

Aluminum Capacitors

Axial High Temperature, High Ripple Current

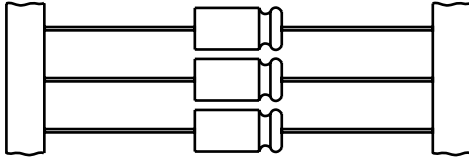
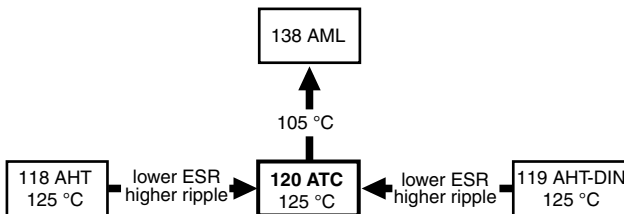


Fig.1 Component outlines



QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes (\varnothing D x L in mm)	10 x 30 to 21 x 38
Rated capacitance range, C_R	47 to 6800 μ F
Tolerance on C_R	$\pm 20\%$
Rated voltage range, U_R	16 to 100 V
Category temperature range	- 40 to + 125 $^{\circ}$ C
Endurance test at 150 $^{\circ}$ C	1000 hours
Endurance test at 125 $^{\circ}$ C	4000 hours
Useful life at 125 $^{\circ}$ C	8000 hours
Useful life at 85 $^{\circ}$ C, 1.4 x I_R applied	40 000 hours
Shelf life at 0 V, 125 $^{\circ}$ C	1000 hours (100 V: 500 hours)
Shelf life at 0 V, 150 $^{\circ}$ C	≤ 63 V: 500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/125/56

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 x 30 mm available for automatic insertion
- Charge and discharge proof
- Extra long useful life: up to 8000 hours at 125 $^{\circ}$ C, high reliability
- Lowest ESR levels providing very high ripple current capability
- Extended temperature range: usable up to 150 $^{\circ}$ 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

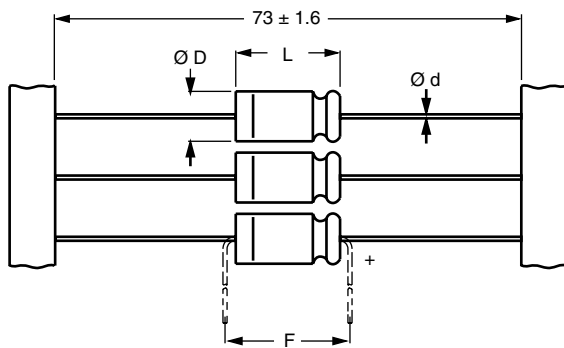
MARKING

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

- Rated capacitance (in μ F)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for $\pm 20\%$)
- Rated voltage (in V)
- Upper category temperature (125 $^{\circ}$ 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)

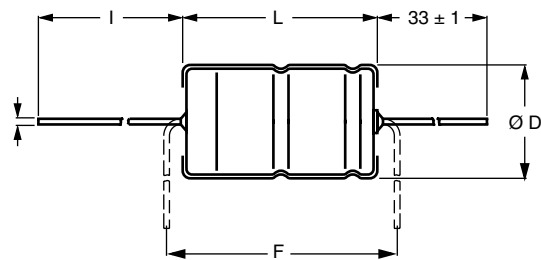
SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZE ($\varnothing D \times L$ in mm)					
C_R (μF)	U_R (V)				
	16	25	40	63	100
47	-	-	-	-	10 x 30
68	-	-	-	-	12.5 x 30
100	-	-	-	10 x 30	12.5 x 30
150	-	-	-	12.5 x 30	15 x 30
220	-	-	10 x 30	12.5 x 30	18 x 30
330	-	-	12.5 x 30	15 x 30	18 x 38
470	-	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 15×30 mm

Fig.2 **Form BR**



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

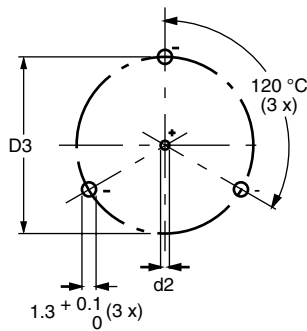
Fig.3 **Form AA**

Table 1

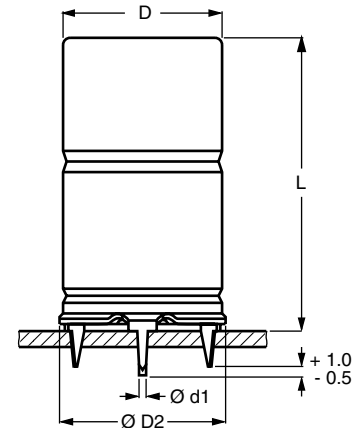
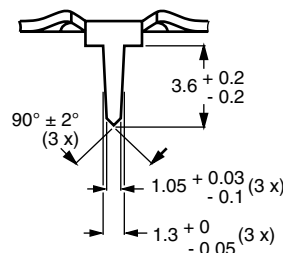
AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES								
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	AXIAL: FORM AA AND BR					MASS (g)	PACKAGING QUANTITIES	
	$\varnothing d(1)$	l	$\varnothing D_{max.}$	$L_{max.}$	$F_{min.}$		FORM AA	FORM BR
10 x 30	0.8	55 ± 1	10.5	30.5	35	≈ 4.8	340	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

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



Mounting holes



Case $\varnothing D \times L = 15 \times 30$ to 21×38 mm
 Case not insulated (insulation on request)
 Especially for applications with severe shocks and vibrations

 Fig.4 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 $\varnothing D \times L$	CASE CODE	MOUNTING RING: FORM MR						MASS (g)	PACKAGING QUANTITIES
		$\varnothing d1$	$\varnothing d2$	$\varnothing D_{max.}$	$\varnothing D2_{max.}$	D3	$L_{max.}$		
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

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 kPa , $RH = 45$ to 75% .

Table 3

ELECTRICAL DATA AND ORDERING INFORMATION													
U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 10 kHz 125 °C (mA)	I_{L1} 1 MIN (μA)	I_{L5} 5 MIN (μA)	TYP. ESR 100 Hz (m Ω)	MAX. ESR 100 Hz (m Ω)	TYP. ESR 10 kHz (m Ω)	MAX. ESR 10 kHz (m Ω)	Z MAX. 10 kHz (m Ω)	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

ORDERING EXAMPLE

Electrolytic capacitor 120 series

1 000 $\mu\text{F}/16\text{ V}$; $\pm 20\%$ Nominal case size: $\varnothing 12.5 \times 30\text{ mm}$; Form BR

Ordering code: MAL212025102E3

Former 12NC: 2222 120 25102



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 $\varnothing D \times L$ 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)

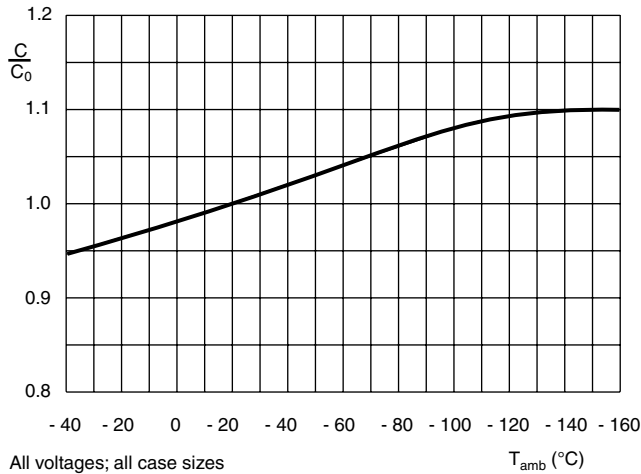


Fig.5 Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

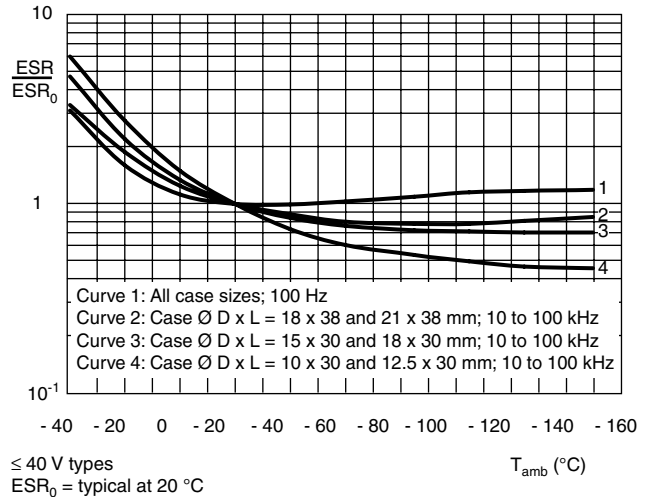


Fig.6 Typical multiplier of ESR as a function of ambient temperature at different frequencies

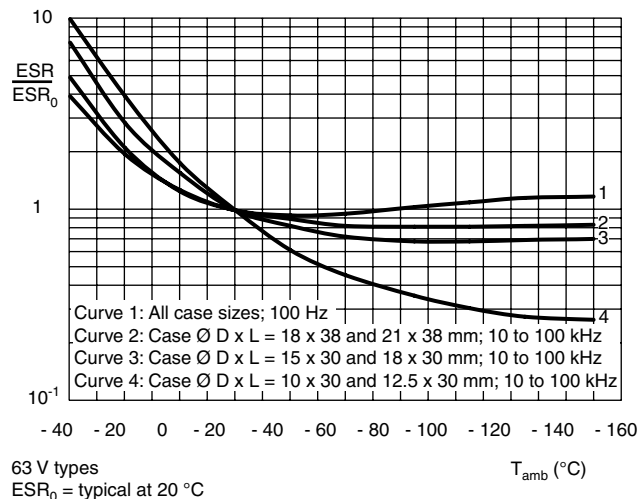


Fig.7 Typical multiplier of ESR as a function of ambient temperature at different frequencies

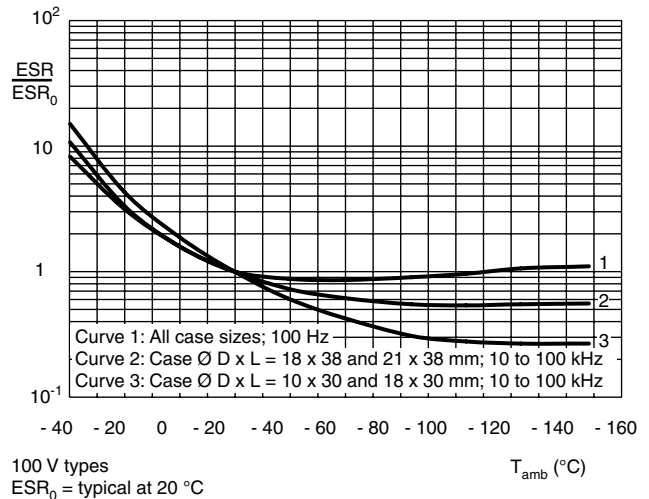
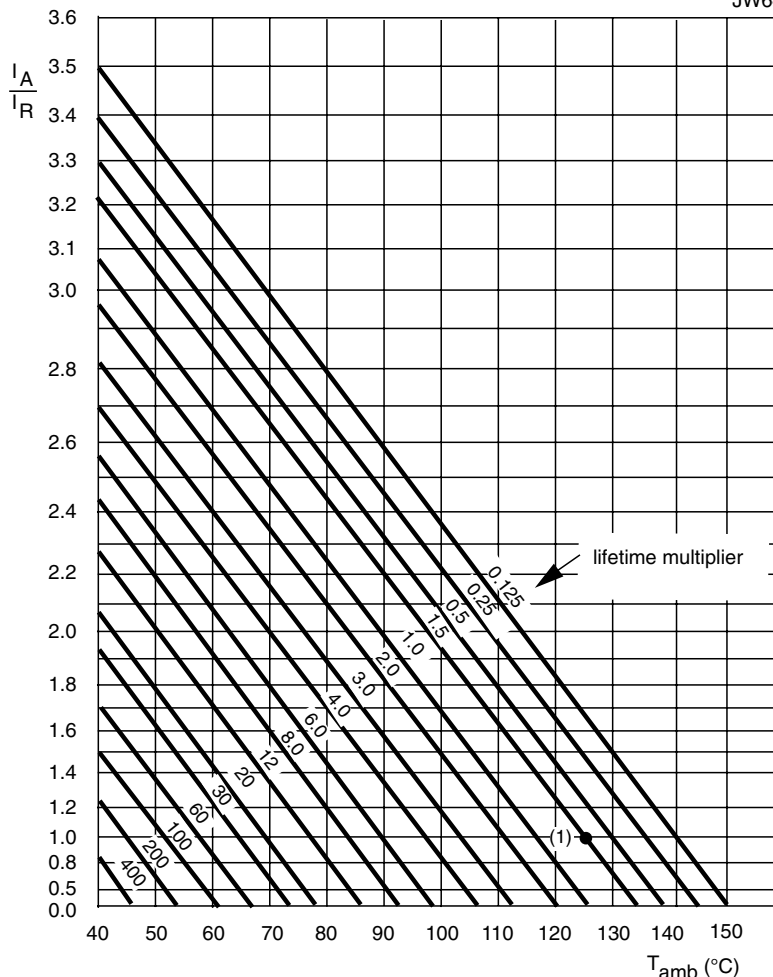


Fig.8 Typical multiplier of ESR as a function of ambient temperature at different frequencies



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 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



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Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (QUICK REFERENCE)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 125\text{ °C}$; U_R applied; 4000 hours $T_{amb} = 150\text{ °C}$; U_R applied; 1000 hours	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 125\text{ °C}$; U_R and I_R applied; 8000 hours	$\Delta C/C: \pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	$T_{amb} = 125\text{ °C}$; no voltage applied; 1000 hours (100 V: 500 hours) $T_{amb} = 150\text{ °C}$; no voltage applied; 500 hours for voltages: $\leq 63\text{ V}$ after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C, \tan \delta, Z$: for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$
Reverse voltage	IEC 60384-4/ EN130300 subclause 4.15	$T_{amb} = 125\text{ °C}$: 125 hours at $U = -1\text{ V}$ followed by 125 hours at U_R	$\Delta C/C: \pm 20\%$ $\tan \delta \leq \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
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 $\Delta C/C: \pm 5\%$ with respect to initial measurement



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