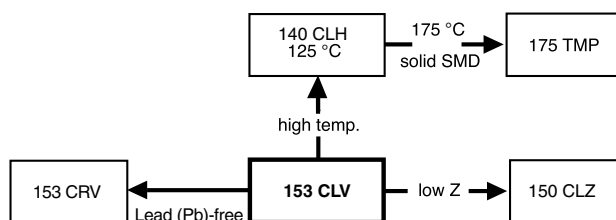




## Aluminum Capacitors SMD (Chip) Long Life Vertical



### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte, self healing
- SMD-version with base plate, vertical construction requiring minimum board space, reflow solderable
- High CV per unit volume
- Long useful life: 2000 h to 3000 h at 105 °C
- Charge and discharge proof, no peak current limitation
- Supplied in blister tape on reel
- Lead (Pb)-free
- ATTENTION: for maximum safe soldering conditions refer to fig.4

### APPLICATIONS

- SMD technology, for high mounting density
- Coupling, decoupling, smoothing, filtering, buffering, timing
- Telecommunications, general industrial, EDP, automotive, portable and lightweight equipment

### MARKING

- Rated capacitance (in  $\mu\text{F}$ )
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Black mark or ‘-’ sign indicating the cathode (the anode is identified by bevelled edges)
- Code indicating group number (V)

### PACKAGING

Supplied in blister tape on reel

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes (L x W x H in mm)	4.0 x 4.0 x 5.3 to 10 x 10 x 14
Rated capacitance range, $C_R$	0.47 $\mu\text{F}$ to 1000 $\mu\text{F}$
Tolerance on $C_R$	$\pm 20\%$
Rated voltage range, $U_R$	6.3 V to 100 V
Category temperature range	- 55 °C to + 105 °C
Endurance test at 105 °C:	
Case sizes 4.0 x 4.0 x 5.3 to 6.3 x 6.3 x 5.3	1000 h
Case sizes 8.0 x 8.0 x 6.5 to 10 x 10 x 14	2000 h
Useful life at 105 °C:	
Case sizes 4.0 x 4.0 x 5.3 to 6.3 x 6.3 x 5.3	2000 h
Case sizes 8.0 x 8.0 x 6.5 to 10 x 10 x 14	3000 h
Useful life at 40 °C; 1.3 x $I_R$ applied:	
Case sizes 4.0 x 4.0 x 5.3 to 6.3 x 6.3 x 5.3	200 000 h
Case sizes 8.0 x 8.0 x 6.5 to 10 x 10 x 14	300 000 h
Shelf life at 0 V, 105 °C	1000 h
Based on sectional specification	IEC 60384-18/ CECC 32300
Climatic category IEC 60068	55/105/56

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SELECTION CHART FOR $C_R$ , $U_R$ AND RELEVANT NOMINAL CASE SIZES (L x W x H in mm)								
$C_R$ ( $\mu F$ )	$U_R$ (V)							
	6.3	10	16	25	35	50	63	100
0.47	-	-	-	-	-	4.0 x 4.0 x 5.3	-	-
1.0	-	-	-	-	-	4.0 x 4.0 x 5.3	-	-
2.2	-	-	-	-	-	4.0 x 4.0 x 5.3	-	-
3.3	-	-	-	-	-	4.0 x 4.0 x 5.3	-	-
4.7	-	-	-	-	4.0 x 4.0 x 5.3	5.0 x 5.0 x 5.3	-	-
10	-	-	4.0 x 4.0 x 5.3	-	5.0 x 5.0 x 5.3	6.3 x 6.3 x 5.3	-	-
22	4.0 x 4.0 x 5.3	-	5.0 x 5.0 x 5.3	-	6.3 x 6.3 x 5.3	8.0 x 8.0 x 6.5	-	-
33	-	5.0 x 5.0 x 5.3	-	6.3 x 6.3 x 5.3	8.0 x 8.0 x 6.5	8.0 x 8.0 x 10	-	10 x 10 x 14
47	5.0 x 5.0 x 5.3	-	6.3 x 6.3 x 5.3	8.0 x 8.0 x 6.5	-	8.0 x 8.0 x 10	-	-
100	6.3 x 6.3 x 5.3	-	8.0 x 8.0 x 6.5	8.0 x 8.0 x 10	-	10 x 10 x 10	10 x 10 x 14	-
	-	-	-	-	-	-	-	-
220	-	8.0 x 8.0 x 10	10 x 10 x 10	-	-	-	-	-
330	8.0 x 8.0 x 10	10 x 10 x 10	-	10 x 10 x 14	-	-	-	-
470	10 x 10 x 10	-	10 x 10 x 14	-	-	-	-	-
680	-	10 x 10 x 14	-	-	-	-	-	-
1000	10 x 10 x 14	-	-	-	-	-	-	-

Table 1

TAPE AND REEL DIMENSIONS in millimeters AND PACKAGING QUANTITIES					
CASE CODE	PITCH $P_1$	TAPE WIDTH W	TAPE THICKNESS $T_2$	REEL DIA.	PACKAGING QUANTITY PER REEL
0405	8	12	5.8	380	2000
0505	12	12	5.8	380	1000
0605	12	16	5.8	380	1000
0807	12	16	6.8	380	1000
0810	16	24	11.3	380	500
1010	16	24	11.3	380	500
1014	16	24	14.8	330	250

**Note**

- Detailed tape dimensions see section 'PACKAGING'.



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Table 2

DIMENSIONS in millimeters AND MASS									
NOMINAL CASE SIZE L x W x H	CASE CODE	L <sub>max.</sub>	W <sub>max.</sub>	H <sub>max.</sub>	Ø D	B <sub>max.</sub>	S	C	MASS (g)
4.0 x 4.0 x 5.3	0405	4.5	4.5	5.5	4.0	0.8	1.0	2.0 ± 0.2	≈ 0.13
5.0 x 5.0 x 5.3	0505	5.5	5.5	5.5	5.0	0.8	1.4	2.3 ± 0.2	≈ 0.20
6.3 x 6.3 x 5.3	0605	6.8	6.8	5.5	6.3	0.8	2.0	2.7 ± 0.2	≈ 0.30
8.0 x 8.0 x 6.5	0807	8.6	8.6	6.8	8.0	0.8	2.3	3.4 ± 0.2	≈ 0.50
8.0 x 8.0 x 10	0810	8.6	8.6	10.5	8.0	1.1	3.1	3.0 ± 0.2	≈ 1.00
10 x 10 x 10	1010	10.6	10.6	10.5	10.0	1.1	4.7	3.3 ± 0.2	≈ 1.30
10 x 10 x 14	1014	10.6	10.6	14.3	10.0	1.2	4.5	3.9 ± 0.2	≈ 1.50

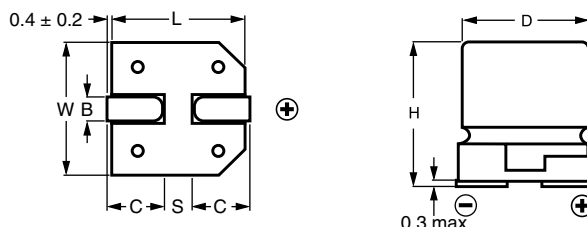


Fig.2 Dimensional outline

**MOUNTING**

The capacitors are designed for automatic placement on to printed-circuit boards.

Optimum dimensions of soldering pads depend amongst others on soldering method, mounting accuracy, print layout and/or adjacent components.

For recommended soldering pad dimensions, refer to Fig.3 and Table 3.

**SOLDERING**

Soldering conditions are defined by the curve, temperature versus time, where the temperature is that measured on the soldering pad during processing.

For maximum conditions refer to Fig.4.

Any temperature versus time curve which does not exceed the specified maximum curves may be applied.

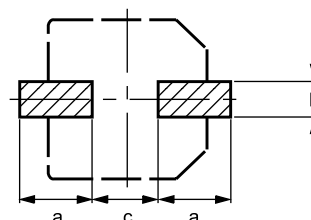


Fig.3 Recommended solder pad dimensions

AS A GENERAL PRINCIPLE, TEMPERATURE AND DURATION SHALL BE THE **MINIMUM** NECESSARY REQUIRED TO ENSURE GOOD SOLDERING CONNECTIONS. HOWEVER, THE SPECIFIED MAXIMUM CURVES SHOULD NEVER BE EXCEEDED.

Table 3

RECOMMENDED SOLDERING PAD DIMENSIONS in millimeters			
CASE CODE	a	b	c
0405	2.6	1.6	1.0
0505	3.0	1.6	1.4
0605	3.5	1.6	1.9
0807	4.0	1.6	2.1
0810	3.5	2.5	3.0
1010	4.0	2.5	4.0
1014	4.3	2.5	4.0

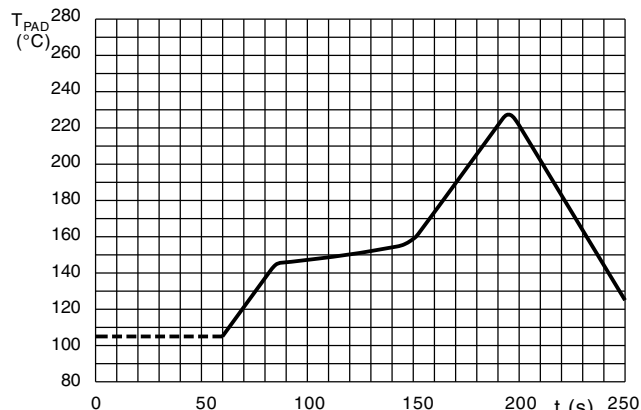


Fig.4 Maximum temperature load during infrared reflow soldering measured on the soldering pad

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ELECTRICAL DATA	
SYMBOL	DESCRIPTION
$C_R$	rated capacitance at 100 Hz or 120 Hz, tolerance $\pm 20\%$
$I_R$	rated RMS ripple current at 100 Hz or 120 Hz, 105 °C
$I_{L2}$	max. leakage current after 2 minutes at $U_R$
$\tan \delta$	max. dissipation factor at 100 or 120 Hz
ESR	equivalent series resistance at 100 kHz

### ORDERING EXAMPLE

Electrolytic capacitor 153 series

100  $\mu$ F/25 V;  $\pm 20\%$

Nominal case size:

8 mm x 8 mm x 10 mm; taped on reel

Ordering code: MAL215366101E3

Former 12NC: 2222 153 66101

#### Note

- Unless otherwise specified, all electrical values in Table 4 apply at  $T_{amb} = 20\text{ °C}$ ,  $P = 86\text{ kPa}$  to  $106\text{ kPa}$ ,  $RH = 45\%$  to  $75\%$ .

Table 4

ELECTRICAL DATA AND ORDERING INFORMATION							
$U_R$ (V)	$C_R$ ( $\mu$ F)	NOMINAL CASE SIZE L x W x H (mm)	$I_R$ 105 °C (mA)	$I_{L2}$ 2 min (mA)	$\tan \delta$	ESR 100 kHz ( $\Omega$ )	ORDERING CODE MAL2153.....
6.3	22	4.0 x 4.0 x 5.3	21	3.0	0.30	8	63229E3
	47	5.0 x 5.0 x 5.3	36	3.0	0.30	4	63479E3
	100	6.3 x 6.3 x 5.3	61	6.3	0.30	2	63101E3
	330	8.0 x 8.0 x 10	180	21	0.30	0.5	63331E3
	470	10 x 10 x 10	320	30	0.30	0.3	63471E3
	1000	10 x 10 x 14	400	63	0.24	0.24	63102E3
10	33	5.0 x 5.0 x 5.3	31	3.3	0.26	4	64339E3
	220	8.0 x 8.0 x 10	180	22	0.26	0.5	64221E3
	330	10 x 10 x 10	320	33	0.26	0.3	64331E3
	680	10 x 10 x 14	380	68	0.19	0.24	64681E3
16	10	4.0 x 4.0 x 5.3	16	3.0	0.22	8	65109E3
	22	5.0 x 5.0 x 5.3	28	3.5	0.22	4	65229E3
	47	6.3 x 6.3 x 5.3	47	7.5	0.22	2.2	65479E3
	100	8.0 x 8.0 x 6.5	110	16	0.22	1.2	65101E3
	220	10 x 10 x 10	320	35	0.22	0.3	65221E3
	470	10 x 10 x 14	370	75	0.16	0.25	65471E3
25	33	6.3 x 6.3 x 5.3	44	8.3	0.16	2.2	66339E3
	47	8.0 x 8.0 x 6.5	110	12	0.16	1.2	66479E3
	100	8.0 x 8.0 x 10	180	25	0.16	0.5	66101E3
	330	10 x 10 x 14	300	83	0.14	0.27	66331E3
35	4.7	4.0 x 4.0 x 5.3	14	3.0	0.13	8	60478E3
	10	5.0 x 5.0 x 5.3	23	3.5	0.13	4	60109E3
	22	6.3 x 6.3 x 5.3	50	7.7	0.13	2.2	60229E3
	33	8.0 x 8.0 x 6.5	110	12	0.13	1.2	60339E3
50	0.47	4.0 x 4.0 x 5.3	5	3.0	0.12	12	61477E3
	1.0	4.0 x 4.0 x 5.3	7	3.0	0.12	12	61108E3
	2.2	4.0 x 4.0 x 5.3	10	3.0	0.12	12	61228E3
	3.3	4.0 x 4.0 x 5.3	12	3.0	0.12	12	61338E3
	4.7	5.0 x 5.0 x 5.3	17	3.0	0.12	6	61478E3
	10	6.3 x 6.3 x 5.3	26	5.0	0.12	3	61109E3
	22	8.0 x 8.0 x 6.5	110	11	0.12	1.2	61229E3
	33	8.0 x 8.0 x 10	180	17	0.12	0.5	61339E3
	47	8.0 x 8.0 x 10	180	24	0.12	0.5	61479E3
	100	10 x 10 x 10	320	50	0.12	0.3	61101E3
63	100	10 x 10 x 14	240	63	0.09	0.41	68101E3
100	33	10 x 10 x 14	170	33	0.07	0.65	69339E3



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ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage	IEC 60384-18, subclause 4.14	$U_s \leq 1.15 \times U_R$
Reverse voltage	IEC 60384-18, subclause 4.16	$U_{rev} \leq 1 V$
<b>Current</b>		
Leakage current	after 2 min at $U_R$	$I_{L2} \leq 0.01 \times C_R \times U_R$ or $3 \mu A$ , whichever is greater
<b>Inductance</b>		
Equivalent series inductance (ESL)	case codes 0405 to 0605	typ. 10 nH
	case codes 0807 to 1010	typ. 15 nH
	case codes 1014	typ. 16 nH

**CAPACITANCE (C)**

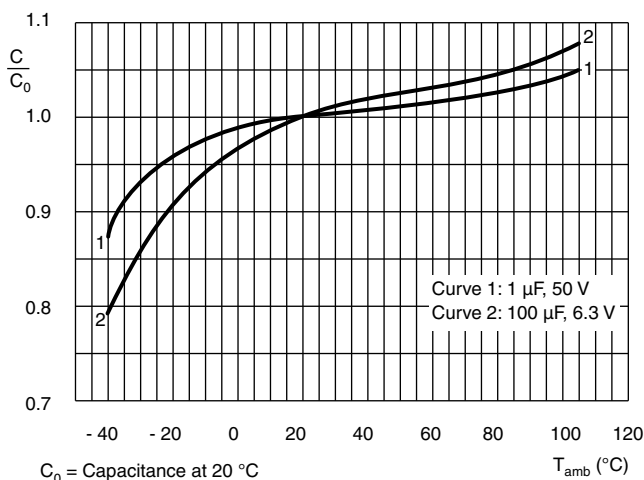


Fig.5 Typical multiplier of capacitance at 100 Hz or 120 Hz as a function of ambient temperature

**EQUIVALENT SERIES RESISTANCE (ESR)**

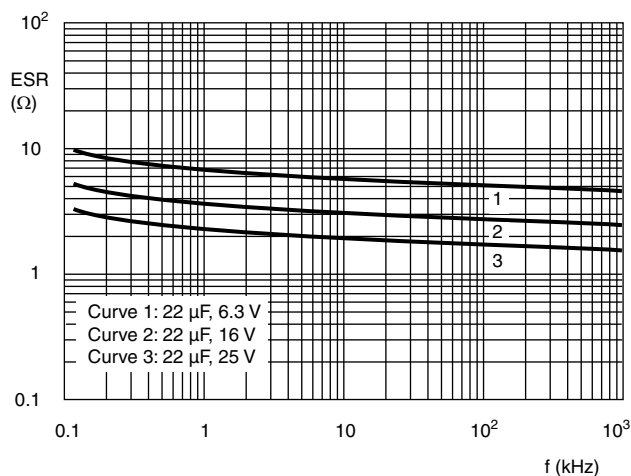


Fig.6 Typical ESR as a function of frequency at 20 °C

**DISSIPATION FACTOR (tan δ)**

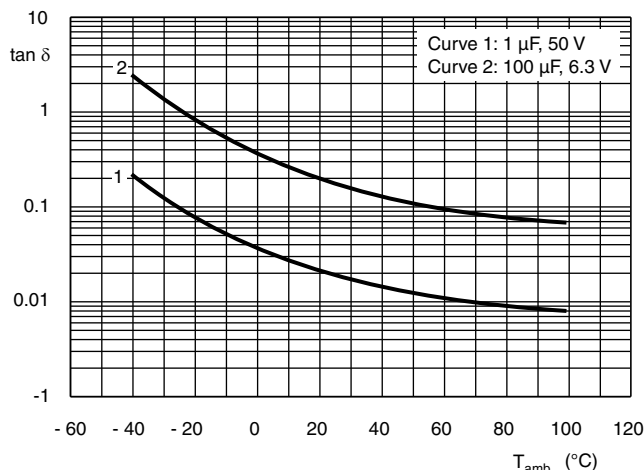


Fig.7 Typical dissipation factor (tan δ) at 100 Hz or 120 Hz as a function of ambient temperature

**IMPEDANCE (Z)**

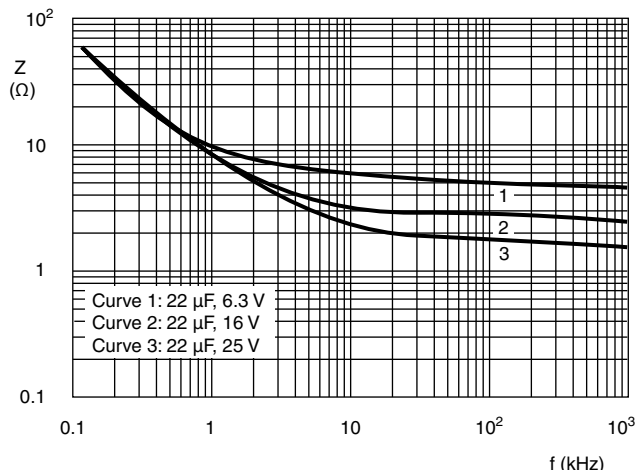
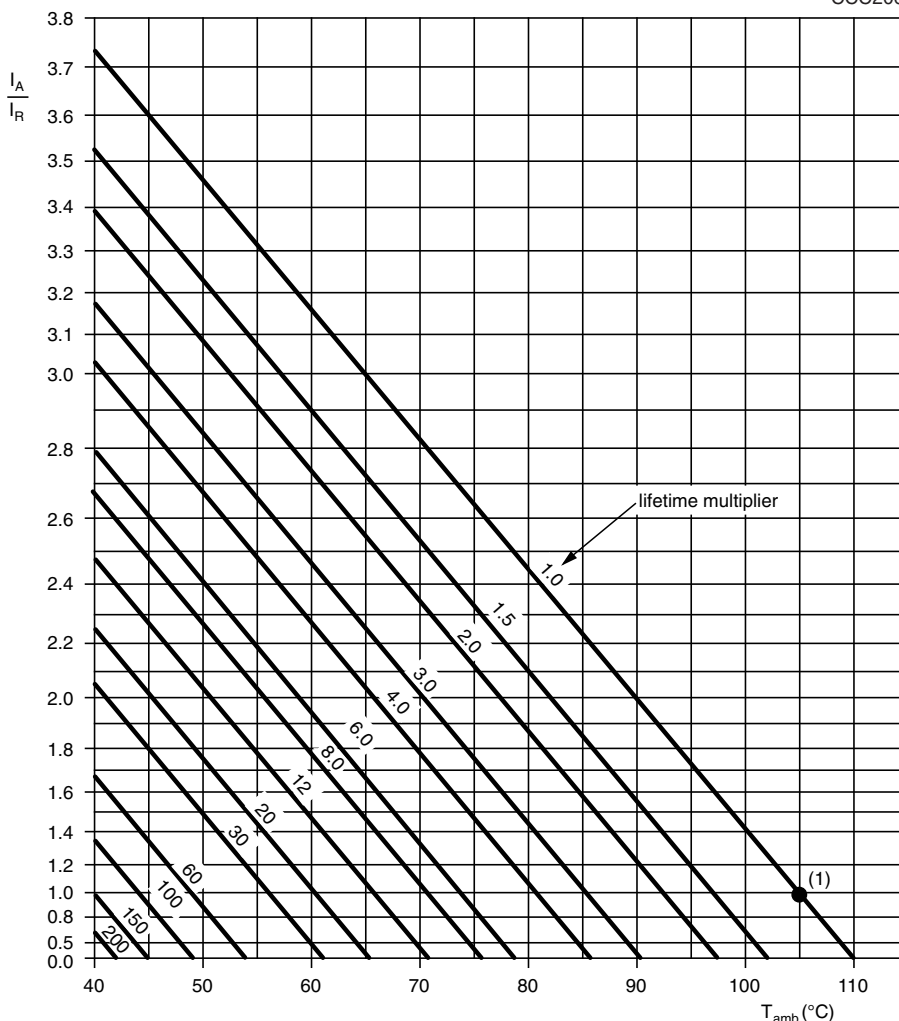


Fig.8 Typical impedance as a function of frequency at 20 °C



**RIPPLE CURRENT AND USEFUL LIFE**

CCC206



$I_A$  = actual ripple current at 100 Hz or 120 Hz  
 $I_R$  = rated ripple current at 100 Hz or 120 Hz at 105 °C

For case codes 0405 to 1010 max.  $I_A/I_R = 2.4$

(1) Useful life at 105 °C and  $I_R$  applied:

- case codes 0405 to 0605: 2000 h
- case codes 0807 to 1014: 3000 h

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 5

MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	$I_R$ MULTIPLIER		
	$U_R = 6.3 \text{ V to } 16 \text{ V}$	$U_R = 25 \text{ V or } 35 \text{ V}$	$U_R = 50 \text{ V to } 100 \text{ V}$
50 or 60	0.80	0.80	0.80
100 or 120	1.00	1.00	1.00
300	1.10	1.15	1.20
1000	1.15	1.25	1.35
3000	1.20	1.35	1.45
$\geq 10\ 000$	1.25	1.40	1.50



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Table 6

<b>TEST PROCEDURES AND REQUIREMENTS</b>			
<b>TEST</b>		<b>PROCEDURE (quick reference)</b>	<b>REQUIREMENTS</b>
<b>NAME OF TEST</b>	<b>REFERENCE</b>		
Mounting	IEC 60384-18, subclause 4.3	shall be performed prior to tests mentioned below; reflow soldering; for maximum temperature load refer to chapter "Mounting"	$\Delta C/C: \pm 10 \%$ $\tan \delta \leq \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Endurance	IEC 60384-18/ CECC 32300, subclause 4.15	$T_{\text{amb}} = 105 \text{ }^\circ\text{C}$ ; $U_R$ applied; 1000 h, case codes 0405 to 0605 2000 h, case codes 0807 to 1014	$\Delta C/C: \pm 20 \%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301, subclause 1.8.1	$T_{\text{amb}} = 105 \text{ }^\circ\text{C}$ ; $U_R$ and $I_R$ applied; 2000 h, case codes 0405 to 0605 3000 h, case codes 0807 to 1014	$\Delta C/C: \pm 50 \%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1 \%$
Shelf life (storage at high temperature)	IEC 60384-18/ CECC 32300, subclause 4.17	$T_{\text{amb}} = 105 \text{ }^\circ\text{C}$ ; no voltage applied; 1000 h  after test: $U_R$ to be applied for 30 min, 24 h to 48 h before measurement	for requirements see 'Endurance test' above



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