DATA SHEET

021 ASM
Aluminum electrolytic capacitors
Axial Standard Miniature

Product specification
Supersedes data of 18th January 2000
File under BCcomponents, BC01

2001 Dec 12

BC COMPONENTS

Aluminum electrolytic capacitors
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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.

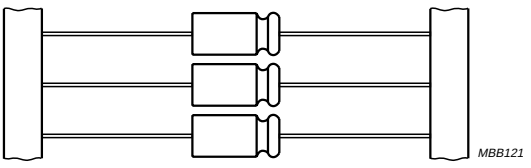
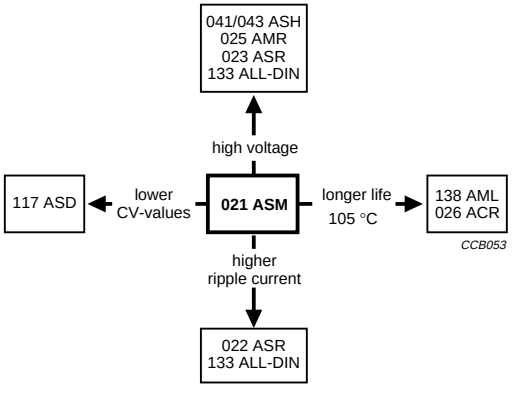


Fig.1 Component outlines.

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 × 40
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 × 40
	–	–	–	10 × 30	–	–	–
1000	8 × 18	**10 × 18**	**10 × 25**	**12.5 × 30**	**12.5 × 30**	**18 × 30**	**21 × 40**
	–	–	**10 × 30**	–	–	–	–
1500	–	10 × 25	12.5 × 30	12.5 × 30	15 × 30	18 × 40	–
	–	10 × 30	–	–	–	–	–
2200	10 × 25	**12.5 × 30**	**12.5 × 30**	**15 × 30**	**18 × 30**	**21 × 40**	–
3300	–	12.5 × 30	15 × 30	18 × 30	18 × 40	–	–
4700	–	**15 × 30**	**18 × 30**	**18 × 40**	**21 × 40**	–	–
6800	–	18 × 30	18 × 40	21 × 40	–	–	–
10000	–	**18 × 40**	**21 × 40**	–	–	–	–
15000	–	21 × 40	–	–	–	–	–

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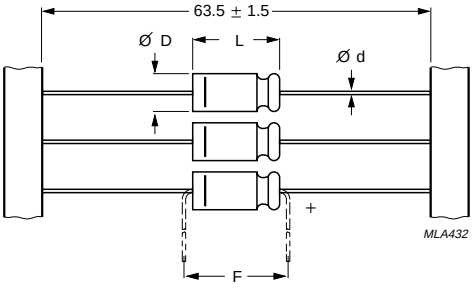
MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.

Form BR: Taped on reel.

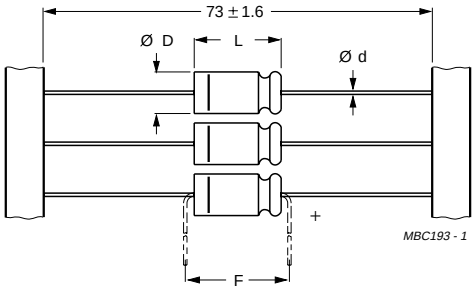
Form BA: Taped in box (ammopack).

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	200	–	500
12.5 × 30	01	0.8	55 ±1	13.0	30.5	35	≈7.4	200	–	400
15 × 30	02	0.8	55 ±1	15.5	30.5	35	≈11.7	200	–	250
18 × 30	03	0.8	55 ±1	18.5	30.5	35	≈12.9	200	–	–
18 × 40	04	0.8	34 ±1	18.5	42.2	45	≈19.4	100	–	–
21 × 40	05	0.8	34 ±1	21.5	42.2	45	≈24.7	100	–	–

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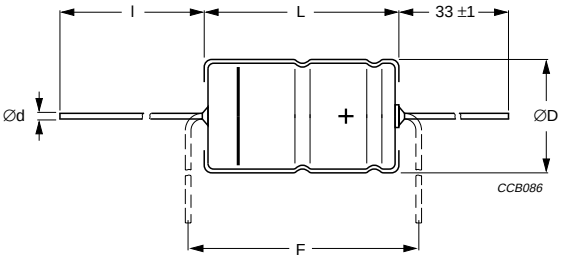
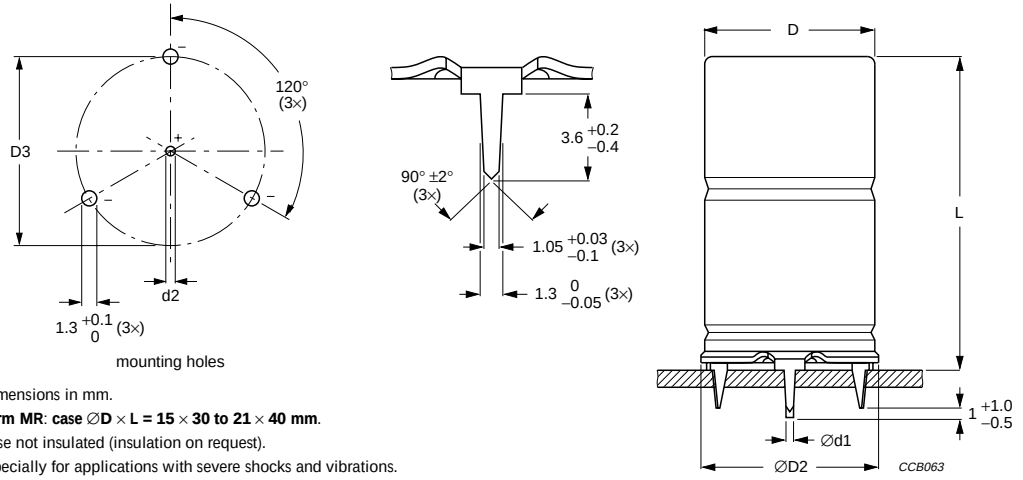


Dimensions in mm.
Form AA: Axial in box.
Case ∅D × L = 10 × 30 and 21 × 40 mm.
For dimensions see Table 1.

Fig.4 Dimensional outline; Form AA.



Dimensions in mm.
Form MR: **case ∅D × L = 15 × 30 to 21 × 40 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	200
18 × 40	04	0.8	1.0 +0.4	19.5	18.5 ±0.2	45	≈19.4	100
21 × 40	05	0.8	1.0 +0.4	22.5	21.5 ±0.2	45	≈24.7	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 × 40**	2090	204	0.40	0.064	0.04	**14103**	–	–	**44103**
	15000	21 × 40	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 × 40	2040	222	0.30	0.070	0.04	15682	–	–	45682
	10000	**21 × 40**	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 × 40**	1920	239	0.23	0.079	0.04	**16472**	–	–	**46472**
	6800	21 × 40	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 × 40	1810	268	0.19	0.090	0.04	17332	–	–	47332
	4700	21 × 40	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 × 40	1530	193	0.11	0.122	0.045	18152	–	–	48152
	2200	**21 × 40**	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 × 40	1260	140	0.09	0.195	0.18	19681	–	–	49681
	1000	**21 × 40**	1470	204	0.10	0.160	0.15	**19102**	–	–	**49102**

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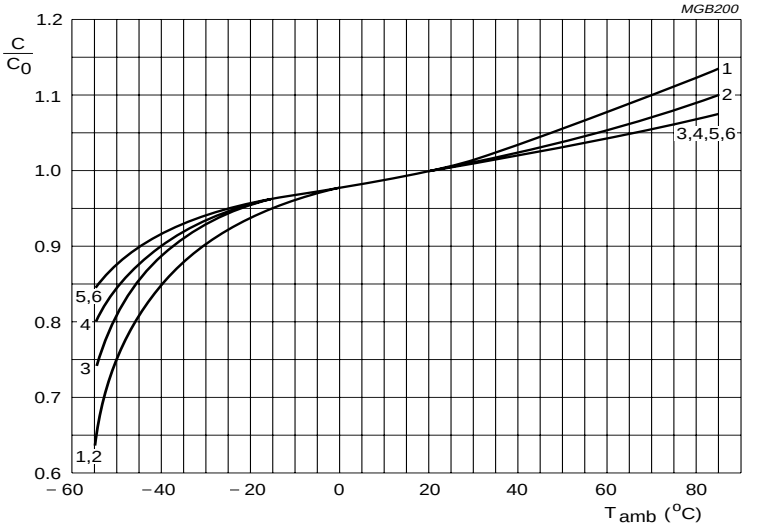
Additional electrical data

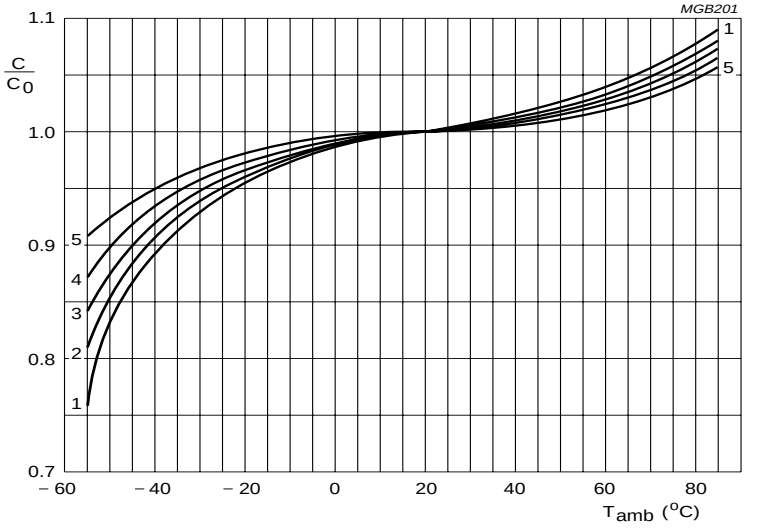
PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Voltage			
Surge voltage		$U_s \leq 1.15 \times U_R$	
Reverse voltage		$U_{rev} \leq 1$ V	
Current			
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 4$ μA	
	after 5 minutes at U_R: U_R = 6.3 V to 100 V	$I_{L5} \leq 0.002 C_R \times U_R + 4$ 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 × 40	typ. 54 nH	typ. 39 nH
	21 × 40	typ. 59 nH	typ. 39 nH

Capacitance (C)



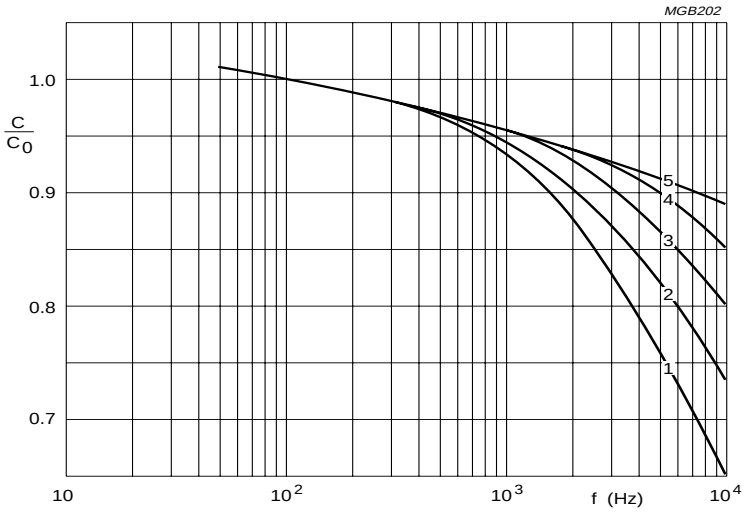
Curve 1: 10 V.
Curve 2: 16 V.
Curve 3: 25 V.
Curve 4: 40 V.
Curve 5: 63 V.
Curve 6: 100 V.
C_0 = capacitance at 20 °C, 100 Hz.
Case ∅D × L = 4 .5 × 10 to 10 × 25 mm.

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 × 40 mm.

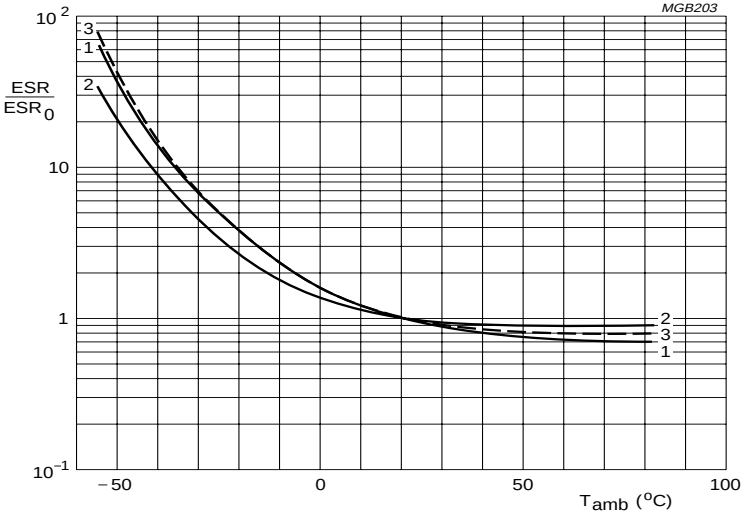
Fig.7 Typical multiplier of capacitance as a function of ambient temperature.



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.

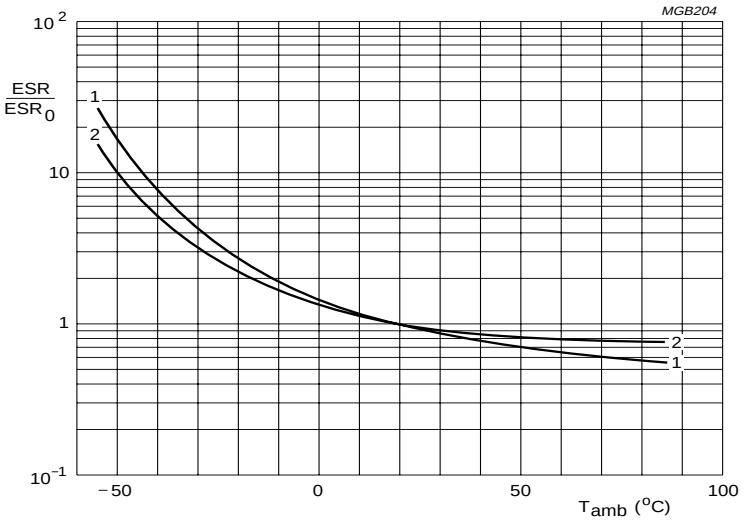
Fig.8 Typical multiplier of capacitance as a function of frequency.

Equivalent series resistance (ESR)



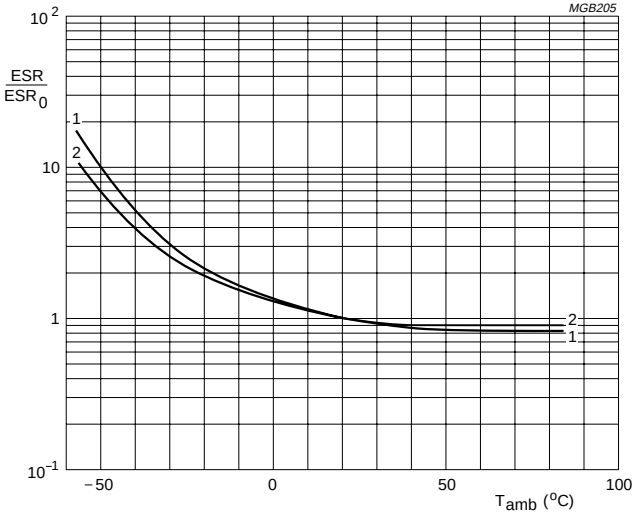
Curve 1: 10 V.
Curve 2: 63 V (≥4.7 μF).
Curve 3: 100 V.
ESR_0 = typical ESR at 20 °C, 100 Hz.
Case ∅D × L = 4.5 × 10 to 10 × 25 mm.

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



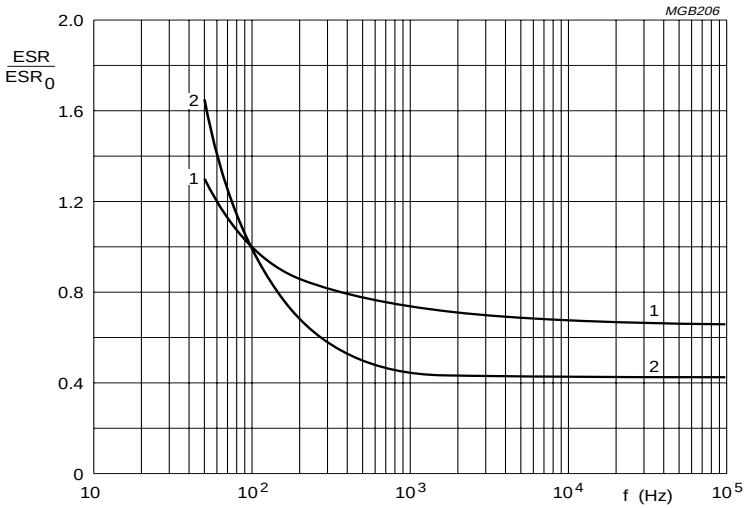
Curve 1: 10 V; 16 V; 25 V.
Curve 2: 40 and 63 V.
ESR_0 = typical ESR at 20 °C, 100 Hz.
Case ∅D × L = 10 × 30, 12.5 × 30 and 15 × 30 mm.

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



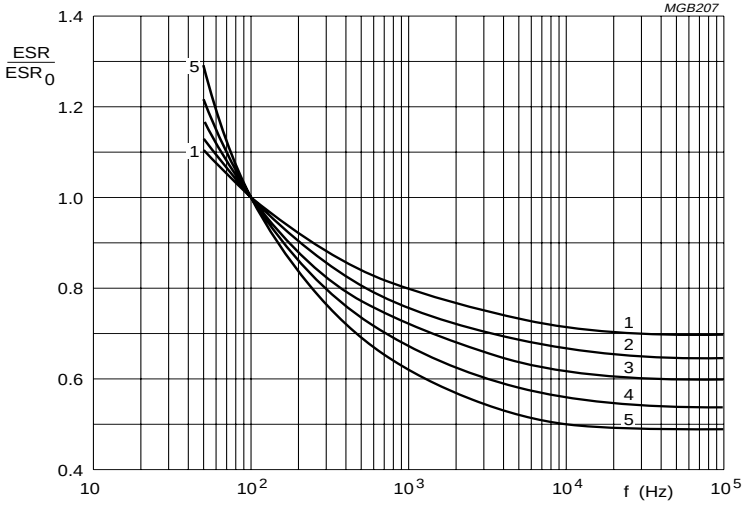
Curve 1: 10 V; 16 V; 25 V.
Curve 2: 40 and 63 V.
ESR_0 = typical ESR at 20 °C, 100 Hz.
Case ∅D × L = 18 × 30, 18 × 40 and 21 × 40 mm.

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 × 40 mm.

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

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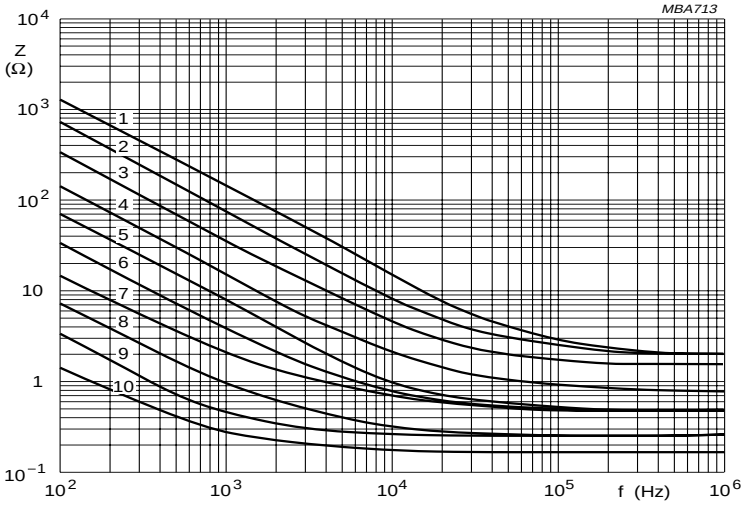
Impedance (Z)

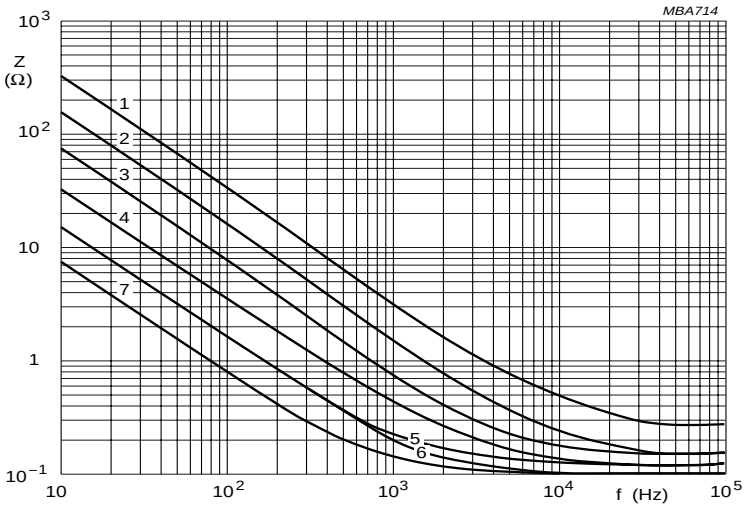
Table 4 Impedance × capacitance values (case ∅D × L = 4.5 × 10 to 10 × 25 mm)

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



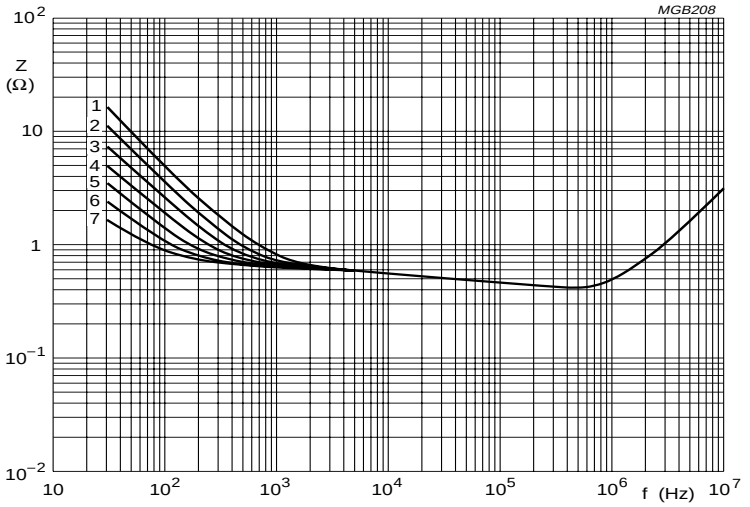
Curve 1: 1 μF, 63 V; ∅4.5 × 10 mm.
Curve 2: 2.2 μF, 63 V; ∅4.5 × 10 mm.
Curve 3: 4.7 μF, 63 V; ∅4.5 × 10 mm.
Curve 4: 10 μF, 63 V; ∅4.5 × 10 mm.
Curve 5: 22 μF, 63 V; ∅6 × 10 mm.
Curve 6: 47 μF, 40 V; ∅6 × 10 mm.
Curve 7: 100 μF, 25 V; ∅6 × 10 mm.
Curve 8: 220 μF, 25 V; ∅6.5 × 18 mm.
Curve 9: 470 μF,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



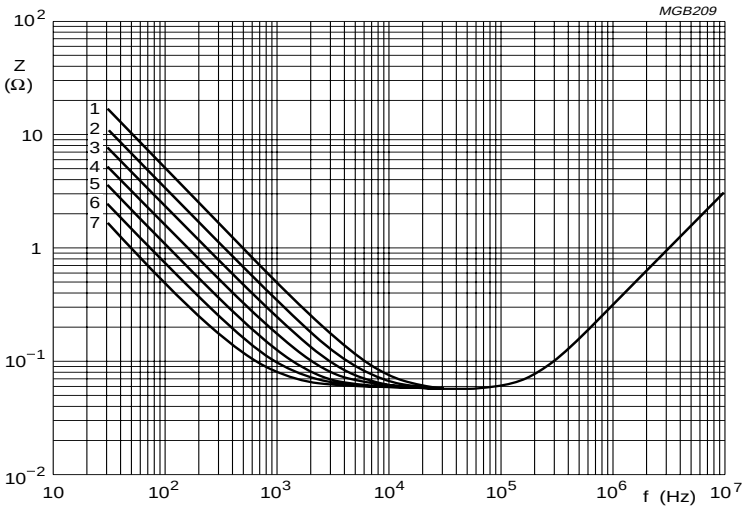
Curve 1: 47 µF, 63 V; ∅8 × 11 mm.
Curve 2: 100 µF, 63 V; ∅8 × 18 mm.
Curve 3: 220 µF, 40 V; ∅10 × 18 mm.
Curve 4: 470 µF, 25 V; ∅10 × 18 mm.
Curve 5: 1000 µF, 10 V; ∅10 × 18 mm.
Curve 6: 1000 µF, 16 V; ∅10 × 25 mm.
Curve 7: 2200 µF, 6.3 V; ∅10 × 25 mm.
Case ∅D × L = 8 × 11 to 10 × 25 mm.

Fig.15 Typical impedance as a function of frequency.



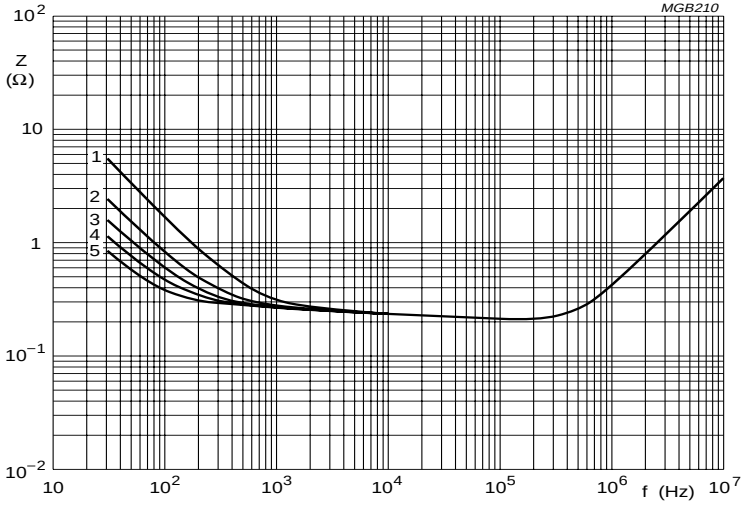
Curve 1: 330 µF, 63 V.
Curve 2: 470 µF, 63 V.
Curve 3: 680 µF, 40 V.
Curve 4: 1000 µF, 25 and 40 V.
Curve 5: 1500 µF, 16 and 25 V.
Curve 6: 2200 µF, 10 and 16 V.
Curve 7: 3300 µF, 10 V.
Case ∅D × L = 12.5 × 30 mm.
T_{amb} = −40 °C.

Fig.16 Typical impedance as a function of frequency.



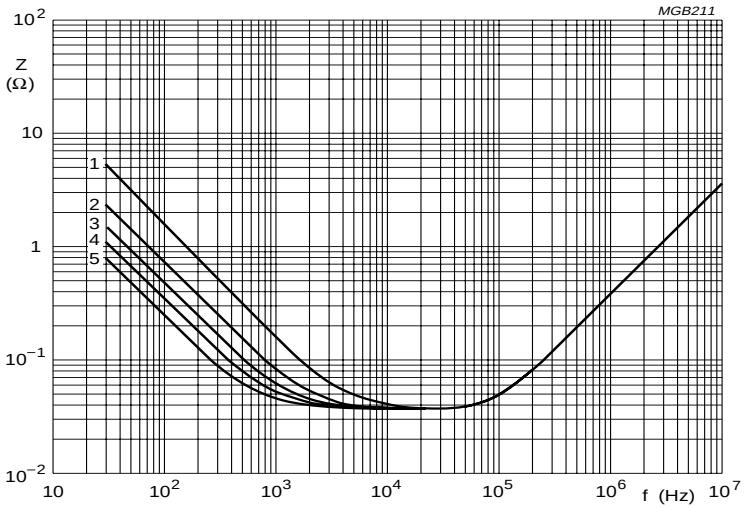
Curve 1: 330 µF, 63 V.
Curve 2: 470 µF, 63 V.
Curve 3: 680 µF, 40 V.
Curve 4: 1000 µF, 25 and 40 V.
Curve 5: 1500 µF, 16 and 25 V.
Curve 6: 2200 µF, 10 and 16 V.
Curve 7: 3300 µF, 10 V.
Case ∅D × L = 12.5 × 30 mm.
T_{amb} = 20 °C.

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

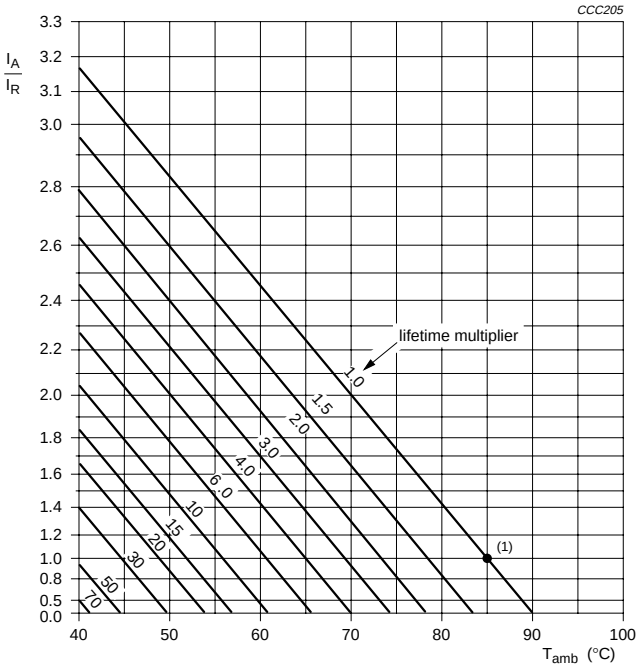
The capacitors are marked (where possible) with the following information:

- 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 × 40 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 × 40 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 × 40 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 × 40 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