Aluminum Capacitors
Axial High Temperature, DIN-Based

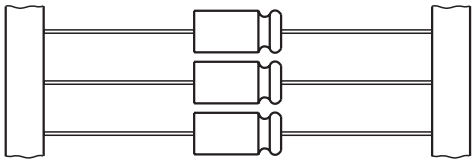
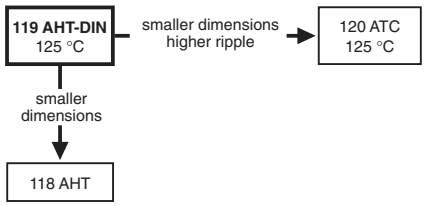


Fig.1 Component outlines



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 ∅15 × 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.

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).

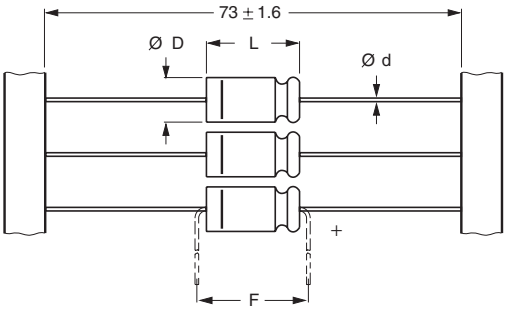
QUICK REFERENCE DATA		
DESCRIPTION	VALUE	
Nominal case sizes (∅D × L in mm)	6.5 × 18 to 10 × 25	10 × 30 to 21 × 38
Rated capacitance range, C_R	4.7 to 4700 µF	
Tolerance on C_R	−10/+50%	
Rated voltage range, U_R	10 to 200 V	
Category temperature range	−55 to +125 °C	
Endurance test at 150 °C	500 hours	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	500000 hours	1000000 hours
Shelf life at 0 V, 125 °C:		
U_R = 10 to 63 V	500 hours	
U_R = 100 and 200 V	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 (∅D × L in mm)

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

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

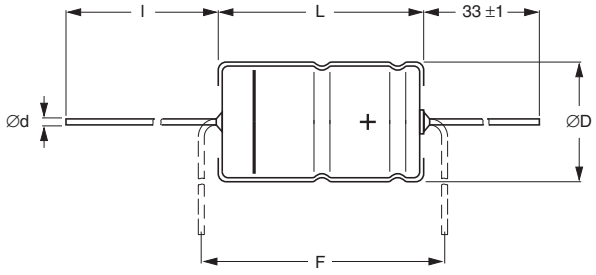
DIMENSIONS in millimeters **AND AVAILABLE FORMS**



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.

Fig.2 **Forms BA and BR.**



Form AA: Axial in box,
case ∅D × L = 10 × 30 to 21 × 38 mm.

Fig.3 **Form AA.**

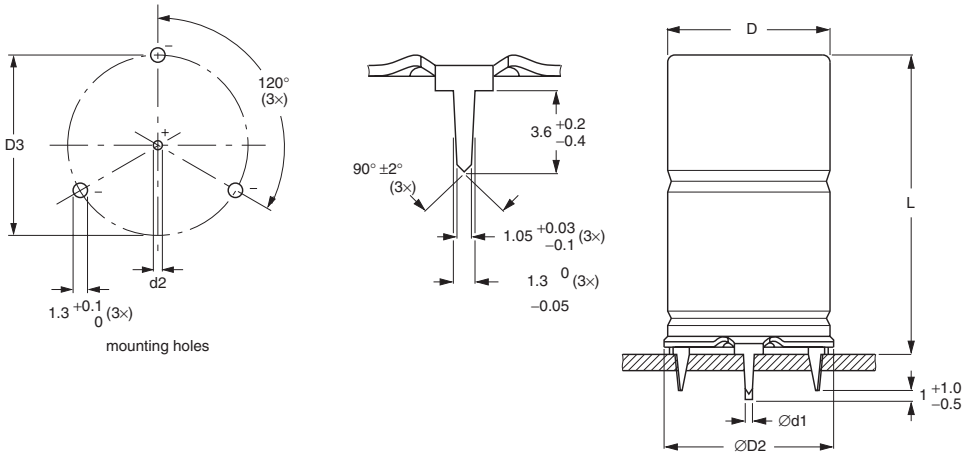
Table 1

AXIAL; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**										
NOMINAL CASE SIZE ∅D × L	**CASE CODE**	**AXIAL FORM AA, BA, and BR**					**MASS (g)**	**PACKAGING QUANTITIES**		
		∅d	**l**	**$∅D_{max}$**	**L_{max}**	**F_{min}**		**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	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	–	–

Note

1. Detailed tape dimensions see section ‘PACKAGING’.

Fig.4 Mounting hole diagram and outline; **Form MR;** mounting ring and pins.



Form MR: case
∅D × L = 15 × 30 to 21 × 38 mm.
Case not insulated (insulation on request).

Table 2

MOUNTING RING; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE ∅D × L	**CASE CODE**	**MOUNTING RING: FORM MR**						**MASS (g)**	**PACKAGING QUANTITIES**
		∅d1	**∅d2**	**∅D_{max}**	**∅$D2_{max}$**	**D3**	**L_{max}**		
15 × 30	02	0.8	1.0 +0.4	15.5	17.5	16.5 ±0.2	33	≈8.6	200
18 × 30	03	0.8	1.0 +0.4	18.5	19.5	18.5 ±0.2	33	≈11.5	240
18 × 38	04	0.8	1.0 +0.4	18.5	19.5	18.5 ±0.2	42	≈14.0	100
21 × 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 δ_{max} and C_R)
Z	max. impedance at 10 kHz

Note

1. Unless otherwise specified, all electrical values in Table 3 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: ∅12.5 × 30 mm; Form BR

Catalog number: 2222 119 25471.

Table 3

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D × 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)	CATALOG NUMBER 2222			
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
10	100	6.5 × 18	4	130	10	6	0.2	3.5	2.2	–	119 24101	119 34101	–
	220	10 × 18	6	240	17	8.4	0.18	1.3	1.0	–	119 24221	119 34221	–
	470	10 × 25	7	380	32	13	0.18	0.61	0.49	–	119 90501	119 90502	–
	470	12.5 × 30	01	550	32	13	0.16	0.54	0.38	119 14471	119 24471	–	–
	680	12.5 × 30	01	640	45	18	0.20	0.47	0.38	119 14681	119 24681	–	–
	1000	15 × 30	02	830	64	24	0.20	0.32	0.24	119 14102	119 24102	–	119 44102
	1500	18 × 30	03	1100	94	34	0.22	0.23	0.17	119 14152	–	–	119 44152
	2200	18 × 30	03	1190	136	48	0.26	0.19	0.17	119 14222	–	–	119 44222
	3300	18 × 38	04	1550	202	70	0.27	0.13	0.10	119 14332	–	–	119 44332
	4700	21 × 38	05	1700	286	90	0.30	0.10	0.09	119 14472	–	–	119 44472
16	47	6.5 × 18	4	110	10	5.5	0.13	4.4	2.2	–	119 25479	119 35479	–
	100	8 × 18	5	170	14	7.2	0.13	2.1	1.3	–	119 25101	119 35101	–
	220	10 × 25	7	300	25	11	0.13	0.94	0.55	–	119 25221	119 35221	–
	330	12.5 × 30	01	560	36	15	0.13	0.63	0.38	119 15331	119 25331	–	–
	470	12.5 × 30	01	570	50	19	0.15	0.51	0.38	119 15471	119 25471	–	–
	680	15 × 30	02	750	69	26	0.15	0.35	0.24	119 15681	119 25681	–	119 45681
	1000	15 × 30	02	850	100	36	0.19	0.30	0.24	119 15102	119 25102	–	119 45102
	1500	18 × 30	03	1120	148	52	0.20	0.21	0.17	119 15152	–	–	119 45152
	2200	18 × 38	04	1440	215	74	0.20	0.14	0.10	119 15222	–	–	119 45222
	3300	21 × 38	05	1650	321	110	0.22	0.11	0.09	119 15332	–	–	119 45332
	4700	21 × 38	05	1710	455	154	0.28	0.09	0.09	119 15472	–	–	119 45472
25	22	6.5 × 18	4	85	10	5.1	0.10	7.2	3.2	–	119 26229	119 36229	–
	100	10 × 18	6	210	19	9	0.10	1.6	1.0	–	119 26101	119 36101	–
	220	10 × 25	7	350	37	15	0.10	0.72	0.58	–	119 90503	119 90504	–
	220	12.5 × 30	01	500	37	15	0.09	0.65	0.38	119 16221	119 26221	–	–
	330	12.5 × 30	01	580	54	21	0.11	0.53	0.38	119 16331	119 26331	–	–
	470	12.5 × 30	01	630	75	28	0.13	0.44	0.38	119 16471	119 26471	–	–
	680	18 × 30	03	990	106	38	0.13	0.30	0.17	119 16681	–	–	119 46681
	1000	18 × 30	03	1090	154	54	0.13	0.21	0.17	119 16102	–	–	119 46102
	1500	18 × 38	04	1420	229	79	0.13	0.14	0.10	119 16152	–	–	119 46152
	2200	21 × 38	05	1550	334	114	0.13	0.11	0.09	119 16222	–	–	119 46222
40	47	8 × 18	5	150	15	7.8	0.08	2.7	1.5	–	119 27479	119 37479	–
	100	10 × 25	7	260	28	12	0.08	1.3	0.7	–	119 27101	119 37101	–
	150	12.5 × 30	01	440	40	16	0.08	0.85	0.51	119 17151	119 27151	–	–
	220	12.5 × 30	01	500	57	22	0.09	0.65	0.48	119 17221	119 27221	–	–
	330	15 × 30	02	630	83	30	0.09	0.43	0.37	119 17331	119 27331	–	119 47331
	470	15 × 30	02	720	117	42	0.12	0.41	0.37	119 17471	119 27471	–	119 47471
	680	18 × 30	03	970	167	58	0.12	0.28	0.22	119 17681	–	–	119 47681
	1000	18 × 38	04	1250	244	84	0.12	0.19	0.14	119 17102	–	–	119 47102
	1500	21 × 38	05	1410	364	124	0.14	0.15	0.12	119 17152	–	–	119 47152
	2200	21 × 38	05	1550	532	180	0.18	0.13	0.11	119 17222	–	–	119 47222

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D × 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)	CATALOG NUMBER 2222			
										IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
63	10	6.5 × 18	4	68	20	5.3	0.07	11	5.6	–	119 28109	119 38109	–
	22	8 × 18	5	110	20	6.7	0.07	5.1	2.8	–	119 28229	119 38229	–
	47	10 × 18	6	180	22	9.9	0.07	2.4	1.3	–	119 28479	119 38479	–
	68	10 × 25	7	230	30	13	0.07	1.6	1.0	–	119 90505	119 90506	–
	68	10 × 30	00	300	30	13	0.07	1.6	0.92	119 18689	119 28689	–	–
	100	10 × 30	00	360	42	17	0.08	1.3	0.75	119 18101	119 28101	–	–
	150	15 × 30	02	560	61	23	0.08	0.85	0.37	119 18151	119 28151	–	119 48151
	220	15 × 30	02	640	87	32	0.08	0.58	0.37	119 18221	119 28221	–	119 48221
	330	18 × 30	03	880	129	46	0.09	0.43	0.23	119 18331	–	–	119 48331
	470	18 × 38	04	1130	182	63	0.09	0.30	0.15	119 18471	–	–	119 48471
	680	21 × 38	05	1290	261	90	0.09	0.21	0.12	119 18681	–	–	119 48681
	1000	21 × 38	05	1430	382	130	0.10	0.16	0.11	119 18102	–	–	119 48102
100	4.7	6.5 × 18	4	44	20	10	0.08	27	10	–	119 29478	119 39478	–
	10	8 × 18	5	70	20	10	0.08	13	6.0	–	119 29109	119 39109	–
	22	10 × 18	6	112	20	10	0.08	5.8	3.5	–	119 29229	119 39229	–
	47	10 × 25	7	178	32	13	0.08	2.7	2.0	–	119 90518	119 90519	–
	47	10 × 30	00	240	32	13	0.08	2.7	2.0	119 19479	119 29479	–	–
	68	12.5 × 30	01	330	45	18	0.08	1.9	1.2	119 19689	119 29689	–	–
	100	15 × 30	02	440	64	24	0.09	1.4	0.96	119 19101	119 29101	–	119 49101
	150	15 × 30	02	520	94	34	0.10	1.1	0.78	119 19151	119 29151	–	119 49151
	220	18 × 30	03	710	136	48	0.10	0.72	0.55	119 19221	–	–	119 49221
	330	18 × 38	04	920	202	70	0.10	0.48	0.37	119 19331	–	–	119 49331
	470	21 × 38	05	1070	286	98	0.10	0.34	0.28	119 19471	–	–	119 49471
200	4.7	10 × 18	6	52	20	10	0.08	27	10	–	119 90507	119 90508	–
	10	10 × 25	7	82	20	10	0.08	13	5.0	–	119 90509	119 90511	–

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)	

ADDITIONAL ELECTRICAL DATA			
PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Inductance			
Equivalent series inductance (ESL)	case ∅D × 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 × 38	typ. 54 nH	typ. 39 nH
	21 × 38	typ. 59 nH	typ. 39 nH

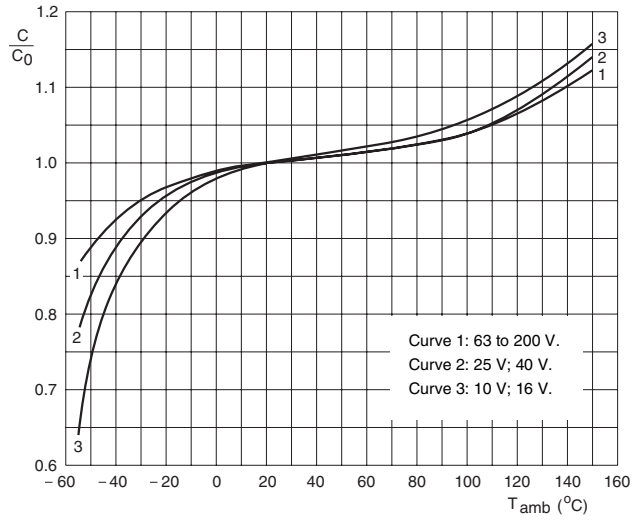
Table 4

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

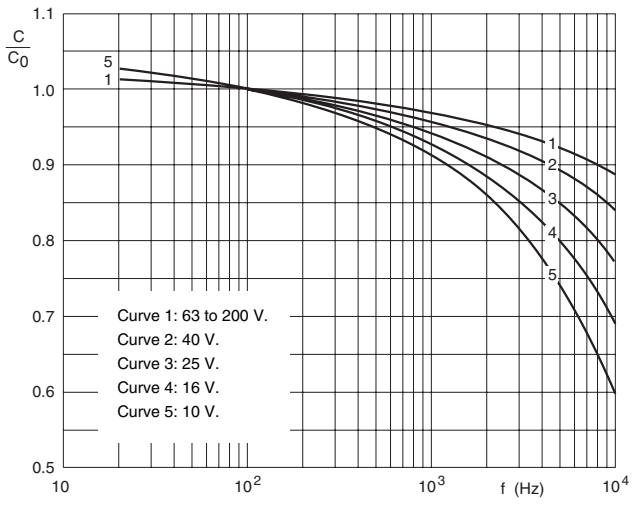
1. For applications at ambient temperatures of ≤85 °C, the rated voltage (U_R) may be raised to U_{R2}.

CAPACITANCE (C)



C_0 = capacitance at 20 °C, 100 Hz.

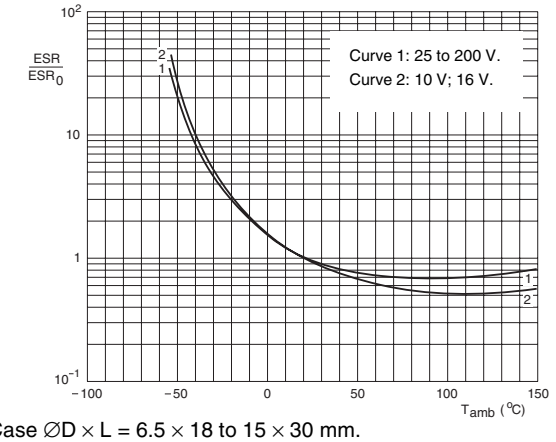
Fig.5 Typical multiplier of capacitance as a function of ambient temperature.



C_0 = capacitance at 20 °C, 100 Hz.

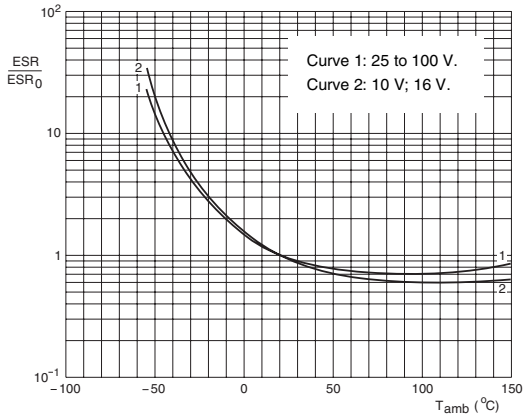
Fig.6 Typical multiplier of capacitance as a function of frequency.

EQUIVALENT SERIES RESISTANCE (ESR)



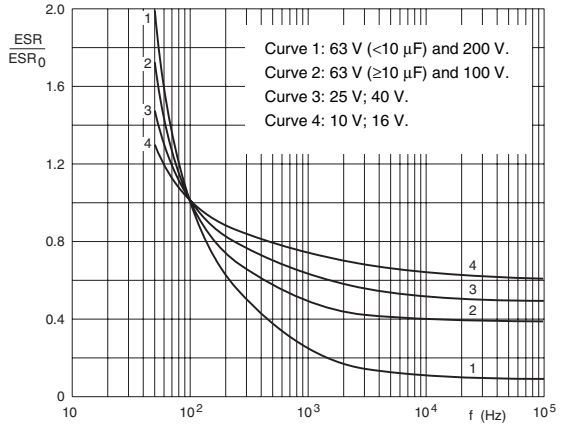
Case ∅D × L = 6.5 × 18 to 15 × 30 mm.
ESR_0 = typical at 20 °C, 100 Hz.

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



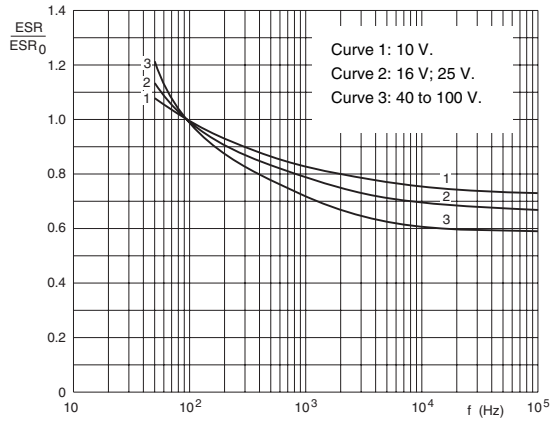
Case ∅D × L = 18 × 30 to 21 × 38 mm.
ESR_0 = typical at 20 °C, 100 Hz.

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



Case ∅D × L = 6.5 × 18 to 10 × 25 mm.
ESR_0 = typical at 20 °C, 100 Hz.

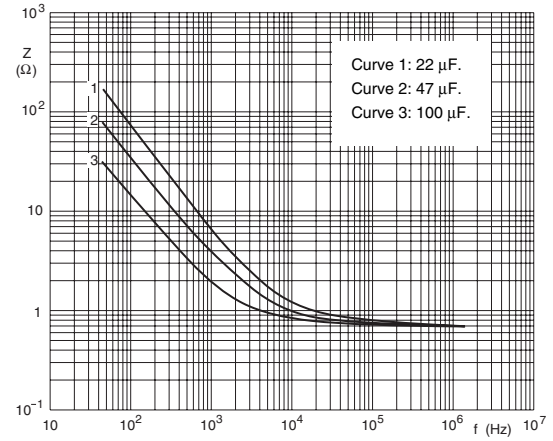
Fig.9 Typical multiplier of ESR as a function of frequency.



Case ∅D × L = 10 × 30 to 21 × 38 mm.
ESR_0 = typical at 20 °C, 100 Hz.

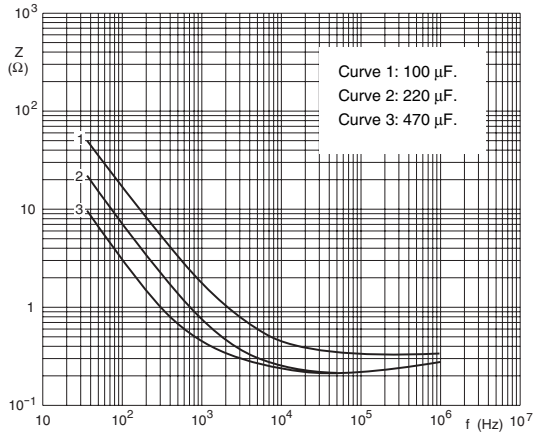
Fig.10 Typical multiplier of ESR as a function of frequency.

IMPEDANCE (Z)



Case ∅D × L = 8 × 18 mm. T_{amb} = 20 °C.

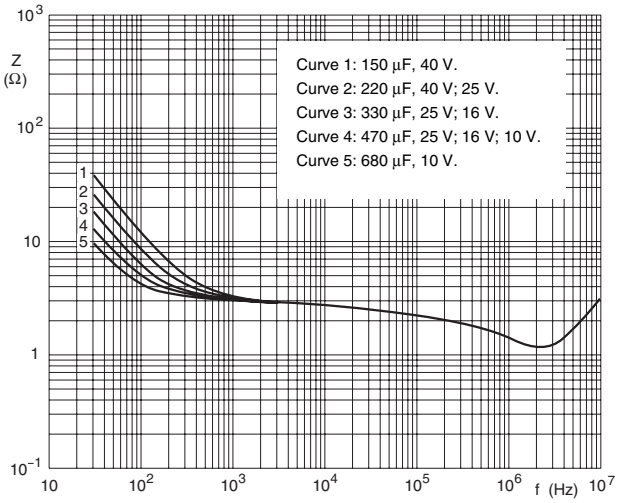
Fig.11 Typical impedance as a function of frequency.



Case ∅D × L = 10 × 25 mm. T_{amb} = 20 °C.

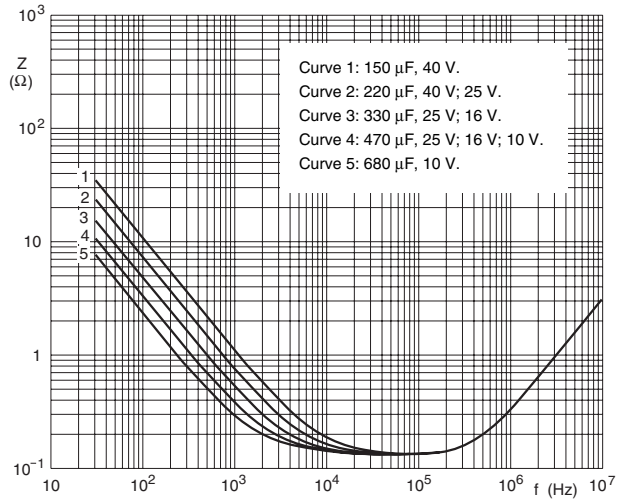
Fig.12 Typical impedance as a function of frequency.

IMPEDANCE (Z)



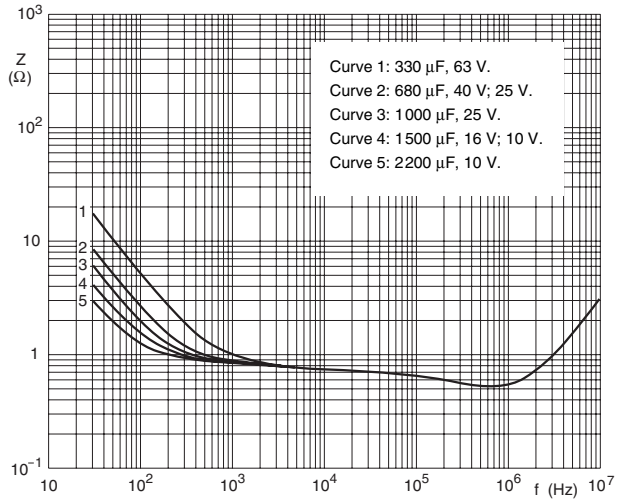
Case ∅D × L = 12.5 × 30 mm. T_{amb} = –40 °C.

Fig.13 Typical impedance as a function of frequency.



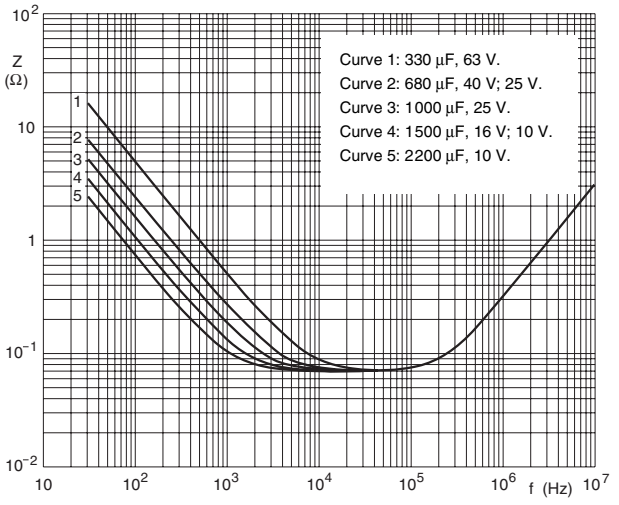
Case ∅D × L = 12.5 × 30 mm. T_{amb} = 20 °C.

Fig.14 Typical impedance as a function of frequency.



Case ∅D × L = 18 × 30 mm. T_{amb} = –40 °C.

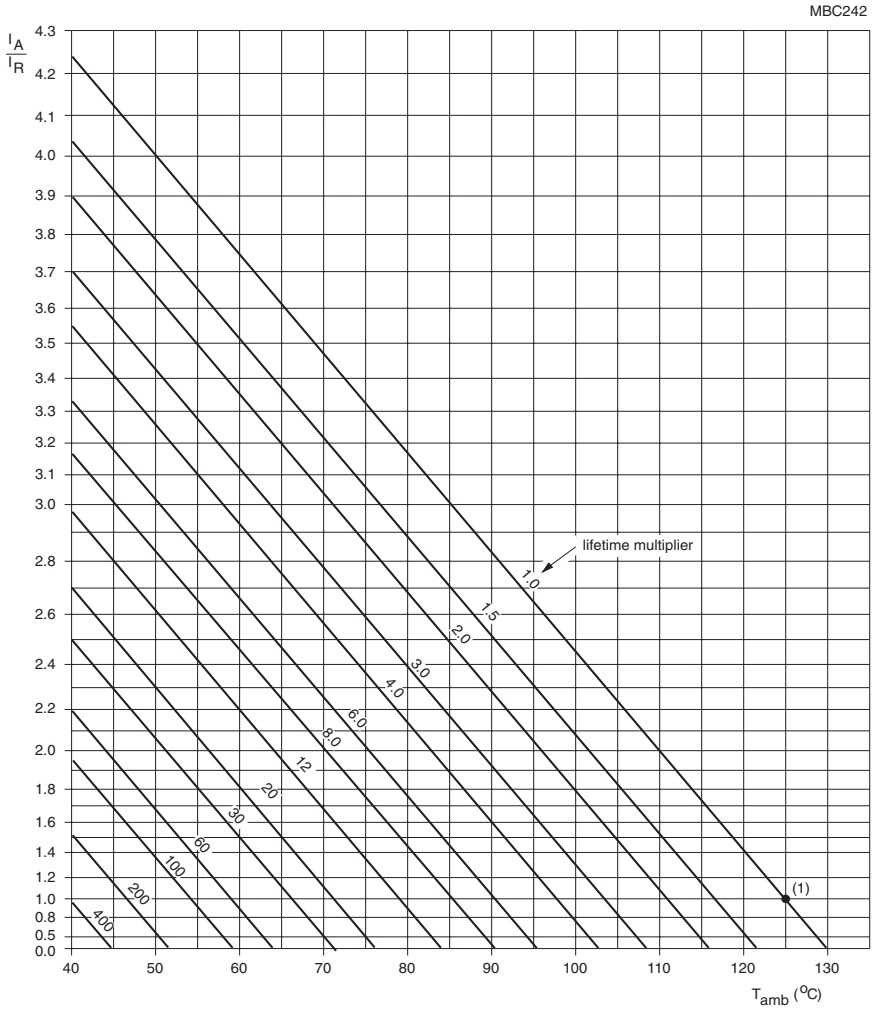
Fig.15 Typical impedance as a function of frequency.



Case ∅D × L = 18 × 30 mm. T_{amb} = 20 °C.

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 × L = 6.5 × 18 to 10 × 25 mm: 4000 hours
case ∅D × L = 10 × 30 to 21 × 38 mm: 8000 hours.

Fig.17 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 = 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
≥10000	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} = 125 °C; U_R applied; case ∅D × L = 6.5 × 18 to 10 × 25 mm: 2000 hours; case ∅D × L = 10 × 30 to 21 × 38 mm: 4000 hours	ΔC/C: ±15% tan δ ≤ 1.3 × spec. limit Z ≤ 2 × spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 125 °C; U_R and I_R applied; case ∅D × L = 6.5 × 18 to 10 × 25 mm: 4000 hours; case ∅D × L = 10 × 30 to 21 × 38 mm: 8000 hours	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% (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	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above I_{L5} ≤ 2 × 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	ΔC/C: ±20% tan δ ≤ spec. limit I_{L5} ≤ spec. limit