Aluminum Capacitors
SMD (Chip) Long Life Vertical

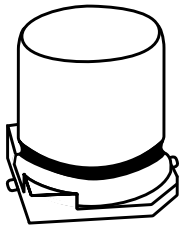
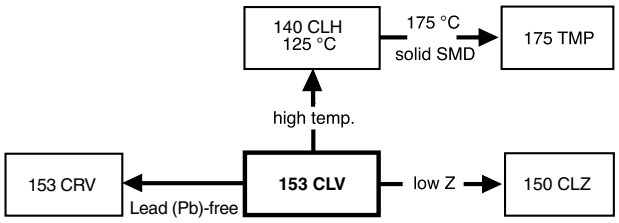


Fig.1 Component outline



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 to 1000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	6.3 to 100 V
Category temperature range	- 55 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

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 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 µF)
- 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

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (L x W x H in mm)								
C_R (µF)	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	-	10 x 10 x 12
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	-	10 x 10 x12
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	10 x 10 x 12	-
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	-
	-	-	-	-	-	10 x 10 x 12	-	-
220	-	8.0 x 8.0 x 10	10 x 10 x 10	10 x 10 x 12	10 x 10 x 12	-	-	-
330	8.0 x 8.0 x 10	10 x 10 x 10	10 x 10 x 12	10 x 10 x 14	-	-	-	-
470	10 x 10 x 10	10 x 10 x 12	10 x 10 x 14	-	-	-	-	-
680	10 x 10 x 12	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
1012	16	24	12.8	330	250
1014	16	24	14.8	330	250

Note

1. Detailed tape dimensions see section ‘PACKAGING’.

Table 2

DIMENSIONS in millimeters **AND MASS**									
NOMINAL CASE SIZE L x W x H	**CASE CODE**	**$L_{max.}$**	**$W_{max.}$**	**$H_{max.}$**	**Ø D**	**$B_{max.}$**	**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 12	1012	10.6	10.6	12.3	10.0	1.2	4.5	3.9 ± 0.2	≈ 1.40
10 x 10 x 14	1014	10.6	10.6	14.3	10.0	1.2	4.5	3.9 ± 0.2	≈ 1.50

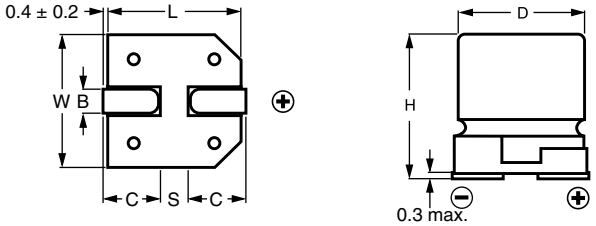


Fig. 2 Dimensional outline

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.

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
1012	4.3	2.5	4.0
1014	4.3	2.5	4.0

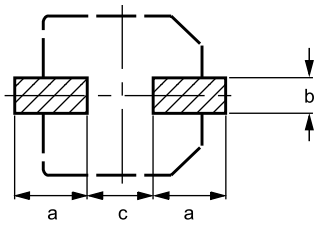


Fig.3 Recommended solder pad dimensions

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.

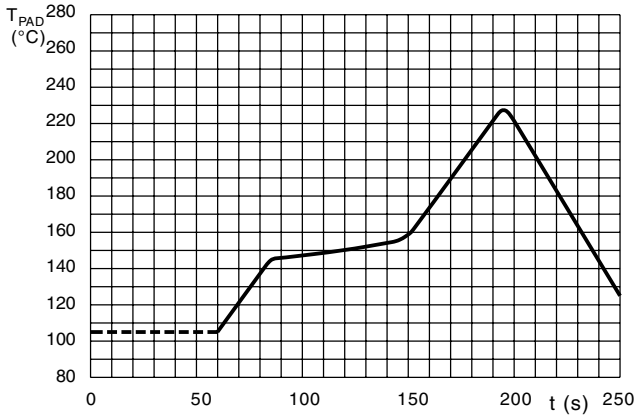


Fig.4 Maximum temperature load during infrared reflow soldering measured on the soldering pad

ELECTRICAL DATA

SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 or 120 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 or 120 Hz, 105 °C
I_{L2}	max. leakage current after 2 minutes at UR
Tan δ	max. dissipation factor at 100 or 120 Hz
ESR	equivalent series resistance at 100 kHz

Note

Unless otherwise specified, all electrical values in Table 4 apply at Tamb = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 153 series

100 µF/25 V; ± 20 %

Nominal case size:
8 x 8 x 10 mm; taped on reel

Ordering code: MAL215366101E3
Former 12NC: 2222 153 66101

Table 4

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R (µF)	NOMINAL CASE SIZE L x W x H (mm)	I_R 105 ×C (mA)	I_{L2} 2 MIN (mA)	Tan δ	ESR 100 kHz (W)	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
	680	10 x 10 x 12	340	43	0.24	0.29	63681E3
	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
	470	10 x 10 x 12	330	47	0.19	0.29	64471E3
	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
	330	10 x 10 x 12	330	53	0.16	0.29	65331E3
	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
	220	10 x 10 x 12	270	55	0.14	0.29	66221E3
	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
	220	10 x 10 x 12	270	77	0.12	0.29	60221E3
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
	100	10 x 10 x 12	230	50	0.12	0.29	91106E3
63	47	10 x 10 x 12	220	30	0.09	0.29	68479E3
	100	10 x 10 x 14	240	63	0.09	0.41	68101E3
100	10	10 x 10 x 12	150	10	0.07	0.9	69109E3
	22	10 x 10 x 12	150	25	0.07	0.9	69229E3
	33	10 x 10 x 14	170	33	0.07	0.65	69339E3

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
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
Current		
Leakage current	after 2 minutes at U_R	$I_{L2} \leq 0.01 \times C_R \times U_R$ or 3 µA, whichever is greater
Inductance		
Equivalent series inductance (ESL)	case codes 0405 to 0605	typ. 10 nH
	case codes 0807 to 1010	typ. 15 nH
	case codes 1012 and 1014	typ. 16 nH

CAPACITANCE (C)

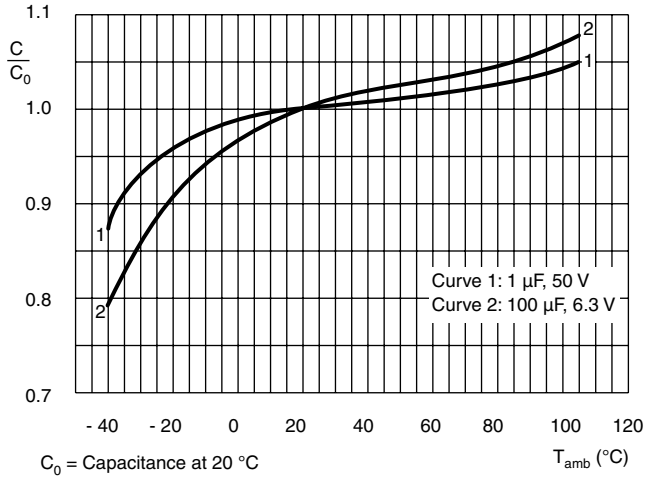


Fig.5 Typical multiplier of capacitance at 100 or 120 Hz as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

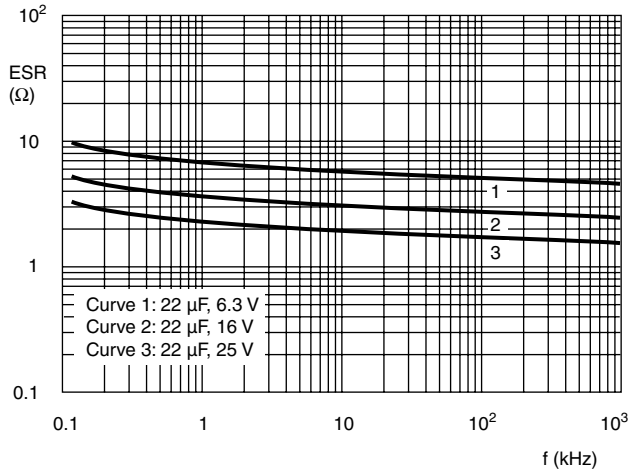


Fig.6 Typical ESR as a function of frequency at 20 °C

DISSIPATION FACTOR (tan δ)

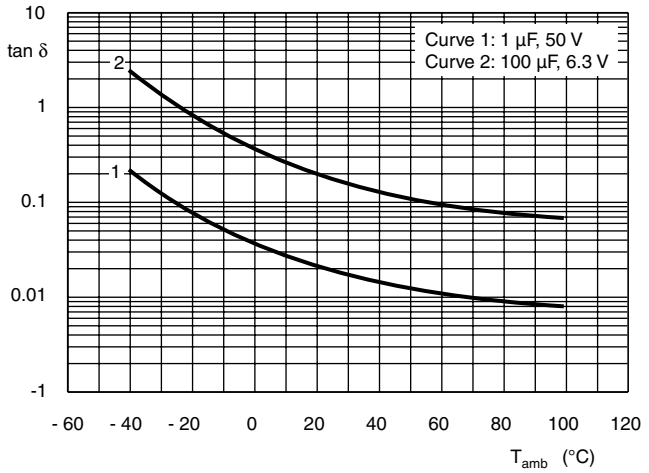


Fig.7 Typical dissipation factor (tan δ) at 100 Hz or 120 Hz as a function of ambient temperature

IMPEDANCE (Z)

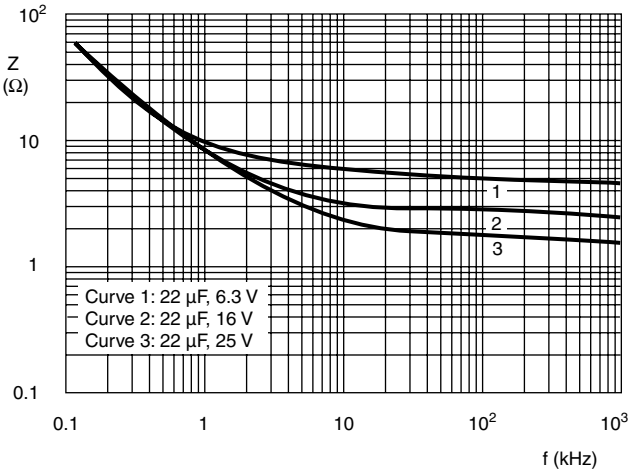
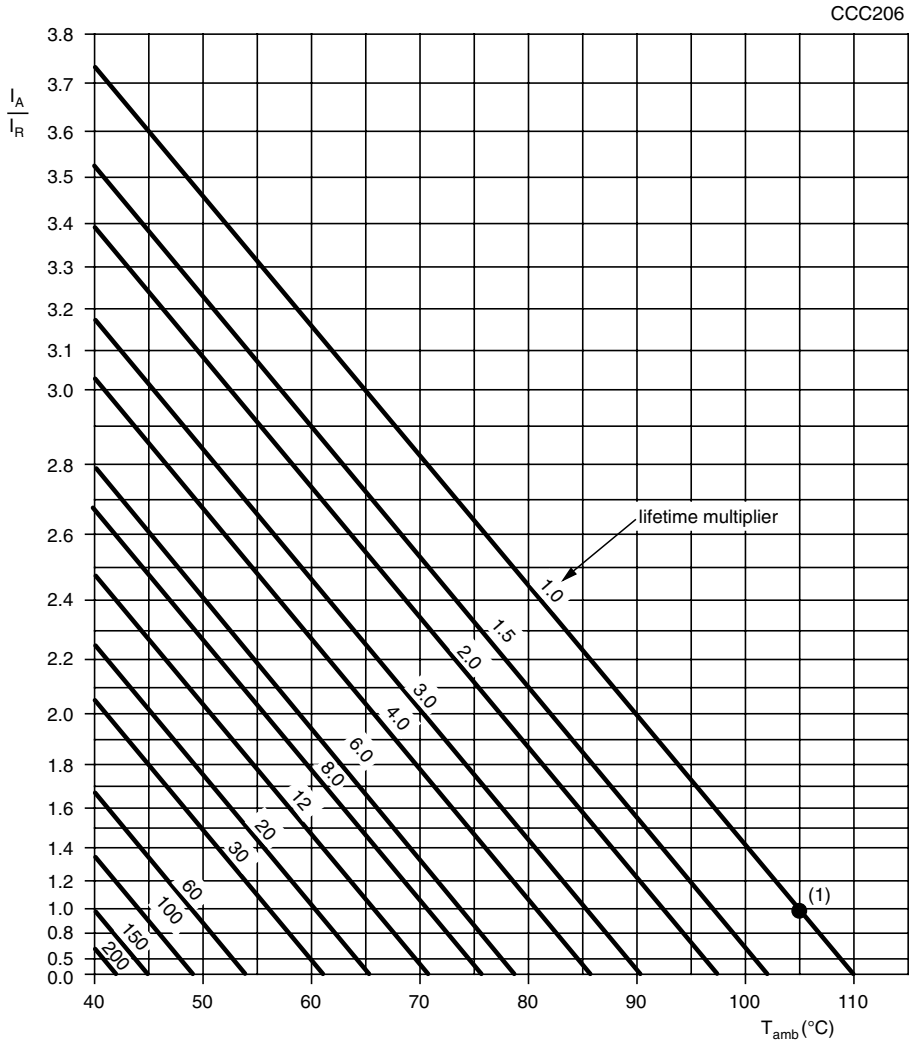


Fig.8 Typical impedance as a function of frequency at 20 °C

RIPPLE CURRENT AND USEFUL LIFE



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 to 16 V	U_R = 25 or 35 V	U_R = 50 to 100 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
≥ 10 000	1.25	1.40	1.50

Table 6

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
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”	$\Delta C/C$: ± 10 % tan $\delta \leq$ spec. limit $I_{L2} \leq$ spec. limit
Endurance	IEC 60384-18/ CECC 32300, subclause 4.15	T_{amb} = 105 °C; U_R applied; 1000 hours, case codes 0405 to 0605 2000 hours, case codes 0807 to 1014	$\Delta C/C$: ± 20 % tan $\delta \leq$ 2 x spec. limit $I_{L2} \leq$ spec. limit
Useful life	CECC 30301, subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; 2000 hours, case codes 0405 to 0605 3000 hours, case codes 0807 to 1014	$\Delta C/C$: ± 50 % tan $\delta \leq$ 3 x spec. limit $I_{L2} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-18/ CECC 32300, 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	for requirements see ‘Endurance test’ above

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