Aluminum Capacitors
Axial Long Life, DIN-Based

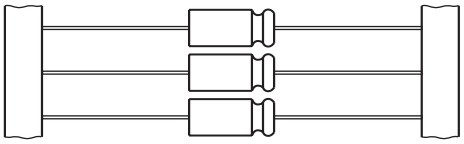
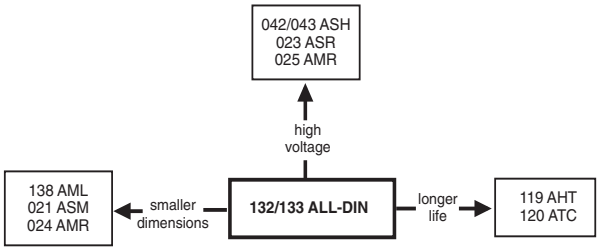


Fig.1 Component outlines



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.
- Long useful life: up to 10000 to 15000 hours at 85 °C, high reliability.
- Lead (Pb)-free versions are RoHS compliant.

Pb-free Available

RoHS* COMPLIANT

APPLICATIONS

- General industrial, power supplies, telecommunication, EDP
- Coupling, decoupling, timing; smoothing, filtering and buffering in SMPS
- 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).
- Upper category temperature (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 (132 or 133).

QUICK REFERENCE DATA

DESCRIPTION	VALUE		
Nominal case sizes (∅D × L in mm)	6.5 ×18 and 8 × 18	10 × 18 and 10 × 25	10 × 30 to 21 × 38
Rated capacitance range, C_R	1 to 4700 μF		
Tolerance on C_R	-10 to +50%		
Rated voltage range, U_R	10 to 350 V		
Category temperature range	-40 to +85 °C		
Endurance test at 105 °C	2000 hours	2000 hours	-
Endurance test at 85 °C	6000 hours	8000 hours	8000 hours
Useful life at 105 °C	3000 hours	3000 hours	-
Useful life at 85 °C	10000 hours	15000 hours	15000 hours
Useful life at 40 °C, 1.8 × I_R applied	160000 hours	240000 hours	240000 hours
Shelf life at 0 V, 85 °C	500 hours		
Based on sectional specification	IEC 60384-4/EN130300		
Climatic category IEC 60068	40/085/56		

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	160	250	350
1.0	-	-	-	-	-	6.5 × 18	-	-	6.5 × 18
2.2	-	-	-	-	-	6.5 × 18	6.5 × 18	8 × 18	8 × 18
4.7	-	-	-	-	6.5 × 18	6.5 × 18	8 × 18	10 × 18	8 × 18
10	-	-	-	-	6.5 × 18	8 × 18	10 × 18	10 × 25	12.5 × 30(1)
	-	-	-	-	-	-	-	10 × 30(1)	-
22	-	-	6.5 × 18	-	8 × 18	10 × 18	10 × 25	12.5 × 30(1	15 × 30(1)
	-	-	-	-	-	-	10 × 30(1)	-	-

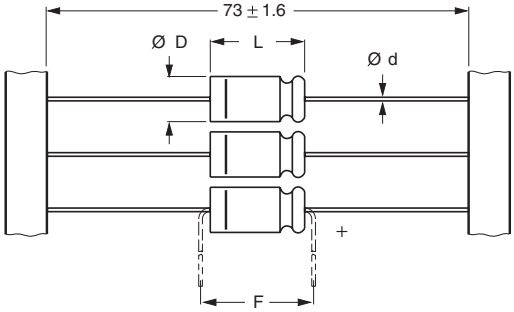
* Pb containing terminations are not RoHS compliant, exemptions may apply

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**	**160**	**250**	**350**
47	-	6.5 × 18	-	8 × 18	10 × 18	10 × 25	15 × 30(1)	18 × 30(1)	18 × 38(1)
	-	-	-	-	-	10 × 30	-	-	-
68	-	-	-	-	10 × 30	12.5 × 30	15 × 30(1)	18 × 38(1)	21 × 38(1)
100	-	8 × 18	-	10 × 18	10 × 30	15 × 30	18 × 30(1)	21 × 38(1)	-
150	-	-	-	12.5 × 30	15 × 30	18 × 30	18 × 38(1)	-	-
220	8 × 18	10 × 18	10 × 25	12.5 × 30	15 × 30	18 × 38	21 × 38(1)	-	-
	-	-	12.5 × 30	-	-	-	-	-	-
330	-	10 × 25	12.5 × 30	15 × 30	18 × 30	18 × 38	-	-	-
	-	12.5 × 30	-	-	-	-	-	-	-
470	12.5 × 30	10 × 25	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	-	-	-	-	-	-	-

Note

1. For these CV-values see data sheet 041-043 ASH.

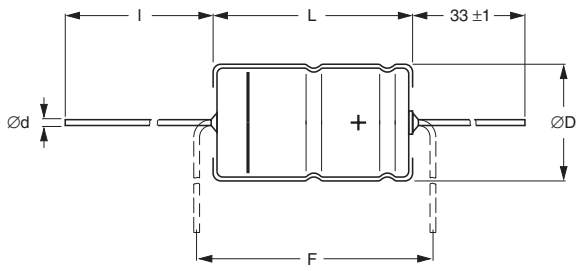
DIMENSIONS in millimeters **AND AVAILABLE FORMS**



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.**

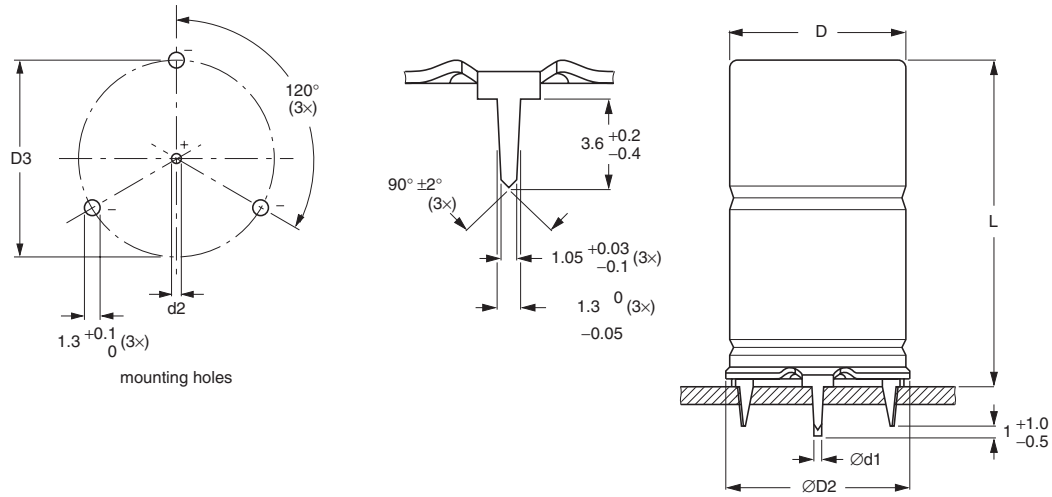
Table 1

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**	**$\varnothing D_{max}$**	**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

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	≈11.7	200
18 × 30	03	0.8	1.0 +0.4	18.5	19.5	18.5 ±0.2	33	≈12.9	240
18 × 38	04	0.8	1.0 +0.4	18.5	19.5	18.5 ±0.2	42	≈19.0	100
21 × 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 −10/+50%
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

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 132 series

100 μF/40 V; −10/+50%

Nominal case size: ∅10 × 18 mm; Form BR

Catalog number: 2222 132 27101.

*Note: To ensure delivery of lead (Pb)-free parts during the transition period, please contact your Vishay sales agent.

Table 3

ELECTRICAL DATA AND ORDERING INFORMATION

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)	Z 100 kHz (Ω)	CATALOG NUMBER 2222			
									IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
10	220	8 × 18	190	8.4	0.18	1.3	0.73	0.70	-	132 24221	132 34221	-
	470	12.5 × 30	350	9.4	0.18	0.61	0.26	0.60	132 14471	132 24471	-	-
	680	12.5 × 30	460	13.6	0.18	0.42	0.20	0.40	132 14681	132 24681	-	-
	1000	15 × 30	640	20	0.18	0.28	0.12	-	132 14102	132 24102	-	132 44102
	1500	18 × 30	800	30	0.22	0.23	0.10	-	132 14152	-	-	132 44152
	2200	18 × 30	1100	44	0.22	0.16	0.09	-	132 14222	-	-	132 44222
	3300	18 × 38	1300	66	0.27	0.13	0.05	-	132 14332	-	-	132 44332
	4700	21 × 38	1800	94	0.27	0.09	0.05	-	132 14472	-	-	132 44472
16	47	6.5 × 18	95	5.5	0.14	4.7	2.6	2.2	-	132 25479	132 35479	-
	100	8 × 18	150	7.2	0.14	2.2	1.2	1.1	-	132 25101	132 35101	-
	220	10 × 18	250	11	0.14	1.0	0.55	0.55	-	132 25221	132 35221	-
	330	10 × 25	320	14.6	0.14	0.67	0.36	0.36	-	132 90508	132 90509	-
	330	12.5 × 30	320	10.6	0.14	0.67	0.36	0.60	132 15331	132 25331	-	-
	470	10 × 25	450	19	0.14	0.47	0.26	0.26	-	132 90507	132 90502	-
	470	12.5 × 30	450	15	0.14	0.47	0.26	0.40	132 15471	132 25471	-	-
	680	15 × 30	550	22	0.14	0.33	0.14	-	132 15681	132 25681	-	132 45681
	1000	15 × 30	780	32	0.14	0.22	0.12	-	132 15102	132 25102	-	132 45102
	1500	18 × 30	950	48	0.15	0.16	0.10	-	132 15152	-	-	132 45152
	2200	18 × 38	1300	70	0.15	0.11	0.06	-	132 15222	-	-	132 45222
	3300	21 × 38	1600	110	0.15	0.07	0.05	-	132 15332	-	-	132 45332
	4700	21 × 38	2300	150	0.15	0.05	0.05	-	132 15472	-	-	132 45472
25	22	6.5 × 18	60	5.1	0.11	8.0	4.1	2.9	-	132 26229	132 36229	-
	220	10 × 25	340	15	0.11	0.8	0.40	0.40	-	132 90503	132 90504	-
	220	12.5 × 30	340	11	0.11	0.8	0.40	0.60	132 16221	132 26221	-	-
	330	12.5 × 30	410	16.5	0.11	0.53	0.30	0.40	132 16331	132 26331	-	-
	470	12.5 × 30	560	24	0.11	0.37	0.20	-	132 16471	132 26471	-	-
	680	18 × 30	700	34	0.11	0.26	0.10	-	132 16681	-	-	132 46681
	1000	18 × 30	1000	50	0.11	0.17	0.10	-	132 16102	-	-	132 46102
	1500	18 × 38	1100	75	0.12	0.13	0.06	-	132 16152	-	-	132 46152
	2200	21 × 38	1850	110	0.13	0.09	0.05	-	132 16222	-	-	132 46222
40	47	8 × 18	120	7.8	0.09	3.0	1.6	1.4	-	132 27479	132 37479	-
	100	10 × 18	210	12	0.09	1.4	0.75	0.75	-	132 27101	132 37101	-
	150	10 × 25	310	16	0.09	0.95	0.50	0.50	-	132 90511	132 90512	-
	150	12.5 × 30	310	12	0.09	0.95	0.50	0.60	132 17151	132 27151	-	-
	220	12.5 × 30	410	17.5	0.09	0.65	0.34	0.40	132 17221	132 27221	-	-
	330	15 × 30	550	26	0.09	0.43	0.20	-	132 17331	132 27331	-	132 47331
	470	15 × 30	700	38	0.09	0.30	0.16	-	132 17471	132 27471	-	132 47471
	680	18 × 30	900	54	0.09	0.21	0.10	-	132 17681	-	-	132 47681
	1000	18 × 38	1200	80	0.09	0.14	0.08	-	132 17102	-	-	132 47102
	1500	21 × 38	1500	120	0.10	0.10	0.06	-	132 17152	-	-	132 47152
	2200	21 × 38	1900	180	0.10	0.07	0.05	-	132 17222	-	-	132 47222
63	4.7	6.5 × 18	38	4.6	0.07	24	12	5	-	132 28478	132 38478	-
	10	6.5 × 18	64	5.3	0.07	11	5.5	3.3	-	132 28109	132 38109	-
	22	8 × 18	100	6.8	0.07	5.1	2.5	2.1	-	132 28229	132 38229	-
	47	10 × 18	170	9.9	0.07	2.4	1.2	1.2	-	132 28479	132 38479	-
	68	10 × 25	210	12.6	0.07	1.6	0.81	0.60	-	132 90513	132 90514	-
	68	10 × 30	210	8.6	0.07	1.6	0.80	0.60	132 18689	132 28689	-	-
	100	10 × 30	300	12.6	0.07	1.1	0.60	0.40	132 18101	132 28101	-	-
	150	15 × 30	350	19	0.07	0.74	0.37	-	132 18151	132 28151	-	132 48151
	220	15 × 30	520	28	0.07	0.50	0.25	-	132 18221	132 28221	-	132 48221
	330	18 × 30	600	42	0.07	0.34	0.15	-	132 18331	-	-	132 48331
	470	18 × 38	970	59	0.07	0.24	0.12	-	132 18471	-	-	132 48471
	680	21 × 38	1000	86	0.07	0.16	0.08	-	132 18681	-	-	132 48681
	1000	21 × 38	1600	130	0.07	0.11	0.06	-	132 18102	-	-	132 48102

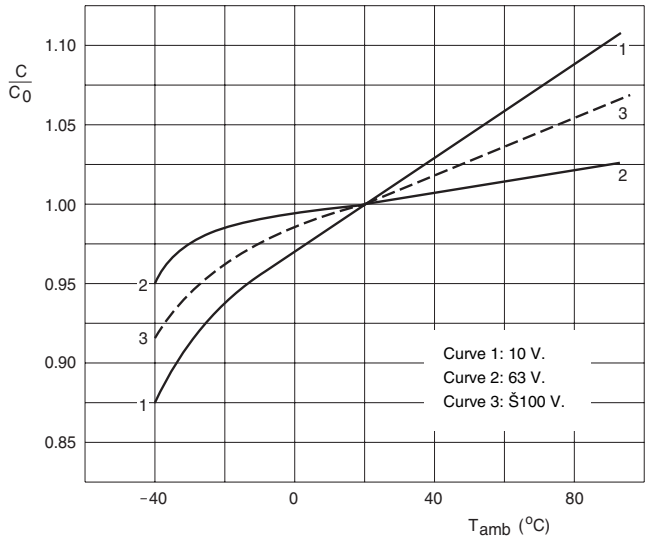
ELECTRICAL DATA AND ORDERING INFORMATION

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)	Z 100 kHz (Ω)	CATALOG NUMBER 2222			
									IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
100	1	6.5 × 18	20	4.0	0.06	95	45	6	-	132 29108	132 39108	-
	2.2	6.5 × 18	30	4.4	0.06	43	20	5	-	132 29228	132 39228	-
	4.7	6.5 × 18	48	4.9	0.06	20	9.6	4	-	132 29478	132 39478	-
	10	8 × 18	73	6	0.06	9.5	4.5	2.8	-	132 29109	132 39109	-
	22	10 × 18	130	8.4	0.06	4.3	2	1.3	-	132 29229	132 39229	-
	47	10 × 25	220	13.4	0.06	2.0	1	0.90	-	132 90505	132 90506	-
	47	10 × 30	220	9.4	0.06	2.0	1	0.90	132 19479	132 29479	-	-
	68	12.5 × 30	250	13.5	0.06	1.4	0.80	-	132 19689	132 29689	-	-
	100	15 × 30	380	20	0.06	0.95	0.50	-	132 19101	132 29101	-	132 49101
	150	18 × 30	400	30	0.06	0.64	0.35	-	132 19151	-	-	132 49151
	220	18 × 38	660	44	0.06	0.43	0.20	-	132 19221	-	-	132 49221
	330	18 × 38	700	66	0.06	0.29	0.15	-	132 19331	-	-	132 49331
	470	21 × 38	1200	94	0.06	0.20	0.10	-	132 19471	-	-	132 49471
160	2.2	6.5 × 18	22	20	0.10	72	55	30	-	133 21228	133 31228	-
	4.7	8 × 18	37	20	0.10	34	26	20	-	133 21478	133 31478	-
	10	10 × 18	61	20	0.10	16	12	10	-	133 21109	133 31109	-
	22	10 × 25	120	20	0.10	7.2	5.5	2.5	-	133 90502	133 90503	-
250	2.2	8 × 18	25	20	0.10	72	50	30	-	133 23228	133 33228	-
	4.7	10 × 18	37	20	0.10	34	23	16	-	133 23478	133 33478	-
	10	10 × 25	66	20	0.10	16	11	9	-	133 23109	133 33109	-
350	1	6.5 × 18	15	20	0.10	160	100	40	-	133 25108	133 35108	-
	2.2	8 × 18	25	20	0.10	72	45	28	-	133 25228	133 35228	-
	4.7	8 × 18	43	20	0.10	34	21	15	-	133 90511	133 90509	-

ADDITIONAL ELECTRICAL DATA

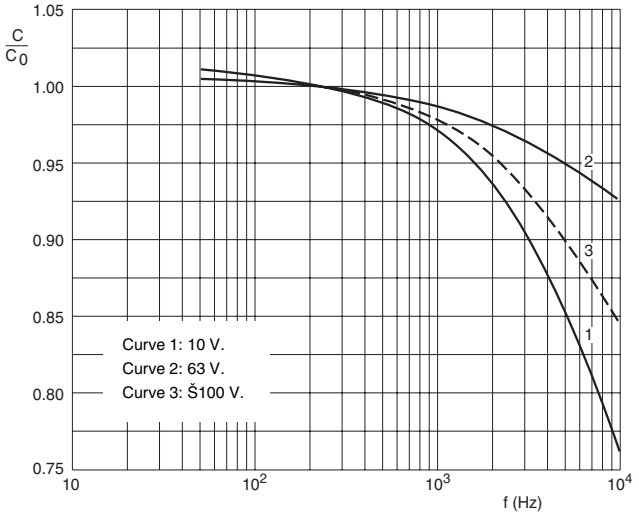
PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Voltage			
Surge voltage	U_R = 10 to 250 V	$U_s \leq 1.15 \times U_R$	
	U_R = 350 V	$U_s \leq 1.1 \times U_R$	
Reverse voltage		$U_{rev} \leq 1$ V	
Current			
Leakage current	after 1 minute: case ∅D × L = 6.5 × 18 to 10 × 25 mm: U_R = 10 to 100 V U_R = 160 to 350 V case ∅D × L = 10 × 30 to 21 × 38 mm: U_R = 10 to 100 V	 $I_{L1} \leq 0.01\ C_R \times U_R + 3$ $I_{L1} \leq 50$ μA $I_{L1} \leq 0.006\ C_R \times U_R + 3$	
	after 5 minutes: case ∅D × L = 6.5 × 18 to 10 × 25 mm: U_R = 10 to 100 V U_R = 160 to 350 V case ∅D × L = 10 × 30 to 21 × 38 mm: U_R = 10 to 100 V	 $I_{L5} \leq 0.002\ C_R \times U_R + 4$ $I_{L5} \leq 20$ μA $I_{L5} \leq 0.002\ C_R \times U_R + 4$ μA	
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

CAPACITANCE (C)



C_0 = capacitance at 20 °C, 100 Hz.

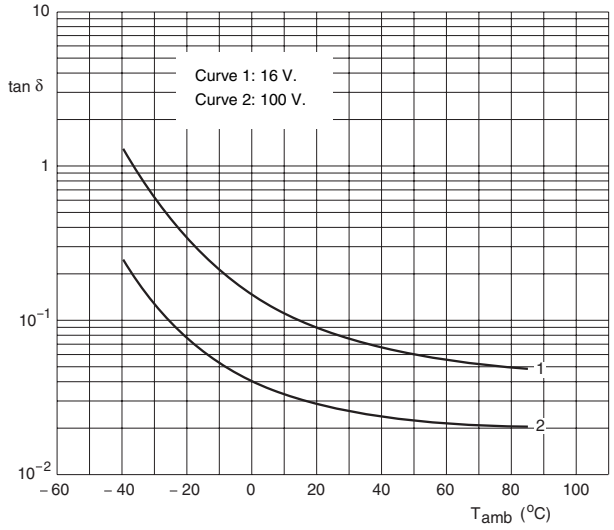
Fig.5 Typical multiplier of capacitance as a function of ambient temperature.



C_0 = capacitance at 20 °C, 100 Hz.

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

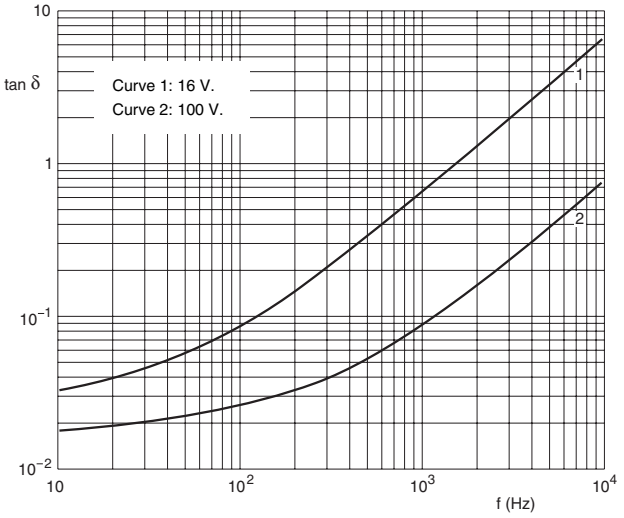
DISSIPATION FACTOR (tan δ)



Case ∅D × L = 6.5 × 18 to 10 × 25 mm.

f = 100 Hz.

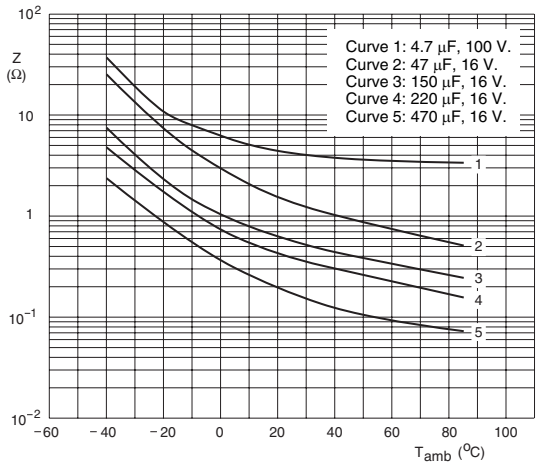
Fig.7 Typical tan δ as a function of ambient temperature.



Case ∅D × L = 6.5 × 18 to 10 × 25 mm.

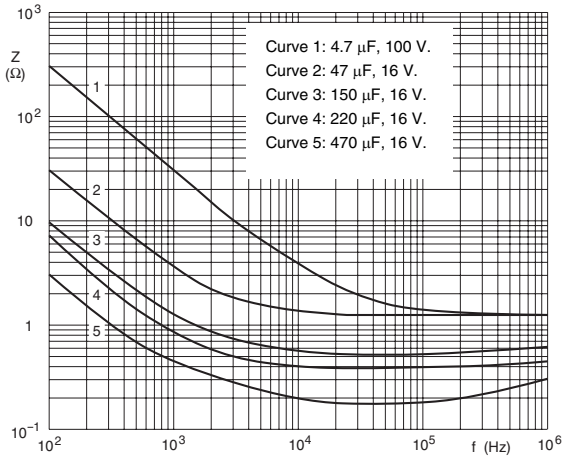
Fig.8 Typical tan δ as a function of frequency.

IMPEDANCE (Z)



Case ∅D × L = 6.5 × 18 mm to 10 × 25 mm. f = 10 kHz.

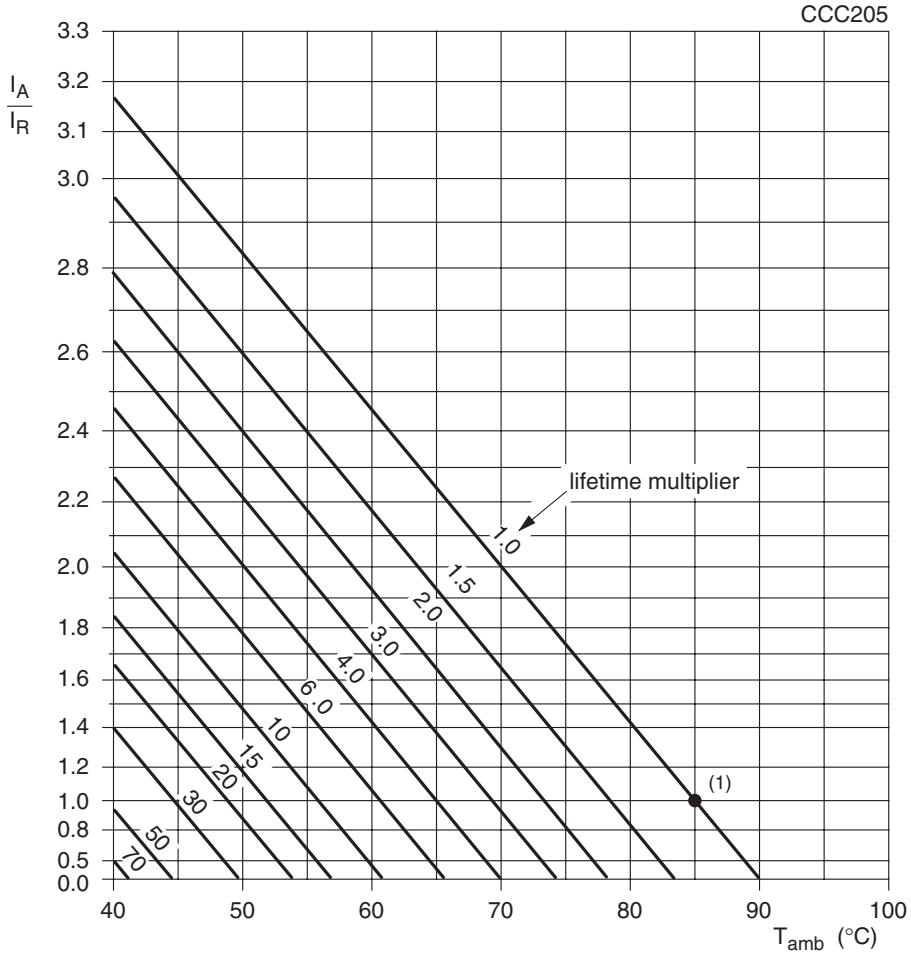
Fig.9 Typical impedance as a function of ambient temperature.



Case ∅D × L = 6.5 × 18 mm to 10 × 25 mm. T_{amb} = 20 °C.

Fig.10 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, 85 °C.

(1) Useful life at 85 °C and I_R applied:
case ∅D × L = 6.5 × 18 to 8 × 18 mm: 10000 hours
case ∅D × L = 10 × 18 to 21 × 38 mm: 15000 hours.

Fig.11 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 63 V	U_R = 100 to 350 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 5

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 = 6.5 × 18 to 8 × 18 mm: 6000 hours; case ∅D × L = 10 × 18 to 21 × 38 mm: 8000 hours	U_R = 10 to 160 V; ΔC/C: ±15% U_R = 250 to 350 V; ΔC/C: ±10% tan δ ≤ 1.3 × 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 = 6.5 × 18 to 8 × 18 mm: 10 000 hours; case ∅D × L = 10 × 18 to 21 × 38 mm: 15 000 hours	U_R = 10 to 160 V; ΔC/C: ±45% U_R = 250 to 350 V; ΔC/C: ±30% 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} ≤ 2 × spec. limit

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