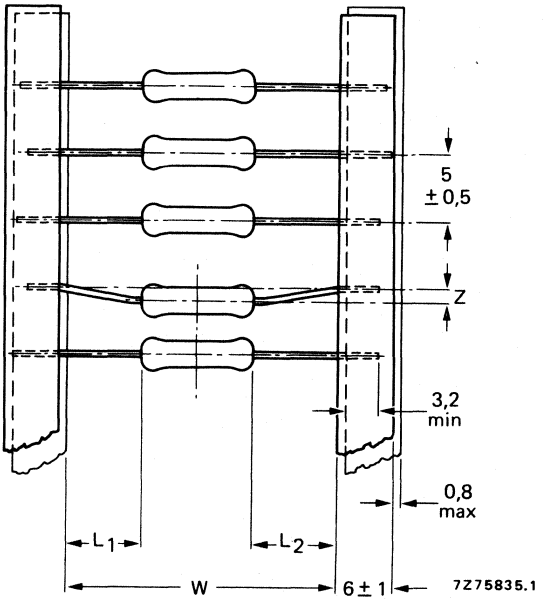


Fig. 2.

size	L max.	D max.	W	Z max.	$L_1 - L_2$ max.
125	7,1	2,8	52^{+2}_{-1}	1,2	1
250	9,1	3,0			

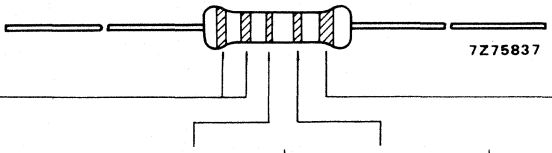
Packing

	box packing (ammunition box)	reel packing
Size 125	2000 pieces	5000 pieces
Size 250	1500 pieces	4000 pieces

Marking

The capacitors are marked as follows.

Fig. 3.



	capacitance value		tolerance	temperature	
	1st, 2nd digit	multiplier	on capacitance	coeff.	char.
Black	0	10^0	± 20%	NP0	
Brown	1	10^1		N30	Y5S (Y)
Red	2	10^2		N80	Y5T (SD)
Orange	3	10^3		N150	
Yellow	4	10^4		N220	
Green	5			N330	
Blue	6			N470	
Purple	7			N750	
Grey	8		± 30%		Y5R (X)
White	9			SL	
Gold		10^{-1}	± 5%		Y5F (V)
Silver		10^{-2}	± 10%		Y5P (SB)

Body colour

50 V capacitors yellow green
25 V and 16 V capacitors pink

ELECTRICAL DATA – TYPE 1

Capacitance values at 1 MHz, ⩽ 5 V		1 to 180 pF, E12 series
	non-preferred	10 to 100 pF, E24 series
Tolerance on capacitance		± 5, ± 10, or ± 20%
Rated d.c. voltage		50 V
Test voltage (d.c.) for 1 to 5 s		150 V
Insulation resistance at 50 V (d.c.) after 1 min		min. 10 000 MΩ
Q at 1 MHz, ⩽ 5 V (see Fig. 4)		
C ⩾ 30 pF		min. 1000
C < 30 pF		min. 400 + 20C
Temperature range		−30 to + 85 °C

See further Table 1

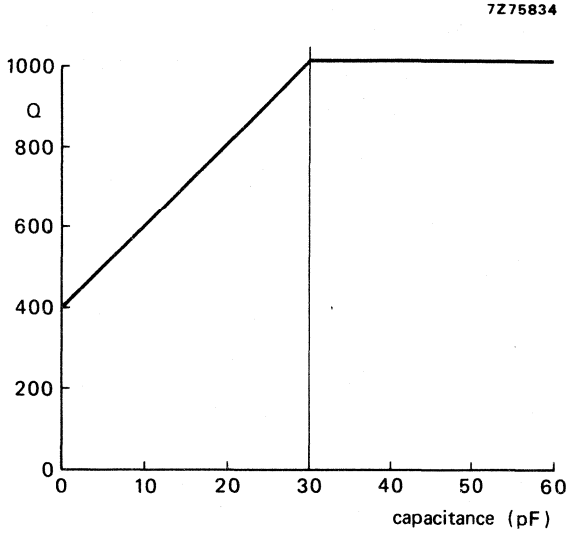


Fig. 4.

Table 1. Type 1 – 50 V

capacitance pF	tol.	suffix of catalogue number for box packing▲ NP0 ± 60	N30 ± 60	N80 ± 60	N150 ± 60
1	± 20%				
1,2					
1,5					
1,8					
2,2	± 10%				
2,7					
3,3		02338	04338	06338	08338
3,9		02398	04398	06398	08398
4,7		02478	04478	06478	08478
5,6		02568	04568	06568	08568
6,8		02688	04688	06688	08688
8,2		02828	04828	06828	08828
10	± 5%	03109	05109	07109	09109
11		03119	05119	07119	09119
12		03129	05129	07129	09129
13		03139	05139	07139	09139
15		03159	05159	07159	09159
16		03169	05169	07169	09169
18		03189	05189	07189	09189
20		03209	05209	07209	09209
22		03229	05229	07229	09229
24		03249	05249	07249	09249
27		03279	05279	07279	09279
30		03309	05309	07309	09309
33		03339	05339	07339 *	09339
36		03369	05369	07369 *	09369 *
39		03399	05399	07399 *	09399 *
43		03439	05439	07439 *	09439 *
47		03479 *	05479 *	07479 *	09479 *
51		03519 *	05519 *	07519 *	09519 *
56		03569 *	05569 *		
62		03629 *	05629 *		
68		03689 *	05689 *		
75					
82					
91					
100					
120					
150					
180					
▲ for reel packing replace		02 by 31 03 by 32	04 by 33 05 by 34	06 by 35 07 by 36	08 by 37 09 by 38

* These capacitors are size 250, all other capacitors are size 125.

suffix of catalogue number for box packing▲

N220 ± 60	N330 ± 60	N470 ± 60	N750 ± 120	SL	capacitance pF
				18108	1
				18128	1,2
				18158	1,5
				18188	1,8
				19228	2,2
				19278	2,7
10338				19338	3,3
10398				19398	3,9
10478	12478			19478	4,7
10568	12568			19568	5,6
10688	12688	14688		19688	6,8
10828	12828	14828	16828	19828	8,2
11109	13109	15109	17109	20109	10
11119	13119	15119	17119	20119	11
11129	13129	15129	17129	20129	12
11139	13139	15139	17139	20139	13
11159	13159	15159	17159	20159	15
11169	13169	15169	17169	20169	16
11189	13189	15189	17189	20189	18
11209	13209	15209	17209	20209	20
11229	13229	15229	17229	20229	22
11249	13249	15249	17249	20249	24
11279	13279	15279	17279	20279	27
11309	13309	15309	17309	20309	30
11339	13339	15339	17339	20339	33
11369	13369	15369	17369	20369	36
11399	13399	15399	17399	20399	39
11439 *	13439 *	15439	17439	20439	43
11479 *	13479 *	15479	17479	20479	47
11519 *	13519 *	15519	17519	20519	51
11569 *	13569 *	15569 *	17569	20569	56
11629 *	13629 *	15629 *	17629	20629	62
11689 *	13689 *	15689 *	17689	20689	68
11759 *		15759 *	17759	20759	75
11829 *		15829 *	17829	20829	82
			17919 *	20919	91
			17101 *	20101	100
			17121 *	20121	120
				20151 *	150
				20181 *	180
10 by 39 11 by 40	12 by 41 13 by 42	14 by 43 15 by 44	16 by 45 17 by 46	18 by 47 19 by 48 20 by 49	▲

* These capacitors are size 250, all other capacitors are size 125.

ELECTRICAL DATA – TYPE 2 AND 3

	type 2	type 3
Capacitance values at 1 kHz, 1 ± 0,5 V	150 to 1500 pF E12 series	1500 to 22 000 pF E6 series
Tolerance on capacitance	± 10 or ± 20%	± 10 or ± 20 and/or ± 30%
Rated d.c. voltage (U_R)		
up to 4700 pF	50 V	50 V
6800 to 22 000 pF	25 V	25 V
22 000 pF		16 V
Test voltage (d.c.) for 1 to 5 s		
temp. characteristics Y5P and Y5T	3 x U_R	
temp. characteristics Y5F and Y5R		1,5 x U_R
temp. characteristic Y5S		18 V
Insulation resistance at U_R after 1 min		
50 V types	min. 10 000 MΩ	
25 V and 16 V types		min. 1000 MΩ
Tan δ at 1 kHz, 1 ± 0,5 V	max. 1,5% (1000 pF char. Y5P max. 2,5%)	max. 1,5% (22 000 pF char. Y5S max. 3%)
Temperature range	–30 to + 85 °C	–30 to + 85 °C

See further Table 2 and graphs

Table 2. Type 2

capacitance	size	voltage		temp. charact.	box packing ▼ suffix of catalogue number for capacitance tolerance of: ± 10%	± 20%	± 30%
150	125	50 V	type 2	Y5P (SB)	21151		
180					21181		
220					21221		
270					21271		
330					21331		
390					21391		
470					21471		
560					21561		
680					21681		
820					21821		
1000					21102		
1000				Y5T (SD)		23102	
1200						23122	
1200	250			Y5P (SB)	21122		
1500					21152		
1500	125		type 3	Y5R (X)		24152	27152
1500				Y5F (V)	22152		
2200				Y5R (X)		24222	27222
2200				Y5F (V)	22222		
3300				Y5R (X)		24332	27332
3300				Y5F (V)	22332		
4700				Y5R (X)		24472	27472
4700				Y5F (V)	22472		
6800	125	25 V		Y5R (X)		25682	28682
10 000	125	25 V		Y5R (X)		25103	28103
15 000	125	25 V		Y5R (X)			28153
22 000	250	25 V		Y5R (X)			28223
22 000	125	16 V		Y5S (Y)			30223
				▼ for reel packing replace	21 by 50 22 by 51	23 by 52 24 by 53 25 by 54	27 by 56 28 by 57 30 by 59

Capacitance change with respect to the capacitance at +20 °C as a function of temperature for the different dielectrics; guaranteed limits.

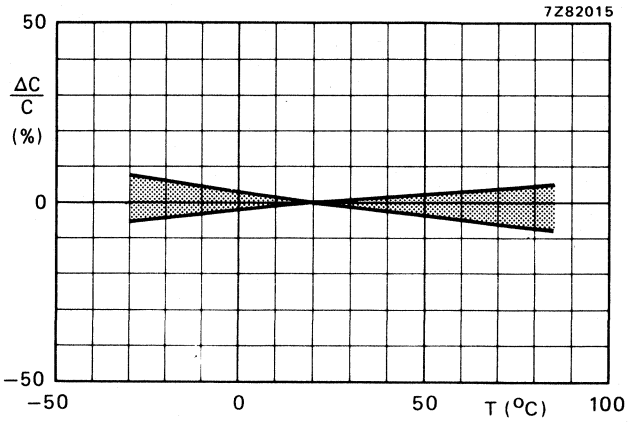


Fig. 5 Characteristic Y5F (V, 3B4).

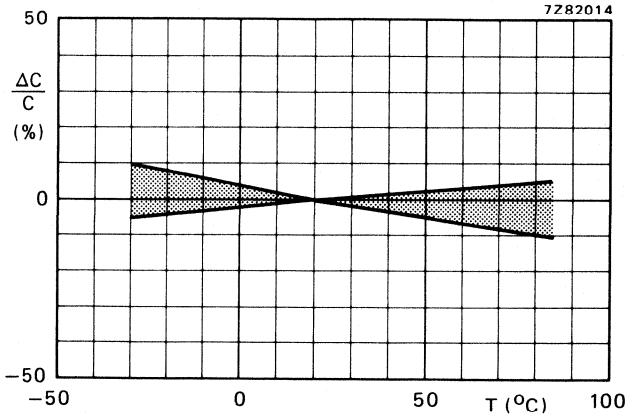


Fig. 6 Characteristic Y5P (SB, 2B4).

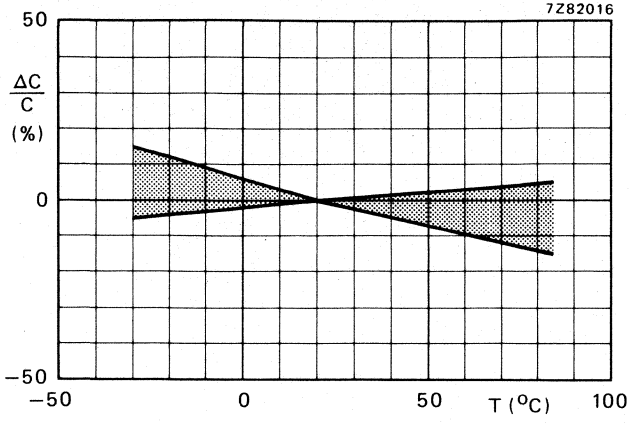


Fig. 7 Characteristic Y5R (X, 3C4).

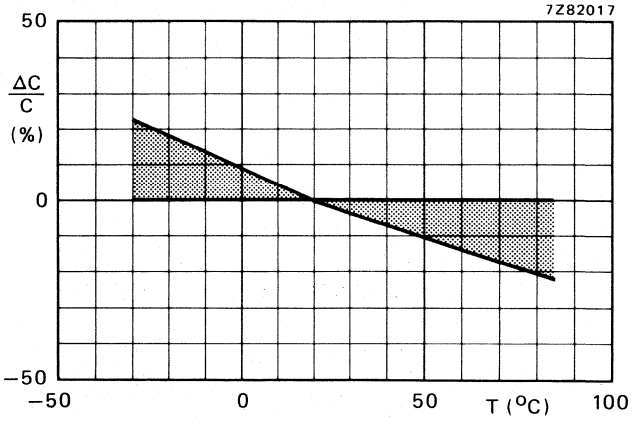


Fig. 8 Characteristic Y5S (Y, 3D4).

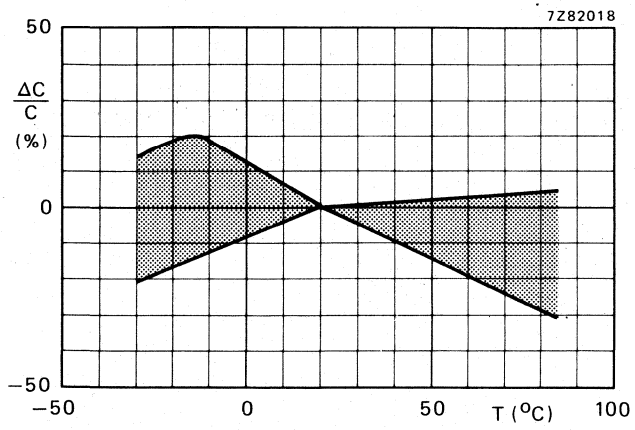


Fig. 9 Characteristic Y5T (SD, 2E4).

TUBULAR CERAMIC CAPACITORS

safety

QUICK REFERENCE DATA

Capacitance range	
in type 1B	22 to 330 pF (E12-series)
in type 2	390 to 4700 pF (E12-series)
Rated a.c. voltage	400 V
Tolerance on capacitance	± 20%
Temperature dependence	type 1B, type 2
Climatic category, IEC 68	25/085/21
Basic specification	IEC 65
Approvals	SEV 1016, 1959 VDE 0560, part 2/5. 70 SEMKO 101 amendment 2 DEMKO (permission for application)

APPLICATION

Safety capacitors are coupling capacitors designed to withstand considerable voltages so that they can be employed in circuits where "live" components should be isolated from conductive parts which might be touched. Such is the case with aerial terminals in radio and television sets, but also mains transformers or picture-tube rimbands can be earthed via a safety capacitor.

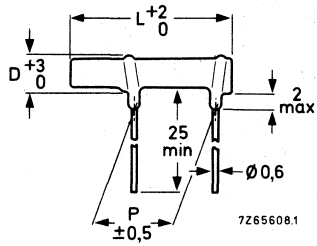
DESCRIPTION

The capacitors consist of a ceramic tube, fully metallized internally, and partly outside, with two tangential leads. An insulated and a non-insulated version are available. The capacitors are tan coloured.

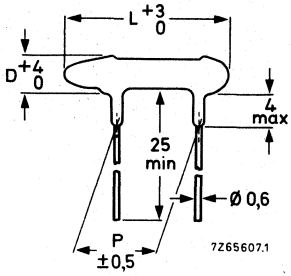
MECHANICAL DATA

Dimensions in mm

Outlines



non-insulated type



insulated type

For dimensions L, D and P, see Table 1

Marking

The body of the capacitors is tan coloured. On the body is indicated in red script for the insulated types and in black script for non-insulated types: the capacitance value, a letter indicating the tolerance (see Table 1), the rated a.c. voltage, the basic part of the catalogue number 619 and the following symbols:

manufacturer's trade mark

VDE mark (Germany)

SEMKO mark (Sweden)

SEV mark (Switzerland)

Approvals: type 1 B insulated : VDE, SEMKO, DEMKO, SEV
type 1 B non-insulated: VDE, SEMKO, DEMKO
type 2 insulated : SEMKO, DEMKO, SEV
type 2 non-insulated: VDE, SEMKO, DEMKO

Mounting

The non-insulated version must be so mounted that it is properly insulated from earth (chassis) and cannot be touched by accident.

Soldering conditions max. 270 °C, max. 5 s

ELECTRICAL DATA

Unless otherwise specified all electrical values apply at an ambient temperature of 20 ± 2 °C, an atmospheric pressure of 930 to 1060 mbar and a relative humidity of max. 75%.

Capacitance values	
measured at 1 MHz, < 5 V for type 1B	22 to 330 pF, see Table 1
measured at 1 kHz, < 1,5 V for type 2	390 to 4700 pF, see Table 1
Tolerance on capacitance	± 20%, see note Table 1
Rated a.c. voltage	400 V
Test voltage (a.c.) for 1 min at 85 °C	2500 V (type test)
Test voltage (a.c.) for 2 s at 15 to 35 °C	2500 V (100% test)
Test voltage (a.c.) of coating for 1 min. insulated type	2500 V
Insulation resistance at 500 V (d.c.) within 1 min.	10 000 MΩ
Tan δ at 1 MHz, < 5 V for type 1B	≤ 10.10^{-4}
at 1 kHz, < 1,5 V for type 2	≤ 3,5%
Category temperature range	−25 to +85 °C
Storage temperature range	−55 to +100 °C
Climatic category (IEC 68)	25/085/21

Table 1

cap. (pF)	type	dimensions			catalogue number with .. suffix
		D	L	P	
22		3	18	10	2212 619 ..229
27		3	18	10	..279
33		3	18	10	..339
39		3	18	10	..399
47		3	20	10	..479
56		3	20	10	..569
68	1B	4	20	10	..689
82	(N750)	4	20	10	..829
100		4	22	12,5	..101
120		4	22	12,5	..121
150		4	24	12,5	..151
180		4	26	15	..181
220		4	30	20	..221
270		4	34	25	..271
330		4	38	27,5	..331
390		4	22	12,5	2212 619 ..391
470		4	22	12,5	..471
560		4	22	12,5	..561
680		4	22	12,5	..681
820		4	22	12,5	..821
1000		4	22	12,5	..102
1200	2	4	22	12,5	..122
1500	(K2000)	4	22	12,5	..152
1800		4	24	12,5	..182
2200		4	26	15	..222
2700		4	28	17,5	..272
3300		4	32	22,5	..332
3900		4	36	25	..392
4700		4	40	30	..472

type	tolerance	suffix for cat. number	
		non-insulated	insulated
1B	± 20% *)	42	52
2	± 20%	62	72

*) For type 1B a capacitance tolerance of ± 10% is available on request.

TESTS AND REQUIREMENTS

Essentially all tests mentioned in the schedule of IEC publication 187, category 25/085/21 (temperature range −25 to +85 °C; damp heat, long term, 21 days) are carried out along the lines of IEC publication 68, see Table below:

IEC 187 clause	IEC 68 test method	test	procedure	requirements
		Robustness of terminations	leads are charged with load of	
14.1	U	Tensile strength of leads	10 N for 10 s in direction of lead	no damage
14.2	Ub	Bending	2 x 90°	no damage
15	T	Soldering (solder bath)	solderability: 4 s 235 °C, non activating flux applied	good tinning
		Climatic sequence		
19.2	B	Dry heat	16 h + 85 °C	no visible damage
19.3	D	Damp heat (accelerated) first cycle	16 h +55 °C 95-100% R.H.	no visible damage after recovery of 1-2 h immediately followed by cold test
19.4	A	Cold	2 h −25 °C	no visible damage
19.6	D	Damp heat (accelerated) remaining cycles	5 cycles 16 h 55 °C 95-100% R.H.	after drying 6 h at 55 °C, 20% R.H. and 1-2 h recovery; $R_{ins} \geq 1500\,M\Omega$ after 24 h $\frac{\Delta C}{C} \leq 5\%$
20.1	Ca	Damp heat (long term)	21 days +40 °C, 90 to 95% R.H.	after drying 6 h at 55 °C ≤ 20% R.H. and 1-2 h recovery: $R_{ins} \geq$ 1500 MΩ, after 24 h $\frac{\Delta C}{C} \leq 5\%$
21.3	–	Endurance	1500 h +85 °C, 800 V a.c. During the test each hour the tension has to rise up to 1600 V a.c. for 0,1 s	after cooling down to 20 °C no breakdown or flash-over; after supply of 2500 V a.c. for 2 s: $R_{ins} \geq$ 1500 MΩ, after 24 h $\frac{\Delta C}{C} \leq 10\%$

TESTS AND REQUIREMENTS (continued)

IEC 65 clause	IEC 68 test method	test	procedure	requirements
14.2	–	Discharge	The capacitor shall be subjected to 50 discharges at a maximum rate of 12 per minute from a 1 nF capacitor charged to 10 kV	1) The component shall withstand without breakdown for a period of 1 minute 2500 V a.c. at 15-35 °C, tension between the terminals. 2) Only for insulated version: Same requirement as under 1), however, tension between the terminals connected together and a metal foil wrapped closely around the body of the capacitor but maintaining a 3 mm distance between the foil and each component terminal. 3) The insulation resistance between the terminals shall not have changed by more than 50% of the value measured before the test.

PACKAGING

250 pcs per box.

Marking on the box: catalogue number, number of pcs, packing date.

CERAMIC DISC CAPACITORS, TYPE 2

QUICK REFERENCE DATA

Capacitance range	1,5 to 4700 pF (E12 series)
Rated d.c. voltage	500 V
Tolerance on capacitance	± 0,5 pF, ± 1 pF, ± 10%, ± 20%, or +50 to −20%, see Tables 1 and 2
Basic specification	IEC 187
Category, IEC 68	40/085/21

APPLICATION

These capacitors are made of high-K dielectric materials except for the lowest values. They are suitable for by-pass and coupling purposes in all kinds of equipment where small dimensions are of importance and the losses need not to be minimized.

DESCRIPTION

The capacitors consist of a ceramic disc, both sides being metallized and provided with long or short connecting leads. The greater part of the capacitor body is coated with a tan lacquer, which is solvent resistant according to MIL-STD-202E, test 215 and uninflammable according to MIL-STD-202E, test 111A. The whole capacitor is protected against atmospheric influences by a coating of material which permits soldering of the leads.

MECHANICAL DATA

Dimensions in mm

Outlines

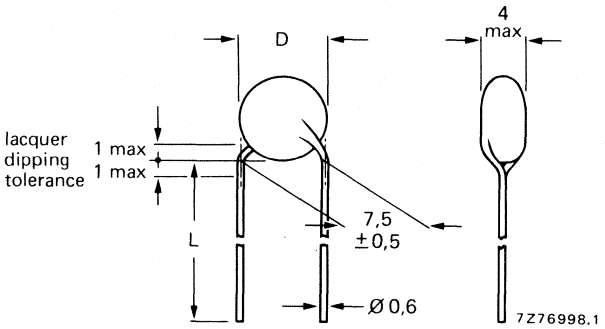


Fig. 1 For dimensions D and L see Tables 1 and 2.

Marking

The body of the capacitors is tan coloured. On the body is indicated in black script the capacitance value and a letter indicating the tolerance (see Tables 1 and 2).

Mounting

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

Soldering conditions max. 270 °C, max. 5 s

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 187. Unless otherwise specified all electrical values apply at an ambient temperature of 20 ± 2 °C, an atmospheric pressure of 930 to 1060 mbar and a relative humidity of 45 to 75%.

Capacitance values, measured at 1 MHz, ⩽ 1,5 V	1,5 to 18 pF (E12 series)
measured at 1 kHz, ⩽ 1,5 V	22 to 4700 pF (E12 series)
Tolerance on capacitance	see Table 1
Rated d.c. voltage	500 V
Test voltage (d.c.) for 1 min	1250 V (type test)
Insulation resistance at 100 V (d.c.) after 1 min	⩾ 10 000 MΩ
Tan δ	
1,5 to 18 pF, at 1 MHz, ⩽ 1,5 V	$\leqslant (\frac{15}{C} + 0{,}7) \times 10^{-3}$
22 to 4700 pF; at 1 kHz ⩽ 1,5 V	⩾ 3,5%
Category temperature range	−40 to +85 °C
Storage temperature range	−55 to +125 °C
Climatic category, IEC 68	40/085/21
Capacitance change versus temperature	
for 1,5 to 270 pF (2C4 material)	see Fig. 2
for 330 to 4700 pF (2E4 material)	see Fig. 3

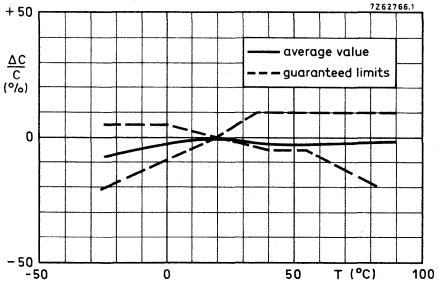


Fig. 2 Capacitance change with respect to the capacitance value at 20 °C as a function of temperature for capacitors of 1,5 to 270 pF, 2C4 material.

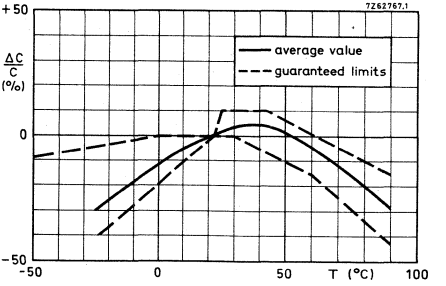


Fig. 3 Capacitance change with respect to the capacitance value at 20 °C as a function of temperature for capacitors of 330 to 4700 pF, 2E4 material.

Table 1

cap. pF	tol. on cap.	max. D mm	marking		catalogue number	
			capacitance	tolerance	L = 5 to 6 mm	L ⩾ 20 mm
1,5	± 0,5 pF	6	1p5	D	2212 657 09158	2212 657 10158
1,8		6	1p8	D	09188	10188
2,2		7	2p2	D	09228	10228
2,7		6	2p7	D	09278	10278
3,3		6	3p3	D	09338	10338
3,9		6	3p9	D	09398	10398
4,7		6	4p7	D	09478	10478
5,6	± 1 pF	6	5p6	F	07568	08568
6,8		6	6p8	F	07688	08688
8,2		6	8p2	F	07828	08828
10	± 10%	6	10p	K	05109	06109
12		6	12p	K	05129	06129
15		7	15p	K	05159	06159
18		7	18p	K	05189	06189
22	± 20%	6	22p	M	01229	03229
27		6	27p	M	01279	03279
33		6	33p	M	01339	03339
39		6	39p	M	01399	03399
47		7	47p	M	01479	03479
56		7	56p	M	01569	03569
68		6	68p	M	01689	03689
82		6	82p	M	01829	03829
100		6	100p	M	01101	03101
120		7	120p	M	01121	03121
150		7	150p	M	01151	03151
180		6	180p	M	01181	03181
220		6	220p	M	01221	03221
270		6	270p	M	01271	03271
330		6	330p	M	01331	03331
390		6	390p	M	01391	03391
470		6	470p	M	01471	03471
560		6	560p	M	01561	03561
680		6	680p	M	01681	03681
820		7	820p	M	01821	03821
1000		7	1n0	M	01102	03102
1200		9	1n2	M	01122	03122
1500		9	1n5	M	01152	03152
1800		9	1n8	M	01182	03182
2200		10	2n2	M	01222	03222
2700		10	2n7	M	01272	03272
3300		10	3n3	M	01332	03332
3900		12	3n9	M	01392	03392
4700		12	4n7	M	01472	03472

Table 2

cap. pF	tol. on cap. %	max. D mm	marking		catalogue number	
			capacitance	tolerance	L = 5 to 6 mm	L ⩾ 20 mm
1000		7	1n0	S	2212 657 02102	2212 657 04102
1200		9	1n2	S	02122	04122
1500		9	1n5	S	02152	04152
1800	+50	9	1n8	S	02182	04182
2200	to	10	2n2	S	02222	04222
2700	−20	10	2n7	S	02272	04272
3300		10	3n3	S	02332	04332
3900		12	3n9	S	02392	04392
4700		12	4n7	S	02472	04472

TESTS AND REQUIREMENTS

Essentially all tests mentioned in the schedule of IEC publication 187, category 40/085/21 (temperature range −40 to +85 °C; damp heat, long term, 21 days) are carried out along the lines of IEC publication 68, see table below.

IEC 187 clause	IEC 68 test method	tests	procedure	requirements
14.1	Ua	Robustness of terminations Tensile strength of leads	wires charged with load of 10 N for 10 s in direction of lead.	no damage
14.2	Ub	Bending	2 x 90°	no damage
15	T	Soldering (solder bath)	solderability: 4 s 235 °C, non-activating flux applied	good tinning
–	(acc. MIL-STD-202E, test 111A)	Inflammability	3 x 5 s, in flame of bunsen burner with flame-height 30 mm	self-extinguishing within 1 s after removal of bunsen burner
–	(acc. MIL-STD-202E method 215)	Resistance to solvents	3 x 1 min immersion benzene, chloroethane, freon, TMC and trichloroethane	no damage of tan coating
19.2	B	Climate sequence Dry heat	16 h +85 °C	no visible damage, $R_{ins} \geqslant 6000$ MΩ
19.3	D	Damp heat (accelerated) first cycle	16 h +55 °C 95-100% R.H.	no visible damage after recovery of 1-2 h immediately to be followed by cold test
19.4	A	Cold	2 h −40 °C	no visible damage
19.6	D	Damp heat (accelerated) remaining cycles	5 cycles 16 h 55 °C 95-100% R.H.	after drying 6 h at 55 °C 20% R.H. and 1-2 h recovery: $R_{ins} \geqslant 1500$ MΩ; after 24 h $\frac{\Delta C}{C} \leqslant 5\%$

TESTS AND REQUIREMENTS (continued)

IEC 187 clause	IEC 68 test method	tests	procedure	requirements
20.1	Ca	Damp heat (long term)	21 days +40 °C, 90 to 95% R.H.	after drying 6 h at 55 °C, $\leqslant$ 20% R.H. and 1-2 h recovery: $R_{ins} \geqslant 1500$ MΩ, after 24 h $\frac{\Delta C}{C} \leqslant 5\%$
21.3	–	Endurance	1000 h +85 °C, 750 V d.c.	$R_{ins} > 1500$ MΩ, after 24 h $\frac{\Delta C}{C} \leqslant 10\%$

CERAMIC DISC CAPACITORS

TYPE 2

high voltage

QUICK REFERENCE DATA	
Capacitance range	33 to 820 pF (E12 series)
Rated voltage, 33-560 pF	2 kV (d.c.) and 2 kV, (pulse, 16 kHz)
33-820 pF	1 kV (d.c.) and 1 kV, (pulse, 16 kHz)
Tolerance on capacitance, 2 kV version	±10%, ±20%
1 kV version	±20%
Basic specification	IEC 187
Category (IEC 68)	40/085/21

APPLICATION

These capacitors can be used in television and other circuitry where high d.c. or high pulse voltages (16 kHz) are applied (e.g. line deflection).

DESCRIPTION

The capacitors consist of a ceramic disc, both sides being metallized and provided with connecting leads. They are insulated by a coating that ensures excellent behaviour under humid conditions.
The capacitors are insulated with a tan coloured lacquer.
This lacquer has an excellent resistance against organic cleaning solvents and is uninflammable (acc. MIL 202 E test 215 and test 111A respectively).

MECHANICAL DATA

Dimensions in mm

Outlines

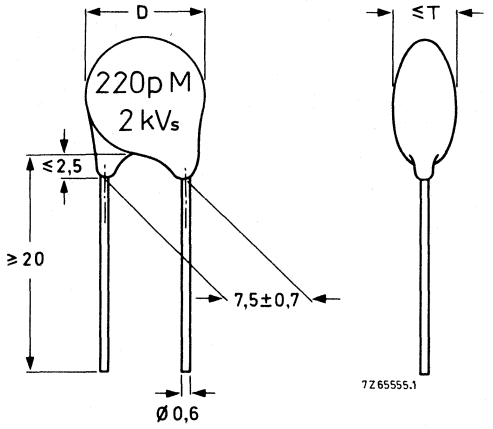


Fig. 1. For dimensions D and T see Tables 1 and 2.

Marking

The body of the capacitors is tan coloured. On the body is indicated in black script the capacitance value, a letter indicating the tolerance (see Table 1) and the rated peak voltage.

Mounting

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

Soldering conditions max. 270 °C, max. 5 s

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 187. Unless otherwise specified all electrical values apply at an ambient temperature of 20 ± 2 °C, an atmospheric pressure of 930 to 1060 mbar and a relative humidity of 45 to 75%.

Capacitance values measured at 1 kHz ≤ 1,5 V	33 to 820 pF (E12 series), see Tables 1 and 2
Tolerance on capacitance	± 10%, ±20%, see Tables 1 and 2
Rated voltage, 33-560 pF 33-820 pF	2 kV (d.c.); 2 kV, (pulse, 16 kHz) 1 kV, (pulse, 16 kHz)
Test voltage for 2 s, 2 kV version 1 kV version	4 kV (d.c.) 2 kV (d.c.)
Insulation resistance at 500 V (d.c.) after 1 min	≥ 10 000 MΩ
Tan δ at 1 kHz, ≤ 1,5 V	≤ 3,5%
Category temperature range	−40 to +85 °C
Storage temperature range	−55 to +125 °C
Climatic category (IEC 68)	40/085/21
Capacitance change versus temperature	see Fig. 2

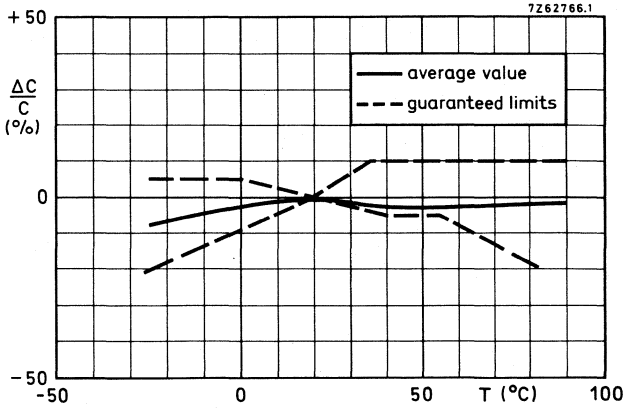


Fig. 2 Capacitance change with respect to the capacitance value at 20 °C as a function of temperature.

Table 1 (2 kV version)

cap. (pF)	D_{max} (mm)	T_{max} (mm)	marking of capacitance	catalogue number	
				tolerance ± 10% mark K	tolerance ± 20% mark M
33	7	6,5	33 p	2212 659 00339	2212 659 01339
39	7	6	39 p	00399	01399
47	7	5,5	47 p	00479	01479
56	7	5	56 p	00569	01569
68	8	5,5	68 p	00689	01689
82	8	5	82 p	00829	01829
100	7	6	100 p	00101	01101
120	7	5,5	120 p	00121	01121
150	7	5	150 p	00151	01151
180	7	5	180 p	00181	01181
220	8	5	220 p	00221	01221
270	8	5	270 p	00271	01271
330	10	5	330 p	00331	01331
390	10	5	390 p	00391	01391
470	11	5	470 p	00471	01471
560	11	4,5	560 p	00561	01561

Table 2 (1 kV version)

cap. (pF)	D_{max} (mm)	T_{max} (mm)	marking of capacitance	catalogue number
				tolerance ± 20% mark M
33	7	4,5	33 p	2212 659 03339
39	7	4	39 p	03399
47	8	4,5	47 p	03479
56	8	4	56 p	03569
68	7	4,5	68 p	03689
82	7	4,5	82 p	03829
100	7	4	100 p	03101
120	8	4,5	120 p	03121
150	8	4	150 p	03151
180	7	5	180 p	03181
220	7	4,5	220 p	03221
270	7	4,5	270 p	03271
330	8	4,5	330 p	03331
390	8	4,5	390 p	03391
470	10	4,5	470 p	03471
560	10	4,5	560 p	03561
680	11	4,5	680 p	03681
820	11	4,5	820 p	03821

TESTS AND REQUIREMENTS

Essentially all tests mentioned in the schedule of IEC publication 187, category 40/085/21 (temperature range −40 to +85 °C; damp heat, long term, 21 days) are carried out along the lines of IEC publication 68, see Table below:

IEC 187 clause	IEC 68 test method	test	procedure	requirements
14.1	Ua	Robustness of terminations Tensile strength of leads	wires charged with load of 10 N for 10 s in direction of lead	no damage
14.2	Ub	Bending	2 x 90°	no damage
15	T	Soldering (solder bath)	solderability: 4 s 235 °C, non-activating flux applied	good tinning
–	(acc. MIL STD 202E, test 111A)	Inflammability	3 x 5 s, in flame of bunsen burner with flame-height 30 mm	self-extinguishing within 1 s after removal of bunsen burner
–	(acc. MIL STD 202E method 215)	Resistance to solvents	3 x 1 min immersion in benzene, chloroethane, freon, TMC and trichloroethane	no damage
		Climatic sequence		
19.2	B	Dry heat	16 h +85 °C	no visible damage, $R_{ins} \geq 6000$ MΩ
19.3	D	Damp heat (accelerated) first cycle	16 h +55 °C 95-100% R.H.	no visible damage after recovery of 1-2 h immediately to be followed by cold test
19.4	A	Cold	2 h −40 °C	no visible damage
19.6	D	Damp heat (accelerated) remaining cycles	5 cycles 16 h 55 °C 95-100% R.H.	after drying 6 h at 55 °C 20% R.H. and 1-2 h recovery: $R_{ins} \geq 1500$ MΩ; after 24 h $\frac{\Delta C}{C} \leq 5\%$

TESTS AND REQUIREMENTS (continued)

IEC 187 clause	IEC 68 test method	test	procedure	requirements
20.1	Ca	Damp heat (steady state)	21 days +40 °C, 90 to 95% R.H. 1/3 part with 1,5 x rated voltage applied 1/3 part with 0,2 x rated voltage applied 1/3 part no voltage applied	after drying 6 h at 55 °C ≤ 20% R.H. and 1 to 2 h recovery: $R_{ins} \geq$ 1500 MΩ; after 24 h $\frac{\Delta C}{C} \leq 5\%$; voltage test 4 kV (d.c.) for 2 s
21.3	–	Endurance	1000 h +85 °C with pulse change 1,5 x rated voltage pulse time 13 μs pulse frequency 16 kHz	after cooling down to 20 °C no breakdown or flashover; $R_{ins} \geq$ 1500 MΩ; after 24 h $\frac{\Delta C}{C} \leq 10\%$

PACKAGING

Multiples of 250 pieces.

CERAMIC DISC CAPACITORS

type 2, interference suppression

QUICK REFERENCE DATA

Capacitance range	220 to 2200 pF (E12-series)
Rated a.c. voltage	250 V
Tolerance on capacitance	± 20%
Basic specification	IEC 161
Approval	VDE 0560 part 7/11. 67
Category, IEC 68	40/085/21

APPLICATION

These capacitors are in accordance with the VDE 0560 part 7/11. 67. Therefore they can be used as interference suppression e.g. in home appliances as "X and Y-capacitor".

DESCRIPTION

The capacitors consist of a ceramic disc, both sides being metallized and provided with connecting leads. They are insulated by a coating that ensures excellent behaviour under humid conditions.
The capacitors are insulated with a tan coloured lacquer.
This lacquer has an excellent resistance against organic cleaning solvents and is uninflammable (acc. MIL 202E test 215 and MIL 202E test 111A).

MECHANICAL DATA

Dimensions in mm

Outlines

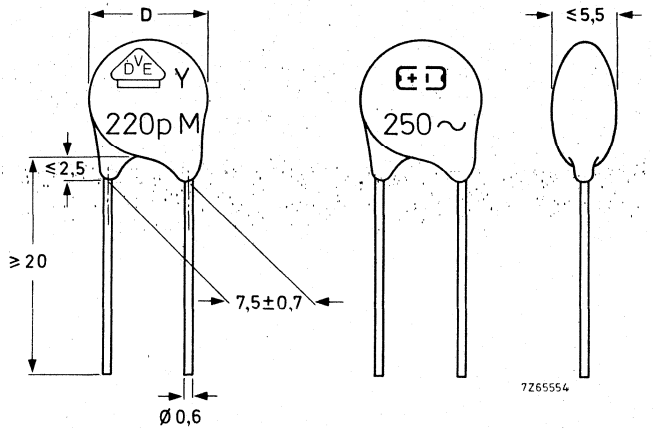


Fig. 1 For dimension D, see Table 1.

Marking

The body of the capacitors is tan coloured. On the body is indicated in black script the capacitance value, a letter indicating the tolerance (see Table 1), the rated voltage, and the following symbols:

manufacturer trade mark

VDE mark Y X

Mounting

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

Soldering conditions max. 270 °C, max. 5 s

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 161. Unless otherwise specified all electrical values apply at an ambient temperature of 20 ± 2 °C, an atmospheric pressure of 930 to 1060 mbar and a relative humidity of 45 to 75%.

Capacitance values measured at 1 kHz ≤ 1,5 V	220 to 2200 pF (E12 series)
Tolerance on capacitance	±20%
Rated a.c. voltage	250 V
Test voltage (a.c.) for 2 s	1800 V (100% tested)
Test voltage (a.c.) for 1 min at 85 °C	1500 V (type test)
Insulation resistance at 500 V (d.c.) after 1 min	≥ 10000 MΩ
Tan δ at 1 kHz, ≤ 1,5 V	≤ 3,5%
Category temperature range	−40 to +85 °C
Storage temperature range	−55 to +125 °C
Climatic category (IEC 68)	40/085/21
Capacitance change versus temperature	see Fig. 2

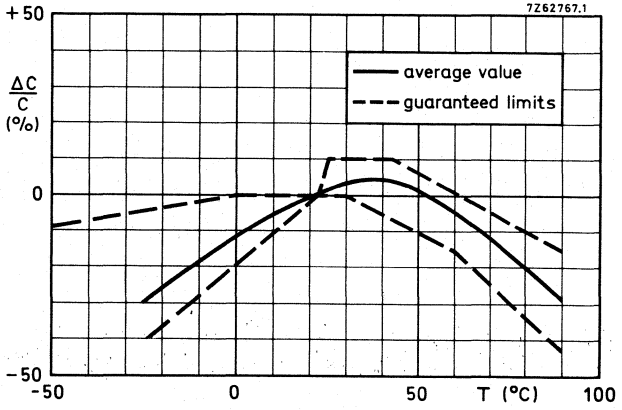


Fig. 2 Capacitance change with respect to the capacitance value at 20 °C as a function of temperature.

Table 1

cap. (pF)	tolerance	D_{max} (mm)	marking of		catalogue number
			capacitance	tolerance	
220	± 20%	8	220 p	M	2212 660 01221
270	± 20%	7	270 p	M	01271
330	± 20%	7	330 p	M	01331
390	± 20%	7	390 p	M	01391
470	± 20%	7	470 p	M	01471
560	± 20%	7	560 p	M	01561
680	± 20%	7	680 p	M	01681
820	± 20%	8	820 p	M	01821
1000	± 20%	10	1n0	M	01102
1200	± 20%	10	1n2	M	01122
1500	± 20%	10	1n5	M	01152
1800	± 20%	10	1n8	M	01182
2200	± 20%	11	2n2	M	01222

TESTS AND REQUIREMENTS

Essentially all tests mentioned in the schedule of IEC publication 161, category 40/085/21 (temperature range −40 to +85 °C; damp heat, long term, 21 days) are carried out along the lines of IEC publication 68, see Table below:

IEC 161 clause	IEC 68 test method	test	procedure	requirements
13.1	Ua	Robustness of terminations Tensile strength of leads	wires charged with load of 10 N for 10 s in direction of lead	no damage
13.2	Ub	Bending	2 x 90°	no damage
14.1	T	Soldering (solder bath)	solderability: 4 s 235 °C, non-activating flux applied	good tinning
–	(acc. MIL STD 202E, test 111A)	Inflammability	3 x 5 s, in flame of bunsen burner with flame-height 30 mm	self-extinguishing within 1 s after removal of bunsen burner
–	(acc. MIL STD 202E method 215)	Resistance to solvents	immersion 3 x 1 min in benzene, chloroethane, freon, TMC and trichloroethane	no damage
		Climatic sequence (10 pcs)		
19.2	B	Dry heat	16 h +85 °C	no visible damage, $R_{ins} \geq 6000$ MΩ
19.3	D	Damp heat (accelerated) first cycle	16 h +55 °C 95-100% R.H.	no visible damage after recovery of 1-2 h immediately to be followed by cold test
19.4	A	Cold	2 h −40 °C	no visible damage
19.6	D	Damp heat (accelerated) remaining cycles	5 cycles 16 h 55 °C 95-100% R.H.	after drying 6 h at 55 °C 20% R.H. and 1-2 h recovery: $R_{ins} \geq 1500$ MΩ; after 24 h $\frac{\Delta C}{C} \leq 5\%$

TESTS AND REQUIREMENTS (continued)

IEC 161 clause	IEC 68 test method	test	procedure	requirements
20.1	Ca	Climatic sequence (15 pcs) Damp heat (long term)	21 days +40 °C, 90 to 95% R.H. 1/3 with 250 V d.c. applied 1/3 with 20 V d.c. 1/3 without voltage	after drying 6 h at 55 °C ; 20% R.H. and 1-2 h recovery: R_{ins} ≥ 1500 MΩ, after 24 h $\frac{\Delta C}{C} \leq 5\%$
21.3	–	Climatic sequence (10 pcs) Endurance	1000 h +85 °C, 425 V a.c.	after cooling down to 20 °C no breakdown or flash over after supply of 1800 V a.c. for 2 s, R_{ins} ≥1500 MΩ, after 24 h $\frac{\Delta C}{C} \leq 10\%$

H.F. DATA VDE 0560/7

The resonance frequency can be measured with the circuit shown in Fig. 3.

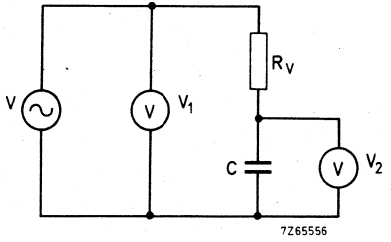


Fig. 3

When $V_1 >> V_2$ and $R_v >> \frac{1}{\omega C}$, the impedance for C is $Z_c = \frac{V_2}{V_1} \times R_V$.

At the resonance frequency $f_r = \frac{1}{2\pi\sqrt{LC}}$, Z_c will reach a minimum

(L = selfinductance of the capacitor including the leads)

The resonance frequency shall be above or equal to the frequency shown in Fig. 4. Lowest resonance frequency $f_r = \frac{1}{1,2\sqrt{C_N}}$.

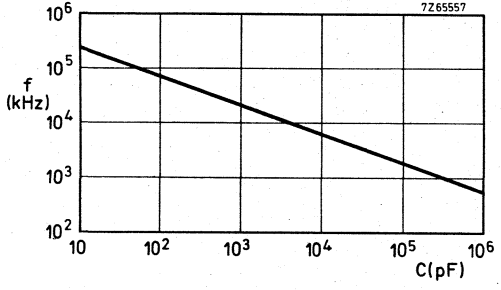


Fig. 4

PACKAGING

Multiples of 250 pieces.

CERAMIC DISC CAPACITORS

type 2, safety

QUICK REFERENCE DATA

Capacitance range	33 to 1000 pF (E12-series)
Rated a.c. voltage	400 V
Tolerance on capacitance	± 10%, ± 20%, −20 to + 50%
Basic specification	IEC 65
Category, IEC 68	40/085/21

APPLICATION

These capacitors can be used for the galvanic separation of mains and conductive parts which might be touched e.g. antenna inputs in radio and television sets.

DESCRIPTION

The capacitors consist of a ceramic disc, both sides being metallized and provided with connecting leads. They are insulated by a coating that ensures excellent behaviour under humid conditions.
The capacitors are insulated with a brown coloured lacquer.
This lacquer has an excellent resistance against organic cleaning solvents and is uninflammable (acc. MIL 202E test 215 and MIL 202E test 111A).

APPROVALS

FEMKO	Finland	2701
SEMKO	Sweden	101, with amendment 2
SEV	Switzerland	1016, 1959 for 33 to 220 pF incl. only
U.L.	U.S.A.	U.L. 1270/1410, file E55811 at 125 V (a.c.)
VDE	Germany	0560 part 2/5. 70

MECHANICAL DATA

Dimensions in mm

Outlines

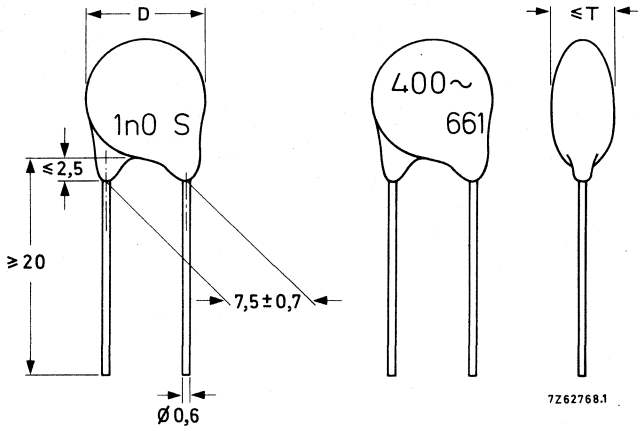


Fig. 1 For dimensions D and T, see table.

Marking

The body of the capacitors is brown coloured. On the body is indicated in black script the capacitance value, a letter indicating the tolerance (see Table), the rated a.c. voltage, the type number and the following symbols:

manufacturer's trade mark	
VDE mark (Germany)	
SEMKO mark (Sweden)	
SEV mark (Switzerland) for 33–220 pF only	

Mounting

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

Soldering conditions max. 270 °C, max. 5 s

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 65. Unless otherwise specified all electrical values apply at an ambient temperature of 20 ± 2 °C, an atmospheric pressure of 930 to 1060 mbar and a relative humidity of 45 to 75%.

Capacitance values measured at 1 kHz ≤ 1,5 V	33 to 1000 pF (E12 series)
Tolerance on capacitance	± 10%, ± 20%, −20 to +50%
Rated a.c. voltage	400 V
Test voltage (a.c.) for 1 min, at 85 °C	2500 V (type test)
Test voltage (a.c.) of coating for 1 min, at 85 °C	2500 V
Insulation resistance at 500 V (d.c.) after 1 min	≥ 10 000 MΩ
Tan δ at 1 kHz, ≤ 1,5 V	≤ 3,5%
Category temperature range	−40 to +85 °C
Storage temperature range	−55 to +125 °C
Climatic category (IEC 68)	40/085/21
Capacitance change versus temperature for 33 to 220 pF for 270 to 1000 pF	 see Fig. 2 see Fig. 3

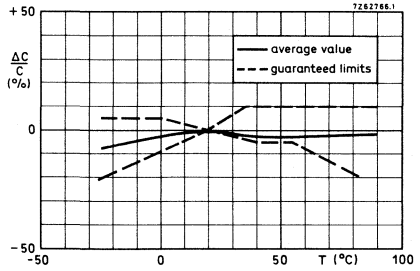


Fig. 2. Capacitance change with respect to the capacitance value at 20 °C as a function of temperature for capacitors of 33 to 220 pF.

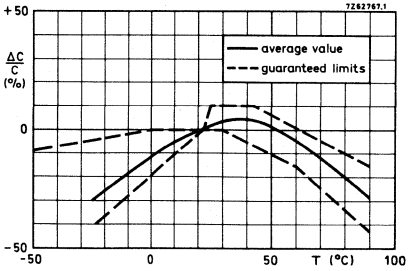


Fig. 3. Capacitance change with respect to the capacitance value at 20 °C as a function of temperature for capacitors of 270 to 1000 pF.

Table

cap. (pF)	D_{max} (mm)	T_{max} (mm)	marking of capacitance	catalogue number	
				tolerance ±20% mark M	tolerance −20 to +50% mark S
33	8	7,5	33 p	2212 661 01339	
39	8	6,5	39 p	01399	
47	8	6,5	47 p	01479	
56	8	6	56 p	01569	
68	9	6,5	68 p	01689	
82	9	6	82 p	01829	
100	8	7	100 p	01101	
120	8	6,5	120 p	01121	
150	8	6	150 p	01151	
180	9	6,5	180 p	01181	
220	9	6	220 p	01221	
270	8	6,5	270 p		2212 661 02271
330	8	6	330 p		02331
390	9	6,5	390 p		02391
470	9	6	470 p		02471
560	10	7	560 p		02561
680	10	6,5	680 p		02681
820	10	6	820 p		02821
1000	11	6	1n0		02102

Available on request:

the capacitance values 33 to 220 pF with a tolerance of ± 10%
the capacitance values 270 to 1000 pF with a tolerance of ± 20%

TESTS AND REQUIREMENTS

Essentially all tests mentioned in the schedule of IEC publication 187, category 40/085/21 (temperature range −40 to +85 °C; damp heat, long term, 21 days) are carried out along the lines of IEC publication 68, see Table below:

IEC 187 clause	IEC 68 test method	tests	procedure	requirements
14.1	Ua	Robustness of terminations Tensile strength of leads	wires charged with load of 10 N for 10 s in direction of lead	no damage
14.2	Ub	Bending	2 x 90°	no damage
15	T	Soldering (solder bath)	solderability: 4 s 235 °C, non-activating flux applied	good tinning
–	(acc. MIL STD 202E, test 111A)	Inflammability	3 x 5 s, in flame of bunsen burner with flame-height 30 mm	self-extinguishing within 1 s after removal of bunsen burner
–	(acc. MIL STD 202E method 215)	Resistance to solvents	3 x 1 min immersion benzene, chloroethane, freon, TMC and trichloroethane	no damage
		Climatic sequence		
19.2	B	Dry heat	16 h +85 °C	no visible damage, $R_{ins} \geq 6000$ MΩ
19.3	D	Damp heat (accelerated) first cycle	16 h +55 °C 95-100% R.H.	no visible damage after recovery of 1-2 h immediately to be followed by cold test
19.4	A	Cold	2 h −40 °C	no visible damage
19.6	D	Damp heat (accelerated) remaining cycles	5 cycles 16 h 55 °C 95-100% R.H.	after drying 6 h at 55 °C 20% R.H. and 1-2 h recovery: $R_{ins} \geq 1500$ MΩ; after 24 h $\frac{\Delta C}{C} \leq 5\%$

TESTS AND REQUIREMENTS (continued)

IEC 187 clause	IEC 68 test method	test	procedure	requirements
20.1	Ca	Damp heat (long term)	21 days +40 °C, 90 to 95% R.H.	after drying 6 h at 55 °C ≤ 20% R.H. and 1-2 h recovery: $R_{ins} \geq 1500$ MΩ, after 24 h $\frac{\Delta C}{C} \leq 5\%$
21.3	–	Endurance	1500 h +85 °C, 800 V a.c.	after cooling down to 20 °C no breakdown or flash over after supply of 2500 V a.c. for 2 s, $R_{ins} \geq 1500$ MΩ, after 24 h $\frac{\Delta C}{C} \leq 10\%$
IEC 65 14.2	–	Discharge test	The capacitor shall be subjected to 50 discharges at a maximum rate of 12 per minute from a 1 nF capacitor charged to 10 kV	1) The component shall withstand without breakdown for a period of 1 minute 2500 V a.c. at 15-35 °C, tension between the terminals. 2) Only for insulated version: Between the terminals connected together and a metal foil wrapped closely around the body of the capacitor but maintaining a 3 mm distance between the foil and each component terminal. 3) The insulation resistance between the terminals shall not have changed by more than 50% of the value measured before the test.

PACKAGING

Multiples of 250 pieces.

TUBULAR CERAMIC CAPACITORS

type 2

QUICK REFERENCE DATA

Capacitance range	680 to 10 000 pF (E6-series)
Rated d.c. voltage	500 V
Tolerance on capacitance	−20/+ 50%
Climatic category, IEC 68	40/085/21

APPLICATION

Type 2 tubular ceramic capacitors are made of high-K dielectric materials. They are suitable for bypass and coupling purposes in all kinds of equipment where a high capacitance and small dimensions are of importance and the losses need not be minimized.

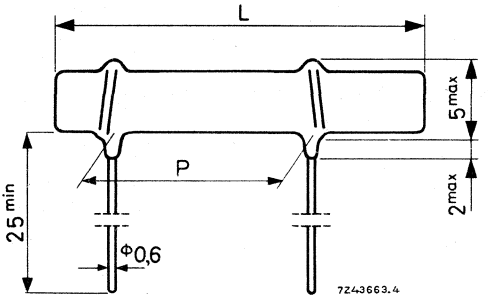
DESCRIPTION

The capacitors consist of a ceramic tube, internally and partly externally covered with a fired-on coating of silver. Two leads of tinned copper, wound around the tube, are soldered to these coatings. A coating of transparant lacquer protects the non-insulated version against atmospheric influences. The coating of the insulated capacitors allows them to be mounted close together or against a metal frame.

MECHANICAL DATA

Dimensions in mm

Outlines



For L and P see table.

Marking

Colour code or figure code, see Survey Ceramic Capacitors.

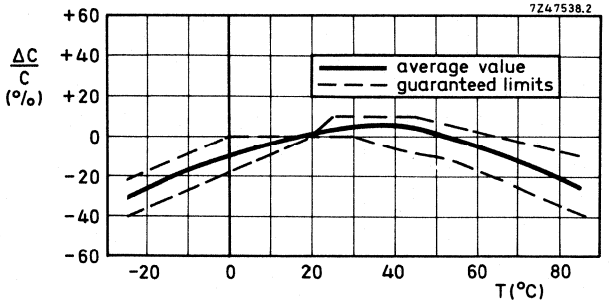
Mounting

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

ELECTRICAL DATA

Unless otherwise specified, all electrical values apply at a temperature of 20 ± 2 °C, an atmospheric pressure of 930 to 1060 mbar and a relative humidity of ≤ 75%.

→ Capacitance values at 1 kHz, < 3,5 V	680 to 10 000 pF, E6-series, see table
Tolerance on capacitance	−20/+ 50%
Rated d.c. voltage	500 V
Test voltage (d.c.) for 1 min	1250 V
Test voltage (d.c.) of coating (insulated capacitors) for 1 s	750 V
Insulation resistance at 500 V (d.c.) after 1 min	> 10 000 MΩ
Tan δ at 1 kHz, < 3,5 V	< 3,5%
Temperature dependence	see graph below
Category temperature range	−40 to + 85 °C
Climatic category, IEC 68	40/085/21



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

capacitance * pF	L mm	P mm	catalogue number	
			insulated	non-insulated **
680	10	5,1	2222 552 04681	2222 552 03681
1 000	10	5,1	04102	03102
1 500	10	5,1	04152	03152
2 200	10	5,1	04222	03222
3 300	12	7,6	04332	03332
4 700	16	10,2	04472	03472
6 800	20	15,2	04682	03682
10 000	22	17,7	04103	03103

* Capacitance values out of the E12 series are subject to minimum order release requirements.
** Available on request.

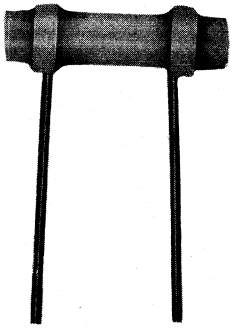
TUBULAR CERAMIC CAPACITORS

type 1B

QUICK REFERENCE DATA

Capacitance range	1 to 560 pF
Rated d.c. voltage	500 V
Tolerance on capacitance	± 5%, ± 0,5 or ± 0,25 pF
Temperature coefficients	NP0, N150, N750
Basic specification	IEC 108, type 1B
Category, IEC 68	40/085/21

RZ 22070-I



APPLICATION

Because low-K ceramic material is used, these capacitors have low losses, a high stability and display a linear temperature dependence of the capacitance. These features render the capacitors ideally suited for application in high frequency equipment, especially in resonant circuits in which advantage can be taken of the linear temperature coefficient to compensate the temperature dependence of other components. These capacitors have connecting leads of 0,6 mm diameter with a pitch of a multiple of one tenth of an inch, so that they are suitable for printed-wiring circuits.

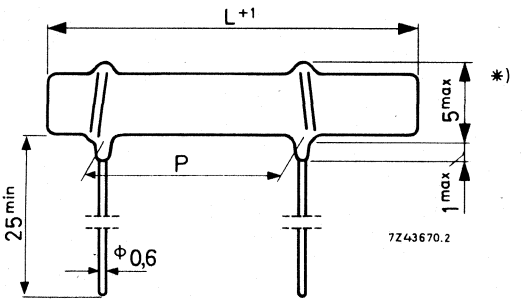
DESCRIPTION

The capacitors consist of a ceramic tube, partly metallized on the outside and, except for the smallest capacitances, internally metallized. A coating of transparent lacquer protects the capacitors against atmospheric influences. The temperature coefficient, the capacitance and the tolerances are indicated by means of a colour or a figure code. The inner electrode is connected to the lead at the side of the colour dot for the temperature coefficient.

MECHANICAL DATA

Dimensions in mm

Outlines



Mass

0,4 to 0,9 g, depending on the dimensions.

Marking

Colour coded or figure coded, see Survey Ceramic Capacitors.

Mounting

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

ELECTRICAL DATA

The capacitors are in conformity with IEC 108.
Unless stated otherwise, all electrical values apply at an ambient temperature of 20 ± 2 °C, an atmospheric pressure of 930 to 1060 mbar and a relative humidity of 45 to 75%.

Capacitance values with tolerances measured at 1 MHz, < 5 V	see table II
Rated d.c. voltage	500 V
Test voltage (d.c.) for 1 min	1250 V

*) Maximum 6 mm for capacitors of 2,7 and 3,3 pF.

Insulation resistance at 500 V d.c. after 1 min.	> 10.000 MΩ
Tan δ at 1 MHz, < 5 V for C of 5 to 50 pF	$\leq (15/C + 0,7).10^{-3}$ (C in pF)
for C > 50 pF	$\leq 10 \times 10^{-4}$, average $< 5 \times 10^{-4}$
Category temperature range	−40 to +85 °C
Climatic category (IEC 68)	40/085/21

Temperature coefficients (Table I)

temperature coefficient (ppm/degC)	tolerance on temperature coefficient (ppm/degC)	
NP0 : 0	for capacitance < 3 pF	: −30/+250
	3 to < 6 pF	: −30/+120
	6 to < 10 pF	: −30/+60
	10 to < 15 pF	: −30/+40
	≥ 15 pF	: ± 30
N150 : −150	for capacitance < 3 pF	: −30/+250
	3 to < 6 pF	: −30/+120
	6 to < 10 pF	: −30/+60
	10 to < 15 pF	: −30/+40
	≥ 15 pF	: ± 30
N750 : −750	for capacitance < 3 pF	: −120/+250
	3 to < 6 pF	: ± 120
	6 to < 10 pF	: ± 120
	10 to < 15 pF	: ± 120
	≥ 15 pF	: ± 120

Capacitors with a temperature coefficient according to P100, N033, N075, N220, N330, N470 and N1500 can be supplied, provided acceptable quantities are ordered.

Capacitance and tolerance

The following table gives the E12 capacitance series with a tolerance of 0.25 pF, 0.5 pF and 5%, depending on the capacitance value. On request values appertaining to the E24 series can be supplied, provided acceptable quantities are ordered. This also applies to capacitors with tolerances of 20% of the E6 series, of 10% of the E12 series and with 2% and 1% tolerances for higher capacitance values.

*) If the capacitor is connected to an a.c. source, the r.m.s. current must not exceed 500 mA, whilst the maximum r.m.s. voltage is $\frac{500}{\sqrt{2}}$ volts.

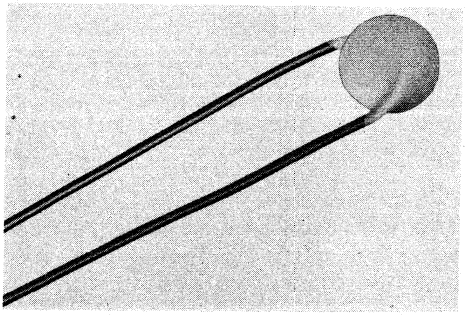
Table II

capacitance		temperature coefficient								
		NP0			N150			N750		
nom. pF	tol. ±	L mm	P mm	suffix	L mm	P mm	suffix	L mm	P mm	suffix
1	0,25 pF							12	7,6	57108
1,2	0,25 pF							12	7,6	57128
1,5	0,25 pF							12	7,6	57158
1,8	0,25 pF	12	7,6	09188				12	7,6	57188
2,2	0,25 pF	12	7,6	09228				12	7,6	57228
2,7	0,5 pF	12	7,6	08278				12	7,6	56278
3,3	0,5 pF	12	7,6	08338				12	7,6	56338
3,9	0,5 pF	12	7,6	08398				12	7,6	56398
4,7	0,5 pF	12	7,6	08478				12	7,6	56478
5,6	0,5 pF	12	7,6	08568	12	7,6	32568	12	7,6	56568
6,8	0,5 pF	12	7,6	08688	12	7,6	32688	12	7,6	56688
8,2	0,5 pF	10	5,1	08828	10	5,1	32828	10	5,1	56828
10	5%	10	5,1	08109	10	5,1	32109	10	5,1	56109
12	5%	10	5,1	08129	10	5,1	32129	10	5,1	56129
15	5%	10	5,1	08159	10	5,1	32159	10	5,1	56159
18	5%	10	5,1	08189	10	5,1	32189	10	5,1	56189
22	5%	10	5,1	08229	10	5,1	32229	10	5,1	56229
27	5%	12	7,6	08279	12	7,6	32279	10	5,1	56279
33	5%	12	7,6	08339	12	7,6	32339	10	5,1	56339
39	5%	12	7,6	08399	12	7,6	32399	10	5,1	56399
47	5%	14	7,6	08479	12	7,6	32479	10	5,1	56479
56	5%	14	7,6	08569	14	7,6	32569	12	7,6	56569
68	5%	16	10,2	08689	16	10,2	32689	12	7,6	56689
82	5%	18	12,7	08829	16	10,2	32829	12	7,6	56829
100	5%	20	15,2	08101	18	12,7	32101	12	7,6	56101
120	5%	22	17,7	08121	20	15,2	32121	14	7,6	56121
150	5%	26	20,3	08151	24	17,7	32151	16	10,2	56151
180	5%	30	20,3	08181	26	20,3	32181	18	12,7	56181
220	5%	34	25,4	08221	30	20,3	32221	20	15,2	56221
270	5%				36	25,4	32271	22	17,7	56271
330	5%							24	17,7	56331
390	5%							28	20,3	56391
470	5%							32	25,4	56471
560	5%							38	30,5	56561

CATALOGUE NUMBER (for ordering) 2222 555 . . . . . , for suffix see Table II.

DISC TYPE CERAMIC CAPACITORS

type 1B



RZ 22070-9

Capacitance range	0,47 to 47 pF
Rated d.c. voltage	400 V

APPLICATION

Because low-K ceramic material is used, these capacitors have low losses, a high stability and display a linear temperature dependence of the capacitance. These features render the capacitors ideally suited for application in high frequency equipment, especially in resonant circuits in which advantage can be taken of the linear temperature coefficient to compensate the temperature dependence of other components.

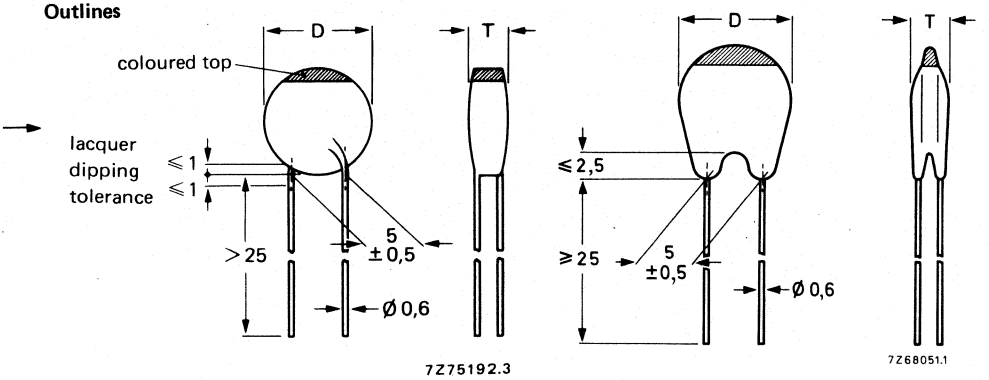
DESCRIPTION

The capacitor consists of a ceramic disc, provided with a silver plating at both sides to which the connecting leads are soldered. The body of version 2222 626 is covered with a tan lacquer that ensures an excellent behaviour under humid conditions. The body of version 2222 625 is partly covered with a tan lacquer so that the leads remain clean; the whole is protected against atmospheric influences by a coating of material which permits soldering of the leads.

MECHANICAL DATA

Dimensions in mm

Outlines



2222 625
partly insulated

2222 626
insulated

For D and T see Table 2.

Marking

Figure code for capacitance value (see Survey Ceramic Capacitors), colour code for temperature coefficient (see Table I).

ELECTRICAL DATA

Unless otherwise specified, all electrical values apply at a temperature of 20 ± 5 °C, an atmospheric pressure of 930–1060 mbar and a relative humidity of < 75%.

Rated d.c. voltage	400 V
Test voltage (d.c.) for 1 min	1100 V
Insulation resistance at 500 V (d.c.) within 1 min	> 10 000 MΩ
Losses (tan δ) at 1 MHz, measured at a voltage of < 3,5 V (a.c.)	
for C < 10 pF	$< \frac{0,01}{C(pF)}$
for C ≥ 10 pF	$< 10 \times 10^{-4}$
Category temperature range	–40 to + 85 °C
Climatic category, IEC 68	40/085/21
Capacitances and tolerances	see Table 2

Table 1 Temperature coefficients

temp. coeff. $10^{-6}/^{o}C$	tolerance $10^{-6}/^{o}C$	t.c. marking colour
P100: +100	−40 to +250	red/violet
NP0: 0	for C ≤ 20 pF: −40 to +120 for C > 20 pF: −40 to +40	black
N150: −150	for C ≤ 20 pF: −40 to +120	orange
N750: −750	for C ≤ 20 pF: −120 to +250 for C > 20 pF: −120 to +120	violet

Capacitors with temperature coefficients N075, N220, N470 and N1500 can be supplied, provided acceptable quantities are ordered.

Composition of the catalogue number

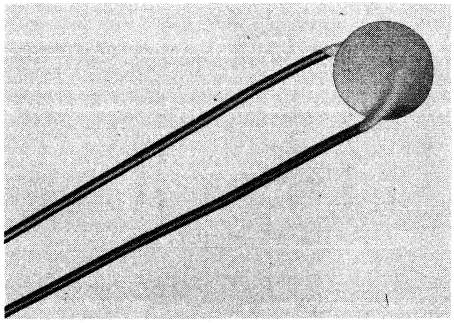
Partly insulated version: 2222 625 . . . . .
Insulated version: 2222 626 . . . . . } for suffix, see Table 2

Capacitances and tolerances (Table 2)

capacitance		temperature coefficient												nom. cap.
		P100			NPO			N150			N750			
nom. pF	tol. ±	D_{max} mm	T_{max} mm	cat. no. suffix	D_{max} mm	T_{max} mm	cat. no. suffix	D_{max} mm	T_{max} mm	cat. no. suffix	D_{max} mm	T_{max} mm	cat. no. suffix	pF
0,47	0,25 pF	5	4,5	03477										0,47
0,75	0,25 pF	5	3,5	03757										0,75
1,0	0,25 pF	6	3	03108	6	5	09108							1,0
1,2	0,25 pF	5	4	03128	6	4,5	09128							1,2
1,5	0,25 pF	5	3,5	03158	6	4	09158							1,5
1,8	0,25 pF	5	3,5	03188	5	3,5	09188	6	6	33188	5	5	57188	1,8
2,2	0,25 pF	6	3,5	03228	6	3,5	09228	5	5	33228	5	4,5	57228	2,2
2,7	0,5 pF	6	3	02278	5	4	08278	5	4,5	32278	5	4	56278	2,7
3,3	0,5 pF	6	3	02338	5	3,5	08338	5	4	32338	5	3,5	56338	3,3
3,9	0,5 pF	6	3	02398	6	4	08398	5	3,5	32398	6	4	56398	3,9
4,7	0,5 pF	8	3	02478	6	3,5	08478	5	3	32478	6	3,5	56478	4,7
5,6	0,5 pF	8	3	02568	6	3	08568	6	3,5	32568	6	3	56568	5,6
6,8	0,5 pF	8	3	02688	6	3	08688	6	3	32688	5	4	56688	6,8
8,2	0,5 pF	8	3	02828	6	3	08828	6	3	32828	5	3,5	56828	8,2
10	0,5 pF				6	3	08109	6	3	32109	5	3	56109	10
12	5 %				8	3	08129	6	3	32129	6	3,5	56129	12
15	5 %				8	3	08159	8	3	32159	6	3	56159	15
18	5 %				8	3	08189	8	3	32189	6	3	56189	18
22	5 %										6	3	56229	22
27	5 %										8	3	56279	27
33	5 %										8	3	56339	33
39	5 %										8	3	56399	39
47	5 %										8	3	56479	47

DISC TYPE CERAMIC CAPACITORS

TYPE 2



RZ 22070-9

Capacitance range	27 to 3900 pF
Rated d.c. voltage	400 V

APPLICATION

These capacitors are suitable for coupling and decoupling where a low self-inductance and a high insulation resistance are required. They occupy only a small area on printed-wiring boards.

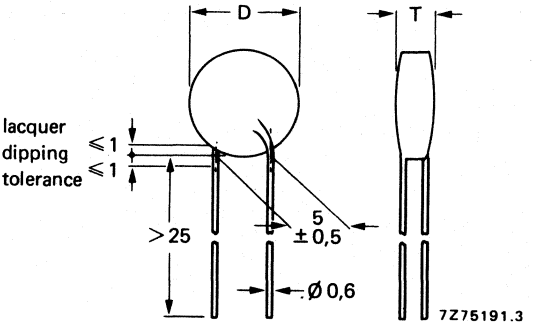
DESCRIPTION

The capacitor consists of a ceramic disc, provided with a silver plating at both sides to which the connecting leads are soldered. The body of the capacitor is partly covered with a brown lacquer so that the leads remain clean. The whole is protected against atmospheric influences by a coating of material which permits soldering of the leads.

MECHANICAL DATA

Dimensions in mm

Outlines



For D and T see table.

Marking

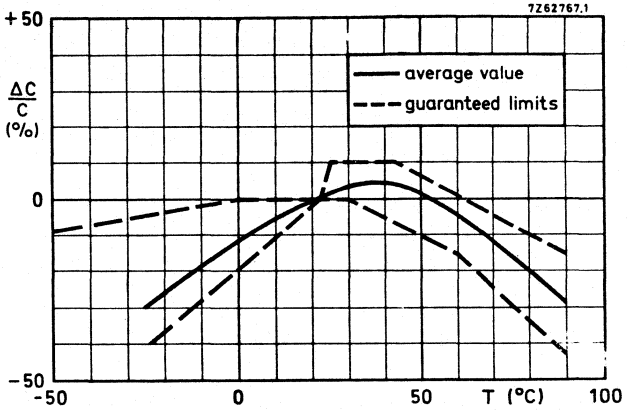
The capacitors are figure coded, see Survey Ceramic Capacitors. They are provided with a blue mark at the top for the applied ceramic material.

ELECTRICAL DATA

Unless otherwise specified, all electrical values apply at a temperature of 20 ± 5 °C, an atmospheric pressure of 930–1060 mbar and a relative humidity of < 75%.

Rated d.c. voltage	400 V
Test voltage (d.c.) for 1 min	1250 V
Insulation resistance at 500 V (d.c.) within 1 min	> 10 000 MΩ
Losses (tan δ) at 1 kHz, measured at < 3,5 V (a.c.)	$< 350.10^{-4}$
Category temperature range	−40 to + 85 °C
Climatic category, IEC 68	40/085/21

capacitance pF	tolerance %	max. D mm	max. T mm	catalogue number
27	± 20	5	3,5	2222 627 14279
33		5	3	14339
39		5	3	14399
47		5	3	14479
56		5	3,5	14569
68		5	3,5	14689
82		5	3	14829
100		5	4,5	14101
150	−20/+ 50	5	3,5	14151
220		6	3,5	14221
330		6	3,5	14331
470		6	3	14471
680		6	3	14681
1000		8	3	14102
1500		9	3	14152
2200		8	3	14222
3300		9	3	14332
3900		9	3	14392



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

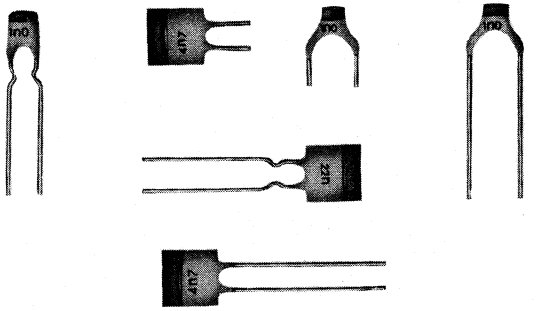
MINIATURE CERAMIC PLATE CAPACITORS

type 2

QUICK REFERENCE DATA

	2222 629-series	2222 630-series	2222 640-series
Capacitance range	1000-22000 pF	180-4700 pF	1000-10000 pF
	E3 series	E12 series	E6 series
Rated d.c. voltage	63 V	100 V	100 V
Tolerance on capacitance	−20/+ 80%	± 10%	−20/+ 50%
Basic specification	IEC 187	IEC 187 (2C2)	IEC 187 (2E2) ←
Climatic category (IEC 68)	10/055/21	55/085/21	55/085/21

A54490-2



APPLICATION

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

DESCRIPTION

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

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

MECHANICAL DATA

Dimensions in mm

The capacitors are available in the following versions.

Table 1

lead spacing	lead length L	lead diameter	Fig.	catalogue number*
5,08 (0,2 in)	$\geqslant 15$	0,6 (0,024 in)	1	2222 629 03 . . . 2222 630 03 . . . 2222 640 03 . . .
5,08 (0,2 in)	$6\ ^{0}_{-2}$	0,6 (0,024 in)	1	2222 629 06 . . . 2222 630 06 . . . 2222 640 06 . . .
2,54 (0,1 in)	$\geqslant 15$	0,6 (0,024 in)	2	2222 629 01 . . . 2222 630 01 . . . 2222 640 01 . . .
2,54 (0,1 in)	$6\ ^{0}_{-2}$	0,6 (0,024 in)	2	2222 629 05 . . . 2222 630 05 . . . 2222 640 05 . . .
2,54 (0,1 in)	$\geqslant 15$ flexible	0,4 (0,016 in)	3	2222 629 02 . . . 2222 630 02 . . . 2222 640 02 . . .
3,0	$\geqslant 10$	0,6 (0,024 in)	4	2222 629 07 . . . 2222 630 07 . . . 2222 640 07 . . .
–	–	0,6 (0,024 in)	5	2222 629 43 . . . 2222 630 43 . . . 2222 640 43 . . .

Outlines

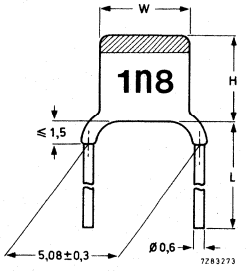


Fig. 1.

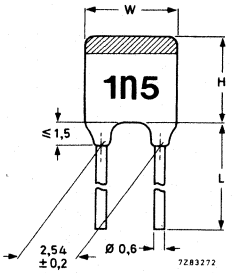


Fig. 2.

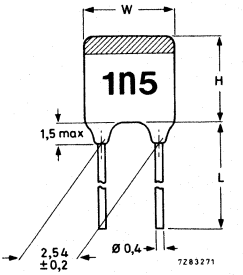


Fig. 3.

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

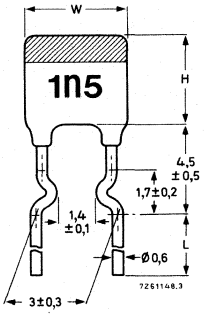


Fig. 4.

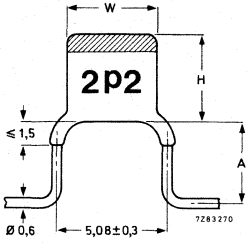


Fig. 5 (see also Fig. 18)

Table 2

size	max. W mm	max. H mm	max. A Fig. 5 mm	approx. mass g
I	3,6	3,7	6	0,14
II	4,5	4,7	6	0,15
III	5,1	5,3	4,5	0,17
IV	6,2	6,4	6	0,20

The thickness of the capacitors does not exceed 2,3 mm (0,09 in), except for a few types as is indicated in Tables 3 and 4.

Lacquer on the leads

When capacitors shown in Figs 1 and 2 are mounted on printed-wiring boards with a thickness of 1,5 mm and with holes of 1,3 mm diameter or on printed-wiring boards with a thickness of 1 mm and with holes of 0,8 mm diameter, there will be no lacquer on the leads at the lower side of the board. Capacitors, shown in Fig. 4 are very suitable for mounting on printed-wiring boards with plated-through holes.

Marking

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

Mounting

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

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

Capacitors shown in Fig. 4 can be mounted on printed-wiring boards with a pitch of 2,54 mm or 5,08 mm (hole diameter 0,8 mm).
The leads are self-clamping and hold the capacitor body at a fixed distance from the board.

ELECTRICAL DATA

Capacitors 2222 629 (colour mark green)

The capacitors are in conformity with the IEC 187.
Unless otherwise specified all electrical values apply a at a temperature of 20 ± 2 °C, an atmospheric pressure of 93 to 106 kPa and a relative humidity ≤ 75%.

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

Table 3

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

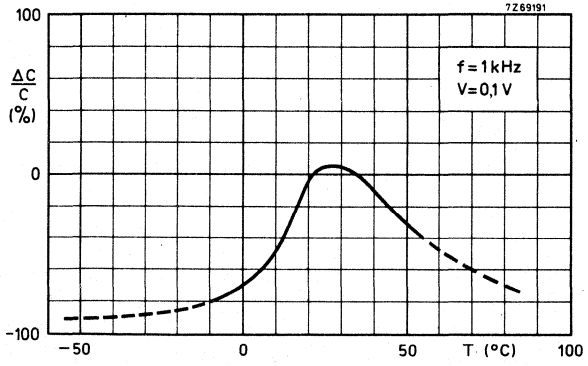


Fig. 6 Typical capacitance change with respect to the capacitance at 20 °C versus temperature. The dotted lines give an indication of the behaviour at higher and lower temperatures.

* Maximum thickness 2,5 mm (0,1 in).

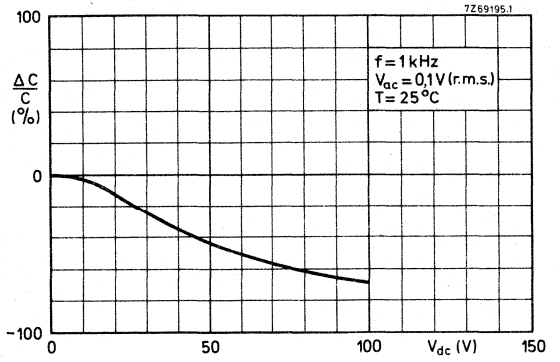


Fig. 7 Typical capacitance change with respect to the capacitance value at 0 V, as a function of d.c. voltage.

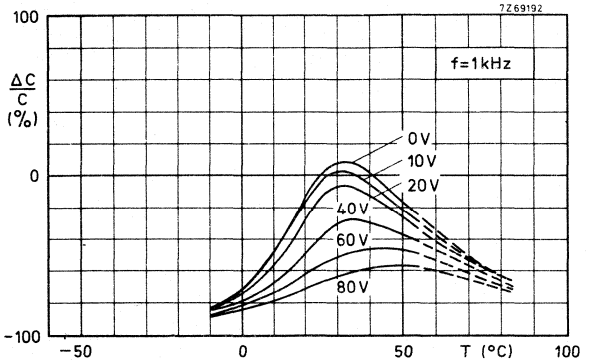


Fig. 8 Typical capacitance change with respect to the capacitance value at 0 V and 25 °C, as a function of temperature at different d.c. voltages.

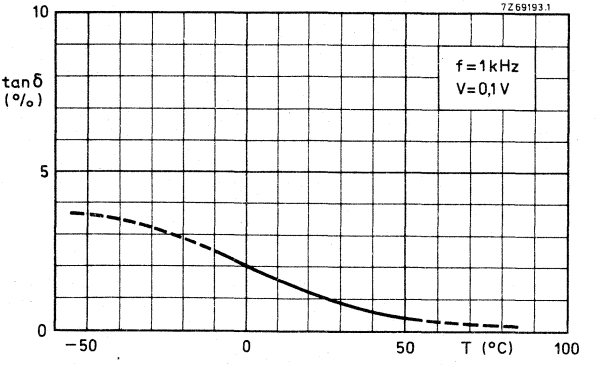


Fig. 9 Typical tan δ as a function of temperature.

ELECTRICAL DATA (continued)

Capacitors 2222 630 (colour mark yellow)

The capacitors are in conformity with IEC 187 (2C2).
Unless otherwise specified all electrical values apply at a temperature of 20 ± 2 °C, an atmospheric pressure of 93 to 106 kPa and a relative humidity of 45 to 75%.

Capacitance values, measured at 1 kHz, ≤ 1 V	180 – 4700 pF, E12 series (see Table 4)
Tolerance on the capacitance	± 10%
Rated d.c. voltage	100 V
Test voltage (d.c.) for 1 min	300 V
Test voltage (d.c.) of coating for 1 min	300 V
Insulation resistance at 100 V (d.c.) after 1 min	> 1000 MΩ
Tan δ at 1 kHz, ≤ 1 V	< 3,5%
Maximum voltage dependence of the capacitance between 0 and 40 V	–5%
Category temperature range	–55 to + 85 °C
Storage temperature range	–55 to + 85 °C
Climatic category (IEC 68)	55/085/21

Table 4

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

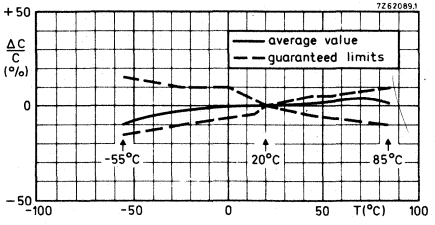


Fig. 10 ΔC with respect to C at 20 °C as a function of temperature.

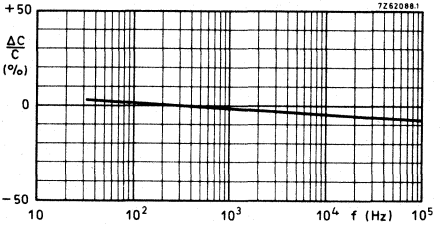


Fig. 11 Typ. ΔC with respect to C at 300 Hz, as a function of frequency.

* Maximum thickness 2,5 mm (0,1 in).

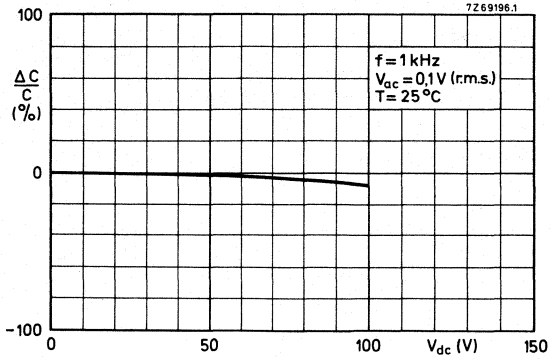


Fig. 12 Typical capacitance change with respect to the capacitance value at 0 V, as a function of d.c. voltage.

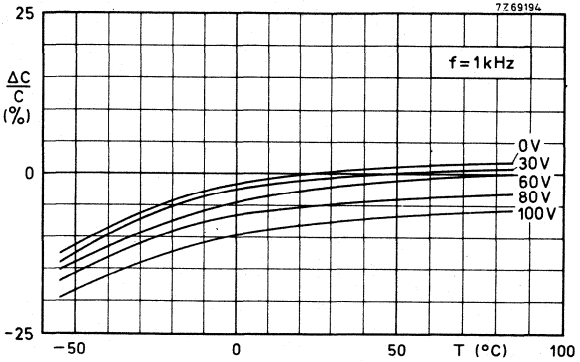


Fig. 13 Typical capacitance change with respect to the capacitance value at 0 V and 25 °C, as a function of temperature at different d.c. voltages.

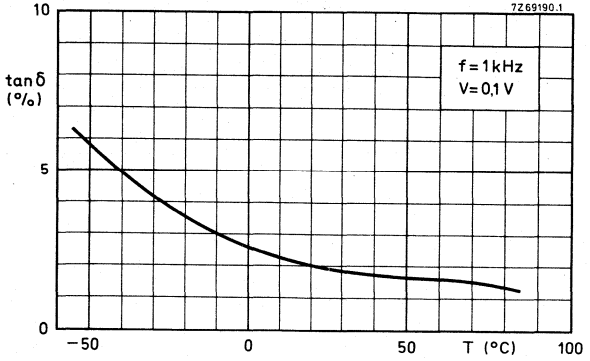


Fig. 14 Typical tan δ as a function of temperature.

ELECTRICAL DATA (continued)

Capacitors 2222 640 (colour mark blue)

The capacitors meet the essential requirements of IEC 187 (2E2).
Unless otherwise specified all electrical values apply at a temperature of 20 ± 2 °C, an atmospheric pressure of 93 to 106 kPa and a relative humidity of 45 to 75%.

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

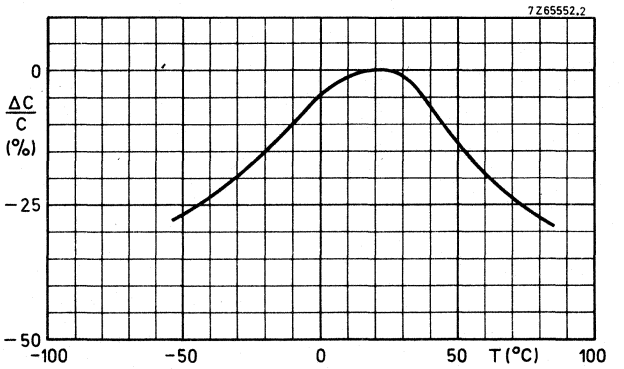


Fig. 15 Typical capacitance change versus temperature at 0 V.

Table 5

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

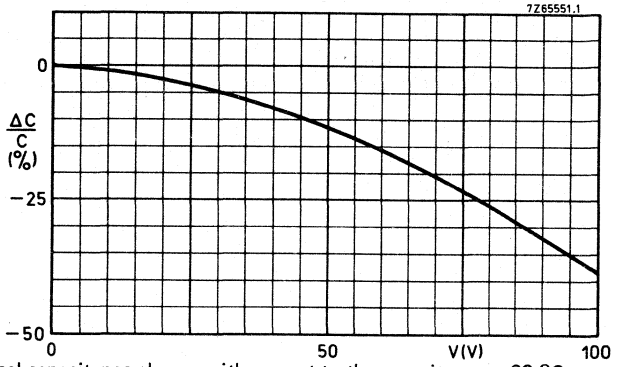


Fig. 16 Typical capacitance change with respect to the capacitance at 20 °C versus d.c. voltage.

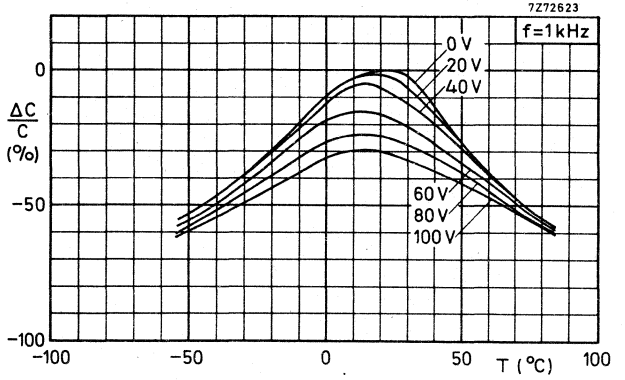


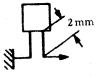
Fig. 17 Typical capacitance change with respect to the capacitance value at 0 V and 25 °C, as a function of temperature at different voltages.

TESTS AND REQUIREMENTS

After manufacturing *each* capacitor is checked on capacitance, tan δ and test voltage. Apart from this the following quality checks are carried out by frequent inspections.

Essentially all tests mentioned in the schedule of IEC publication 187, category 55/085/21 (temperature range –55/+ 85 °C; damp heat; long term, 21 days) are carried out along the lines of IEC publication 68.

Table 6

IEC 187 clause	IEC 68 test method	Test	Procedure	Requirements
– 14.1	– Ua	Robustness of terminations Pull-off Tensile strength	 pull velocity 15 cm/min load 5 N lead dia 0,6 mm: axial force 10 N lead dia 0,4 mm: aixal force 5 N	no wire breakage or complete damage of capacitor
14.2	Ub	Bending (half number of samples)	load 5 N, 4 x 90°	no wire breakage
15	T	Soldering (solder bath)	solderability: 2 s at 235 °C	good tinning, ΔC/C after 24 h, 2222 630: ± < 10% 2222 629, 2222 640: ± < 20%
16	–	Rapid change of temperature	pre-conditioning 2222 629 : 1 h + 55 °C 2222 630, 2222 640 : 1 h + 85 °C reference measurements after 24 h	
16.3	Na		1 cycle 2222 630: 3 h –55 °C/3 h + 85 °C 2222 640: 3 h –55 °C/3 h + 85 °C 2222 629: 3 h –10 °C/3 h + 55 °C	no damage, ΔC/C after 24 h, 2222 630: ± < 10% 2222 629, 2222 640: ± < 20%

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

Table 5 (continued)

IEC 187 clause	IEC 68 test method	Test	Procedure	Requirements
20.1	Ca	Damp heat (steady state)	21 days + 40 °C, 90 to 95% R.H. half number of samples 100 V (d.c.), half number of samples no voltage applied	no visible damage; after 1 - 2 h: $\Delta C/C$, 2222 630 $\pm <$ 10% 2222 629, 2222 640: $\pm <$ 20% tan $\delta <$ 7% $R_{ins} >$ 100 MΩ
21.1	–	Endurance Pre-conditioning	2222 630, 2222 640: 1 h + 85 °C 2222 629: 1 h + 55 °C reference measurements after 24 h	
21.3	–	Endurance	1000 h (IEC) 2222 630, 2222 640: + 85 °C, 150 V (d.c.) 2222 629: + 55 °C, 100 V (d.c.)	after 24 h at 20 °C: $\Delta C/C$, 2222 630 $\pm <$ 10% 2222 629, 2222 640 $\pm <$ 20% tan $\delta <$ 5,25% $R_{ins} >$ 300 MΩ
–	H	Storage	72 h –65 °C, recovery 1 - 2 h	electr. parameters within specification

STANDARD PACKAGING

1000 pieces per box, except types
2222 629 43 . . .
2222 630 43 . . .
2222 640 43 . . .,
which are supplied on tape on reel, see below.

Configuration of tape

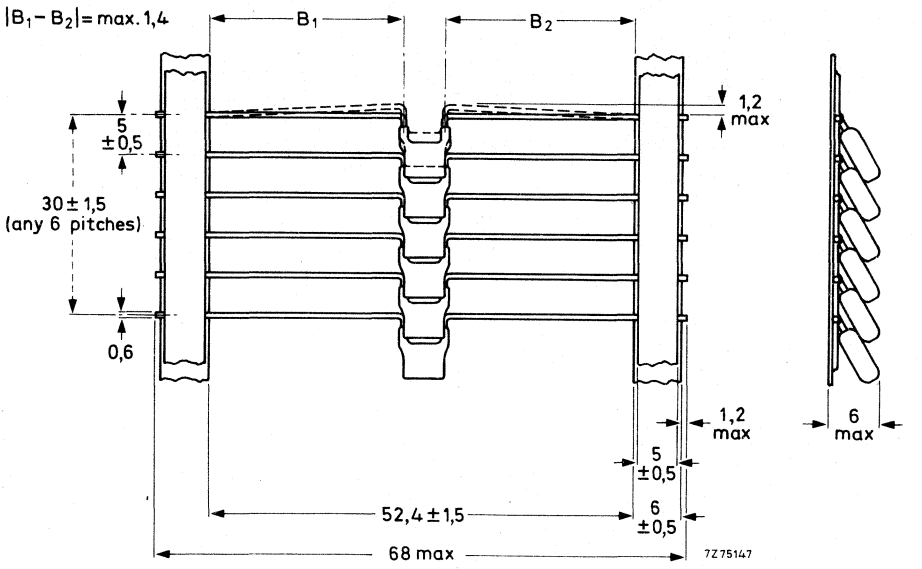


Fig. 18.

Reel dimensions (mm)

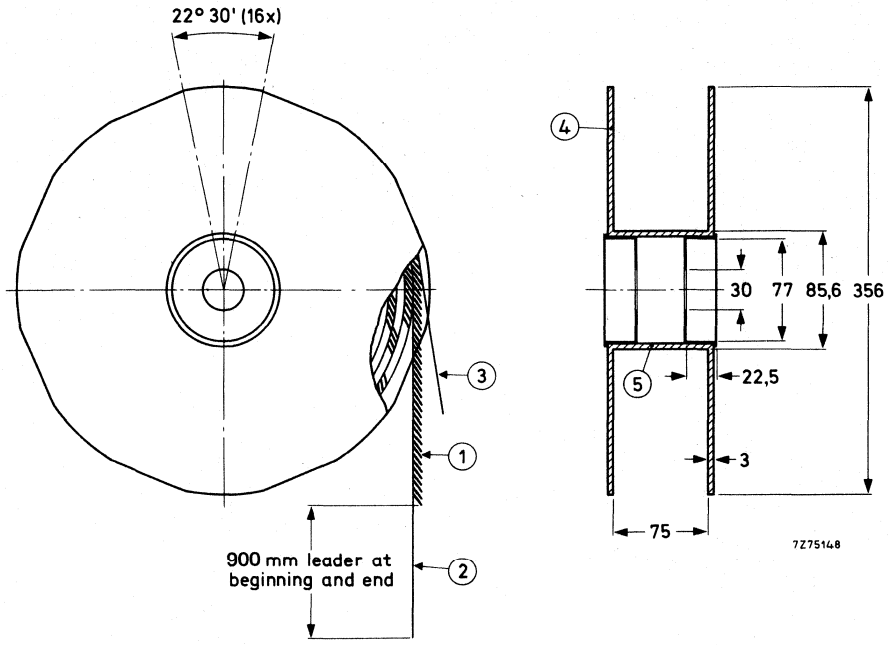


Fig. 19.

(1) capacitor
(2) tape
(3) paper
(4) flange
(5) cylinder

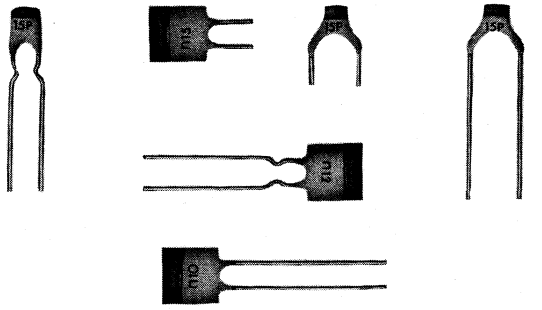
MINIATURE CERAMIC PLATE CAPACITORS

type 1B, temperature compensating types

QUICK REFERENCE DATA

Capacitance range	0,56 to 560 pF (E12 series)
Rated d.c. voltage	100 V
Tolerance on capacitance	± 2% or ± 0,25 pF
Temperature coefficients	P100, NP0, N075, N150, N220 N330, N470, N750, N1500
Basic specification	IEC 108, type 1B
Climatic category (IEC 68)	55/085/21

A54490-2



APPLICATION

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

DESCRIPTION

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

MECHANICAL DATA

Dimensions in mm

The capacitors are available in six versions:

Table 1

lead spacing	lead length L	lead diameter	Fig.	catalogue number ***
5,08 (0,2 in)	$\geqslant 15$	0,6 (0,024 in)	1	2222 638 . . . . .
5,08 (0,2 in)	6^{0}_{-2}	0,6 (0,024 in)	1	2222 642 . . . . .
2,54 (0,1 in)	$\geqslant 15$	0,6 (0,024 in)	2	2222 631 . . . . .
2,54 (0,1 in)	6^{0}_{-2}	0,6 (0,024 in)	2	2222 641 . . . . .
2,54 (0,1 in)	$\geqslant 15$	0,4 (0,016 in) **	3	2222 632 . . . . .
3,0	$\geqslant 10$	0,6 (0,024 in)	4	2222 643 . . . . .
–	–	0,6 (0,024 in)	5	2222 665 . . . . .

Outlines

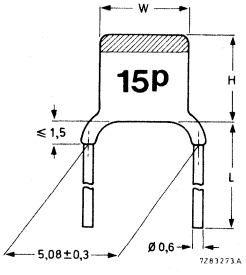


Fig. 1.

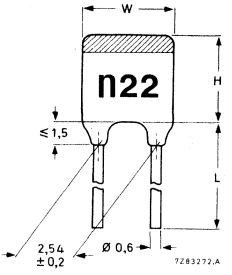


Fig. 2.

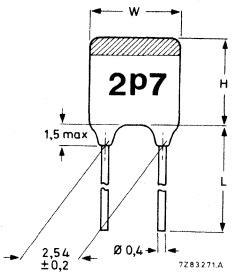


Fig. 3.

* Capacitors with silver electrodes suffer from the "silver migration" effect. Silver particles move from one electrode to the other under the influence of a d.c. voltage and moisture. Capacitors with silver electrodes are considerably larger.

** Flexible leads.

*** For suffix see Tables 3 to 11.

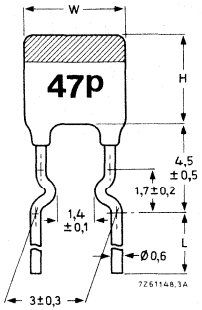


Fig. 4.

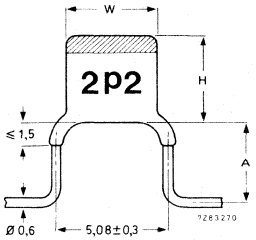


Fig. 5 (see also Fig. 6).

Table 2

size	max. W mm	max. H mm	max. A Fig. 5 mm	approx. mass g
I	3,6	3,7	6	0,14
II	4,5	4,7	6	0,15
III	5,1	5,3	4,5	0,17
IV	6,2	6,4	6	0,20
V	6,2	8,6	4,5	0,20

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

Lacquer on the leads

When capacitors shown in Figs 1 and 2 are mounted on printed-wiring boards with a thickness of 1,5 mm and with holes of 1,3 mm diameter, or on printed-wiring boards with a thickness of 1 mm and with holes of 0,8 mm diameter, there will be no lacquer on the leads at the lower side of the board. Capacitors shown in Fig. 4 are very suitable for mounting on printed-wiring boards with plated-through holes.

Marking

The temperature coefficient is indicated by a colour code as per IEC and EIA recommendations. The capacitance value is indicated by figures in black script.

Mounting

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

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

Capacitors shown in Fig. 4 can be mounted on printed-wiring boards with a grid of 2,54 mm or 5,08 mm (hole diameter 0,8 mm). In either case the leads are self-clamping and keep the capacitor body at a certain spacing from the board.

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 108. Unless stated otherwise all electrical values apply at an ambient temperature of 20 ± 2 °C, an atmospheric pressure of 93 to 106 kPa and a relative humidity of 45 to 75%.

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

* Inclusing 2 mm per connecting lead.

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

Capacitance range	0,56 to 47 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	+ 100 x 10^{-6}/K
Tolerance on the temperature coefficient	
for C < 20 pF	(–40 to + 120) x 10^{-6}/K
for C > 20 pF	± 40 x 10^{-6}/K
Marking colour of the temperature coefficient	red/violet

Table 3

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

* Maximum thickness 2,5 mm (0,1 in).

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

Capacitance range	1,8 to 120 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	0×10^{-6}/K
Tolerance on the temperature coefficient	
for $C < 20$ pF	$(-40 \text{ to } +120) \times 10^{-6}$/K
→ for $C > 20$ pF	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	black

Table 4

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

* Maximum thickness 2,5 mm (0,1 in).

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

Capacitance range	3,9 to 120 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-75×10^{-6}/K
Tolerance on the temperature coefficient	
for C < 20 pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for C > 20 pF	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	red

Table 5

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

* Maximum thickness 2,5 mm (0,1 in).

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

Capacitance range	3,9 to 150 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-150×10^{-6}/K
Tolerance on the temperature coefficient	
for C < 20 pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for C > 20 pF	$\pm 40 \times 10^{-6}$/K
Marking colour of the temperature coefficient	orange

Table 6

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

* Maximum thickness 2,5 mm (0,1 in).

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

Capacitance range	3,9 to 150 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-220×10^{-6}/K
Tolerance on the temperature coefficient	
for C < 20 pF	$(-40 \text{ to } +60) \times 10^{-6}$/K
for C > 20 pF	$\pm 40 \times 10^{-6}$/K
Marking colour of the temperature coefficient	yellow

Table 7

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

* Maximum thickness 2,5 mm (0,1 in).

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

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

Table 8

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

* Maximum thickness 2,5 mm (0,1 in).

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

Capacitance range	6,8 to 220 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-470×10^{-6}/K
Tolerance on the temperature coefficient	
for C < 20 pF	$(-90 \text{ to } +250) \times 10^{-6}$/K
for C > 20 pF	$\pm 60 \times 10^{-6}$/K
Marking colour of the temperature coefficient	blue

Table 9

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

* Maximum thickness 2,5 mm (0,1 in).

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

Capacitance range	3,9 to 330 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-750×10^{-6}/K
Tolerance on the temperature coefficient	
for C < 20 pF	$(-120 \text{ to } +250) \times 10^{-6}$/K
for C > 20 pF	$\pm 120 \times 10^{-6}$/K
Marking colour of the temperature coefficient	violet

Table 10

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

* Maximum thickness 2,5 mm (0,1 in).

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

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

Table 11

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

* Maximum thickness 2,5 mm (0,1 in).

TESTS AND REQUIREMENTS

After manufacture, *each* capacitor is checked on capacitance, tan δ and test voltage. Apart from this the following quality checks are carried out by frequent inspections.
Essentially all tests mentioned in the schedule of IEC publication 108, category 55/085/21 (temperature range –55/+ 85 °C; damp heat, long term, 21 days) are carried out along the lines of IEC publication 68, see Table 12 below.

Table 12

IEC 108 clause	IEC 68 test method	test	procedure	requirements
–	–	Robustness of terminations Pull-off	pull velocity 15 cm/min  load 5 N	no wire breakage or complete damage of capacitor
15.1	Ua	Tensile strength	lead dia. 0,6 mm, axial force 10 N lead dia. 0,4 mm, axial force 5 N	
15.2	Ub	Bending	load 5 N, 4 x 90°	no wire breakage
16	T	Soldering (solder bath)	solderability: 2 s 235 °C	good tinning, ΔC/C < 0,5% or 0,5 pF after 30 min to 1 h
17.2	Na	Rapid change of temperature	3 hours –55 °C/3 hours + 85 °C, 1 cycle	no damage, ΔC/C < 0,5% or 0,5 pF
18.1	F	Vibration	10-55-10 Hz 0,75 mm displacement 3 directions, 6 h	no visible damage
19.1	E	Bump	4000 bumps in 2 directions, 40 g; pulse time 6 ms	no visible damage
–	–	Inflammability	15 s, 35 mm above bunsen burner with flame-height 40-60 mm	self-extinguishing within 15 s after removal of bunsen burner
14.5	–	Temperature coefficient	between + 20 and + 85 °C	within tolerance as specified for each particular material

		Climatic sequence		
20.2	B	Dry heat	16 h + 85 °C	no visible damage
20.3	Db	Damp heat (accel.) 1st cycle	1 day + 55 °C, 100% R.H.	after recovery of 1-2 h immediately followed by cold test
20.4	A	Cold	2 h −55 °C	no visible damage
20.5	M	Low air pressure	1 h 8,5 kPa	no breakdown or flashover
20.6	Db	Damp heat (accel.)	1 day + 55 °C, 100% R.H.	$\Delta C/C \leqslant 1\%$ or 1 pF tan $\delta < 2$ x specified tan δ R_{ins} after 1-2 h > 100 MΩ
21	Ca	Damp heat, steady state (half number of the lot at rated voltage, other half at zero voltage)	21 days + 40 °C 90 to 95% R.H.	$\Delta C/C \leqslant 1\%$ or 1 pF tan $\delta \leqslant 2$ x specified tan δ R_{ins} after 1-2 h > 100 MΩ
22	–	Endurance	1000 h at + 85 °C, 150 V (d.c.)	$\Delta C/C \leqslant 1\%$ or 1 pF tan $\delta \leqslant 1{,}5$ x specified tan δ $R_{ins} > 300$ MΩ

STANDARD PACKAGING

2222 641 . . . . .
2222 642 . . . . .: 1000 pieces per box
2222 665 . . . . .: on tape on reel, see below
other versions: 500 pieces per box

Configuration of tape

Version 2222 665 . . . . .

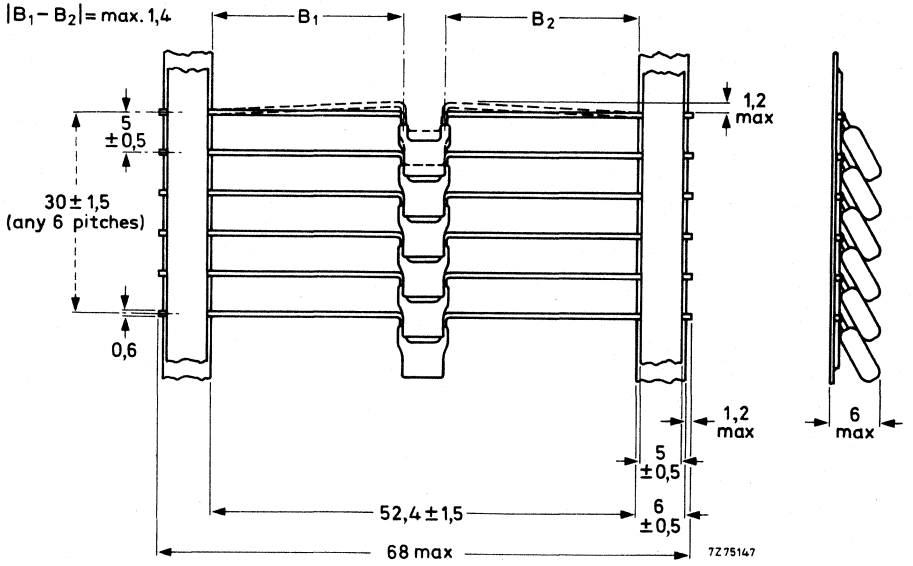


Fig. 6.

Reel dimensions (mm)

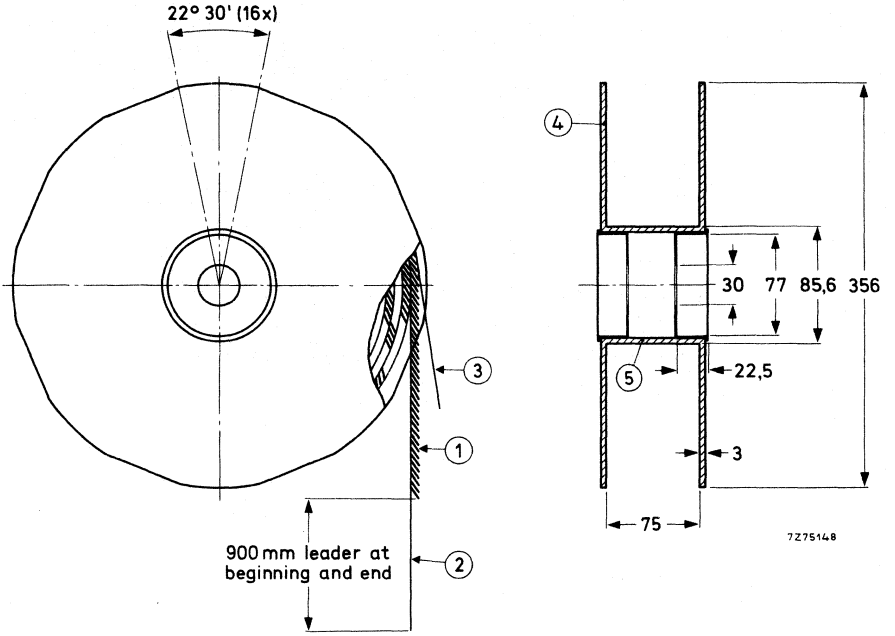


Fig. 7. (1) capacitor
(2) tape
(3) paper
(4) flange
(5) cylinder

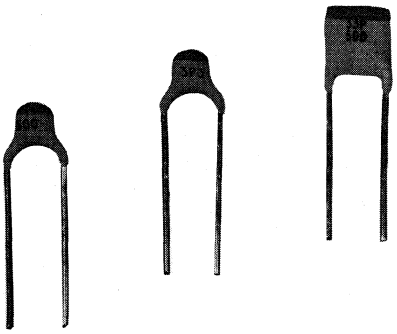
MINIATURE CERAMIC PLATE CAPACITORS

type 1B, 500 V (d.c.)
temperature compensating types

QUICK REFERENCE DATA

Capacitance range	0,47 to 270 pF (E12 series)
Rated d.c. voltage	500 V
Tolerance on capacitance	± 2% or ± 0,25 pF
Temperature coefficients	P100, NP0, N150, N750, N1500
Basic specification	IEC 108, type 1B
Category (IEC 68)	55/085/21

RZ 29887-3



APPLICATION

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

DESCRIPTION

The capacitors consist of a rectangular ceramic plate, both sides being metallized and provided with connecting leads. They are insulated by a coating that ensures an excellent behaviour under humid conditions. The colour of the capacitor body is grey. Characteristic electrical properties are low losses, a very close tolerance on the capacitance (0,25 pF or 2%) and high stability. As the capacitors do not have silver electrodes, no silver migration* can occur.

MECHANICAL DATA

Dimensions in mm

Table 1

size	W max.	H max.	approx. mass g
I	3,6	3,7	0,15
II	4,5	4,7	0,15
III	5,1	5,3	0,17
IV	6,2	6,4	0,21
V	6,2	8,6	0,23

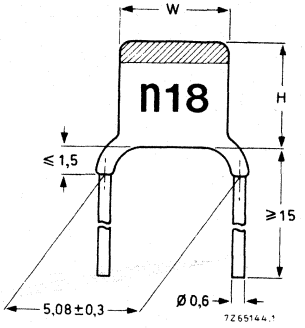


Fig. 1.

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

Lacquer on the leads

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

Marking

The temperature coefficient is indicated by a colour code as per IEC and EIA recommendations. The capacitance value and the voltage are indicated in black script on the capacitor, see Tables 2 to 5.

Mounting

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

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

* Silver migration is the movement of silver particles from one electrode to the other, under the influence of a d.c. voltage and moisture, which may cause short-circuits.

PACKAGING

1000 items per box.

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 108. Unless stated otherwise all electrical values apply at an ambient temperature of 20 ± 2 °C, an atmospheric pressure of 93 to 106 kPa and a relative humidity of 40 to 75%.

Capacitance values and tolerances, measured at 1 MHz, < 5 V*	0,47 to 270 pF, E12 series, see Tables 2 to 6
Rated d.c. voltage	500 V
Test voltage (d.c.) for 1 minute	1250 V
Test voltage (d.c.) of coating for 1 minute	1250 V
Insulation resistance at 500 V (d.c.) after 1 min	> 10 000 MΩ
Tan δ at 1 MHz, < 5 V* for C < 50 pF	$\leqslant 15\,(\frac{15}{C} + 0{,}7).10^{-4}$, (max. 55.10^{-4})
for C > 50 pF	$\leqslant 15.10^{-4}$
Category temperature range	−55 to + 85 °C
Storage temperature range	−65 to + 125 °C
Climatic category (IEC 68)	55/085/21

* Including 2 mm per connecting lead.

Capacitors with temperature coefficient P100

Capacitance range	0,47 to 33 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	+ 100 x 10^{-6}/K
Tolerance on the temperature coefficient	
for C < 20 pF	(−40 to + 120) x 10^{-6}/K
for C > 20 pF	± 40 x 10^{-6}/K
Marking colour of the temperature coefficient	red/violet

Table 2

capacitance pF	tolerance	size	marking		catalogue number
0,47*	± 0,25 pF	I	P47	500	2222 650 03477
0,68*	± 0,25 pF	I	P68	500	03687
1,0 *	± 0,25 pF	I	1P0	500	03108
1,2 *	± 0,25 pF	I	1P2	500	03128
1,5 *	± 0,25 pF	I	1P5	500	03158
1,8 *	± 0,25 pF	I	1P8	500	03188
2,2	± 0,25 pF	I	2P2	500	03228
2,7	± 0,25 pF	I	2P7	500	03278
3,3	± 0,25 pF	I	3P3	500	03338
3,9	± 0,25 pF	I	3P9	500	03398
4,7	± 0,25 pF	II	4P7	500	03478
5,6	± 0,25 pF	II	5P6	500	03568
6,8	± 0,25 pF	II	6P8	500	03688
8,2	± 0,25 pF	II	8P2	500	03828
10	± 2%	III	10P	500	04109
12	± 2%	III	12P	500	04129
15	± 2%	III	15P	500	04159
18	± 2%	IV	18P	500	04189
22	± 2%	IV	22P	500	04229
27	± 2%	V	27P	500	04279
33	± 2%	V	33P	500	04339

* Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient NP0

Capacitance range	0,82 to 47 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	0 x 10^{-6}/K
Tolerance on the temperature coefficient	
for C < 20 pF	(–40 +120) x 10^{-6}/K
for C > 20 pF	± 30 x 10^{-6}/K
Marking colour for the temperature coefficient	black

Table 3

capacitance pF	tolerance	size	marking		catalogue number
0,82*	± 0,25 pF	I	P82	500	2222 650 09827
1 *	± 0,25 pF	I	1P0	500	09108
1,2 *	± 0,25 pF	I	1P2	500	09128
1,5 *	± 0,25 pF	I	1P5	500	09158
1,8 *	± 0,25 pF	I	1P8	500	09188
2,2 *	± 0,25 pF	I	2P2	500	09228
2,7 *	± 0,25 pF	I	2P7	500	09278
3,3 *	± 0,25 pF	I	3P3	500	09338
3,9	± 0,25 pF	I	3P9	500	09398
4,7	± 0,25 pF	I	4P7	500	09478
5,6	± 0,25 pF	I	5P6	500	09568
6,8	± 0,25 pF	II	6P8	500	09688
8,2	± 0,25 pF	II	8P2	500	09828
10	± 2%	II	10P	500	10109
12	± 2%	II	12P	500	10129
15	± 2%	III	15P	500	10159
18	± 2%	III	18P	500	10189
22	± 2%	III	22P	500	10229
27	± 2%	IV	27P	500	10279
33	± 2%	IV	33P	500	10339
39	± 2%	V	39P	500	10399
47	± 2%	V	47P	500	10479

* Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient N150

Capacitance range	2,2 to 56 pF (E12 series)
Temperature coefficient of the capacitance ($\frac{\Delta C}{C.\Delta T}$)	-150×10^{-6}/K
Tolerance on the temperature coefficient	
for C < 20 pF	$(-40 + 60) \times 10^{-6}$/K
for C > 20 pF	$\pm 30 \times 10^{-6}$/K
Marking colour of the temperature coefficient	orange

Table 4

capacitance pF	tolerance	size	marking		catalogue number
2,2*	± 0,25 pF	I	2P2	500	2222 650 33228
2,7*	± 0,25 pF	I	2P7	500	33278
3,3*	± 0,25 pF	I	3P3	500	33338
3,9*	± 0,25 pF	I	3P9	500	33398
4,7	± 0,25 pF	I	4P7	500	33478
5,6	± 0,25 pF	I	5P6	500	33568
6,8	± 0,25 pF	I	6P8	500	33688
8,2	± 0,25 pF	II	8P2	500	33828
10	± 2%	II	10P	500	34109
12	± 2%	II	12P	500	34129
15	± 2%	II	15P	500	34159
18	± 2%	II	18P	500	34189
22	± 2%	III	22P	500	34229
27	± 2%	III	27P	500	34279
33	± 2%	IV	33P	500	34339
39	± 2%	IV	39P	500	34399
47	± 2%	V	47P	500	34479
56	± 2%	V	56P	500	34569

* Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient N750

Capacitance range	1,8 to 120 pF (E12 series)
Temperature coefficient of the capacitance $(\frac{\Delta C}{C.\Delta T})$	-750×10^{-6}/K
Tolerance on the temperature coefficient	
for $C \leqslant 18$ pF	$(-120 + 250) \times 10^{-6}$/K
for $C > 18$ pF	$\pm 120 \times 10^{-6}$/K
Marking colour of the temperature coefficient	violet

Table 5

capacitance pF	tolerance	size	marking		catalogue number
1,8*	± 0,25 pF	I	1P8	500	2222 650 57188
2,2*	± 0,25 pF	I	2P2	500	57228
2,7*	± 0,25 pF	I	2P7	500	57278
3,3*	± 0,25 pF	I	3P3	500	57338
3,9*	± 0,25 pF	I	3P9	500	57398
4,7*	± 0,25 pF	I	4P7	500	57478
5,6*	± 0,25 pF	I	5P6	500	57568
6,8*	± 0,25 pF	I	6P8	500	57688
8,2	± 0,25 pF	I	8P2	500	57828
10	± 2%	I	10P	500	58109
12	± 2%	I	12P	500	58129
15	± 2%	I	15P	500	58159
18	± 2%	II	18P	500	58189
22	± 2%	II	22P	500	58229
27	± 2%	II	27P	500	58279
33	± 2%	II	33P	500	58339
39	± 2%	II	39P	500	58399 ←
47	± 2%	III	47P	500	58479
56	± 2%	III	56P	500	58569
68	± 2%	IV	68P	500	58689
82	± 2%	IV	82P	500	58829
100	± 2%	IV	n10	500	58101 ←
120	± 2%	V	n12	500	58121

* Maximum thickness 2,5 mm.

Capacitors with a temperature coefficient N1500

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

Table 6

capacitance pF	tolerance	size	marking		catalogue number
8,2*	± 0,25 pF	I	8P2	500	2222 650 69828
10 *	± 2%	I	10P	500	70109
12 *	± 2%	I	12P	500	70129
15 *	± 2%	I	15P	500	70159
18	± 2%	I	18P	500	70189
22	± 2%	I	22P	500	70229
27	± 2%	I	27P	500	70279
33	± 2%	II	33P	500	70339
39	± 2%	II	39P	500	70399
47	± 2%	II	47P	500	70479
56	± 2%	II	56P	500	70569
68	± 2%	II	68P	500	70689
→ 82	± 2%	II	82P	500	70829
100	± 2%	III	n10	500	70101
120	± 2%	III	n12	500	70121
150	± 2%	IV	n15	500	70151
180	± 2%	IV	n18	500	70181
→ 220	± 2%	IV	n22	500	70221
270	± 2%	V	n27	500	70271

* Maximum thickness 2,5 mm.

TESTS AND REQUIREMENTS

Essentially all tests mentioned in the schedule of IEC publication 108, category 55/085/21 (temperature range −55/+ 85 °C; damp heat, long term, 21 days) are carried out along the lines of IEC publication 68, see Table 7 below.

Table 7

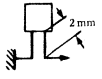
IEC108 clause	IEC 68 test method	test	procedure	requirements
–	–	Robustness of terminations Pull-off	pull velocity 15 cm/min max. load 5 N 	no wire breakage or complete damage of capacitor
15.1	Ua	Tensile strength of leads	axial force 10 N	
15.2	Ub	Bending	load 5 N, 4 x 90°	no wire breakage
16	T	Soldering	solderability: 2 s, 235 °C	good tinning, ΔC/C < 0,5% or 0,5 pF after 30 min to 1 h
17.2	Na	Rapid change of temperature	3 hours −55 °C/3 hours + 85 °C, 1 cycle	no damage, ΔC/C < 0,5% or 0,5 pF
18.1	F	Vibration	10-55-10 Hz 0,75 mm displacement 3 directions, 6 h	no visible damage
19.1	E	Bump	4000 bumps in 2 directions, 40g; pulse time 6 ms	no visible damage
–	–	Inflammability	15 s, 35 mm above bunsen burner with flame height 40 - 60 mm	self-extinguishing within 15 s
–	–	Resistance to solvents	3 min ultrasonic washing in trichloroethylene 1 min drying, 30 °C 10 brush strokes	marking and colour code must remain legible and not be discoloured; no mechanical or electrical damage or deterioration of the material

Table 7 continued

IEC 108 clause	IEC 68 test method	test	procedure	requirements
14.5	–	Temperature coefficient	between + 20 and + 85 °C	within tolerance as specified for each particular material
		Climatic sequence		
20.2	B	Dry heat	16 h + 85 °C	no visible damage
20.3	Db	Damp heat (accel.) 1st cycle	1 day + 55 °C, 100% R.H.	after recovery of 1-2 h immediately followed by cold test
20.4	A	Cold	2 h –55 °C	no visible damage
20.5	M	Low air pressure	1 h 8,5 kPa	no breakdown or flashover
20.6	Db	Damp heat (accel.)	1 day + 55 °C, 100% R.H.	
21	Ca	Damp heat, steady state (half number of the lot at rated voltage, other half at zero voltage)	21 days + 40 °C 90 to 95% R.H.	$\Delta C/C \leqslant 1\%$ or 1 pF tan $\delta \leqslant$ 2 x specified tan δ, R_{ins} after 1-2 h > 5000 MΩ
22	–	Endurance	100 h + 85 °C, 750 V (d.c.)	$\Delta C/C \leqslant 1\%$ or 1 pF tan $\delta \leqslant$ 1,5 x specified tan δ $R_{ins} > 3000$ MΩ

MINIATURE CERAMIC PLATE CAPACITORS

type 2, 500 V (d.c.), high-K type

QUICK REFERENCE DATA

Capacitance range	100 - 2700 pF (E12 series)
Rated d.c. voltage	500 V
Tolerance on capacitance	± 10 %
Basic specification	IEC 187 (2C2)
Category (IEC 68)	55/085/21

RZ 29887-2

APPLICATION

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

DESCRIPTION

The capacitors consist of a rectangular ceramic plate, both sides being metallized and provided with connecting leads. They are insulated by a coating that ensures an excellent behaviour under humid conditions. The capacitor body is tan coloured. The temperature dependence of the capacitance is very small and non-linear. As the capacitors do not have silver electrodes no "silver migration" * can occur.

MECHANICAL DATA

Dimensions in mm

Table 1

size	W max.	H max.	approx. mass g
I	3,6	3,7	0,15
II	4,5	4,7	0,15
III	5,1	5,3	0,17
IV	6,2	6,4	0,21
V	6,2	8,6	0,23

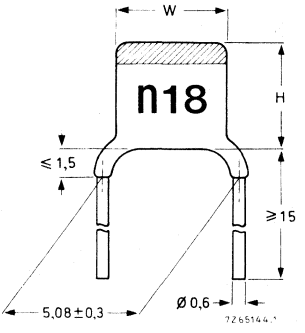


Fig. 1

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

Lacquer on the leads

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

Marking

The temperature dependence is indicated by a yellow colour cap. Capacitance value and voltage are indicated in black script according to Table 2.

Mounting

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

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

* Silver migration is the movement of silver particles from one electrode to the other, under the influence of a d.c. voltage and moisture, which may cause short-circuits.

ELECTRICAL DATA

The capacitors meet the essential requirements of IEC 187. Unless stated otherwise all electrical values apply at an ambient temperature of 20 ± 2 °C, an atmospheric pressure of 93 to 106 kPa and a relative humidity of 45 to 76 %.

Capacitance values, measured at 1 kHz ± 10 % < 1 V	100 to 2700 pF, E12 series, see Table 2
Tolerance on the capacitance	± 10%
Rated d.c. voltage	500 V
Test voltage (d.c.) for 1 min	1250 V
Test voltage (d.c.) of coating for 1 min	1250 V
Insulation resistance at 500 V (d.c.) after 1 min	> 3000 MΩ
Tan δ a 1 kHz, < 1 V	< 3,5 %
Category temperature range	−55 to +85 °C
Climatic category	55/085/21
Storage temperature range	−65 to +125 °C
Capacitance change versus temperature	see Fig. 2
Capacitance change versus frequency	see Fig. 3

Table 2

capacitance pF	size	marking		catalogue number
100 *	I	n10	500	2222 655 03101
120 *	I	n12	500	03121
150 *	I	n15	500	03151
180 *	I	n18	500	03181
220 *	I	n22	500	03221
270	I	n27	500	03271
330	I	n33	500	03331
390	II	n39	500	03391
470	II	n47	500	03471
560	II	n56	500	03561
680	II	n68	500	03681
820	II	n82	500	03821
1000	III	1n0	500	03102
1200	III	1n2	500	03122
1500	IV	1n5	500	03152
1800	IV	1n8	500	03182
2200	IV	2n2	500	03222
2700	V	2n7	500	03272

* Maximum thickness 2,5 mm.

TESTS AND REQUIREMENTS

Essentially all tests mentioned in the schedule of IEC publication 187, category 55/085/21 (temperature range −55/+85 °C; damp heat, long term, 21 days) are carried out along the lines of IEC publication 68, see Table 3 below.

Table 3

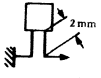
IEC 187 clause	IEC 68 test method	test	procedure	requirements
–	–	Robustness of terminations Pull-off	pull velocity 15 cm/min load 5 N 	no wire breakage or complete damage of capacitor
14.1	Ua	Tensile strength	lead dia. 0,6 mm; axial force 10 N lead dia. 0,4 mm; axial force 5 N	
14.2	Ub	Bending	load 5 N, 4 x 90°	no wire breakage
15	T	Soldering (solder bath)	solderability: 2 s at 235 °C	good tinning, ΔC/C between +20% and −10% after 24 h
16	–	Rapid change of temperature	deaging 1 h +85 °C reference measurement after 24 h	
16.3	Na		3 h −55 °C/3 h +85 °C 1 cycle	no damage ΔC/C after 24 h ⩽ 10%
17.1	Fb	Vibration	10-55-10 Hz 0,75 mm displacement 3 directions, 6 h	no visible damage
18.1	Eb	Bump	4000 bumps in 2 directions, 40g; pulse time 6 ms	no visible damage
–	–	Inflammability	15 s, 35 mm above bunsen burner with flame-height 40-60 mm	self-extinguishing within 15 s after removal of bunsen burner

Table 3 continued

IEC 187 clause	IEC 68 test method	test	procedure	requirements
–	–	Resistance to solvents	3 min ultrasonic washing in trichloroethylene 1 min drying, 30 °C, 10 brush strokes	marking and colour coding must remain legible and not discoloured; no mechanical or electrical damage or deterioration of the material.
19.1	–	Climatic sequence Pre-conditioning	1 h +85 °C reference measurement after 24 h	
19.2	B	Dry heat	16 h +85 °C	no visible damage
19.3	Db	Damp heat (accel.) 1st cycle	1 day +55 °C 100% R.H.	no visible damage after recovery of 1-2 h immediately followed by cold test
19.4	A	Cold	2 h – 55 °C	no visible damage

Table 3 continued

IEC 187 clause	IEC 68 test method	test	procedure	requirements
19.5	M	Low air pressure	1 h at 8,5 kPa last 5 min 500 V d.c. applied	no breakdown or flashover
19.6	Db	Damp heat (accel.) remaining cycles	1 day +55 °C, 100 % R.H.	after recovery of 1 - 2 h Δ C/C $< 10\%$ tan δ $< 700.10^{-4}$ R_{ins} > 1000 MΩ
20.1	Ca	Damp heat (long term)	21 days + 40 °C, 90 to 95% R.H.	Δ C/C $\leqslant 10\%$ tan $\delta \leqslant 700.10^{-4}$ R_{ins} after 1 - 2 h > 1500 MΩ
20.3	–	Endurance	1000 h + 85 °C, 750 V d.c.	Δ C/C $\leqslant 10\%$ tan $\delta < 525.10^{-4}$ $R_{ins} > 1000$ MΩ after 24 h

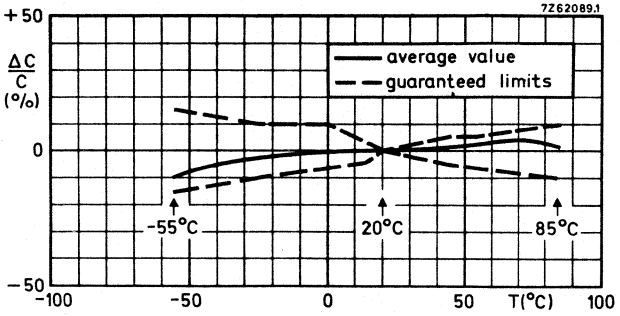


Fig. 2 Capacitance change with respect to the capacitance at 20 °C as a function of temperature.

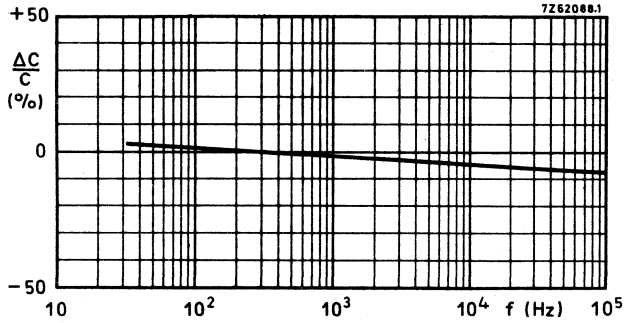


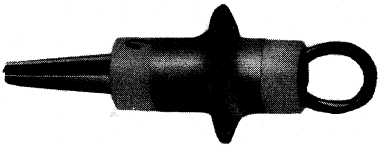
Fig. 3 Typical capacitance change with respect to the capacitance value at 300 Hz as a function of frequency.

PACKAGING: 1000 items per box.

CERAMIC FEED-THROUGH CAPACITORS

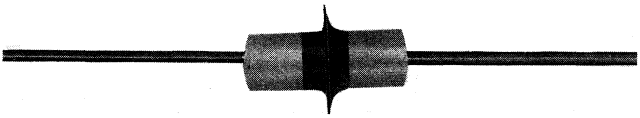
TYPE 2

RZ 22070-3



700-series :	Maximum working voltage	400 V (d. c.)
	Capacitance range	2, 5 to 2200 pF

RZ 22070-4



702-series :	Maximum working voltage	400 V (d. c.)
	Capacitance range	2, 5 to 4700 pF

APPLICATION

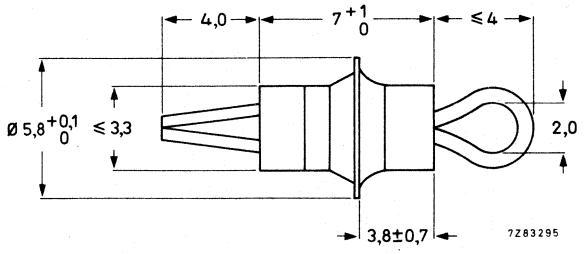
Ceramic feed-through capacitors are designed for decoupling the supply leads of high-frequency equipment, for instance in TV tuners. However, due to their extremely low inductances, they might also be used in frequency-determining circuits in similar equipment.

CONSTRUCTION

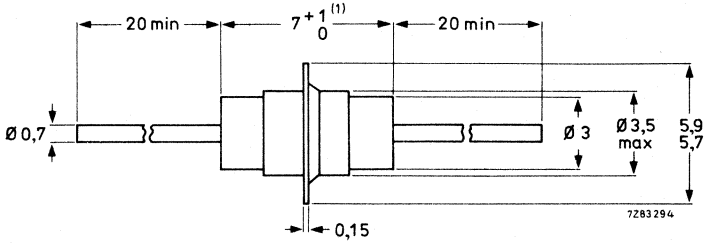
The capacitors consist of a ceramic tube provided with silver electrodes. The outer connection is formed by a flange, and the inner one by a split pen (700-series) or an axial lead (702-series). Both types are provided with sufficient soldering tin to facilitate mounting.
The split pen capacitors are marked in black script or with a colour dot. The lead feed-through type is not marked.

Dimensions in mm

700-series



702-series



TECHNICAL PERFORMANCE

Unless otherwise specified all electrical values apply at a temperature of 20 ± 5 °C, an atmospheric pressure of 93 - 106 kPa and a relative humidity of ≤ 75 %.

Rated d.c. voltage	400 V
Test voltage (d.c.) for 1 min	1100 V
Tan δ measured at < 3,5 V	
for C ≤ 68 pF at 1 MHz	$< \left(\frac{15}{C} + 0,7\right) \times 10^{-3}$
for C > 68 pF at 1 kHz	$< 3,5.10^{-4}$
Insulation resistance at 100 V d.c. (within 1 min)	> 10 000 MΩ
Working temperature range	−40 to +85 °C
Climatic category (IEC 68)	40/085/21

(1) 10^{+1} mm for the 3300 pF capacitor
12^{+1} mm for the 4700 pF capacitor

AVAILABLE VERSIONS

Split pen feed-through capacitors, catalogue number 2222 700 .....

suffix, see table

capacitance (pF)	tolerance	suffix
≤ 2.5		00258
3.3	±0.5 pF	01338
4.7	±0.5 pF	01478
6.8	±1 pF	02688
10	±1 pF	02109
15	±10 %	03159
22		03229
33		03339
47		03479
68	±20 %	04689
100		04101
150		04151
220		04221
330		04331
470		04471
680		04681
1000	-20/+50 %	05102
1500		05152
2200		05222

Lead feed-through capacitors, catalogue number 2222 702 .....
suffix, see table

cap. (pF)	tolerance	suffix
≤ 2.5	± 0.5 pF	04258
3.3		04338
4.7		04478
6.8		04688
10	±10%	05109
15		07159
22		07229
33		07339
47		07479
68		07689
100	± 20 %	08101
150		08151
220		08221
330		08331
470		08471
680	-20/+50 %	09681
1000		09102
1500		09152
2200		09222
3300		09332
4700		09472

Capacitance values of the E12 series are subject to minimum order release requirements.

MULTILAYER CERAMIC CHIP CAPACITORS

QUICK REFERENCE DATA

Capacitance range	
NP0 (C0G) dielectric	10 to 33 000 pF (E12 series)
K1800 (X7R) dielectric	180 to 470 000 pF (E12 series)
Rated d.c. voltage	50 V (EIA), 63 V (IEC)
Tolerance on capacitance	
NP0 (C0G)	± 10% ± 5%
K1800 (X7R)	± 20%, ± 10%
Basic specification	IEC 384-10 (EIA RS198/B)
Climatic category (IEC68)	
NP0 (C0G)	55/125/56
K1800 (X7R)	55/125/56

APPLICATION

These multilayer ceramic capacitors provide a very high capacitance per unit volume which, together with physical size and performance, makes them very suitable for use in hybrid and other micro-circuitry. These small size components can be applied to the same functions as other ceramic capacitors i.e. coupling, by-passing, blocking, frequency discrimination, etc.

DESCRIPTION

The capacitors consist of a rectangular block of ceramic dielectric in which a number of interleaved precious-metal electrodes yield a high capacitance per unit volume. The capacitors are Pd Ag metallized at the end terminal (see Fig. 2).

MECHANICAL DATA

Dimensions in mm

Outlines

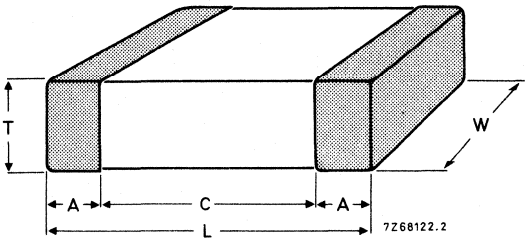


Fig. 1

Table 1

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

Soldering

Limiting conditions	min.	220 °C, 3 s
	max.	250 °C, 60 s

PACKAGING

Multiples of 100 pieces.

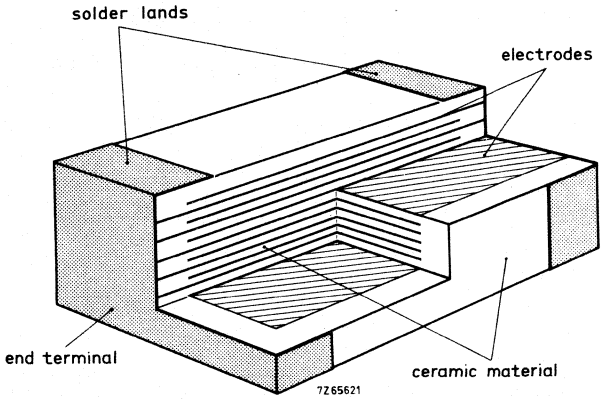


Fig.2.

COMPOSITION OF THE CATALOGUE NUMBER

2222 . . . . . .

style code

851 for size 0805
852 for size 1210
853 for size 1206
854 for size 1808
855 for size 1812
856 for size 2220

	tolerance	
NP0(C0G)	5%	12
	10%	13
K1800 (X7R)	10%	47
	20%	48

capacitance value code, first two significant figures of the capacitance value according to E12 series followed by multiplying factor:
9 for x 1
1 for x 10
2 for x 10^2
3 for x 10^3
4 for x 10^4

See Tables 2 and 3.

ELECTRICAL DATA

Unless otherwise specified all electrical values apply at an ambient temperature of 20 ± 7 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Type 1, High-Q, NP0 (EIA: C0G)

Capacitance range	
⩽ 1000 pF measured at 1 MHz, 1 V	
> 1000 pF measured at 1 kHz, 1 V	see Table 2, (E12 series)
Tolerance on capacitance	± 10%, ± 5%
Rated d.c. voltage (U_R)	50 V (EIA), 63 V (IEC)
D.C. test voltage for 1 min	200 V
Dissipation factor, measured at 1 V,	
1 MHz, C < 30 pF	$10\ (\frac{10}{C} + 0{,}7) \times 10^{-4}$
1 MHz, 30 pF < C ⩽ 1000 pF	$< 10 \times 10^{-4}$
1 kHz, C > 1000 pF	$< 10 \times 10^{-4}$
Insulation resistance	> 100 000 MΩ
Category temperature range	−55 to +125 °C
Capacitance change as a function of temperature, −55 to +125 °C	± 30 x 10^{-6}/K

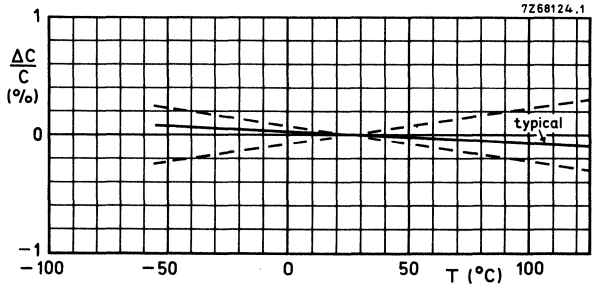


Fig. 3 Typical capacitance change as a function of temperature. Dotted lines indicate the limits.

Table 2: NP0 (C0G)

size	capacitance range	capacitance tolerance	catalogue number
0805	10 to 1 000 pF	5%	2222 851 12 . . .
		10%	2222 851 13 . . .
1206	33 to 3 300 pF	5%	2222 853 12 . . .
		10%	2222 853 13 . . .
1210	100 to 8 200 pF	5%	2222 852 12 . . .
		10%	2222 852 13 . . .
1808	100 to 10 000 pF	5%	2222 854 12 . . .
		10%	2222 854 13 . . .
1812	1 000 to 15 000 pF	5%	2222 855 12 . . .
		10%	2222 855 13 . . .
2220	10 000 to 33 000 pF	5%	2222 856 12 . . .
		10%	2222 856 13 . . .

code for capacitance value:
first two significant figures
of capacitance value according
to E12 series followed by:
9 for 10 to 82 pF
1 for 100 to 820 pF
2 for 1 000 to 8 200 pF
3 for 10 000 to 33 000 pF

e.g.: fill in 272 for 2700 pF.

Type 2, K1800 (EIA: X7R)

Capacitance range measured at 1 kHz, 1 V	see Table 3 (E12 series)
Tolerance on capacitance	±20%
Rated d.c. voltage (U_R)	50 V (EIA), 63 V (IEC)
D.C. test voltage for 1 min	200 V
Dissipation factor, measured at 1 kHz, 1 V	< 2,5%
Insulation resistance	
$C \leqslant 10\,000$ pF	> 100 000 MΩ
$C > 10\,000$ pF	$R_{ins} \times C > 1000$ s
Category temperature range	−55 to +125 °C
Maximum capacitance change as a function of temperature	±15%, see Fig. 4

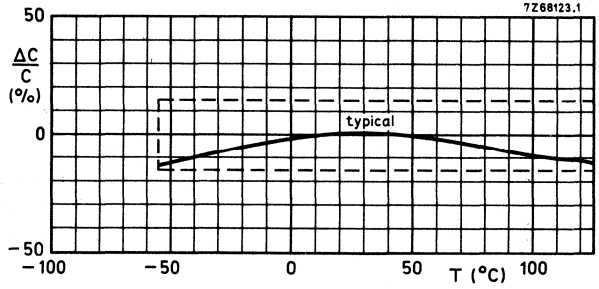


Fig. 4 Typical capacitance change as a function of temperature. Dotted lines indicate the limits.

Table 3: K1800 (X7R)

size	capacitance range	capacitance tolerance	catalogue number
0805	180 to 22 000 pF	10%	2222 851 47 . . .
		20%	2222 851 48 . . .
1206	1 800 to 56 000 pF	10%	2222 853 47 . . .
		20%	2222 853 48 . . .
1210	2 700 to 100 000 pF	10%	2222 852 47 . . .
		20%	2222 852 48 . . .
1808	10 000 to 150 000 pF	10%	2222 854 47 . . .
		20%	2222 854 48 . . .
1812	10 000 to 270 000 pF	10%	2222 855 47 . . .
		20%	2222 855 48 . . .
2220	100 000 to 470 000 pF	10%	2222 856 47 . . .
		20%	2222 856 48 . . .

code for capacitance value:
first two significant figures
of capacitance value according
to E12 series followed by:
1 for 180 to 820 pF
2 for 1 000 to 8 200 pF
3 for 10 000 to 82 000 pF
4 for 100 000 to 470 000 pF

e.g.: fill in 683 for 68 000 pF.

TESTS AND REQUIREMENTS–IEC

sampling group	number of samples	IEC 384-1 par.	IEC draft 40(C.O.) 343 par.	test	procedure	requirements
1A	20	7	8.5	Visual inspection and check of dimensions	any applicable method	in accordance with specification
		10	8.6	Capacitance	$C \leqslant 1000$ pF f = 1 MHz $C > 1000$ pF f = 1 kHz measuring voltage 1 V, T = + 20 °C	within specified tolerance
		11	8.7	Tan δ	see 8.6	in accordance with specification
		8	8.8	Insulation resistance	at 10 V (d.c.)	in accordance with specification
		9	8.9	Voltage proof	3 x U_R for 1 min	no breakdown or flashover
1B	20		8.15	Solderability	unmounted chips completely immersed for 4 ± 1 s in a solder bath of 230 ± 10 °C	the termination of the chip must be well tinned. capacitance within tolerance
2A	55	same measurements as group 1A, however, the capacitors are mounted on a substrate				capacitance and tan δ shall be used as a reference for further tests. R_{ins}: same as 8.8 test voltage: same as 8.9
2B2	15		8.13	Adhesion	a force of 5 N shall be applied normal to the line joining the terminations and in a plane parallel to the substrate	no visible damage
		19	8.14	Vibration IEC 68, test Fc	severity IV	no visible damage

2B2		18	8.16	De-ageing and recovery	K1800: 1 h at max. temperature	
					K1800: cap. measured after 24 h recovery for reference	within specified tolerance
				Rapid change of temperature	3 h at max. temperature followed by 3 h at min. temperature (1 cycle)	no visible damage NP0: $\Delta C/C \pm \leqslant 1\%$ or 1 pF after 24 h recovery K1800: $\Delta C/C \pm \leqslant 10\%$
		21	8.17	Climatic sequence De-ageing and recovery	K1800: 1 h at max. temperature	
		21.1			K1800: cap. measured after 24 h recovery for reference	
		21.2		Dry heat	16 h at max. temperature	no visible damage
		21.3		Damp heat accelerated, 1 cycle	24 h, R.H. 100% at 55 °C	no visible damage
		21.4		Cold	2 h at min. temperature	no visible damage
		21.6		Damp heat accelerated, remaining cycles	at 55 °C, R.H. 100% 5 cycles of 24 h	after recovery $\leqslant$ 8 h: no visible damage $\Delta C/C$, NP0: $\pm \leqslant 2\%$ or 2 pF K1800: $\pm \leqslant 10\%$ tan δ, NP0: $\leqslant$ 2 x specified tan δ in group 2A K1800: $\pm \leqslant 5\%$ R_{ins}: $> 2.10^3$ MΩ for C $\leqslant$ 25 000 pF or RC > 50 s for C > 25 000 pF

TESTS AND REQUIREMENTS—IEC (continued)

sampling group	number of samples	IEC 384-1 par.	IEC draft 40(C.O.) 343 par.	test	procedure	requirements
2B3	15	22	8.18	Damp heat, steady state	56 days, R.H. 90–95% at 40 °C, no voltage applied	no visible damage. electrical data same as 8.16, however ΔC deviation from group 2A
2B4	5		8.10	Temperature coefficient	NP0: between min. and max. temperature	in accordance with specification
			8.11	Temperature characteristic	K1800: 96 h drying at 55 °C K1800: + 25, −55, + 25, + 125 °C	$\Delta C/C \pm \leqslant 15\%$
2B5	20	24	8.19	Endurance Preconditioning	1 h at max. temperature	no visible damage, after 24 h recovery $\Delta C/C$, NP0: $\pm \leqslant 2\%$ or 2 pF K1800: $\pm \leqslant 10\%$ $\tan \delta$, NP0: $\leqslant 1{,}5 \times \tan \delta$ in group 2A K1800: $\leqslant 3{,}75\%$ R_{ins}, NP0: $> 15.10^3$ MΩ for $C \leqslant 25$ nF K1800: $> 5.10^3$ for $C \leqslant 25$ nF $RC > 125$ s for $C > 25$ nF
				Capacitance	after 24 h recovery	
				Test	1000 h at max. temperature with $1{,}5 \times U_R$ applied	

TESTS AND REQUIREMENTS –EIA

sampling group	number of samples	EIA RS 198/B test	EIA RS 198/B par.	test	procedure	requirements
1	50		4.4	Construction and appearance	any applicable method	chips shall be in accordance with specification
		1. 6. 1	1. 5. 2	Capacitance	C0G, $C \leqslant 1000$ pF at 1 MHz $C > 1000$ pF at 1 kHz X7R at 1 kHz; measuring voltage 1 V	capacitance shall be within specified tolerance
		1. 6. 2 2. 5. 2	1. 5. 3 2. 4. 3	Tan δ	see 1. 5. 2	C0G at 1 MHz, 30 pF $\leqslant C \leqslant$ 1000 pF: $< 10.10^{-4}$ at 1 kHz, $C >$ 1000 pF: $< 20.10^{-4}$ $C <$ 30 pF acc. EIA RS198 par. 1.5.3.1 X7R $\leqslant$ 2,5%
		1. 6. 3 2. 5. 3	1. 5. 4 2. 4. 4	Insulation resistance	for 1 min at U_R	in accordance with specification C0G, $R_{ins} > 10^5$ MΩ X7R, $C \leqslant 10$ nF, $R_{ins} > 10^5$ MΩ $C > 10$ nF, $RC >$ 1000 s
		1. 6. 4 2. 5. 4	1. 5. 5 2. 4. 6	Test voltage	for 1 s at 2,5 x U_R	no breakdown or flashover
2	5	1. 6. 5	1. 5. 6	Temperature coefficient	C0G: + 25, –55, + 25, + 85, + 25 °C, temp. coefficient = $\frac{\Delta C}{C25.\Delta T}$	max. $\Delta C/C$: $\pm 30.10^{-6}$/K in accordance with specification
		2. 5. 5	2. 4. 6	Temperature characteristic	X7R: + 25, –55, + 25, + 125 °C	max. $\Delta C/C$: ± 15%

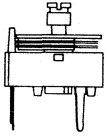
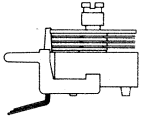
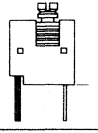
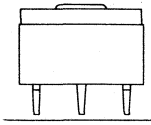
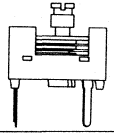
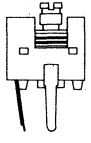
TESTS AND REQUIREMENTS—EIA (continued)

sampling group	number of samples	EIA RS198/B test	EIA RS198/B par.	test	procedure	requirements
3	20	1. 6. 6 2. 5. 6	1. 5. 7 2. 4. 7	Seal test	5 cycles of 15 min. at + 25 °C, −20 °C, + 25 °C and + 85 °C followed by 100 h at R.H. 90-95% and 40 °C	within 30 min to be measured; $\Delta C/C$, C0G: $\pm \leqslant 2\%$ or 0,25 pF X7R: $\pm \leqslant 20\%$ tan δ, C0G: $\leqslant$ two times initial value of group 1 X7R: $\leqslant 5\%$ R_{ins}, C0G: $> 10^4$ MΩ X7R: C $\leqslant$ 10 nF, $R_{ins} > 10^4$ MΩ C $>$ 10 nF, RC $>$ 100 s
4	20	1. 6. 7 2. 5. 7	1. 5. 8 2. 4. 8	Endurance Preconditioning	1 h at max. temperature	
				Capacitance	see group 1	in accordance with specification
				Test	250 h at max. temperature with 2 x U_R applied	see group 3

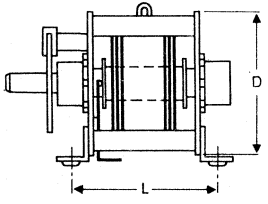
VARIABLE CAPACITORS

SURVEY

FILM DIELECTRIC TRIMMERS

model		capacitance max. C_{min}/min. C_{max} pF	rated voltage (d.c.) V	temperature coefficient 10^{-6}/K	temperature range °C	dimensions range mm	catalogue number 2222 followed by
 	(1)	1,5/5 to 4/20	150	−50 ± 200 to −500 ± 450	−40 to + 70	φ 5	808 . . . . .
		1,4/5,5 to 3/40	250		−40 to + 70 −40 to + 85	φ 7,5	
		2,5/15 to 6/100	250		−40 to + 70 −40 to + 85	φ 10	
		11/120	150		−40 to + 85	φ 13,5	
	(1)	1,2/3,5 1,8/10 2/18	300	−250 ± 150 −350 ± 150 −350 ± 150	−40 to + 125	6 x 8	809 05001 809 05002 809 05003
	(2)	single stator split stator diff. type	2,5/20 to 7/100 1,5/5 to 3/25 2/12 to 7/150	200	0 ± 200	−40 to + 125	11 x 14	809 070 . .
	(1)		4/40 5/60	300	−250 ± 150	−40 to + 125	10 x 11	809 08002 809 08003
	(1)		1,4/5,5 2/9 2/18	300	−250 ± 150	−40 to + 125	8 x 9	809 09001 809 09002 809 09003

PRECISION TUNING CAPACITORS

model	capacitance range pF				L x D mm			catalogue number
	stator types	40 x 40 mm linear	60 x 60 mm linear	60 x 60 mm logarithmic	number of gangs	D = 40 x 40 mm	D = 60 x 60 mm	
	single 1 - 4 gangs	16 - 250	100 - 640	100 - 500	1	L = 45	L = 67	2222 805 . . . . .
	split 1 - 4 gangs	10 - 64	25 - 125	25 - 125	2	L = 76,5	L = 117,5	
					3	L = 108	L = 168	
	differential 1 gang	64 - 160	–	–	4	L = 139,5	L = 218,5	
temperature range: –40 to + 85 °C								

Notes

Some data on our trimmers, such as the temperature coefficient and the climatic category, are defined on the basis of type approval tests.

All specified values are continuously checked by a random test system of which the results are gathered in periodical surveys from which typical values can be derived and made available on request.

1. Top and bottom adjustment.
2. Top adjustment only.

PRECISION TUNING CAPACITORS

QUICK REFERENCE DATA			
types	40 x 40 mm standard torque	60 x 60 mm standard torque	
	linear law	linear law	logarithmic law
single stator 1-4 gangs	16-250 pF *)	100-640 pF	100-500 pF
split stator 1-4 gangs	10-64 pF	25-125 pF	25-125 pF
differential 1 gang	64-160 pF *)		
Law and ganging tolerances		± 0,7 %	

*) 1 gang types also available with high torque and spindle-end slotted.

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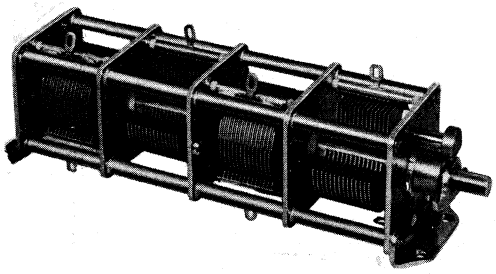

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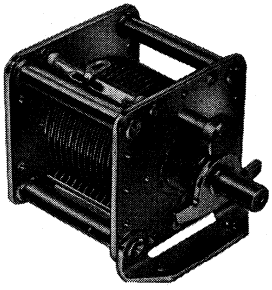


APPLICATION

These air dielectric capacitors are applicable where a high accuracy of adjustment and a high degree of stability are required.
They are available with one to four gangs.

DESCRIPTION

Frame

Nickel-plated brass plates and bars, assembled by riveting and soldering.

Spindle

Ball bearings on both ends.

Rotor

Clean brass vanes soldered to the shaft. The rotor sections are insulated from the frame and from each other by siliconized ceramic bars.

Stator

Clean brass vanes supported and insulated by siliconized ceramic balls.

Protruding spindle end

Diameter 6 mm, standard free length 10 and 14.5 mm for (40x40 mm) version and (60x60 mm) version respectively.

Direction of rotation

Clockwise for increasing capacitance.

Angle of rotation

180° or 360° at choice.

Owing to the eccentric rotor vanes, the versions with logarithmic laws have 180° as maximum angle of rotation.

High stability and freedom from noise are obtained by soldering all the metal parts together. Low contact resistance is ensured by silver contact points on the rotor drag spring and a gold plated contact ring soldered to the rotor.
Silicone treated ceramics are used exclusively for insulation ensuring that the insulation resistance is high and the losses are low, even in humid conditions. The resistance to shock and vibration is high as the stator is supported by and insulated with ceramic balls. The ceramic spindles are able to withstand severe impact and vibration.
The standard spindle end is provided with a detent which, together with a removable stop on the front plate, permits the accurate setting of a rotation angle of 15° as a reference for checking the capacitance and its variation as a function of rotation. For rotation angles of 165° and above, the stop should be removed.

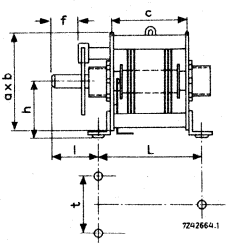
Single capacitors of the (40x40 mm) version for direct drive operation have the spindle end slotted for screwdriver adjustment.

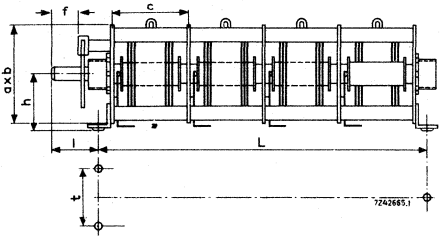
The capacitors are built entirely of basic parts with symmetrically placed stator and rotor packs. Non-listed combinations having non-standard capacitances, extra compartments, longer spindle ends (protruding up to 50 mm from both faces) and different connections, can be obtained on customers specification.

Fully customer-built capacitors, of which the technical specification has been discussed with the local field engineer, can also be supplied.

MECHANICAL DATA

Dimensions (mm)





dimensions in mm		a x b	number of gangs			
			1	2	3	4
distance between mounting holes (±0.5)	L	40 x 40	45	76,5	108	139,5
		60 x 60	67	117,5	168	218,5
	t	40 x 40	22			
		60 x 60	35			
compartment length (±0.2)	c	40 x 40	31,5			
		60 x 60	50,5			
spindle length (±0.5)	l	40 x 40	16			
		60 x 60	18			
spindle height (±0.5)	h	40 x 40	22,5			
		60 x 60	32,5			
free spindle length	f	40 x 40	10			
		60 x 60	14,5			
weight (g)		40 x 40	120	200	300	400
		60 x 60	400	700	1000	1300

Direction of rotation for increase in capacitance	clockwise
Effective angle of rotation, linear capacitor	360°
logarithmic capacitor	180°
Maximum axial thrust	50 N

Operating torque	1 gang		2 gangs	3 gangs	4 gangs	
	direct drive	indirect drive				
Minimum	20					mNm
Maximum	50	20	25	30	35	mNm

Mounting

The capacitors can be mounted by means of screws passed through the three holes in the mounting brackets.

Connecting leads
Two wires of 1.5 mm^2 maximum diameter can be connected to each soldering tag.

ELECTRICAL DATA

Nominal capacitance swing	see C_{var} in table I
Maximum capacitance at 0^o	see C_0 in table I
Test voltage	see V_{test} in table I
Rated voltage	$\frac{1}{2} V_{test}$
Coupling capacitance	
between stator packs	$\leq$ 0.02 pF
between rotor packs (if insulated)	$\leq$ 0.05 pF
Insulation resistance between stator and rotor and between frame and stator and rotor	> 10 000 MΩ
Contact resistance between any soldering tag and the relative rotor pack	$\leq$ 5 mΩ
Parallel damping at 1.5 MHz with 50 pF (or max. capacitance if < 50 pF)	> 10 MΩ

Temperature coefficient of capacitance for the first compartment, (at C = 1/3 cap. swing + capacitance at 15^o) in ppm/^{o}C.

version	40 x 40 mm	60 x 60 mm
1 gang	20 ± 20	30 ± 30
2 gangs	20 ± 20	30 ± 30
3 gangs	30 ± 30	50 ± 50
4 gangs	50 ± 50	50 ± 50

Capacitance law

angle of rotation	capacitance increase (% of capacitance swing)	
	linear law	logarithmic law
15°	0	0
20°	3.12	0.83
30°	9.38	2.68
40°	15.62	4.81
50°	21.88	7.28
70°	34.38	13.41
90°	46.88	21.58
110°	59.38	32.49
130°	71.88	47.03
150°	84.38	66.42
175°	100	100

Capacitance tolerance

For angles of rotation between 15° and 175°, the capacitance tolerance in the first compartment is given by the expression:

$$\pm 0.7\ (0.11\ C + C')/100$$

where

C = capacitance swing (minimum 25 pF)

C' = capacitance increase calculated from the capacitance law.

Ganging tolerance (rotation angles between 15° and 175°)

The capacitance in the second, third, and fourth compartments will not differ from the actual capacitance in the first compartment by more than ±0.7%.

Backlash (reproducibility)
(for indirect drive capacitors) Better than 150×10^{-6} pF/pF

Category temperature range −40 to +85 °C

Electrical Data continued

Table I

	size a x b = 40 x 40 mm linear capacitance law				size a x b = 60 x 60 mm linear capacitance law				size a x b = 60 x 60 mm logarithmic capacitance law			
	single-stator or differential type		split-stator type		single-stator type		split-stator type		single-stator type		split-stator type	
C_{var} (pF)	$C_0 \pm 1$ pF[1] (pF)	V_{test}[2] (V d.c.)	$C_0 \pm 1$pF (pF)	V_{test}[3] (Vd.c.)	$C_0 \pm 1$pF (pF)	V_{test}[3] (Vd.c.)	$C_0 \pm 1$pF (pF)	V_{test}[3] (Vd.c.)	$C_0 \pm 1$pF (pF)	V_{test}[3] (Vd.c.)	$C_0 \pm 1$pF) (pF)	V_{test}[3] (Vd.c.)
10			3	3000								
16	8	2500	3.6	2000								
25	8.5	2000	4	2000			5	4000			5	2500
32							5	3000			5	2500
40	9	1500	4	1600			5	3000			5.5	2000
50							5	2500			5.5	2000
64	9	1000	4	1300			5.5	2000			5.5	1600
80							5.5	2000			5.5	1600
100	10	1000			14.5	2000	5.5	2000	13	1500	5.5	1600
125					15	2000	6	1600	13	1250	5.5	1300
160	11	800			15.5	1500			14.5	1000		
250					16	1250			14.5	1000		
200	11.5	650[4]			16	1250			14	1000		
320					17.5	1000			14	800		
400					19	1000			14	800		
500					20.5	1000			14	650		
640					21.5	800						

1) For the differential version the C_o values are 1 pF less than the tabulated values
2) Between rotor and stator
3) Between the two stators
4) Differential type only up to and including C_{var} = 160 pF

CATALOGUE NUMBERS

2222 805 ⋯ suffix, see Tables II and III

00 for 40 x 40 mm version
02 for 60 x 60 mm version

Table II 40 x 40 mm version

type	C_{var} (pF)	single-stator		split-stator	differential type	
		indirect drive [1])	direct drive [2])	indirect drive [1])	indirect drive [1])	direct drive [2])
1 gang	10			187		
	16	131	173	188		
	25	132	178	189		
	40	133	174	191		
	64	134	175	192	239	252
	100	135	176		241	253
	160	136	177		242	254
	250	137	179			
2 gangs	2 x 10			194		
	2 x 16	138		195		
	2 x 25	139		196		
	2 x 40	141		197		
	2 x 64	142		198		
	2 x 100	143				
	2 x 160	144				
	2 x 250	145				
3 gangs	3 x 10					
	3 x 16	146		201		
	3 x 25	147		202		
	3 x 40	148		203		
	3 x 64	149		204		
	3 x 100	151		205		
	3 x 160	152				
	3 x 250	153				
4 gangs	4 x 10			207		
	4 x 16	154		208		
	4 x 25	155		209		
	4 x 40	156		211		
	4 x 64	157		212		
	4 x 100	158				
	4 x 160	159				
	4 x 250	161				

[1]) low torque

[2]) high torque

Table III 60 x 60 mm version

type	C_{var} (pF)	single-stator		split-stator	
		linear law	logarithmic law	linear law	logarithmic law
1 gang	25			298	345
	32			299	346
	40			301	347
	50			302	348
	64			303	349
	80			304	351
	100	196	249	305	352
	125	197	251	306	353
	160	198	252		
	200	199	253		
	250	201	254		
	320	202	255		
	400	203	256		
	500	204	257		
	640	205			
2 gangs	2 x 25			307	354
	2 x 32			308	355
	2 x 40			309	356
	2 x 50			311	357
	2 x 64			312	358
	2 x 80			313	359
	2 x 100	206	258	314	361
	2 x 125	207	259	315	362
	2 x 160	208	261		
	2 x 200	209	262		
	2 x 250	211	263		
	2 x 320	212	264		
	2 x 400	213	265		
	2 x 500	214	266		
	2 x 640	215			

Table III continued

type	C_{var} (pF)	single-stator		split-stator	
		linear law	logarithmic law	linear law	logarithmic law
3 gangs	3 x 25			316	363
	3 x 32			317	364
	3 x 40			318	365
	3 x 50			319	366
	3 x 64			321	367
	3 x 80			322	368
	3 x 100	216	267	323	369
	3 x 125	217	268	324	371
	3 x 160	218	269		
	3 x 200	219	271		
	3 x 250	221	272		
	3 x 320	222	273		
	3 x 400	223	274		
	3 x 500	224	275		
	3 x 640	225			
4 gangs	4 x 25			325	372
	4 x 32			326	373
	4 x 40			327	374
	4 x 50			328	375
	4 x 64			329	376
	4 x 80			331	377
	4 x 100	226	276	332	378
	4 x 125	227	277	333	379
	4 x 160	228	278		
	4 x 200	229	279		
	4 x 250	231	281		
	4 x 320	232	282		
	4 x 400	233	283		
	4 x 500	234	284		
	4 x 640	235			

FILM DIELECTRIC TRIMMERS

QUICK REFERENCE DATA

Max. C_{min}/min. C_{max}	1,5/5 to 4/20 pF *
Diameter	5 mm
Rated voltage (d.c.)	150 V
Climatic category (IEC 68)	40/070/21
Basic specification	IEC 418-1 and 4

APPLICATION

These film dielectric trimmers have been designed for use on printed-wiring boards, e.g. in radio sets. Moreover, thanks to their good stability, these trimmers are suitable for industrial equipment.

DESCRIPTION

The vanes are stacked on a sturdy plastic base. The dielectric is a film of polypropylene which supports the vanes in such a way that good stability is ensured and no microphony can occur. The capacitor has top and bottom adjustment by means of a screwdriver. Flux absorption between the vanes is prevented. The trimmers are resistant to all standard cleaning solvents except trichloroethylene and trichloroethane.

MECHANICAL DATA

Dimensions in mm

Outlines

See Fig. 1.

Table 1

Effective angle of rotation	180°
Operating torque	1-15 mNm
Maximum axial thrust ($\Delta C \leqslant 0{,}3\%$ of C_{max})	2 N
Mass (approximately)	0,45 g

* The data on the 5 pF, 15 pF and 20 pF versions are provisional.

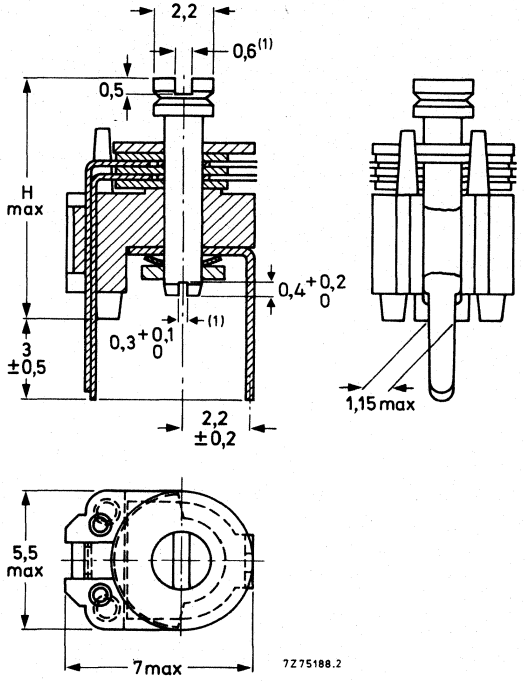


Fig. 1 H is given in Table 2.

(1) Angle between screwdriver adjustment slots is arbitrary.

Type identification

The different capacitance values can be identified by the colour of the base, see Table 2.

Soldering

Soldering conditions max. 260 °C, max. 10 s

Mounting

The trimmers can be mounted on printed-wiring boards with holes with a minimum diameter of 1,25 mm. The hole pattern is given in the figure below.

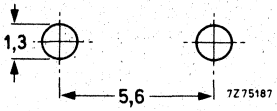


Fig. 2.

ELECTRICAL DATA

Table 2

reference C_{min}/C_{max} (note 1) pF	guaranteed max. C_{min} min. C_{max} (note 2) pF	tan δ at C_{max} x 10^{-4} 1 MHz	tan δ at C_{max} x 10^{-4} 100 MHz	temperature coefficient (note 3) 10^{-6}/K	min. f_{res} at C_{max} MHz	colour of base	H in Fig. 1 mm	catalogue number
1,2/5	1,5/5	< 10	< 25			grey	6,8	2222 808 23508
1,4/10	2 /10	< 10	< 25	−200 ± 300	500	yellow	6,8	2222 808 23109
1,6/15	2,5/15	< 10	< 25	−50 ± 200	400	blue	8,8	2222 808 23159
3,5/20	4 /20	< 10	< 25	−50 ± 200	300	green	8,8	2222 808 23209

Rated voltage (d.c.)	150 V
Test voltage (d.c.) for 1 minute	300 V
Contact resistance	max. 10 mΩ
Insulation resistance	min. 10 000 MΩ
Category temperature range	−40 to + 70 °C
Climatic category (IEC 68)	40/070/21

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410.

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{max}, and is also subjected to the full test voltage. See also Notes under Survey of variable capacitors.

PACKAGING

Bulk packing in cardboard boxes lined with expanded plastic.

Notes

1. This column indicates the reference values of the capacitance ranges currently available on the market which are equivalent to our range.
2. Measured at 200 kHz.
3. C at 60 to 80% of C_{max}; ΔT from + 20 °C to upper category temperature.

TESTS AND REQUIREMENTS

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
4.2		method of mounting	method A		
14		cap. drift	after T.C. measurement	ΔC/C	⩽ 1,75%
19		thrust	axial thrust of 2N	ΔC/C	⩽ 0,4%
21		robustness of terminations:			
21.1	Ua	tensile	1N		
21.2	Ub	bending	1 cycle		no damage
22	Na	rapid change of temperature	1 cycle: ½ h at the lower and ½ h at the upper category temperature	ΔC/C	⩽ 2,5%
23	T	soldering			good wetting
	Ta	solderability	solder bath, immersion 3 mm, 235 °C, 2 s		no mech. damage
	Tb	resistance to heat	solder bath 260 °C, 10 s		no mech. damage
24		impact		ΔC/C	⩽ 1%
	Eb	bump	4000 ± 10 bumps, 40g, 6 ms		no mech. damage
25	Fc	vibration	freq. 10 to 55 Hz, amplitude 0,75 mm, 1½ h	ΔC/C	⩽ 1% no mech. damage

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
26		climatic sequence		$\Delta C/C$ tan δ R_{ins} rotor contact R voltage proof visual examination operating torque	$\leqslant 4\%$ $\leqslant 15 \times 10^{-4}$ $\geqslant 10\,000$ MΩ $\leqslant 10$ mΩ as specified no mech. damage 1-15 mNm
26.1	B	dry heat	16 h at the upper category temperature		
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h + 40 °C, 95 to 100% R.H.		
26.3	Aa	cold	16 h −40 °C		
26.5		damp heat accelerated, remaining cycles	1 cycle 24 h + 40 °C, 95 to 100% R.H.		
27	C	damp heat steady state	21 days + 40 °C, 90 to 95% R.H.	$\Delta C/C$ tan δ R_{ins} rotor contact R voltage proof visual examination operating torque	$\leqslant 3\%$ 15×10^{-4} $\geqslant 10\,000$ MΩ $\leqslant 10$ mΩ as specified no mech. damage 1-15 mNm
29 29.1		endurance mechanical	10 cycles	$\Delta C/C$ rotor contact R voltage proof $\Delta C/C$ after axial thrust visual examination operating torque	$\leqslant 3\%$ $\leqslant 10$ mΩ as specified $\leqslant 0{,}3\%$ no mech. damage 0,5-22,5 mNm

FILM DIELECTRIC TRIMMERS

QUICK REFERENCE DATA

Max. C_{min}/min. C_{max}	1,4/5,5 to 3/40 pF
Diameter	7,5 mm
Rated voltage (d.c.)	250 V
Climatic category (IEC 68)	40/070/21 or 40/085/21
Basic specification	IEC 418-1 and 4

APPLICATION

These film dielectric trimmers have been designed for use on printed-wiring boards, e.g. in radio sets. Moreover, thanks to their good stability, these trimmers have even proved their value in industrial equipment.

DESCRIPTION

The vanes are stacked on a sturdy plastic base. The dielectric is a film of polyethylene, polypropylene, polycarbonate or P.T.F.E. which supports the vanes in such a way that good stability is ensured and no microphony can occur. Flux absorption between the vanes is prevented. The trimmers are resistant to all standard cleaning solvents except trichloroethane and trichloroethylene.
A version with vertical spindle (Fig. 1) and a version with horizontal spindle (Fig. 2) are available (see Table 2). Both versions have top adjustment by means of a screwdriver and bottom adjustment by means of a key (see Fig. 5).

MECHANICAL DATA

Dimensions in mm

Outlines

See Figs 1 and 2.

Table 1

Effective angle of rotation	180°
Operating torque	1-15 mNm
Maximum axial thrust ($\Delta C \leqslant 0{,}3\%$ of C_{max})	2 N
Mass (approximately)	0,8 g

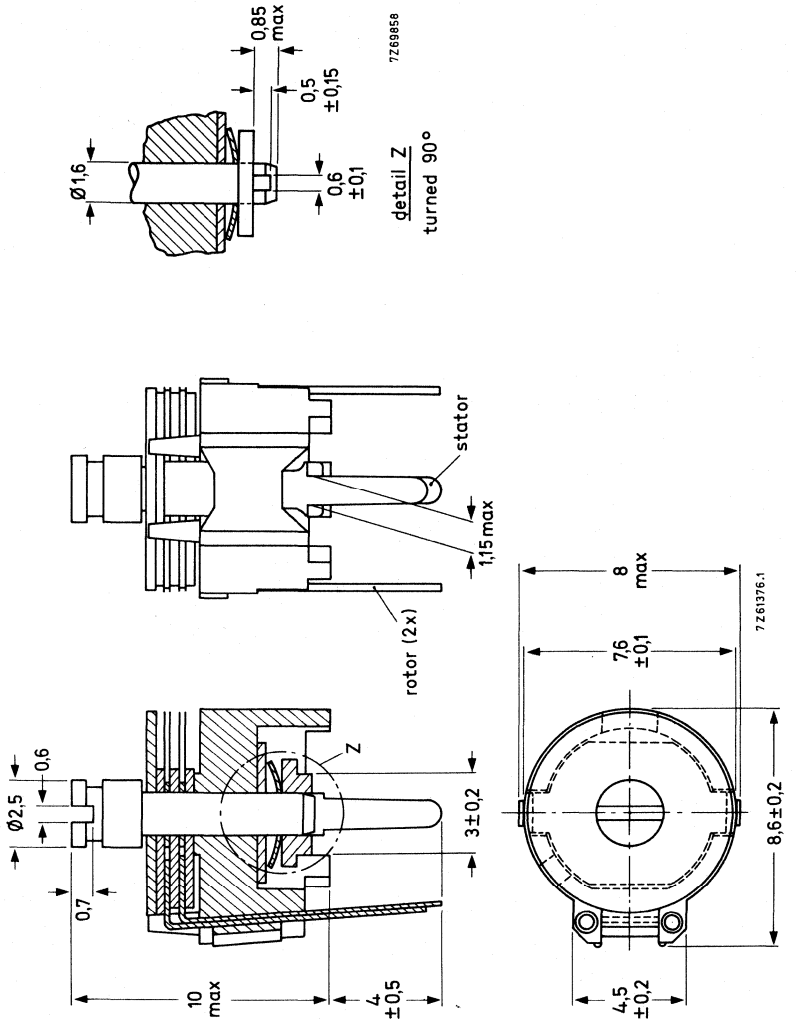


Fig. 1 Version with vertical spindle.

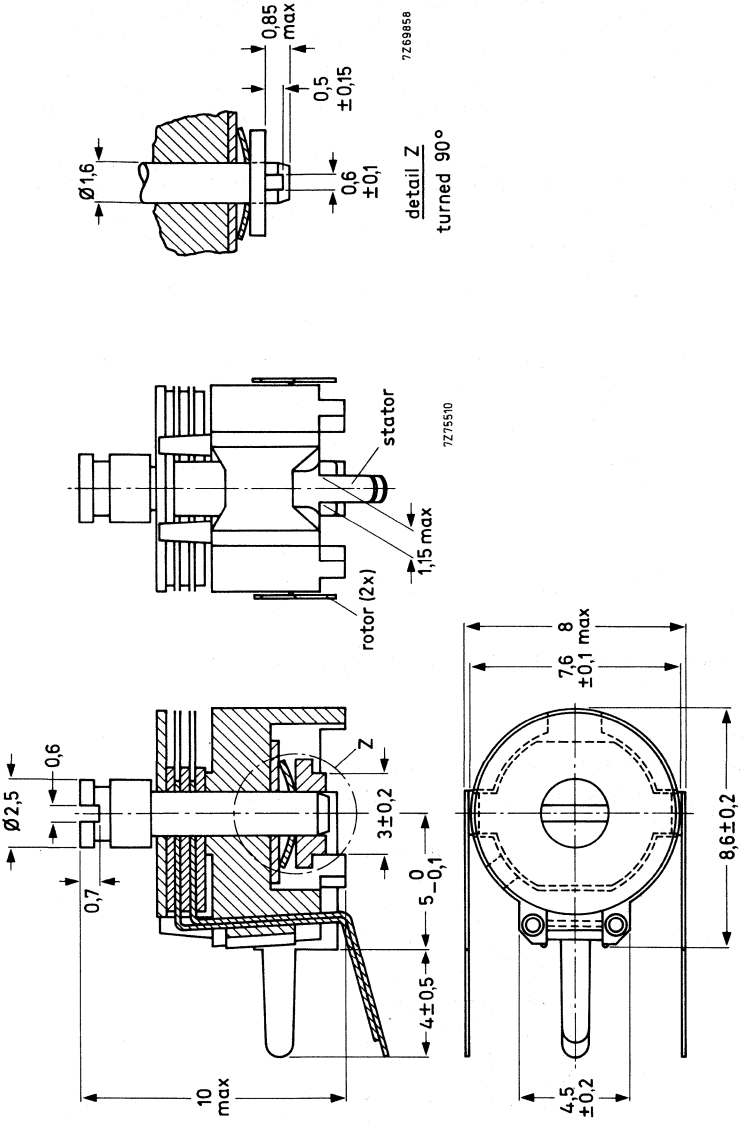


Fig. 2 Version with horizontal spindle.

Type identification

The different capacitance values can be identified by the colour of the base, see Table 2.

Soldering

Soldering conditions: max. 260 °C, max. 10 s.

Mounting

The trimmers can be mounted on printed-wiring boards with a pitch of 2,50 mm or 2,54 mm (0,1 in) and holes with a minimum diameter of 1,25 mm. The hole pattern is given in the figures below (R = rotor; S = stator).

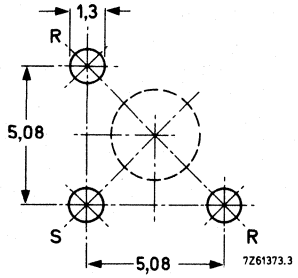


Fig. 3 For types of Fig. 1.

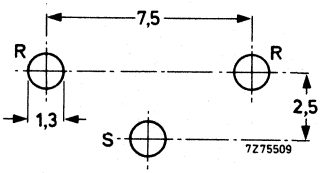


Fig. 4 For types of Fig. 2.

Note

The large hole is necessary for bottom adjustment of the vertical types. Diameter determined by the user's requirements.

Key for adjustment

The dimensions essential for the design of a key are given in Fig. 5.

A key (catalogue number 7122 347 21600) and the associated handle (catalogue number 7122 005 47910) can be supplied on request.

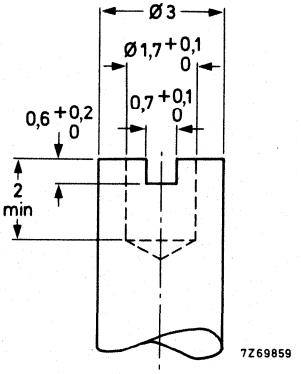


Fig. 5.

ELECTRICAL DATA

Table 2

reference C_{min}/C_{max} (note 1) pF	guaranteed max. C_{min} min. C_{max} (note 2) pF	tan δ at C_{max} x 10^{-4} 1 MHz	tan δ at C_{max} x 10^{-4} 100 MHz	temperature coefficient (note 3) 10^{-6}/K	min. f_{res} at C_{max} MHz	colour of base	Fig.	catalogue number (note 4)
1,2/6	1,4/5,5	⩽ 10	⩽ 25	−400 ± 300	850	grey	1	2222 808 11558
1,4/9	2/9	⩽ 10	⩽ 15	−500 ± 450	480	yellow	1	2222 808 00018
1,4/10	2/10	⩽ 10	⩽ 25	−200 ± 400	480	yellow	1	2222 808 11109
							2	2222 808 51109
1,6/15	2/15	⩽ 10	⩽ 25	−200 ± 350	450	blue	1	2222 808 11159
1,8/18	2/18	⩽ 10	⩽ 15	−400 ± 200	350	green	1	2222 808 00016
1,8/22	2/22	⩽ 10	⩽ 25	−250 ± 350	350	green	1	2222 808 11229
							2	2222 808 51229
1,8/27	2/27	⩽ 50		−250 ± 300	350	red	1	2222 808 11279
							2	2222 808 51279
2/33	3/33	⩽ 10		−250 ± 300	300	tan	1	2222 808 11339
2/40	3/40	⩽ 50		−250 ± 300	300	violet	1	2222 808 11409

Rated voltage (d.c.)	250 V
Test voltage (d.c.) for 1 minute	500 V
Contact resistance	max. 10 mΩ
Insulation resistance	min. 10 000 MΩ
Category temperature range	
C_{max} = 10, 15, 22, 33 pF	−40 to + 70 °C
C_{max} = 5,5, 9, 18, 27, 40 pF	−40 to + 85 °C
Climatic category (IEC 68)	
C_{max} = 10, 15, 22, 33 pF	40/070/21
C_{max} = 5,5, 9, 18, 27, 40 pF	40/085/21

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410.

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{max}, and is also subjected to the full test voltage. See also Note under Survey of variable capacitors.

PACKAGING

Bulk packing in cardboard boxes lined with expanded plastic.

Notes

1. This column indicates the reference values of the capacitance ranges currently available on the market which are equivalent to our range.
2. Measured at 200 kHz.
3. C at 60 to 80% of C_{max}; ΔT from + 20 °C to upper category temperature.
4. All capacitance values are available according to Fig. 2 on request.

TESTS AND REQUIREMENTS

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
4.2		method of mounting	method A		
14		cap. drift	after T.C. measurement	ΔC/C	⩽ 1% ⩽ 2,5% for C_{max} = 40 pF
19		thrust	axial thrust of 2N	ΔC/C	⩽ 0,3%
21		robustness of terminations:			
21.1	Ua	tensile	1N		
21.2	Ub	bending	1 cycle		no damage
22	Na	rapid change of temperature	1 cycle: ½ h at the lower and ½ h at the upper category temperature	ΔC/C	⩽ 2%
23	T	soldering			good wetting
	Ta	solderability	solder bath, immersion 3 mm, 235 °C, 2 s		no mech. damage
	Tb	resistance to heat	solder bath 260 °C, 10 s		no mech. damage
24	Eb	impact bump	4000 ± 10 bumps, 40g, 6 ms	ΔC/C	⩽ 0,6% no mech. damage
25	Fc	vibration	freq. 10 to 55 Hz, amplitude 0,35 mm, 1½ h	ΔC/C	⩽ 0,6% no mech. damage

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
26		climatic sequence		$\Delta C/C$	$\leqslant 4\%$
				tan δ	$\leqslant 10 \times 10^{-4}$
					$\leqslant 70 \times 10^{-4}$ for $C_{max} \geqslant 27$ pF
26.1	B	dry heat	16 h at the upper category temperature	R_{ins}	$\geqslant 10\,000$ MΩ
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h + 40 °C, 95 to 100% R.H.	rotor contact R	$\leqslant 10$ mΩ
				voltage proof	as specified
				visual examination	no mech. damage
26.3	Aa	cold	16 h −40 °C	operating torque	1-15 mNm
26.5		damp heat accelerated, remaining cycles	1 cycle 24 h + 40 °C, 95 to 100% R.H.		
27	C	damp heat steady state	21 days + 40 °C, 90 to 95% R.H.	$\Delta C/C$	$\leqslant 5\%$
				tan δ	$\leqslant 30 \times 10^{-4}$
					$\leqslant 70 \times 10^{-4}$ for $C_{max} \geqslant 27$ pF
				R_{ins}	$\geqslant 10\,000$ MΩ
				rotor contact R	$\leqslant 10$ mΩ
				voltage proof	table
				visual examination	no mech. damage
				operating torque	1-15 mNm
29		endurance		$\Delta C/C$	$\leqslant 1{,}5\%$
29.1		mechanical	10 cycles	rotor contact R	$\leqslant 10$ mΩ
				voltage proof	as specified
				$\Delta C/C$ after axial thrust	$\leqslant 0{,}3\%$
				visual examination	no mech. damage
				operating torque	1-15 mNm

FILM DIELECTRIC TRIMMERS

QUICK REFERENCE DATA

Max. C_{min}/min. C_{max}	2,5/15 to 6/100 pF
Diameter	10 mm
Rated voltage (d.c.)	250 V
Climatic category (IEC 68)	40/070/21 or 40/085/21
Basic specification	IEC 418-1 and 4

APPLICATION

These film dielectric trimmers have been designed for use on printed-wiring boards, e.g. in radio sets. Moreover, thanks to their good stability, these trimmers have even proved their value in industrial equipment.

DESCRIPTION

The vanes are stacked on a sturdy plastic base. The dielectric is a film of polypropylene, polycarbonate or P.T.F.E. which supports the vanes in such a way that good stability is ensured and no microphony can occur. Flux absorption between the vanes is prevented. The trimmers are resistant to all standard cleaning solvents except trichloroethane and trichloroethylene.
This series comprises different versions, see Table 1. For complete catalogue numbers refer to Table 3.

Table 1 Versions

position of spindle	angle between 2 rotor tags	hole pattern Fig.	adjustment top	adjustment bottom		Fig.1
vertical	90°	4	screwdriver	key		1
vertical	180°	5	screwdriver	key	see	2
vertical	180°	5	spanner	key	also	2
horizontal		5	screwdriver	key	Fig. 6	3
horizontal		5	spanner	key		3

MECHANICAL DATA

Dimensions in mm

Outlines See Figs 1, 2 and 3.

Table 2

Effective angle of rotation	180°
Operating torque	2-25 mNm
Maximum axial thrust ($\Delta C \leqslant 0{,}3\%$ of C_{max})	2 N
Mass (approximately)	1,3 g

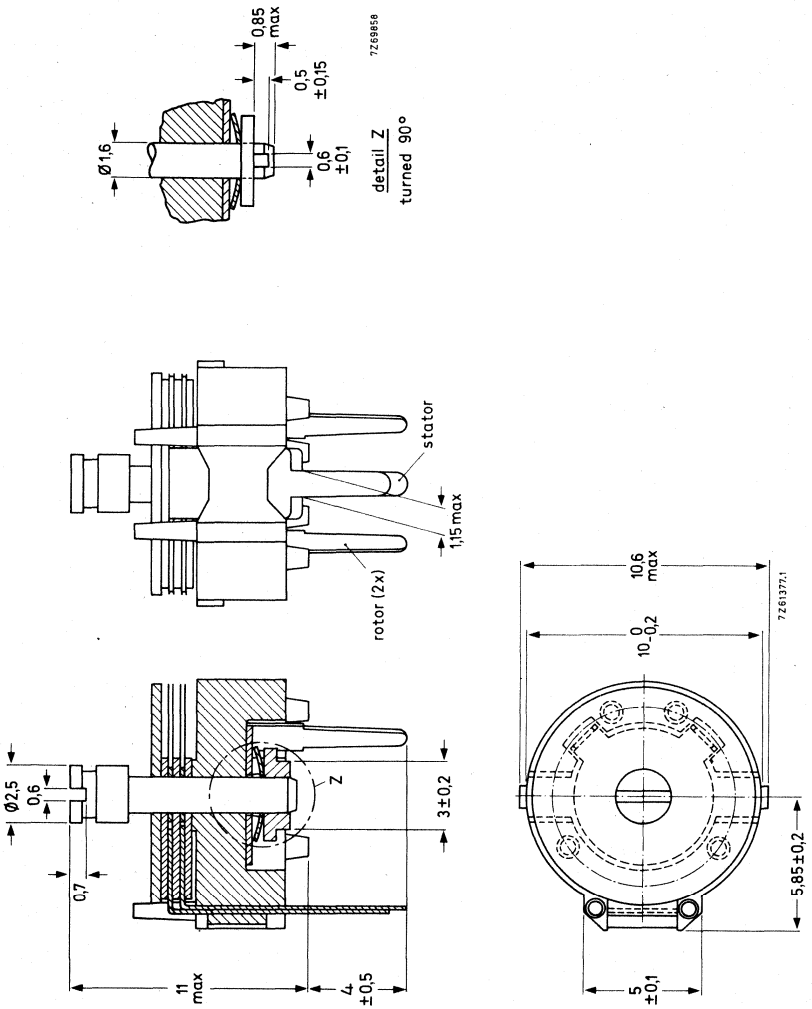
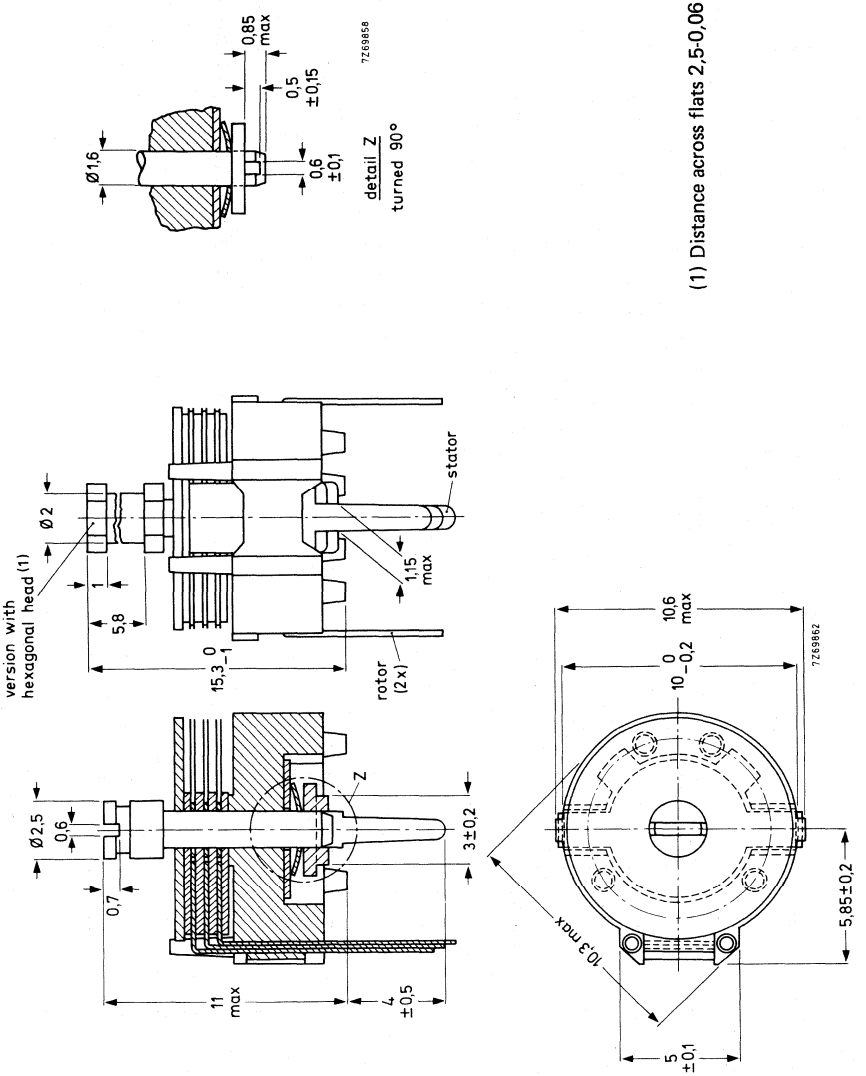
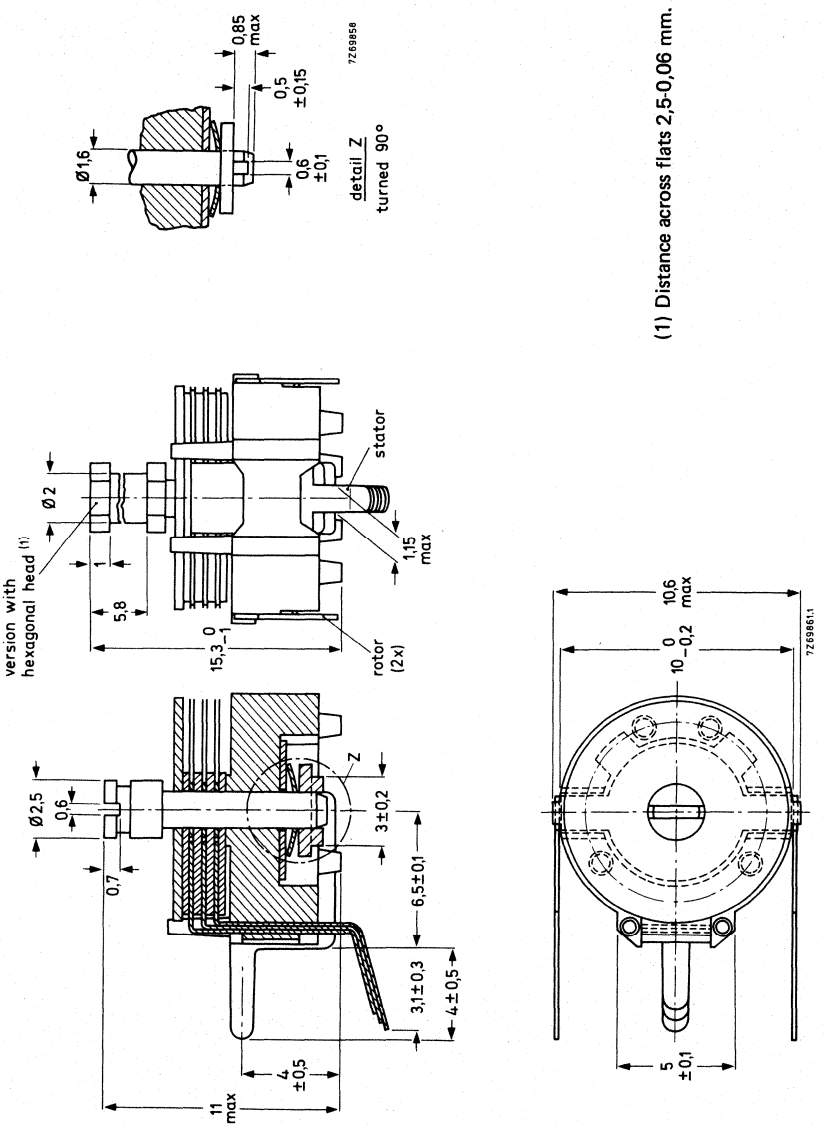


Fig. 1 Version with vertical spindle and hole pattern of Fig. 4.



(1) Distance across flats 2,5-0,06 mm.

Fig. 2 Version with vertical spindle and hole pattern of Fig. 5.



(1) Distance across flats 2,5-0,06 mm.

Fig. 3 Version with horizontal spindle and hole pattern of Fig. 5.

Type identification

The different capacitance values can be identified by the colour of the base, see Table 3.

Soldering

Soldering conditions: max. 260 °C, max. 10 s.

Mounting

The trimmers can be mounted on printed-wiring boards with a pitch of 2,50 mm or 2,54 mm (0,1 in) and holes with a minimum diameter of 1,25 mm. The hole pattern is given in the figures below (R = rotor; S = stator).

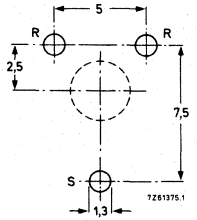


Fig. 4 For types of Fig. 1.

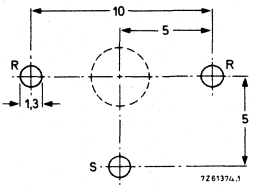


Fig. 5 For types of Figs 2 and 3.

Note

The large hole is necessary for bottom adjustment of the vertical types. Diameter determined by the user's requirements.

Spanner adjustment

The hexagonal spindle head is specially designed for the trimming of car radios. It enables adjustment of the trimmer from the front by means of a long flexible rod provided with a hexagonal hole. The special shape of the trimmer head prevents a bending load on the trimmer spindle when the adjustment rod and spindle are not in line. It also allows a large axial tolerance.

Key for adjustment

The dimensions essential for the design of a key are given in Fig. 6.

A key (catalogue number 7122 347 21600) and the associated handle (catalogue number 7122 005 47910) can be supplied on request.

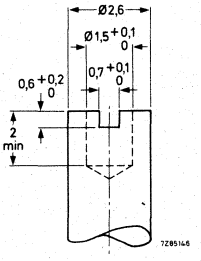


Fig. 6.

ELECTRICAL DATA

Table 3

reference C_{min}/C_{max} (note 1) pF	guaranteed max. C_{min} min. C_{max} (note 2) pF	tan δ at C_{max} x 10^{-4} 1 MHz	100 MHz	temperature coefficient (note 3) 10^{-6}/K	min. f_{res} at C_{max} MHz	colour of base	Fig.	catalogue number
1,8/15	2,5/15	⩽ 10	⩽ 25	−150 ± 500	420	blue	1	2222 808 32159
							2	2222 808 31159
							3	2222 808 61159
2,5/25	3/22,5	⩽ 10	⩽ 25	−150 ± 400	200	green	1	2222 808 32229
							2	2222 808 31229
							3	2222 808 61229
4/40	5,5/40	⩽ 10	⩽ 25	−150 ± 350	200	grey	1	2222 808 32409
							2	2222 808 31409
							3	2222 808 61409
4/50	5,5/50	⩽ 10	⩽ 25	−500 ± 150	170	yellow	1	2222 808 01006
							2	2222 808 01029
4,5/70	5,5/65	⩽ 10	⩽ 25	−200 ± 300	170	yellow	1	2222 808 32659
							2	2222 808 31659
							3	2222 808 61659
			–				3*	2222 808 64659
5/90	6/80	⩽ 50	–	−100 ± 300	170	red	1	2222 808 32809
							2	2222 808 31809
							2*	2222 808 34809
							3	2222 808 61809
							3*	2222 808 64809
5/105	6/100	⩽ 50	–	−100 ± 300	170	violet	1	2222 808 32101
							2	2222 808 31101
							3*	2222 808 64101

* Version with hexagonal head.

Rated voltage (d.c.)	250 V
Test voltage (d.c.) for 1 minute	500 V
Contact resistance	max. 10 mΩ
Insulation resistance	min. 10 000 MΩ
Category temperature range,	
C_{max} = 15, 22,5, 40, 65 pF	−40 to + 70 °C
C_{max} = 50, 80, 100 pF	−40 to + 85 °C
Climatic category (IEC 68)	
C_{max} = 15, 22,5, 40, 65 pF	40/070/21
C_{max} = 50, 80, 100 pF	40/085/21

Notes

1. This column indicates the reference values of the capacitance ranges currently available on the market which are equivalent to our range.
2. Measured at 200 kHz.
3. C at 60 to 80% of C_{max}, ΔT from + 20 °C to upper category temperature.

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{max}, and is also subjected to the full test voltage. See also Note under Survey of variable capacitors.

PACKAGING

Bulk packing in cardboard boxes lined with expanded plastic.

TESTS AND REQUIREMENTS

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
4.2		method of mounting	method A		
14		cap. drift	after T.C. measurement	ΔC/C	⩽ 1,5%; ⩽ 1% for C_{max} ⩾ 50 pF
19		thrust	axial thrust of 2N	ΔC/C	⩽ 0,3%
21		robustness of terminations:			
21.1	Ua	tensile	1N		
21.2	Ub	bending	1 cycle		no damage
22	Na	rapid change of temperature	1 cycle: ½ h at the lower and ½ h at the upper category temperature	ΔC/C	⩽ 1,5%
23	T	soldering			good wetting
	Ta	solderability	solder bath, immersion 3 mm, 235 °C, 2 s		no mech. damage
	Tb	resistance to heat	solder bath 260 °C, 10 s		no mech. damage
24		impact		ΔC/C	⩽ 0,4%
	Eb	bump	4000 ± 10 bumps, 40g, 6 ms		no mech. damage
25	Fc	vibration	freq. 10 to 55 Hz, amplitude 0,35 mm, 1½ h	ΔC/C	⩽ 0,2% no mech. damage

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
26		climatic sequence		$\Delta C/C$	$\leqslant 3\%$
					$\leqslant 6\%$ for $C_{max} \geqslant 80$ pF
26.1	B	dry heat	16 h at the upper category temperature	$\tan \delta$	$\leqslant 15 \times 10^{-4}$
					$\leqslant 85 \times 10^{-4}$ for $C_{max} \geqslant 80$ pF
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h + 40 °C, 95 to 100% R.H.	R_{ins}	$\geqslant 10\,000$ MΩ
				rotor contact R	$\leqslant 10$ mΩ
				voltage proof	as specified
26.3	Aa	cold	16 h −40 °C	visual examination	no mech. damage
26.5		damp heat accelerated, remaining cycles	1 cycle 24 h + 40 °C, 95 to 100% R.H.	operating torque	2-35 mNm
27	C	damp heat steady state	21 days + 40 °C, 90 to 95% R.H.	$\Delta C/C$	$\leqslant 3\%$; $\leqslant 3{,}5\%$ for $C_{max} \geqslant 100$ pF
				$\tan \delta$	$\leqslant 20 \times 10^{-4}$
					$\leqslant 70 \times 10^{-4}$ for $C_{max} \geqslant 80$ pF
				R_{ins}	$\geqslant 10\,000$ MΩ
				rotor contact R	$\leqslant 10$ mΩ
				voltage proof	as specified
				visual examination	no mech. damage
				operating torque	2-35 mNm
29		endurance		$\Delta C/C$	$\leqslant 1\%$
29.1		mechanical	10 cycles	rotor contact R	$\leqslant 10$ mΩ
				voltage proof	as specified
				$\Delta C/C$ after axial thrust	$\leqslant 0{,}4\%$
				visual examination	no mech. damage
				operating torque	1,5-37 mNm

FILM DIELECTRIC TRIMMERS

QUICK REFERENCE DATA

Max. C_{min}/min. C_{max}	11/120 pF
Diameter	13,5 mm
Rated voltage (d.c.)	150 V
Climatic category (IEC 68)	40/085/21
Basic specification	IEC 418-1 and 4

APPLICATION

These film dielectric trimmers have been designed for use on printed-wiring boards, e.g. in radio sets. Moreover, thanks to their good stability, these trimmers are suitable for industrial equipment.

DESCRIPTION

The vanes are stacked on a sturdy plastic base. The dielectric is a film of polycarbonate which supports the vanes in such a way that good stability is ensured and no microphony can occur. The capacitor has top and bottom adjustment by means of a screwdriver. Flux absorption between the vanes is prevented. The trimmers are resistant to all standard cleaning solvents except trichloroethylene and trichloroethane. A version with vertical spindle (Fig. 1) and a version with horizontal spindle (Fig. 2) are available (see Table 2). All types have top adjustment either by means of a screwdriver or a spanner, and bottom adjustment by means of a screwdriver.

MECHANICAL DATA

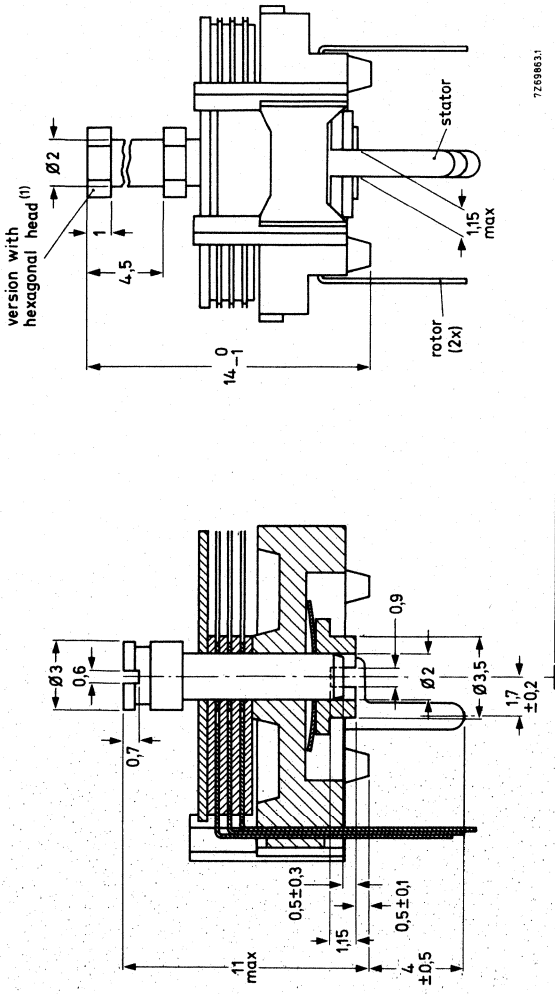
Dimensions in mm

Outlines

See Figs 1 and 2.

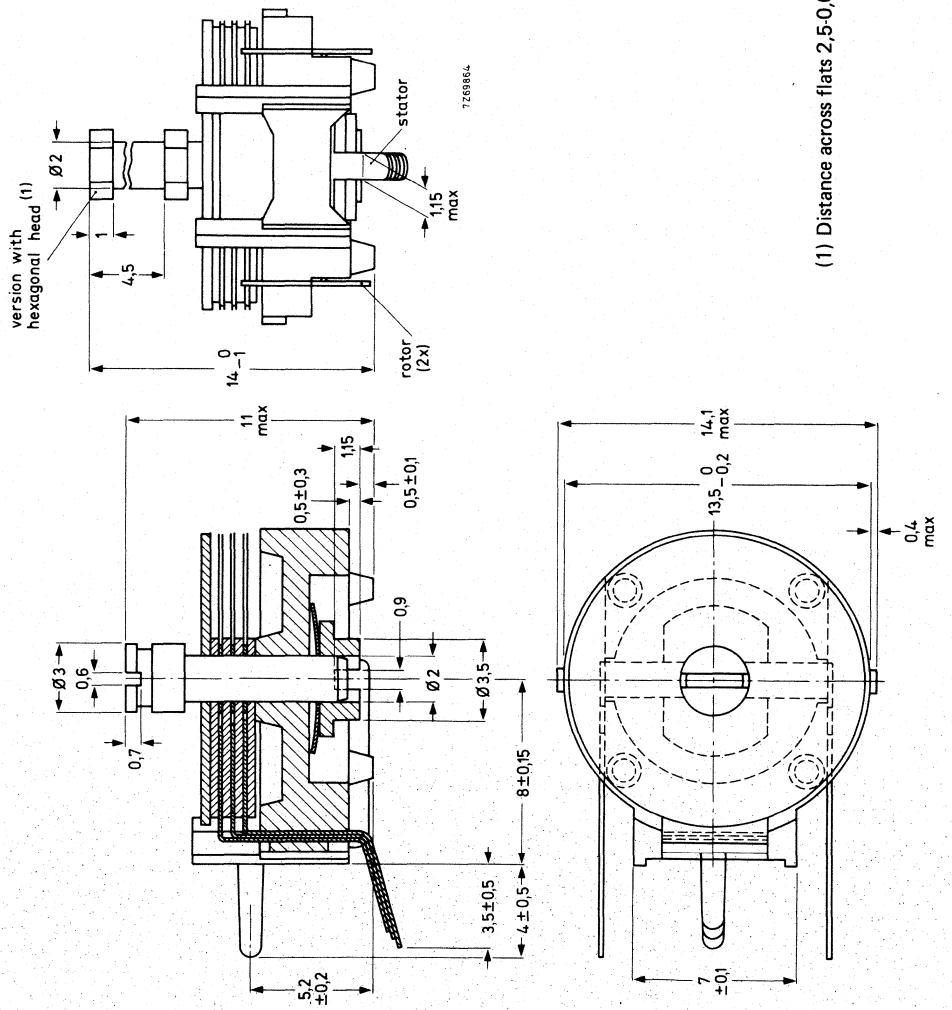
Table 1

Effective angle of rotation	180°
Operating torque	2-35 mNm
Maximum axial thrust ($\Delta C \leqslant 0{,}3\%$ of C_{max})	2 N
Mass (approximately)	2 g



(1) Distance across flats 2,5-0,06 mm.

Fig. 1 Outlines of the capacitors 2222 808 41 . . . and 2222 808 44 . . . (versions with vertical spindle).



(1) Distance across flats 2,5-0,06 mm.

Fig. 2 Outlines of the capacitors 2222 808 71 . . . and 2222 808 74 . . . (versions with horizontal spindle).

Type identification

The colour of the base is green.

Soldering

Soldering conditions: max. 260 °C, max. 10 s.

Mounting

The trimmers can be mounted on printed-wiring boards with a pitch of 2,50 mm or 2,54 mm (0,1 in) and holes with a minimum diameter of 1,25 mm. The hole pattern is given in the figure below (R = rotor; S = stator).

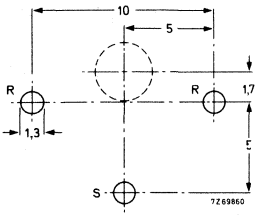


Fig. 3.

Note

The large hole is necessary for bottom adjustment of the vertical types. Diameter determined by the user's requirements.

Spanner adjustment

The hexagonal spindle head is specially designed for the trimming of car radios. It enables adjustment of the trimmer from the front by means of a long flexible rod provided with a hexagonal hole. The special shape of the trimmer head prevents a bending load on the trimmer spindle when the adjustment rod and spindle are not in line. It also allows a large axial tolerance.

ELECTRICAL DATA

Table 2

reference C_{min}/C_{max} (note 1) pF	guaranteed max. C_{min} min. C_{max} (note 2) pF	tan δ at C_{max} at 1 MHz x 10^{-4}	temperature coefficient (note 3) 10^{-6}/K	f_{res} at C_{max} MHz	colour of base	Fig.	catalogue number
8/130	11/120	⩽ 50	0 ± 300	> 150	green	1	2222 808 41121
8/130	11/120	⩽ 50	0 ± 300	> 150	green	1*	2222 808 44121
8/130	11/120	⩽ 50	−200 ± 300	> 150	green	2	2222 808 71121
8/130	11/120	⩽ 50	−200 ± 300	> 150	green	2*	2222 808 74121

* Version with hexagonal head.

Rated voltage (d.c.)	150 V
Test voltage (d.c.) for 1 minute	300 V
Contact resistance	max. 10 mΩ
Insulation resistance	min. 10 000 MΩ
Category temperature range	−40 to + 85 °C
Climatic category (IEC 68)	40/085/21

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{max}, and is also subjected to the full test voltage. See also Note under Survey of variable capacitors.

PACKAGING

Bulk packing in cardboard boxes lined with expanded plastic.

Notes

1. This column indicates the reference values of the capacitance ranges currently available on the market which are equivalent to our range.
2. Measured at 200 kHz.
3. C at 60 to 80% of C_{max}, ΔT from + 20 to + 85 °C.

TESTS AND REQUIREMENTS

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
4.2		method of mounting	method A		
14		cap. drift	after T.C. measurement	ΔC/C	⩽ 1%
19		thrust	axial thrust of 2N	ΔC/C	⩽ 0,3%
21		robustness of terminations:			
21.1	Ua	tensile	1N		
21.2	Ub	bending	1 cycle		no damage
22	Na	rapid change of temperature	1 cycle: ½ h at the lower and ½ h at the upper category temperature	ΔC/C	⩽ 2%
23	T	soldering			good wetting
	Ta	solderability	solder bath, immersion 3 mm, 235 °C, 2 s		no mech. damage
	Tb	resistance to heat	solder bath 260 °C, 10 s		no mech. damage
24		impact		ΔC/C	⩽ 0,6%
	Eb	bump	4000 ± 10 bumps, 40g, 6 ms		no mech. damage
25	Fc	vibration	freq. 10 to 55 Hz, amplitude 0,35 mm, 1½ h	ΔC/C	⩽ 0,6% no mech. damage

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
26		climatic sequence		ΔC/C tan δ R_{ins} rotor contact R voltage proof visual examination operating torque	⩽ 3,5% ⩽ 70 x 10^{-4} ⩾ 10 000 MΩ ⩽ 10 mΩ as specified no mech. damage 2-20 mNm
26.1	B	dry heat	16 h at the upper category temperature		
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h + 40 °C, 95 to 100% R.H.		
26.3	Aa	cold	16 h –40 °C		
26.5		damp heat accelerated, remaining cycles	1 cycle 24 h + 40 °C, 95 to 100% R.H.		
27	C	damp heat steady state	21 days + 40 °C, 90 to 95% R.H.	ΔC/C tan δ R_{ins} rotor contact R voltage proof visual examination operating torque	⩽ 3% ⩽ 50 x 10^{-4} ⩾ 10 000 MΩ ⩽ 10 mΩ as specified no mech. damage 2-35 mNm
29 29.1		endurance mechanical	10 cycles	ΔC/C rotor contact R voltage proof ΔC/C after axial thrust visual examination operating torque	⩽ 0,3% ⩽ 10 mΩ as specified ⩽ 0,3% no mech. damage 1,5-30 mNm

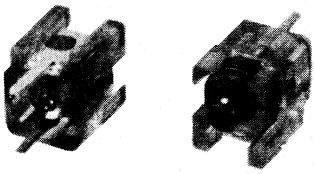
FILM DIELECTRIC TRIMMERS

high temperature type

QUICK REFERENCE DATA

Max. C_{min}/min. C_{max}	1,2/3,5 pF 1,8/10 pF 2/18 pF
Overall dimensions	6 x 8 x 9 mm
Rated voltage (d.c.)	300 V
Climatic category (IEC 68)	40/125/21
Basic specification	418-1 and 4

RZ 30185-5



APPLICATION

For use in miniaturized measuring and telecommunication equipment, e.g. for fine adjustment of h.f. tuned circuits.

DESCRIPTION

The trimmers consist of a polysulphone housing, brass rotor and silver-plated brass stator with either a P.T.F.E., or a polyimide/F.E.P. sandwich film as the dielectric. The stator plates with their tag are heat-sealed to the housing. The rotor contact surfaces are gold plated to ensure a long life and a stable contact even under severe climatic conditions. Flux absorption between the vanes is prevented.
The capacitors have top and bottom adjustment. Top adjustment should be done by means of a screwdriver, bottom adjustment by means of the key according to Fig. 3.

MECHANICAL DATA

Dimensions in mm

Outlines

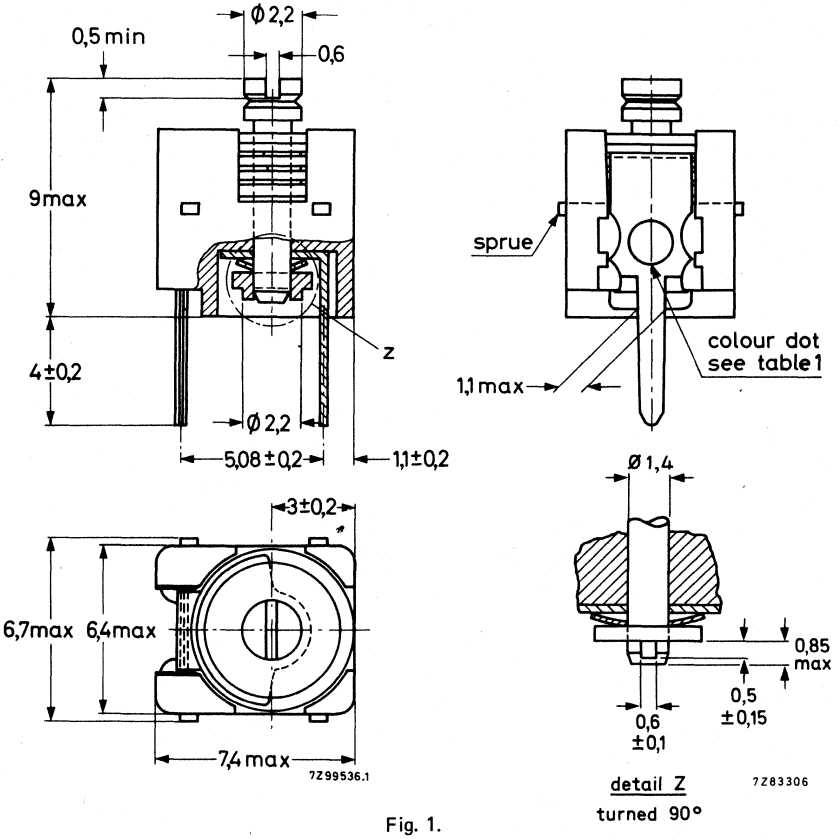


Fig. 1.

Table 1

max. capacitance	3,5 pF	10 pF	18 pF
effective angle of rotation	180°	180°	180°
operating torque	1-15 mNm	2,5-20 mNm	2,5-20 mNm
maximum axial thrust ($\Delta C \leqslant 0{,}3\%$ of C_{max})	2 N	2 N	2 N
mass approx.	0,7 g	0,7 g	0,7 g
colour dot	orange	white	red

Type identification

The different capacitance values can be identified by the colour dot, see Table 1.

Soldering

Soldering conditions: max. 260 °C, max. 10 s.

Mounting

The trimmers can be mounted on printed-wiring boards having holes with a minimum diameter of 1,25 mm. The hole pattern is given in the figure below.

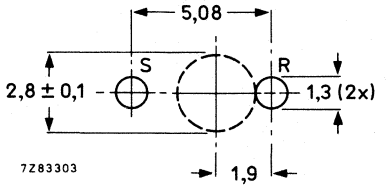


Fig. 2 The large hole is necessary only if bottom adjustment is to be used. R = rotor, S = stator.

Key for adjustment

The dimensions essential for the design of a key are given in Fig. 3.

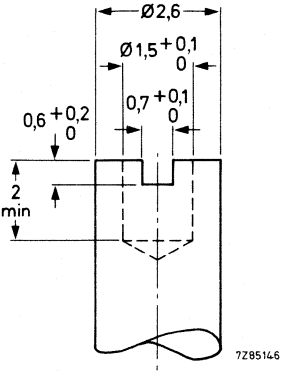


Fig. 3.

ELECTRICAL DATA

Table 2

C_{max}* pF	C_{min}* pF	max. tan δ at 1 MHz	max. tan δ at 100 MHz	temperature coefficient** 10^{-6}/K	min. f_{res} at C_{max} MHz	catalogue number
⩾ 3,5	⩽ 1,2	10 x 10^{-4}	20 x 10^{-4}	−250 ± 150	850	2222 809 05001
⩾ 10	⩽ 1,8	10 x 10^{-4}	20 x 10^{-4}	−350 ± 150	580	2222 809 05002
⩾ 18	⩽ 2	25 x 10^{-4}	40 x 10^{-4}	−350 ± 150	360	2222 809 05003

Rated voltage (d.c.)	300 V
Test voltage (d.c.) for 1 minute	600 V
Contact resistance	max. 5 mΩ
Insulation resistance between stator and rotor	min. 10 000 MΩ
Category temperature range	−40 to + 125 °C
Climatic category (IEC 68)	40/125/21

* Measured at 200 kHz.

** C at 60 to 80% of C_{max}; ΔT from + 20 to + 125 °C.

TESTS AND REQUIREMENTS

Table 3

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
4.2		method of mounting	method A		
14		cap. drift	after T.C. measurement	ΔC/C	⩽ 1%
19		thrust	axial thrust of 2N	ΔC/C	⩽ 0,3%
21		robustness of terminations:			
21.1	Ua	tensile	1N		
21.2	Ub	bending	1 cycle		no damage
22	Na	rapid change of temperature	1 cycle: ½ h at the lower and ½ h at the upper category temperature	ΔC/C	⩽ 2%
23	T	soldering			good wetting
	Ta	solderability	solder bath, immersion 3 mm, 235 °C, 2 s		no mech. damage
	Tb	resistance to heat	solder bath 260 °C, 10 s		no mech. damage
24		impact		ΔC/C	⩽ 0,6%
	Eb	bump	4000 ± 10 bumps, 40g, 6 ms		no mech. damage
25	Fc	vibration	freq. 10 to 55 Hz, amplitude 0,35 mm, 1½ h	ΔC/C	⩽ 0,2% no mech. damage

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
26		climatic sequence		$\Delta C/C$	$\leqslant 2{,}5\%$
				tan δ, $C_{max} < 18$ pF	$\leqslant 10 \times 10^{-4}$
26.1	B	dry heat	16 h at the upper category temperature	$C_{max} \geqslant 18$ pF	$\leqslant 40 \times 10^{-4}$
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h + 40 °C, 95 to 100% R.H.	R_{ins}	$\geqslant 10\,000$ MΩ
				rotor contact R	$\leqslant 5$ mΩ
				voltage proof	600 V for 1 min
				visual examination	no mech. damage
26.3	Aa	cold	16 h −40 °C	operating torque	1-20 mNm
26.5		damp heat accelerated, remaining cycles	1 cycle 24 h + 40 °C, 95 to 100% R.H.		
27	Ca	damp heat steady state	21 days + 40 °C, 90 to 95% R.H.	$\Delta C/C$	$\leqslant 2{,}5\%$
				tan δ, $C_{max} < 18$ pF	$\leqslant 10 \times 10^{-4}$
				$C_{max} \geqslant 18$ pF	$\leqslant 25 \times 10^{-4}$
				R_{ins}	$\geqslant 10\,000$ MΩ
				rotor contact R	$\leqslant 5$ mΩ
				voltage proof	600 V for 1 min
				visual examination	no mech. damage
				operating torque	1-20 mNm
29		endurance		$\Delta C/C$	$\leqslant 0{,}3\%$
29.1		mechanical	25 cycles	rotor contact R	$\leqslant 5$ mΩ
				voltage proof	600 V for 1 min
				$\Delta C/C$ after axial thrust	$\leqslant 0{,}3\%$
				visual examination	no mech. damage
				operating torque	1-20 mNm

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{max}, and is also subjected to the full test voltage.

See also Note under Survey of variable capacitors.

PACKAGING

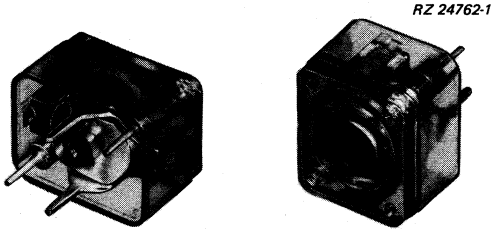
Blister packs of 100 pieces each.

FILM DIELECTRIC TRIMMERS

high temperature type

QUICK REFERENCE DATA

Max. C_{min}/min. C_{max}	
single stator type	2,5/20 pF to 7/100 pF
split stator type	1,5/5 pF to 3/25 pF
differential type	2/12 pF to 7/150 pF
Overall dimensions	11 x 14 x 9 mm
Rated voltage (d.c.)	200 V
Climatic category (IEC 68)	40/125/21
Basic specification	IEC 418-1 and 4



RZ 24762-1

APPLICATION

For use in miniaturized measuring and telecommunication equipment, specially where high temperatures occur and a low temperature coefficient is important, e.g. single-stator trimmers are suitable for fine adjustment of h.f. tuned circuits, split-stator trimmers for symmetrically built h.f. circuits and differential types for capacitive volume or voltage control.

DESCRIPTION

The trimmers consist of a glass reinforced polysulphone frame with a transparent polysulphone dust cover, brass rotor and stator with P.T.F.E. or polycarbonate film as the dielectric. The stator plates are stacked on pins and separated by rings, so that it is possible to produce a single-stator, a split-stator or a differential type. The rotor contact surfaces are silver plated to ensure a long life and a stable contact even under severe climatic conditions.
The capacitors have top adjustment by means of a screwdriver. Capacitance increase is obtained with clockwise rotation.*

* With counter-clockwise rotation on request.

MECHANICAL DATA

Dimensions in mm

Outlines

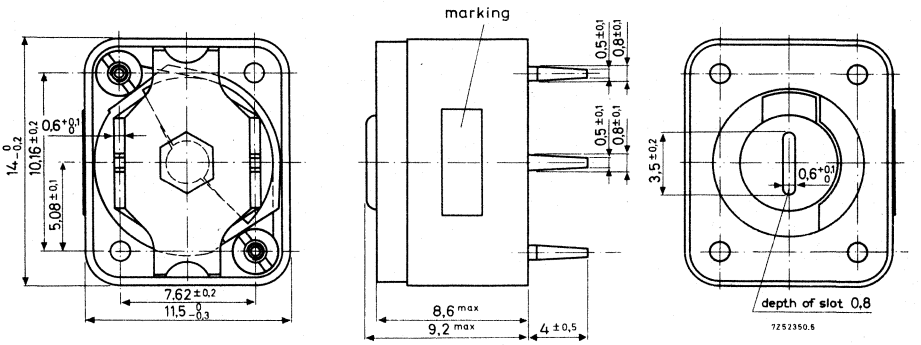


Fig. 1.

Table 1

	single stator type	differential type	split stator type
effective angle of rotation	180°	180°	180°
operating torque	1,5-25 mNm	1,5-25 mNm	1,5-25 mNm
max. endstop torque	100 mNm	100 mNm	100 mNm
max. axial thrust ($\Delta C \leqslant 0{,}3\%$ of C_{max})	2N	2N	2N
mass approx.	2,3 g	2,9 g	2,8 g

Type identification (marking)

Capacitance value in pF plus letter E, in the case of a differential capacitor followed by the letter D, in the case of a split-stator type by the letter S.

Soldering

Soldering conditions: max. 260 °C, max. 10 s.

Mounting

The trimmers can be mounted on printed-wiring boards having holes with a minimum diameter of 1,25 mm. The hole pattern is given in the figure below.

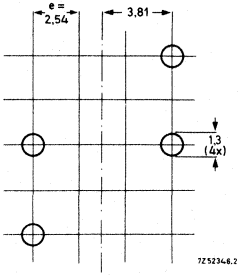


Fig. 2.

Bending the tags is not permitted.

ELECTRICAL DATA

Table 2

type	C_{max}* pF	C_{min}* pF	max. tan δ at 100 MHz	catalogue number
single-stator	⩾ 20	⩽ 2,5	17 x 10^{-4}	2222 809 07004
	⩾ 40	⩽ 4	17 x 10^{-4}	07008
	⩾ 60	⩽ 5	25 x 10^{-4}	07011
	⩾ 80	⩽ 6	25 x 10^{-4}	07013
	⩾ 100	⩽ 7	25 x 10^{-4}	07015
split-stator	⩾ 5	⩽ 1,5	17 x 10^{-4}	07001
	⩾ 10	⩽ 2	17 x 10^{-4}	07002
	⩾ 15	⩽ 3	25 x 10^{-4}	07003
	⩾ 20	⩽ 3	25 x 10^{-4}	07005
	⩾ 25	⩽ 3	25 x 10^{-4}	07007
differential	⩾ 12	⩽ 2	17 x 10^{-4}	07018
	⩾ 20	⩽ 2,5	17 x 10^{-4}	07006
	⩾ 40	⩽ 4	17 x 10^{-4}	07009
	⩾ 60	⩽ 5	25 x 10^{-4}	07012
	⩾ 80	⩽ 6	25 x 10^{-4}	07014
	⩾ 100	⩽ 7	25 x 10^{-4}	07016
	⩾ 150	⩽ 7	–	07107

Rated voltage (d.c.)	200 V
Test voltage (d.c.) for 1 minute	400 V
Tan δ at 1 MHz	max. 10 x 10^{-4}
differential cap. with C_{max} ⩾ 150 pF	max. 50 x 10^{-4}
Contact resistance	max. 5 mΩ
Insulation resistance between stator and rotor	min. 10 000 MΩ
Temperature coefficient**	(0 ± 200) x 10^{-6}/K
Category temperature range	–40 to + 125 °C
Climatic category (IEC 68)	40/125/21

* Measured at 200 kHz.

** C at 60 to 80% of C_{max}; ΔT from + 20 to + 125 °C.

TESTS AND REQUIREMENTS

Table 3

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
4.2		method of mounting	method A		
14		cap. drift	after T.C. measurement	ΔC/C	⩽ 1%
19		thrust	axial thrust of 2N	ΔC/C	⩽ 0,3%
21		robustness of terminations:			
21.1	Ua	tensile	1N		no damage
22	Na	rapid change of temperature	1 cycle: ½ h at the lower and ½ h at the upper category temperature	ΔC/C	⩽ 1%
23	T	soldering			good wetting
	Ta	solderability	solder bath, immersion 3 mm, 235 °C, 2 s		no mech. damage
	Tb	resistance to heat	solder bath 260 °C, 10 s		no mech. damage
24		impact		ΔC/C	⩽ 0,2%
	Eb	bump	4000 ± 10 bumps, 40g, 6 ms		no mech. damage
25	Fc	vibration	freq. 10 to 55 Hz, amplitude 0,35 mm, 1½ h	ΔC/C	⩽ 0,25% no mech. damage

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
26		climatic sequence		ΔC/C tan δ R_{ins} rotor contact R voltage proof visual examination operating torque	⩽ 3% ⩽ 10 x 10^{-4} ⩾ 10 000 MΩ ⩽ 10 mΩ 400 V for 1 min no mech. damage 1,5-35 mNm
26.1	B	dry heat	16 h at the upper category temperature		
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h + 40 °C, 95 to 100% R.H.		
26.3	Aa	cold	16 h −40 °C		
26.5		damp heat accelerated, remaining cycles	1 cycle 24 h + 40 °C, 95 to 100% R.H.		
27	Ca	damp heat steady state	21 days + 40 °C, 90 to 95% R.H.	ΔC/C tan δ R_{ins} rotor contact R voltage proof visual examination operating torque	⩽ 3% ⩽ 10 x 10^{-4} ⩾ 10 000 MΩ ⩽ 10 mΩ 400 V for 1 min no mech. damage 1,5-35 mNm
29 29.1		endurance mechanical	25 cycles	ΔC/C rotor contact R voltage proof ΔC/C after axial thrust visual examination operating torque	⩽ 0,3% ⩽ 10 mΩ 400 V for 1 min ⩽ 0,3% no mech. damage 1-50 mNm

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{max}, and is also subjected to the full test voltage.

See also Note under Survey of variable capacitors.

PACKAGING

Blister packs of 50 pieces each.

FILM DIELECTRIC TRIMMERS

high temperature type

QUICK REFERENCE DATA

Max. C_{min}/min. C_{max}	4/40 pF 5/60 pF
Overall dimensions	10 x 11 x 11 mm
Rated voltage (d.c.)	300 V
Climatic category (IEC 68)	40/125/21
Basic specification	IEC 418-1 and 2

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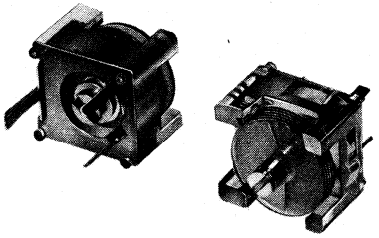


APPLICATION

For use in miniaturized measuring and telecommunication equipment, specially where high temperatures occur and a low temperature coefficient is important, e.g. for fine adjustment of h.f. tuned circuits.

DESCRIPTION

The trimmers consist of a polysulphone housing, brass rotor and silver-plated brass stator with P.T.F.E. film as the dielectric. The stator plates with their tag are heat sealed to the housing. The rotor contact surface is silver plated to ensure a long life and a stable contact even under severe climatic conditions. Flux absorption between the vanes is prevented. The trimmers have top adjustment by means of a screwdriver and bottom adjustment by means of a key (see Fig. 3).

MECHANICAL DATA

Dimensions in mm

Outlines

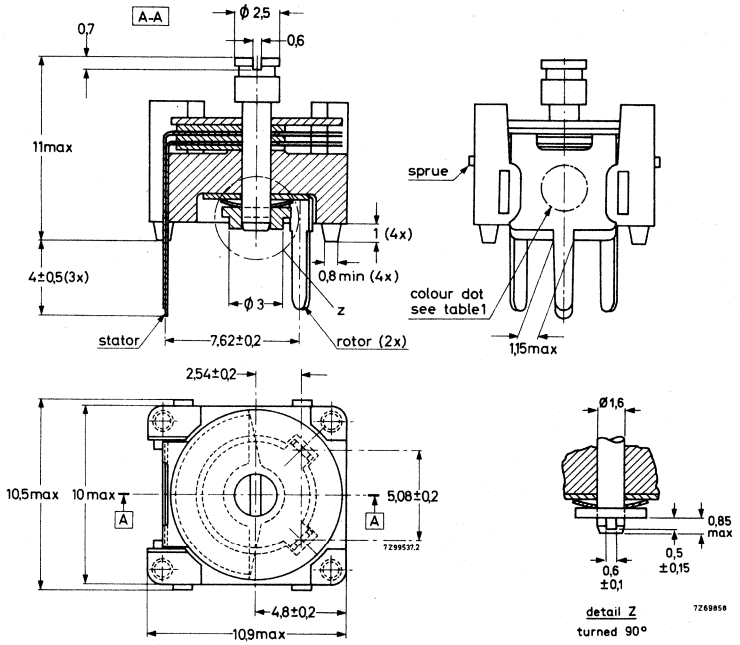


Fig. 1.

Table 1

max. capacitance	40 pF	60 pF
effective angle of rotation	180°	180°
operating torque	2-25 mNm	2-25 mNm
maximum axial thrust ($\Delta C \leqslant 0{,}3\%$ of C_{max})	2 N	2 N
mass	1,6 g	1,6 g
colour dot	yellow	blue

Type identification

The different capacitance values can be identified by the colour dot, see Table 1.

Soldering

Soldering conditions: max. 260 °C, max. 10 s.

Mounting

The trimmers can be mounted on printed-wiring boards having holes with a minimum diameter of 1,25 mm. The hole pattern is given in the figure below.

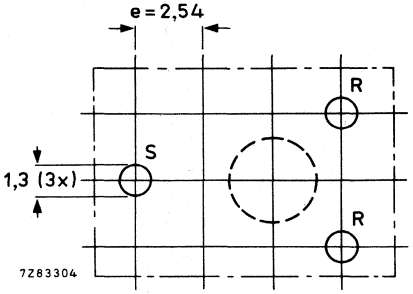


Fig. 2 Large hole is necessary only if bottom adjustment is to be used R = rotor, S = stator.

Key for adjustment

The dimensions essential for the design of a key are given in Fig. 3.

A key (catalogue number 7122 347 21600) and the associated handle (catalogue number 7122 005 47910) can be supplied on request.

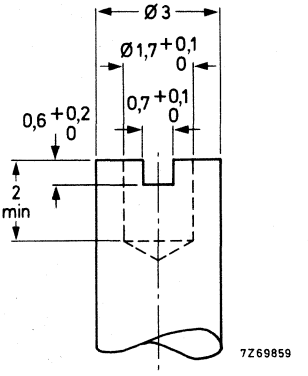


Fig. 3.

ELECTRICAL DATA

Table 2

C_{max}* pF	C_{min}* pF	max. tan δ at 1 MHz	max. tan δ at 100 MHz	temperature coefficient** 10^{-6}/K	min. f_{res} at C_{max} MHz	catalogue number
⩾ 40	⩽ 4	10 x 10^{-4}	25 x 10^{-4}	−250 ± 150	170	2222 809 08002
⩾ 60	⩽ 5	10 x 10^{-4}	25 x 10^{-4}	−250 ± 150	150	2222 809 08003

Rated voltage (d.c.)	300 V
Test voltage (d.c.) for 1 minute	600 V
Contact resistance	max. 5 mΩ
Insulation resistance between stator and rotor	min. 10 000 MΩ
Category temperature range	−40 to + 125 °C
Climatic category (IEC 68)	40/125/21

* Measured at 200 kHz.

** C at 60 to 80% of C_{max}; ΔT from + 20 to + 125 °C.

TESTS AND REQUIREMENTS

Table 3

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
4.2		method of mounting	method A		
14		cap. drift	after T.C. measurement	ΔC/C	⩽ 1,5%
19		thrust	axial thrust of 2N	ΔC/C	⩽ 0,2%
21		robustness of terminations:			
21.1	Ua	tensile	1N		
21.2	Ub	bending	1 cycle		no damage
22	Na	rapid change of temperature	1 cycle: ½ h at the lower and ½ h at the upper category temperature	ΔC/C	⩽ 2,5%
23	T	soldering			good wetting
	Ta	solderability	solder bath, immersion 3 mm, 235 °C, 2 s		no mech. damage
	Tb	resistance to heat	solder bath, 260 °C, 10 s		no mech. damage
24		impact		ΔC/C	⩽ 0,5%
	Eb	bump	4000 ± 10 bumps, 40g, 6 ms		no mech. damage
25	Fc	vibration	freq. 10 to 55 Hz, amplitude 0,35 mm. 1½ h	ΔC/C	⩽ 0,2% no mech. damage

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
26		climatic sequence		$\Delta C/C$ tan δ	$\leqslant$ 2,5% $\leqslant 10 \times 10^{-4}$
26.1	B	dry heat	16 h at the upper category temperature	R_{ins}	$>$ 10 000 MΩ
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h + 40 °C, 95 to 100% R.H.	rotor contact R voltage proof visual examination operating torque	$\leqslant$ 5 mΩ 600 V for 1 min no mech. damage 1-20 mNm
26.3	Aa	cold	16 h −40 °C		
26.5		damp heat accelerated, remaining cycles	1 cycle 24 h + 40 °C, 95 to 100% R.H.		
27	Ca	damp heat steady state	21 days + 40 °C, 90 to 95% R.H.	$\Delta C/C$ tan δ R_{ins} rotor contact R voltage proof visual examination operating torque	$\leqslant$ 2,5% $\leqslant 10 \times 10^{-4}$ $>$ 10 000 MΩ $\leqslant$ 5 mΩ 600 V for 1 min no mech. damage 1-20 mNm
29 29.1		endurance mechanical	25 cycles	$\Delta C/C$ rotor contact R voltage proof $\Delta C/C$ after axial thrust visual examination operating torque	$\leqslant$ 0,3% $\leqslant$ 5 mΩ 600 V for 1 min $\leqslant$ 0,3% no mech. damage 1-20 mNm

QUALITY LEVEL

Sampling and data evaluation for quality level in accordance with MIL-STD-105D and IEC 410

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{max}, and is also subjected to the full test voltage.

See also Note under Survey of variable capacitors.

PACKAGING

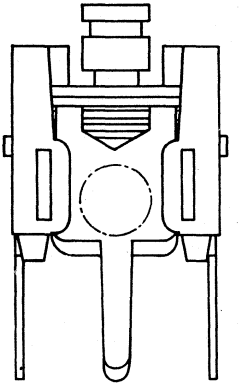
Blister packs of 50 pieces each.

FILM DIELECTRIC TRIMMERS

high temperature type

QUICK REFERENCE DATA

Max. C_{min}/min. C_{max}	1,4/5,5 pF 2/9 pF 2/18 pF
Overall dimensions	8 x 9 x 10 mm
Rated voltage (d.c.)	300 V
Climatic category (IEC 68)	40/125/21
Basic specification	IEC 418-1 and 2



APPLICATION

For use in measuring and telecommunication equipment, specially where high temperatures occur and a low temperature coefficient is important, e.g. for fine adjustment of h.f. tuned circuits.

DESCRIPTION

The trimmers consist of a polysulphone housing, brass rotor and silver-plated brass stator with P.T.F.E. film as the dielectric. The stator plates with their tag are heat sealed to the housing. The rotor contact surface is silver plated to ensure a long life and a stable contact even under severe climatic conditions. Flux absorption between the vanes is prevented. The trimmers have top adjustment by means of a screwdriver and bottom adjustment by means of a key (see Fig. 5). Two versions are available, a 3-tag version with two rotor tags and a 2-tag version with one rotor tag.

MECHANICAL DATA

Dimensions in mm

Outlines

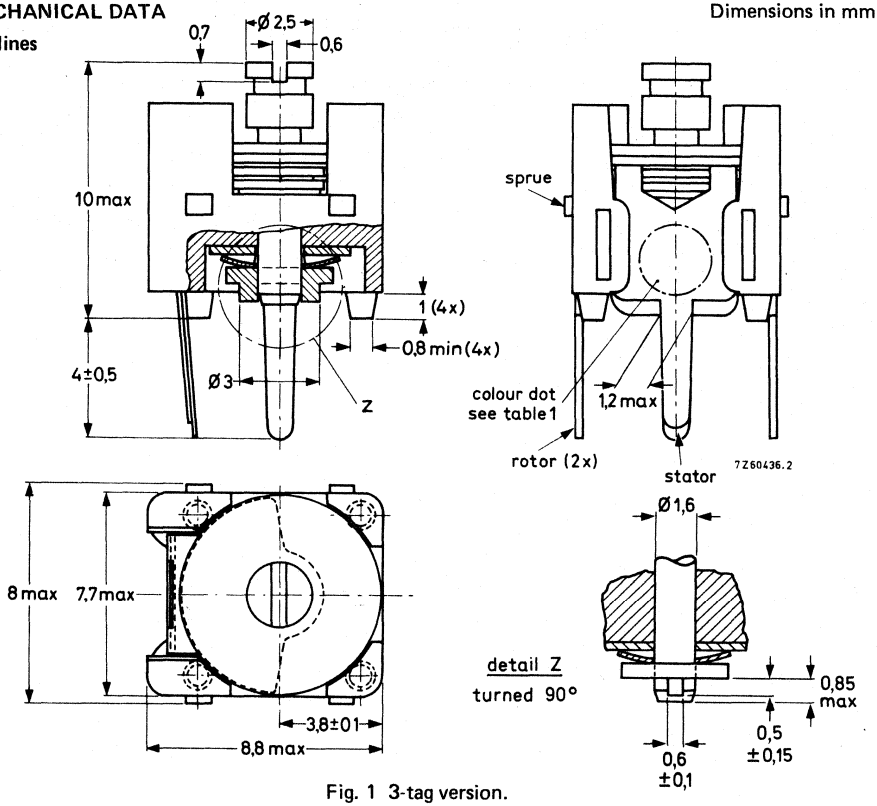


Fig. 1 3-tag version.

7Z69858

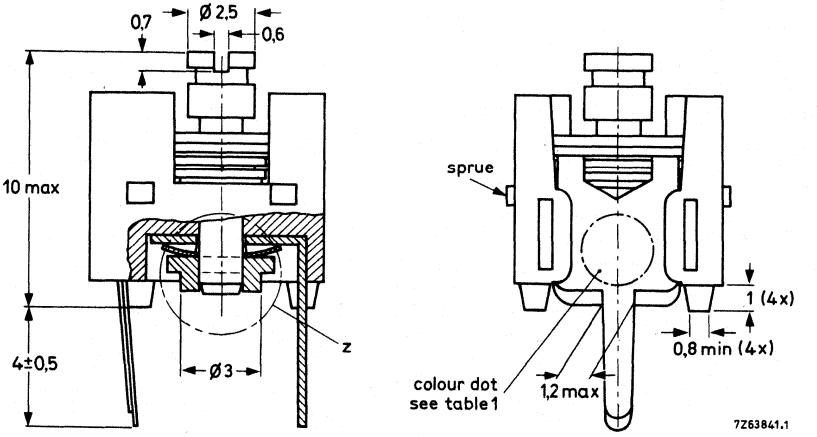


Fig. 2 2-tag version.

Table 1

max. capacitance	5,5 pF	9 pF	18 pF
effective angle of rotation	180°	180°	180°
operating torque	1-15 mNm	2,5-20 mNm	2,5-20 mNm
maximum axial thrust ($\Delta C \leqslant 0{,}3\%$ of C_{max})	2 N	2 N	2 N
mass approx.	0,8 g	0,8 g	0,9 g
colour dot	green	white	red

Type identification

The different capacitance values can be identified by the colour dot, see Table 1.

Soldering

Soldering conditions: max. 260 °C, max. 10 s.

Mounting

The trimmers can be mounted on printed-wiring boards having holes with a minimum diameter of 1,25 mm. The hole pattern is given in the figures below (R = rotor; S = stator).

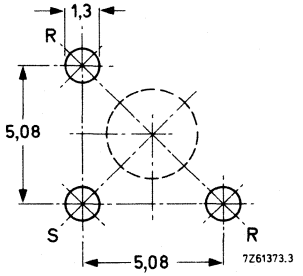


Fig. 3 For types of Fig. 1.

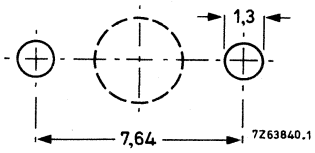


Fig. 4 For types of Fig. 2.

Note

The large hole is necessary only for bottom adjustment.

Key for adjustment

The dimensions essential for the design of a key are given in Fig. 5.

A key (catalogue number 7122 347 21600) and the associated handle (catalogue number 7122 005 47910) can be supplied on request.

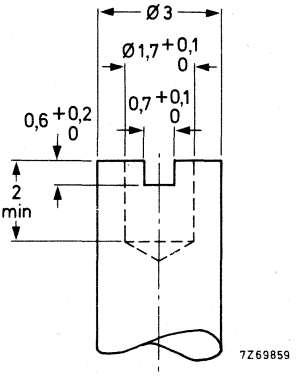


Fig. 5.

ELECTRICAL DATA

Table 2

C_{max}* pF	C_{min}* pF	max. tan δ at 1 MHz	max. tan δ at 100 MHz	temperature coefficient** 10^{-6}/K	min. f_{res} at C_{max} MHz	catalogue number 2222 809 . . . . . 2-tag version	3-tag version
⩾ 5,5	⩽ 1,4	10×10^{-4}	15×10^{-4}	−250 ± 150	850	09004	09001
⩾ 9	⩽ 2	10×10^{-4}	15×10^{-4}	−250 ± 150	580	09005	09002
⩾ 18	⩽ 2	10×10^{-4}	15×10^{-4}	−250 ± 150	360	09006	09003

Rated voltage (d.c.)	300 V
Test voltage (d.c.) for 1 minute	600 V
Contact resistance	max. 5 mΩ
Insulation resistance between stator and rotor	min. 10 000 MΩ
Category temperature range	−40 to + 125 °C
Climatic category (IEC 68)	40/125/21

* Measured at 200 kHz.

** C at 60 to 80% of C_{max}; ΔT from + 20 to + 125 °C.

TESTS AND REQUIREMENTS

Table 3

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
4.2		method of mounting	method A		
14		cap. drift	after T.C. measurement	ΔC/C	⩽ 1,5%
19		thrust	axial thrust of 2N	ΔC/C	⩽ 0,3%
21		robustness of terminations:			
21.1	Ua	tensile	1N		
21.2	Ub	bending	1 cycle		no damage
22	Na	rapid change of temperature	1 cycle: ½ h at the lower and ½ h at the upper category temperature	ΔC/C	⩽ 1%
23	T	soldering			good wetting
	Ta	solderability	solder bath, immersion 3 mm, 235 °C, 2 s		no mech. damage
	Tb	resistance to heat	solder bath 260 °C, 10 s		no mech. damage
24		impact		ΔC/C	⩽ 0,5%
	Eb	bump	4000 ± 10 bumps, 40g, 6 ms		no mech. damage
25	Fc	vibration	freq. 10 to 55 Hz, amplitude 0,35 mm, 1½ h	ΔC/C	⩽ 0,3% no mech. damage

TESTS AND REQUIREMENTS (continued)

IEC 418-1 clause	IEC 68 test method	test	procedure	requirements	
26		climatic sequence		$\Delta C/C$ $\tan \delta$ R_{ins} rotor contact R voltage proof visual examination operating torque	$\leqslant 2{,}5\%$ $\leqslant 10 \times 10^{-4}$ $> 10\,000\ M\Omega$ $\leqslant 5\ m\Omega$ 600 V for 1 min no mech. damage 1-20 mNm
26.1	B	dry heat	16 h at the upper category temperature		
26.2	D	damp heat accelerated, first cycle	1 cycle, 24 h + 40 °C, 95 to 100% R.H.		
26.3	Aa	cold	16 h −40 °C		
26.5		damp heat accelerated, remaining cycles	1 cycle 24 h + 40 °C, 95 to 100% R.H.		
27	Ca	damp heat steady state	21 days + 40 °C, 90 to 95% R.H.	$\Delta C/C$ $\tan \delta$ R_{ins} rotor contact R voltage proof visual examination operation torque	$\leqslant 3\%$ $\leqslant 10 \times 10^{-4}$ $> 10\,000\ M\Omega$ $\leqslant 5\ m\Omega$ 600 V for 1 min no mech. damage 1-20 mNm
29 29.1		endurance mechanical	25 cycles	$\Delta C/C$ rotor contact R voltage proof $\Delta C/C$ after axial thrust visual examination operating torque	$\leqslant 3\%$ $\leqslant 5\ m\Omega$ 600 V for 1 min $\leqslant 0{,}3\%$ no mech. damage 1-20 mNm

QUALITY LEVEL

Sampling and data evalution for quality level in accordance with MIL-STD-105D and IEC 410

A.Q.L. 0,4%, major defects

A.Q.L. 1,5%, minor defects

Each capacitor is tested for minimum C_{max}, and is also subjected to the full test voltage.

See also Note under Survey of variable capacitors.

PACKAGING

In blisters containing 100 capacitors.

DATE CODE SYSTEM

FOR CAPACITORS AND RESISTORS ACCORDING TO IEC PUBLICATION 62, CLAUSE 5.

Two-character code (year/month)

Where the marking of the year and month of manufacture is required, the following system is used.

year	letter
1979	L
1980	M
1981	N
1982	P
1983	R
1984	S
1985	T
1986	U
1987	V
1988	W
1989	X

month	character
January	1
February	2
March	3
April	4
May	5
June	6
July	7
August	8
September	9
October	0
November	N
December	D

Examples: November 1979 = LN
March 1980 = M3

Four-character code (year/week)

Where the marking of the year and week of manufacture is required, the code system uses four figures. The first two figures shall be the last two figures of the year, and the last two figures the numbering of the week; the numbering of the week shall be in accordance with ISO Recommendation R2015, Numbering of Weeks.

Example: Fifth week of 1980 = 8005.

Contents

FILM, CERAMIC AND VARIABLE CAPACITORS

CONTENTS

STANDARD SERIES OF VALUES IN A DECADE
for resistances and capacitances

according to I.E.C. publication 63

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

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