

Aluminum Capacitors Radial Standard Miniature

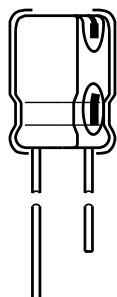
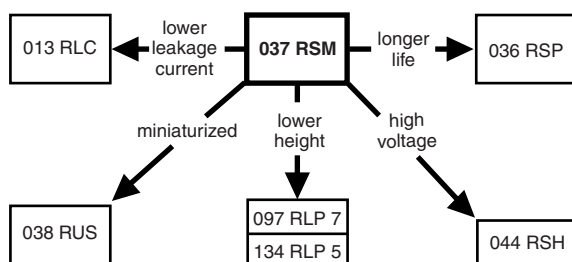


Fig.1 Component outline



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue vinyl sleeve
- Pressure relief for case $\varnothing D \geq 6.3$ mm.
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Lead (Pb)-Free versions are RoHS compliant


RoHS
COMPLIANT

APPLICATIONS

- General purpose, industrial, automotive and audio-video
- Coupling, decoupling, timing, smoothing, filtering, buffering in SMPS
- Portable and mobile equipment (small size, low mass)

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in μF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for $\pm 20\%$)
- Rated voltage (in V)
- Date code in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (037)

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes ($\varnothing D \times L$ in mm)	5 x 11 to 16 x 31
Rated capacitance range, C_R	0.47 to 10 000 μF
Tolerance on C_R	$\pm 20\%$; $\pm 10\%$ on request
Rated voltage range, U_R	6.3 to 100 V
Category temperature range	- 40 to + 85 °C
Endurance test at 85 °C	2000 h
Useful life at 85 °C	2500 h
Useful life at 40 °C, $1.4 \times I_R$ applied	70 000 h
Shelf life at 0 V, 85 °C	500 h
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/085/56

SELECTION CHART FOR C_R , U_R AND RELEVANT NOMINAL CASE SIZES ($\varnothing D \times L$ in mm)

C_R (μF)	U_R (V)								
	6.3	10	16	25	35	40	50	63	100
0.47	—	—	—	—	—	—	—	5 x 11	5 x 11
1.0	—	—	—	—	—	—	—	5 x 11	5 x 11
2.2	—	—	—	—	—	—	—	5 x 11	5 x 11
3.3	—	—	—	—	—	—	—	5 x 11	5 x 11
4.7	—	—	—	—	—	—	—	5 x 11	5 x 11
10	—	—	—	—	—	—	5 x 11	5 x 11	6.3 x 11
22	—	—	—	—	—	—	5 x 11	6.3 x 11	8 x 12
33	—	—	—	—	5 x 11	—	—	6.3 x 11	10 x 12
47	—	—	—	5 x 11	—	—	6.3 x 11	8 x 12	10 x 16
68	—	—	5 x 11	6.3 x 11	—	—	8 x 12	10 x 12	—
100	—	5 x 11	6.3 x 11	6.3 x 11	—	—	8 x 12	10 x 12	10 x 20
150	—	6.3 x 11	—	8 x 12	—	10 x 12	—	10 x 16	—
220	—	6.3 x 11	8 x 12	8 x 12	10 x 12	—	10 x 16	10 x 20	12.5 x 2

SELECTION CHART FOR C_R , U_R AND RELEVANT NOMINAL CASE SIZES ($\varnothing D \times L$ in mm)

C_R (μF)	U_R (V)								
	6.3	10	16	25	35	40	50	63	100
330	6.3 x 11	–	8 x 12	10 x 12	10 x 16	–	10 x 20	12.5 x 20	16 x 25
470	–	8 x 12	10 x 12	10 x 16	10 x 20	12.5 x 20	12.5 x 20	12.5 x 25	16 x 31
680	–	–	10 x 16	–	12.5 x 20	12.5 x 25	12.5 x 25	16 x 25	–
1000	10 x 12	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 25	16 x 31	–
1500	10 x 20	–	12.5 x 20	12.5 x 25	16 x 25	–	–	–	–
2200	12.5 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31	–	–	–	–
3300	12.5 x 20	12.5 x 25	16 x 25	16 x 31	–	–	–	–	–
4700	–	16 x 25	16 x 31	–	–	–	–	–	–
6800	–	16 x 31	–	–	–	–	–	–	–
10 000	16 x 31	–	–	–	–	–	–	–	–

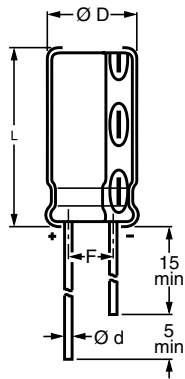
DIMENSIONS in millimeters AND AVAILABLE FORMS


Fig.2 **Form CA:**
Long leads

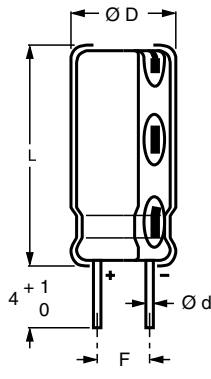
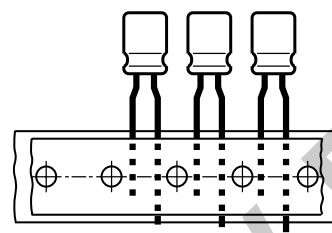
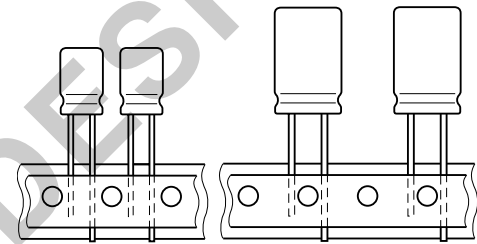


Fig.3 **Form CB:**
Cut leads



Case $\varnothing D = 5$ to 8 mm; pitch $F = 5$ mm



Pitch F see tables 1 and 2

Fig.5 **Form TNA, Form TFA:** Taped in box
(ammopack), straight leads

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE $\varnothing D \times L$	CASE CODE	$\varnothing d$	$\varnothing D_{max}$	L_{max}	F	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA, TNA
5 x 11	11	0.5	5.5	12.5	2.0 ± 0.5	≈ 0.4	3000	–	2000
6.3 x 11	12	0.5	6.8	12.5	2.5 ± 0.5	≈ 0.6	2000	–	2000
8 x 12	13	0.6	8.5	13.0	3.5 ± 0.5	≈ 1.1	1000	–	1000
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	1000	500
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	1000	1000	500
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	1000	500	500
12.5 x 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	1000	2000	500
12.5 x 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	500	2000	500
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	500	1000	250
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	200	1000	250

Note

- Detailed tape dimensions see section 'PACKAGING'.

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 Hz, 85 °C
I_{L1}	max. leakage current after 1 min at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
Z	max. impedance at 10 kHz

Note

1. Unless otherwise specified, all electrical values in Table 2 apply at $T_{amb} = 20\text{ °C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .

ORDERING EXAMPLE

Electrolytic capacitor 037 series

1000 $\mu\text{F}/16\text{ V}$; $\pm 20\%$ Nominal case size: $\varnothing 10 \times 20\text{ mm}$; Form TFA

Ordering Code: MAL203735102

Former 12NC: 2222 037 35102

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION															
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE Ø D × L (mm)	I _R 100 Hz 85 °C (mA)	I _{L1} 1 min (μA)	Tan δ 100 Hz	Z 10 kH z (Ω)	ORDERING CODE MAL2037.....								
							BULK PACKAGING				TAPED AMMOPACK				
							LONG LEADS		CUT LEADS						
							FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)	
6.3	330	6.3 x 11	280	24	0.24	1.8	90021E6	2.5	—	—	90027E6	5.0	90028E6	2.5	
	1000	10 x 12	530	66	0.24	0.6	53102E3	5.0	63102E3	5.0	33102E3	5.0	—	—	
	1500	10 x 20	730	98	0.25	0.4	53152E3	5.0	63152E3	5.0	33152E3	5.0	—	—	
	2200	12.5 x 20	990	140	0.26	0.27	53222E3	5.0	63222E3	5.0	33222E3	5.0	—	—	
	3300	12.5 x 20	1150	210	0.28	0.18	53332E3	5.0	63332E3	5.0	33332E3	5.0	—	—	
	10 000	16 x 31	2250	630	0.42	0.07	53103E3	7.5	63103E3	7.5	33103E3	7.5	—	—	
10	100	5 x 11	140	13	0.20	4.5	54101E6	2.0	—	—	34101E6	5.0	74101E6	2.5	
	150	6.3 x 11	180	18	0.20	3.0	54151E6	2.5	—	—	34151E6	5.0	74151E6	2.5	
	220	6.3 x 11	250	25	0.20	2.0	90029E6	2.5	—	—	90036E6	5.0	90037E6	2.5	
	470	8 x 12	410	50	0.20	0.96	54471E6	3.5	—	—	34471E6	5.0	74471E6	3.5	
	1000	10 x 16	630	100	0.20	0.45	54102E3	5.0	64102E3	5.0	34102E3	5.0	—	—	
	2200	12.5 x 20	1050	220	0.22	0.20	54222E3	5.0	64222E3	5.0	34222E3	5.0	—	—	
	3300	12.5 x 25	1350	330	0.24	0.14	54332E3	5.0	64332E3	5.0	34332E3	5.0	—	—	
	4700	16 x 25	1800	470	0.28	0.10	54472E3	7.5	64472E3	7.5	34472E3	7.5	—	—	
	6800	16 x 31	2200	680	0.32	0.07	54682E3	7.5	64682E3	7.5	34682E3	7.5	—	—	
16	68	5 x 11	130	14	0.16	4.7	55689E6	2.0	—	—	35689E6	5.0	75689E6	2.5	
	100	6.3 x 11	180	19	0.16	3.2	55101E6	2.5	—	—	35101E6	5.0	75101E6	2.5	
	220	8 x 12	300	38	0.16	1.5	55221E6	3.5	—	—	35221E6	5.0	75221E6	3.5	
	330	8 x 12	370	56	0.16	0.97	90038E6	3.5	—	—	90045E6	5.0	90046E6	3.5	
	470	10 x 12	420	78	0.16	0.68	55471E3	5.0	65471E3	5.0	35471E3	5.0	—	—	
	680	10 x 16	520	110	0.16	0.47	55681E3	5.0	65681E3	5.0	35681E3	5.0	—	—	
	1000	10 x 20	740	160	0.16	0.32	55102E3	5.0	65102E3	5.0	35102E3	5.0	—	—	
	1500	12.5 x 20	900	240	0.17	0.21	55152E3	5.0	65152E3	5.0	35152E3	5.0	—	—	
	2200	12.5 x 25	1200	360	0.18	0.15	55222E3	5.0	65222E3	5.0	35222E3	5.0	—	—	
	3300	16 x 25	1650	530	0.20	0.10	55332E3	7.5	65332E3	7.5	35332E3	7.5	—	—	
	4700	16 x 31	2100	760	0.24	0.07	55472E3	7.5	65472E3	7.5	35472E3	7.5	—	—	
	25	47	5 x 11	120	15	0.14	4.7	56479E6	2.0	—	—	36479E6	5.0	76479E6	2.5
		68	6.3 x 11	130	20	0.14	3.2	56689E6	2.5	—	—	36689E6	5.0	76689E6	2.5
100		6.3 x 11	190	28	0.14	2.2	90047E6	2.5	—	—	90054E6	5.0	90055E6	2.5	
150		8 x 12	230	41	0.14	1.5	56151E6	3.5	—	—	36151E6	5.0	76151E6	3.5	
220		8 x 12	320	58	0.14	1.0	56221E6	3.5	—	—	36221E6	5.0	76221E6	3.5	
330		10 x 12	410	86	0.14	0.67	56331E3	5.0	66331E3	5.0	36331E3	5.0	—	—	
470		10 x 16	510	120	0.14	0.47	56471E3	5.0	66471E3	5.0	36471E3	5.0	—	—	
1000		12.5 x 20	910	250	0.14	0.22	56102E3	5.0	66102E3	5.0	36102E3	5.0	—	—	
1500		12.5 x 25	1100	380	0.15	0.15	56152E3	5.0	66152E3	5.0	36152E3	5.0	—	—	
2200		16 x 25	1500	550	0.16	0.10	56222E3	7.5	66222E3	7.5	36222E3	7.5	—	—	
3300		16 x 31	1900	830	0.18	0.07	56332E3	7.5	66332E3	7.5	36332E3	7.5	—	—	

**ELECTRICAL DATA AND ORDERING INFORMATION**

U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE Ø D × L (mm)	I _R 100 Hz 85 °C (mA)	I _{L1} 1 min (μA)	Tan δ 100 Hz	Z 10 kHz z (Ω)	ORDERING CODE MAL2037.....							
							BULK PACKAGING				TAPED AMMOPACK			
							LONG LEADS		CUT LEADS					
							FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
35	33	5 x 11	110	15	0.12	4.5	50339E6	2.0	—	—	30339E6	5.0	70339E6	2.5
	220	10 x 12	330	80	0.12	0.68	50221E3	5.0	60221E3	5.0	30221E3	5.0	—	—
	330	10 x 16	450	120	0.12	0.45	50331E3	5.0	60331E3	5.0	30331E3	5.0	—	—
	470	10 x 20	590	170	0.12	0.32	50471E3	5.0	60471E3	5.0	30471E3	5.0	—	—
	680	12.5 x 20	830	240	0.12	0.22	50681E3	5.0	60681E3	5.0	30681E3	5.0	—	—
	1000	12.5 x 25	1050	350	0.12	0.15	50102E3	5.0	60102E3	5.0	30102E3	5.0	—	—
	1500	16 x 25	1400	530	0.13	0.10	50152E3	7.5	60152E3	7.5	30152E3	7.5	—	—
	2200	16 x 31	1750	770	0.14	0.07	50222E3	7.5	60222E3	7.5	30222E3	7.5	—	—
40	150	10 x 12	250	63	0.12	0.87	57151E3	5.0	67151E3	5.0	37151E3	5.0	—	—
	470	12.5 x 20	670	190	0.12	0.28	57471E3	5.0	67471E3	5.0	37471E3	5.0	—	—
	680	12.5 x 25	850	280	0.12	0.19	57681E3	5.0	67681E3	5.0	37681E3	5.0	—	—
	1000	16 x 25	1200	400	0.12	0.13	57102E3	7.5	67102E3	7.5	37102E3	7.5	—	—
50	10	5 x 11	65	8	0.10	9.5	51109E6	2.0	—	—	31109E6	5.0	71109E6	2.5
	22	5 x 11	95	14	0.10	4.3	90056E6	2.0	—	—	90063E6	5.0	90064E6	2.5
	47	6.3 x 11	150	27	0.10	2.0	90065E6	2.5	—	—	90072E6	5.0	90073E6	2.5
	68	8 x 12	190	37	0.10	1.4	51689E6	3.5	—	—	31689E6	5.0	71689E6	3.5
	100	8 x 12	260	53	0.10	0.95	51101E6	3.5	—	—	31101E6	5.0	71101E6	3.5
	220	10 x 16	400	110	0.10	0.43	51221E3	5.0	61221E3	5.0	31221E3	5.0	—	—
	330	10 x 20	580	170	0.10	0.29	51331E3	5.0	61331E3	5.0	31331E3	5.0	—	—
	470	12.5 x 20	740	240	0.10	0.20	51471E3	5.0	61471E3	5.0	31471E3	5.0	—	—
	680	12.5 x 25	950	340	0.10	0.14	51681E3	5.0	61681E3	5.0	31681E3	5.0	—	—
	1000	16 x 25	1350	500	0.10	0.10	51102E3	7.5	61102E3	7.5	31102E3	7.5	—	—
63	0.47	5 x 11	11	3.3	0.09	170	58477E6	2.0	—	—	38477E6	5.0	78477E6	2.5
	1.0	5 x 11	16	3.6	0.09	80	58108E6	2.0	—	—	38108E6	5.0	78108E6	2.5
	2.2	5 x 11	29	4.4	0.09	36	58228E6	2.0	—	—	38228E6	5.0	78228E6	2.5
	3.3	5 x 11	35	5.1	0.09	24	58338E6	2.0	—	—	38338E6	5.0	78338E6	2.5
	4.7	5 x 11	45	6.0	0.09	17	58478E6	2.0	—	—	38478E6	5.0	78478E6	2.5
	10	5 x 11	70	9.3	0.09	8.0	58109E6	2.0	—	—	38109E6	5.0	78109E6	2.5
	22	6.3 x 11	110	17	0.09	3.6	58229E6	2.5	—	—	38229E6	5.0	78229E6	2.5
	33	6.3 x 11	140	24	0.09	2.4	90074E6	2.5	—	—	90081E6	5.0	90082E6	2.5
	47	8 x 12	190	33	0.09	1.7	58479E6	3.5	—	—	38479E6	5.0	78479E6	3.5
	68	10 x 12	200	46	0.09	1.2	58689E3	5.0	68689E3	5.0	38689E3	5.0	—	—
	100	10 x 12	260	66	0.09	0.80	58101E3	5.0	68101E3	5.0	38101E3	5.0	—	—
	150	10 x 16	320	98	0.09	0.53	58151E3	5.0	68151E3	5.0	38151E3	5.0	—	—
	220	10 x 20	460	140	0.09	0.36	58221E3	5.0	68221E3	5.0	38221E3	5.0	—	—
	330	12.5 x 20	650	210	0.09	0.24	58331E3	5.0	68331E3	5.0	38331E3	5.0	—	—
	470	12.5 x 25	850	300	0.09	0.17	58471E3	5.0	68471E3	5.0	38471E3	5.0	—	—
	680	16 x 25	1150	430	0.09	0.12	58681E3	7.5	68681E3	7.5	38681E3	7.5	—	—
	1000	16 x 31	1550	630	0.09	0.08	58102E3	7.5	68102E3	7.5	38102E3	7.5	—	—
100	0.47	5 x 11	12	3.5	0.07	130	59477E6	2.0	—	—	39477E6	5.0	79477E6	2.5
	1.0	5 x 11	22	4	0.07	60	59108E6	2.0	—	—	39108E6	5.0	79108E6	2.5
	2.2	5 x 11	33	5.2	0.07	27	59228E6	2.0	—	—	39228E6	5.0	79228E6	2.5
	3.3	5 x 11	40	6.3	0.07	18	59338E6	2.0	—	—	39338E6	5.0	79338E6	2.5
	4.7	5 x 11	48	7.7	0.07	13	59478E6	2.0	—	—	39478E6	5.0	79478E6	2.5
	10	6.3 x 11	80	13	0.07	6.0	59109E6	2.5	—	—	39109E6	5.0	79109E6	2.5
	22	8 x 12	130	25	0.07	2.7	59229E6	3.5	—	—	39229E6	5.0	79229E6	3.5
	33	10 x 12	160	36	0.07	1.8	59339E3	5.0	69339E3	5.0	39339E3	5.0	—	—
	47	10 x 16	210	50	0.07	1.3	59479E3	5.0	69479E3	5.0	39479E3	5.0	—	—
	100	10 x 20	350	100	0.07	0.60	59101E3	5.0	69101E3	5.0	39101E3	5.0	—	—
	220	12.5 x 25	580	220	0.07	0.27	59221E3	5.0	69221E3	5.0	39221E3	5.0	—	—
	330	16 x 25	710	330	0.07	0.18	59331E3	7.5	69331E3	7.5	39331E3	7.5	—	—
	470	16 x 31	900	470	0.07	0.13	59471E3	7.5	69471E3	7.5	39471E3	7.5	—	—

ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 1 min at U_R	$I_{L1} \leq 0.01 C_R \times U_R + 3 \mu\text{A}$
	after 5 min at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 3 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D \leq 8 \text{ mm}$	typ. 13 nH
	case $\varnothing D = 10 \text{ mm}$	typ. 16 nH
	case $\varnothing D \geq 12.5 \text{ mm}$	typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	calculated from $\tan \delta_{\max}$ and C_R (see Table 2)	$\text{ESR} = \tan \delta / 2\pi f C_R$

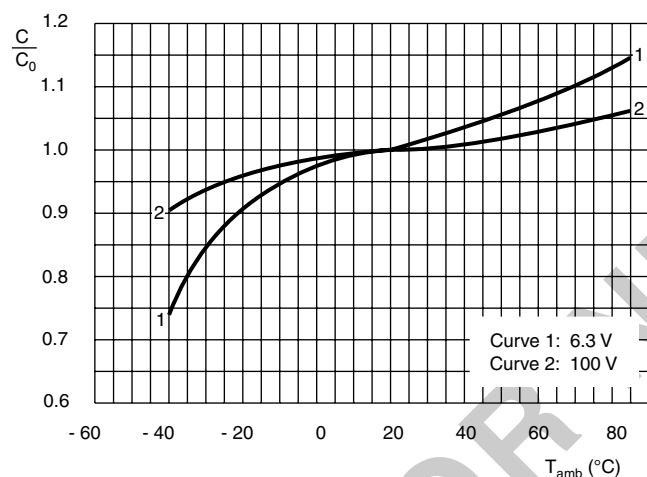
CAPACITANCE (C) C_0 = capacitance at 20 °C

Fig. 6 Typical multiplier of capacitance as a function of ambient temperature

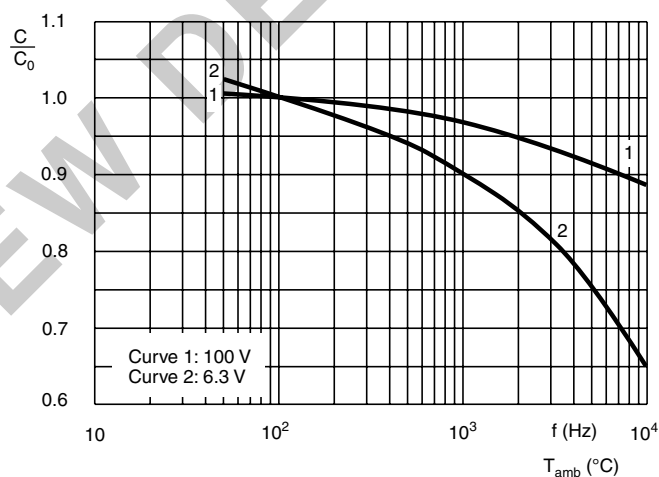
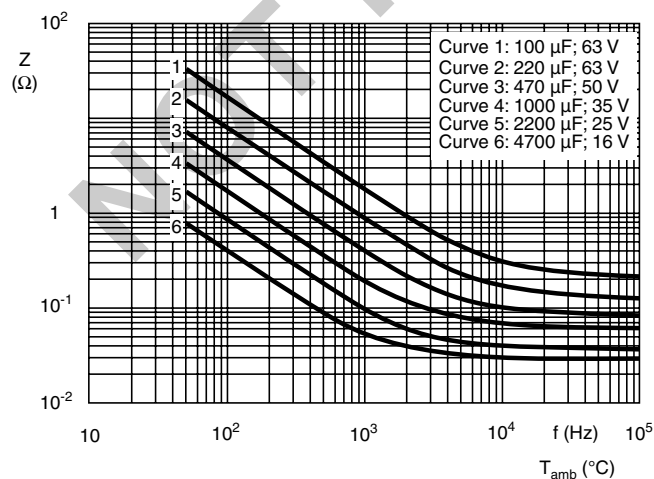
 C_0 = capacitance at 20 °C, 100 Hz

Fig. 7 Typical multiplier of capacitance as a function of frequency

IMPEDANCE (Z)

RIPPLE CURRENT AND USEFUL LIFE

I_A = actual ripple current at 100 Hz
 I_R = rated ripple current at 100 Hz, 85 °C
 (1) Useful life at 85 °C and I_R applied: 2500 h

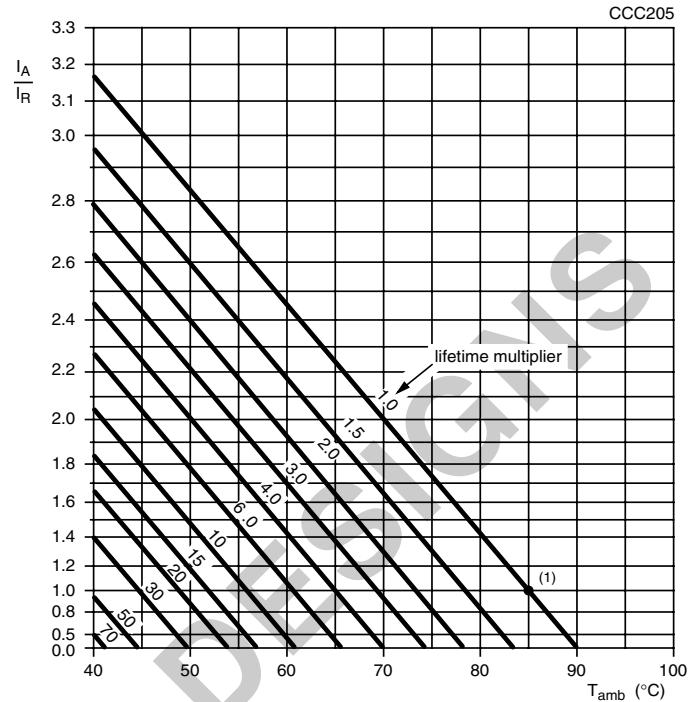


Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 6.3$ to 10 V	$U_R = 16$ to 35 V	$U_R = 40$ to 100 V
50	0.90	0.85	0.80
100	1.00	1.00	1.00
500	1.12	1.20	1.25
1000	1.20	1.30	1.40
3000	1.25	1.35	1.50
$\geq 10\,000$	1.30	1.40	1.60

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 85\text{ °C}$; U_R applied; 2000 h	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: + 15 / - 30 % $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 20\text{ %}$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ °C}$; U_R and I_R applied; 2500 h	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: + 45 / - 50 % $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 50\text{ %}$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 3\text{ %}$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	$T_{amb} = 85\text{ °C}$; no voltage applied; 500 h after test: U_R to be applied for 30 min, 24 to 48 h before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$



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