

## Aluminum Electrolytic Capacitors

### Radial Miniature, Low Impedance, High Vibration Capability

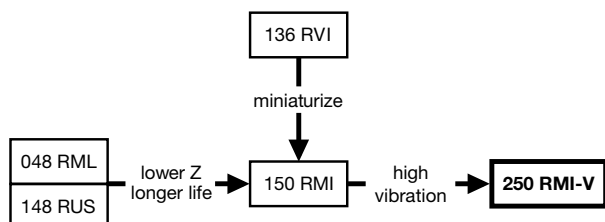
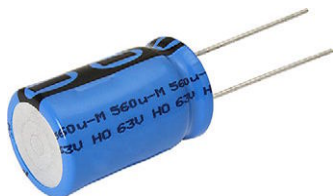


Fig. 1

## QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes (Ø D x L in mm)	16 x 20 to 18 x 40
Rated capacitance range, C <sub>R</sub>	330 µF to 8200 µF
Tolerance on C <sub>R</sub>	± 20 %
Rated voltage range, U <sub>R</sub>	10 V to 100 V
Category temperature range	-55 °C to +105 °C
Endurance test at 105 °C	3000 h to 7000 h
Useful life at 105 °C	7000 h to 10 000 h
Useful life at 40 °C, 1.8 x I <sub>R</sub> applied	200 000 h to 500 000 h
Shelf life at 0 V, 105 °C	1000 h
Based on sectional specification	IEC 60384-4 / EN130300
Climatic category IEC 60068	55 / 105 / 56

## FEATURES

- Very long useful life: 7000 h to 10 000 h at 105 °C, high stability, high reliability
  - Very low impedance and low ESR in smaller case sizes than the 136 RVI series
  - Excellent ripple current capability
  - High vibration resistance up to 50 g
  - AEC-Q200 qualified
  - Polarized aluminum electrolytic capacitors, non-solid electrolyte
  - Radial leads, cylindrical aluminum case, insulated with a blue sleeve
  - Charge and discharge proof
  - Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)
- 
- RoHS**  
COMPLIANT



## APPLICATIONS

- Power supplies (SMPS, DC/DC converters) for general industrial, EDP, audio-video, automotive, and telecommunications
- Smoothing, filtering, buffering

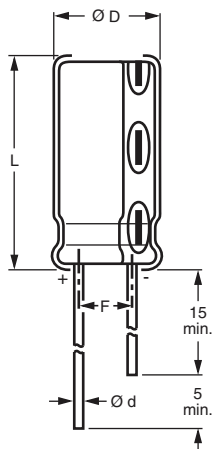
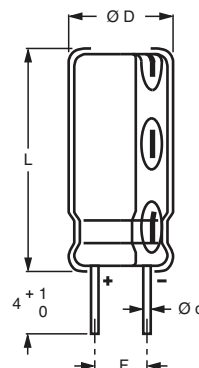
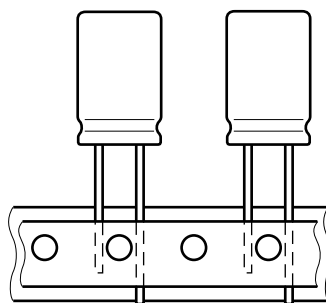
## MARKING

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)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Upper category temperature ( $105^\circ\text{C}$ )
- Negative terminal identification
- Series number (250)

### SELECTION CHART FOR C<sub>B</sub>, U<sub>B</sub>, AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C <sub>R</sub> (μF)	U <sub>R</sub> (V)						
	10	16	25	35	50	63	100
330	-	-	-	-	-	-	18 x 20
470	-	-	-	-	-	16 x 20	-
680	-	-	-	-	-	16 x 20	-
	-	-	-	-	-	16 x 25	-
1000	-	-	-	-	16 x 25	16 x 31	-
	-	-	-	16 x 20	-	-	-
1200	-	-	-	-	16 x 31	-	-
1500	-	-	-	16 x 20	16 x 31	-	-
2200	-	-	16 x 20	16 x 31	-	18 x 40	-
3300	-	16 x 20	16 x 31	18 x 31	18 x 40	-	-
4700	16 x 25	16 x 31	16 x 35	18 x 40	-	-	-
6800	16 x 31	16 x 35	18 x 40	-	-	-	-
8200	-	18 x 40	-	-	-	-	-

**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**

Fig. 2 - **Form CA:** Long leads

Fig. 3 - **Form CB:** Cut leads

Fig. 4 - **Form TFA:** Taped in box (ammopack)

**Table 1**

<b>DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b>									
NOMINAL CASE SIZE Ø D x L	CASE CODE	Ø d	Ø D <sub>max.</sub>	L <sub>max.</sub>	F	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA
16 x 20	19a	0.8	16.5	22.0	7.5 ± 0.5	≈ 6.0	250	250	250
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.0	100	100	-
18 x 20	1820	0.8	18.5	22.0	7.5 ± 0.5	≈ 8.0	100	100	-
18 x 31	1831	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	100	100	-
18 x 40	1840	0.8	18.5	42.5	7.5 ± 0.5	≈ 16.5	100	100	-

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
$C_R$	Rated capacitance at 100 Hz, tolerance $\pm 20\%$
$I_R$	Rated RMS ripple current at 100 kHz, 105 °C
$I_{L2}$	Maximum leakage current after 2 min at $U_R$
$\tan \delta$	Maximum dissipation factor at 100 Hz
Z	Maximum impedance at 100 kHz

**Note**

- Unless otherwise specified, all electrical values in Table 2 apply at  $T_{amb} = 20\text{ °C}$ ,  $P = 86\text{ kPa}$  to  $106\text{ kPa}$ ,  $RH = 45\%$  to  $75\%$ .

**Table 2**

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> 100 kHz 105 °C (mA)	I <sub>L2</sub> 2 min (μA)	tan δ 100 Hz	Z 100 kHz +20 °C (Ω)	Z 100 kHz -40 °C (Ω)	ORDERING CODE MAL2250.....		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
10	4700	16 x 25	2390	473	0.23	0.022	0.150	54472E3	64472E3	34472E3
	6800	16 x 31	2890	683	0.25	0.019	0.130	54682E3	64682E3	34682E3
16	3300	16 x 20	1840	531	0.20	0.028	0.200	55332E3	65332E3	35332E3
	4700	16 x 31	2890	755	0.22	0.019	0.130	55472E3	65472E3	35472E3
	6800	16 x 35	3100	1091	0.24	0.018	0.130	55682E3	65682E3	-
	8200	18 x 40	3500	1315	0.28	0.018	0.130	55822E3	65822E3	-
25	2200	16 x 20	1840	553	0.16	0.028	0.200	56222E3	66222E3	36222E3
	3300	16 x 31	2890	828	0.16	0.019	0.130	56332E3	66332E3	36332E3
	4700	16 x 35	3100	1178	0.18	0.018	0.130	56472E3	66472E3	-
	6800	18 x 40	3500	1703	0.22	0.018	0.130	56682E3	66682E3	-
35	1000	16 x 20	1840	353	0.12	0.028	0.200	90105E3	90106E3	90103E3
	1500	16 x 20	1840	528	0.12	0.028	0.200	50152E3	60152E3	30152E3
	2200	16 x 31	2890	773	0.14	0.019	0.130	50222E3	60222E3	30222E3
	3300	18 x 31	3000	1155	0.16	0.019	0.130	50332E3	60332E3	-
	4700	18 x 40	3300	1648	0.18	0.018	0.130	50472E3	60472E3	-
50	1000	16 x 25	1800	503	0.10	0.034	0.240	51102E3	61102E3	31102E3
	1200	16 x 31	2200	603	0.10	0.027	0.190	51122E3	61122E3	31122E3
	1500	16 x 31	2200	753	0.10	0.027	0.190	51152E3	61152E3	31152E3
	3300	18 x 40	3200	1653	0.14	0.024	0.168	51332E3	61332E3	-
63	470	16 x 20	1100	299	0.10	0.074	0.520	98475E3	98476E3	98473E3
	680	16 x 20	1100	431	0.10	0.074	0.520	58681E3	68681E3	38681E3
	680	16 x 25	1500	431	0.10	0.054	0.380	98685E3	98686E3	98683E3
	1000	16 x 31	1900	633	0.10	0.042	0.295	58102E3	68102E3	38102E3
	2200	18 x 40	3100	1389	0.12	0.033	0.231	58222E3	68222E3	-
100	330	18 x 20	1700	330	0.07	0.074	2.0	90183E3	90185E3	-

**Table 3**

EXTENDED VIBRATION SPECIFICATIONS		
PARAMETER	PROCEDURE	REQUIREMENTS
Vibration specifications	From 10 g to 50 g	No visible damage; no leakage of electrolyte; marking legible $\Delta C/C: \pm 5\%$ with respect to initial measurements
Vibration frequency range	10 Hz to 2 kHz	
Vibration profile	<ul style="list-style-type: none"> <li>Constant sinus sweep (1 oct./min.)</li> <li>3 directions</li> <li>8 h per direction</li> </ul>	

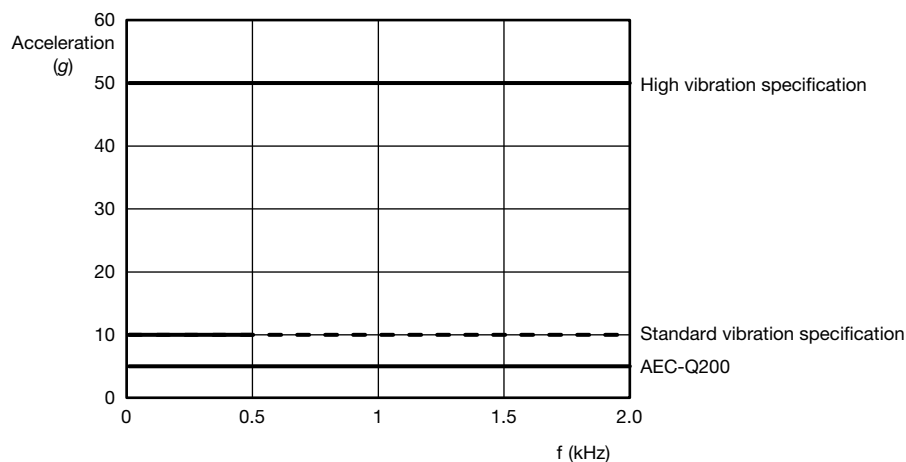


Fig. 5 - Vibration profile

Table 4

ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
<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 2 min at $U_R$	$I_{L2} \leq 0.01 C_R \times U_R + 3 \mu\text{A}$
<b>Inductance</b>		
Equivalent series inductance (ESL)	Case $\varnothing D \geq 16 \text{ mm}$	Typ. 18 nH
<b>Resistance</b>		
Equivalent series resistance (ESR)	Calculated from $\tan \delta_{max}$ and $C_R$ (see Table 2)	$ESR = \tan \delta / 2 \pi f C_R$

## CAPACITANCE (C)

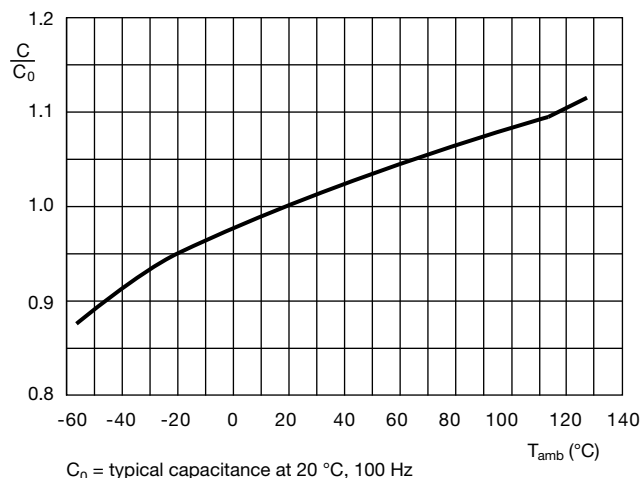


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

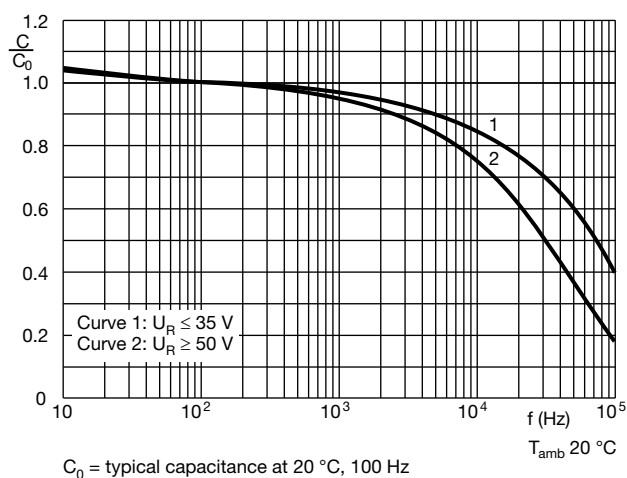


Fig. 7 - Typical multiplier of capacitance as a function of frequency

# EQUIVALENT SERIES RESISTANCE (ESR)

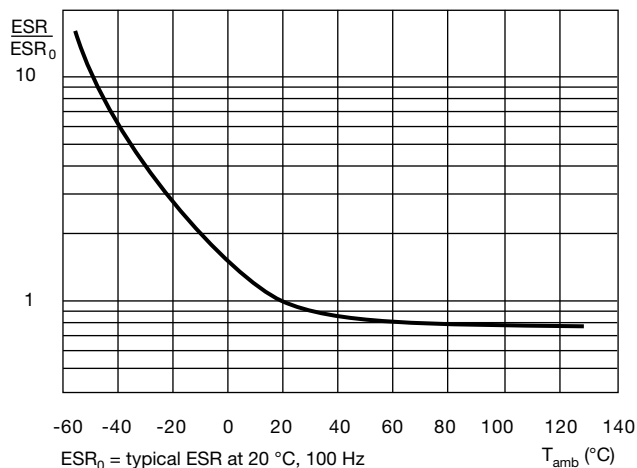


Fig. 8 - Typical multiplier of ESR as a function of ambient temperature

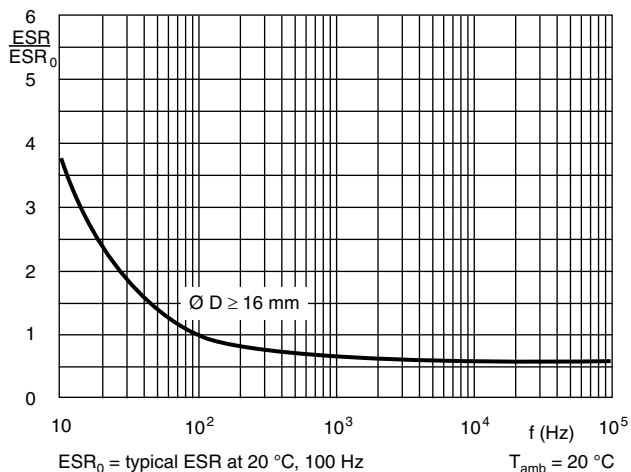


Fig. 9 - Typical multiplier of ESR as a function of frequency

# IMPEDANCE (Z)

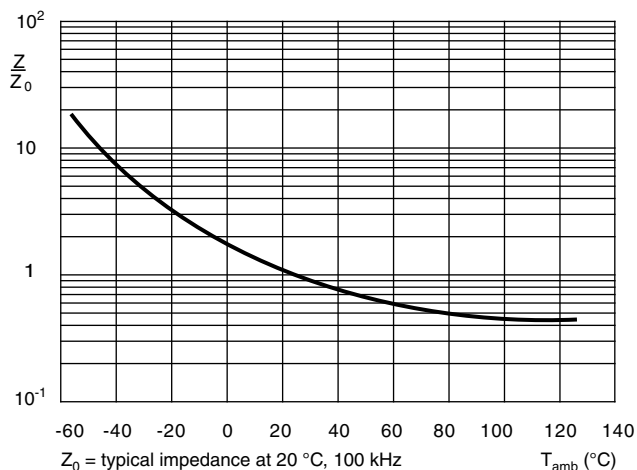


Fig. 10 - Typical multiplier of impedance as a function of ambient temperature

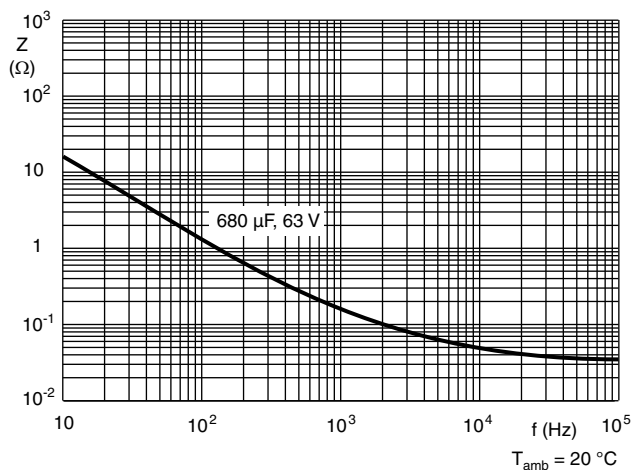


Fig. 11 - Typical impedance as a function of frequency

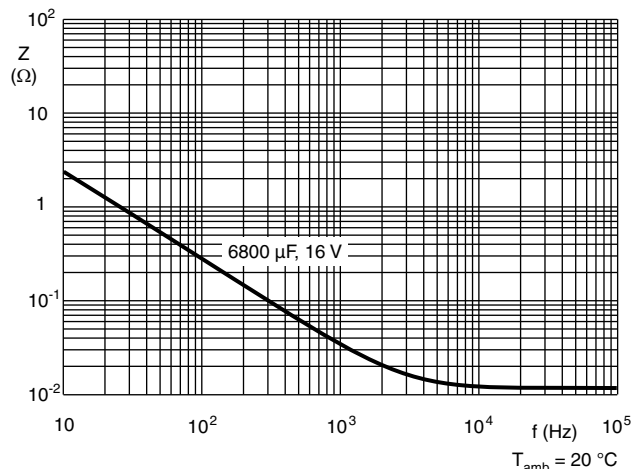


Fig. 12 - Typical impedance as a function of frequency

## RIPPLE CURRENT AND USEFUL LIFE

Table 5

ENDURANCE TEST DURATION AND USEFUL LIFE AS A FUNCTION OF CASE SIZE			
NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	ENDURANCE AT 105 °C (h)	USEFUL LIFE AT 105 °C (h)
16 x 20	19a	3000	7000
16 x 25	19	5000	10 000
16 x 31	20	5000	10 000
16 x 35	21	5000	10 000
18 x 20	1820	3000	7000
18 x 31	1831	6000	10 000
18 x 40	1840	8000	10 000

### Note

- Multiplier of useful life code: CCC206

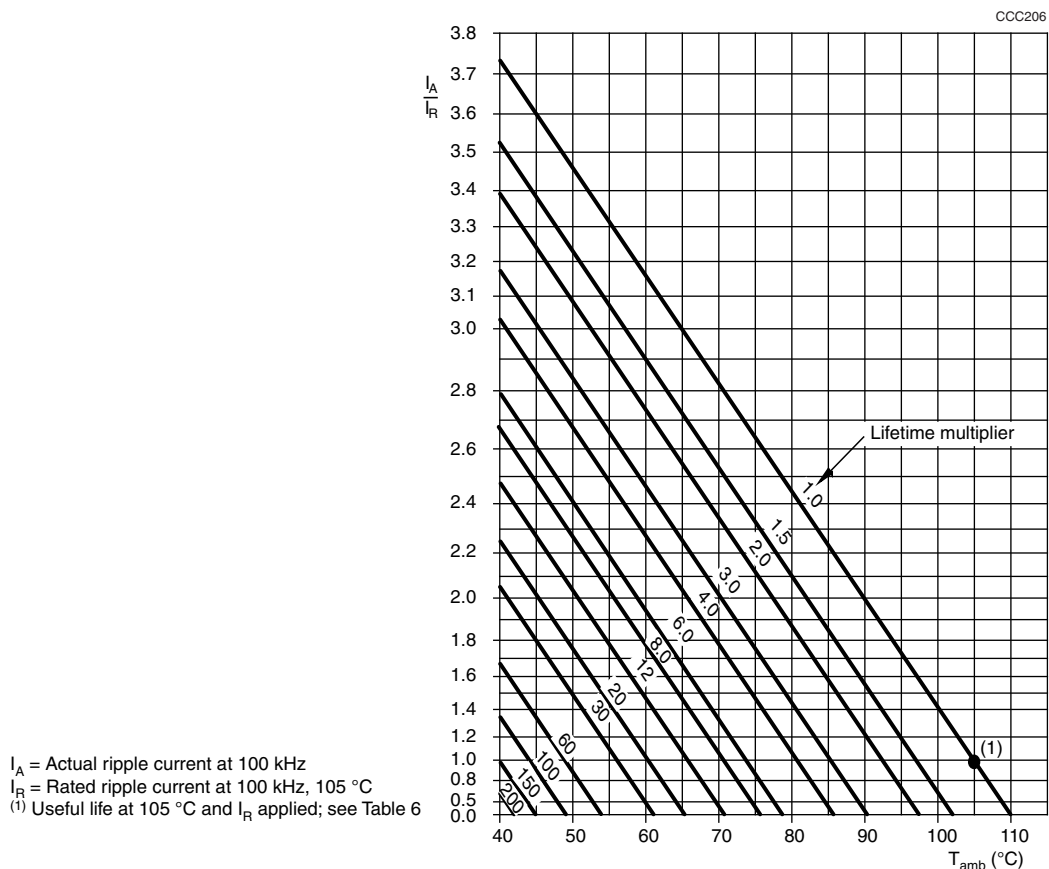


Fig. 13 - Multiplier of useful life as a function of ambient temperature and ripple current load



Table 6

MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY						
FREQUENCY (Hz)						
100	300	1000	3000	10 000	30 000	100 000
$I_R$ MULTIPLIER						
0.76	0.85	0.91	0.94	0.96	0.98	1.00

Table 7

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4 / EN130300 subclause 4.13	$T_{amb} = 105\text{ °C}$ ; $U_R$ applied; for test duration see Table 3	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ °C}$ ; $U_R$ and $I_R$ applied; for test duration see Table 3	$\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4 / EN130300 subclause 4.17	$T_{amb} = 105\text{ °C}$ ; no voltage applied; 1000 h after test: $U_R$ to be applied for 30 min., 24 h to 48 h before measurement	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$

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