Aluminum Capacitors
Axial High Temperature, DIN-Based

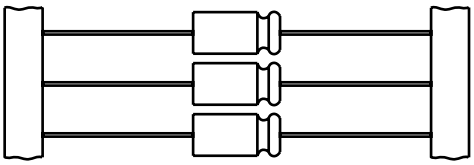
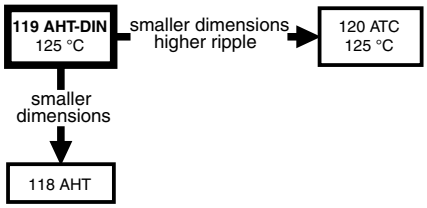


Fig.1 Component outlines



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- 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
- Extra long useful life: up to 8000 hours at 125 °C, high stability, high reliability
- Extended temperature range: 125 °C (usable up to 150 °C)
- High ripple current capability
- Lead (Pb)-free versions are RoHS compliant

Pb-free

RoHS COMPLIANT

APPLICATIONS

- Military, industrial control, EDP and telecommunication
- Smoothing, filtering, buffering in SMPS; coupling, decoupling
- For use where low mounting height is important; 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 (T for - 10 to + 50 %)
- Rated voltage (in V) at 125 °C and 85 °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
- Series number (119)

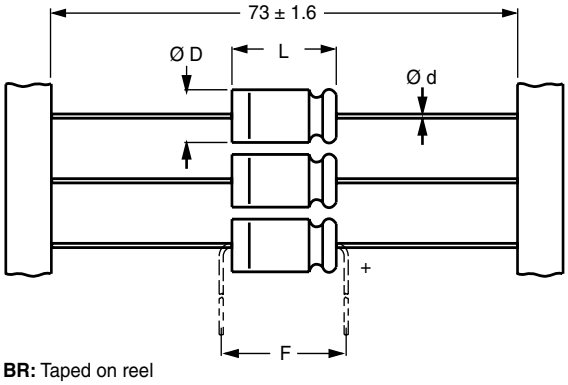
QUICK REFERENCE DATA		
DESCRIPTION	**VALUE**	
Nominal case sizes (Ø D x L in mm)	6.5 x 18 to 10 x 25	10 x 30 to 21 x 38
Rated capacitance range, C_R	4.7 to 4700 µF	
Tolerance on C_R	- 10/+ 50 %	
Rated voltage range, U_R	10 to 200 V	
Category temperature range	- 55 to + 125 °C	
Endurance test at 150 °C	500 hours	500 hours
Endurance test at 125 °C	2000 hours	4000 hours
Useful life at 125 °C	4000 hours	8000 hours
Useful life at 40 °C, 1.8 I_R applied	500 000 hours	100 0000 hours
Shelf life at 0 V, 125 °C: U_R = 10 to 63 V U_R = 100 and 200 V	 500 hours 100 hours	
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	55/125/56	

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)						
	10	**16**	**25**	**40**	**63**	**100**	**200**
4.7	-	-	-	-	-	6.5 x 18	10 x 18
10	-	-	-	-	6.5 x 18	8 x 18	10 x 25
22	-	-	6.5 x 18	-	8 x 18	10 x 18	-
47	-	6.5 x 18	-	8 x 18	10 x 18	10 x 25	-
	-	-	-	-	-	10 x 30	-
68	-	-	-	-	10 x 30	12.5 x 30	-
100	6.5 x 18	8 x 18	10 x 18	10 x 25	10 x 30	15 x 30	-
150	-	-	-	12.5 x 30	15 x 30	15 x 30	-

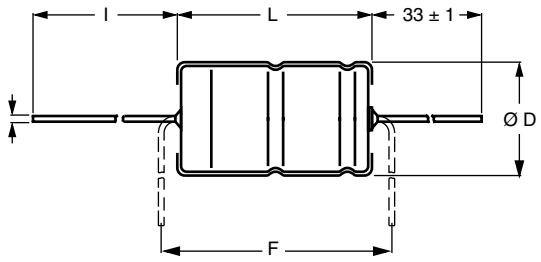
SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)							
C_R (µF)	**U_R (V)**						
	10	**16**	**25**	**40**	**63**	**100**	**200**
220	10 x 18	10 x 25	10 x 25	12.5 x 30	15 x 30	18 x 30	-
	-	-	12.5 x 30	-	-	-	-
330	-	12.5 x 30	12.5 x 30	15 x 30	18 x 30	18 x 38	-
470	10 x 25	12.5 x 30	12.5 x 30	15 x 30	18 x 38	21 x 38	-
	12.5 x 30	-	-	-	-	-	-
680	12.5 x 30	15 x 30	18 x 30	18 x 30	21 x 38	-	-
1000	15 x 30	15 x 30	18 x 30	18 x 38	21 x 38	-	-
1500	18 x 30	18 x 30	18 x 38	21 x 38	-	-	-
2200	18 x 30	18 x 38	21 x 38	21 x 38	-	-	-
3300	18 x 38	21 x 38	-	-	-	-	-
4700	21 x 38	21 x 38	-	-	-	-	-

DIMENSIONS IN MILLIMETERS AND AVAILABLE FORMS



Form BR: Taped on reel
case Ø D x L = 6.5 x 18 to 15 x 30 mm
Form BA: Taped in box (ammopack)
case Ø D x L = 6.5 x 18 to 10 x 25 mm

Fig.2 **Forms BA and BR**



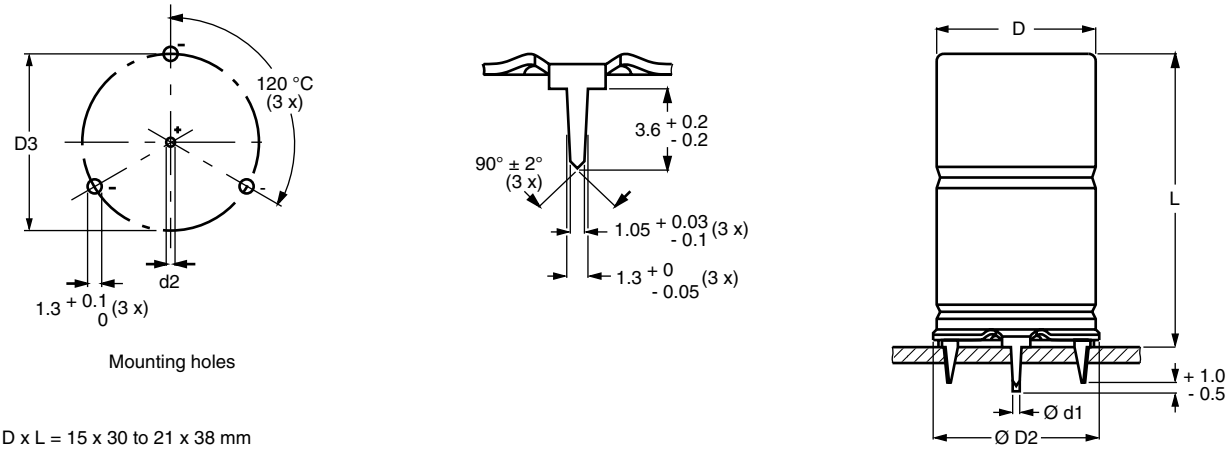
Form AA: Axial in box
case Ø D x L = 10 x 30 to 21 x 38 mm

Fig.3 **Form AA**

Table 1

AXIAL; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**										
NOMINAL CASE SIZE Ø D x L	**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**
6.5 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'.



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.4 Mounting hole digram 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**	**Ø $D_{max.}$**	**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	≈ 8.6	200
18 x 30	03	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	33	≈ 11.5	240
18 x 38	04	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	42	≈ 14.0	100
21 x 38	05	0.8	1.0 + 0.4	21.5	22.5	21.5 ± 0.2	42	≈ 19.2	100

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance - 10/+ 50 %
I_R	rated RMS ripple current at 100 Hz, 125 °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 $\delta_{max.}$ and C_R)
Z	max. impedance at 10 kHz

Note

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

ORDERING EXAMPLE

Electrolytic capacitor 119 series

470 µF/16 V; - 10/+ 50 %

Nominal case size: Ø 12.5 x 30 mm; Form BR

Ordering code: MAL211925471E3
Former 12NC: 2222 119 25471

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2119.....			
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
10	100	6.5 x 18	4	130	10	6	0.2	3.5	2.2	-	24101E3	34101E3	-
	220	10 x 18	6	240	17	8.4	0.18	1.3	1.0	-	24221E3	34221E3	-
	470	10 x 25	7	380	32	13	0.18	0.61	0.49	-	90501E3	90502E3	-
	470	12.5 x 30	01	550	32	13	0.16	0.54	0.38	14471E3	24471E3	-	-
	680	12.5 x 30	01	640	45	18	0.20	0.47	0.38	14681E3	24681E3	-	-
	1000	15 x 30	02	830	64	24	0.20	0.32	0.24	90032E3	24102E3	-	44102E3
	1500	18 x 30	03	1100	94	34	0.22	0.23	0.17	14152E3	-	-	44152E3
	2200	18 x 30	03	1190	136	48	0.26	0.19	0.17	14222E3	-	-	44222E3
	3300	18 x 38	04	1550	202	70	0.27	0.13	0.10	14332E3	-	-	44332E3
	4700	21 x 38	05	1700	286	90	0.30	0.10	0.09	14472E3	-	-	44472E3
16	47	6.5 x 18	4	110	10	5.5	0.13	4.4	2.2	-	25479E3	35479E3	-
	100	8 x 18	5	170	14	7.2	0.13	2.1	1.3	-	25101E3	35101E3	-
	220	10 x 25	7	300	25	11	0.13	0.94	0.55	-	25221E3	35221E3	-
	330	12.5 x 30	01	560	36	15	0.13	0.63	0.38	15331E3	25331E3	-	-
	470	12.5 x 30	01	570	50	19	0.15	0.51	0.38	15471E3	25471E3	-	-
	680	15 x 30	02	750	69	26	0.15	0.35	0.24	15681E3	25681E3	-	45681E3
	1000	15 x 30	02	850	100	36	0.19	0.30	0.24	15102E3	25102E3	-	45102E3
	1500	18 x 30	03	1120	148	52	0.20	0.21	0.17	15152E3	-	-	45152E3
	2200	18 x 38	04	1440	215	74	0.20	0.14	0.10	15222E3	-	-	45222E3
	3300	21 x 38	05	1650	321	110	0.22	0.11	0.09	15332E3	-	-	45332E3
	4700	21 x 38	05	1710	455	154	0.28	0.09	0.09	15472E3	-	-	45472E3
25	22	6.5 x 18	4	85	10	5.1	0.10	7.2	3.2	-	26229E3	36229E3	-
	100	10 x 18	6	210	19	9	0.10	1.6	1.0	-	26101E3	36101E3	-
	220	10 x 25	7	350	37	15	0.10	0.72	0.58	-	90503E3	90504E3	-
	220	12.5 x 30	01	500	37	15	0.09	0.65	0.38	16221E3	26221E3	-	-
	330	12.5 x 30	01	580	54	21	0.11	0.53	0.38	16331E3	26331E3	-	-
	470	12.5 x 30	01	630	75	28	0.13	0.44	0.38	16471E3	26471E3	-	-
	680	18 x 30	03	990	106	38	0.13	0.30	0.17	16681E3	-	-	46681E3
	1000	18 x 30	03	1090	154	54	0.13	0.21	0.17	16102E3	-	-	46102E3
	1500	18 x 38	04	1420	229	79	0.13	0.14	0.10	16152E3	-	-	46152E3
	2200	21 x 38	05	1550	334	114	0.13	0.11	0.09	16222E3	-	-	46222E3
40	47	8 x 18	5	150	15	7.8	0.08	2.7	1.5	-	27479E3	37479E3	-
	100	10 x 25	7	260	28	12	0.08	1.3	0.7	-	27101E3	37101E3	-
	150	12.5 x 30	01	440	40	16	0.08	0.85	0.51	17151E3	27151E3	-	-
	220	12.5 x 30	01	500	57	22	0.09	0.65	0.48	17221E3	27221E3	-	-
	330	15 x 30	02	630	83	30	0.09	0.43	0.37	17331E3	27331E3	-	47331E3
	470	15 x 30	02	720	117	42	0.12	0.41	0.37	17471E3	27471E3	-	47471E3
	680	18 x 30	03	970	167	58	0.12	0.28	0.22	17681E3	-	-	47681E3
	1000	18 x 38	04	1250	244	84	0.12	0.19	0.14	17102E3	-	-	47102E3
	1500	21 x 38	05	1410	364	124	0.14	0.15	0.12	17152E3	-	-	47152E3
	2200	21 x 38	05	1550	532	180	0.18	0.13	0.11	17222E3	-	-	47222E3

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2119.....			
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
63	10	6.5 x 18	4	68	20	5.3	0.07	11	5.6	-	28109E3	38109E3	-
	22	8 x 18	5	110	20	6.7	0.07	5.1	2.8	-	28229E3	38229E3	-
	47	10 x 18	6	180	22	9.9	0.07	2.4	1.3	-	28479E3	38479E3	-
	68	10 x 25	7	230	30	13	0.07	1.6	1.0	-	90505E3	90506E3	-
	68	10 x 30	00	300	30	13	0.07	1.6	0.92	18689E3	28689E3	-	-
	100	10 x 30	00	360	42	17	0.08	1.3	0.75	18101E3	28101E3	-	-
	150	15 x 30	02	560	61	23	0.08	0.85	0.37	18151E3	28151E3	-	48151E3
	220	15 x 30	02	640	87	32	0.08	0.58	0.37	18221E3	28221E3	-	48221E3
	330	18 x 30	03	880	129	46	0.09	0.43	0.23	18331E3	-	-	48331E3
	470	18 x 38	04	1130	182	63	0.09	0.30	0.15	18471E3	-	-	48471E3
	680	21 x 38	05	1290	261	90	0.09	0.21	0.12	18681E3	-	-	48681E3
	1000	21 x 38	05	1430	382	130	0.10	0.16	0.11	18102E3	-	-	48102E3
100	4.7	6.5 x 18	4	44	20	10	0.08	27	10	-	29478E3	39478E3	-
	10	8 x 18	5	70	20	10	0.08	13	6.0	-	29109E3	39109E3	-
	22	10 x 18	6	112	20	10	0.08	5.8	3.5	-	29229E3	39229E3	-
	47	10 x 25	7	178	32	13	0.08	2.7	2.0	-	90518E3	90519E3	-
	47	10 x 30	00	240	32	13	0.08	2.7	2.0	19479E3	29479E3	-	-
	68	12.5 x 30	01	330	45	18	0.08	1.9	1.2	19689E3	29689E3	-	-
	100	15 x 30	02	440	64	24	0.09	1.4	0.96	19101E3	29101E3	-	49101E3
	150	15 x 30	02	520	94	34	0.10	1.1	0.78	19151E3	29151E3	-	49151E3
	220	18 x 30	03	710	136	48	0.10	0.72	0.55	19221E3	-	-	49221E3
	330	18 x 38	04	920	202	70	0.10	0.48	0.37	19331E3	-	-	49331E3
	470	21 x 38	05	1070	286	98	0.10	0.34	0.28	19471E3	-	-	49471E3
200	4.7	10 x 18	6	52	20	10	0.08	27	10	-	90507E3	90508E3	-
	10	10 x 25	7	82	20	10	0.08	13	5.0	-	90509E3	90511E3	-

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:		
	U_R = 10 to 40 V	$I_{L1} \leq 0.006\ C_R \times U_R + 4$ µA, or 10 µA (whichever is greater)	
	U_R = 63 V to 200 V	$I_{L1} \leq 0.006\ C_R \times U_R + 4$ µA, or 20 µA (whichever is greater)	
	After 5 minutes:		
	U_R = 10 to 63 V	$I_{L5} \leq 0.002\ C_R \times U_R + 4$ µA	
	U_R = 100 and 200 V	$I_{L5} \leq 0.002\ C_R \times U_R + 4$ µA, or 10 µA (whichever is greater)	
Inductance			

ADDITIONAL ELECTRICAL DATA			
PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Equivalent series inductance (ESL)	Case Ø D x L mm:		
	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	typ. 39 nH
	18 x 30	typ. 50 nH	typ. 39 nH
	18 x 38	typ. 54 nH	typ. 39 nH
	21 x 38	typ. 59 nH	typ. 39 nH

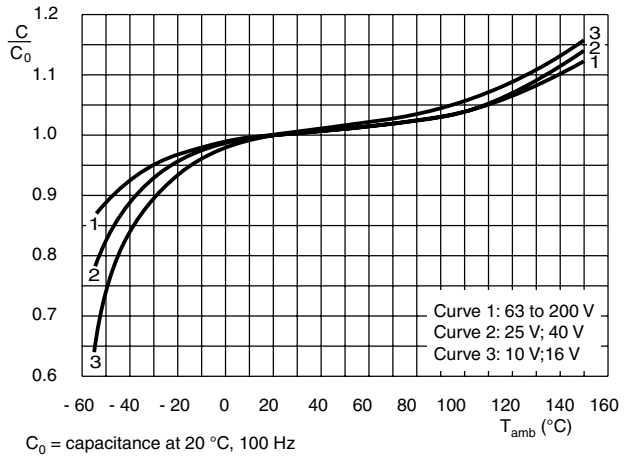
Table 3

UPRATING VALUES AT REDUCED AMBIENT TEMPERATURE									
SYMBOL	CONDITIONS	VALUES							UNIT
U_R	T_{amb} > 85 to 125 °C	10	16	25	40	63	100	200	V
U_{R2}	$T_{amb} \leq 85$ °C	16	25	40	63	100	125	250	V

Note

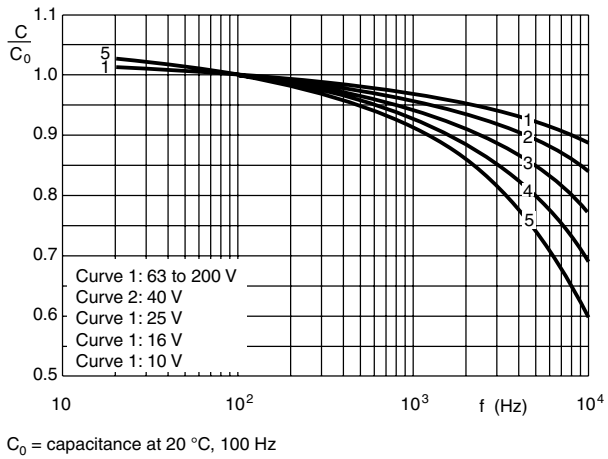
1. For applications at ambient temperatures of ≤ 85 °C, the rated voltage (U_R) may be raised to U_{R2}.

CAPACITANCE (C)



C_0 = capacitance at 20 °C, 100 Hz

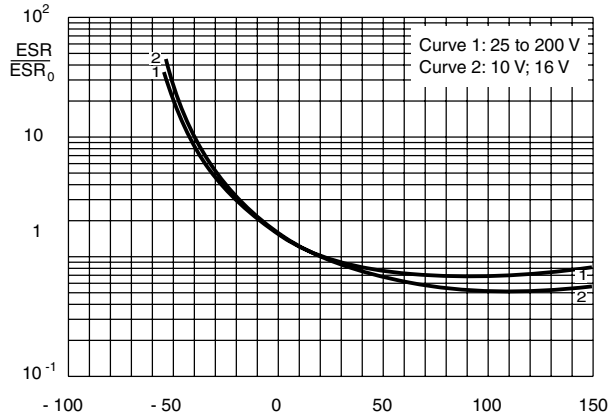
Fig.5 Typical multiplier of capacitance as a function of ambient temperature



C_0 = capacitance at 20 °C, 100 Hz

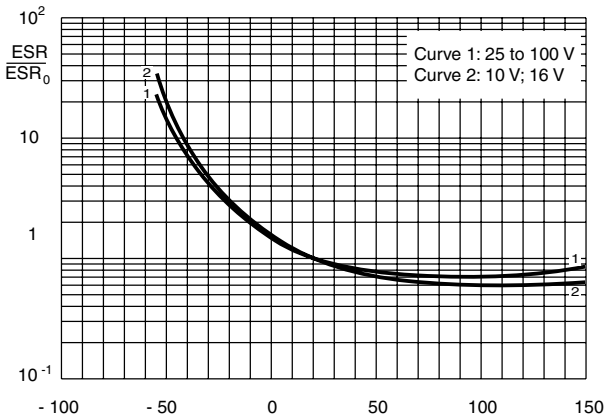
Fig.6 Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)



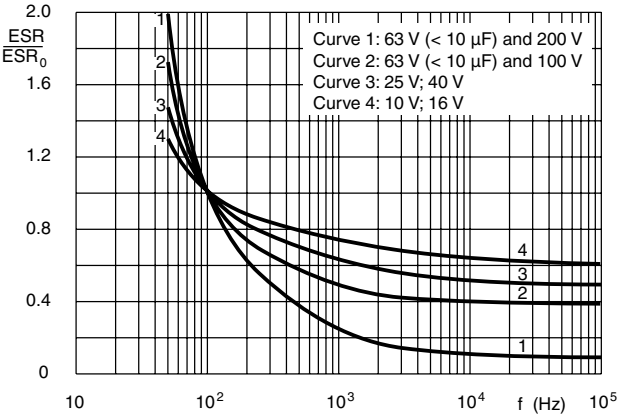
Case Ø D x L = 6.5 x 18 to 15 x 30 mm
ESR_0 = typical at 20 °C, 100 Hz

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



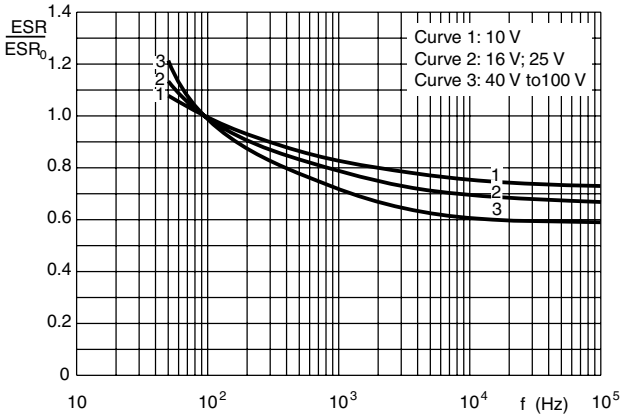
Case Ø D x L = 18 x 30 to 21 x 38 mm
ESR_0 = typical at 20 °C, 100 Hz

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



Case Ø D x L = 6.5 x 18 to 10 x 25 mm
ESR_0 = typical at 20 °C, 100 Hz

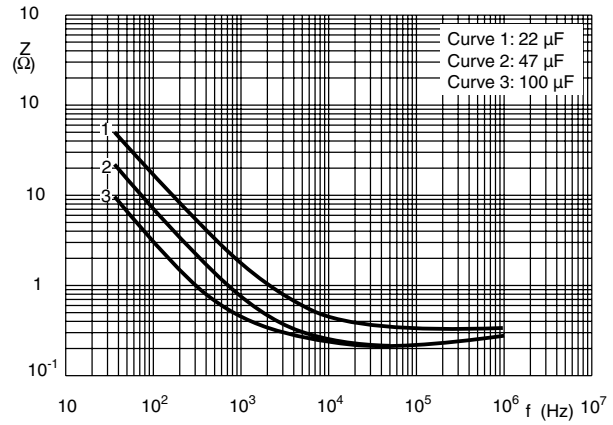
Fig.9 Typical multiplier of ESR as a function of frequency



Case Ø D x L = 10 x 30 to 21 x 38 mm
ESR_0 = typical at 20 °C, 100 Hz

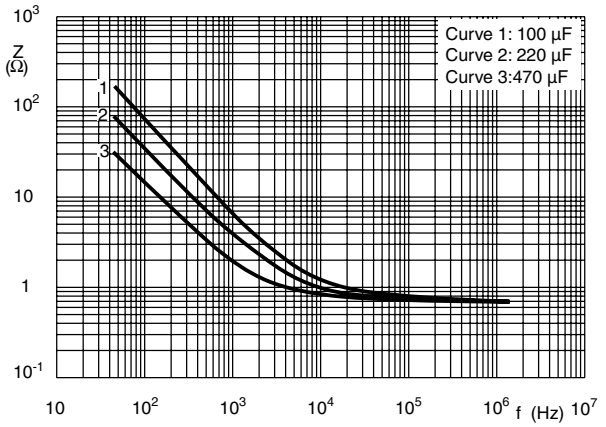
Fig.10 Typical multiplier of ESR as a function of frequency

IMPEDANCE (Z)



Case Ø D x L = 8 x 18 mm

Fig.11 Typical impedance as a function of frequency



Case Ø D x L = 8 x 18 mm

T_{amb} (°C)

Fig.12 Typical impedance as a function of frequency

IMPEDANCE (Z)

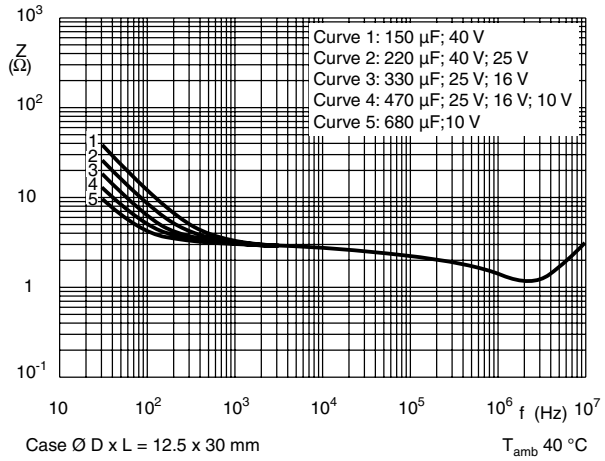


Fig.13 Typical impedance as a function of frequency

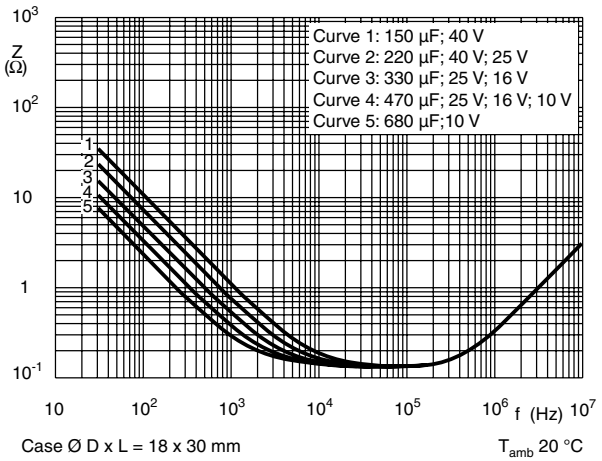


Fig.14 Typical impedance as a function of frequency

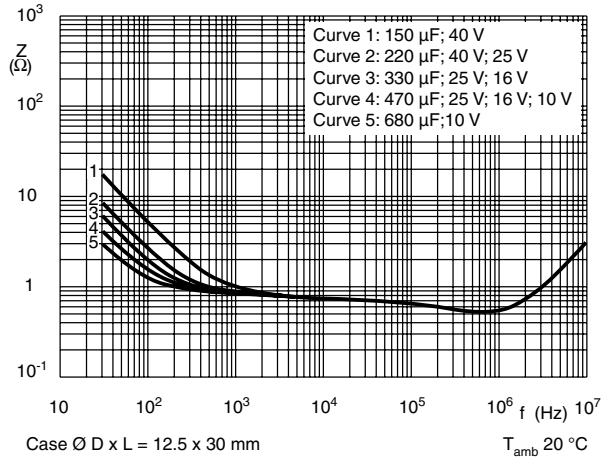


Fig.15 Typical impedance as a function of frequency

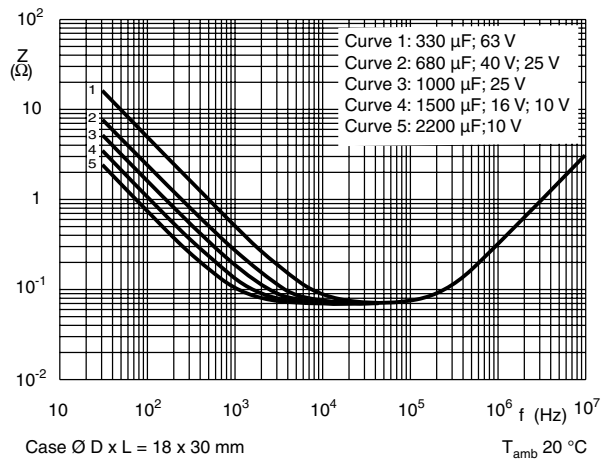
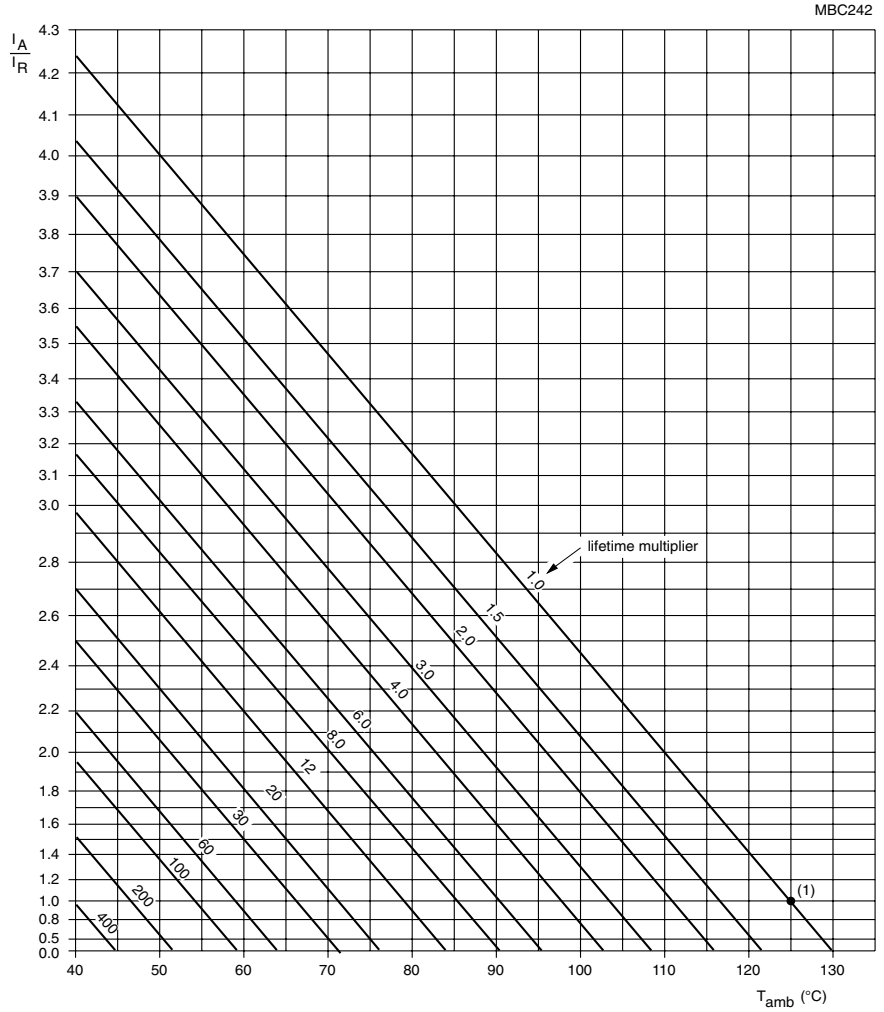


Fig.16 Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 125 °C
(1) Useful life at 125 °C and I_R applied:
case ∅ D x L = 6.5 x 18 to 10 x 25 mm: 4000 hours
case ∅ D x L = 10 x 30 to 21 x 38 mm: 8000 hours

Fig.17 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	U_R = 10 and 16 V	U_R = 25 and 40 V	U_R = 63 to 200 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 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T_{amb} = 125 °C; U_R applied; Case Ø D x L = 6.5 x 18 to 10 x 25 mm: 2000 hours; Case Ø D x L = 10 x 30 to 21 x 38 mm: 4000 hours	$\Delta C/C$: ± 15 % tan $\delta \leq$ 1.3 x spec. limit $Z \leq$ 2 x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 125 °C; U_R and I_R applied; Case Ø D x L = 6.5 x 18 to 10 x 25 mm: 4000 hours; Case Ø D x L = 10 x 30 to 21 x 38 mm: 8000 hours	$\Delta C/C$: ± 45 % tan $\delta \leq$ 3 x spec. limit $Z \leq$ 3 x spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 % (200 V ≤ 3 %)
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 125 °C; no voltage applied; U_R = 10 to 63 V: 500 hours; U_R = 100 and 200 V: 100 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 x spec. limit
Reverse voltage	IEC 60384-4/ EN130300 subclause 4.15	T_{amb} = 125 °C: 125 hours at U = - 1 V followed by 125 hours at U_R	$\Delta C/C$: ± 20 % tan $\delta \leq$ spec. limit $I_{L5} \leq$ spec. limit

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