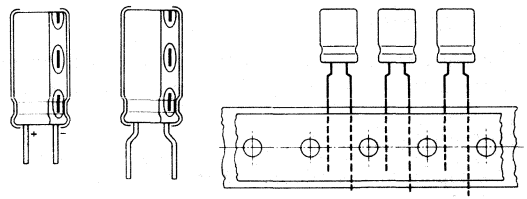
NON-SOLID ALUMINIUM ELECTROLYTIC CAPACITORS

- **Miniature and small types**
- **Single ended**
- **Very high CU-product per unit volume**
- **General applications**



QUICK REFERENCE DATA

Nominal capacitance range (E6 series)	0,10 to 10 000 μF
Tolerance on nominal capacitance	± 20% **
Rated voltage range, U_R (R5 series)	6,3 to 100 V
Category temperature range	−40 to + 85 °C
Endurance test at 85 °C	
U_R = 6,3 to 16 V	1000 hours ***
U_R = 25 to 100 V	2000 hours
Shelf life at 0 V, 85 °C	500 hours
Basic specifications IEC 384-4, G.P. grade DIN 41332/DIN 41259	
Climatic category IEC 68 DIN 40040	40/085/56 GPF

Table 2 Case dimensions

case size	nominal dimensions (mm)
11	Ø 5 x 11
12	Ø 6,3 x 11
13	Ø 8 x 12
14	Ø 10 x 12
15	Ø 10 x 16
16	Ø 10 x 20
17	Ø 12,5 x 20
18	Ø 12,5 x 25
19	Ø 16 x 25
20	Ø 16 x 31

* size reduction by 1 step under consideration
** ± 10% to special order
*** 2000 hours under development
( ) under consideration

Table 1 Selection chart for C_{nom}–U_R and relevant case sizes

C_{nom} μF	U_R (V) 6,3	10	16	25	35	40	50	63	100
0,10								11	
0,15								11	
0,22								11	11
0,33								11	
0,47								11	11
0,68								11	
1								11	11
1,5								11	11
2,2								11	11
3,3								11	11
4,7								11	11
6,8								11	11
10							11	11	12
15						11		11	13
22					11	11	12*	12	13
33			11		11	12	12	13*	14
47		11		11		12	13*	13	15
68	11		11	12		13	13	14	15
100		11	12	13*		13	(13)	14	16
150	12	12	13	13		14		15	17
220	12	13*	13	(13)	14		15	16	18
330	13	13	14*	(14)	15	16	(16)	17	19
470	13	(13)	14	(15)	16	17	17	18	20
680		14	15		17	18	18	19	
1000		15	16	17	18	19	19	20	
1500	16		17	18	19	20			
2200	17	(17)	18	19	20				
3300	(17)	18	19	20					
4700		19	20						
6800	19	20							
10 000	20								

APPLICATION

These capacitors with very high CU-product per unit volume are mainly used for smoothing, coupling and decoupling purposes in consumer applications, such as audio and television circuits.
Other applications are in timing and delay circuits. The taped versions are suitable for automatic insertion and for cutting and forming equipment.

DESCRIPTION

The capacitors have etched and oxidized aluminium foil electrodes rolled up with a paper strip impregnated with an electrolyte. The capacitors are in an insulated aluminium case.

MECHANICAL DATA

Dimensions in mm

The capacitor is available in 6 styles:
style 1: long leads; in boxes;
style 2: straight short leads; non preferred, in boxes;
style 3: bent short leads, case sizes 11, 12 and 13 only; non preferred, in boxes;
style 4: long leads; on tape on reel, positive leading; case sizes 11 to 13 only;
style 5: long leads; on tape in ammunition pack; case sizes 11 to 13 only;
style 6: long leads; on tape on reel, negative leading; case sizes 11 to 13 only.

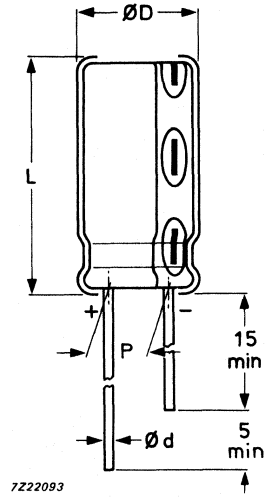


Fig. 1 Style 1; see Table 3 for dimensions ϕd, ϕD, L and P.

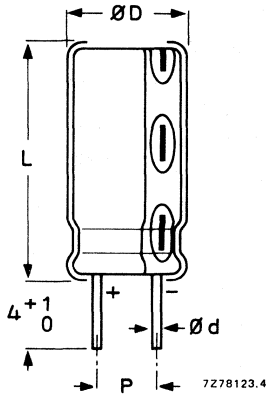


Fig. 2 Style 2; non preferred. see Table 3 for dimensions ϕd, ϕD, L and P.

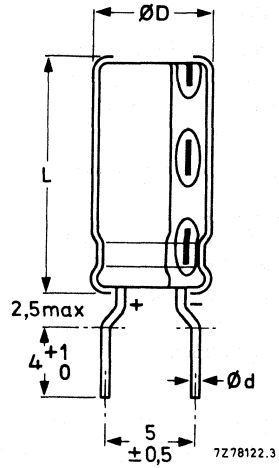
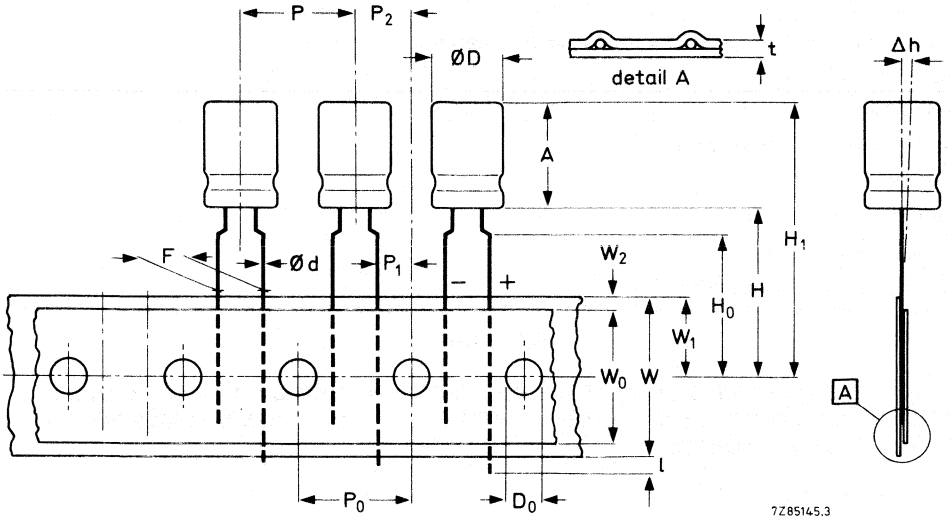


Fig. 3 Style 3, case sizes 11, 12 and 13; non preferred, see Table 3 for dimensions ϕd, ϕD and L.

Table 3 Physical dimensions

case size	dimensions					mass grams
	ϕd	ϕD_{max}	L_{max}	P		
11	0,5	5,5	12,0	2,0		0,4
12	0,6	6,8	12,0	2,5		0,6
13	0,6	8,5	12,5	3,5	± 0,5	1,1
14	0,6	10,5	12,5	5,0		1,6
15	0,6	10,5	17,0	5,0		1,9

case size	dimensions					mass grams
	ϕd	ϕD_{max}	L_{max}	P		
16	0,6	10,5	21,0	5,0		2,2
17	0,6	13,0	21,0	5,0		4,0
18	0,6	13,0	26,0	5,0	± 0,5	5,0
19	0,8	16,5	26,0	7,5		8,0
20	0,8	16,5	32,0	7,5		9,0



→ direction of tape transport (positive leading)

Fig. 4 Styles 4, 5 and 6, case sizes 11 to 13; see Table 4 for dimensions. For style 6 the tape transport is in opposite direction (negative leading).

DEVELOPMENT DATA

Table 4 Taping dimensions

	symbol	case size			tolerance	
		11	12	13		
Body diameter	D	5,5	6,8	8,5	maximum	←
Body height	A	12,0	12,0	12,5	maximum	
Lead-wire diameter	d	0,5	0,6	0,6	± 0,05	
Pitch of component	P	12,7	12,7	12,7	± 1,0	
Feed-hole pitch	P_0	12,7	12,7	12,7	± 0,2**	
Hole centre to lead	P_1	3,85	3,85	3,85	± 0,7	←
Feed hole centre to component centre	P_2	6,35	6,35	6,35	± 1,0	
Lead-to-lead distance	F	5,0*	5,0*	5,0*	+ 0,8/–0	←
Component alignment	Δh	0	0	0	± 1,0	
Tape width	W	18,0	18,0	18,0	± 0,5	
Hold-down tape width	W_0	12,5	12,5	12,5	minimum***	
Hole position	W_1	9,0	9,0	9,0	+ 0,75/–0,5	←
Hold-down tape position	W_2	2,5	2,5	2,5	maximum	
Height of component from tape centre	H	18,0	18,0	18,0	+ 1,5/–0	
Lead-wire clinch height	H_0	16,0	16,0	16,0	± 0,75	←
Component height	H_1	32,0	32,0	32,0	maximum	
Lead-wire protrusion	l	2,0	2,0	2,0	maximum	
Feed-hole diameter	D_0	4,0	4,0	4,0	± 0,3	←
Total tape thickness	t	0,9	0,9	0,9	maximum	

* available on request: F = 2,5 mm for case sizes 11 and 12
F = 3,5 mm for case size 13

** cumulative pitch error: ± 1 mm/20 pitches

*** other widths under consideration

Marking

The capacitors are marked with the following information:

- nominal capacitance value
- rated voltage
- negative terminal identification
- group number (037)
- code indicating factory of origin
- name of manufacturer
- date code, in accordance with IEC 62

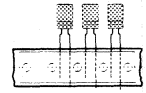
WARNING

NON-SOLID ELECTROLYTIC CAPACITORS MAY CONTAIN CHEMICALS WHICH CAN BE REGARDED AS HAZARDOUS IF HANDLED INCORRECTLY. CAUTION IS NECESSARY IF THE OUTER CASE IS FRACTURED.

ELECTRICAL DATA

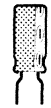
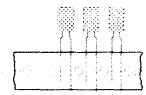
Unless otherwise specified all electrical values in Table 5 apply at an ambient temperature of 20 to 25 °C, a frequency of 100 Hz, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Table 5 Electrical data

U_R	nom. cap.	max. RMS ripple current at T_{amb} = 85 °C	max. DC leakage current at U_R after 1 minute	max. tan δ	max. ESR	max. impedance (Ω) at T_{amb} = 20 °C		case size	catalogue number 2222 037 followed by					
														
V	µF	mA	µA		Ω	at 1 kHz	at 10 kHz		style 1	style 2	style 3	on reel** style 4	in ammopack style 5	on reel*** style 6
6,3	68	80	7,3	0,24	7,0		8,8	11	53689	83689	63689	23689	33689	43689
	150	130	12	0,24	3,2		4,0	12	53151	83151	63151	23151	33151	43151
	220	170	17	0,24	2,2		2,7	12	53221	83221	63221	23221	33221	43221
	330	240	24	0,24	1,4		1,8	13	53331	83331	63331	23331	33331	43331
	470	300	33	0,24	1,0		1,3	13	53471	83471	63471	23471	33471	43471
	1 500	670	98	0,25	0,33	0,44	0,4	16	53152	63152				
	2 200	890	140	0,26	0,24	0,31	0,27	17	53222	63222				
	6 800	1550	430	0,35	0,10	0,12	0,09	19	53682	63682				
	10 000	1750	630	0,42	0,08	0,10	0,07	20	53103	63103				
10	47	75	7,7	0,20	8,5		9,6	11	54479	84479	64479	24479	34479	44479
	100	110	13	0,20	4,0		4,5	11	54101	84101	64101	24101	34101	44101
	150	140	18	0,20	2,7		3,0	12	54151	84151	64151	24151	34151	44151
	220	210	25	0,20	1,8		2,0	13*	54221	84221	64221	24221	34221	44221
	330	270	36	0,20	1,2		1,4	13	54331	84331	64331	24331	34331	44331
	680	420	71	0,20	0,59		0,66	14	54681	64681				
	1 000	630	100	0,20	0,40		0,45	15	54102	64102				
	3 300	1250	330	0,24	0,14	0,18	0,14	18	54332	64332				
	4 700	1450	470	0,28	0,12	0,13	0,1	19	54472	64472				
	6 800	1700	680	0,32	0,09	0,10	0,07	20	54682	64682				

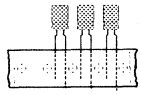
* size reduction by 1 step under consideration
** positive leading
*** negative leading

Table 5 (continued)

U_R	nom. cap.	max. RMS ripple current at T_{amb} = 85 °C	max. DC leakage current at U_R after 1 minute	max. tan δ	max. ESR	max. impedance (Ω) at T_{amb} = 20 °C		case size	catalogue number 2222 037 followed by					
						at	at							
V	μF	mA	μA		Ω	1 kHz	10 kHz		style 1	style 2	style 3	on reel** style 4	in ammopack style 5	on reel*** style 6
16	33	70	8,3	0,16	9,6		9,7	11	55339	85339	65339	25339	35339	45339
	68	100	14	0,16	4,7		4,7	11	55689	85689	65689	25689	35689	45689
	100	140	19	0,16	3,2		3,2	12	55101	85101	65101	25101	35101	45101
	150	200	27	0,16	2,1		2,1	13	55151	85151	65151	25151	35151	45151
	220	240	38	0,16	1,4		1,5	13	55221	85221	65221	25221	35221	45221
	330	330	56	0,16	0,96		0,97	14*	55331	65331				
	470	420	78	0,16	0,68		0,68	14	55471	65471				
	680	520	110	0,16	0,47		0,47	15	55681	65681				
	1000	740	160	0,16	0,32		0,32	16	55102	65102				
	1500	900	240	0,17	0,23	0,29	0,21	17	55152	65152				
	2200	1150	360	0,18	0,16	0,21	0,15	18	55222	65222				
	3300	1400	530	0,20	0,12	0,15	0,1	19	55332	65332				
	4700	1650	760	0,24	0,10	0,11	0,07	20	55472	65472				
25	47	90	15	0,14	5,9		4,7	11	56479	86479	66479	26479	36479	46479
	68	110	20	0,14	4,1		3,2	12	56689	86689	66689	26689	36689	46689
	100	170	28	0,14	2,8		2,2	13*	56101	86101	66101	26101	36101	46101
	150	200	41	0,14	1,9		1,5	13	56151	86151	66151	26151	36151	46151
	1000	890	250	0,14	0,28		0,22	17	56102	66102				
	1500	1000	380	0,15	0,20	0,24	0,15	18	56152	66152				
	2200	1300	550	0,16	0,14	0,17	0,1	19	56222	66222				
	3300	1500	830	0,18	0,11	0,12	0,07	20	56332	66332				

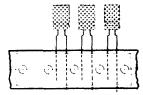
* size reduction by 1 step under consideration
** positive leading
*** negative leading

Table 5 (continued)

U_R	nom. cap.	max. RMS ripple current at T_{amb} = 85 °C	max. DC leakage current at U_R after 1 minute	max. tan δ	max. ESR	max. impedance (Ω) at T_{amb} = 20 °C		case size	catalogue number 2222 037 followed by					
														
						at	at					on reel*	in ammopack	on reel**
V	μF	mA	μA		Ω	1 kHz	10 kHz		style 1	style 2	style 3	style 4	style 5	style 6
35	22	65	11	0,12	11		6,8	11	50229	80229	60229	20229	30229	40229
	33	80	15	0,12	7,2		4,5	11	50339	80339	60339	20339	30339	40339
	220	330	80	0,12	1,1		0,68	14	50221	60221				
	330	450	120	0,12	0,72		0,45	15	50331	60331				
	470	550	170	0,12	0,51		0,32	16	50471	60471				
	680	740	240	0,12	0,35		0,22	17	50681	60681				
	1000	990	250	0,12	0,24		0,15	18	50102	60102				
	1500	1150	530	0,13	0,17	0,21	0,1	19	50152	60152				
	2200	1400	770	0,14	0,13	0,14	0,07	20	50222	60222				
40	15	55	9	0,12	16		8,7	11	57159	87159	67159	27159	37159	47159
	22	70	12	0,12	11		5,9	11	57229	87229	67229	27229	37229	47229
	33	90	16	0,12	7,2		3,9	12	57339	87339	67339	27339	37339	47339
	47	110	22	0,12	5,1		2,8	12	57479	87479	67479	27479	37479	47479
	68	150	30	0,12	3,5		1,9	13	57689	87689	67689	27689	37689	47689
	100	190	43	0,12	2,4		1,3	13	57101	87101	67101	27101	37101	47101
	150	250	63	0,12	1,6		0,87	14	57151	67151				
	330	500	140	0,12	0,72		0,39	16	57331	67331				
	470	650	190	0,12	0,51		0,28	17	57471	67471				
	680	810	280	0,12	0,35		0,19	18	57681	67681				
	1000	1050	400	0,12	0,24		0,13	19	57102	67102				
	1500	1100	600	0,13	0,17	0,18	0,09	20	57152	67152				

* positive leading
** negative leading

Table 5 (continued)

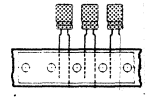
U_R	nom. cap.	max. RMS ripple current at T_{amb} = 85 °C	max. DC leakage current at U_R after 1 minute	max. tan δ	max. ESR	max. impedance (Ω) at T_{amb} = 20 °C		case size	catalogue number 2222 037 followed by					
						at 1 kHz	at 10 kHz		 style 1	 style 2	 style 3	 on reel** style 4	in ammopack style 5	on reel*** style 6
V	μF	mA	μA		Ω									
50	10	47	8	0,10	20		9,5	11	51109	81109	61109	21109	31109	41109
	22	81	14	0,10	9		4,3	12*	51229	81229	61229	21229	31229	41229
	33	100	20	0,10	6		2,9	12	51339	81339	61339	21339	31339	41339
	47	140	27	0,10	4,2		2,0	13*	51479	81479	61479	21479	31479	41479
	68	160	37	0,10	2,9		1,4	13	51689	81689	61689	21689	31689	41689
	220	400	110	0,10	0,90		0,43	15	51221	61221				
	470	670	240	0,10	0,42		0,20	17	51471	61471				
	680	850	340	0,10	0,29		0,14	18	51681	61681				
	1000	1100	500	0,10	0,20		0,10	19	51102	61102				

* size reduction by 1 step under consideration

** positive leading

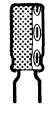
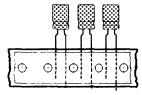
*** negative leading

Table 5 (continued)

U_R	nom. cap.	max. RMS ripple current at T_{amb} = 85 °C	max. DC leakage current at U_R after 1 minute	max. tan δ	max. ESR	max. impedance (Ω) at T_{amb} = 20 °C		case size	catalogue number 2222 037 followed by					
														
V	µF	mA	µA		Ω	at 1 kHz	at 10 kHz		style 1	style 2	style 3	on reel** style 4	in ammopack style 5	on reel*** style 6
63	0,10	5	3,1	0,09	1800		800	11	58107	88107	68107	28107	38107	48107
	0,15	6	3,1	0,09	1200		530	11	58157	88157	68157	28157	38157	48157
	0,22	8	3,1	0,09	810		360	11	58227	88227	68227	28227	38227	48227
	0,33	10	3,2	0,09	540		240	11	58337	88337	68337	28337	38337	48337
	0,47	11	3,3	0,09	380		170	11	58477	88477	68477	28477	38477	48477
	0,68	13	3,4	0,09	260		120	11	58687	88687	68687	28687	38687	48687
	1,0	16	3,6	0,09	180		80	11	58108	88108	68108	28108	38108	48108
	1,5	19	3,9	0,09	120		53	11	58158	88158	68158	28158	38158	48158
	2,2	23	4,4	0,09	81		36	11	58228	88228	68228	28228	38228	48228
	3,3	29	5,1	0,09	54		24	11	58338	88338	68338	28338	38338	48338
	4,7	35	6,0	0,09	38		17	11	58478	88478	68478	28478	38478	48478
	6,8	41	7,3	0,09	26		12	11	58688	88688	68688	28688	38688	48688
	10	50	9,3	0,09	18		8,0	11	58109	88109	68109	28109	38109	48109
	15	61	12	0,09	12		5,3	11	58159	88159	68159	28159	38159	48159
	22	85	17	0,09	8,1		3,6	12	58229	88229	68229	28229	38229	48229
	33	120	24	0,09	5,4		2,4	13*	58339	88339	68339	28339	38339	48339
	47	150	33	0,09	3,8		1,7	13	58479	88479	68479	28479	38479	48479
	68	200	46	0,09	2,6		1,2	14	58689	68689				
	100	260	66	0,09	1,8		0,80	14	58101	68101				
	150	320	98	0,09	1,2		0,53	15	58151	68151				
	220	460	140	0,09	0,81		0,36	16	58221	68221				
	330	600	210	0,09	0,54		0,24	17	58331	68331				
	470	830	300	0,09	0,38		0,17	18	58471	68471				
	680	1000	430	0,09	0,26		0,12	19	58681	68681				
	1000	1250	630	0,09	0,18		0,08	20	58102	68102				

* size reduction by 1 step under consideration
** positive leading
*** negative leading

Table 5 (continued)

U_R	nom. cap.	max. RMS ripple current at T_{amb} = 85 °C	max. DC leakage current at U_R after 1 minute	max. tan δ	max. ESR	max. impedance (Ω) at T_{amb} = 20 °C		case size	catalogue number 2222 037 followed by					
														
						at 1 kHz	at 10 kHz		st style 1	style 2	style 3	on reel* style 4	in ammopack style 5	on reel** style 6
V	μF	mA	μA		Ω									
100	0,22	8	3,2	0,07	630		270	11	59227	89227	69227	29227	39227	49227
	0,47	12	3,5	0,07	300		130	11	59477	89477	69477	29477	39477	49477
	1,0	18	4	0,07	140		60	11	59108	89108	69108	29108	39108	49108
	1,5	22	4,5	0,07	93		40	11	59158	89158	69158	29158	39158	49158
	2,2	27	5,2	0,07	63		27	11	59228	89228	69228	29228	39228	49228
	3,3	33	6,3	0,07	42		18	11	59338	89338	69338	29338	39338	49338
	4,7	39	7,7	0,07	30		13	11	59478	89478	69478	29478	39478	49478
	6,8	47	9,8	0,07	20		8,8	11	59688	89688	69688	29688	39688	49688
	10	62	13	0,07	14		6,0	12	59109	89109	69109	29109	39109	49109
	15	91	18	0,07	9,3		4,0	13	59159	89159	69159	29159	39159	49159
	22	115	25	0,07	6,3		2,7	13	59229	89229	69229	29229	39229	49229
	33	160	36	0,07	4,2		1,8	14	59339	69339				
	47	210	50	0,07	3,0		1,3	15	59479	69479				
	68	250	71	0,07	2,0		0,88	15	59689	69689				
	100	350	100	0,07	1,4		0,60	16	59101	69101				
	150	460	150	0,07	0,93		0,40	17	59151	69151				
	220	580	220	0,07	0,63		0,27	18	59221	69221				
	330	710	330	0,07	0,42		0,18	19	59331	69331				
	470	900	470	0,07	0,30		0,13	20	59471	69471				

* positive leading

** negative leading

Capacitance

Nominal capacitance at 100 Hz and T_{amb} = 20 °C	see Table 5
Tolerance on nominal capacitance at 100 Hz	± 20%

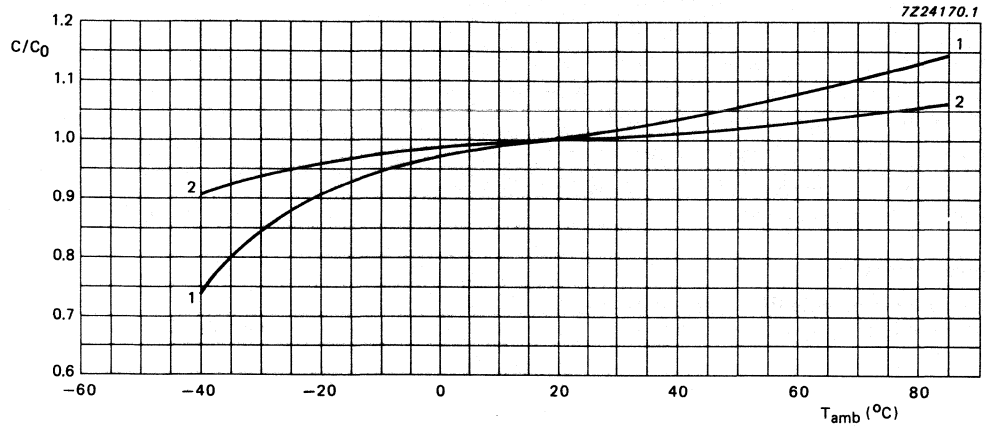


Fig. 5 Multiplier of capacitance (C/C_0) as a function of ambient temperature; C_0 = capacitance at 20 °C, 100 Hz.

Curve 1 = 6,3 V
curve 2 = 100 V

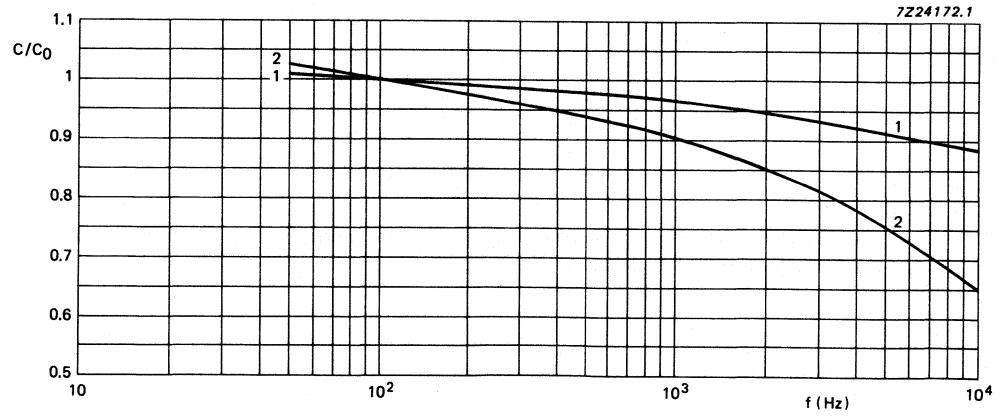


Fig. 6 Multiplier of capacitance (C/C_0) as a function of frequency; C_0 = capacitance at 20 °C, 100 Hz.

Curve 1 = 100 V
curve 2 = 6,3 V

DEVELOPMENT DATA

Voltage

	core temperature ▲	
	< 50 °C	50 to 85 °C
Rated voltage = maximum permissible voltage	1,15 x U_R	U_R
Ripple voltage* = maximum permissible AC voltage providing the following three conditions are met:		
a) maximum (DC + peak AC) voltage	1,15 x U_R	U_R
b) maximum peak AC voltage without DC voltage applied	1 V	
c) momentary value of applied voltage	between U_R and −1 V	
Surge voltage = maximum permissible voltage for short periods	1,15 x U_R	
Reverse voltage = maximum DC voltage applied in the reverse polarity for short periods	1 V	

Ripple current **

Maximum permissible RMS ripple current at 100 Hz and T_{amb} = 85 °C	see Table 5

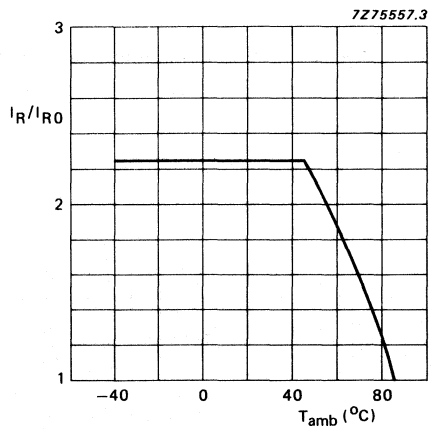


Fig. 7 Typical multiplier of ripple current (I_R/I_{R0}) as a function of ambient temperature; I_{R0} = ripple current at 85 °C, 100 Hz.

▲ See Introduction, section 5, "Ripple current".

* Ripple voltages are not applicable if the maximum permissible ripple current is exceeded. In that case the ripple current is decisive.

** Ripple currents are not applicable if the maximum permissible ripple voltage is exceeded. In that case the ripple voltage is decisive.

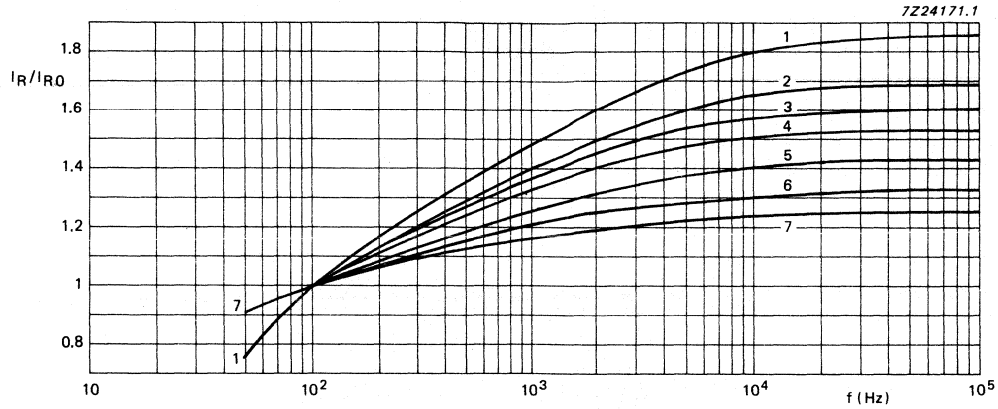


Fig. 8 Typical multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 85 °C, 100 Hz.

Curve 1 = 63/100 V, ($\leqslant$ 2,2 μF)
curve 2 = 100 V ($\geqslant$ 3,3 μF)
curve 3 = 63 V ($\geqslant$ 3,3 μF)
curve 4 = 50 V
curve 5 = 35/40 V
curve 6 = 16/25 V
curve 7 = 6,3/10 V

DEVELOPMENT DATA

Non-sinusoidal ripple currents have to be analyzed into a number of sinusoidal currents and the following requirements shall then be satisfied:

$$\sum_n \frac{I_N^2}{r_N} \leqslant I_{R\,max}^2$$

$I_{R\,max}$ = maximum ripple current at 100 Hz and applicable ambient temperature;
I_N = ripple current at a certain frequency;
$\sqrt{r_N} = I_R/I_{R0}$ = multiplying factor at a same frequency.

Charge and discharge current

The capacitors may be charged from a source without internal resistance and they may be discharged by short-circuiting. If the capacitors are charged and discharged continuously several times per minute, the charge and discharge currents have to be considered as ripple currents flowing through the capacitor. The RMS value of these currents should be determined and the value thus found must not exceed the applicable limit. (See also Tests and requirements).

DC leakage current

Maximum DC leakage current 1 minute after application of U_R at T_{amb} = 20 °C	see Table 5 (0,01 CU + 3 μA)
DC leakage current during continuous operation at U_R,	
at T_{amb} = 25 °C	approx. 0,1 x value stated in Table 5
at T_{amb} = 85 °C	$\leqslant$ value stated in Table 5

If owing to prolonged storage and/or storage at an excessive temperature (> 40 °C) the DC leakage current is too high, application of the rated voltage for some hours will cause the DC leakage current to fall to a value lower than specified in Table 5.

Tan δ (dissipation factor)

Maximum tan δ at 100 Hz and T_{amb} = 25 °C, measured by means of a four-terminal circuit (Thomson circuit) — see Table 5

Equivalent series resistance (ESR)

Maximum ESR at 100 Hz and T_{amb} = 25 °C, measured using a four terminal (Thomson) circuit — see Table 5

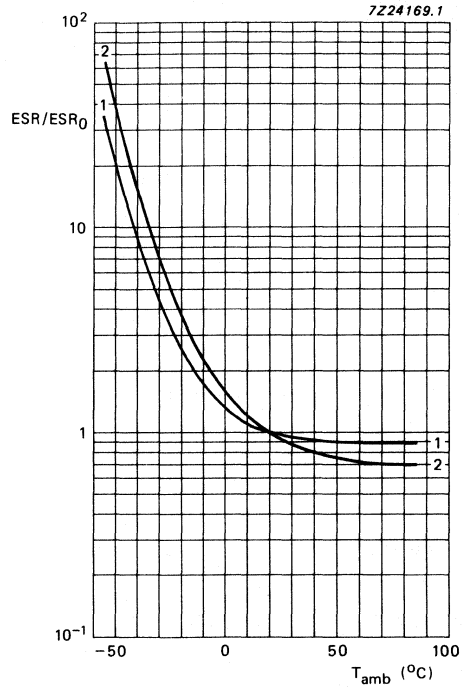


Fig. 9 Multiplier of ESR (ESR/ESR$_0$) as a function of ambient temperature; ESR$_0$ = typical ESR at 20 °C, 100 Hz.

curve 1 = 63 V ($\geqslant$ 4,7 μF)
curve 2 = 10 V

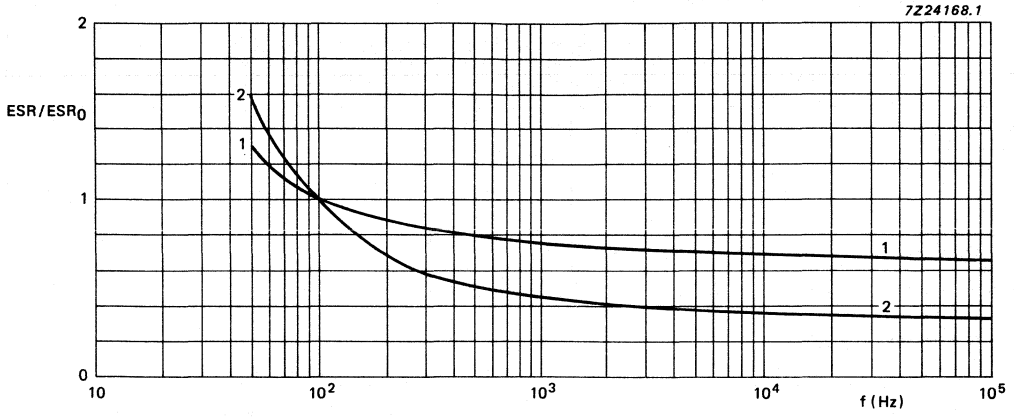


Fig. 10 Multiplier of ESR (ESR/ESR_0) as a function of frequency; ESR_0 = typical ESR at 20 °C, 100 Hz.

curve 1 = 6,3 V
curve 2 = 63 V ($\geqslant$ 4,7 μF)

DEVELOPMENT DATA

Equivalent series inductance (ESL)

Case sizes 11, 12, 13	typ. 13 nH
Case sizes 14, 15, 16	typ. 16 nH
Case sizes 17, 18, 19, 20	typ. 18 nH

Impedance (Z)

Maximum impedance at T_{amb} = 20 °C and 10 kHz and 1 kHz ($C_{nom} > 1000$ μF only), measured by means of a four-terminal circuit (Thomson circuit) — see Table 5

$z = Z \times C_{nom}$ — see Table 6

Maximum ratio between impedances at T_{amb} = −25 °C and + 20 °C, and at T_{amb} = −40 °C and + 20 °C, at 100 Hz measured by means of a four-terminal circuit (Thomson circuit) — see Table 7

Table 6 $Z \times C_{nom}$ values

	T_{amb}	$z = Z \times C_{nom}$ (Ω μF) at U_R								
		6,3 V	10 V	16 V	25 V	35 V	40 V	50 V	63 V	100 V
$C_{nom} > 1000$ μF, measured at 1 kHz*	+20 °C	650	530	430	350	300	270	260	250	240
	−25 °C	5500	4000	2700	1700	1200	1000	700	550	500
$C_{nom} \leqslant 1000$ μF, measured at 10 kHz	+20 °C	600	450	320	220	150	130	95	80	60
	−25 °C	5500	4000	2700	1700	1200	950	650	500	450

* Values shall be increased by 5% per 1000 μF.

Table 7 Maximum impedance ratio values

	maximum impedance ratio at U_R and 100 Hz								
	6,3 V	10 V	16 V	25 V	35 V	40 V	50 V	63 V	100 V
$\frac{Z \text{ at } -25\ ^oC}{Z \text{ at } +20\ ^oC}$	4	3	2	2	2	2	2	2	2
$\frac{Z \text{ at } -40\ ^oC}{Z \text{ at } +20\ ^oC}$	8	6	5	4	4	4	3	3	3

OPERATIONAL DATA

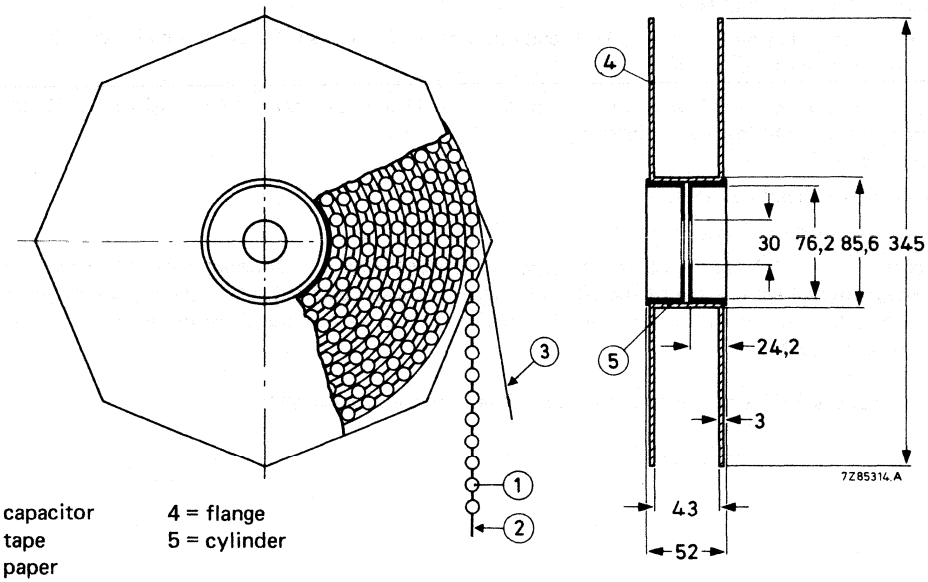
Category temperature range	−40 to + 85 °C	
Typical life time	U_R = 25 to 100 V	U_R = 6,3 to 16 V
at T_{amb} = 40 °C	70 000 hours	35 000 hours
at T_{amb} = 85 °C	3000 hours	1500 hours
at T_{amb} = 95 °C	1500 hours	750 hours
at T_{amb} = 105 °C	750 hours	400 hours
Shelf life at 0 V and T_{amb} = 85 °C	500 hours	500 hours

PACKING

Capacitors of styles 1, 2 and 3 are supplied in boxes, those of styles 4, 6 and 5 on tape on reel and in ammunition pack respectively. The numbers per box, per reel and per ammunition pack are given in Table 8.

Table 8 Packing quantities

case size	number of capacitors				
	style 1 per box	style 2 per box	style 3 per box	styles 4 and 6 per reel	style 5 per ammunition pack
11	1000	1000	1000	1000	2000
12	1000	1000	1000	1000	2000
13	1000	1000	1000	500	1000
14	1000	1000			
15	500	500			
16	500	500			
17	200	200			
18	200	200			
19	200	200			
20	200	200			



1 = capacitor
2 = tape
3 = paper
4 = flange
5 = cylinder

Fig. 11 Capacitors (styles 4 or 6) on tape on reel.

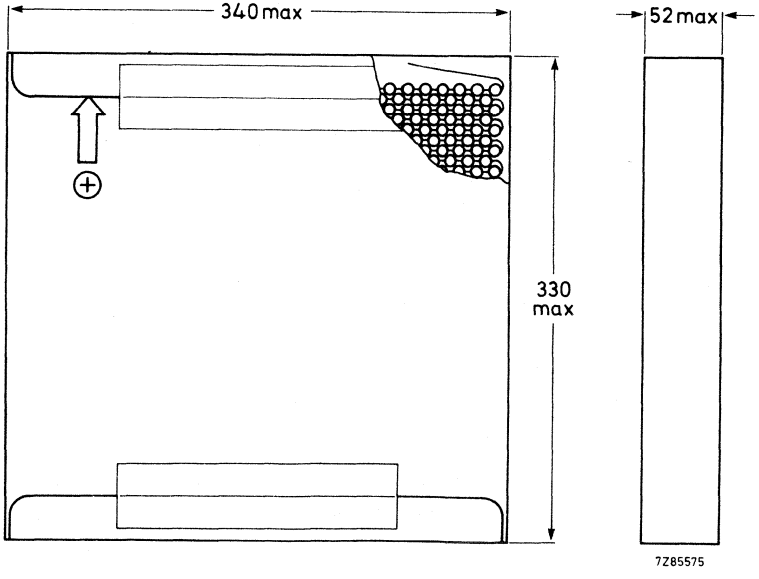


Fig. 12 Capacitors (style 5) on tape in ammunition pack.

DEVELOPMENT DATA

TESTS AND REQUIREMENTS

See Introduction, section 9, Table 1, Tests and requirements — non-solid aluminium electrolytic capacitors, with the following addition.

After endurance test, 1000 hours (U_R = 6,3 to 16 V) or 2000 hours (U_R = 25 to 100 V), 85 °C, the capacitors meet the following requirements:

$\Delta C/C \leqslant \pm 20\%$,

tan $\delta \leqslant 1{,}5$ x specified value,

DC leakage current ⩽ specified value.

After shelf life test, 500 hours, 85 °C, the capacitors meet the same requirements as after endurance test, except for leakage current of the 100 V range: ⩽ 200% of specified value. The rated voltage shall be applied to the capacitors for minimum 30 minutes, at least 24 hours and not more than 48 hours before measurements.

Note: Capacitors 2222 037 are miniature and small, general-purpose grade.