

Aluminum Capacitors Axial Miniature, Long-Life

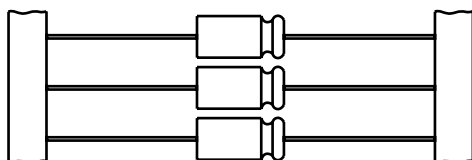


Fig.1 Component outlines



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve (case Ø 6.3 x 12.7 and 7.7 x 12.7 mm are moulded with flame retardant plastic material)
- Mounting ring version not available in insulated form
- Taped versions up to case Ø 15 x 30 mm available for automatic insertion
- Charge and discharge proof
- Long useful life: 2000 to 10 000 hours at 105 °C, high reliability
- High ripple current capability
- Miniaturized, high CV-product per unit volume
- Lead (Pb)-free versions are RoHS compliant



RoHS
COMPLIANT

APPLICATIONS

- Industrial, automotive, EDP and telecommunication
- Smoothing, filtering, buffering in SMPS; coupling, decoupling, timing
- Portable and mobile equipment (small size, low mass)
- Stand-by applications
- Low mounting height boards, vibration and shock resistant

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 (M for ± 20 %)
- Rated voltage (in V)
- Upper category temperature (105 °C)
- Date code, in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal (not for case sizes L < 18 mm)
- Series number (138)

QUICK REFERENCE DATA		
DESCRIPTION	VALUE	
Nominal case sizes (Ø D x L in mm)	6.3 x 12.7 to 10 x 25	10 x 30 to 21 x 38
Rated capacitance range, C _R	1.0 to 15 000 µF	
Tolerance on C _R	± 20 %	
Rated voltage range, U _R	6.3 to 100 V	
Category temperature range	- 40 to + 105 °C	
Endurance test at 105 °C	1000 hours	5000 hours
Useful life at 105 °C	2000 hours	10 000 hours
Useful life at 40 °C, I _R applied	1.3 x I _R applied: 200 000 hours	1.8 x I _R applied: 500 000 hours
Shelf life at 0 V, 105 °C	500 hours	500 hours
Based on sectional specification	IEC 60384-4/EN130 300	
Climatic category IEC 60068	40/105/56	

SELECTION CHART FOR C_R , U_R AND RELEVANT NOMINAL CASE SIZES ($\varnothing D \times L$ in mm)

C_R (μF)	U_R (V)							
	6.3	10	16	25	40	50	63	100
1.0	-	-	-	-	-	-	-	6.3 x 12.7
2.2	-	-	-	-	-	-	-	6.3 x 12.7
4.7	-	-	-	-	-	-	6.3 x 12.7	7.7 x 12.7
10	-	-	-	6.3 x 12.7	-	6.3 x 12.7	7.7 x 12.7	6.5 x 18
22	-	-	6.3 x 12.7	6.3 x 12.7	-	7.7 x 12.7	6.5 x 18	8 x 18
33	-	-	-	6.3 x 12.7	7.7 x 12.7	-	-	-
47	-	-	6.3 x 12.7	7.7 x 12.7	6.5 x 18	-	8 x 18	10 x 25
68	-	-	-	-	-	-	-	10 x 30
100	6.3 x 12.7	-	7.7 x 12.7	6.5 x 18	8 x 18	10 x 18	10 x 25	12.5 x 30
150	-	7.7 x 12.7	-	-	-	-	10 x 30	15 x 30
220	7.7 x 12.7	6.5 x 18	8 x 18	10 x 18	10 x 25	-	12.5 x 30	15 x 30
330	-	-	-	-	10 x 30	-	12.5 x 30	18 x 30
470	6.5 x 18	8 x 18	10 x 18	10 x 25	12.5 x 30	-	15 x 30	18 x 38
680	-	-	-	10 x 30	12.5 x 30	-	18 x 30	21 x 38
1000	10 x 18	10 x 25	10 x 30	12.5 x 30	15 x 30	-	18 x 38	-
1500	-	10 x 30	12.5 x 30	15 x 30	18 x 30	-	21 x 38	-
2200	10 x 25	12.5 x 30	15 x 30	18 x 30	18 x 38	-	-	-
3300	-	15 x 30	18 x 30	18 x 38	21 x 38	-	-	-
4700	-	18 x 30	18 x 30	18 x 38	-	-	-	-
6800	-	18 x 38	18 x 38	21 x 38	-	-	-	-
10 000	-	18 x 38	21 x 38	-	-	-	-	-
15 000	-	21 x 38	-	-	-	-	-	-

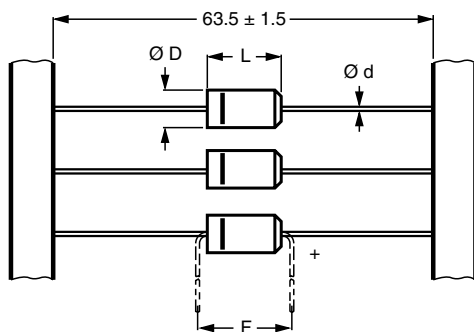
DIMENSIONS in millimeters AND AVAILABLE FORMS**Form BR:** Taped on reel**Form BA:** Taped in box (ammopack)case $\varnothing D \times L = 6.3 \times 12.7$ to 7.7×12.7 mm

Fig.2 Forms BA and BR

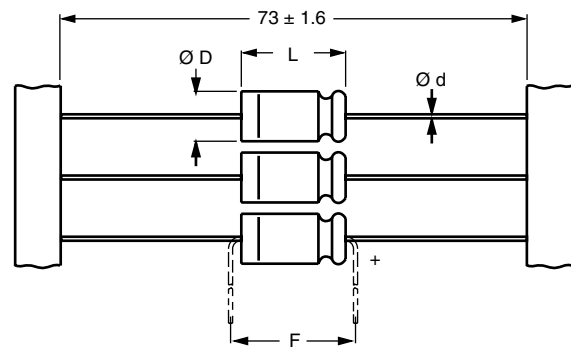
**Form BR:** Taped on reelcase $\varnothing D \times L = 6.5 \times 18$ to 15×30 mm**Form BA:** Taped in box (ammopack)case $\varnothing D \times L = 6.5 \times 18$ to 10×25 mm

Fig.3 Forms BA and BR

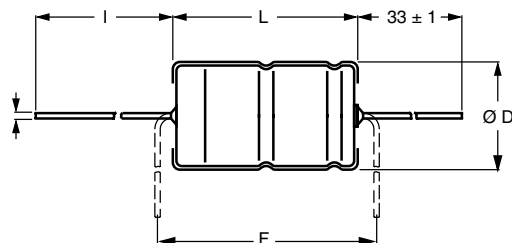
**Form AA:** Axial in boxcase $\varnothing D \times L = 10 \times 30$ to 21×38 mm

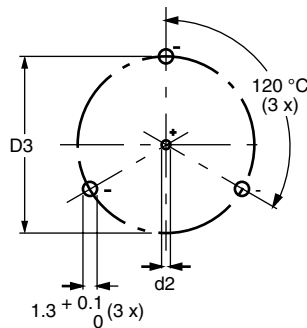
Fig.4 Form AA

Table 1

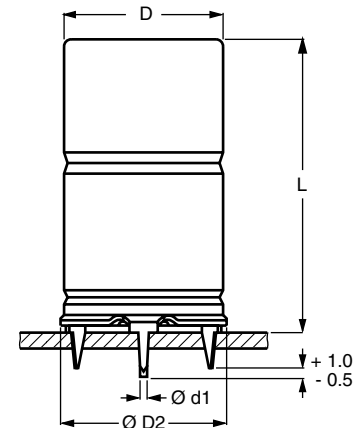
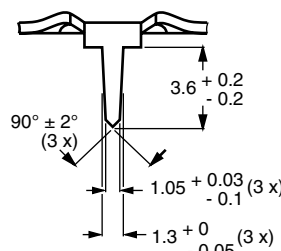
AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES										
NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	AXIAL: FORM AA, BA, and BR					MASS (g)	PACKAGING QUANTITIES		
		Ø d	l	Ø D _{max.}	L _{max.}	F _{min.}		FORM AA	FORM BA	FORM BR
6.3 x 12.7	(2)	0.6	-	6.5	12.9	17.5	≈ 1.1	-	1000	1000
7.7 x 12.7	(3)	0.6	-	7.9	12.9	17.5	≈ 1.3	-	500	500
6.5 x 18	4	0.8	-	6.9	18.5	25	≈ 1.3	-	1000	1000
8 x 18	5	0.8	-	8.5	18.5	25	≈ 1.7	-	500	500
10 x 18	6	0.8	-	10.5	18.5	25	≈ 2.5	-	500	500
10 x 25	7	0.8	-	10.5	25.5	30	≈ 3.3	-	500	500
10 x 30	00	0.8	55 ± 1	10.5	30.5	35	≈ 4.8	340	-	500
12.5 x 30	01	0.8	55 ± 1	13.0	30.5	35	≈ 7.4	260	-	400
15 x 30	02	0.8	55 ± 1	15.5	30.5	35	≈ 11.7	200	-	250
18 x 30	03	0.8	55 ± 1	18.5	30.5	35	≈ 12.9	120	-	-
18 x 38	04	0.8	34 ± 1	18.5	39.5	44	≈ 19.0	125	-	-
21 x 38	05	0.8	34 ± 1	21.5	39.5	44	≈ 24.0	100	-	-

Note

Detailed tape dimensions see section 'PACKAGING'.



Mounting holes



Case Ø D x L = 15 x 30 to 21 x 38 mm

Case not insulated (insulation on request)

Especially for applications with severe shocks and vibrations

Fig.5 Mounting hole diagram and outline; **Form MR:** With mounting ring and pins

Table 2

MOUNTING RING; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE Ø D x L	CASE CODE	MOUNTING RING: FORM MR						MASS (g)	PACKAGING QUANTITIES
		Ø d1	Ø d2	D _{max.}	Ø D2 _{max.}	D3	L _{max.}		
15 x 30	02	0.8	1.0 + 0.4	15.5	17.5	16.5 ± 0.2	33	≈ 11.7	200
18 x 30	03	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	33	≈ 12.9	240
18 x 38	04	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	42	≈ 19.0	100
21 x 38	05	0.8	1.0 + 0.4	21.5	22.5	21.5 ± 0.2	42	≈ 24.0	100

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 Hz, 105 °C
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 or 100 kHz

Note

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

Table 3

ELECTRICAL DATA AND ORDERING INFORMATION													
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE Ø D x L (mm)	I _R 100 Hz 105 °C (mA)	I _{L5} 5 min (μA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	ORDERING CODE MAL2138.....				
									IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR	
6.3	100	6.3 x 12.7	99	5.3	0.24	3.8	3.0	1.8	-	23101E3	33101E3	-	
	220	7.7 x 12.7	160	6.8	0.24	1.7	1.4	0.95	-	23221E3	33221E3	-	
	470	6.5 x 18	250	9.9	0.24	0.81	0.64	0.5	-	23471E3	33471E3	-	
	1000	10 x 18	430	17	0.24	0.38	0.30	0.24	-	23102E3	33102E3	-	
	2200	10 x 25	640	32	0.29	0.21	0.18	0.15	-	23222E3	33222E3	-	
10	150	7.7 x 12.7	140	7.0	0.2	2.1	1.3	0.95	-	24151E3	34151E3	-	
	220	6.5 x 18	190	8.4	0.2	1.4	0.91	0.5	-	24221E3	34221E3	-	
	470	8 x 18	300	13	0.2	0.68	0.43	0.35	-	24471E3	34471E3	-	
	1000	10 x 25	520	24	0.2	0.32	0.20	0.16	-	24102E3	34102E3	-	
	1500	10 x 30	670	34	0.28	0.32	0.26	0.26	14152E3	24152E3	-		
	2200	12.5 x 30	890	48	0.29	0.22	0.19	0.19	14222E3	24222E3	-		
	3300	15 x 30	1140	70	0.30	0.16	0.13	0.15	14332E3	24332E3	-		
	4700	18 x 30	1450	98	0.33	0.12	0.11	0.13	14472E3	-	-		
	6800	18 x 38	1880	140	0.34	0.085	0.074	0.11	14682E3	-	-		
	10 000	18 x 38	1980	200	0.41	0.070	0.062	0.10	14103E3	-	-		
15 000	21 x 38	2200	300	0.55	0.063	0.058	0.099	14153E3	-	-			
16	22	6.3 x 12.7	58	4.7	0.12	8.7	7.3	2.7	-	25229E3	35229E3	-	
	47	6.3 x 12.7	83	5.5	0.16	5.4	3.4	1.9	-	25479E3	35479E3	-	
	100	7.7 x 12.7	130	7.2	0.16	2.5	1.6	1.0	-	25101E3	35101E3	-	
	220	8 x 18	230	11	0.16	1.2	0.73	0.35	-	25221E3	35221E3	-	
	470	10 x 18	360	19	0.16	0.54	0.34	0.25	-	25471E3	35471E3	-	
	1000	10 x 30	630	36	0.20	0.34	0.27	0.26	15102E3	25102E3	-		
	1500	12.5 x 30	860	52	0.20	0.23	0.19	0.19	15152E3	25152E3	-		
	2200	15 x 30	1090	74	0.21	0.17	0.14	0.15	15222E3	25222E3	-		
	3300	18 x 30	1420	110	0.24	0.12	0.10	0.13	15332E3	-	-		
	4700	18 x 30	1480	150	0.28	0.10	0.090	0.12	15472E3	-	-		
	6800	18 x 38	1930	220	0.28	0.072	0.062	0.10	15682E3	-	-		
	10 000	21 x 38	2100	320	0.38	0.065	0.057	0.098	15103E3	-	-		
25	10	6.3 x 12.7	46	4.5	0.09	14	12	2.8	-	26109E3	36109E3	-	
	22	6.3 x 12.7	61	5.1	0.14	10	5.5	2.5	-	26229E3	36229E3	-	
	33	6.3 x 12.7	74	5.7	0.14	6.8	3.6	1.9	-	26339E3	36339E3	-	
	47	7.7 x 12.7	96	6.4	0.14	4.7	2.6	1.0	-	26479E3	36479E3	-	

ORDERING EXAMPLE

Electrolytic capacitor 138 series

470 μF /10 V; $\pm 20\%$

Nominal case size: $\varnothing 8 \times 18\text{ mm}$; Form BA

Ordering code: MAL213834471E3

Former 12 NC: 2222 138 34471



Aluminum Capacitors
Axial Miniature, Long-Life

Vishay BCcomponents

ELECTRICAL DATA AND ORDERING INFORMATION												
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE Ø D x L (mm)	I _R 100 Hz 105 °C (mA)	I _{L5} 5 min (μA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	ORDERING CODE MAL2138.....			
									IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
25	100	6.5 x 18	160	9.0	0.13	2.1	1.2	0.55	-	26101E3	36101E3	-
	220	10 x 18	270	15	0.13	0.94	0.55	0.27	-	26221E3	36221E3	-
	470	10 x 25	440	28	0.13	0.44	0.26	0.17	-	26471E3	36471E3	-
	680	10 x 30	580	38	0.14	0.36	0.26	0.25	16681E3	26681E3	-	-
	1000	12.5 x 30	790	54	0.15	0.25	0.18	0.19	16102E3	26102E3	-	-
	1500	15 x 30	1020	79	0.15	0.17	0.13	0.15	16152E3	26152E3	-	46152E3
	2200	18 x 30	1320	110	0.17	0.13	0.10	0.13	16222E3	-	-	46222E3
	3300	18 x 38	1720	170	0.17	0.090	0.071	0.11	16332E3	-	-	46332E3
	4700	18 x 38	1840	240	0.21	0.076	0.063	0.10	16472E3	-	-	46472E3
	6800	21 x 38	2100	340	0.27	0.068	0.058	0.099	16682E3	-	-	46682E3
40	33	7.7 x 12.7	91	6.6	0.11	5.3	2.7	1.0	-	27339E3	37339E3	-
	47	6.5 x 18	120	7.8	0.10	3.4	1.9	0.65	-	27479E3	37479E3	-
	100	8 x 18	180	12	0.10	1.6	0.9	0.40	-	27101E3	37101E3	-
	220	10 x 25	350	22	0.10	0.72	0.41	0.20	-	27221E3	37221E3	-
	330	10 x 30	490	30	0.09	0.47	0.32	0.30	17331E3	27331E3	-	-
	470	12.5 x 30	650	42	0.09	0.34	0.23	0.22	17471E3	27471E3	-	-
	680	12.5 x 30	750	58	0.10	0.25	0.18	0.18	17681E3	27681E3	-	-
	1000	15 x 30	970	84	0.10	0.17	0.12	0.14	17102E3	27102E3	-	47102E3
	1500	18 x 30	1250	120	0.12	0.13	0.098	0.12	17152E3	-	-	47152E3
	2200	18 x 38	1640	180	0.12	0.093	0.069	0.10	17222E3	-	-	47222E3
	3300	21 x 38	1810	270	0.15	0.079	0.061	0.10	17332E3	-	-	47332E3
50	10	6.3 x 12.7	51	5.0	0.09	14	7	2.7	-	21109E3	31109E3	-
	22	7.7 x 12.7	82	6.2	0.09	6.5	3.2	1.1	-	21229E3	31229E3	-
	100	10 x 18	230	14	0.08	1.3	0.7	0.30	-	21101E3	31101E3	-
63	4.7	6.3 x 12.7	35	4.6	0.09	30	17	5	-	28478E3	38478E3	-
	10	7.7 x 12.7	59	5.3	0.08	13	8	1.8	-	28109E3	38109E3	-
	22	6.5 x 18	100	6.8	0.07	5.1	3.6	0.85	-	28229E3	38229E3	-
	47	8 x 18	150	9.9	0.07	2.4	1.7	0.50	-	28479E3	38479E3	-
	100	10 x 25	280	17	0.07	1.1	0.8	0.27	-	28101E3	38101E3	-
	150	10 x 30	410	23	0.11	0.73	0.44	0.40	18151E3	28151E3	-	-
	220	12.5 x 30	560	32	0.11	0.50	0.31	0.29	18221E3	28221E3	-	-
	330	12.5 x 30	660	46	0.12	0.37	0.23	0.22	18331E3	28331E3	-	-
	470	15 x 30	860	63	0.12	0.26	0.16	0.16	18471E3	28471E3	-	48471E3
	680	18 x 30	1130	90	0.12	0.19	0.12	0.14	18681E3	-	-	48681E3
	1000	18 x 38	1460	130	0.12	0.13	0.086	0.11	18102E3	-	-	48102E3
	1500	21 x 38	1680	190	0.13	0.10	0.072	0.11	18152E3	-	-	48152E3
100	1.0	6.3 x 12.7	16	4.2	0.09	140	55	10	-	29108E3	39108E3	-
	2.2	6.3 x 12.7	24	4.4	0.09	65	25	8	-	29228E3	39228E3	-
	4.7	7.7 x 12.7	40	4.9	0.08	27	17	5	-	29478E3	39478E3	-
	10	6.5 x 18	67	6.0	0.07	11	8	2.4	-	29109E3	39109E3	-
	22	8 x 18	100	8.4	0.07	5.1	3.6	1.4	-	29229E3	39229E3	-
	47	10 x 25	190	13	0.07	2.4	1.7	0.67	-	29479E3	39479E3	-
	68	10 x 30	300	18	0.07	1.7	1.1	0.97	19689E3	29689E3	-	-
	100	12.5 x 30	410	24	0.07	1.1	0.77	0.67	19101E3	29101E3	-	-
	150	15 x 30	550	34	0.07	0.78	0.52	0.46	19151E3	29151E3	-	49151E3
	220	15 x 30	650	48	0.07	0.54	0.37	0.33	19221E3	29221E3	-	49221E3
	330	18 x 30	880	70	0.08	0.38	0.27	0.24	19331E3	-	-	49331E3
	470	18 x 38	1130	98	0.08	0.27	0.19	0.17	19471E3	-	-	49471E3
	680	21 x 38	1330	140	0.09	0.21	0.14	0.14	19681E3	-	-	49681E3

ADDITIONAL ELECTRICAL DATA			
PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Voltage			
Surge voltage		$U_s \leq 1.15 \times U_R$	
Reverse voltage		$U_{rev} \leq 1 \text{ V}$	
Current			
Leakage current	After 1 minute at U_R :		
	case $\varnothing D \times L = 6.3 \times 12.7$ and $7.7 \times 12.7 \text{ mm}$	$I_{L1} \leq 0.02 C_R \times U_R + 3 \mu A$	
	case $\varnothing D \times L = 6.5 \times 18$ to $21 \times 38 \text{ mm}$	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu A$	
	After 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu A$	
Inductance			
Equivalent series inductance (ESL)	Case $\varnothing D \times L \text{ mm}$:		
		6.3 x 12.7	typ. 20 nH
		7.7 x 12.7	typ. 30 nH
		6.5 x 18	typ. 15 nH
		8 x 18	typ. 35 nH
		10 x 18	typ. 69 nH
		10 x 25	typ. 38 nH
		10 x 30	typ. 38 nH
		12.5 x 30	typ. 46 nH
		15 x 30	typ. 48 nH
		18 x 30	typ. 50 nH
		18 x 38	typ. 54 nH
		21 x 38	typ. 59 nH

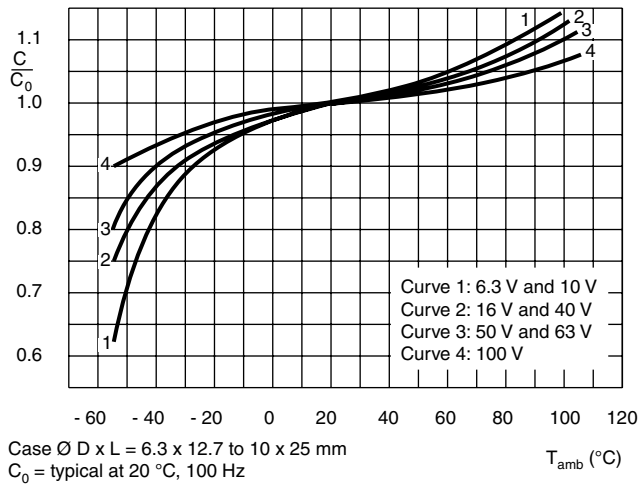
CAPACITANCE (C)

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

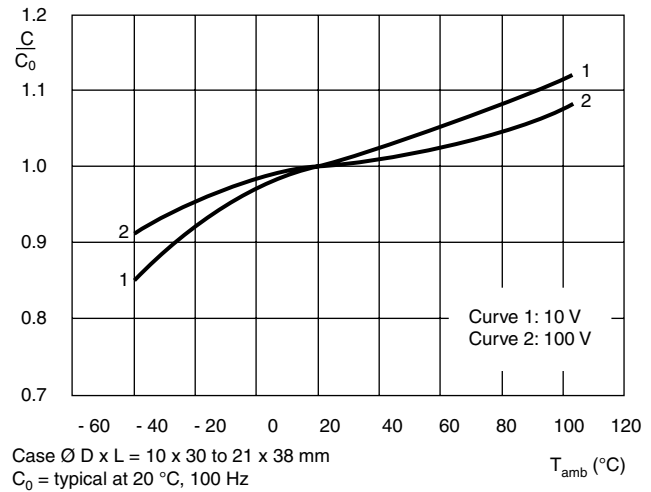


Fig.7 Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

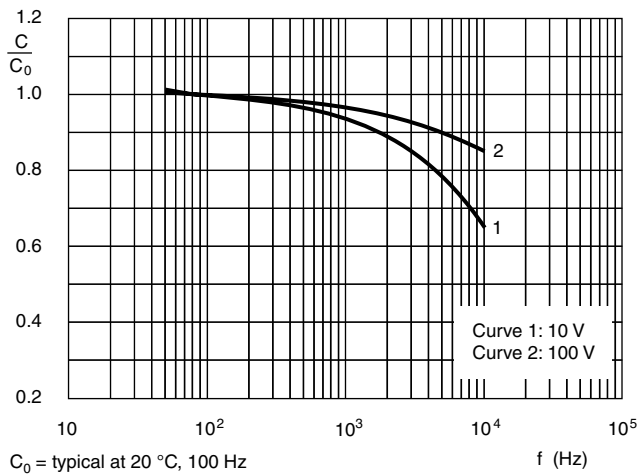


Fig.8 Typical multiplier of capacitance as a function of frequency

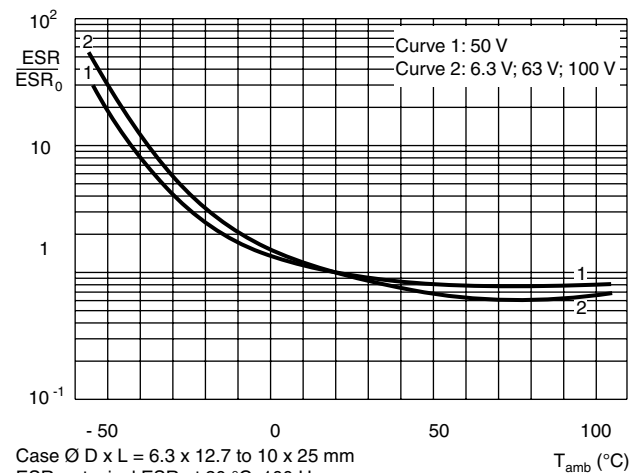


Fig.9 Typical multiplier of ESR as a function of ambient temperature

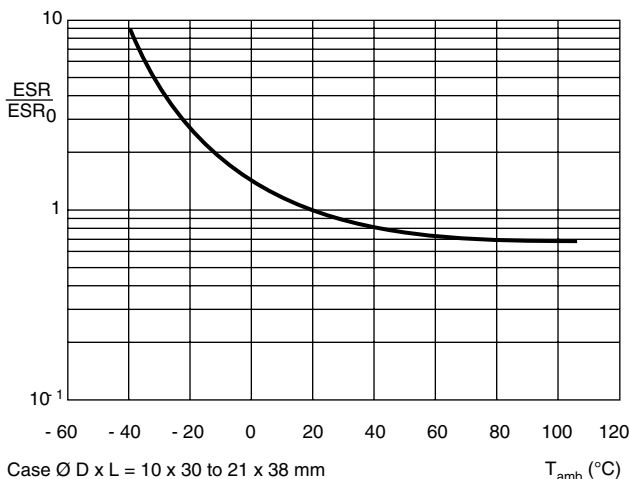


Fig.10 Typical multiplier of ESR as a function of ambient temperature

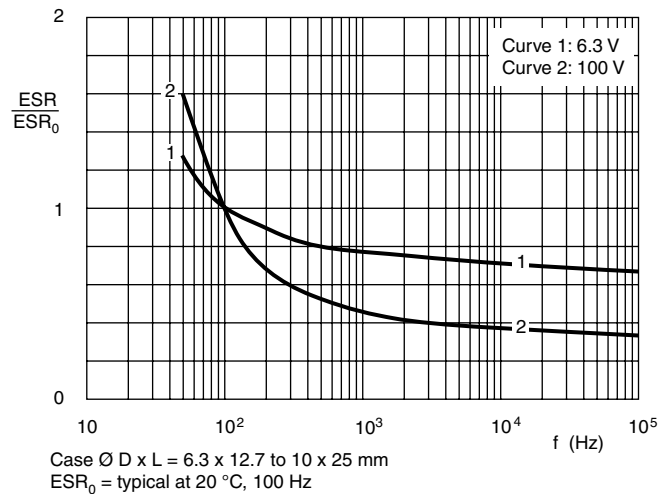


Fig.11 Typical multiplier ESR as a function of frequency

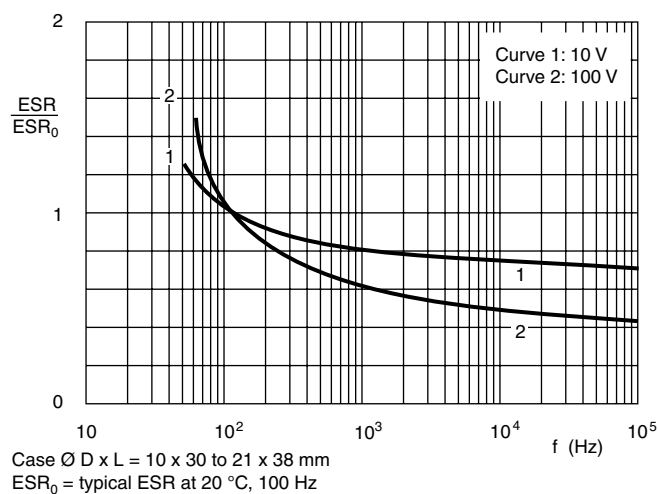
EQUIVALENT SERIES RESISTANCE (ESR)

Fig.12 Typical multiplier ESR as a function of frequency

IMPEDANCE (Z)

Table 4

IMPEDANCE VS. CAPACITANCE VALUES (case $\varnothing D \times L = 6.3 \times 12.7$ to 10×25 mm)								
T_{amb}	Z x C_R ($\Omega \times \mu F$) AT 10 kHz							
	6.3 V	10 V	16 V	25 V	40 V	50 V	63 V	100 V
+ 20 °C	≤ 300	≤ 200	≤ 160	≤ 120	≤ 90	≤ 70	≤ 80	≤ 80
- 25 °C	≤ 2000	≤ 1200	≤ 750	≤ 560	≤ 450	≤ 300	≤ 550	≤ 550
- 40 °C	≤ 5500	≤ 3200	≤ 2000	≤ 1500	≤ 1200	≤ 900	≤ 1500	≤ 1500

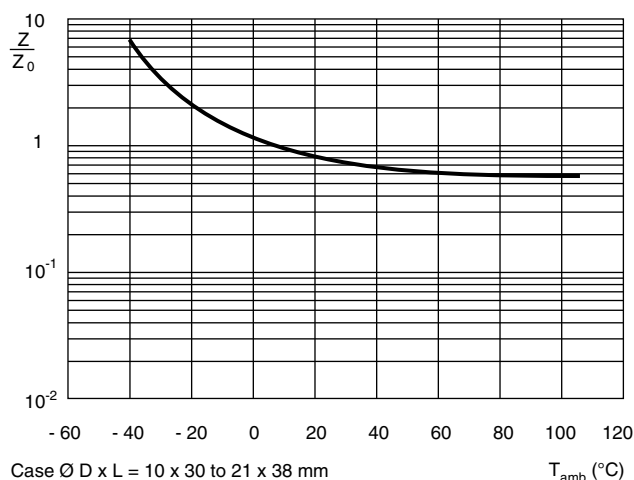


Fig.13 Typical multiplier of ESR as a function of ambient temperature at 10 kHz

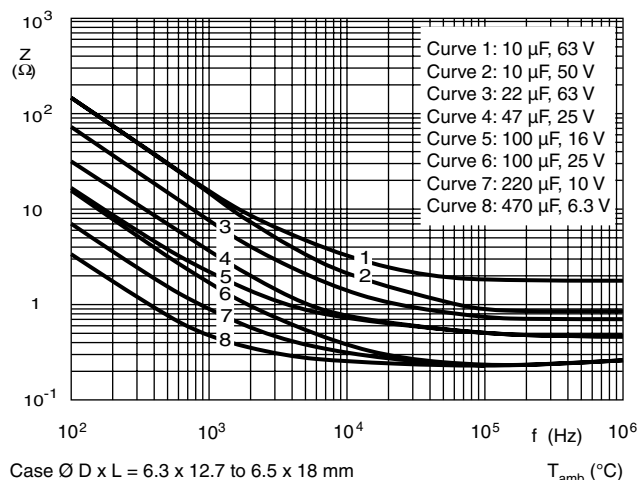


Fig.14 Typical impedance as a function of frequency

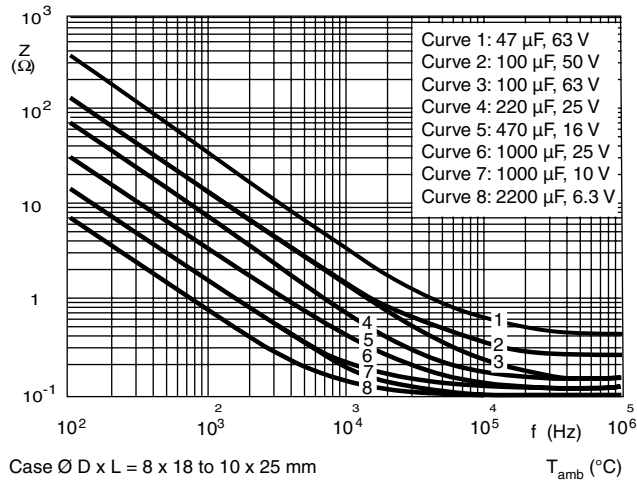


Fig.15 Typical impedance as a function of frequency

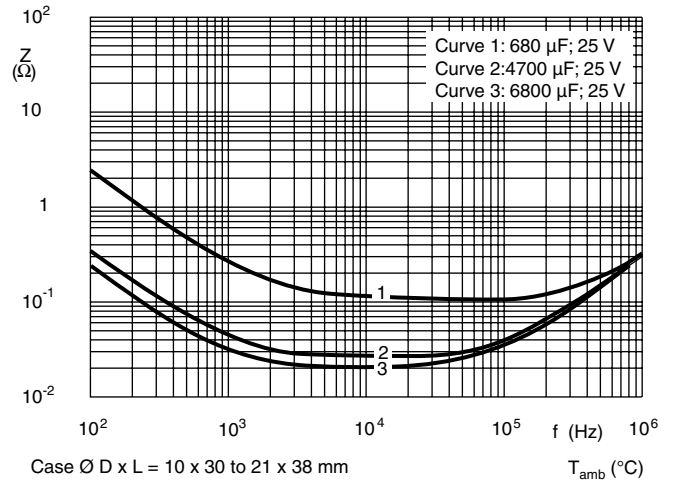


Fig.16 Typical impedance as a function of frequency

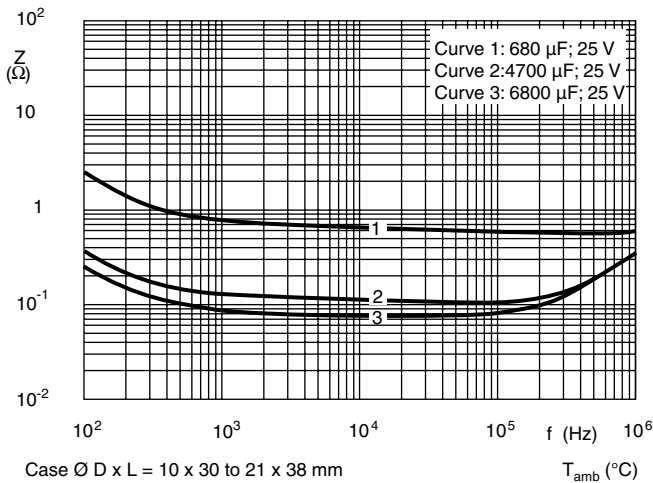


Fig.17 Typical impedance as a function of frequency

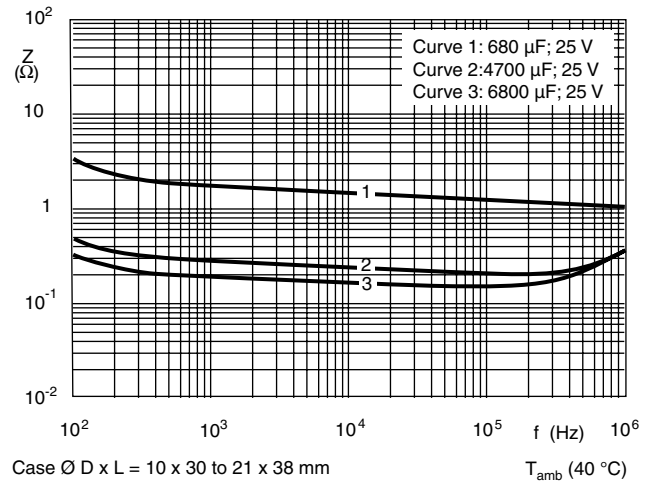


Fig.18 Typical impedance as a function of frequency

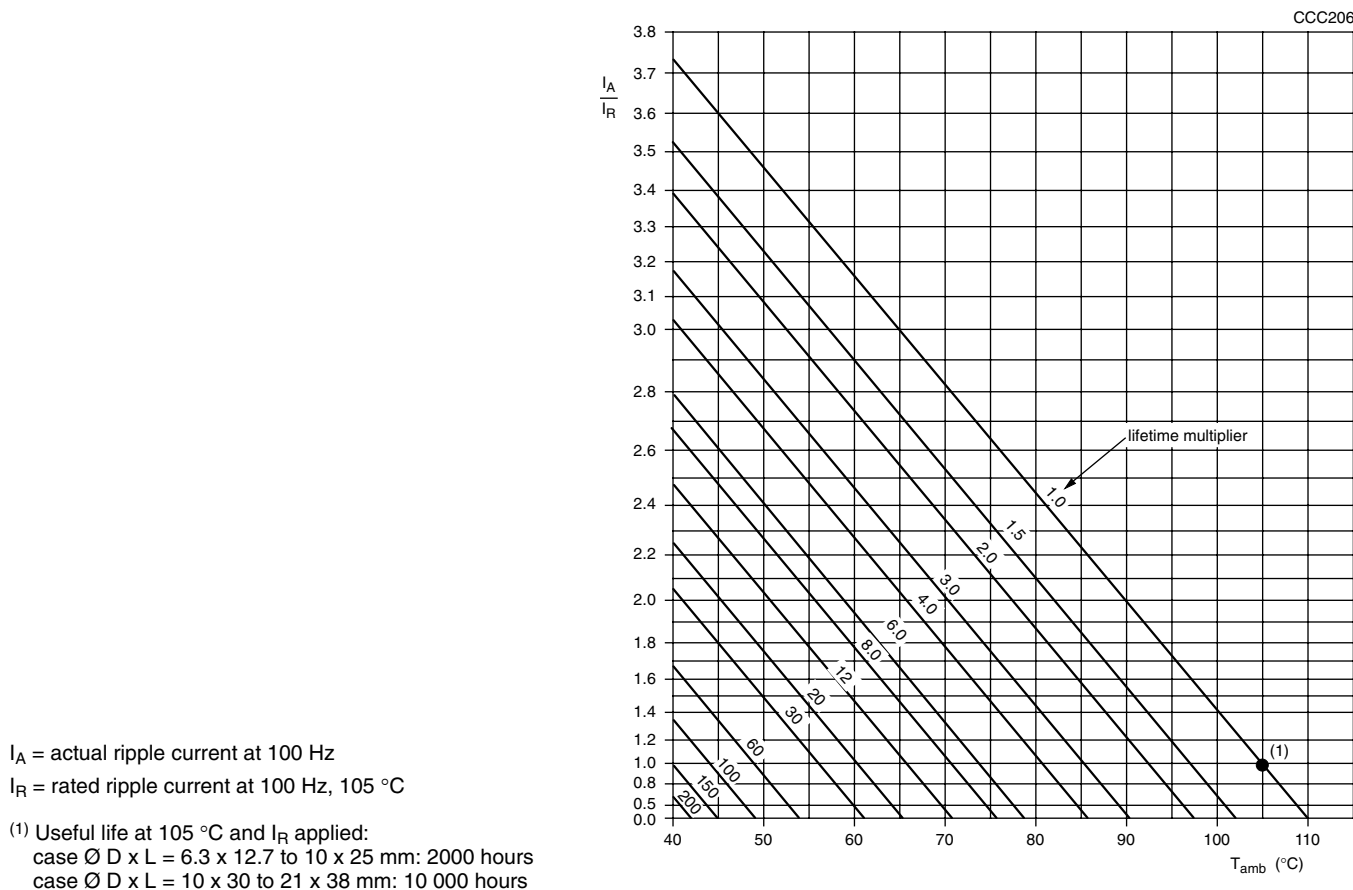
RIPPLE CURRENT AND USEFUL LIFE

Fig.19 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 5

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 25 V	$U_R = 40$ to 100 V
50	0.95	0.90	0.85
100	1.00	1.00	1.00
300	1.07	1.12	1.20
1000	1.12	1.20	1.30
3000	1.15	1.25	1.35
≥ 10 000	1.20	1.30	1.40



Table 6

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; case $\varnothing D \times L$: 6.3 x 12.7 to 10 x 25 mm: 1000 hours; 10 x 30 to 21 x 38 mm: 5000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: + 15/- 30 % $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; case $\varnothing D \times L$: 6.3 x 12.7 to 10 x 25 mm: 2000 hours; 10 x 30 to 21 x 38 mm: 10 000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: + 45/- 50 % $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300, subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$; 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 $I_{L5} \leq 2 \times \text{spec. limit}$



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