

## Aluminum Capacitors Axial High Temperature, High Ripple Current



Fig. 1

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 µF to 6800 µF
Tolerance on C <sub>R</sub>	± 20 %
Rated voltage range, U <sub>R</sub>	16 V to 100 V
Category temperature range	- 40 °C to + 125 °C
Endurance test at 150 °C	1000 h
Endurance test at 125 °C	4000 h
Useful life at 125 °C	8000 h
Useful life at 85 °C, 1.4 x I <sub>R</sub> applied	40 000 h
Shelf life at 0 V, 125 °C	1000 h (100 V: 500 h)
Shelf life at 0 V, 150 °C	≤ 63 V: 500 h
Based on sectional specification	IEC 60384-4/EN 130300
Climatic category IEC 60068	40/125/56

**FEATURES**

- Extra long useful life: Up to 8000 h at 125 °C
- Extended temperature range: Usable up to 150 °C
- Lowest ESR levels providing very high ripple current capability
- Miniaturized, high CV-product per unit volume
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Taped versions up to case Ø 15 mm x 30 mm available for automatic insertion
- Lead diameter Ø d = 1.0 mm, available on request
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS  
COMPLIANT**
**APPLICATIONS**

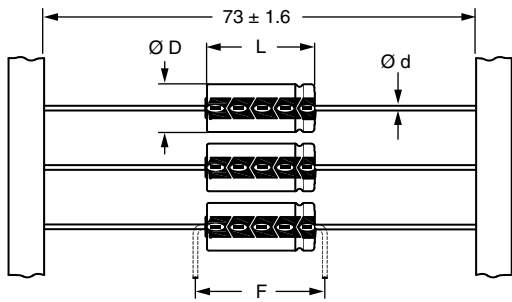
- Automotive, industrial and telecommunication
- Smoothing, filtering, buffering
- Low mounting height applications, vibration and shock resistant
- SMPS and standard power supplies

**MARKING**

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

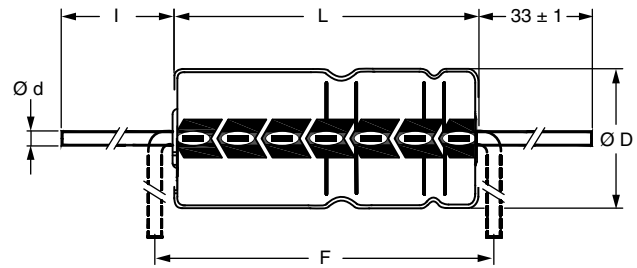
- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Upper category temperature (125 °C)
- Date code in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (120)

SELECTION CHART FOR C <sub>R</sub> , U <sub>R</sub> , AND RELEVANT NOMINAL CASE SIZE (Ø D x L in mm)					
C <sub>R</sub> (µF)	U <sub>R</sub> (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  
Case  $\text{Ø D} \times \text{L} = 6.5 \text{ mm} \times 18 \text{ mm}$  to  $15 \text{ mm} \times 30 \text{ mm}$

Fig. 2 - Form BR



**Form AA:** Axial in box  
Case  $\text{Ø D} \times \text{L} = 10 \text{ mm} \times 30 \text{ mm}$  to  $21 \text{ mm} \times 38 \text{ mm}$

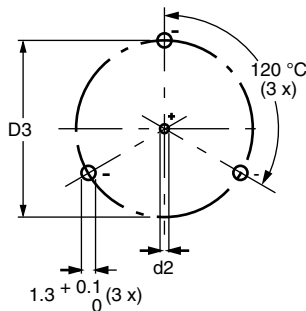
Fig. 3 - Form AA

Table 1

<b>AXIAL; DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES</b>								
NOMINAL CASE SIZE $\text{Ø D} \times \text{L}$ (mm)	AXIAL: FORM AA AND BR					MASS (g)	PACKAGING QUANTITIES	
	$\text{Ø d}^{(1)}$	l	$\text{Ø D}_{\text{max.}}$	$L_{\text{max.}}$	$F_{\text{min.}}$		FORM AA	FORM BR
10 x 30	0.8	$55 \pm 1$	10.5	30.5	35	$\approx 4.8$	340	500
12.5 x 30	0.8	$55 \pm 1$	13.0	30.5	35	$\approx 7.4$	260	400
15 x 30	0.8	$55 \pm 1$	15.5	30.5	35	$\approx 11.7$	200	250
18 x 30	0.8	$55 \pm 1$	18.5	30.5	35	$\approx 12.9$	120	-
18 x 38	0.8	$34 \pm 1$	18.5	39.5	44	$\approx 19.0$	125	-
21 x 38	0.8	$34 \pm 1$	21.5	39.5	44	$\approx 24.0$	100	-

**Notes**

- (1) Lead diameter  $\text{Ø d} = 1.0 \text{ mm}$ , available on request.
- For detailed tape dimensions, please see [www.vishay.com/doc?28361](http://www.vishay.com/doc?28361).



Mounting holes

Case  $\text{Ø D} \times \text{L} = 15 \text{ mm} \times 30 \text{ mm}$  to  $21 \text{ mm} \times 38 \text{ mm}$   
Especially for applications with severe shocks and vibrations

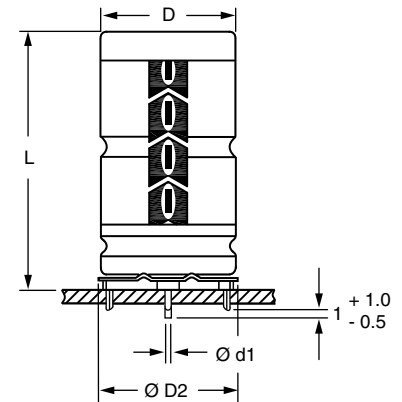
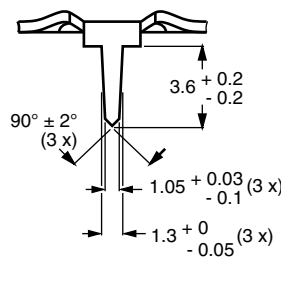


Fig. 4 - Mounting hole diagram and outline; **form MR:** With mounting ring and pins

Table 2

<b>MOUNTING RING; DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES</b>									
NOMINAL CASE SIZE $\text{Ø D} \times \text{L}$	CASE CODE	MOUNTING RING: FORM MR						MASS (g)	PACKAGING QUANTITIES
		$\text{Ø d1}$	$\text{Ø d2}$	$\text{Ø D}_{\text{max.}}$	$\text{Ø D2}_{\text{max.}}$	D3	$L_{\text{max.}}$		
15 x 30	02	0.8	$1.0 + 0.4$	15.5	17.5	$16.5 \pm 0.2$	33	$\approx 8.6$	200
18 x 30	03	0.8	$1.0 + 0.4$	18.5	19.5	$18.5 \pm 0.2$	33	$\approx 11.5$	240
18 x 38	04	0.8	$1.0 + 0.4$	18.5	19.5	$18.5 \pm 0.2$	42	$\approx 14.0$	100
21 x 38	05	0.8	$1.0 + 0.4$	21.5	22.5	$21.5 \pm 0.2$	42	$\approx 19.2$	100



ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C <sub>R</sub>	Rated capacitance at 100 Hz, tolerance ± 20 %
I <sub>R</sub>	Rated RMS ripple current at 10 kHz, 125 °C
I <sub>L1</sub>	Max. leakage current after 1 min at U <sub>R</sub>
I <sub>L5</sub>	Max. leakage current after 5 min at U <sub>R</sub>
ESR	Equivalent series resistance at 100 Hz (calculated from tan δ <sub>max.</sub> and C <sub>R</sub> )
Z	Max. impedance at 10 kHz

**ORDERING EXAMPLE**

Electrolytic capacitor 120 series  
 1000 µF/16 V; ± 20 %  
 Nominal case size: Ø 12.5 mm x 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<sub>amb</sub> = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %.

**Table 3**

ELECTRICAL DATA AND ORDERING INFORMATION													
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I <sub>R</sub> 10 kHz 125 °C (mA)	I <sub>L1</sub> 1 min (µA)	I <sub>L5</sub> 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)	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 min at $U_R$	$I_{L1} \leq 0.012 C_R \times U_R + 40 \mu\text{A}$	
	After 5 min 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)**

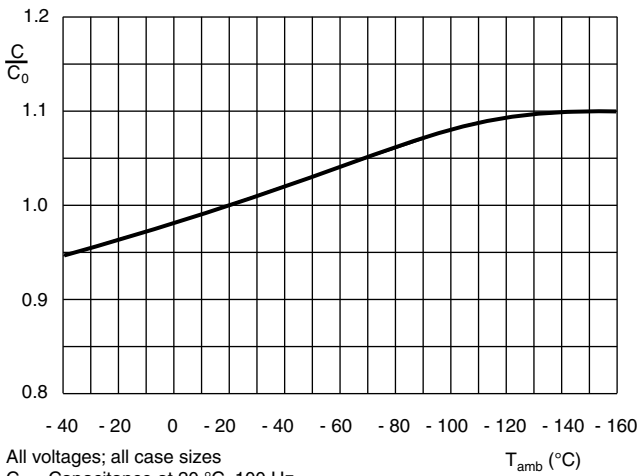


Fig. 5 - Typical multiplier of capacitance as a function of ambient temperature

**EQUIVALENT SERIES RESISTANCE (ESR)**

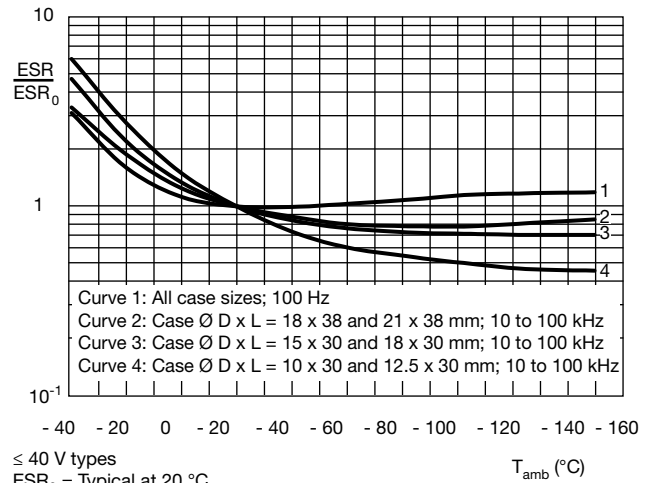


Fig. 6 - Typical multiplier of ESR as a function of ambient temperature at different frequencies

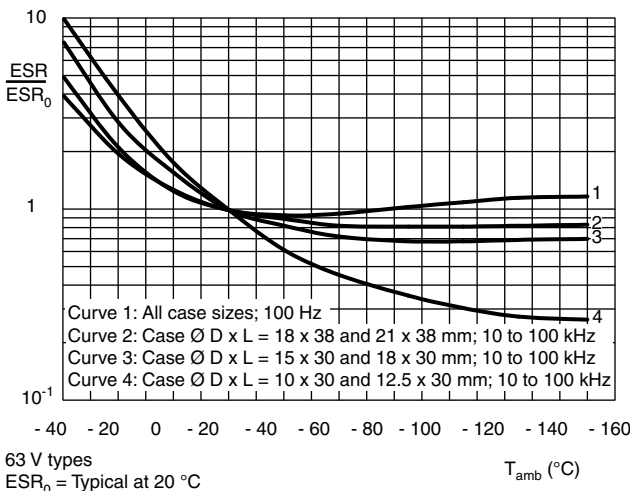


Fig. 7 - Typical multiplier of ESR as a function of ambient temperature at different frequencies

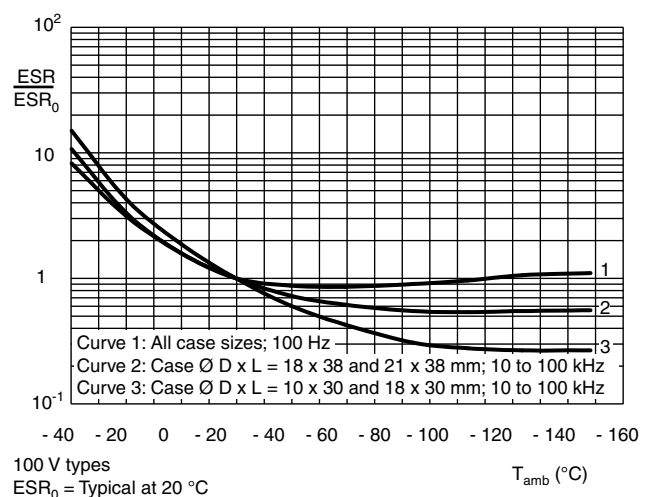
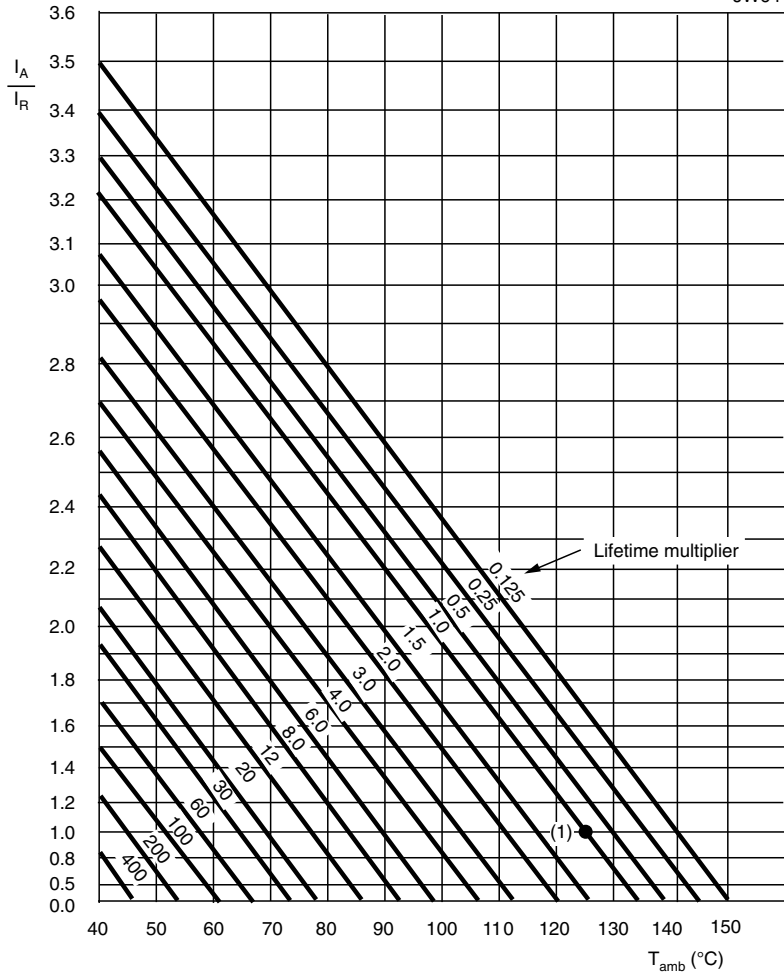


Fig. 8 - Typical multiplier of ESR as a function of ambient temperature at different frequencies

**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 h

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			
	$U_R = 16\text{ V TO }40\text{ V}$ CASE SIZES (10 x 30 to 15 x 30) mm	$U_R = 16\text{ V TO }40\text{ V}$ CASE SIZES (18 x 30 to 21 x 38) mm	$U_R = 63\text{ V AND }100\text{ V}$ CASE SIZES (10 x 30 to 15 x 30) mm	$U_R = 63\text{ V AND }100\text{ V}$ 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

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN 130300 subclause 4.13	$T_{amb} = 125\text{ }^{\circ}\text{C}$ ; $U_R$ applied; 4000 h  $T_{amb} = 150\text{ }^{\circ}\text{C}$ ; $U_R$ applied; 1000 h	$\Delta C/C$ : $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 125\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied; 8000 h	$\Delta C/C$ : $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN 130300 subclause 4.17	$T_{amb} = 125\text{ }^{\circ}\text{C}$ ; no voltage applied; 1000 h (100 V: 500 h)  $T_{amb} = 150\text{ }^{\circ}\text{C}$ ; no voltage applied; 500 h for voltages: $\leq 63\text{ V}$  After test: $U_R$ to be applied for 30 min, 24 h to 48 h 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/ EN 130300 subclause 4.15	$T_{amb} = 125\text{ }^{\circ}\text{C}$ : 125 h at $U = -1\text{ V}$ Followed by 125 h at $U_R$	$\Delta C/C$ : $\pm 20\%$ $\tan \delta \leq \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$



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