

Aluminum Capacitors Radial Miniature Long Life

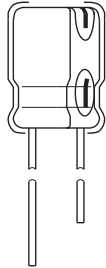
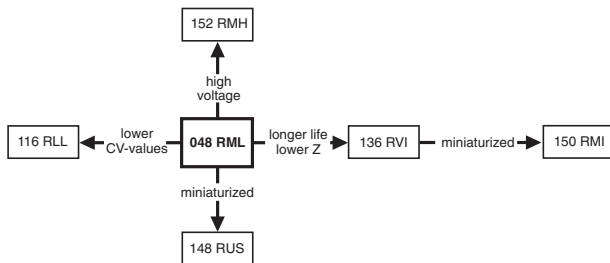


Fig.1 Component outline.



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Very long useful life: 3000 to 4000 hours at 105 °C, high reliability
- Lead (Pb)-free versions are RoHS compliant.



RoHS*
COMPLIANT

APPLICATIONS

- EDP, telecommunication, industrial, automotive and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Portable and mobile equipment (small size, low mass).

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 $\pm 20\%$).
- Rated voltage (in V).
- Date code, in accordance with IEC 60062.
- Code indicating factory of origin.
- Name of manufacturer.
- Upper category temperature (105 °C).
- Negative terminal identification.
- Series number (048).

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes ($\varnothing D \times L$ in mm)	10 × 12 to 18 × 35
Rated capacitance range, C_R	100 to 10 000 μF
Tolerance on C_R	$\pm 20\%$
Rated voltage range, U_R	6.3 to 63 V
Category temperature range	-40 to +105 °C
Endurance test at 105 °C	2000 hours
Useful life at 105 °C	
case $\varnothing D = 10$ and 12.5 mm	3000 hours
case $\varnothing D = 16$ and 18 mm	4000 hours
Useful life at 40 °C, $1.6 \times I_R$ applied	
case $\varnothing D = 10$ and 12.5 mm	200 000 hours
case $\varnothing D = 16$ and 18 mm	260 000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/105/56

C_R (μF)	U_R (V)							
	6.3	10	16	25	35	40	50	63
100	-	-	-	-	-	-	-	10 × 12
220	-	-	-	-	10 × 12	-	10 × 16	10 × 20
330	-	-	-	-	-	-	-	12.5 × 20
470	-	-	10 × 12	10 × 16	10 × 20	-	12.5 × 20	12.5 × 25
1000	-	10 × 16	10 × 20	12.5 × 20	12.5 × 25	-	16 × 25	16 × 31
2200	-	12.5 × 20	12.5 × 25	16 × 25	16 × 31	16 × 35	18 × 35	18 × 35
3300	-	12.5 × 25	16 × 25	16 × 31	18 × 35	18 × 35	18 × 35	-
4700	-	16 × 25	16 × 31	18 × 35	18 × 35	-	-	-
6800	16 × 25	16 × 31	16 × 35	-	-	-	-	-
10000	16 × 35	18 × 35	18 × 35	-	-	-	-	-

* Pb containing terminations are not RoHS compliant, exemptions may apply

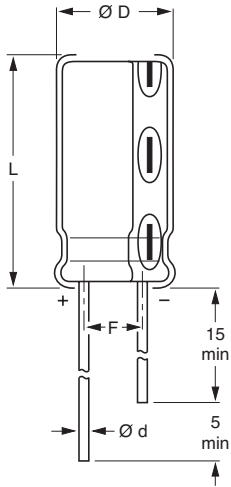
DIMENSIONS in millimeters, **AND AVAILABLE FORMS**


Fig.2 Form CA: Long leads.

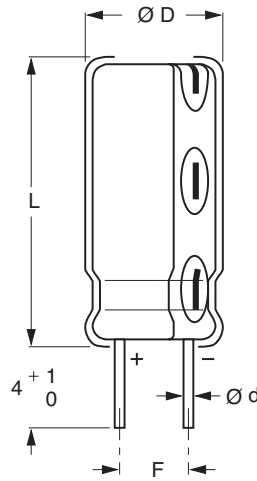


Fig.2 Form CB: Cut leads.

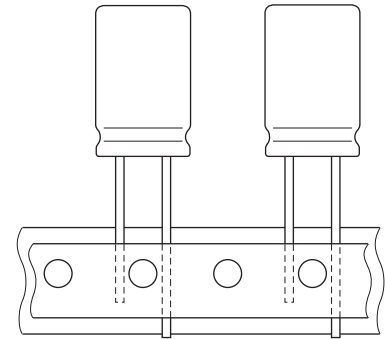


Fig.4 Form TFA: Taped in box (ammopack).

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE ØD × L	CASE CODE	Ød	ØD _{max}	L _{max}	F	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA
10 × 12	14	0.6	10.5	13.5	5.0 ±0.5	≈1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5.0 ±0.5	≈1.9	500	500	800
10 × 20	16	0.6	10.5	22.0	5.0 ±0.5	≈2.2	500	500	800
12.5 × 20	17	0.6	13.0	22.0	5.0 ±0.5	≈4.0	500	500	500
12.5 × 25	18	0.6	13.0	27.0	5.0 ±0.5	≈5.0	250	250	500
16 × 25	19	0.8	16.5	27.0	7.5 ±0.5	≈8.0	250	250	250
16 × 31	20	0.8	16.5	33.5	7.5 ±0.5	≈9.0	100	100	250
16 × 35	21	0.8	16.5	37.5	7.5 ±0.5	≈11.5	100	100	–
18 × 35	22	0.8	18.5	37.5	7.5 ±0.5	≈14.5	100	100	–

Note

- Detailed tape dimensions see section 'PACKAGING'.

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 Hz, 105 °C
I_{L1}	max. leakage current after 1 minute at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz

Note

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

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION									
U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (μA)	$\tan \delta$ 100 Hz	Z 100 kHz (m Ω)	CATALOG NUMBER 2222 048		
							BULK PACKAGING		TAPED
							FORM CA	FORM CB	FORM TFA
6.3	6800	16 × 25	1350	430	0.32	56	53682	63682	33682
	10000	16 × 35	1700	630	0.40	42	53103	63103	–
10	1000	10 × 16	470	100	0.19	180	54102	64102	34102
	2200	12.5 × 20	800	220	0.21	90	54222	64222	34222
	3300	12.5 × 25	1000	330	0.23	68	54332	64332	34332
	4700	16 × 25	1270	470	0.25	56	54472	64472	34472
	6800	16 × 31	1550	680	0.29	45	54682	64682	34682
	10000	18 × 35	1870	1000	0.37	36	54103	64103	–
16	470	10 × 12	360	78	0.16	250	55471	65471	35471
	1000	10 × 20	600	160	0.16	140	55102	65102	35102
	2200	12.5 × 25	1000	360	0.18	70	55222	65222	35222
	3300	16 × 25	1220	530	0.20	56	55332	65332	35332
	4700	16 × 31	1500	760	0.22	45	55472	65472	35472
	6800	16 × 35	1690	1100	0.26	42	55682	65682	–
	10000	18 × 35	1980	1600	0.34	34	55103	65103	–
25	470	10 × 16	440	120	0.14	180	56471	66471	36471
	1000	12.5 × 20	720	250	0.14	100	56102	66102	36102
	2200	16 × 25	1120	550	0.16	56	56222	66222	36222
	3300	16 × 31	1450	830	0.18	45	56332	66332	36332
	4700	18 × 35	1720	1200	0.20	36	56472	66472	–
35	220	10 × 12	310	80	0.12	280	50221	60221	30221
	470	10 × 20	500	170	0.12	150	50471	60471	30471
	1000	12.5 × 25	900	350	0.12	75	50102	60102	30102
	2200	16 × 31	1340	770	0.14	45	50222	60222	30222
	3300	18 × 35	1600	1200	0.16	36	50332	60332	–
	4700	18 × 35	1950	1600	0.18	34	50472	60472	–
40	2200	16 × 35	1500	880	0.13	45	57222	67222	–
	3300	18 × 35	1600	1300	0.15	36	57332	67332	–
50	220	10 × 16	340	110	0.10	250	51221	61221	31221
	470	12.5 × 20	620	240	0.10	110	51471	61471	31471
	1000	16 × 25	1030	500	0.10	60	51102	61102	31102
	2200	18 × 35	1500	1100	0.12	50	51222	61222	–
	3300	18 × 35	1900	1700	0.14	40	51332	61332	–
63	100	10 × 12	240	66	0.09	310	58101	68101	38101
	220	10 × 20	400	140	0.09	200	58221	68221	38221
	330	12.5 × 20	550	210	0.09	120	58331	68331	38331
	470	12.5 × 25	700	300	0.09	80	58471	68471	38471
	1000	16 × 31	1150	630	0.09	49	58102	68102	38102
	2200	18 × 35	1600	1400	0.11	45	58222	68222	–

ORDERING EXAMPLE*

Electrolytic capacitor 048 series

2200 $\mu\text{F}/16\text{ V}$; $\pm 20\%$ Nominal case size: $\varnothing 12.5 \times 25\text{ mm}$; Form TFA

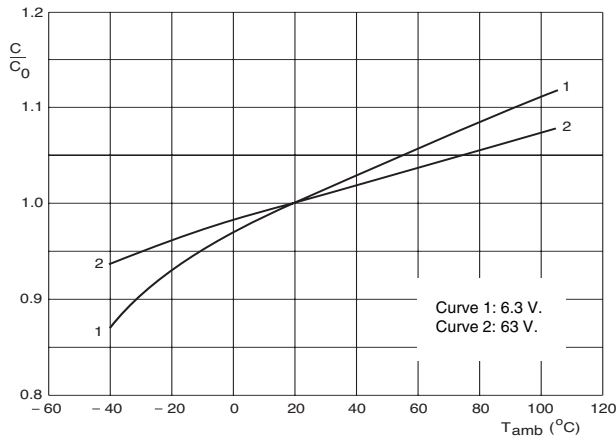
Catalog number: 2222 048 35222.

* To ensure delivery of lead (Pb)-free parts during the transition period, please contact your Vishay sales agent.



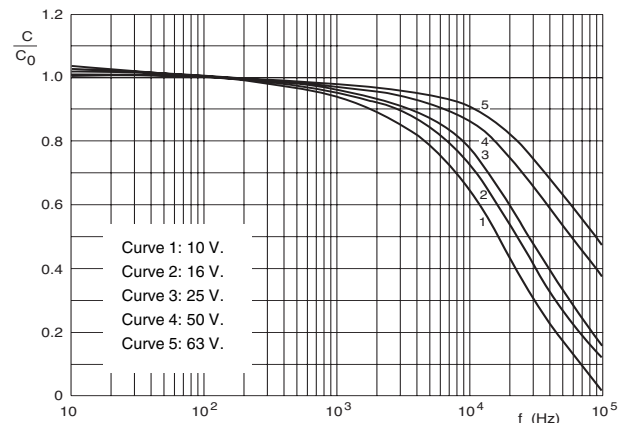
ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15 U_R$
Reverse voltage		$U_{rev} \leq 1 V$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.01 C_R \times U_R + 3 \mu A$
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 3 \mu A$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 10 \text{ mm}$	typ. 16 nH
	case $\varnothing D \geq 12.5 \text{ mm}$	typ. 18 nH
Resistance		
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)



C₀ = typical capacitance at 20 °C, 100 Hz.

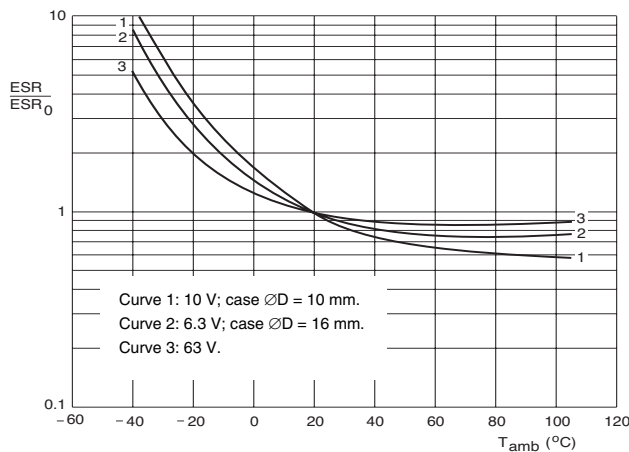
Fig.5 Typical multiplier of capacitance as a function of ambient temperature.



C₀ = typical capacitance at 20 °C, 100 Hz. T_{amb} = 20 °C.

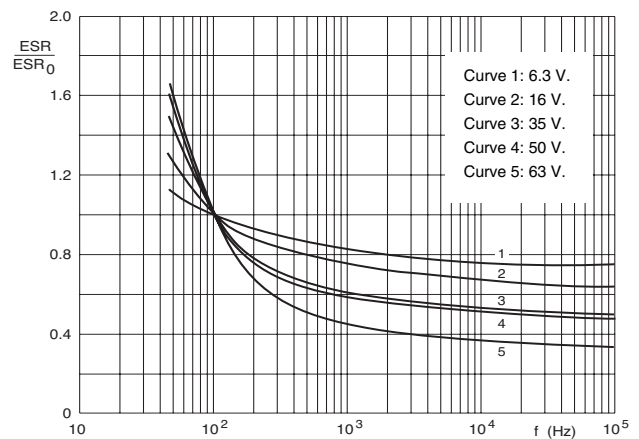
Fig.6 Typical multiplier of capacitance as a function of frequency.

EQUIVALENT SERIES RESISTANCE (ESR)



ESR₀ = typical ESR at 20 °C, 100 Hz.

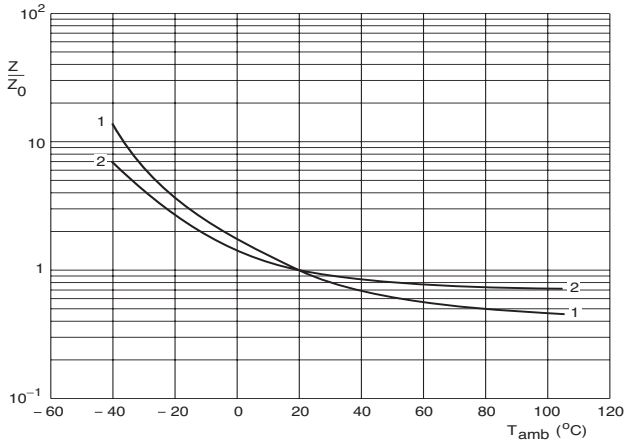
Fig.7 Multiplier of ESR as a function of ambient temperature.



ESR₀ = typical ESR at 20 °C, 100 Hz.

Fig.8 Multiplier of ESR as a function of frequency.

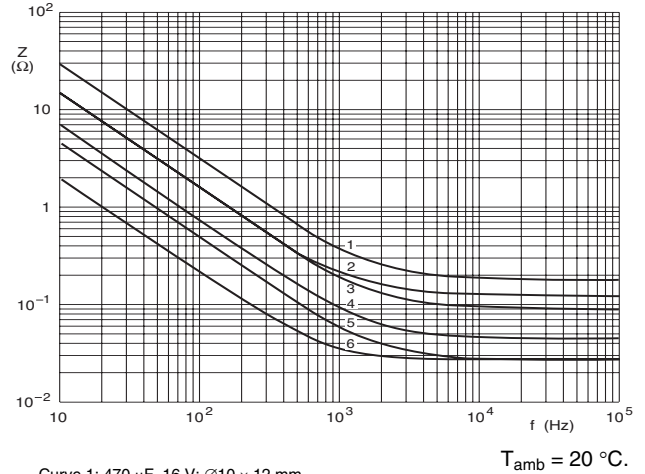
IMPEDANCE (Z)



Curve 1: case $\varnothing D = 10$ mm.
Curve 2: case $\varnothing D = 16$ mm.

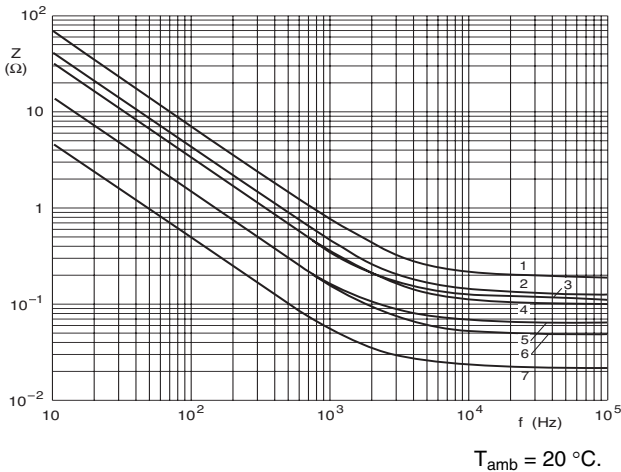
Z_0 = typical impedance at 20 °C, 10 kHz.

Fig.9 Typical multiplier of impedance as a function of ambient temperature.



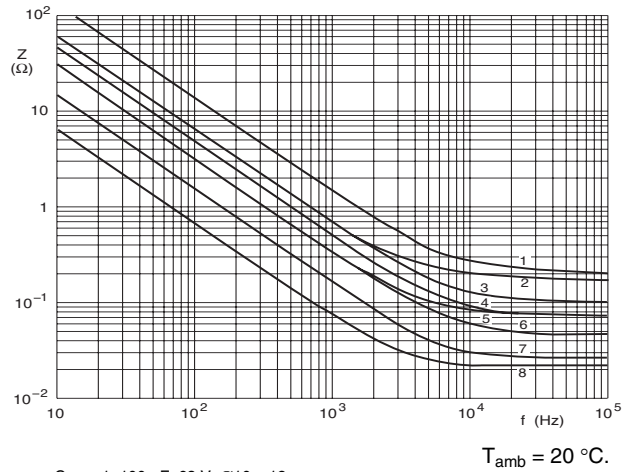
Curve 1: 470 μ F, 16 V; $\varnothing 10 \times 12$ mm.
Curve 2: 1000 μ F, 10 V; $\varnothing 10 \times 16$ mm.
Curve 3: 1000 μ F, 16 V; $\varnothing 10 \times 20$ mm.
Curve 4: 2200 μ F, 16 V; $\varnothing 12.5 \times 25$ mm.
Curve 5: 3300 μ F, 16 V; $\varnothing 16 \times 25$ mm.
Curve 6: 6800 μ F, 6.3 V; $\varnothing 16 \times 25$ mm.

Fig.10 Typical impedance as a function of frequency.



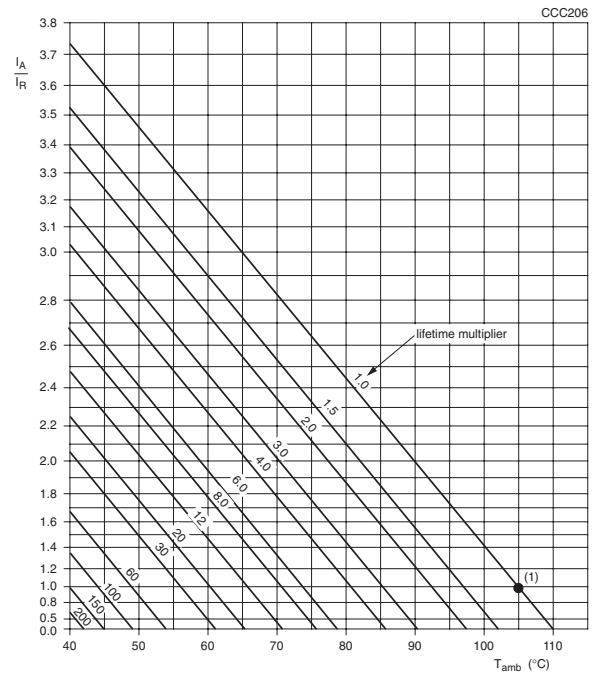
Curve 1: 220 μ F, 35 V; $\varnothing 10 \times 12$ mm.
Curve 2: 330 μ F, 35 V; $\varnothing 10 \times 16$ mm.
Curve 3: 470 μ F, 25 V; $\varnothing 10 \times 16$ mm.
Curve 4: 470 μ F, 35 V; $\varnothing 10 \times 20$ mm.
Curve 5: 1000 μ F, 25 V; $\varnothing 12.5 \times 20$ mm.
Curve 6: 1000 μ F, 35 V; $\varnothing 12.5 \times 25$ mm.
Curve 7: 3300 μ F, 25 V; $\varnothing 16 \times 31$ mm.

Fig.10 Typical impedance as a function of frequency.



Curve 1: 100 μ F, 63 V; $\varnothing 10 \times 12$ mm.
Curve 2: 220 μ F, 50 V; $\varnothing 10 \times 16$ mm.
Curve 3: 220 μ F, 63 V; $\varnothing 10 \times 20$ mm.
Curve 4: 330 μ F, 63 V; $\varnothing 12.5 \times 20$ mm.
Curve 5: 470 μ F, 50 V; $\varnothing 12.5 \times 20$ mm.
Curve 6: 470 μ F, 63 V; $\varnothing 12.5 \times 25$ mm.
Curve 7: 1000 μ F, 63 V; $\varnothing 16 \times 31$ mm.
Curve 8: 2200 μ F, 40 V; $\varnothing 16 \times 35$ mm.

Fig.11 Typical impedance as a function of frequency.

RIPPLE CURRENT AND USEFUL LIFE

 I_A = actual ripple current at 100 Hz.

 I_R = rated ripple current at 100 Hz, 105 °C.

 (1) Useful life at 105 °C and I_R applied (see table 4)

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

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 6.3$ to 25 V	$U_R = 35$ and 40 V	$U_R = 50$ and 63 V
50	0.95	0.85	0.80
100	1.00	1.00	1.00
300	1.07	1.20	1.25
1000	1.12	1.30	1.40
3000	1.15	1.35	1.50
≥ 10000	1.20	1.40	1.60

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 105$ °C; U_R applied; 2000 hours	$U_R \leq 6.3$ V; $\Delta C/C$: +15/-30% $U_R > 6.3$ V; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times$ spec. limit $Z \leq 2 \times$ spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105$ °C; U_R and I_R applied; case $\varnothing D = 10$ and 12.5 mm: 3000 hours case $\varnothing D = 16$ and 18 mm: 4000 hours	$U_R \leq 6.3$ V; $\Delta C/C$: +45/-50% $U_R > 6.3$ V; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times$ spec. limit $Z \leq 3 \times$ spec. limit $I_{L5} \leq$ 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	$T_{amb} = 105$ °C; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$U_R \leq 6.3$ V; $\Delta C/C$: +15/-30% $U_R > 6.3$ V; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times$ spec. limit $Z \leq 2 \times$ spec. limit $I_{L5} \leq 2 \times$ spec. limit



Notice

Specifications of the products displayed herein are subject to change without notice. Vishay Intertechnology, Inc., or anyone on its behalf, assumes no responsibility or liability for any errors or inaccuracies.

Information contained herein is intended to provide a product description only. No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document. Except as provided in Vishay's terms and conditions of sale for such products, Vishay assumes no liability whatsoever, and disclaims any express or implied warranty, relating to sale and/or use of Vishay products including liability or warranties relating to fitness for a particular purpose, merchantability, or infringement of any patent, copyright, or other intellectual property right.

The products shown herein are not designed for use in medical, life-saving, or life-sustaining applications. Customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Vishay for any damages resulting from such improper use or sale.