

## Aluminum Capacitors

### Axial High Temperature, High Ripple Current

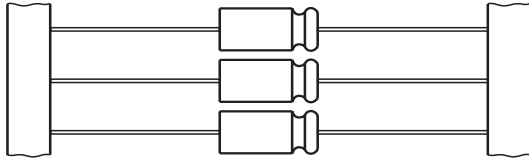
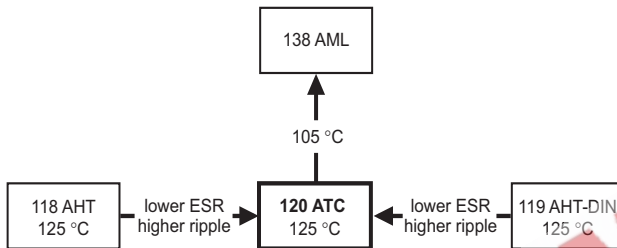


Fig.1 Component outlines


**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  $\varnothing 15 \times 30$  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  $\varnothing d = 1.0$  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:

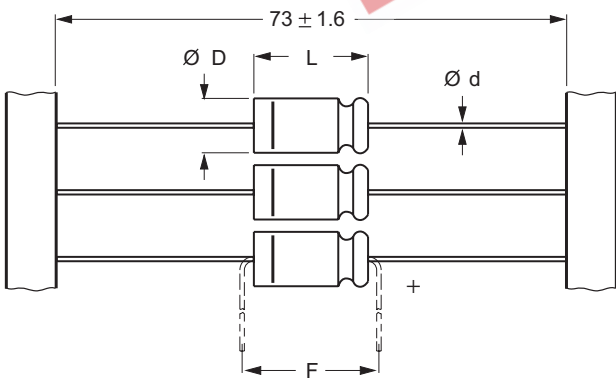
- Rated capacitance (in  $\mu\text{F}$ ).
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for  $\pm 20\%$ ).
- Rated voltage (in V).
- Upper category temperature (125 °C).
- Date code in accordance with IEC 60062.
- Code for factory of origin.
- Name of manufacturer.
- Band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

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes ( $\varnothing D \times L$ in mm)	10 × 30 to 21 × 38
Rated capacitance range, $C_R$	47 to 6800 $\mu\text{F}$
Tolerance on $C_R$	$\pm 20\%$
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, $1.4 \times I_R$ applied	40000 hours
Shelf life at 0 V, 125 °C	1000 hours (100 V: 500 hours)
Shelf life at 0 V, 150 °C	$\leq 63$ 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

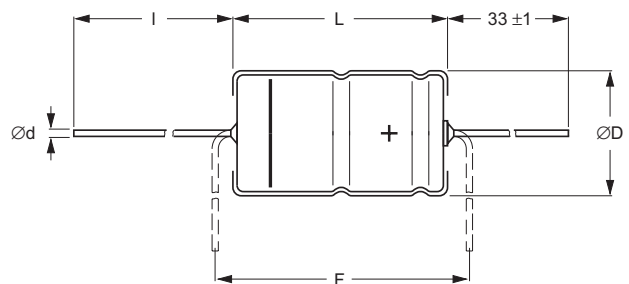
<b>SELECTION CHART FOR <math>C_R</math>, <math>U_R</math> AND RELEVANT NOMINAL CASE SIZE (<math>\varnothing D \times L</math> in mm)</b>					
$C_R$ ( $\mu F$ )	$U_R$ (V)				
	16	25	40	63	100
47	-	-	-	-	10 × 30
68	-	-	-	-	12.5 × 30
100	-	-	-	10 × 30	12.5 × 30
150	-	-	-	12.5 × 30	15 × 30
220	-	-	10 × 30	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  $\varnothing D \times L = 10 \times 30$  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

<b>AXIAL; DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b>								
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	AXIAL: FORM AA AND BR					MASS (G)	PACKAGING QUANTITIES	
	$\varnothing d(1)$	l	$\varnothing D_{max}$	L <sub>MAX</sub>	F <sub>MIN</sub>		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**

- Lead diameter  $\varnothing d = 1.0$  mm, available on request.
- Detailed tape dimensions see section 'PACKAGING'.

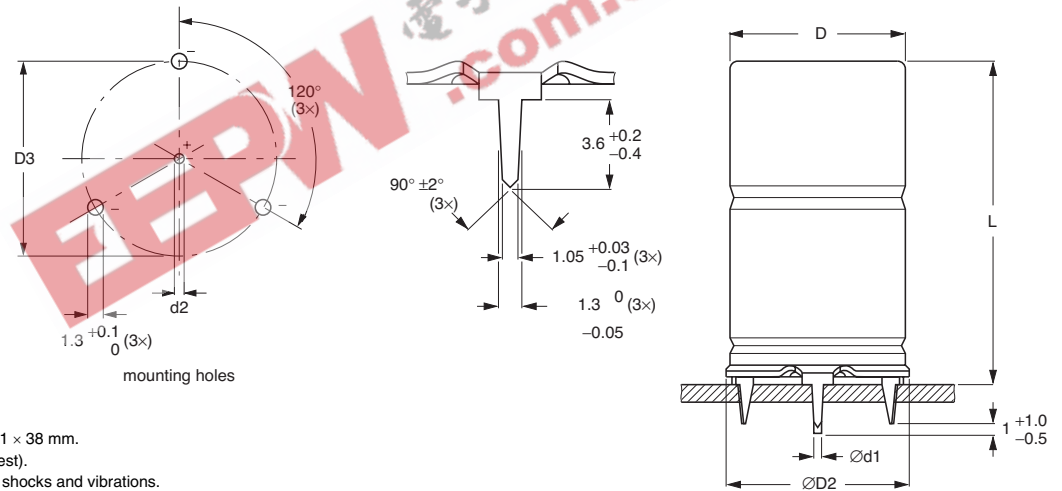
 Fig.4 Mounting hole diagram and outline; **Form MR**; with mounting ring and pins.


Table 2

<b>MOUNTING RING; DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b>									
NOMINAL CASE SIZE $\varnothing D \times L$	CASE CODE	MOUNTING RING: FORM MR						MASS (g)	PACKAGING QUANTITIES
		$\varnothing d1$	$\varnothing d2$	$\varnothing D_{MAX}$	$\varnothing D2_{MAX}$	D3	L <sub>MAX</sub>		
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 $\pm 20\%$
$I_R$	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

**Note**

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

Table 3

ELECTRICAL DATA AND ORDERING INFORMATION													
$U_R$ (V)	$C_R$ 100 Hz ( $\mu\text{F}$ )	NOMINAL CASE SIZE $\varnothing \times L$ (mm)	$I_R$ 10 KHZ 125 °C (mA)	$I_{L1}$ 1 MIN ( $\mu\text{A}$ )	$I_{L5}$ 5 MIN ( $\mu\text{A}$ )	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 $\Omega$ )	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

**ORDERING EXAMPLE\***

Electrolytic capacitor 120 series

1000  $\mu\text{F}/16\text{ V}$ ;  $\pm 20\%$ Nominal case size:  $\varnothing 12.5 \times 30\text{ mm}$ ; 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.

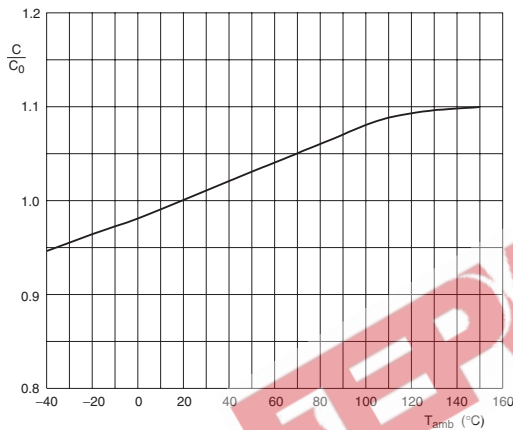


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Vishay BCcomponents

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 × 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

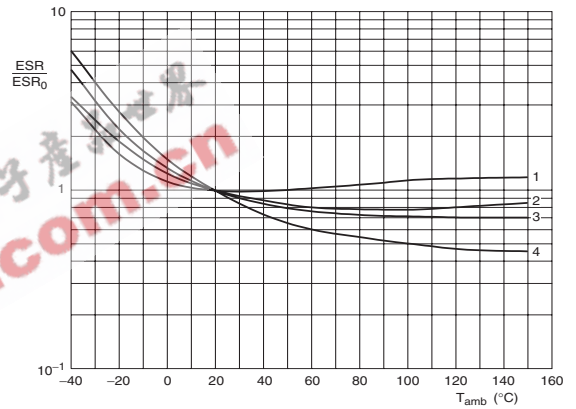
**CAPACITANCE (C)**



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.

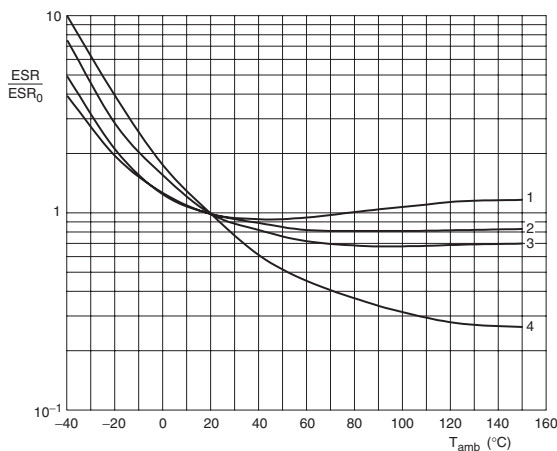
**EQUIVALENT SERIES RESISTANCE (ESR)**



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

Curve 1: All case sizes; 100 Hz.  
Curve 2: Case  $\varnothing D \times L = 18 \times 38$  and  $21 \times 38$  mm; 10 to 100 kHz.  
Curve 3: Case  $\varnothing D \times L = 15 \times 30$  and  $18 \times 30$  mm; 10 to 100 kHz.  
Curve 4: Case  $\varnothing D \times L = 10 \times 30$  and  $12.5 \times 30$  mm; 10 to 100 kHz.

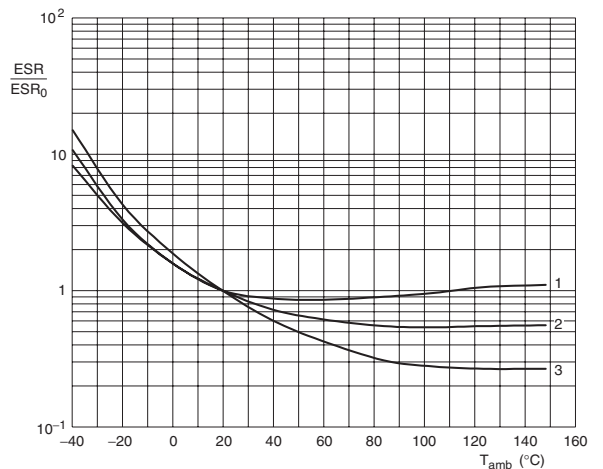
Fig.6 Typical multiplier of ESR as a function of ambient temperature at different frequencies.



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

Curve 1: All case sizes; 100 Hz.  
Curve 2: Case  $\varnothing D \times L = 18 \times 38$  and  $21 \times 38$  mm; 10 to 100 kHz.  
Curve 3: Case  $\varnothing D \times L = 15 \times 30$  and  $18 \times 30$  mm; 10 to 100 kHz.  
Curve 4: Case  $\varnothing D \times L = 10 \times 30$  and  $12.5 \times 30$  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.

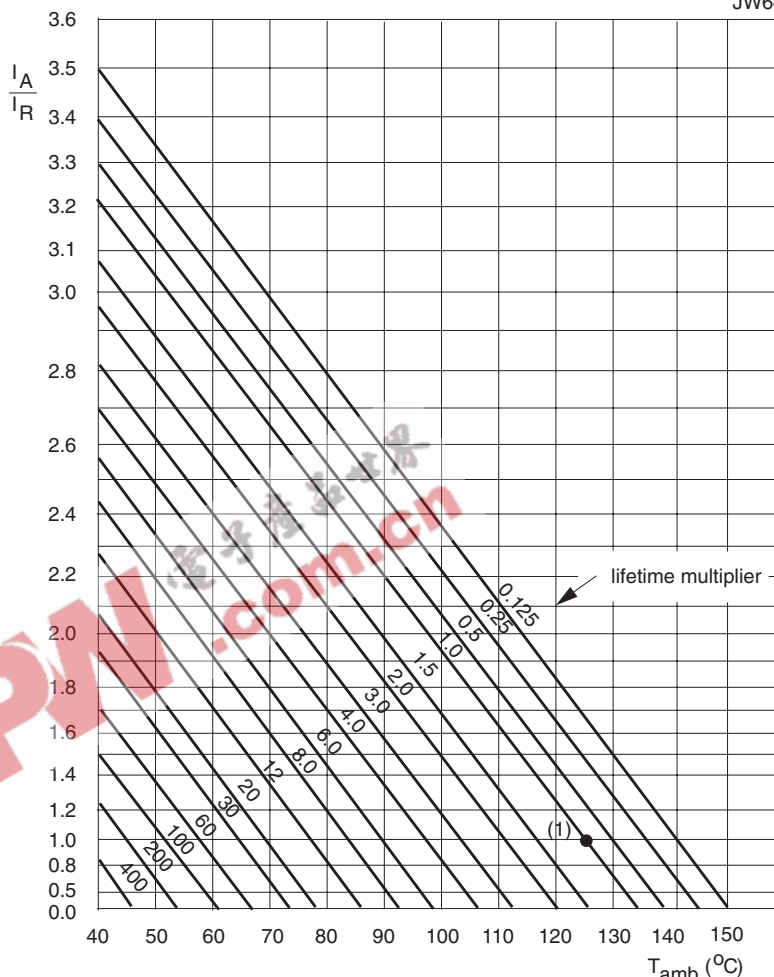
Curve 1: All case sizes; 100 Hz.  
Curve 2: Case  $\varnothing D \times L = 18 \times 38$  and  $21 \times 38$  mm; 10 to 100 kHz.  
Curve 3: Case  $\varnothing D \times L = 10 \times 30$  to  $18 \times 30$  mm; 10 to 100 kHz.

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



**RIPPLE CURRENT AND USEFUL LIFE**

JW64



$I_A$  = 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 $10 \times 30$ to $15 \times 30$ mm	$U_R = 16$ to $40$ V case sizes $18 \times 30$ to $21 \times 38$ mm	$U_R = 63$ and $100$ V case sizes $10 \times 30$ to $15 \times 30$ mm	$U_R = 63$ and $100$ V case sizes $18 \times 30$ to $21 \times 38$ 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
$\geq 10000$	1.00	1.00	1.00	1.00



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Vishay BCcomponents

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (QUICK REFERENCE)	REQUIREMENTS
NAME OF TEST	REFERENCE		
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 × 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 × spec. limit  Z ≤ 3 × 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 × 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
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  ΔC/C: ±5% with respect to initial measurement



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