DATA SHEET

116 RLL
Aluminum electrolytic capacitors
Radial Long Life

Product specification
Supersedes data of January 1998
File under BCcomponents, BC01

2000 Jan 18

BC COMPONENTS

Aluminum electrolytic capacitors
Radial Long Life

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FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum 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.

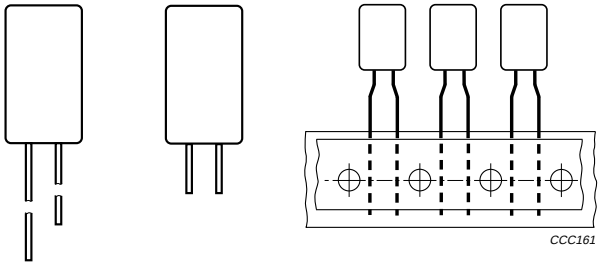
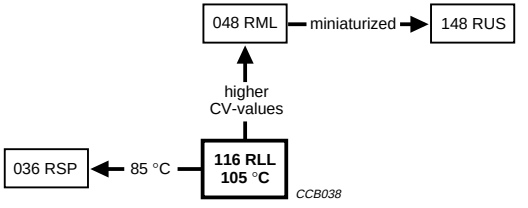


Fig.1 Component outlines.

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 ($\varnothing D_{nom} \times L_{nom}$ in mm)	5×11 and 8.2×11
Rated capacitance range, C_R	0.47 to 470 µF
Tolerance on C_R	±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 60384-4/EN130300
Climatic category IEC 60068	55/105/56

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Selection chart for C_R, U_R and relevant nominal case sizes (∅D × 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

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

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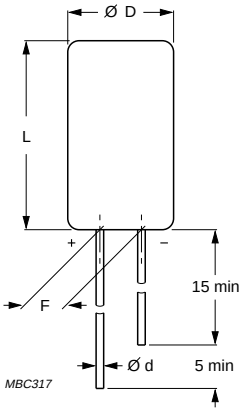
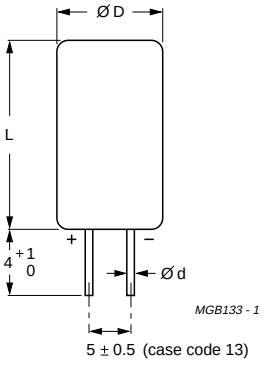
MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.
For dimensions see Table 1.

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



Dimensions in mm.
For dimensions see Table 1.

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

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

NOMINAL CASE SIZE ∅D × L (mm)	CASE CODE	∅d (mm)	$\varnothing D_{max}$ (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

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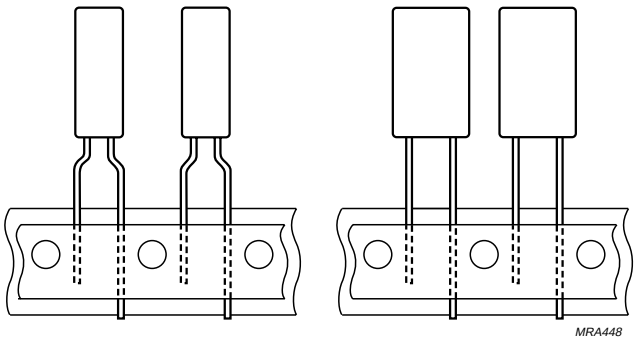
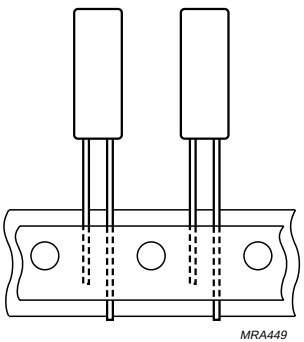
Taped products



Form TFA:
Pitch F = 5 mm.
Case ∅D × L = 5 × 11 and 8.2 × 11 mm.
Tape dimensions are specified in this handbook, section *"Packaging"*.

Fig.4 Taped in box (ammopack).



Form TNA:
Pitch F = 2.5 mm.
Case ∅D × L = 5 × 11 mm only.
Tape dimensions are specified in this handbook, section *"Packaging"*.

Fig.5 Taped in box (ammopack).

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"*
- Rated voltage (in V)
- Group number (116)
- Name of manufacturer
- Date code in accordance with *"IEC 60062"*
- Code indicating factory of origin
- Minus-sign on top to identify the negative terminal.

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ELECTRICAL DATA

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

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance ±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
Tan δ	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from tan δ_{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 ∅D × 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)
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

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ORDERING INFORMATION

Ordering example

Electrolytic capacitor 116 series

220 μF/16 V; ±20%

Nominal case size: ∅8.2 × 11 mm; Form TFA

Catalogue number: 2222 116 35221.

Table 3 Ordering information; 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)
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	–	–

ELECTRICAL DATA (continued)

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

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × 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		$U_s \leq 1.3\ U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 3$ μA
	after 5 minutes at U_R	$I_{L5} \leq 0.001 C_R \times U_R + 3$ μA
Inductance		
Equivalent series inductance (ESL)	case ∅D × L = 5 × 11 mm	typ. 13 nH
	case ∅D × L = 8.2 × 11 mm	typ. 16 nH

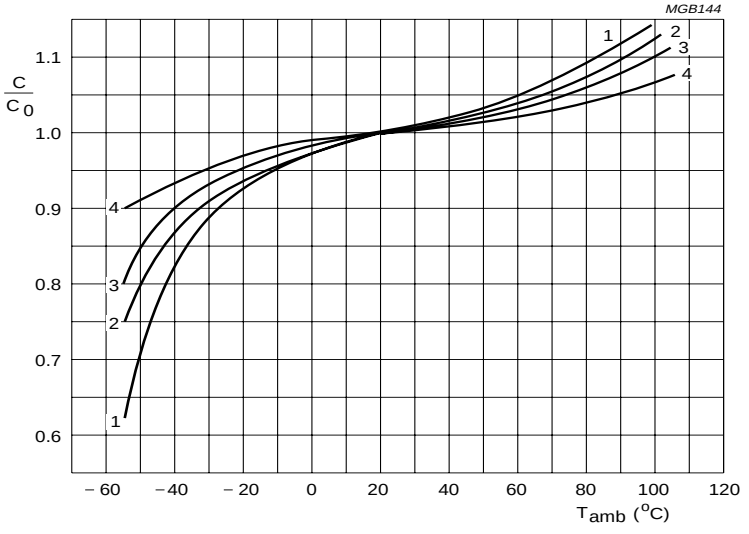
ORDERING INFORMATION (continued)

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	–	–

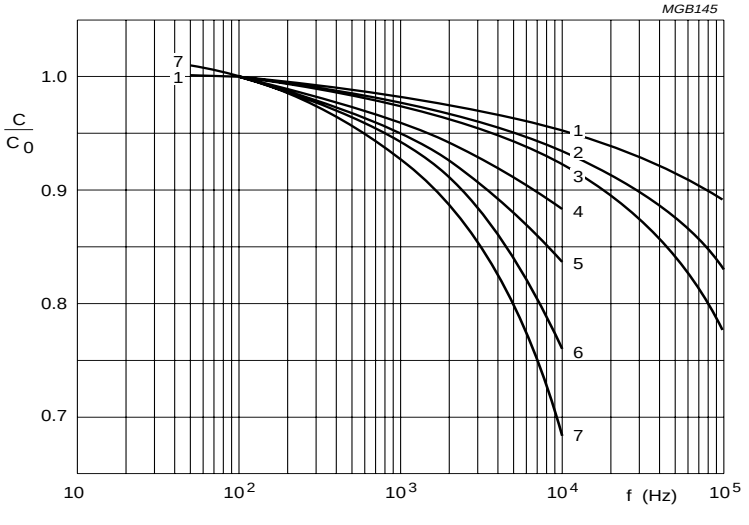
ELECTRICAL DATA (continued)

Capacitance (C)



Curve 1: 6.3 V.
Curve 2: 10 V; 16 V.
Curve 3: 35 V; 40 V; 63 V; 100 V.
Curve 4: 50 V.
C_0 = capacitance at 20 °C, 100 Hz.

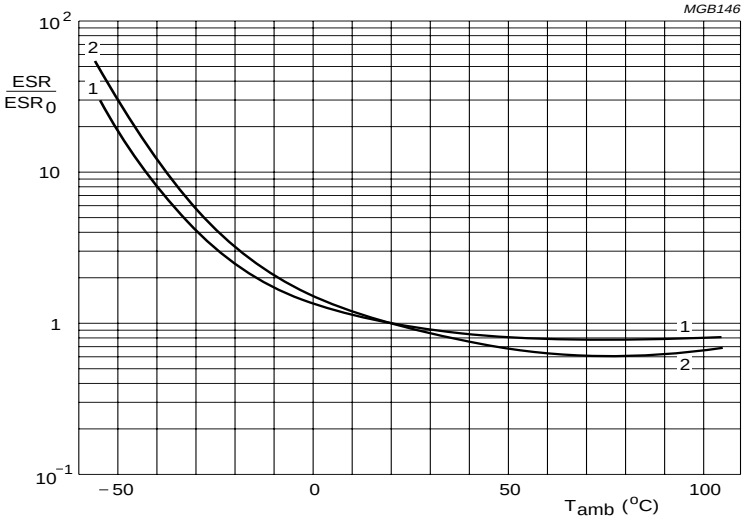
Fig.6 Typical multiplier of capacitance as a function of ambient temperature.



Curve 1: 50 V (≤2.2 µF).
Curve 2: 50 V (>2.2 µF).
Curve 3: 50 V (≥15 µF).
Curve 4: 35 V; 40 V; 63 V; 100 V.
Curve 5: 25 V.
Curve 6: 16 V.
Curve 7: 6.3 V; 10 V.
C_0 = capacitance at 20 °C, 100 Hz.

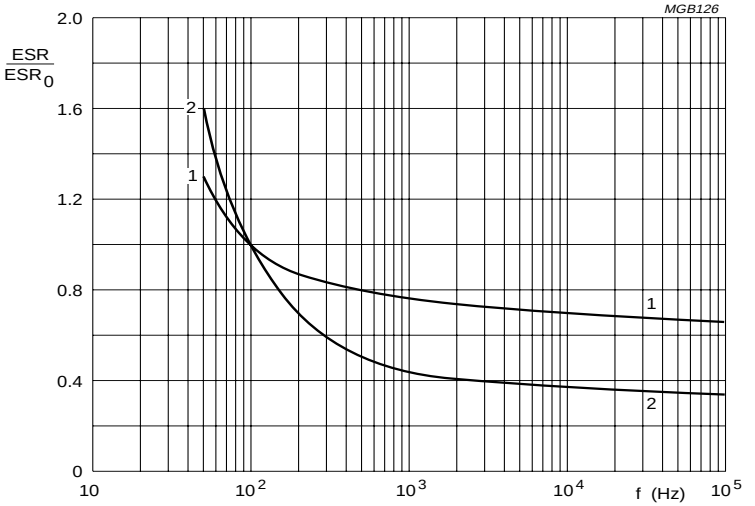
Fig.7 Typical multiplier of capacitance as a function of frequency.

Equivalent series resistance (ESR)



Curve 1: 50 V (≥10 μF).
Curve 2: 6.3 V; 63 V; 100 V.
ESR_0 = typical at 20 °C, 100 Hz.

Fig.8 Typical multiplier of ESR as a function of ambient temperature.



Curve 1: 6.3 V.
Curve 2: 50 V (≥10 μF); 63 V; 100 V.
ESR_0 = typical at 20 °C, 100 Hz.

Fig.9 Typical multiplier of ESR as a function of frequency.

Impedance (Z)

Curve 1: 0.47 µF.
Curve 2: 1.0 µF.
Curve 3: 1.5 µF.
Curve 4: 2.2 µF.
Curve 5: 3.3 µF.
Curve 6: 4.7 µF.
Curve 7: 6.8 µ.F
Curve 8: 10 µF.
Curve 9: 15 µF.
Curve 10: 22 µF.
Curve 11: 33 µF.
Curve 12: 47 µF.
Curve 13: 68 µF.
Curve 14: 100 µF.
Curve 15: 150 µF.
Case ∅D × L = 5 × 11 mm.
T_{amb} = 20 °C.

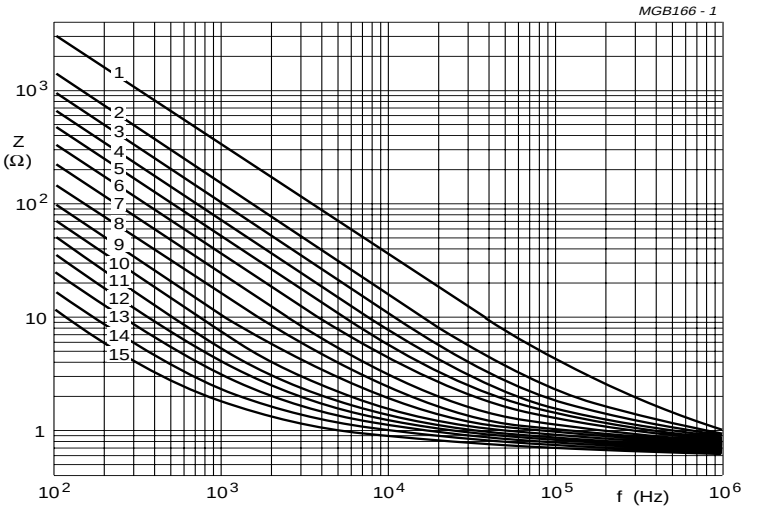


Fig.10 Typical impedance as a function of frequency.

Curve 1: 2.2 µF.
Curve 2: 4.7 µF.
Curve 3: 10 µF, 100 V.
Curve 4: 10 µF, 50 V.
Curve 5: 22 µF, 50 V.
Curve 6: 33 µF.
Curve 7: 47 µF.
Curve 8: 68 µF.
Curve 9: 100 µF.
Curve 10: 150 µF.
Curve 11: 220 µF.
Curve 12: 330 µF.
Curve 13: 470 µF.
Case ∅D × L = 8.2 × 11 mm.
T_{amb} = 20 °C.

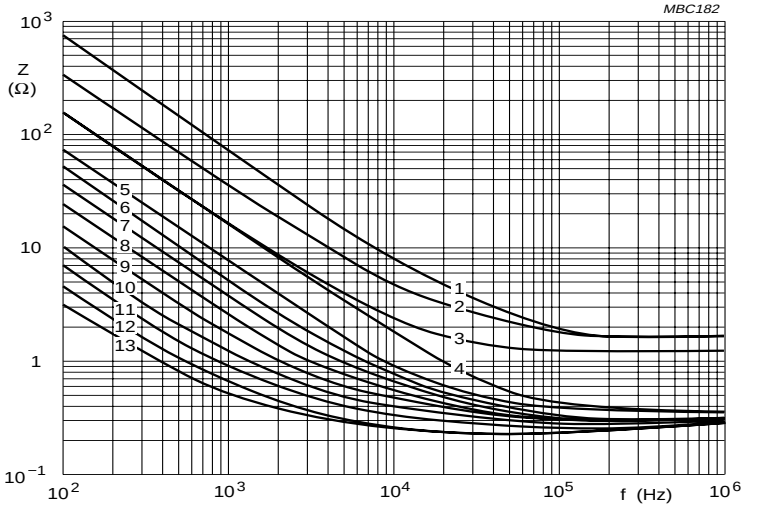
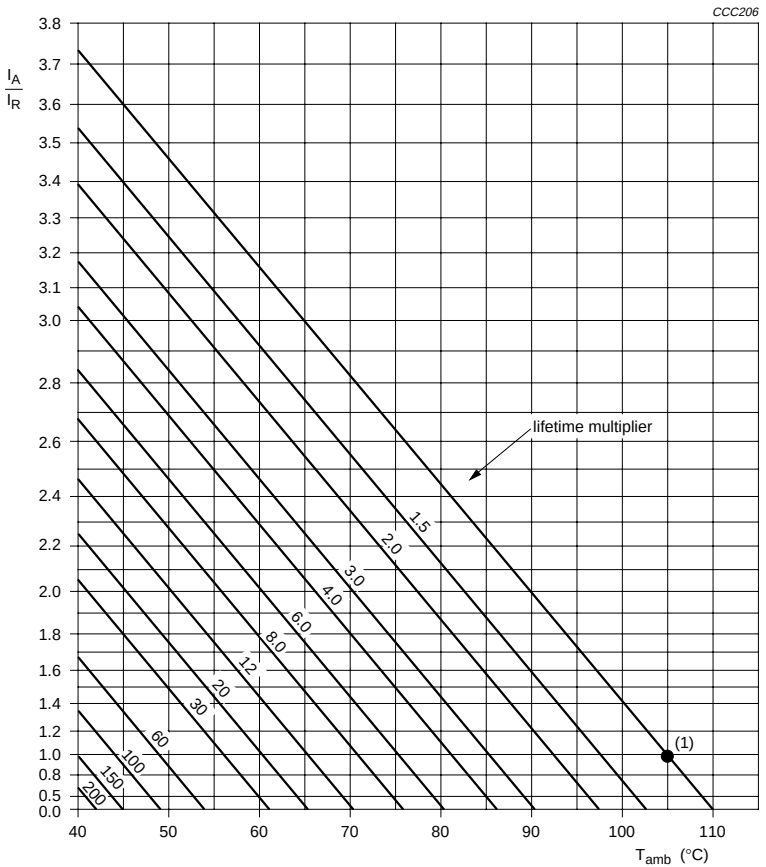


Fig.11 Typical impedance as a function of frequency.

RIPPLE CURRENT AND USEFUL LIFE

Table 6 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 ($C_R \geq 10$ μF)
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



I_A = actual ripple current at 100 kHz.

I_R = rated ripple current at 100 kHz, 105 °C.

(1) Useful life at 105 °C and I_R applied: 2000 hours.

Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load.

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 60384-4/ EN130300 subclause 4.13	T_{amb} = 105 °C; U_R applied; 1500 hours	$U_R \leq 6.3$ V; $\Delta C/C$: +15/–30% $U_R > 6.3$ V; $\Delta C/C$: ±15% tan $\delta \leq 1.3 \times$ spec. limit $Z_{10} \leq 2 \times$ spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; 2000 hours	$U_R \leq 6.3$ V; $\Delta C/C$: +45/–50% $U_R > 6.3$ V; $\Delta C/C$: ±45% tan $\delta \leq 3 \times$ spec. limit $Z_{10} \leq 3 \times$ spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 105 °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 δ, Z: for requirements see 'Endurance test' above $I_{L5} \leq 2 \times$ spec. limit