Aluminum Capacitors
Axial High Temperature, High Ripple Current

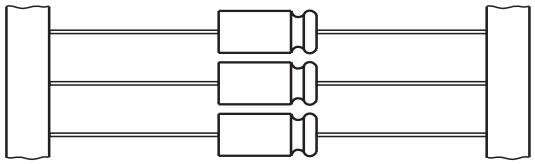
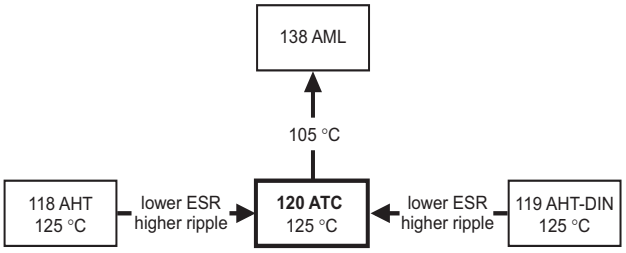


Fig.1 Component outlines



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 x 30 mm available for automatic insertion.
- Charge and discharge proof.
- Extra long useful life: up to 8000 hours at 125 °C, high reliability.
- Lowest ESR levels providing very high ripple current capability.
- Extended temperature range: usable up to 150 °C.
- Miniaturized, high CV-product per unit volume.
- Lead diameter ∅d = 1.0 mm, available on request
- Lead (Pb)-free versions are RoHS compliant.

Pb-free Available

RoHS* COMPLIANT

APPLICATIONS

- Automotive, industrial and telecommunication
- Smoothing, filtering, buffering
- Low mounting height applications, vibration and shock resistant
- SMPS and standard power supplies.

MARKING

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

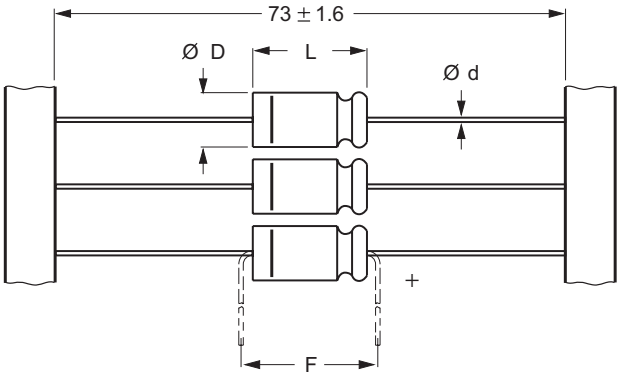
- Rated capacitance (in μF).
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ±20%).
- Rated voltage (in V).
- Upper category temperature (125 °C).
- Date code in accordance with IEC 60062.
- Code for factory of origin.
- Name of manufacturer.
- Band to indicate the negative terminal.
- '+' sign to identify the positive terminal
- Series number (120).

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (∅D × L in mm)	10 × 30 to 21 × 38
Rated capacitance range, C_R	47 to 6800 μF
Tolerance on C_R	±20%
Rated voltage range, U_R	16 to 100 V
Category temperature range	–40 to +125 °C
Endurance test at 150 °C	1000 hours
Endurance test at 125 °C	4000 hours
Useful life at 125 °C	8000 hours
Useful life at 85 °C, 1.4 × I_R applied	40000 hours
Shelf life at 0 V, 125 °C	1000 hours (100 V: 500 hours)
Shelf life at 0 V, 150 °C	≤ 63 V: 500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/125/56

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

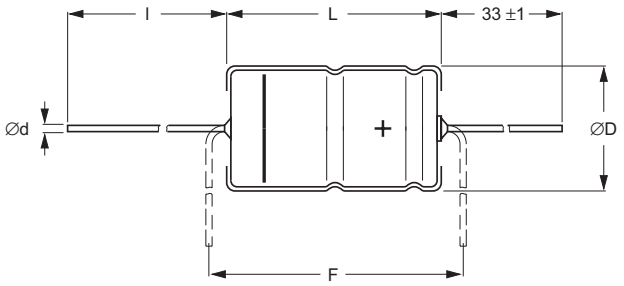
SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZE (∅D × L in mm)					
C_R (μF)	**U_R (V)**				
	16	**25**	**40**	**63**	**100**
47	–	–	–	–	10 × 30
68	–	–	–	–	12.5 × 30
100	–	–	–	10 × 30	12.5 × 30
150	–	–	–	12.5 × 30	15 × 30
220	–	–	10 × 30	12.5 × 30	18 × 30
330	–	–	12.5 × 30	15 × 30	18 × 38
470	–	10 × 30	12.5 × 30	18 × 30	21 × 38
680	10 × 30	12.5 × 30	15 × 30	18 × 38	–
1000	12.5 × 30	12.5 × 30	18 × 30	21 × 38	–
1500	12.5 × 30	15 × 30	18 × 38	–	–
2200	15 × 30	18 × 30	21 × 38	–	–
3300	18 × 30	18 × 38	–	–	–
4700	18 × 38	21 × 38	–	–	–
6800	21 × 38	–	–	–	–

DIMENSIONS in millimeters **AND AVAILABLE FORMS**



Form BR: Taped on reel,
case ∅D × L = 10 × 30 to 15 × 30 mm.

Fig.2 **Form BR.**



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

Fig.3 **Form AA.**

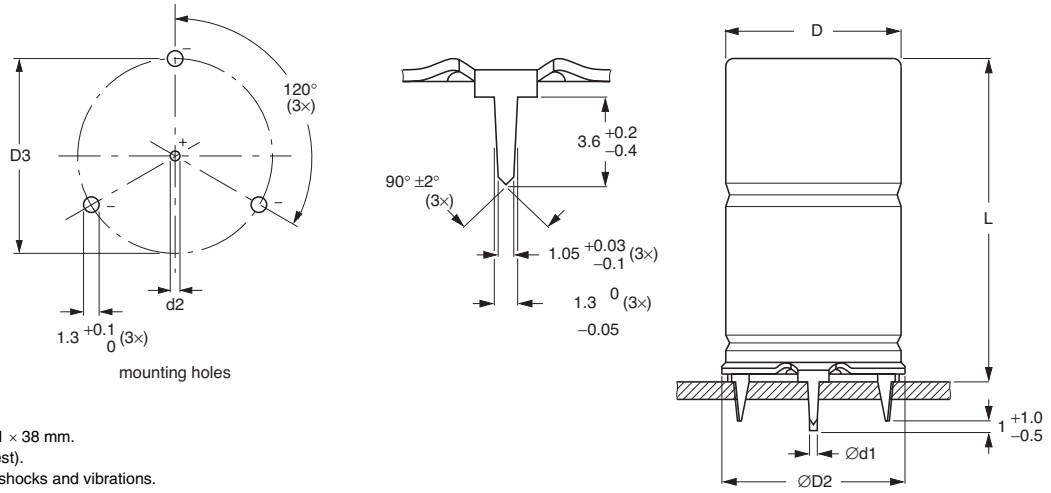
Table 1

AXIAL; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**								
NOMINAL CASE SIZE ∅D × L (mm)	**AXIAL: FORM AA AND BR**					**MASS (G)**	**PACKAGING QUANTITIES**	
	∅d(1)	**l**	**∅D_{max}**	**L_{MAX}**	**F_{MIN}**		**FORM AA**	**FORM BR**
10 × 30	0.8	55 ±1	10.5	30.5	35	≈4.8	340	500
12.5 × 30	0.8	55 ±1	13.0	30.5	35	≈7.4	260	400
15 × 30	0.8	55 ±1	15.5	30.5	35	≈11.7	300	250
18 × 30	0.8	55 ±1	18.5	30.5	35	≈12.9	200	–
18 × 38	0.8	34 ±1	18.5	39.0	44	≈19.0	125	–
21 × 38	0.8	34 ±1	21.5	39.0	44	≈24.0	100	–

Note

1. Lead diameter ∅d = 1.0 mm, available on request.
2. Detailed tape dimensions see section 'PACKAGING'.

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



Form MR: case ∅D × L = 15 × 30 to 21 × 38 mm.
Case not insulated (insulation on request).
Especially for applications with severe shocks and vibrations.

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 ±20%
I_R	rated RMS ripple current at 10 kHz, 125 °C
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
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 120 series

1000 µF/16 V; ±20%

Nominal case size: ∅12.5 × 30 mm; Form BR

Catalog number: 2222 120 25102.

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

Table 3

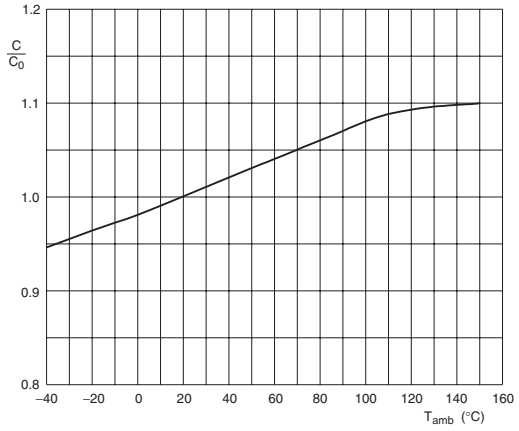
ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D × L (mm)	I_R 10 KHZ 125 °C (mA)	I_{L1} 1 MIN (µA)	I_{L5} 5 MIN (µA)	TYP. ESR 100 Hz (mΩ)	MAX. ESR 100 Hz (mΩ)	TYP. ESR 10 KHz (mΩ)	MAX. ESR 10 KHz (mΩ)	Z MAX. 10 KHz (mΩ)	CATALOG NUMBER 2222 120		
											IN BOX FORM AA	TAPED ON REEL FORM BR	MOUNTING RING FORM MR
16	680	10 × 30	2100	171	84	106	177	44	74	78	15681	25681	–
	1000	12.5 × 30	2550	232	104	77	128	35	58	61	15102	25102	–
	1500	12.5 × 30	2650	328	136	60	100	32	53	53	15152	25152	–
	2200	15 × 30	2940	462	181	48	79	28	46	46	15222	25222	45222
	3300	18 × 30	3430	674	251	41	68	26	43	43	15332	–	45332
	4700	18 × 38	4350	942	341	27	45	18	29	29	15472	–	45472
	6800	21 × 38	4590	1346	475	26	43	18	29	29	15682	–	45682
25	470	10 × 30	2100	181	87	112	187	45	74	84	16471	26471	–
	680	12.5 × 30	2550	244	108	81	136	35	59	64	16681	26681	–
	1000	12.5 × 30	2600	340	140	64	107	32	53	55	16102	26102	–
	1500	15 × 30	2890	490	190	49	82	28	46	46	16152	26152	46152
	2200	18 × 30	3310	700	260	43	71	27	44	44	16222	–	46222
	3300	18 × 38	4350	1030	370	28	47	18	29	29	16332	–	46332
	4700	21 × 38	4470	1450	510	27	44	18	29	29	16472	–	46472
40	220	10 × 30	1990	146	75	192	320	52	87	124	17221	27221	–
	330	12.5 × 30	2430	198	93	130	216	37	62	83	17331	27331	–
	470	12.5 × 30	2550	266	115	101	169	35	58	70	17471	27471	–
	680	15 × 30	2840	366	149	75	125	30	50	55	17681	27681	47681
	1000	18 × 30	3150	520	200	59	99	28	47	49	17102	–	47102
	1500	18 × 38	4130	760	280	39	65	19	31	32	17152	–	47152
	2200	21 × 38	4170	1096	392	34	56	19	31	31	17222	–	47222
63	100	10 × 30	1560	116	65	297	495	92	154	249	18101	28101	–
	150	12.5 × 30	2050	153	78	195	325	61	102	162	18151	28151	–
	220	12.5 × 30	2150	206	95	149	249	55	92	126	18221	28221	–
	330	15 × 30	2510	289	123	105	175	44	73	91	18331	28331	48331
	470	18 × 30	2860	395	158	81	135	38	64	74	18471	–	48471
	680	18 × 38	3720	554	211	55	92	26	43	49	18681	–	48681
	1000	21 × 38	3780	796	292	44	74	25	41	43	18102	–	48102
100	47	10 × 30	760	96	59	760	1269	349	581	720	19479	29479	–
	68	12.5 × 30	1030	122	67	531	885	246	410	503	19689	29689	–
	100	12.5 × 30	1140	160	80	389	648	196	327	381	19101	29101	–
	150	15 × 30	1480	220	100	266	443	137	229	262	19151	29151	49151
	220	18 × 30	1960	304	128	181	302	95	158	179	19221	–	49221
	330	18 × 38	2550	436	172	120	200	62	104	117	19331	–	49331
	470	21 × 38	2800	604	228	92	154	52	86	94	19471	–	49471

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 at U_R	$I_{L1} \leq 0.012\ C_R \times U_R + 40\ \mu A$	
	after 5 minutes at U_R	$I_{L5} \leq 0.004\ C_R \times U_R + 40\ \mu A$	
Inductance			
Equivalent series inductance (ESL)	case ∅D × L mm:		
	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

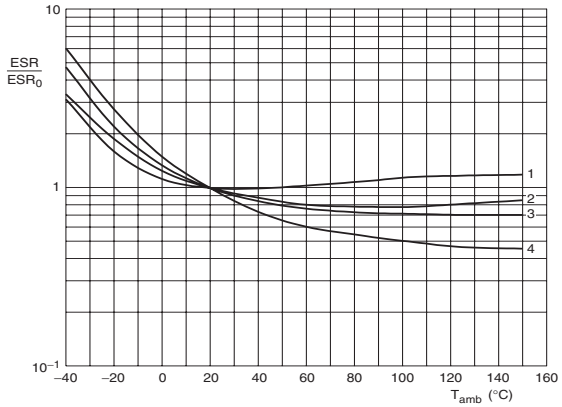
CAPACITANCE (C)



All voltages; all case sizes.
C_0 = capacitance at 20 °C, 100 Hz.

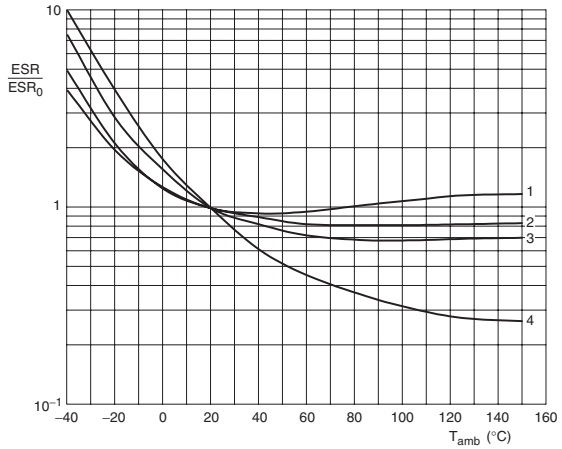
Fig.5 Typical multiplier of capacitance as a function of ambient temperature.

EQUIVALENT SERIES RESISTANCE (ESR)



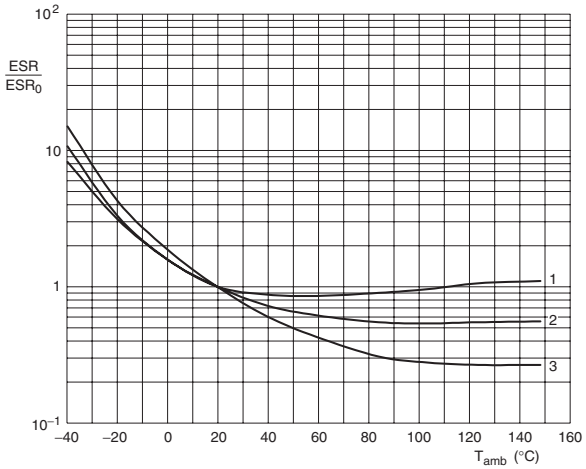
≤40 V types. ESR_0 = typical at 20 °C.
Curve 1: All case sizes; 100 Hz.
Curve 2: Case ∅D × L = 18 × 38 and 21 × 38 mm; 10 to 100 kHz.
Curve 3: Case ∅D × L = 15 × 30 and 18 × 30 mm; 10 to 100 kHz.
Curve 4: Case ∅D × L = 10 × 30 and 12.5 × 30 mm; 10 to 100 kHz.

Fig.6 Typical multiplier of ESR as a function of ambient temperature at different frequencies.



63 V types. ESR_0 = typical at 20 °C.
Curve 1: All case sizes; 100 Hz.
Curve 2: Case ∅D × L = 18 × 38 and 21 × 38 mm; 10 to 100 kHz.
Curve 3: Case ∅D × L = 15 × 30 and 18 × 30 mm; 10 to 100 kHz.
Curve 4: Case ∅D × L = 10 × 30 and 12.5 × 30 mm; 10 to 100 kHz.

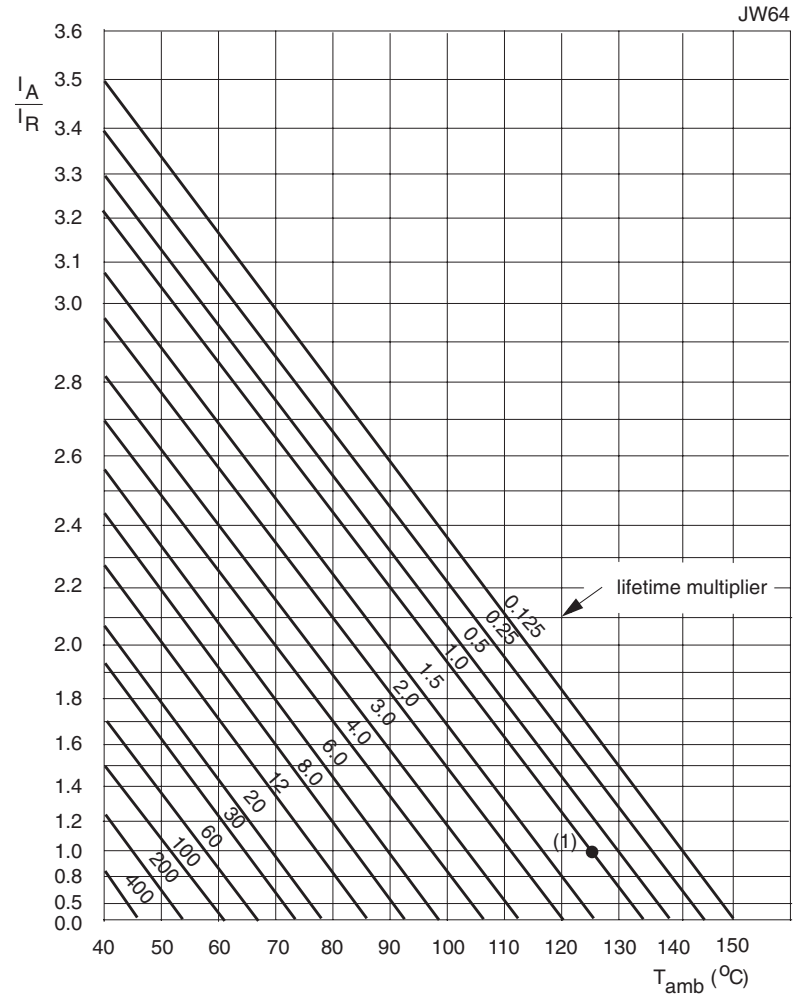
Fig.7 Typical multiplier of ESR as a function of ambient temperature at different frequencies.



100 V types. ESR_0 = typical at 20 °C.
Curve 1: All case sizes; 100 Hz.
Curve 2: Case ∅D × L = 18 × 38 and 21 × 38 mm; 10 to 100 kHz.
Curve 3: Case ∅D × L = 10 × 30 to 18 × 30 mm; 10 to 100 kHz.

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

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 10 kHz.
I_R = rated ripple current at 10 kHz, 125 °C.
(1) Useful life at 125 °C and I_R applied: 8000 hours.

Fig.9 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 = 16 to 40 V case sizes 10 × 30 to 15 × 30 mm	U_R = 16 to 40 V case sizes 18 × 30 to 21 × 38 mm	U_R = 63 and 100 V case sizes 10 × 30 to 15 × 30 mm	U_R = 63 and 100 V case sizes 18 × 30 to 21 × 38 mm
50	0.37	0.54	0.23	0.44
100	0.48	0.63	0.32	0.56
300	0.69	0.75	0.53	0.76
1000	0.86	0.81	0.77	0.88
3000	0.96	0.87	0.93	0.94
≥10000	1.00	1.00	1.00	1.00

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; 4000 hours T_{amb} = 150 °C; U_R applied; 1000 hours	$\Delta C/C$: ±15% tan $\delta \leq 1.3 \times$ spec. limit $Z \leq 2 \times$ 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; 8000 hours	$\Delta C/C$: ±45% tan $\delta \leq 3 \times$ spec. limit $Z \leq 3 \times$ spec. limit $I_{L5} \leq$ 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} = 125 °C; no voltage applied; 1000 hours (100 V: 500 hours) T_{amb} = 150 °C; no voltage applied; 500 hours for voltages: ≤63 V 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 $I_{L5} \leq 2 \times$ 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
Vibration	IEC 60068-2 subclause 4.15 test method Fc	10 to 2000 Hz; 1.5 mm or 20 g (whichever is less severe); in 3 directions; 2.5 hours per direction	no visible damage; no leakage of electrolyte; markings legible $\Delta C/C$: ±5% with respect to initial measurement

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