

## Aluminum Capacitors Axial High Temperature, High Ripple Current

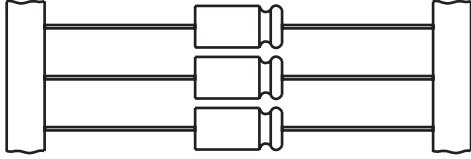
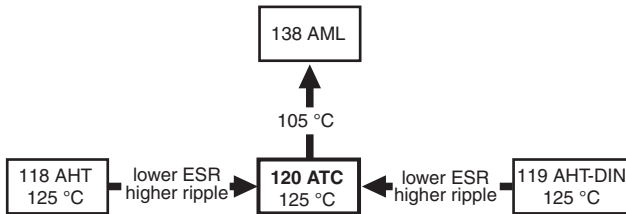


Fig.1 Component outlines



### 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 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 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 Ø d = 1.0 mm, available on request
- Lead (Pb)-free versions are RoHS compliant



**RoHS**  
COMPLIANT

### APPLICATIONS

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

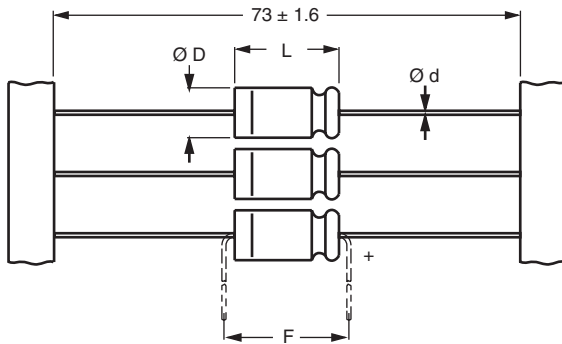
### MARKING

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)

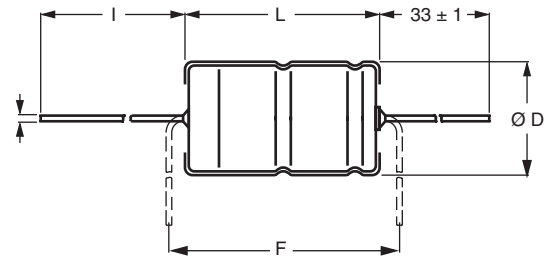
QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes (Ø D x L in mm)	10 x 30 to 21 x 38
Rated capacitance range, C <sub>R</sub>	47 to 6800 µF
Tolerance on C <sub>R</sub>	± 20 %
Rated voltage range, U <sub>R</sub>	16 to 100 V
Category temperature range	- 40 to + 125 °C
Endurance test at 150 °C	1000 hours
Endurance test at 125 °C	4000 hours
Useful life at 125 °C	8000 hours
Useful life at 85 °C, 1.4 x I <sub>R</sub> applied	40 000 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

<b>SELECTION CHART FOR <math>C_R</math>, <math>U_R</math> AND RELEVANT NOMINAL CASE SIZE (<math>\varnothing D \times L</math> in mm)</b>					
$C_R$ ( $\mu F$ )	$U_R$ (V)				
	16	25	40	63	100
47	-	-	-	-	10 x 30
68	-	-	-	-	12.5 x 30
100	-	-	-	10 x 30	12.5 x 30
150	-	-	-	12.5 x 30	15 x 30
220	-	-	10 x 30	12.5 x 30	18 x 30
330	-	-	12.5 x 30	15 x 30	18 x 38
470	-	10 x 30	12.5 x 30	18 x 30	21 x 38
680	10 x 30	12.5 x 30	15 x 30	18 x 38	-
1000	12.5 x 30	12.5 x 30	18 x 30	21 x 38	-
1500	12.5 x 30	15 x 30	18 x 38	-	-
2200	15 x 30	18 x 30	21 x 38	-	-
3300	18 x 30	18 x 38	-	-	-
4700	18 x 38	21 x 38	-	-	-
6800	21 x 38	-	-	-	-

**DIMENSIONS in millimeters AND AVAILABLE FORMS**


**Form BR:** Taped on reel, non-preferred  
 case  $\varnothing D \times L = 10 \times 30$  to  $15 \times 30$  mm

Fig.2 **Form BR**



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

Fig.3 **Form AA**

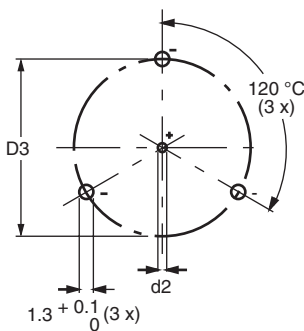
Table 1

AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES								
NOMINAL CASE SIZE Ø D x L (mm)	AXIAL: FORM AA AND BR					MASS (g)	PACKAGING QUANTITIES	
	Ø d <sup>(1)</sup>	l	Ø D <sub>max.</sub>	L <sub>max.</sub>	F <sub>min.</sub>		FORM AA	FORM BR
10 x 30	0.8	55 ± 1	10.5	30.5	35	≈ 4.8	340	500
12.5 x 30	0.8	55 ± 1	13.0	30.5	35	≈ 7.4	260	400
15 x 30	0.8	55 ± 1	15.5	30.5	35	≈ 11.7	200	250
18 x 30	0.8	55 ± 1	18.5	30.5	35	≈ 12.9	120	-
18 x 38	0.8	34 ± 1	18.5	39.5	44	≈ 19.0	125	-
21 x 38	0.8	34 ± 1	21.5	39.5	44	≈ 24.0	100	-

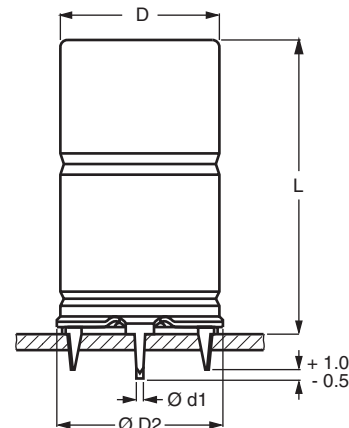
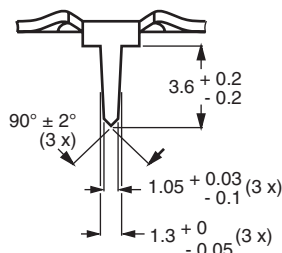
**Note**

<sup>(1)</sup> Lead diameter Ø d = 1.0 mm, available on request.

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	Ø D <sub>max.</sub>	Ø D <sub>2max.</sub>	D3	L <sub>max.</sub>		
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



Aluminum Capacitors  
Axial High Temperature, High Ripple Current

Vishay BCcomponents

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
$C_R$	rated capacitance at 100 Hz, tolerance $\pm 20\%$
$I_R$	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 $\tan \delta_{max.}$ and $C_R$ )
Z	max. impedance at 10 kHz

**ORDERING EXAMPLE**

Electrolytic capacitor 120 series  
1000  $\mu$ F/16 V;  $\pm 20\%$   
Nominal case size:  $\varnothing 12.5 \times 30$  mm; Form BR  
Ordering code: MAL212025102E3  
Former 12NC: 2222 120 25102

**Note**

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

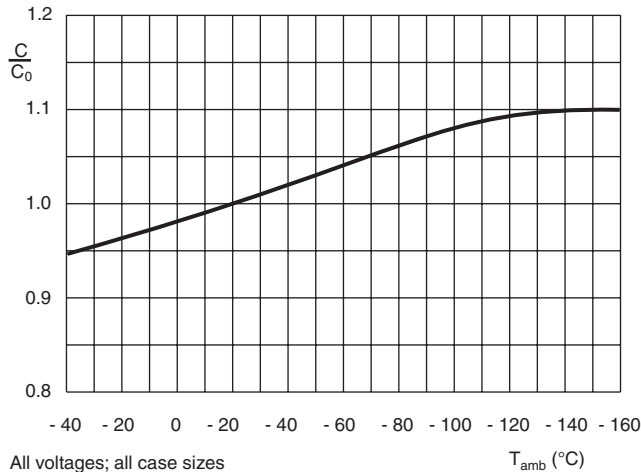
Table 3

ELECTRICAL DATA AND ORDERING INFORMATION													
$U_R$ (V)	$C_R$ 100 Hz ( $\mu$ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	$I_R$ 10 kHz 125 °C (mA)	$I_{L1}$ 1 MIN ( $\mu$ A)	$I_{L5}$ 5 MIN ( $\mu$ A)	TYP. ESR 100 Hz (m $\Omega$ )	MAX. ESR 100 Hz (m $\Omega$ )	TYP. ESR 10 kHz (m $\Omega$ )	MAX. ESR 10 kHz (m $\Omega$ )	Z MAX. 10 kHz (m $\Omega$ )	ORDERING CODE MAL2120.....		
											IN BOX FORM AA	TAPED ON REEL FORM BR	MOUNTING RING FORM MR
16	680	10 x 30	2100	171	84	106	177	44	74	78	15681E3	25681E3	-
	1000	12.5 x 30	2550	232	104	77	128	35	58	61	15102E3	25102E3	-
	1500	12.5 x 30	2650	328	136	60	100	32	53	53	15152E3	25152E3	-
	2200	15 x 30	2940	462	181	48	79	28	46	46	15222E3	25222E3	45222E3
	3300	18 x 30	3430	674	251	41	68	26	43	43	15332E3	-	45332E3
	4700	18 x 38	4350	942	341	27	45	18	29	29	15472E3	-	45472E3
	6800	21 x 38	4590	1346	475	26	43	18	29	29	15682E3	-	45682E3
25	470	10 x 30	2100	181	87	112	187	45	74	84	16471E3	26471E3	-
	680	12.5 x 30	2550	244	108	81	136	35	59	64	16681E3	26681E3	-
	1000	12.5 x 30	2600	340	140	64	107	32	53	55	16102E3	26102E3	-
	1500	15 x 30	2890	490	190	49	82	28	46	46	16152E3	26152E3	46152E3
	2200	18 x 30	3310	700	260	43	71	27	44	44	16222E3	-	46222E3
	3300	18 x 38	4350	1030	370	28	47	18	29	29	16332E3	-	46332E3
	4700	21 x 38	4470	1450	510	27	44	18	29	29	16472E3	-	46472E3
40	220	10 x 30	1990	146	75	192	320	52	87	124	17221E3	27221E3	-
	330	12.5 x 30	2430	198	93	130	216	37	62	83	17331E3	27331E3	-
	470	12.5 x 30	2550	266	115	101	169	35	58	70	17471E3	27471E3	-
	680	15 x 30	2840	366	149	75	125	30	50	55	17681E3	27681E3	47681E3
	1000	18 x 30	3150	520	200	59	99	28	47	49	17102E3	-	47102E3
	1500	18 x 38	4130	760	280	39	65	19	31	32	17152E3	-	47152E3
	2200	21 x 38	4170	1096	392	34	56	19	31	31	17222E3	-	47222E3
63	100	10 x 30	1560	116	65	297	495	92	154	249	18101E3	28101E3	-
	150	12.5 x 30	2050	153	78	195	325	61	102	162	18151E3	28151E3	-
	220	12.5 x 30	2150	206	95	149	249	55	92	126	18221E3	28221E3	-
	330	15 x 30	2510	289	123	105	175	44	73	91	18331E3	28331E3	48331E3
	470	18 x 30	2860	395	158	81	135	38	64	74	18471E3	-	48471E3
	680	18 x 38	3720	554	211	55	92	26	43	49	18681E3	-	48681E3
	1000	21 x 38	3780	796	292	44	74	25	41	43	18102E3	-	48102E3
100	47	10 x 30	760	96	59	760	1269	349	581	720	19479E3	29479E3	-
	68	12.5 x 30	1030	122	67	531	885	246	410	503	19689E3	29689E3	-
	100	12.5 x 30	1140	160	80	389	648	196	327	381	19101E3	29101E3	-
	150	15 x 30	1480	220	100	266	443	137	229	262	19151E3	29151E3	49151E3
	220	18 x 30	1960	304	128	181	302	95	158	179	19221E3	-	49221E3
	330	18 x 38	2550	436	172	120	200	62	104	117	19331E3	-	49331E3
	470	21 x 38	2800	604	228	92	154	52	86	94	19471E3	-	49471E3



ADDITIONAL ELECTRICAL DATA			
PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
<b>Voltage</b>			
Surge voltage		$U_s \leq 1.15 \times U_R$	
Reverse voltage		$U_{rev} \leq 1 \text{ V}$	
<b>Current</b>			
Leakage current	After 1 minute at $U_R$	$I_{L1} \leq 0.012 C_R \times U_R + 40 \mu\text{A}$	
	After 5 minutes at $U_R$	$I_{L5} \leq 0.004 C_R \times U_R + 40 \mu\text{A}$	
<b>Inductance</b>			
Equivalent series inductance (ESL)	Case $\varnothing D \times L$ mm:		
	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

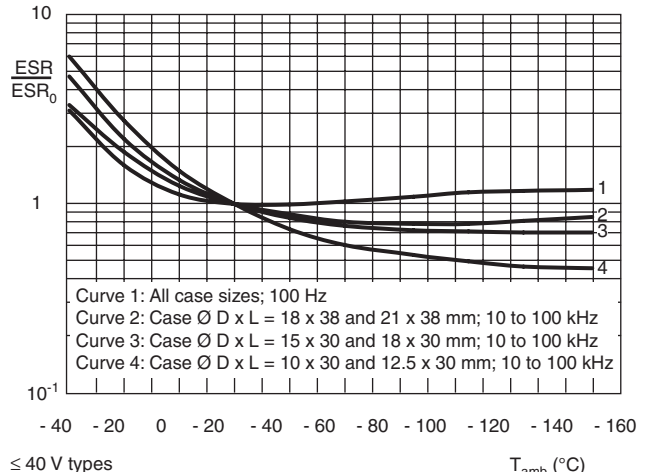
**CAPACITANCE (C)**



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

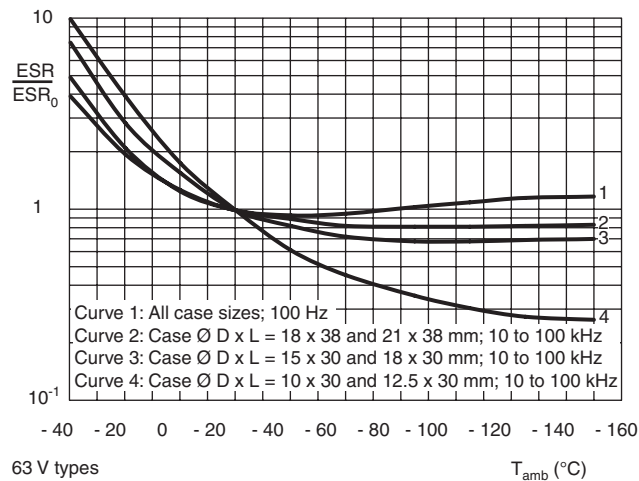
Fig.5 Typical multiplier of capacitance as a function of ambient temperature

**EQUIVALENT SERIES RESISTANCE (ESR)**



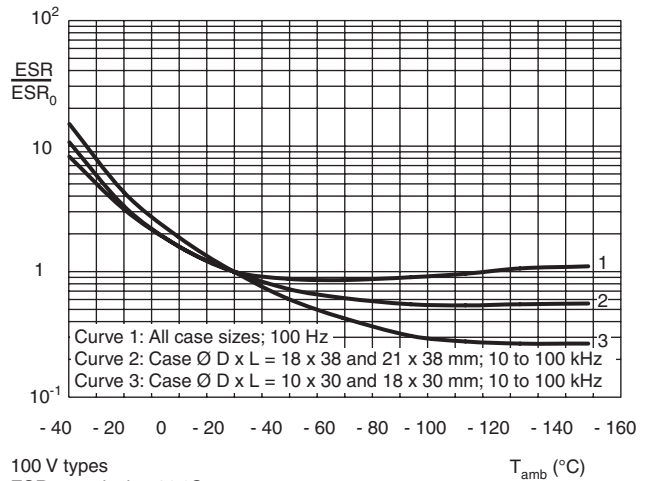
$\leq 40 \text{ V}$  types  
 $ESR_0$  = typical at 20 °C

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



63 V types  
 $ESR_0$  = typical at 20 °C

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

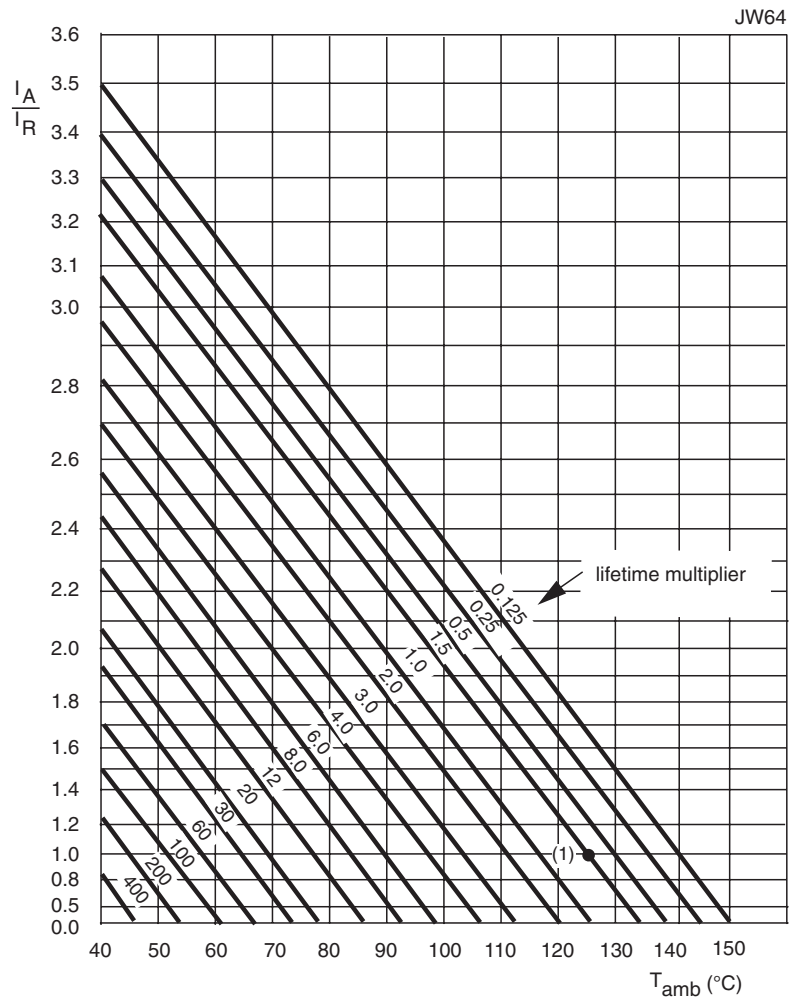


100 V types  
 $ESR_0$  = typical at 20 °C

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 x 30 to 15 x 30 mm	$U_R = 16$ to $40$ V CASE SIZES 18 x 30 to 21 x 38 mm	$U_R = 63$ and $100$ V CASE SIZES 10 x 30 to 15 x 30 mm	$U_R = 63$ and $100$ V CASE SIZES 18 x 30 to 21 x 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
$\geq 10\ 000$	1.00	1.00	1.00	1.00

Table 5

<b>TEST PROCEDURES AND REQUIREMENTS</b>			
<b>TEST</b>		<b>PROCEDURE (QUICK REFERENCE)</b>	<b>REQUIREMENTS</b>
<b>NAME OF TEST</b>	<b>REFERENCE</b>		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	T <sub>amb</sub> = 125 °C; U <sub>R</sub> applied; 4000 hours  T <sub>amb</sub> = 150 °C; U <sub>R</sub> applied; 1000 hours	ΔC/C: ± 15 %  tan δ ≤ 1.3 x spec. limit  Z ≤ 2 × spec. limit  I <sub>L5</sub> ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T <sub>amb</sub> = 125 °C; U <sub>R</sub> and I <sub>R</sub> applied; 8000 hours	ΔC/C: ± 45 %  tan δ ≤ 3 x spec. limit  Z ≤ 3 x spec. limit  I <sub>L5</sub> ≤ 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 <sub>amb</sub> = 125 °C; no voltage applied; 1000 hours (100 V: 500 hours)  T <sub>amb</sub> = 150 °C; no voltage applied; 500 hours for voltages: ≤ 63 V  after test: U <sub>R</sub> to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above  I <sub>L5</sub> ≤ 2 x spec. limit
Reverse voltage	IEC 60384-4/ EN130300 subclause 4.15	T <sub>amb</sub> = 125 °C: 125 hours at U = - 1 V followed by 125 hours at U <sub>R</sub>	ΔC/C: ± 20 %  tan δ ≤ spec. limit  I <sub>L5</sub> ≤ spec. limit



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