

Aluminium electrolytic capacitors

Axial Standard, High Voltage

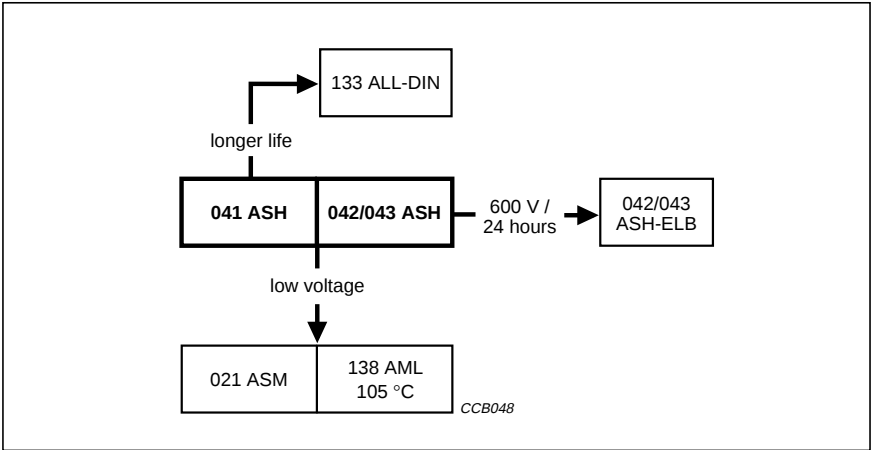
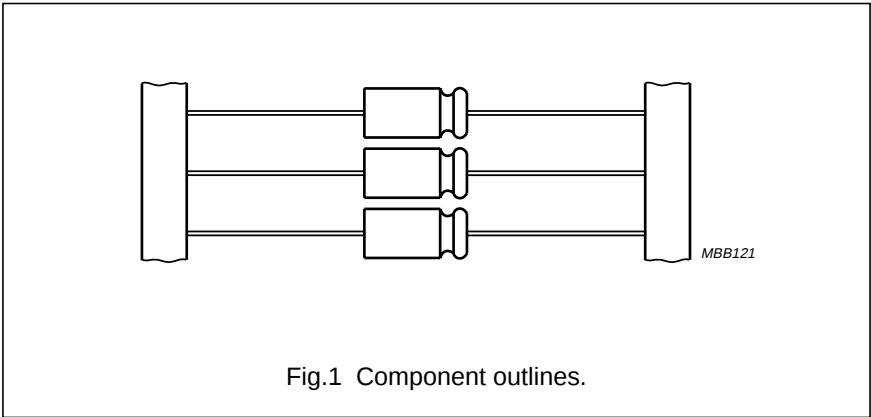
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FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case $\varnothing 10 \times 30$ to 21×40 mm with pressure relief
- Taped versions up to case $\varnothing 15 \times 30$ mm available for automatic insertion
- Charge and discharge proof
- Useful life:
5000 to 15000 hours at 85 °C
- High rated voltage: up to 450 V.

APPLICATIONS

- General purpose, industrial, power supply, audio-video and lighting
- Smoothing, filtering, buffering at high voltages
- Boards with restricted mounting height, vibration and shock resistant.



QUICK REFERENCE DATA

DESCRIPTION	VALUE	
Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm)	6.5×18 to 10×25	10×30 to 21×40
Rated capacitance range, C_R	1 to 220 μF	
Tolerance on C_R	-10 to +50%	
Rated voltage range, U_R	160 to 450 V	
Category temperature range	-40 to +85 °C (450 V: -25 to +85 °C)	
Endurance test at 85 °C	2000 hours	8000 hours (450 V: 2000 hours)
Useful life at 85 °C	5000 hours	15000 hours (450 V: 5000 hours)
Useful life at 40 °C	$1.4 \times I_R$ applied: 120000 hours	$1.8 \times I_R$ applied: 240000 hours (450 V: 120000 hours)
Shelf life at 0 V, 85 °C	500 hours	500 hours
Based on sectional specification	IEC 384-4/CECC 30300	
Climatic category IEC 68	40/085/56 (450 V: 25/085/56)	

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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)					
	160	250	350	385	400	450
1.0	–	–	–	6.5×18	–	–
2.2	–	6.5×18	–	8×18	–	–
4.7	6.5×18	8×18	10×18	10×25	–	–
6.8	–	–	10×30	10×30	10×30	10×30
10	8×18	10×25	12.5×30	12.5×30	12.5×30	12.5×30
	–	10×30	–	–	–	–
15	–	12.5×30	12.5×30	15×30	15×30	12.5×30
22	10×25	12.5×30	15×30	18×30	18×30	15×30
	10×30	–	–	–	–	–
33	12.5×30	15×30	18×30	18×40	18×40	18×30
47	15×30	18×30	18×40	18×40	18×40	18×40
68	15×30	18×40	21×40	21×40	21×40	21×40
100	18×30	21×40	–	–	–	–
150	18×40	–	–	–	–	–
220	21×40	–	–	–	–	–

MARKING

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

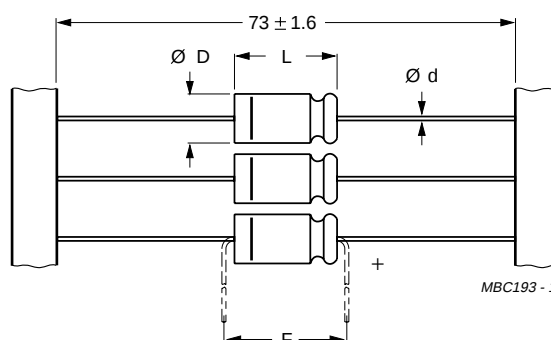
- Rated capacitance (in μF)
- Tolerance on rated capacitance, code letter in accordance with “IEC 62”
- Rated voltage (in V)
- Group number (041, 042 or 043)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with “IEC 62”
- Code indicating factory of origin
- Band to identify the negative terminal
- ‘+’ sign to indicate the positive terminal.

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.

Form BR: Taped on reel,

case $\varnothing D \times L = 6.5 \times 18$ to 15×30 mm.

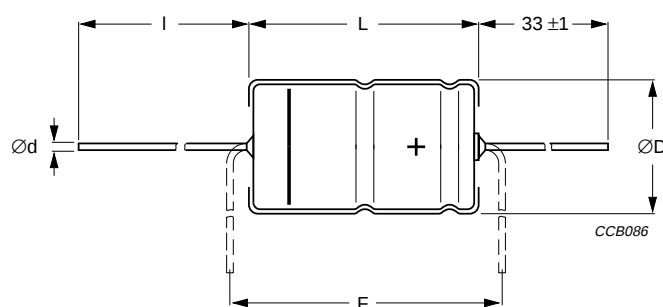
Form BA: Taped in box (ammopack),

case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm.

For dimensions see Table 1.

Tape dimensions are specified in this handbook, Section "Packaging".

Fig.2 Dimensional outline; Forms BA and BR.



Dimensions in mm.

Form AA: Axial in box,

case $\varnothing D \times L = 10 \times 30$ to 21×40 mm

For dimensions see Table 1.

For case sizes 18×40 mm and 21×40 mm, the stated L may be exceeded by 0.7 mm.

Fig.3 Dimensional outline; Form AA.

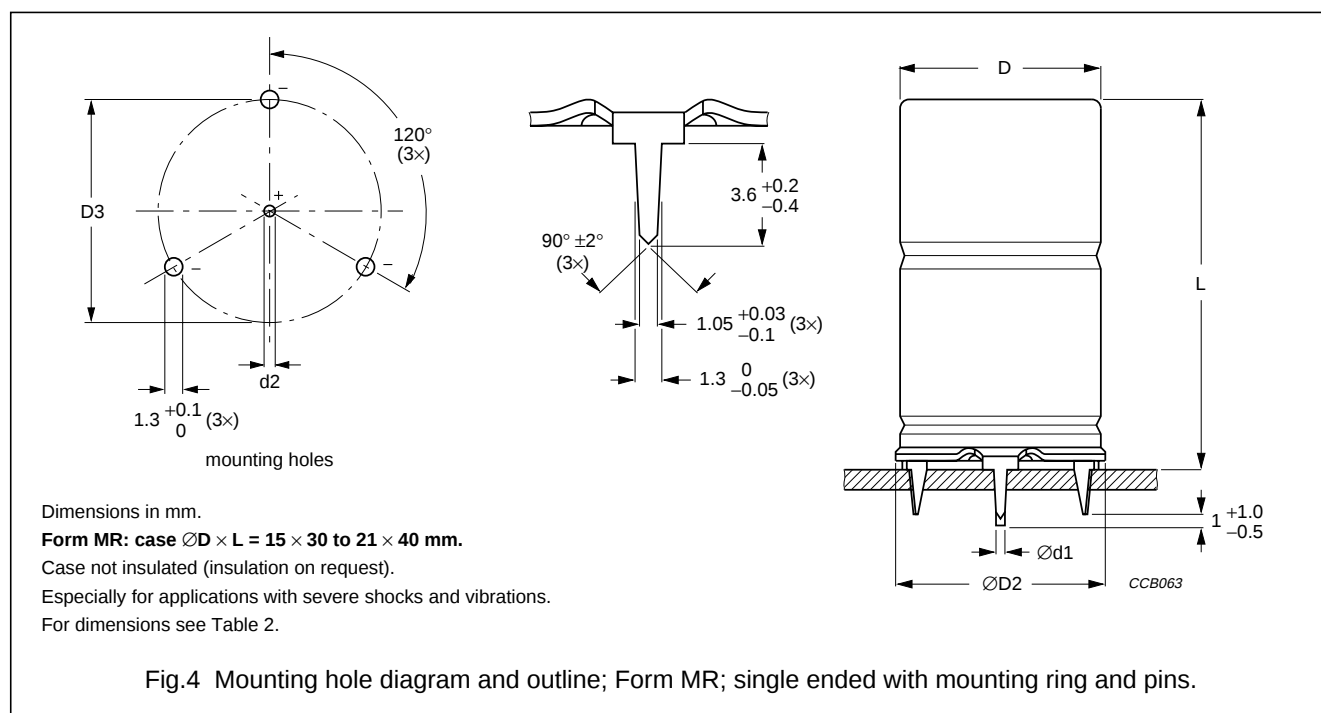
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Table 1 Axial; physical dimensions, mass and packaging information; see Figs 2 and 3

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	AXIAL: FORM AA, BA, and BR					MASS (g)	PACKAGING QUANTITIES		
		$\varnothing d$ (mm)	l (mm)	$\varnothing D_{\max}$ (mm)	$L_{\max}$ (mm)	$F_{\min}$ (mm)		FORM AA	FORM BA	FORM BR
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	41.5	45	≈19.4	100	–	–
21 × 40	05	0.8	34 ±1	21.5	41.5	45	≈24.7	100	–	–

**Table 2** Single ended; physical dimensions, mass and packaging information; see Fig.4

NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	SINGLE ENDED WITH MOUNTING RING: FORM MR						MASS (g)	PACKAGING QUANTITIES
		$\varnothing d1$ (mm)	$\varnothing d2$ (mm)	$\varnothing D_{\max}$ (mm)	$\varnothing D2_{\max}$ (mm)	$D3$ (mm)	$L_{\max}$ (mm)		
15 × 30	02	0.8	1.0 +0.4	15.5	17.5	16.5 ±0.2	33	≈11.7	200
18 × 30	03	0.8	1.0 +0.4	18.5	19.5	18.5 ±0.2	33	≈12.9	200
18 × 40	04	0.8	1.0 +0.4	18.5	19.5	18.5 ±0.2	45	≈19.4	100
21 × 40	05	0.8	1.0 +0.4	21.5	22.5	21.5 ±0.2	45	≈24.7	100

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Ordering example

Electrolytic capacitor 041 series

10 μ F/250 V; -10/+50%Nominal case size: $\varnothing 10 \times 25$ mm; Form BA

Catalogue number: 2222 041 33109.

ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 3 apply at $T_{amb} = 20\text{ }^{\circ}\text{C}$,
 $P = 86$ to 106 kPa , $RH = 45$ to 75% .

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance -10 to +50%
I_R	rated RMS ripple current at 100 Hz, 85 $^{\circ}\text{C}$
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{max}$ and C_R)
Z	max. impedance at 10 kHz

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

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 85 $^{\circ}\text{C}$ (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222			
										AXIAL			SINGLE ENDED
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
160	4.7	6.5×18	4	50	38	8	0.15	51	26	—	041 21478	041 31478	—
	10	8×18	5	70	68	14	0.15	24	12	—	041 21109	041 31109	—
	22	10×25	7	150	130	25	0.15	11	5.5	—	041 21229	041 31229	—
	22	10×30	00	120	42	25	0.10	6.8	5.5	042 11229	042 21229	—	—
	33	12.5×30	01	150	58	36	0.10	4.5	3.1	042 11339	042 21339	—	—
	47	15×30	02	190	78	49	0.10	3.2	2.1	042 11479	042 21479	—	042 41479
	68	15×30	02	230	110	69	0.10	2.2	1.4	042 11689	042 21689	—	042 41689
	100	18×30	03	350	150	100	0.10	1.5	1.0	042 11101	—	—	042 41101
	150	18×40	04	430	230	150	0.10	1.0	0.7	043 11151	—	—	043 41151
	220	21×40	05	610	330	220	0.10	0.7	0.5	043 11221	—	—	043 41221
250	2.2	6.5×18	4	35	28	6	0.10	72	50	—	041 23228	041 33228	—
	4.7	8×18	5	55	55	11	0.10	34	23	—	041 23478	041 33478	—
	10	10×25	7	90	95	19	0.10	16	11	—	041 23109	041 33109	—
	10	10×30	00	72	33	19	0.10	15	11	042 13109	042 23109	—	—

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	I _R 100 Hz 85 °C (mA)	I _{L1} 1 min (μA)	I _{L5} 5 min (μA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222			
										AXIAL			SINGLE ENDED
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
250	15	12.5 × 30	01	100	44	27	0.10	10	7.4	042 13159	042 23159	–	–
	22	12.5 × 30	01	130	60	37	0.10	6.8	5.0	042 13229	042 23229	–	–
	33	15 × 30	02	160	84	54	0.10	4.5	3.4	042 13339	042 23339	–	042 43339
	47	18 × 30	03	220	120	75	0.10	3.2	2.3	042 13479	–	–	042 43479
	68	18 × 40	04	290	160	110	0.10	2.2	1.7	043 13689	–	–	043 43689
	100	21 × 40	05	390	240	150	0.10	1.5	1.1	043 13101	–	–	043 43101
350	4.7	10 × 18	6	60	69	14	0.10	34	22	–	041 25478	041 35478	–
	6.8	10 × 30	00	60	32	18	0.10	22	14	042 15688	042 25688	–	–
	10	12.5 × 30	01	90	42	25	0.10	15	10	042 15109	042 25109	–	–
	15	12.5 × 30	01	100	57	36	0.10	10	6.7	042 15159	042 25159	–	–
	22	15 × 30	02	140	79	50	0.10	6.8	4.5	042 15229	042 25229	–	042 45229
	33	18 × 30	03	160	110	73	0.10	4.5	3.1	042 15339	–	–	042 45339
	47	18 × 40	04	270	160	100	0.10	3.2	2.1	043 15479	–	–	043 45479
	68	21 × 40	05	320	220	150	0.10	2.2	1.4	043 15689	–	–	043 45689
385	1	6.5 × 18	4	20	19	4	0.10	160	100	–	041 28108	041 38108	–
	2.2	8 × 18	5	40	42	8	0.10	72	45	–	041 28228	041 38228	–
	4.7	10 × 25	7	70	71	15	0.10	34	22	–	041 28478	041 38478	–
	6.8	10 × 30	00	60	34	20	0.10	22	14	042 18688	042 28688	–	–
	10	12.5 × 30	01	90	45	27	0.10	15	10	042 18109	042 28109	–	–
	15	15 × 30	02	110	62	39	0.10	10	6.0	042 18159	042 28159	–	042 48159
	22	18 × 30	03	150	86	55	0.10	6.8	4.1	042 18229	–	–	042 48229
	33	18 × 40	04	200	120	80	0.10	4.5	2.7	043 18339	–	–	043 48339
	47	18 × 40	04	270	170	110	0.10	3.2	2.1	043 18479	–	–	043 48479
	68	21 × 40	05	320	250	160	0.10	2.2	1.4	043 18689	–	–	043 48689

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U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	CASE CODE	I _R 100 Hz 85 °C (mA)	I _{L1} 1 min (μA)	I _{L5} 5 min (μA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	CATALOGUE NUMBER 2222			
										AXIAL			SINGLE ENDED
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
400	6.8	10 × 30	00	82	220	110	0.055	11.5	7.3	042 16688	042 26688	–	–
	10	12.5 × 30	01	130	240	110	0.055	7.5	4.6	042 16109	042 26109	–	–
	15	15 × 30	02	160	250	110	0.055	5.0	3.1	042 16159	042 26159	–	042 46159
	22	18 × 30	03	210	280	120	0.055	3.5	2.1	042 16229	–	–	042 46229
	33	18 × 40	04	290	320	130	0.055	2.3	1.4	043 16339	–	–	043 46339
	47	18 × 40	04	330	370	140	0.055	1.7	1.1	043 16479	–	–	043 46479
	68	21 × 40	05	430	440	150	0.055	1.2	0.7	043 16689	–	–	043 46689
450	6.8	10 × 30	00	60	230	110	0.10	22	14	042 17688	042 27688	–	–
	10	12.5 × 30	01	90	240	110	0.10	15	10	042 17109	042 27109	–	–
	15	12.5 × 30	01	100	260	110	0.10	10	6	042 17159	042 27159	–	–
	22	15 × 30	02	140	290	120	0.10	6.8	4.1	042 17229	042 27229	–	042 47229
	33	18 × 30	03	190	330	130	0.10	4.5	2.7	042 17339	–	–	042 47339
	47	18 × 40	04	250	390	140	0.10	3.2	2.1	043 17479	–	–	043 47479
	68	21 × 40	05	330	460	160	0.10	2.2	1.4	043 17689	–	–	043 47689

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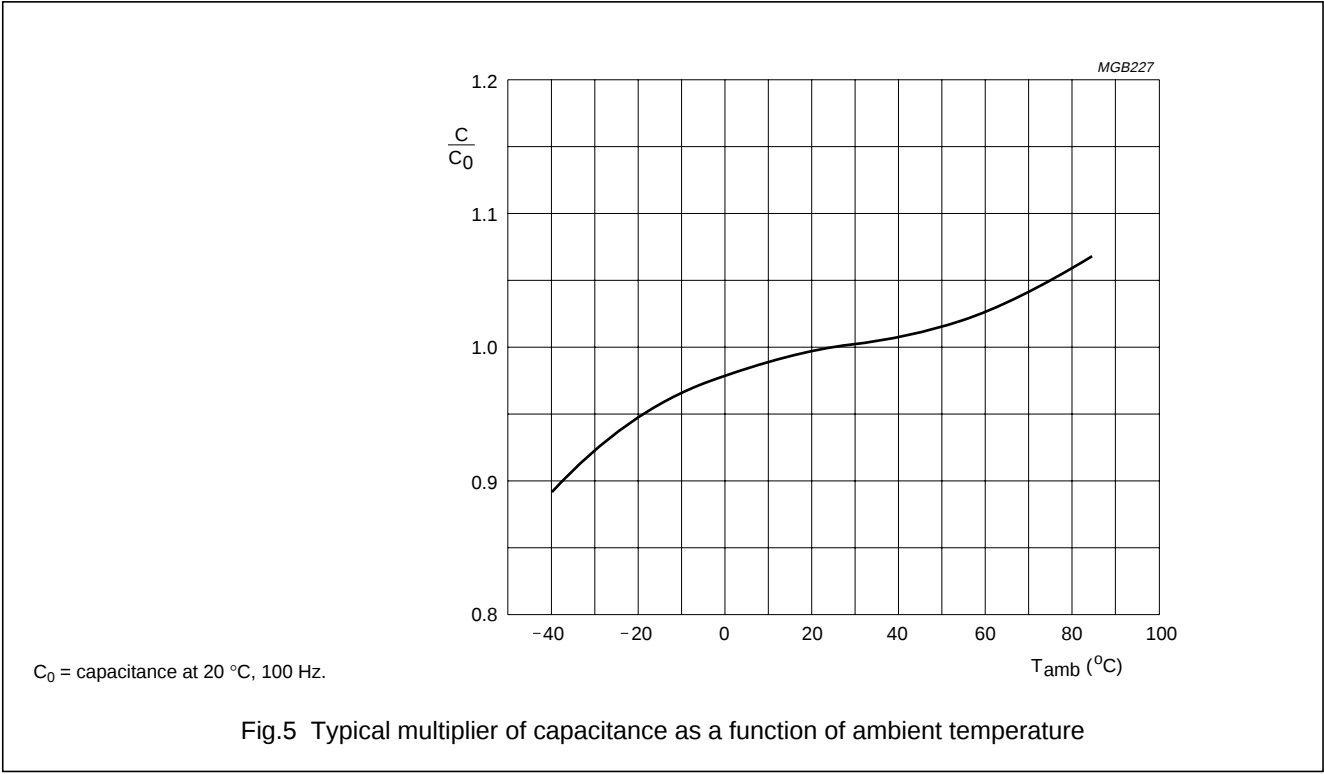
Additional electrical data

PARAMETER	CONDITIONS	VALUE	
		AXIAL	SINGLE ENDED
Voltage			
Surge voltage for short periods	U _R = 160 to 250 V	U _s ≤ 1.15 × U _R	
	U _R = 350 to 450 V	U _s ≤ 1.1 × U _R	
Reverse voltage		U _{rev} ≤ 1 V	
Current			
Leakage current	after 1 minute: case ØD × L = 6.5 × 18 to 10 × 25 mm: CV ≤ 1000 µC CV > 1000 µC case ØD × L = 10 × 30 to 21 × 40 mm: U _R = 160 to 385 V U _R = 400 and 450 V	I _{L1} ≤ 0.05C _R × U _R or 5 µA, whichever is greater I _{L1} ≤ 0.03C _R × U _R + 20 µA I _{L1} ≤ 0.009C _R × U _R + 10 µA I _{L1} ≤ 0.009C _R × U _R + 200 µA	
	after 5 minutes: U _R = 160 to 385 V: CV ≤ 1000 µC CV > 1000 µC U _R = 400 and 450 V	I _{L5} ≤ 0.01C _R × U _R or 1 µA, whichever is greater I _{L5} ≤ 0.006C _R × U _R + 4 µA I _{L5} ≤ 0.002C _R × U _R + 100 µA	
Inductance			
Equivalent series inductance (ESL)	case ØD × L mm:		
	6.5 × 18	typ. 15 nH	–
	8 × 18	typ. 35 nH	–
	10 × 18	typ. 69 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	

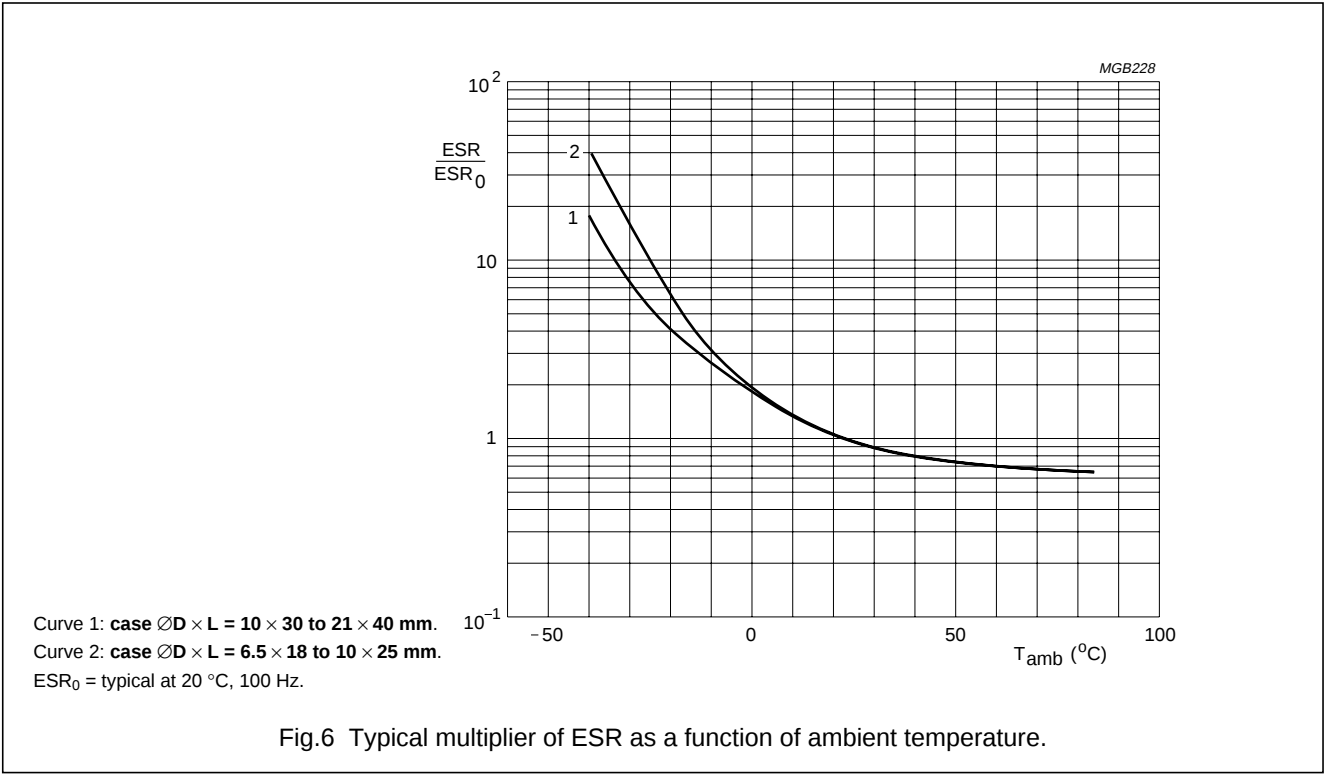
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Capacitance (C)



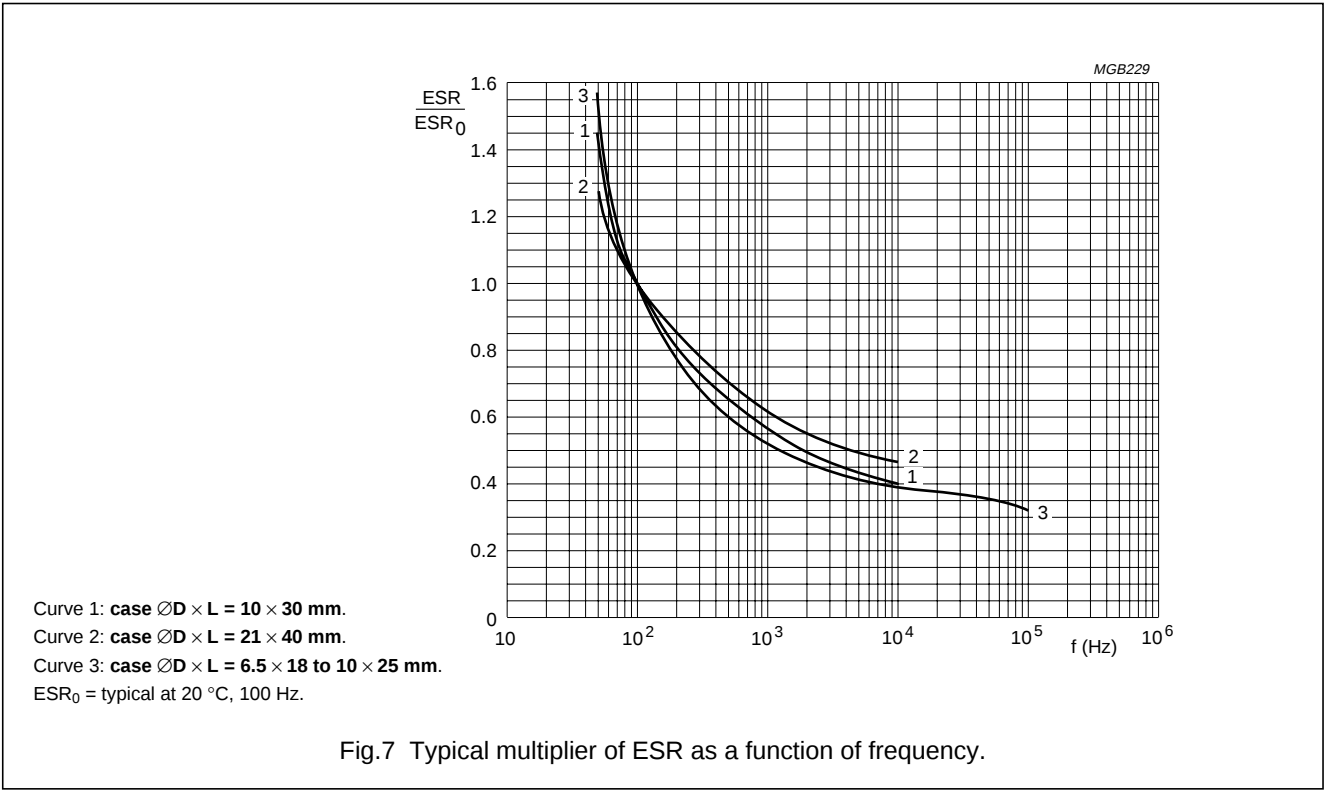
Equivalent series resistance (ESR)



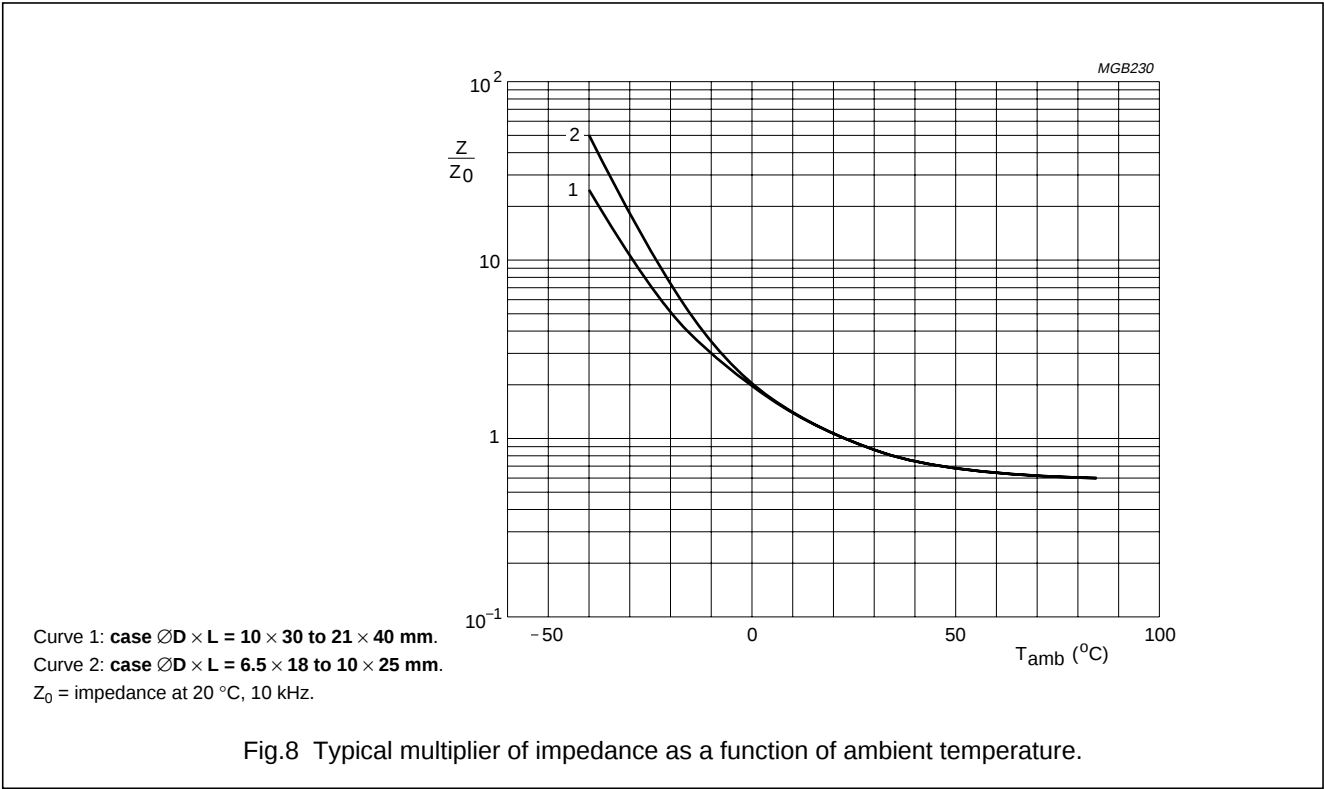
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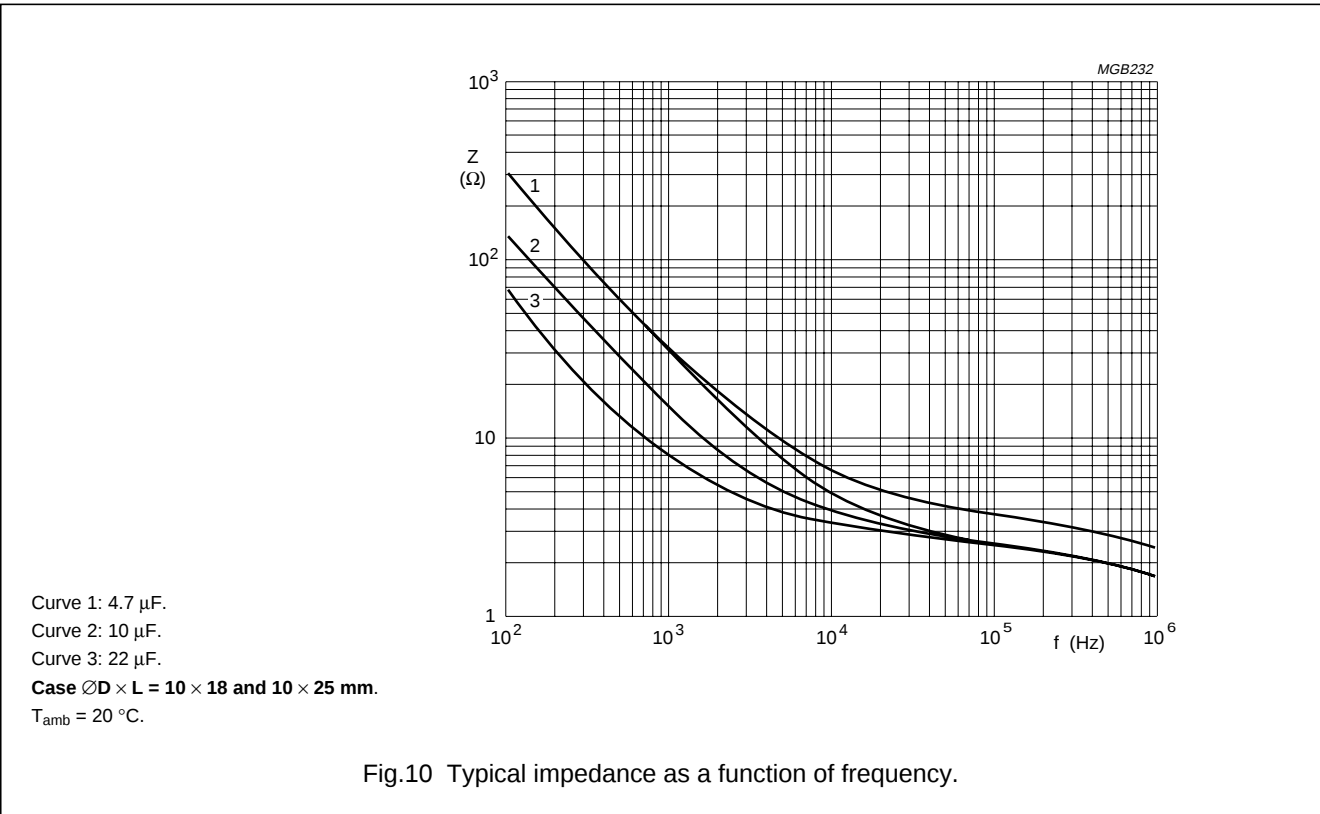
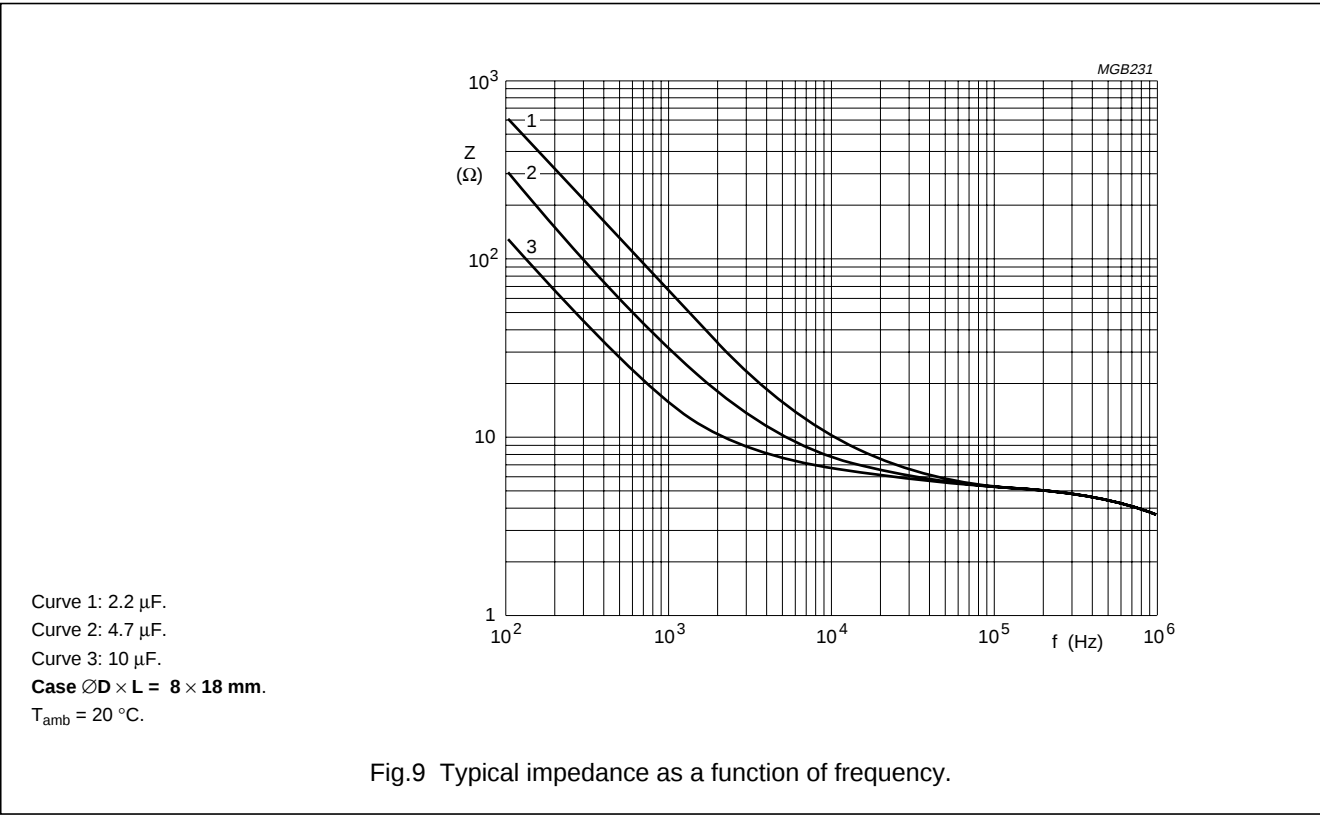


Impedance (Z)



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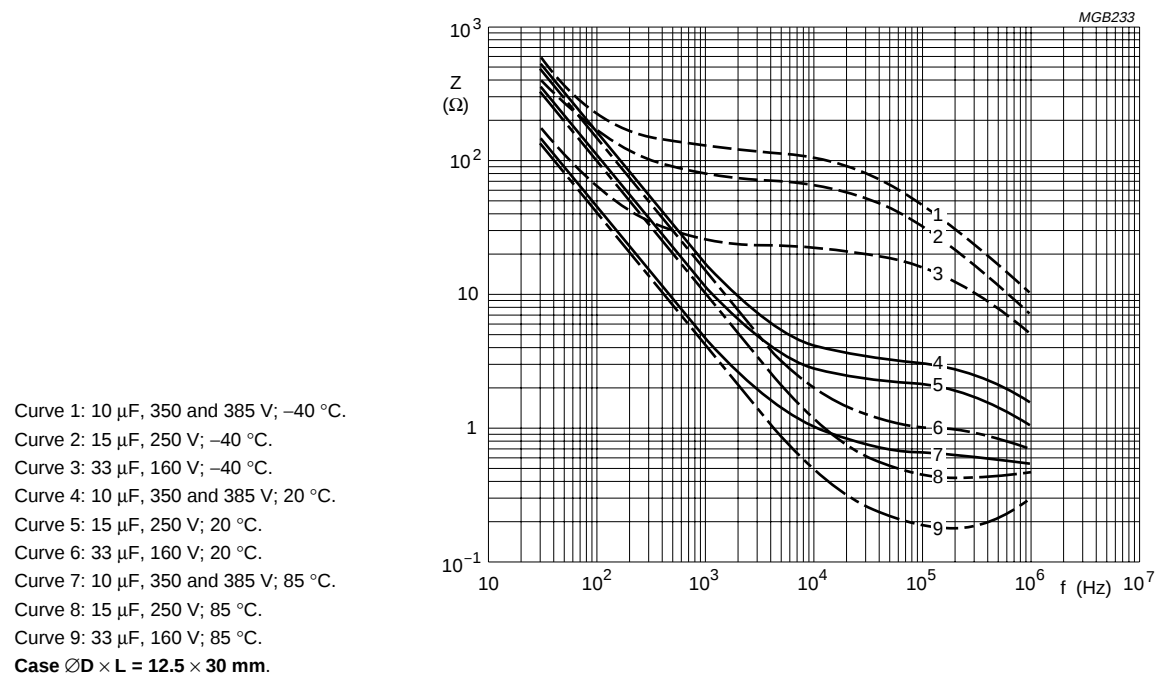


Fig.11 Typical impedance as a function of frequency at different ambient temperatures.

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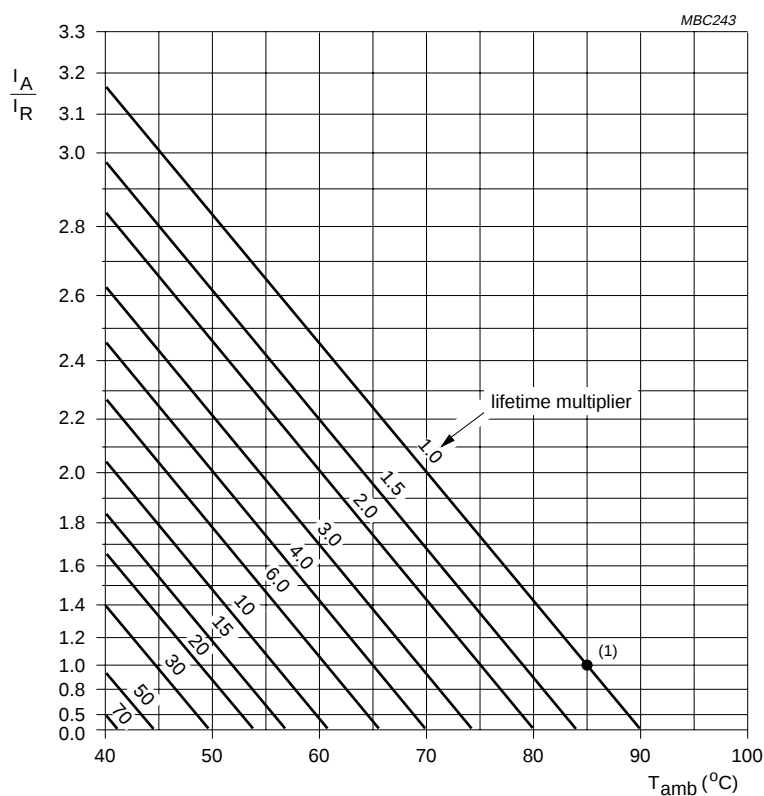
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RIPPLE CURRENT AND USEFUL LIFE

Table 4 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 85 °C, 100 Hz

FREQUENCY (Hz)	I _R MULTIPLIER
50	0.75
100	1.0
300	1.15
1000	1.3
3000	1.4
≥10000	1.5



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_B applied;

case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm: 5000 hours
case $\varnothing D \times L = 10 \times 30$ to 21×40 mm: 15000 hours (450 V: 5000 hours).

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

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SPECIFIC TESTS AND REQUIREMENTS

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

Table 5 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; case $\varnothing D \times L$: 6.5 × 18 to 10 × 25 mm: 2000 hours; 10 × 30 to 21 × 40 mm: 8000 hours (450 V: 2000 hours)	$U_R = 160\text{ V}$; $\Delta C/C$: $\pm 15\%$ $U_R = 250$ to 450 V ; $\Delta C/C$: $\pm 10\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; case $\varnothing D \times L$: 6.5 × 18 to 10 × 25 mm: 5000 hours; 10 × 30 to 21 × 40 mm: 15000 hours (450 V: 5000 hours)	$U_R = 160\text{ V}$; $\Delta C/C$: $\pm 45\%$ $U_R = 250$ to 450 V ; $\Delta C/C$: $\pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 384-4/ CECC 30300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 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 $I_{L5} \leq 2 \times \text{spec. limit}$