DATA SHEET

021 ASM
Aluminum electrolytic capacitors
Axial Standard Miniature

Product specification
Supersedes data of 12th June 2002
File under BCcomponents, BC01

2003 Feb 25

BC COMPONENTS

Aluminum electrolytic capacitors
Axial Standard Miniature

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FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not insulated
- Charge and discharge proof
- Taped versions up to case ∅15 × 30 mm available for automatic insertion
- Miniaturized, high CV-product per unit volume.

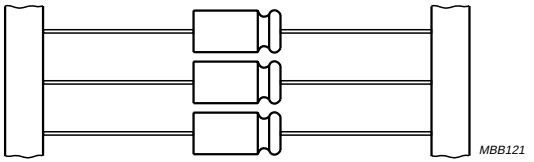
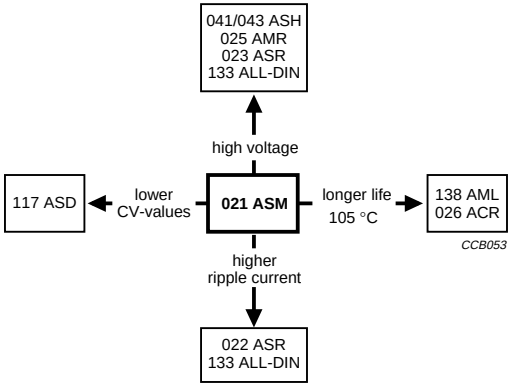


Fig.1 Component outlines.

APPLICATIONS

- General purpose, industrial, automotive, audio-video
- Coupling, decoupling, smoothing, filtering, buffering
- Portable and mobile equipment (small size, low mass)
- Low mounting height boards, vibration and shock resistant.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	4.5 × 10 to 10 × 25	10 × 30 to 21 × 38
Rated capacitance range, C_R	0.47 to 15000 µF	
Tolerance on C_R	±20%	
Rated voltage range, U_R	6.3 to 100 V	
Category temperature range	−40 to +85 °C	
Endurance test at 85 °C:		
U_R = 6.3 to 25 V	1000 hours	5000 hours
U_R = 40 to 100 V	2000 hours	5000 hours
Endurance test at 105 °C	–	1500 hours
Useful life at 85 °C	2500 hours	8000 hours
Useful life at 40 °C, 1.4 × I_R applied	70000 hours	200000 hours
Shelf life at 0 V, 85 °C	500 hours	500 hours
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	40/085/56	

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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**	**40**	**63**	**100**
0.47	–	–	–	–	–	4.5 × 10	–
1	–	–	–	–	–	**4.5 × 10**	4.5 × 10
2.2	–	–	–	–	–	**4.5 × 10**	4.5 × 10
3.3	–	–	–	–	–	4.5 × 10	–
4.7	–	–	–	–	–	**4.5 × 10**	4.5 × 10
10	–	–	–	–	–	**4.5 × 10**	6 × 10
15	–	–	–	–	–	4.5 × 10	8 × 11
	–	–	–	–	–	–	6.5 × 18
22	–	–	–	–	**4.5 × 10**	**6 × 10**	8 × 11
	–	–	–	–	–	–	6.5 × 18
33	–	–	–	–	–	6 × 10	6.5 × 18
47	–	–	–	**4.5 × 10**	**6 × 10**	8 × 11	8 × 18
	–	–	–	–	–	**6.5 × 18**	–
68	–	–	4.5 × 10	–	–	8 × 11	10 × 18
	–	–	–	–	–	6.5 × 18	–
100	–	**4.5 × 10**	–	**6 × 10**	8 × 11	**8 × 18**	10 × 25
	–	–	–	–	**6.5 × 18**	–	**10 × 30**
150	–	–	6 × 10	8 × 11	8 × 18	10 × 18	12.5 × 30
	–	–	–	6.5 × 18	–	–	–
220	–	**6 × 10**	8 × 11	**6.5 × 18**	**10 × 18**	10 × 25	**12.5 × 30**
	–	–	–	–	–	**10 × 30**	–
330	–	8 × 11	6.5 × 18	8 × 18	10 × 25	12.5 × 30	15 × 30
470	**8 × 11**	**6.5 × 18**	8 × 18	**10 × 18**	10 × 25	**12.5 × 30**	**18 × 30**
	–	–	–	–	**10 × 30**	–	–
680	–	8 × 18	10 × 18	10 × 25	12.5 × 30	15 × 30	18 × 38
	–	–	–	10 × 30	–	–	–
1000	8 × 18	**10 × 18**	**10 × 25**	**12.5 × 30**	**12.5 × 30**	**18 × 30**	**21 × 38**
	–	–	**10 × 30**	–	–	–	–
1500	–	10 × 25	12.5 × 30	12.5 × 30	15 × 30	18 × 38	–
	–	10 × 30	–	–	–	–	–
2200	10 × 25	**12.5 × 30**	**12.5 × 30**	**15 × 30**	**18 × 30**	**21 × 38**	–
3300	–	12.5 × 30	15 × 30	18 × 30	18 × 38	–	–
4700	–	**15 × 30**	**18 × 30**	**18 × 38**	**21 × 38**	–	–
6800	–	18 × 30	18 × 38	21 × 38	–	–	–
10000	–	**18 × 38**	**21 × 38**	–	–	–	–
15000	–	21 × 38	–	–	–	–	–

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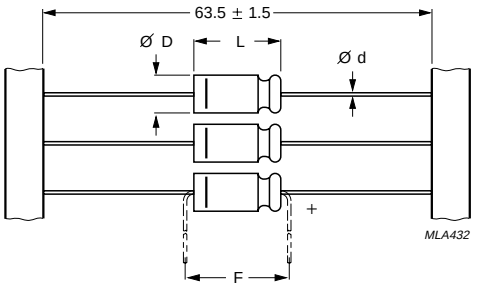
MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.

Form BR: Taped on reel.

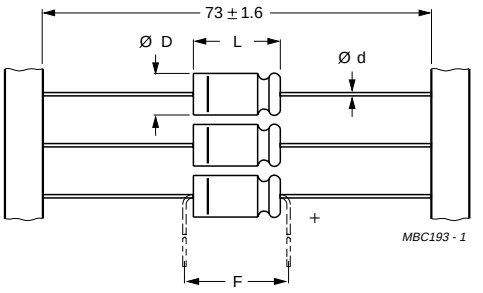
Form BA: Taped in box (ammopack).

Case ∅D × L = 4.5 × 10 to 8 × 11 mm.

For dimensions see Table 1.

Tape dimensions are specified in data handbook BC01, section *"Packaging"*.

Fig.2 Dimensional outline; Forms BA and BR.



Dimensions in mm.

Form BR: Taped on reel,
case ∅D × L = 6.5 × 18 to 15 × 30 mm.

Form BA: Taped in box (ammopack),
case ∅D × L = 6.5 × 18 to 10 × 25 mm.

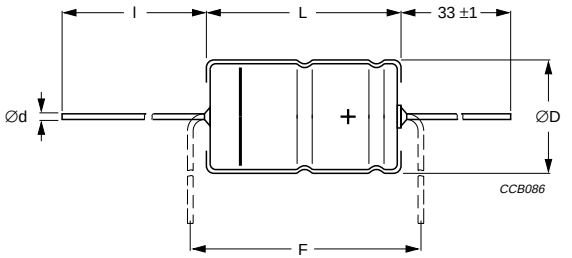
For dimensions see Table 1.

Tape dimensions are specified in data handbook BC01, section *"Packaging"*.

Fig.3 Dimensional outline; Forms BA and BR.

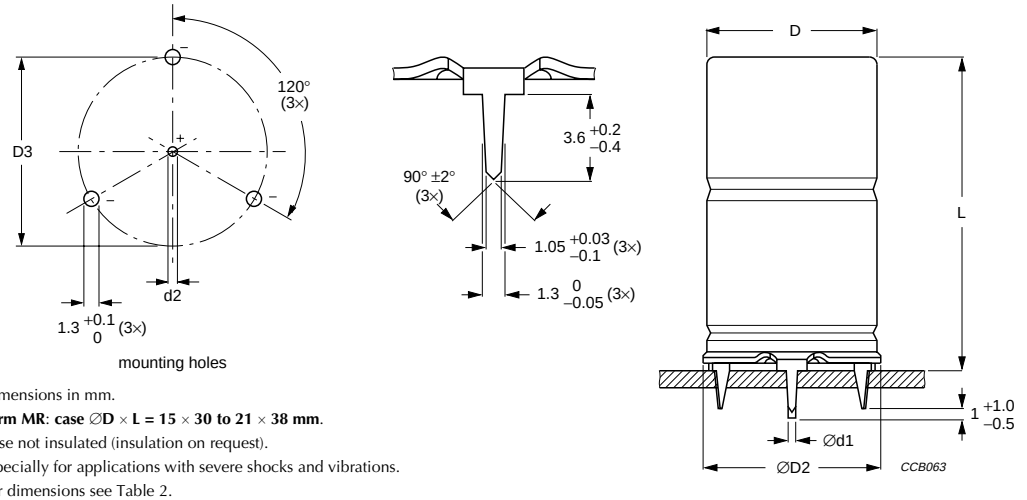
Table 1 Axial; physical dimensions, mass and packaging quantities; see Figs 2, 3 and 4

NOMINAL CASE SIZE ∅D × L (mm)	CASE CODE	AXIAL: FORM AA, BA, and BR					MASS (g)	PACKAGING QUANTITIES		
		∅d	l	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F_{min} (mm)		FORM AA	FORM BA	FORM BR
4.5 × 10	2	0.6	–	5.0	10.5	15	≈0.50	–	1000	3000
6 × 10	3	0.6	–	6.3	10.5	15	≈0.70	–	1000	1000
8 × 11	5a	0.6	–	8.5	11.5	15	≈1.1	–	500	500
6.5 × 18	4	0.8	–	6.9	18.5	25	≈1.3	–	1000	1000
8 × 18	5	0.8	–	8.5	18.5	25	≈1.7	–	500	500
10 × 18	6	0.8	–	10.5	18.5	25	≈2.5	–	500	500
10 × 25	7	0.8	–	10.5	25.0	30	≈3.3	–	500	500
10 × 30	00	0.8	55 ±1	10.5	30.5	35	≈4.8	340	–	500
12.5 × 30	01	0.8	55 ±1	13.0	30.5	35	≈7.4	260	–	400
15 × 30	02	0.8	55 ±1	15.5	30.5	35	≈11.7	300	–	250
18 × 30	03	0.8	55 ±1	18.5	30.5	35	≈12.9	200	–	–
18 × 38	04	0.8	34 ±1	18.5	39.0	44	≈19.0	125	–	–
21 × 38	05	0.8	34 ±1	21.5	39.0	44	≈24.0	100	–	–



Dimensions in mm.
Form AA: Axial in box.
Case ∅D × L = 10 × 30 to 21 × 38 mm.
For dimensions see Table 1.

Fig.4 Dimensional outline; Form AA.



Dimensions in mm.
Form MR: **case ∅D × L = 15 × 30 to 21 × 38 mm**.
Case not insulated (insulation on request).
Especially for applications with severe shocks and vibrations.
For dimensions see Table 2.

Fig.5 Mounting hole diagram and outline; Form MR; with mounting ring and pins.

Table 2 Mounting ring; mass and packaging quantities; see Fig.5

NOMINAL CASE SIZE ∅D × L (mm)	CASE CODE	MOUNTING RING: FORM MR					MASS (g)	PACKAGING QUANTITIES
		∅d1 (mm)	∅d2 (mm)	$\varnothing D2_{max}$ (mm)	D3 (mm)	L_{max} (mm)		
15 × 30	02	0.8	1.0 +0.4	17.5	16.5 ±0.2	33	≈11.7	200
18 × 30	03	0.8	1.0 +0.4	19.5	18.5 ±0.2	33	≈12.9	240
18 × 38	04	0.8	1.0 +0.4	19.5	18.5 ±0.2	42	≈19.0	100
21 × 38	05	0.8	1.0 +0.4	22.5	21.5 ±0.2	42	≈24.0	100

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ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 3 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 Hz, 85 °C
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	max. impedance at 10 kHz

Ordering example

Electrolytic capacitor 021 series

1000 μF/16 V; ±20%

Nominal case size: ∅10 × 25 mm; Form BA

Catalogue number: 2222 021 90518.

Table 3 Electrical data and ordering Information; preferred types in **bold**

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × L (mm)	I_R 100 Hz 85 °C (mA)	I_{L5} 5 min (μA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222 021			
								IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
6.3	**470**	**8 × 11**	260	10	0.25	0.85	0.64	–	23471	**33471**	–
	1000	8 × 18	440	17	0.25	0.4	0.5	–	23102	33102	–
	2200	10 × 25	710	32	0.29	0.21	0.16	–	90588	90589	–
10	**100**	**4.5 × 10**	100	6	0.20	3.2	2.0	–	24101	**34101**	–
	220	**6 × 10**	160	8.4	0.20	1.5	0.91	–	24221	**34221**	–
	330	8 × 11	230	11	0.20	1.0	0.61	–	24331	34331	–
	470	**6.5 × 18**	310	13	0.20	0.68	0.43	–	24471	**34471**	–
	680	8 × 18	400	18	0.20	0.47	0.29	–	24681	34681	–
	1000	**10 × 18**	550	24	0.20	0.32	0.20	–	24102	**34102**	–
	1500	10 × 25	690	34	0.23	0.25	0.18	–	90524	90525	–
	1500	10 × 30	740	34	0.23	0.245	0.18	14152	24152	–	–
	2200	**12.5 × 30**	980	48	0.25	0.177	0.095	**14222**	**24222**	–	–
	3300	12.5 × 30	1090	70	0.27	0.128	0.095	14332	24332	–	–
	4700	**15 × 30**	1320	98	0.29	0.100	0.07	**14472**	**24472**	–	**44472**
	6800	18 × 30	1590	140	0.34	0.079	0.065	14682	–	–	44682
	10000	**18 × 38**	2090	204	0.40	0.064	0.04	**14103**	–	–	**44103**
	15000	21 × 38	2250	304	0.50	0.054	0.035	14153	–	–	44153
16	68	4.5 × 10	90	6.2	0.16	3.8	2.4	–	25689	35689	–
	150	6 × 10	140	8.8	0.16	1.7	1.1	–	25151	35151	–
	220	8 × 11	210	11	0.16	1.2	0.73	–	25221	35221	–
	330	6.5 × 18	290	15	0.16	0.77	0.48	–	25331	35331	–
	470	8 × 18	380	19	0.16	0.55	0.34	–	25471	35471	–
	680	10 × 18	500	26	0.16	0.38	0.24	–	25681	35681	–
	1000	**10 × 25**	660	36	0.16	0.26	0.18	–	90517	**90518**	–
	1000	**10 × 30**	700	36	0.16	0.260	0.175	**15102**	**25102**	–	–
	1500	12.5 × 30	950	52	0.19	0.205	0.095	15152	25152	–	–

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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × L (mm)	I_R 100 Hz 85 °C (mA)	I_{L5} 5 min (μA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222 021			
								IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
16	**2200**	**12.5 × 30**	1040	74	0.21	0.150	0.095	**15222**	**25222**	–	–
	3300	15 × 30	1290	110	0.23	0.111	0.07	15332	25332	–	45332
	4700	**18 × 30**	1560	154	0.25	0.087	0.065	**15472**	–	–	**45472**
	6800	18 × 38	2040	222	0.30	0.070	0.04	15682	–	–	45682
	10000	**21 × 38**	2170	324	0.36	0.058	0.035	**15103**	–	–	**45103**
25	**47**	**4.5 × 10**	80	6.4	0.14	4.8	2.6	–	26479	**36479**	–
	100	**6 × 10**	150	9	0.14	2.3	1.2	–	26101	**36101**	–
	150	8 × 11	190	12	0.14	1.5	0.80	–	90534	90535	–
	150	6.5 × 18	210	12	0.14	1.5	0.80	–	26151	36151	–
	220	**6.5 × 18**	250	15	0.14	1.0	0.55	–	26221	**36221**	–
	330	8 × 18	340	21	0.14	0.68	0.36	–	26331	36331	–
	470	**10 × 18**	450	28	0.14	0.48	0.26	–	26471	**36471**	–
	680	10 × 25	560	38	0.14	0.33	0.18	–	90527	90528	–
	680	10 × 30	640	38	0.14	0.323	0.175	16681	26681	–	–
	1000	**12.5 × 30**	840	54	0.14	0.220	0.095	**16102**	**26102**	–	–
	1500	12.5 × 30	950	79	0.17	0.179	0.095	16152	26152	–	–
	2200	**15 × 30**	1180	114	0.19	0.132	0.07	**16222**	**26222**	–	**46222**
	3300	18 × 30	1470	169	0.21	0.099	0.065	16332	–	–	46332
	4700	**18 × 38**	1920	239	0.23	0.079	0.04	**16472**	–	–	**46472**
	6800	21 × 38	2070	344	0.28	0.064	0.035	16682	–	–	46682
40	**22**	**4.5 × 10**	60	5.8	0.11	8.0	3.2	–	27229	**37229**	–
	47	**6 × 10**	110	7.8	0.11	3.8	1.5	–	27479	**37479**	–
	100	8 × 11	170	12	0.11	1.8	0.70	–	90537	90538	–
	100	**6.5 × 18**	190	12	0.11	1.8	0.70	–	27101	**37101**	–
	150	8 × 18	250	16	0.11	1.1	0.47	–	27151	37151	–
	220	**10 × 18**	330	22	0.11	0.8	0.32	–	27221	**37221**	–
	330	10 × 25	430	30	0.11	0.53	0.21	–	27331	37331	–
	470	10 × 25	520	42	0.11	0.37	0.18	–	90514	90515	–
	470	**10 × 30**	590	42	0.12	0.404	0.175	**17471**	**27471**	–	–
	680	12.5 × 30	800	58	0.12	0.297	0.110	17681	27681	–	–
	1000	**12.5 × 30**	900	84	0.12	0.190	0.110	**17102**	**27102**	–	–
	1500	15 × 30	1120	124	0.15	0.159	0.07	17152	27152	–	47152
	2200	**18 × 30**	1390	180	0.17	0.118	0.065	**17222**	–	–	**47222**
	3300	18 × 38	1810	268	0.19	0.090	0.04	17332	–	–	47332
	4700	21 × 38	1940	380	0.21	0.072	0.035	**17472**	–	–	**47472**
63	0.47	4.5 × 10	8	4.1	0.09	310	120	–	28477	38477	–
	1	**4.5 × 10**	12	4.1	0.09	150	55	–	28108	**38108**	–
	2.2	**4.5 × 10**	21	4.3	0.09	65	25	–	28228	**38228**	–
	3.3	4.5 × 10	25	4.4	0.09	44	17	–	28338	38338	–
	4.7	**4.5 × 10**	31	4.6	0.09	31	12	–	28478	**38478**	–

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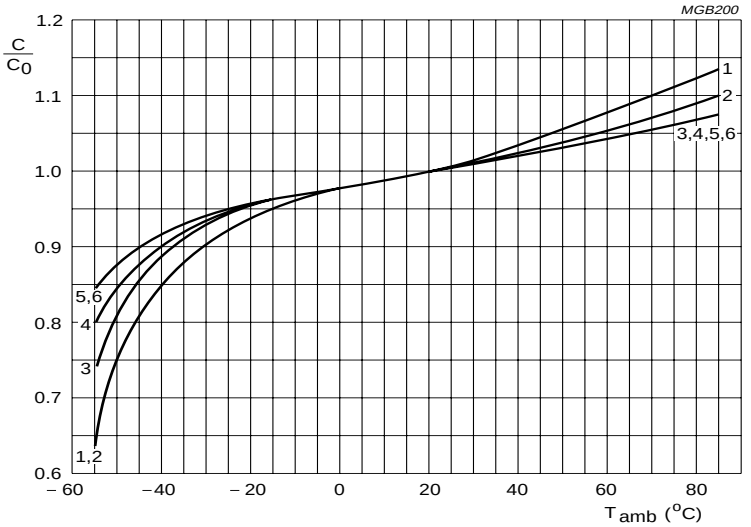
U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × L (mm)	I_R 100 Hz 85 °C (mA)	I_{L5} 5 min (μA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222 021			
								IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
63	**10**	**4.5 × 10**	50	5.3	0.08	13	5.5	–	28109	**38109**	–
	15	4.5 × 10	55	5.9	0.08	8.5	3.7	–	28159	38159	–
	22	**6 × 10**	90	6.8	0.08	5.8	2.5	–	28229	**38229**	–
	33	6 × 10	100	8.2	0.08	3.9	1.7	–	28339	38339	–
	47	8 × 11	140	10	0.08	2.7	1.2	–	90541	90542	–
	47	**6.5 × 18**	150	10	0.08	2.7	1.2	–	28479	**38479**	–
	68	8 × 11	160	13	0.08	1.9	0.81	–	90544	90545	–
	68	6.5 × 18	170	13	0.08	1.9	0.81	–	28689	38689	–
	100	**8 × 18**	250	17	0.08	1.3	0.55	–	28101	**38101**	–
	150	10 × 18	320	23	0.08	0.85	0.37	–	28151	38151	–
	220	10 × 25	430	32	0.08	0.60	0.25	–	90511	90512	–
	220	**10 × 30**	480	32	0.08	0.614	0.26	**18221**	**28221**	–	–
	330	12.5 × 30	610	46	0.08	0.409	0.19	18331	28331	–	–
	470	**12.5 × 30**	700	63	0.08	0.287	0.13	**18471**	**28471**	–	–
	680	15 × 30	890	90	0.08	0.199	0.095	18681	28681	–	48681
	1000	**18 × 30**	1170	130	0.08	0.135	0.075	**18102**	–	–	**48102**
	1500	18 × 38	1530	193	0.11	0.122	0.045	18152	–	–	48152
	2200	**21 × 38**	1780	281	0.13	0.099	0.040	**18222**	–	–	**48222**
100	1	4.5 × 10	14	4.2	0.08	130	90	–	29108	39108	–
	2.2	4.5 × 10	20	4.4	0.08	58	41	–	29228	39228	–
	4.7	4.5 × 10	30	4.9	0.08	27	19	–	29478	39478	–
	10	6 × 10	65	6	0.08	13	9	–	29109	39109	–
	15	8 × 11	77	7	0.08	8.5	6	–	90547	90548	–
	15	6.5 × 18	85	7	0.08	8.5	6	–	29159	39159	–
	22	8 × 11	95	8.4	0.08	5.8	4.1	–	90551	90552	–
	22	6.5 × 18	100	8.4	0.08	5.8	4.1	–	29229	39229	–
	33	6.5 × 18	120	10.6	0.08	3.9	2.7	–	29339	39339	–
	47	8 × 18	160	13.4	0.08	2.7	1.9	–	29479	39479	–
	68	10 × 18	220	17.6	0.08	1.9	1.3	–	29689	39689	–
	100	10 × 25	300	24	0.08	1.3	0.9	–	90531	90532	–
	100	**10 × 30**	340	24	0.07	1.150	1.0	**19101**	**29101**	–	–
	150	12.5 × 30	490	34	0.07	0.645	0.61	19151	29151	–	–
	220	**12.5 × 30**	560	48	0.08	0.610	0.56	**19221**	**29221**	–	–
	330	15 × 30	740	70	0.09	0.420	0.40	19331	29331	–	49331
	470	**18 × 30**	980	98	0.09	0.310	0.29	**19471**	–	–	**49471**
	680	18 × 38	1260	140	0.09	0.195	0.18	19681	–	–	49681
	1000	**21 × 38**	1470	204	0.10	0.160	0.15	**19102**	–	–	**49102**

Additional electrical data

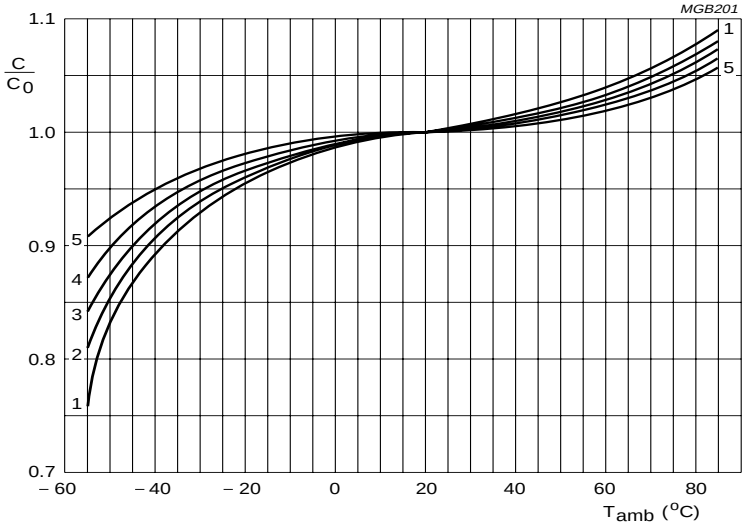
PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Voltage			
Surge voltage		$U_s \leq 1.15 \times U_R$	
Reverse voltage		$U_{rev} \leq 1$ V	
Current			
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006C_R \times U_R + 4$ μA	
	after 5 minutes at U_R:	$I_{L5} \leq 0.002C_R \times U_R + 4$ μA	
Inductance			
Equivalent series inductance (ESL)	case ∅D × L mm:		
	4.5 × 10	typ. 10 nH	–
	6 × 10	typ. 22 nH	–
	8 × 11	typ. 85 nH	–
	6.5 × 18	typ. 25 nH	–
	8 × 18	typ. 40 nH	–
	10 × 18	typ. 61 nH	–
	10 × 25	typ. 38 nH	–
	10 × 30	typ. 38 nH	–
	12.5 × 30	typ. 46 nH	–
	15 × 30	typ. 48 nH	typ. 39 nH
	18 × 30	typ. 50 nH	typ. 39 nH
	18 × 38	typ. 54 nH	typ. 39 nH
	21 × 38	typ. 59 nH	typ. 39 nH

Capacitance (C)



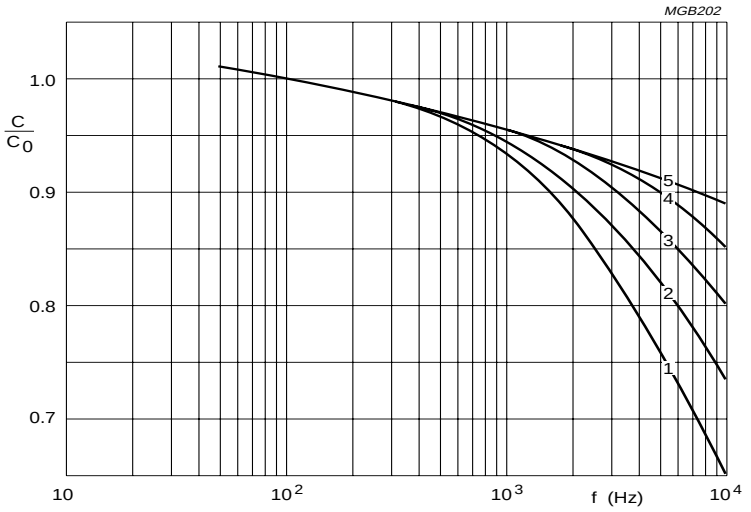
Curve 1: 10 V.
Curve 2: 16 V.
Curve 3: 25 V.
Curve 4: 40 V.
Curve 5: 63 V.
Curve 6: 100 V.
C_0 = capacitance at 20 °C, 100 Hz.
Case ∅D × L = 4 .5 × 10 to 10 × 25 mm.

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



Curve 1: 10 V.
Curve 2: 16 V.
Curve 3: 25 V.
Curve 4: 40 V.
Curve 5: 63 V.
C_0 = capacitance at 20 °C, 100 Hz.
Case ∅D × L = 10 × 30 to 21 × 38 mm.

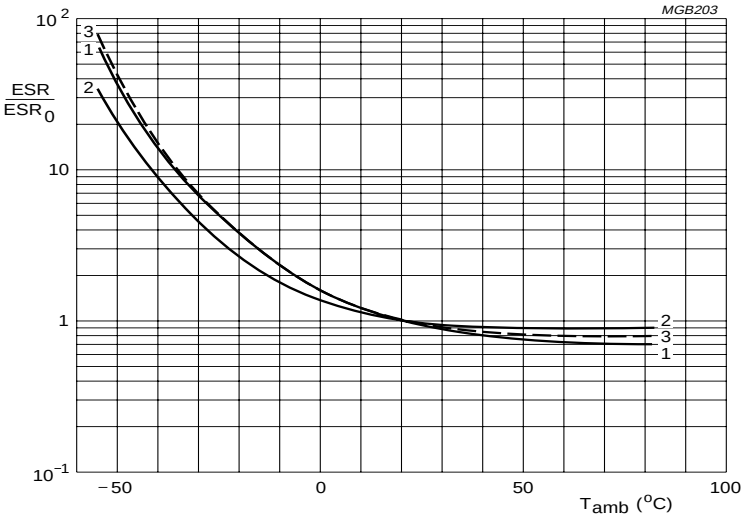
Fig.7 Typical multiplier of capacitance as a function of ambient temperature.



Curve 1: 10 V.
Curve 2: 16 V.
Curve 3: 25 V.
Curve 4: 40 V.
Curve 5: 63 V.
C_0 = capacitance at 20 °C; 100 Hz.

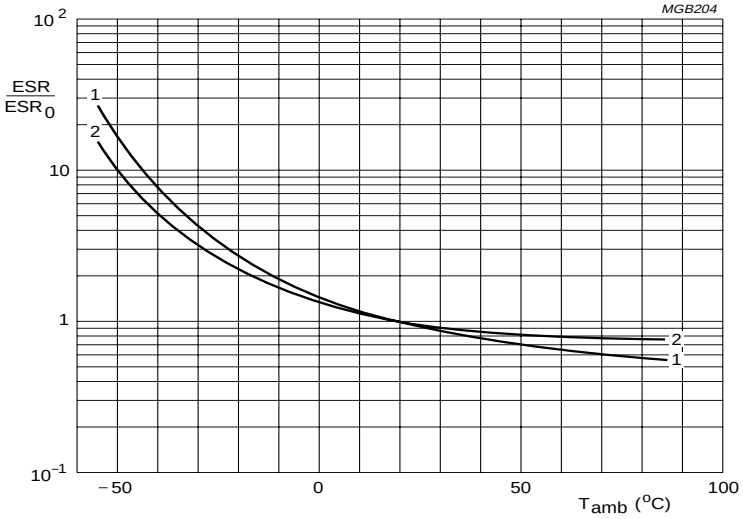
Fig.8 Typical multiplier of capacitance as a function of frequency.

Equivalent series resistance (ESR)



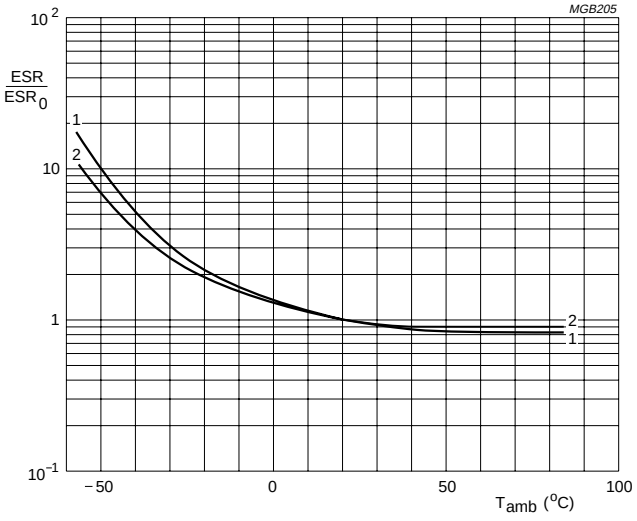
Curve 1: 10 V.
Curve 2: 63 V (≥4.7 µF).
Curve 3: 100 V.
ESR_0 = typical ESR at 20 °C, 100 Hz.
Case ∅D × L = 4.5 × 10 to 10 × 25 mm.

Fig.9 Typical multiplier of ESR as a function of ambient temperature.



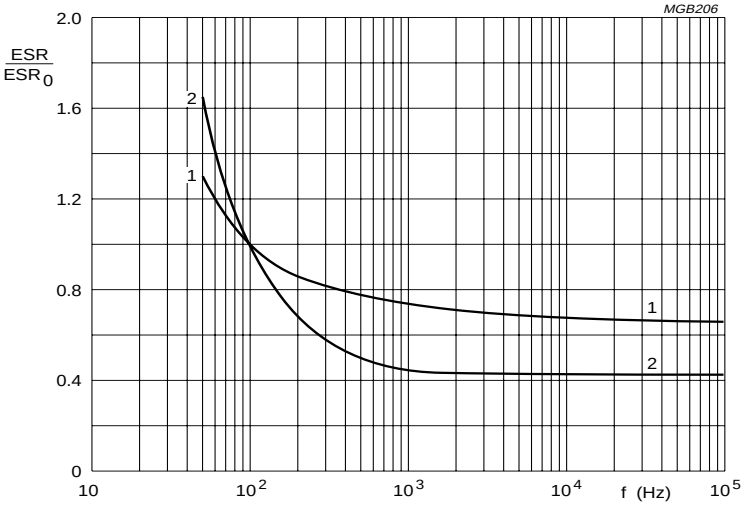
Curve 1: 10 V; 16 V; 25 V.
Curve 2: 40 and 63 V.
ESR_0 = typical ESR at 20 °C, 100 Hz.
Case ∅D × L = 10 × 30, 12.5 × 30 and 15 × 30 mm.

Fig.10 Typical multiplier of ESR as a function of ambient temperature.



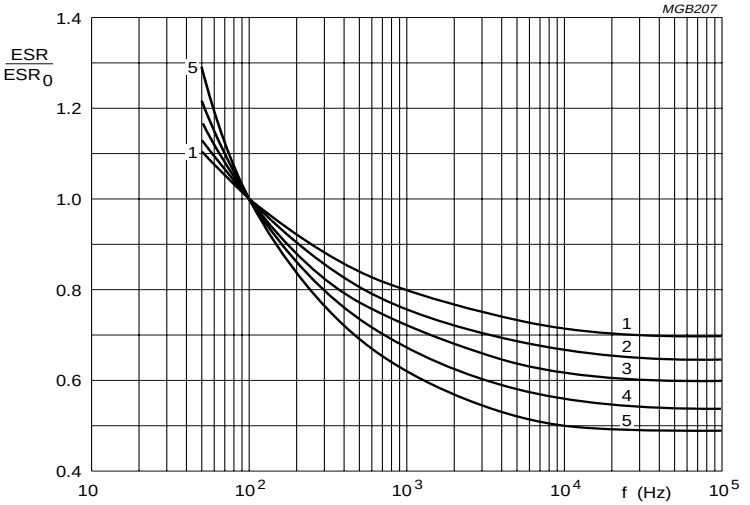
Curve 1: 10 V; 16 V; 25 V.
Curve 2: 40 and 63 V.
ESR_0 = typical ESR at 20 °C, 100 Hz.
Case ∅D × L = 18 × 30, 18 × 38 and 21 × 38 mm.

Fig.11 Typical multiplier of ESR as a function of ambient temperature.



Curve 1: 10 V.
Curve 2: 63 V (≥4.7 µF).
ESR_0 = typical ESR at 20 °C, 100 Hz.
Case ∅D × L = 4.5 × 10 to 10 × 25 mm.

Fig.12 Typical multiplier of ESR as a function of frequency.



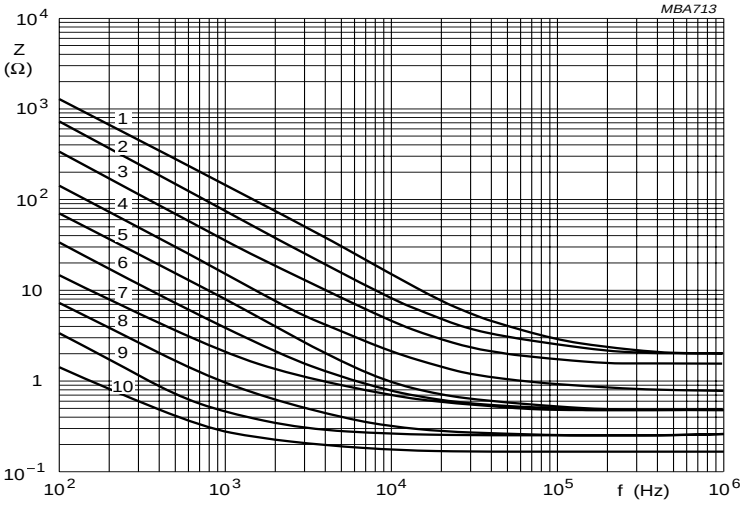
Curve 1: 10 V.
Curve 2: 16 V.
Curve 3: 25 V.
Curve 4: 40 and 100 V.
Curve 5: 63 V.
ESR_0 = typical ESR at 20 °C, 100 Hz.
Case ∅D × L = 10 × 30 to 21 × 38 mm.

Fig.13 Typical multiplier of ESR as a function of frequency.

Impedance (Z)

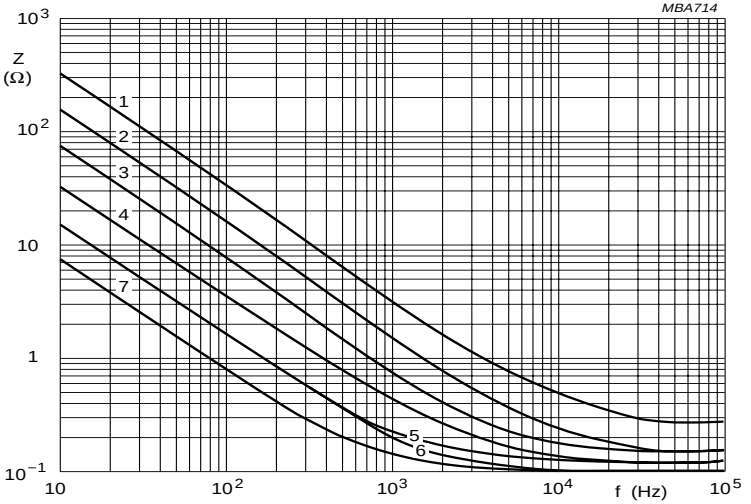
Table 4 Impedance × capacitance values (case ∅D × L = 4.5 × 10 to 10 × 25 mm)

T_{amb}	$Z \times C_R$ (Ω × μF) at 10 kHz						
	6.3 V	**10 V**	**16 V**	**25 V**	**40 V**	**63 V**	**100 V**
+20 °C	≤300	≤200	≤160	≤120	≤70	≤55	≤90
−25 °C	≤2000	≤1200	≤750	≤560	≤300	≤180	≤600
−40 °C	≤5500	≤3200	≤2000	≤1500	≤900	≤500	≤1600



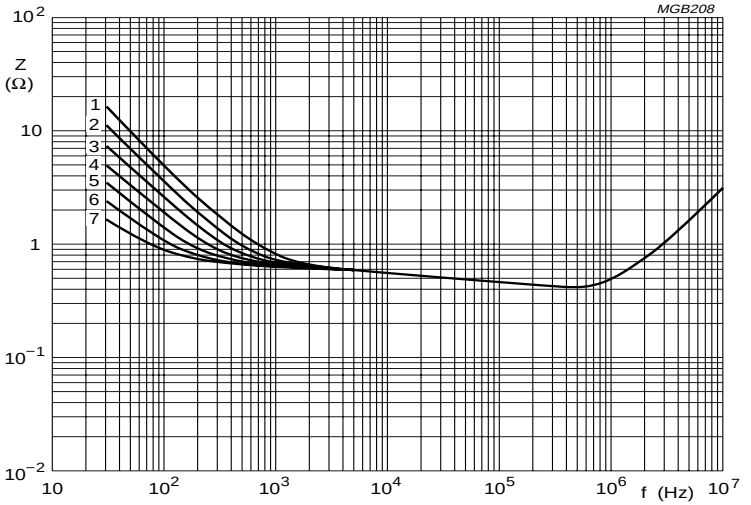
Curve 1: 1 μF, 63 V; ∅4.5 × 10 mm.
Curve 2: 2.2 μF, 63 V; ∅4.5 × 10 mm.
Curve 3: 4.7 μF, 63 V; ∅4.5 × 10 mm.
Curve 4: 10 μF, 63 V; ∅4.5 × 10 mm.
Curve 5: 22 μF, 63 V; ∅6 × 10 mm.
Curve 6: 47 μF, 40 V; ∅6 × 10 mm.
Curve 7: 100 μF, 25 V; ∅6 × 10 mm.
Curve 8: 220 μF, 25 V; ∅6.5 × 18 mm.
Curve 9: 470 μF, 10 V; ∅6.5 × 18 mm.
Curve 10: 1000 μF, 6.3 V; ∅6.5 × 25 mm.
Case ∅D × L = 4.5 × 10 to 6.5 × 25 mm.

Fig.14 Typical impedance as a function of frequency.



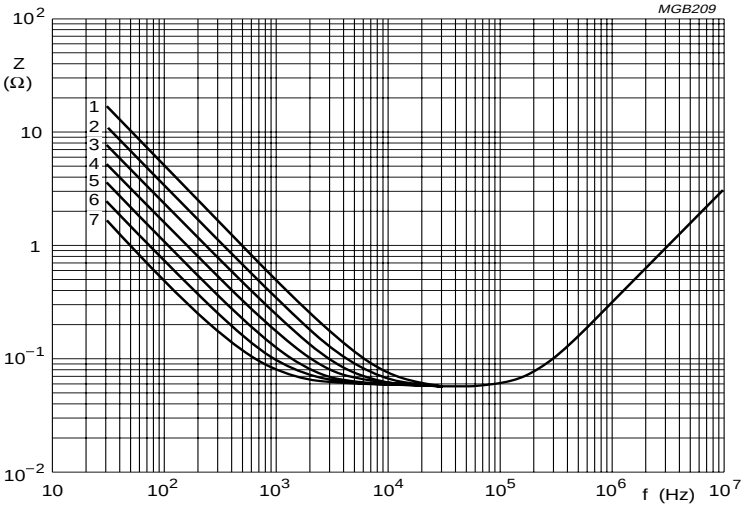
Curve 1: 47 µF, 63 V; ∅8 × 11 mm.
Curve 2: 100 µF, 63 V; ∅8 × 18 mm.
Curve 3: 220 µF, 40 V; ∅10 × 18 mm.
Curve 4: 470 µF, 25 V; ∅10 × 18 mm.
Curve 5: 1000 µF, 10 V; ∅10 × 18 mm.
Curve 6: 1000 µF, 16 V; ∅10 × 25 mm.
Curve 7: 2200 µF, 6.3 V; ∅10 × 25 mm.
Case ∅D × L = 8 × 11 to 10 × 25 mm.

Fig.15 Typical impedance as a function of frequency.



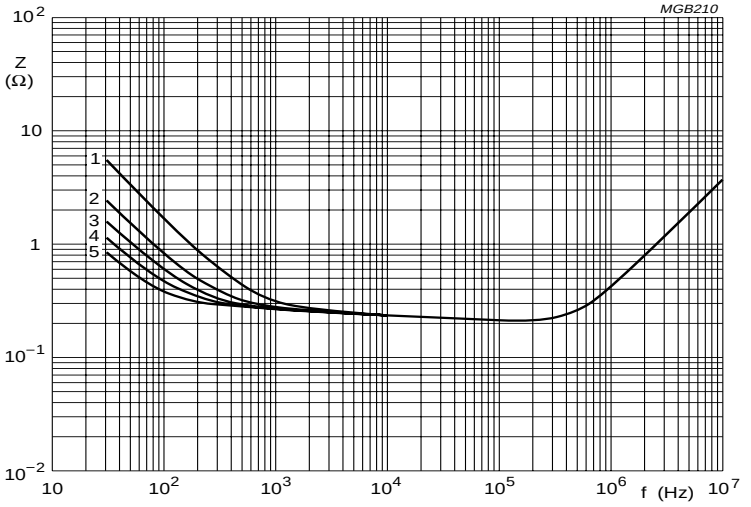
Curve 1: 330 µF, 63 V.
Curve 2: 470 µF, 63 V.
Curve 3: 680 µF, 40 V.
Curve 4: 1000 µF, 25 and 40 V.
Curve 5: 1500 µF, 16 and 25 V.
Curve 6: 2200 µF, 10 and 16 V.
Curve 7: 3300 µF, 10 V.
Case ∅D × L = 12.5 × 30 mm.
T_{amb} = −40 °C.

Fig.16 Typical impedance as a function of frequency.



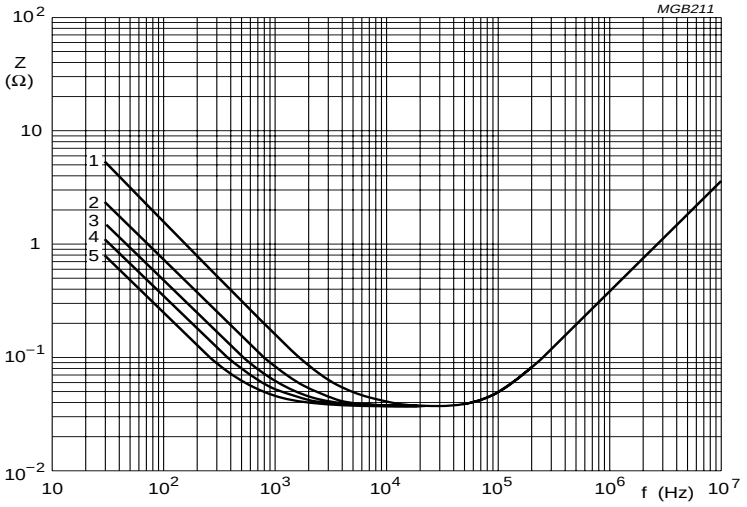
Curve 1: 330 µF, 63 V.
Curve 2: 470 µF, 63 V.
Curve 3: 680 µF, 40 V.
Curve 4: 1000 µF, 25 and 40 V.
Curve 5: 1500 µF, 16 and 25 V.
Curve 6: 2200 µF, 10 and 16 V.
Curve 7: 3300 µF, 10 V.
Case ∅D × L = 12.5 × 30 mm.
T_{amb} = 20 °C.

Fig.17 Typical impedance as a function of frequency.



Curve 1: 1000 µF, 63 V.
Curve 2: 2200 µF, 40 V.
Curve 3: 3300 µF, 25 V.
Curve 4: 4700 µF, 16 V.
Curve 5: 6800 µF, 10 V.
Case ∅D × L = 18 × 30 mm.
T_{amb} = −40 °C.

Fig.18 Typical impedance as a function of frequency.



Curve 1: 1000 µF, 63 V.
Curve 2: 2200 µF, 40 V.
Curve 3: 3300 µF, 25 V.
Curve 4: 4700 µF, 16 V.
Curve 5: 6800 µF, 10 V.
Case ∅D × L = 18 × 30 mm.
T_{amb} = 20 °C.

Fig.19 Typical impedance as a function of frequency.

MARKING

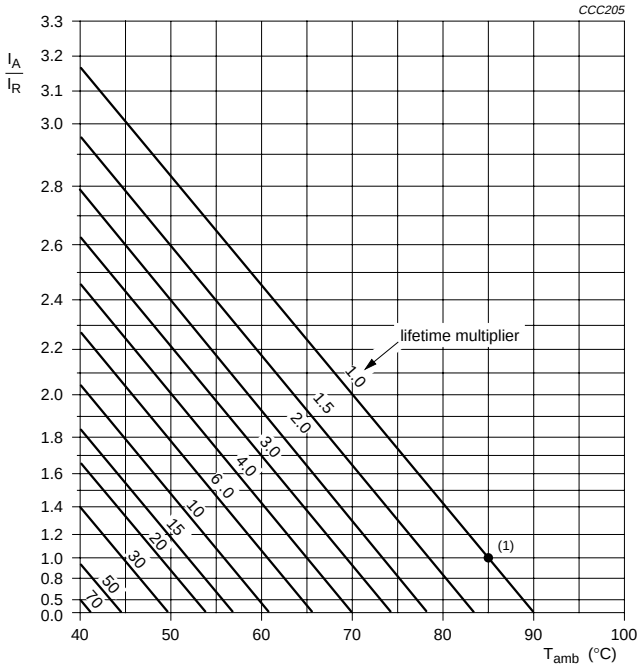
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on nominal capacitance (in accordance with *"IEC 60062"*)
- Rated voltage (in V)
- Group number (021)
- Name of manufacturer
- Date code in accordance with *"IEC 60062"*
- Code for factory of origin
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal (not for case sizes L < 18 mm).

RIPPLE CURRENT AND USEFUL LIFE

Table 5 Multiplier of ripple current (I_R) as a function of frequency

FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 6.3 to 16 V	U_R = 25 to 40 V	U_R = 63 to 100 V
50	0.95	0.9	0.85
100	1	1	1
300	1.07	1.12	1.2
1000	1.12	1.2	1.3
3000	1.15	1.25	1.35
≥10000	1.2	1.3	1.4



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:
case ∅D × L = 4.5 × 10 to 10 × 25 mm: 2500 hours
case ∅D × L = 10 × 30 to 21 × 38 mm: 8000 hours.

Fig.20 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 data handbook BC01, section *"Tests and Requirements"*.

Table 6 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 85 °C; U_R applied; case ∅D × L = 4.5 × 10 to 10 × 25 mm: U_R = 6.3 to 25 V: 1000 hours; U_R = 40 to 100 V: 2000 hours; case ∅D × L = 10 × 30 to 21 × 38 mm: U_R = 6.3 to 100 V: 5000 hours	$U_R \leq 6.3$ V; ΔC/C: +15/–30% $U_R > 6.3$ V; ΔC/C: ±15% tan δ ≤ 1.3 × spec. limit Z ≤ 2 × spec. limit I_{L5} ≤ spec. limit
		T_{amb} = 105 °C; U_R applied; case ∅D × L = 10 × 30 to 21 × 38 mm: 1500 hours	ΔC/C: ≤ ±15% tan δ ≤ 1.6 × spec. limit Z ≤ 2 × spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; case ∅D × L = 4.5 × 10 to 10 × 25 mm: 2500 hours; case ∅D × L = 10 × 30 to 21 × 38 mm: 8000 hours	$U_R \leq 6.3$ V; ΔC/C: +45/–50% $U_R > 6.3$ V; ΔC/C: ±45% tan δ ≤ 3 × spec. limit Z ≤ 3 × spec. limit I_{L5} ≤ 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} = 85 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above $I_{L5} \leq 2 \times$ spec. limit