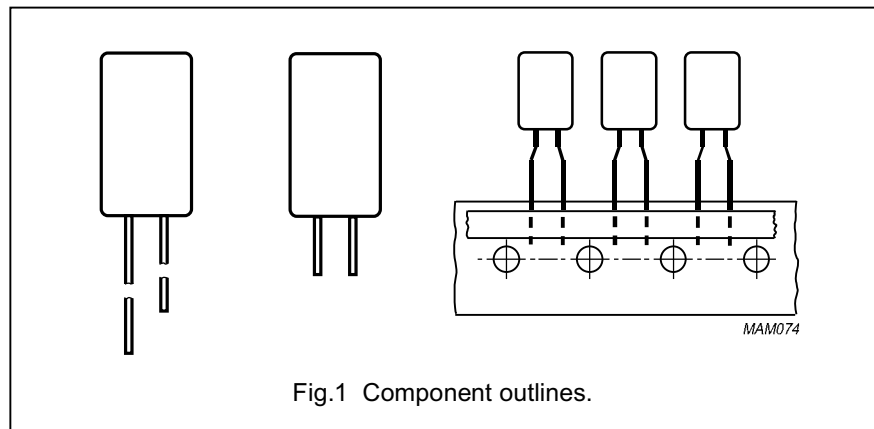


Non-solid Al - electrolytic capacitors Radial Long Life

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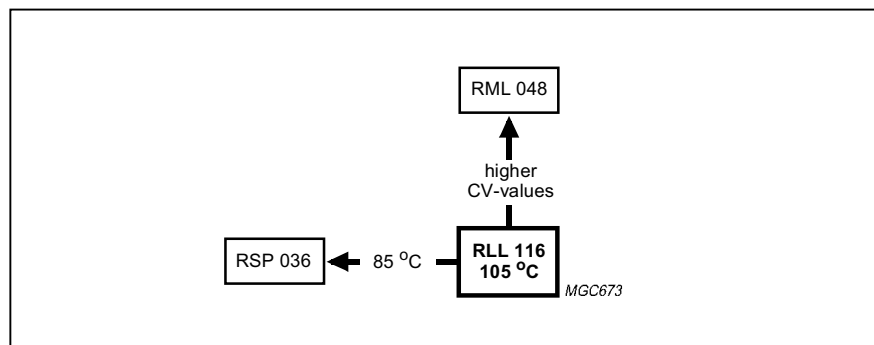
FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Long useful life: 2000 hours at 105 °C, high reliability.



APPLICATIONS

- Automotive, telecommunication, industrial and EDP
- Stand-by applications in audio and video equipment
- Coupling, decoupling, timing; smoothing, filtering and buffering in DC-DC converters
- Portable and mobile equipment (small size, low mass).



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$)	5 × 11 and 8.2 × 11 mm
Rated capacitance range, C_R	0.47 to 470 μ F
Tolerance on C_R	$\pm 20\%$
Rated voltage range, U_R	6.3 to 100 V
Category temperature range	-55 to +105 °C
Endurance test at 105 °C	1500 hours
Endurance test at 85 °C	5000 hours
Useful life at 105 °C	2000 hours
Useful life at 40 °C, $1.3 \times I_R$ applied	200000 hours
Shelf life at 0 V, 105 °C	1500 hours
Based on sectional specification	IEC 384-4/CECC 30 300
Climatic category IEC 68 (DIN 40040)	55/105/56 (FMF)

Non-solid Al - electrolytic capacitors

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Selection chart for C_R , U_R , and relevant nominal case sizes ($\varnothing D \times L$ in mm)

Preferred types in **bold**.

C_R (μF)	U_R (V)								
	6.3	10	16	25	35	40	50	63	100
0.47	–	–	–	–	–	–	5 × 11	–	–
1.0	–	–	–	–	–	–	5 × 11	–	–
1.5	–	–	–	–	–	–	5 × 11	–	–
2.2	–	–	–	–	–	–	5 × 11	–	8.2 × 11
3.3	–	–	–	–	–	–	5 × 11	–	–
4.7	–	–	–	–	–	–	5 × 11	–	8.2 × 11
6.8	–	–	–	–	–	–	5 × 11	–	–
10	–	–	–	–	–	–	5 × 11	8.2 × 11	8.2 × 11
	–	–	–	–	–	–	8.2 × 11	–	–
15	–	–	–	–	–	–	5 × 11	–	–
22	–	–	–	–	–	–	5 × 11	8.2 × 11	–
	–	–	–	–	–	–	8.2 × 11	–	–
33	–	–	–	–	5 × 11	5 × 11	8.2 × 11	–	–
47	–	–	–	5 × 11	–	–	8.2 × 11	–	–
68	–	–	5 × 11	–	–	–	8.2 × 11	–	–
100	–	5 × 11	–	–	8.2 × 11	8.2 × 11	–	–	–
150	5 × 11	–	–	8.2 × 11	–	–	–	–	–
220	–	–	8.2 × 11	–	–	–	–	–	–
330	–	8.2 × 11	–	–	–	–	–	–	–
470 ⁽¹⁾	8.2 × 11	–	–	–	–	–	–	–	–

Note

- For higher CV-values see "data sheet RML 048".

Non-solid Al - electrolytic capacitors
Radial Long Life

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

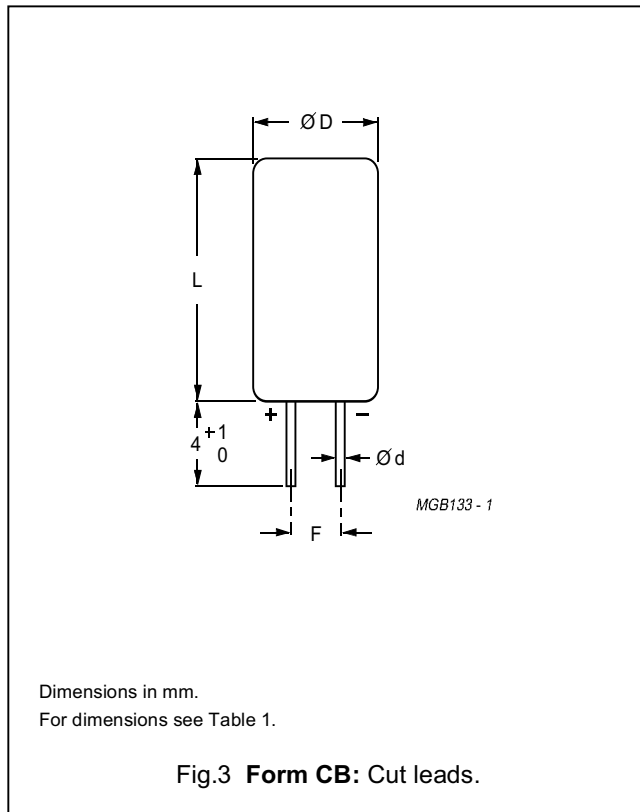
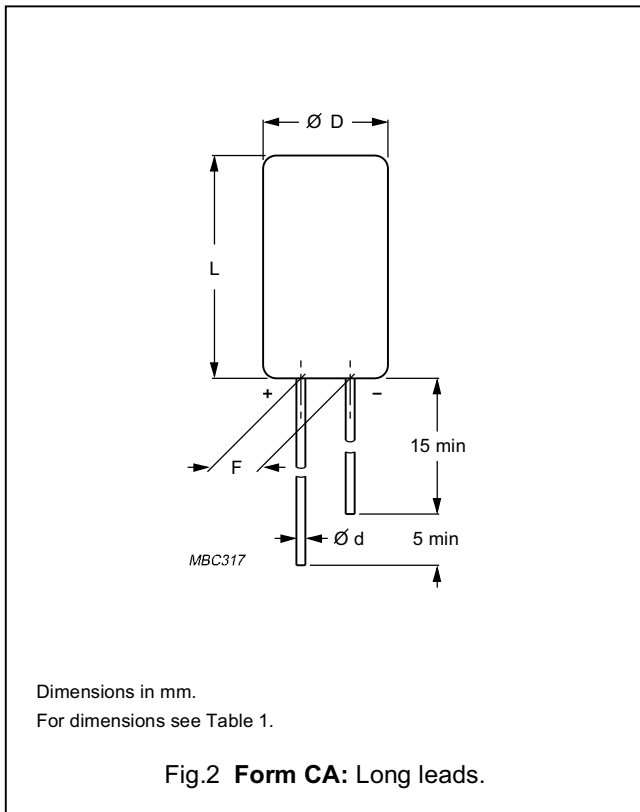


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

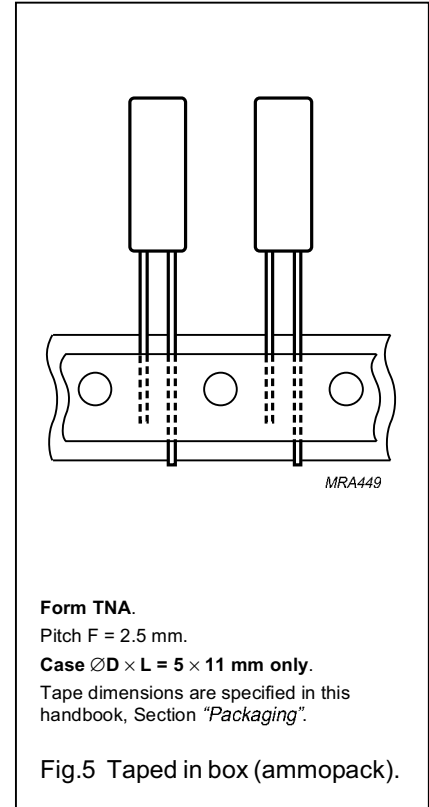
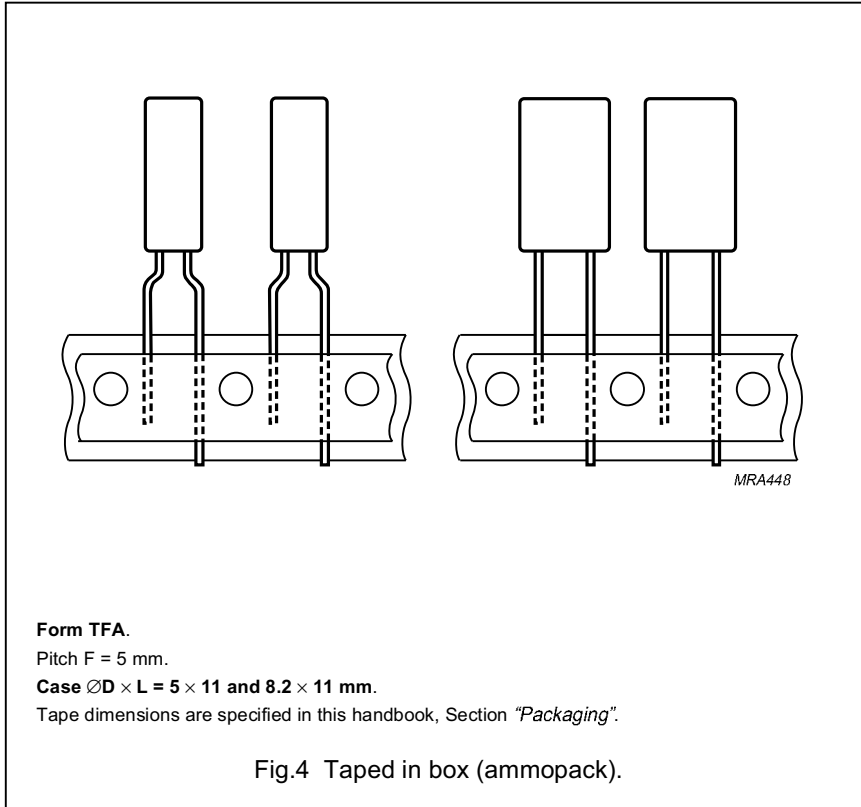
NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	Ød (mm)	ØD _{max} (mm)	L _{max} (mm)	F (mm)	MASS (g)	PACKAGING QUANTITIES		
							FORM CA, CB	FORM TR+,TN+	FORM TFA, TNA
5 × 11	11	0.5	5.5	12	2.5 ±0.5	≈0.4	1000	1000	2000
8.2 × 11	13	0.6	8.7	12	5 ±0.5	≈1.1	1000	500	1000

Non-solid Al - electrolytic capacitors

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Taped products



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 62"
- Rated voltage (in V)
- Group number (116)
- Name of manufacturer (PH)
- Date code in accordance with "IEC 62"
- Code indicating factory of origin
- Minus-sign on top to identify the negative terminal.

Non-solid Al - electrolytic capacitors

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 2 and 4 apply at $T_{amb} = 20\text{ °C}$,
 $P = 86$ to 106 kPa , $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 kHz, 105 °C
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
$\text{Tan } \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\text{tan } \delta_{max}$ and C_R)
Z_{10}	max. impedance at 10 kHz and 20 or -40 °C
Z_{100}	max. impedance at 100 kHz and 20 °C

Table 2 Electrical data; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 kHz 105 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\text{Tan } \delta$ 100 Hz	ESR 100 Hz (Ω)	Z_{10} 10 kHz 20 °C (Ω)	Z_{100} 100 kHz 20 °C (Ω)	Z_{10} 10 kHz -40 °C (Ω)
6.3	150	5×11	11	130	8.7	3.9	0.25	2.7	2	1.3	32
	470	8.2×11	13	300	21	6	0.25	0.8	0.64	0.45	10
10	100	5×11	11	130	9	4	0.2	3.2	2	1.4	32
	330	8.2×11	13	280	23	6.3	0.2	1.0	0.61	0.45	9.7
16	68	5×11	11	130	9.5	4.1	0.16	3.7	2.4	1.5	29
	220	8.2×11	13	280	24	6.5	0.16	1.2	0.73	0.5	9.1
25	47	5×11	11	120	10	4.2	0.14	4.7	2.6	1.6	32
	150	8.2×11	13	260	26	6.8	0.14	1.5	0.8	0.5	10
35	33	5×11	11	110	9.9	4.2	0.12	5.8	2.7	1.7	33
	100	8.2×11	13	240	24	6.5	0.12	1.9	0.9	0.55	11
40	33	5×11	11	110	10.9	4.3	0.12	5.8	2.7	1.7	33
	100	8.2×11	13	240	27	7	0.12	1.9	0.9	0.55	11

Non-solid Al - electrolytic capacitors

Radial Long Life

RLL 116

ORDERING INFORMATION**Ordering example**

Electrolytic capacitor RLL 116

220 μ F/16 V; \pm 20%Nominal case size: \varnothing 8.2 \times 11 mm; Form TFA

Catalogue number: 2222 116 35221.

Table 3 Ordering information; preferred types in **bold**

U _R (V)	C _R 100 Hz (μ F)	CASE CODE	CATALOGUE NUMBER 2222							
			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	150	11	116 53151	2.5	–	–	116 33151	5.0	116 73151	2.5
	470	13	116 53471	5.0	116 63471	5.0	116 33471	5.0	–	–
10	100	11	116 54101	2.5	–	–	116 34101	5.0	116 74101	2.5
	330	13	116 54331	5.0	116 64331	5.0	116 34331	5.0	–	–
16	68	11	116 55689	2.5	–	–	116 35689	5.0	116 75689	2.5
	220	13	116 55221	5.0	116 65221	5.0	116 35221	5.0	–	–
25	47	11	116 56479	2.5	–	–	116 36479	5.0	116 76479	2.5
	150	13	116 56151	5.0	116 66151	5.0	116 36151	5.0	–	–
35	33	11	116 50339	2.5	–	–	116 30339	5.0	116 70339	2.5
	100	13	116 50101	5.0	116 60101	5.0	116 30101	5.0	–	–
40	33	11	116 57339	2.5	–	–	116 37339	5.0	116 77339	2.5
	100	13	116 57101	5.0	116 67101	5.0	116 37101	5.0	–	–

Non-solid Al - electrolytic capacitors

Radial Long Life

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ELECTRICAL DATA (continued)

Table 4 Electrical data continued; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 kHz 105 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z_{10} 10 kHz 20 °C (Ω)	Z_{100} 100 kHz 20 °C (Ω)	Z_{10} 10 kHz -40 °C (Ω)
50	0.47	5 × 11	11	30	3.1	3	0.09	300	150	10	1900
	1.0	5 × 11	11	40	3.3	3.1	0.09	140	70	6	900
	1.5	5 × 11	11	50	3.5	3.1	0.09	95	47	4	600
	2.2	5 × 11	11	60	3.7	3.1	0.09	65	32	3.5	410
	3.3	5 × 11	11	65	4	3.2	0.09	43	21	3.1	270
	4.7	5 × 11	11	70	4.4	3.2	0.09	30	15	2.8	190
	6.8	5 × 11	11	75	5	3.3	0.09	21	10	2.5	130
	10	5 × 11	11	80	6	3.5	0.09	14	7	2.2	90
	10	8.2 × 11	13	160	6	3.5	0.05	8.0	3.6	1.0	40
	15	5 × 11	11	90	7.5	3.8	0.09	9.5	4.7	2.0	60
	22	5 × 11	11	110	9.6	4.1	0.09	6.5	3.2	1.9	41
	22	8.2 × 11	13	190	9.6	4.1	0.06	4.4	2.2	0.9	29
	33	8.2 × 11	13	190	13	4.7	0.09	4.3	2.1	0.77	27
	47	8.2 × 11	13	210	17	5.4	0.09	3.0	1.5	0.65	19
	68	8.2 × 11	13	240	23	6.4	0.09	2.1	1.0	0.55	13
63	10	8.2 × 11	13	160	7	3.6	0.06	9.5	3.5	1.3	45
	22	8.2 × 11	13	190	11	4.4	0.06	4.4	1.8	0.9	23
100	2.2	8.2 × 11	13	60	4.3	3.2	0.06	43	18	4	190
	4.7	8.2 × 11	13	75	5.8	3.5	0.07	24	12	3.5	170
	10	8.2 × 11	13	100	9	4	0.08	13	4.5	3	70

Additional electrical data

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.3 U_R$
Reverse voltage		$U_{rev} \leq 1 V$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 3 \mu\text{A}$
	after 5 minutes at U_R	$I_{L5} \leq 0.001 C_R \times U_R + 3 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D \times L = 5 \times 11 \text{ mm}$	typ. 13 nH
	case $\varnothing D \times L = 8.2 \times 11 \text{ mm}$	typ. 16 nH

Non-solid Al - electrolytic capacitors

Radial Long Life

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ORDERING INFORMATION (continued)**Table 5** Ordering information continued; preferred types in **bold**

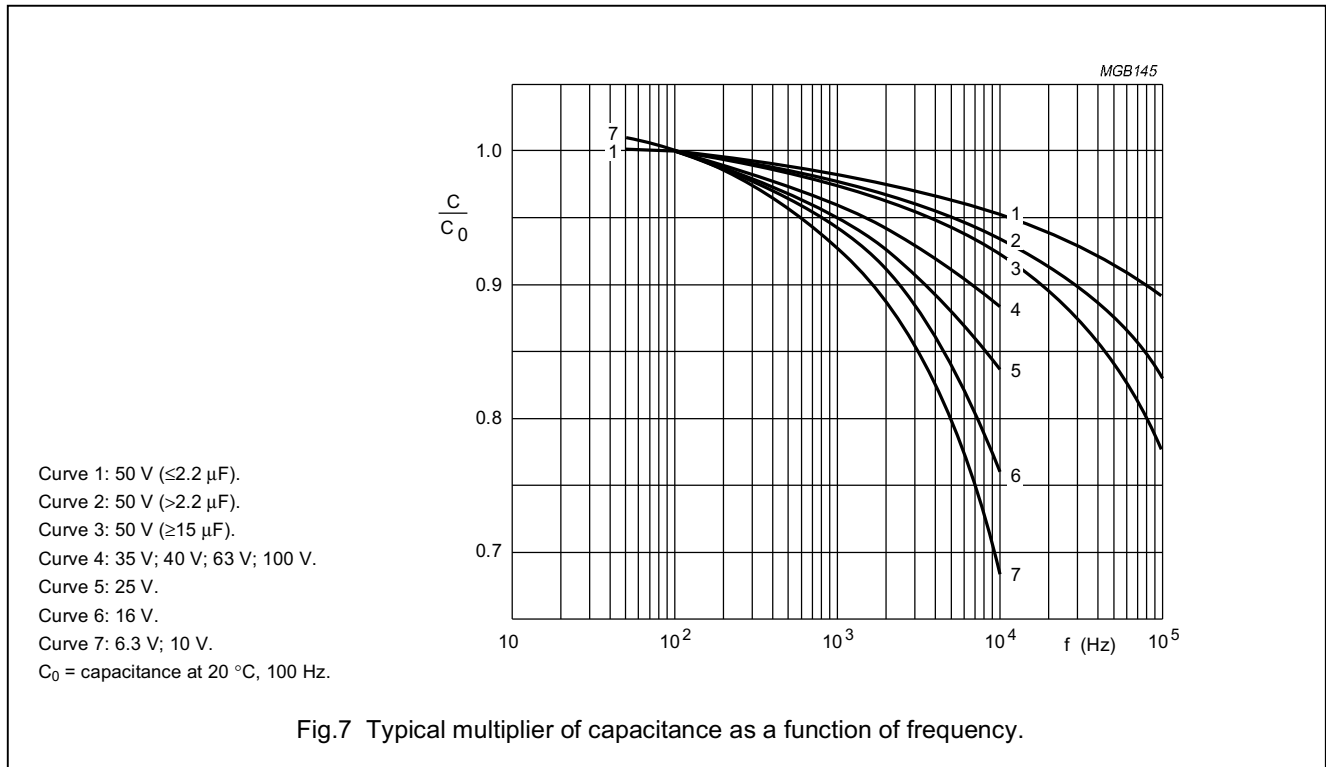
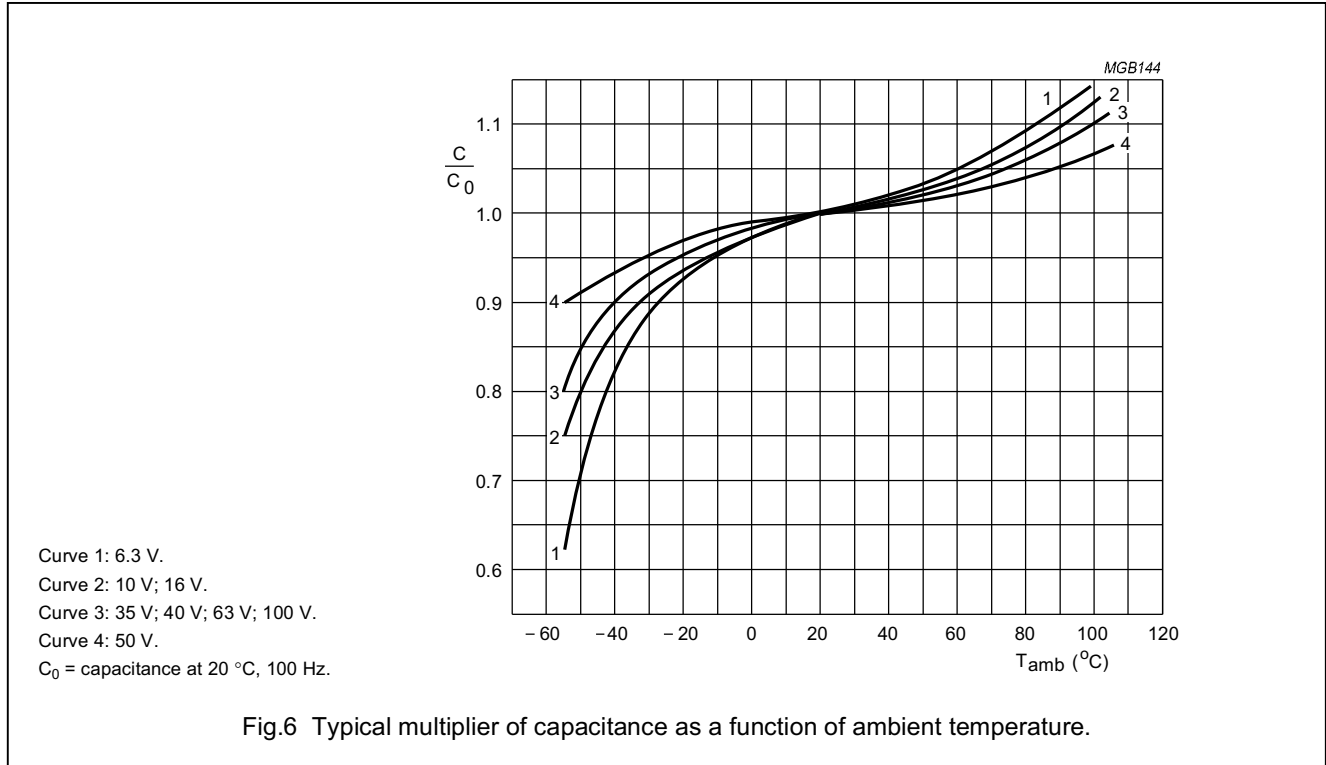
U _R (V)	C _R 100 Hz (μF)	CASE CODE	CATALOGUE NUMBER 2222							
			BULK PACKAGING				TAPED AMMOPACK			
			LONG LEADS		CUT LEADS					
			FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
50	0.47	11	116 51477	2.5	–	5.0	116 31477	5.0	116 71477	2.5
	1.0	11	116 51108	2.5	–	5.0	116 31108	5.0	116 71108	2.5
	1.5	11	116 51158	2.5	–	5.0	116 31158	5.0	116 71158	2.5
	2.2	11	116 51228	2.5	–	5.0	116 31228	5.0	116 71228	2.5
	3.3	11	116 51338	2.5	–	5.0	116 31338	5.0	116 71338	2.5
	4.7	11	116 51478	2.5	–	5.0	116 31478	5.0	116 71478	2.5
	6.8	11	116 51688	2.5	–	5.0	116 31688	5.0	116 71688	2.5
	10	11	116 51109	2.5	–	5.0	116 31109	5.0	116 71109	2.5
	10	13	116 90084	5.0	116 90085	5.0	116 90036	5.0	–	–
	15	11	116 51159	2.5	–	5.0	116 31159	5.0	116 71159	2.5
	22	11	116 51229	2.5	–	5.0	116 31229	5.0	116 71229	2.5
	22	13	116 90025	5.0	116 90086	5.0	116 90039	5.0	–	–
	33	13	116 51339	5.0	116 61339	5.0	116 31339	5.0	–	–
	47	13	116 51479	5.0	116 61479	5.0	116 31479	5.0	–	–
68	13	116 51689	5.0	116 61689	5.0	116 31689	5.0	–	–	
63	10	13	116 58109	5.0	116 68109	5.0	116 38109	5.0	–	–
	22	13	116 58229	5.0	116 68229	5.0	116 38229	5.0	–	–
100	2.2	13	116 59228	5.0	116 69228	5.0	116 39228	5.0	–	–
	4.7	13	116 59478	5.0	116 69478	5.0	116 39478	5.0	–	–
	10	13	116 59109	5.0	116 69109	5.0	116 39109	5.0	–	–

Non-solid Al - electrolytic capacitors Radial Long Life

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ELECTRICAL DATA (continued)

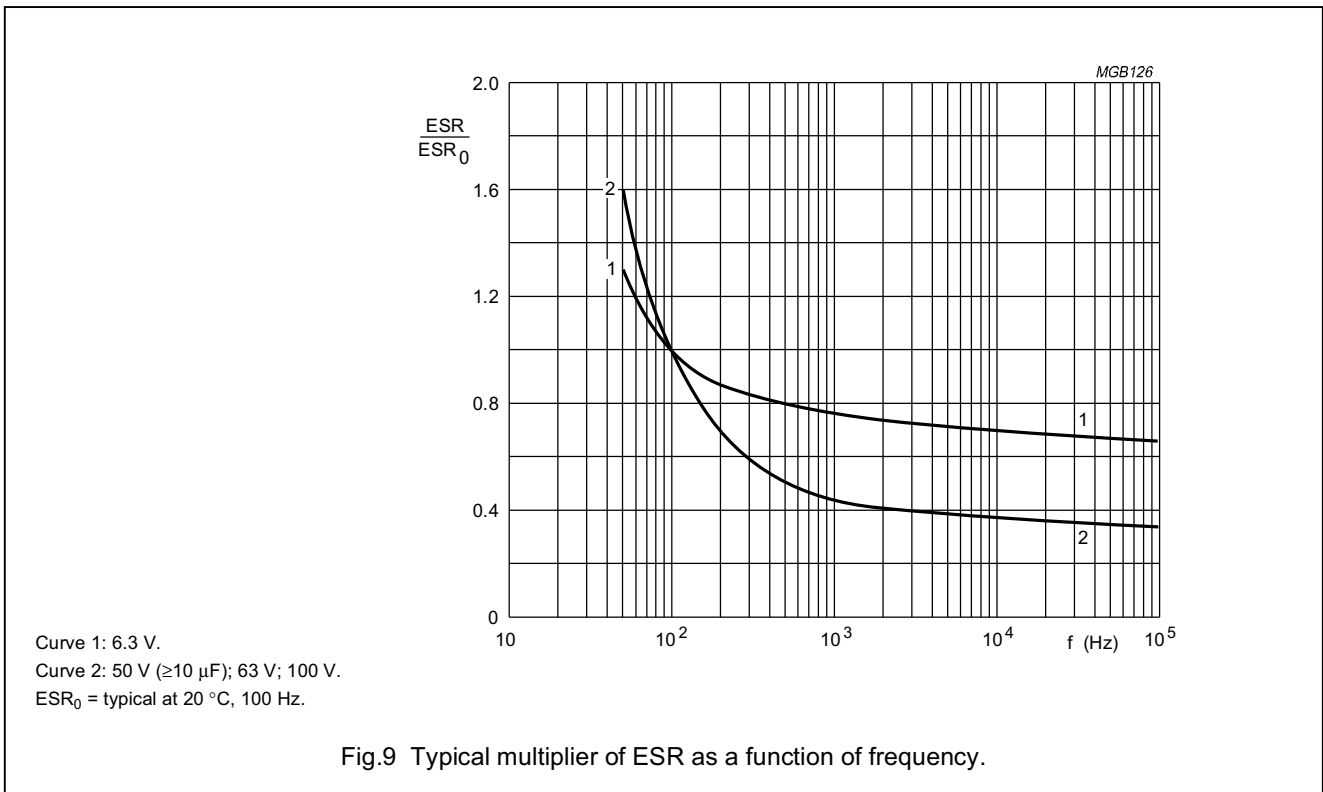
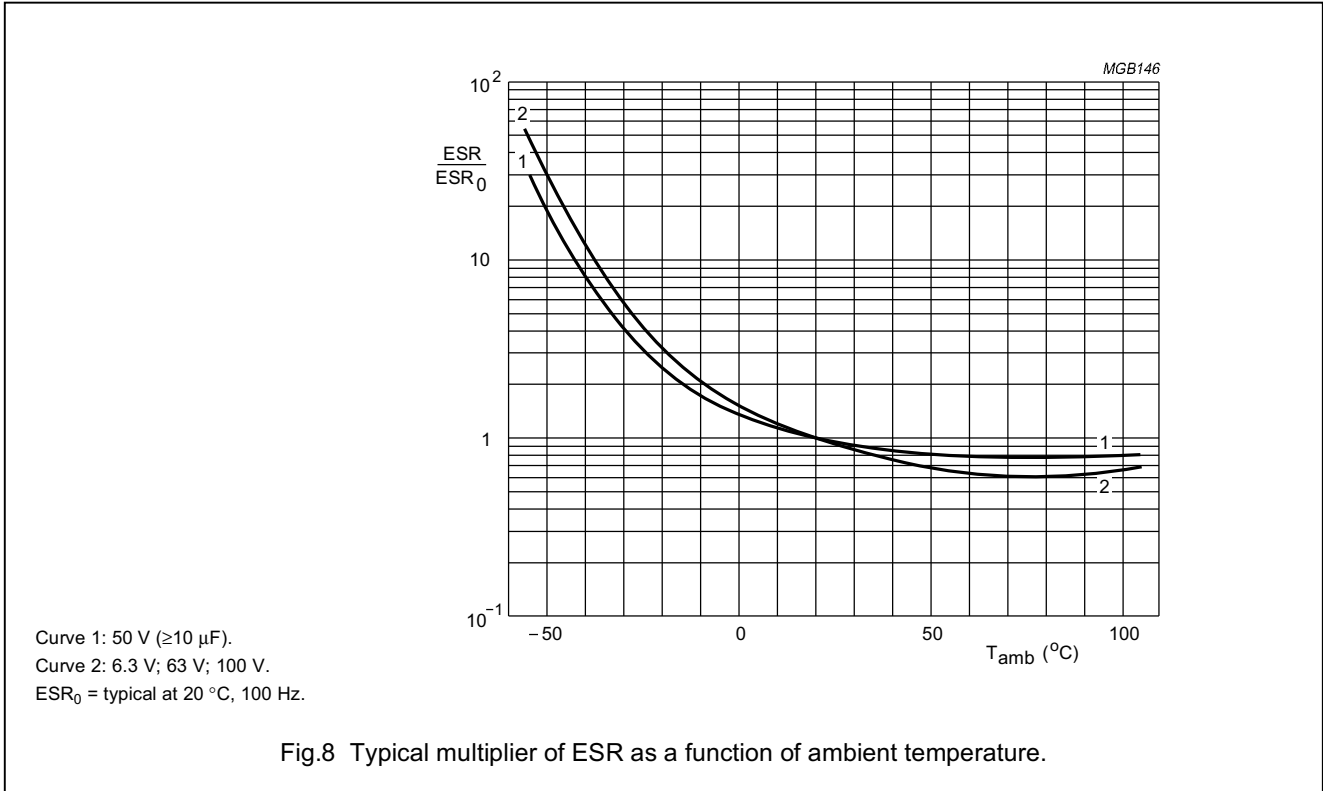
Capacitance (C)



Non-solid Al - electrolytic capacitors
Radial Long Life

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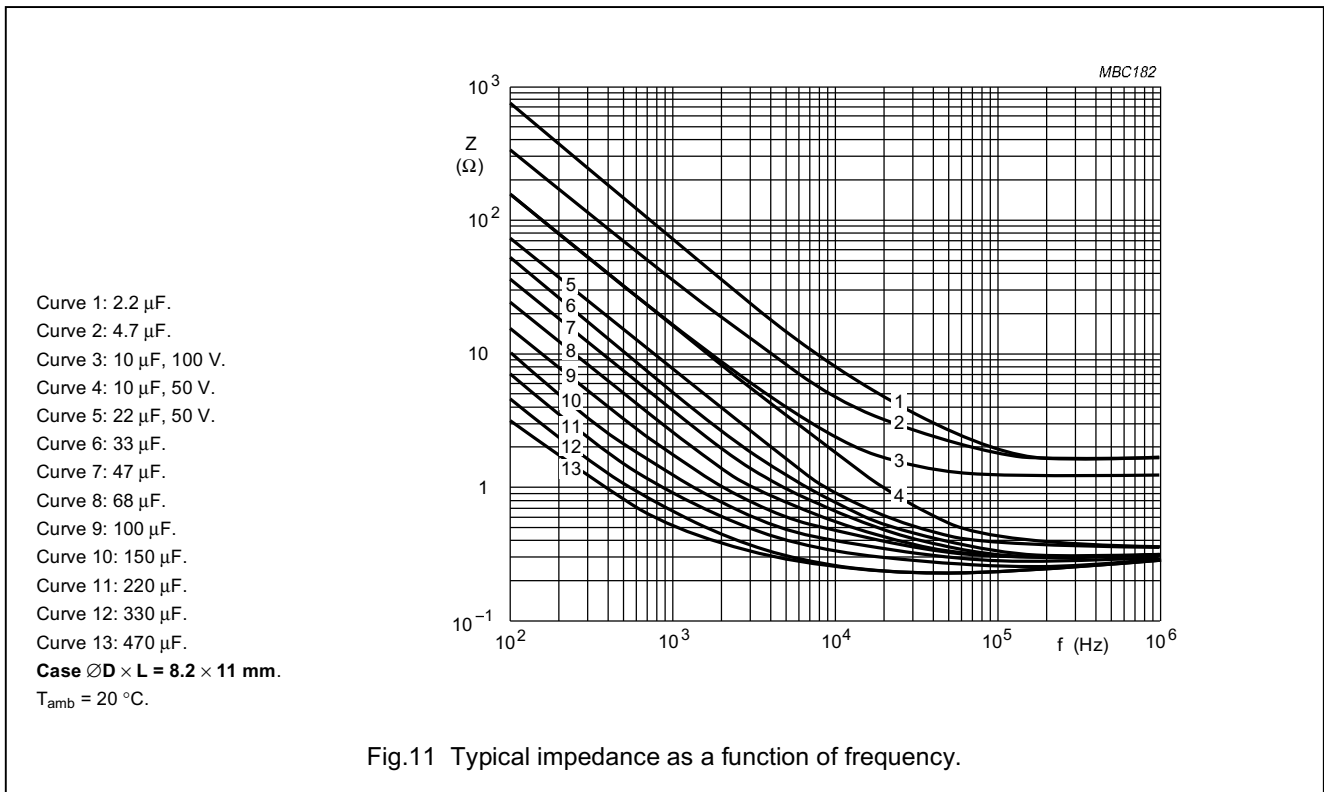
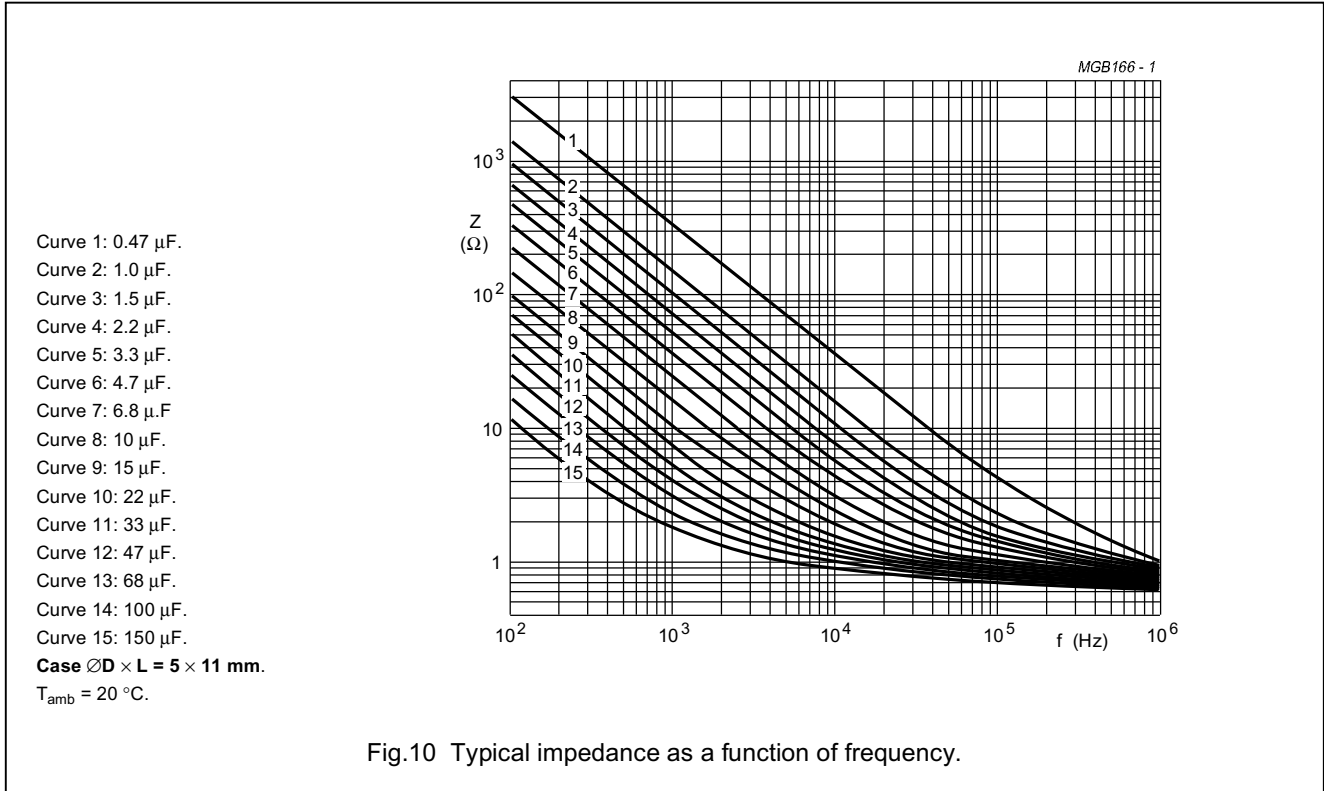
Equivalent series resistance (ESR)



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Impedance (Z)



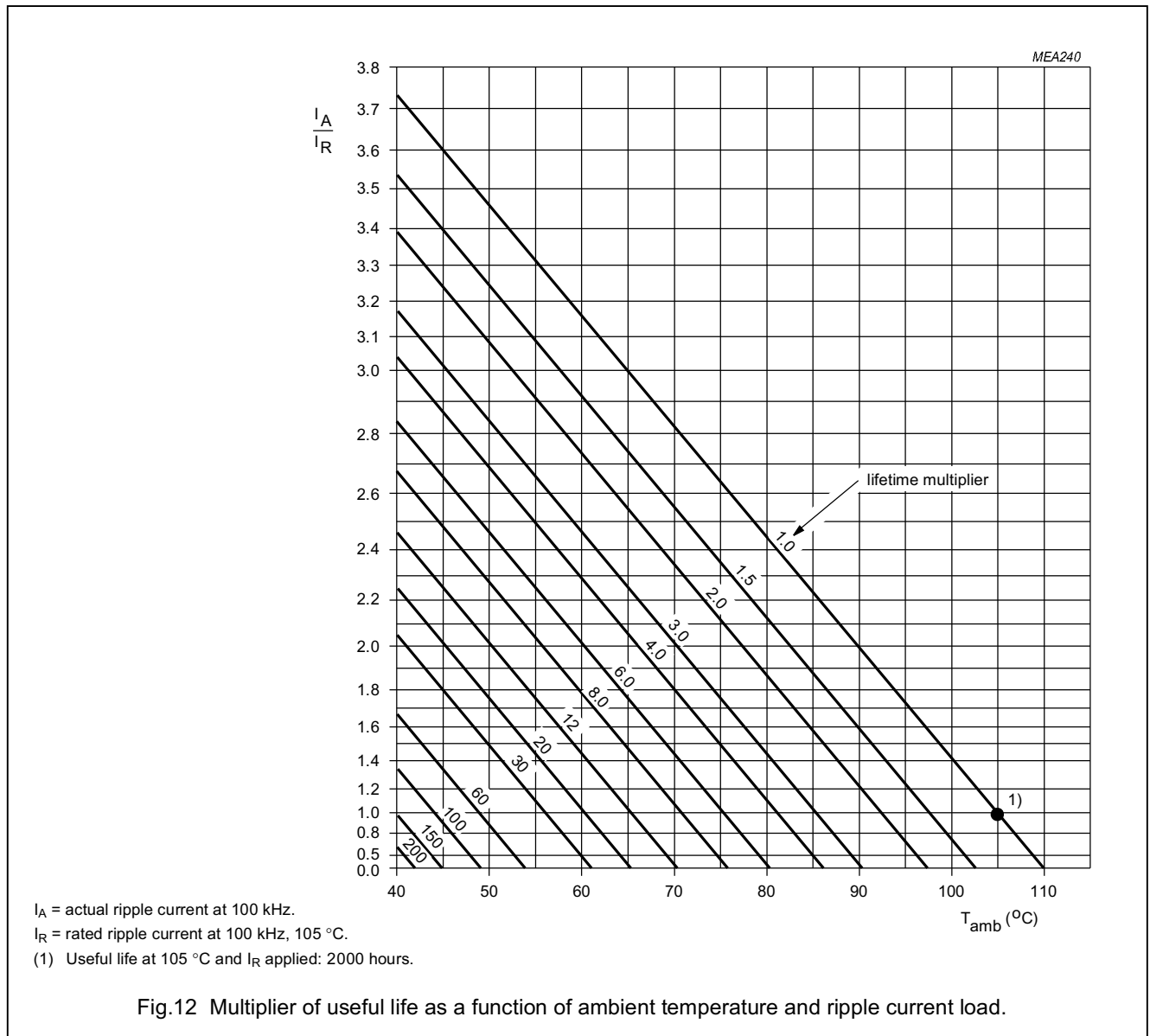
Non-solid Al - electrolytic capacitors Radial Long Life

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RIPPLE CURRENT AND USEFUL LIFE

Table 6 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = ripple current at 100 kHz

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 6.3$ to 10 V	$U_R = 16$ to 35 V	$U_R = 40$ to 100 V ($C_R \geq 10 \mu\text{F}$)
50	0.7	0.6	0.5
100	0.77	0.71	0.63
300	0.86	0.85	0.78
1000	0.92	0.93	0.88
3000	0.96	0.96	0.94
10 to 100 k	1.0	1.0	1.0



Non-solid Al - electrolytic capacitors

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SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section "Tests and Requirements".

Table 7 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; 1500 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +15/-30% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z_{10} \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; 2000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +45/-50% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z_{10} \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$; no voltage applied; 1500 hours; after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$