

Aluminum Capacitors Radial Standard Long Life

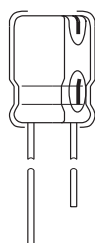
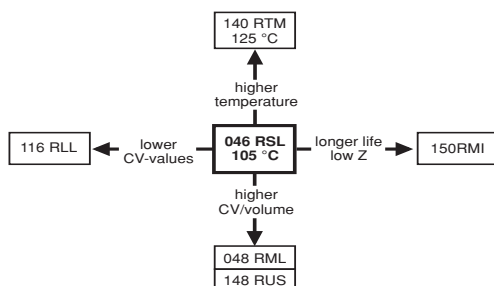


Fig.1 Component outline.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes (ØD x L in mm)	10 x 12 to 18 x 35
Rated capacitance range, C _R	22 to 10 000 µF
Tolerance on C _R	±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 ØD = 10 and 12.5 mm	3000 hours
case ØD = 16 and 18 mm	4000 hours
Useful life at 40 °C, 1.6 x I _R applied	
case ØD = 10 and 12.5 mm	200 000 hours
case ØD = 16 and 18 mm	260 000 hours
Shelf life at 0 V, 105 °C	1 000 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/105/56

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
- Very long useful life: 3000 to 4000 hours at 105 °C, high reliability.
- High ripple current capability, low impedance, low ESR.

APPLICATIONS

- Power conversion, EDP, telecommunication, industrial and audio-video
- Smoothing, filtering, buffering in SMPS, timing

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).
- 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 (046).

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (ØD x L in mm)

C _R (µF)	U _R (V)							
	6.3	10	16	25	35	40	50	63
22	—	—	—	—	—	—	—	10 x 12
47	—	—	—	—	—	—	—	10 x 12
100	—	—	—	—	—	10 x 12	10 x 16	10 x 20
220	—	—	10 x 12	—	10 x 16	10 x 20	12.5 x 20	12.5 x 25
330	—	10 x 12	10 x 16	—	10 x 20	12.5 x 20	12.5 x 25	16 x 25
470	10 x 12	10 x 16	10 x 20	—	12.5 x 20	12.5 x 25	—	16 x 25
1000	10 x 20	12.5 x 20	12.5 x 25	12.5 x 25	16 x 25	—	16 x 31	18 x 35
2200	12.5 x 25	—	16 x 25	16 x 31	16 x 35	18 x 35	18 x 35	—
3300	16 x 25	—	16 x 31	18 x 35	—	18 x 35	—	—
4700	16 x 31	16 x 35	18 x 35	18 x 35	—	—	—	—
6800	16 x 35	18 x 35	18 x 35	—	—	—	—	—
10 000	18 x 35	18 x 35	—	—	—	—	—	—

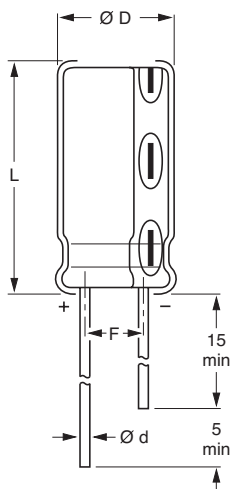
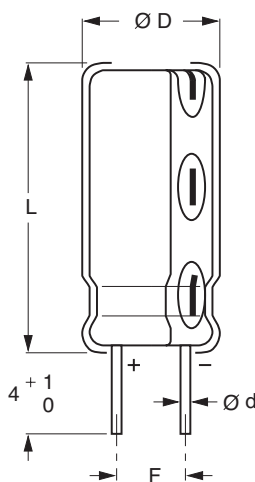
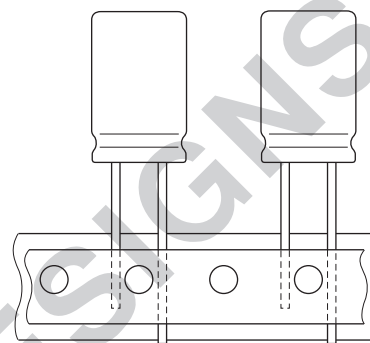
DIMENSIONS in millimeters, **AND AVAILABLE FORMS**Fig.2 **Form CA:** Long leads.Fig.3 **Form CB:** Cut leads.Case $\varnothing D \times L \leq 16 \times 31$ mm.Fig.4 **Form TFA:** Taped in box (ammopack).

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE $\varnothing D \times L$	CASE CODE	$\varnothing d$	$\varnothing D_{max}$	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	300	1000	–

Note

1. Detailed tape dimensions see section 'PACKAGING'.

Aluminum Capacitors
Radial Miniature Long Life

Vishay BCcomponents

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_{RH}	rated RMS ripple current at 100 kHz, 105 °C
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from $\tan \delta_{\max}$ and C_R)
Z	max. impedance at 10 kHz or 100 kHz

Note

1. Unless otherwise specified, all electrical values in Table 2 apply at $T_{\text{amb}} = 20^\circ\text{C}$, $P = 86$ 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)	CASE CODE	I_R 100 Hz 105 °C (mA)	I_{RH} 100 kHz 105 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	$\tan \delta$ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	CATALOG NUMBER 2222 046		
												BULK PACKAGING		TAPED
												FORM CA	FORM CB	FORM TFA
6.3	470	10 × 12	14	360	600	33	9	0.19	0.64	0.32	0.28	046 53471	046 63471	046 33471
	1000	10 × 20	16	600	1000	66	16	0.19	0.30	0.15	0.14	046 53102	046 63102	046 33102
	2200	12.5 × 25	18	950	1500	140	31	0.23	0.17	0.08	0.07	046 53222	046 63222	046 33222
	3300	16 × 25	19	1200	1700	210	45	0.25	0.12	0.06	0.06	046 53332	046 63332	046 33332
	4700	16 × 31	20	1400	2000	300	62	0.27	0.09	0.05	0.05	046 53472	046 63472	046 33472
	6800	16 × 35	21	1600	2100	430	89	0.31	0.07	0.05	0.05	046 53682	046 63682	–
	10 000	18 × 35	22	1800	2300	630	130	0.39	0.06	0.04	0.04	046 53103	046 63103	–
10	330	10 × 12	14	370	620	36	10	0.15	0.72	0.38	0.31	046 54331	046 64331	046 34331
	470	10 × 16	15	460	800	50	12	0.15	0.51	0.27	0.22	046 54471	046 64471	046 34471
	1000	12.5 × 20	17	770	1100	100	23	0.15	0.24	0.13	0.12	046 54102	046 64102	046 34102
	4700	16 × 35	21	1600	2300	470	97	0.23	0.08	0.04	0.04	046 54472	046 64472	–
	6800	18 × 35	22	1800	2500	680	140	0.27	0.06	0.03	0.03	046 54682	046 64682	–
	10 000	18 × 35	22	2000	2600	1000	200	0.35	0.06	0.03	0.03	046 54103	046 64103	–
16	220	10 × 12	14	350	620	38	10	0.13	0.94	0.40	0.31	046 55221	046 65221	046 35221
	330	10 × 16	15	430	800	56	14	0.13	0.63	0.30	0.22	046 55331	046 65331	046 35331
	470	10 × 20	16	560	920	78	18	0.13	0.44	0.21	0.18	046 55471	046 65471	046 35471
	1000	12.5 × 25	18	900	1500	160	35	0.13	0.21	0.10	0.10	046 55102	046 65102	046 35102
	2200	16 × 25	19	1300	1800	360	73	0.17	0.12	0.06	0.05	046 55222	046 65222	046 35222
	3300	16 × 31	20	1600	2200	530	110	0.19	0.09	0.04	0.04	046 55332	046 65332	046 35332
	4700	18 × 35	22	1800	2500	760	150	0.21	0.07	0.03	0.03	046 55472	046 65472	–
	6800	18 × 35	22	2000	2600	1100	220	0.25	0.06	0.03	0.03	046 55682	046 65682	–
25	1000	12.5 × 25	18	900	1500	250	53	0.11	0.18	0.09	0.08	046 56102	046 66102	046 36102
	2200	16 × 31	20	1600	2100	550	110	0.15	0.11	0.04	0.04	046 56222	046 66222	046 36222
	3300	18 × 35	22	1900	2500	830	170	0.17	0.08	0.03	0.03	046 56332	046 66332	–
	4700	18 × 35	22	2000	2600	1200	240	0.19	0.06	0.03	0.03	046 56472	046 66472	–
35	220	10 × 16	15	400	740	80	18	0.10	0.72	0.30	0.23	046 50221	046 60221	046 30221
	330	10 × 20	16	510	880	120	26	0.10	0.48	0.26	0.16	046 50331	046 60331	046 30331
	470	12.5 × 20	17	650	1000	170	36	0.10	0.34	0.14	0.11	046 50471	046 60471	046 30471
	1000	16 × 25	19	1200	1600	350	73	0.10	0.16	0.07	0.06	046 50102	046 60102	046 30102
	2200	16 × 35	21	1800	2000	770	160	0.12	0.10	0.04	0.04	046 50222	046 60222	–

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	I_R 100 Hz 105 °C (mA)	I_{RH} 100 kHz 105 °C (mA)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	CATALOG NUMBER 2222 046		
												BULK PACKAGING		TAPED
												FORM CA	FORM CB	FORM TFA
40	100	10 × 12	14	300	560	43	11	0.09	1.43	0.60	0.35	046 57101	046 67101	046 37101
	220	10 × 20	16	450	850	91	21	0.09	0.65	0.27	0.17	046 57221	046 67221	046 37221
	330	12.5 × 20	17	590	1000	140	29	0.09	0.43	0.18	0.13	046 57331	046 67331	046 37331
	470	12.5 × 25	18	750	1300	190	41	0.09	0.30	0.13	0.08	046 57471	046 67471	046 37471
	2200	18 × 35	22	1900	2500	880	180	0.11	0.08	0.03	0.03	046 57222	046 67222	—
	3300	18 × 35	22	2100	2600	1300	270	0.12	0.06	0.03	0.03	046 57332	046 67332	—
50	100	10 × 16	15	310	610	53	13	0.07	1.11	0.50	0.28	046 51101	046 61101	046 31101
	220	12.5 × 20	17	500	980	110	25	0.07	0.51	0.23	0.13	046 51221	046 61221	046 31221
	330	12.5 × 25	18	680	1200	170	36	0.07	0.34	0.15	0.09	046 51331	046 61331	046 31331
	1000	16 × 31	20	1400	1800	500	100	0.07	0.11	0.05	0.05	046 51102	046 61102	046 31102
	2200	18 × 35	22	2000	2600	1100	220	0.09	0.07	0.03	0.03	046 51222	046 61222	—
63	22	10 × 12	14	170	310	17	9	0.06	4.3	1.6	0.7	046 58229	046 68229	046 38229
	47	10 × 12	14	230	430	33	9	0.06	2.03	0.96	0.40	046 58479	046 68479	046 38479
	100	10 × 20	16	360	710	66	16	0.06	0.95	0.45	0.20	046 58101	046 68101	046 38101
	220	12.5 × 25	18	610	1100	140	31	0.06	0.43	0.20	0.11	046 58221	046 68221	046 38221
	330	16 × 25	19	750	1300	210	45	0.06	0.29	0.14	0.08	046 58331	046 68331	046 38331
	470	16 × 25	19	950	1600	300	62	0.06	0.20	0.10	0.06	046 58471	046 68471	046 38471
	1000	18 × 35	22	1500	2100	630	130	0.06	0.10	0.04	0.04	046 58102	046 68102	—

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 $\varnothing D = 10 mm$	typ. 16 nH
	case $\varnothing D \geq 12.5 mm$	typ. 18 nH

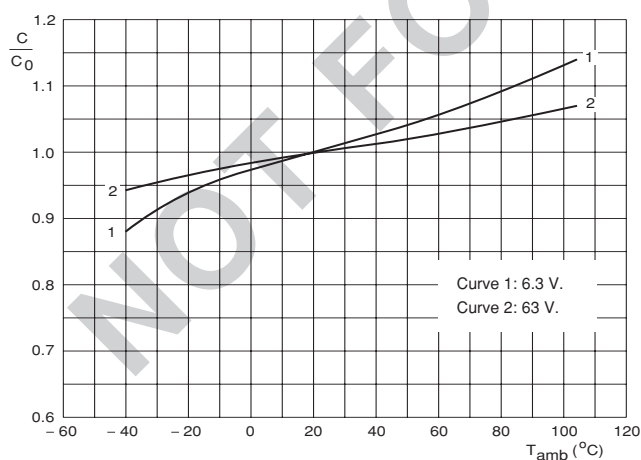
CAPACITANCE (C) C_0 = capacitance at 20 °C, 100 Hz.

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

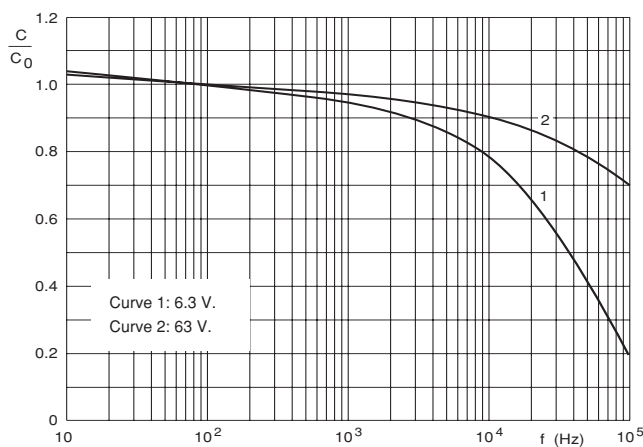
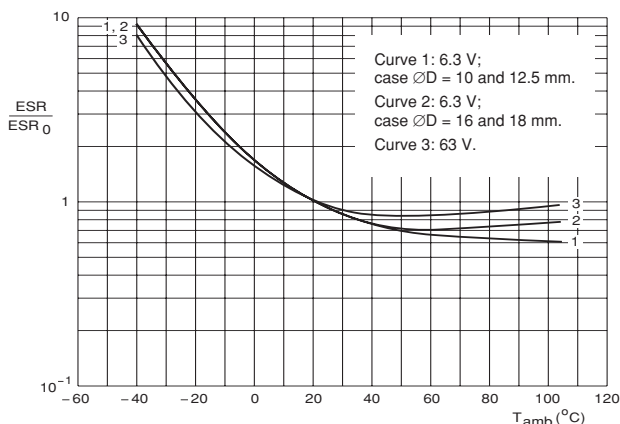
 C_0 = capacitance at 20 °C, 100 Hz. $T_{amb} = 20 ^\circ C$.

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

EQUIVALENT SERIES RESISTANCE (ESR)



ESR_0 = typical at 20 °C, 100 Hz.

Fig.7 Typical multiplier of ESR as a function of ambient temperature.

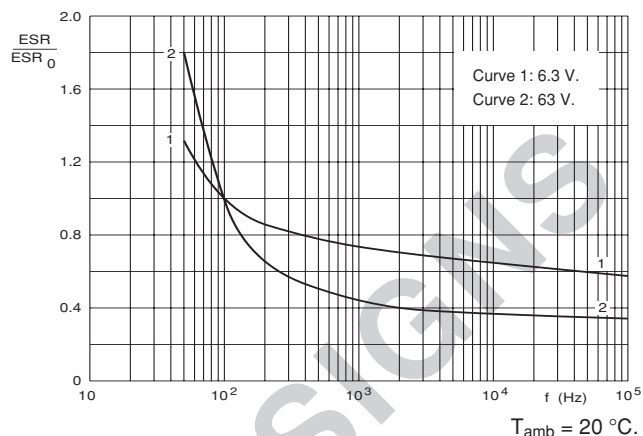
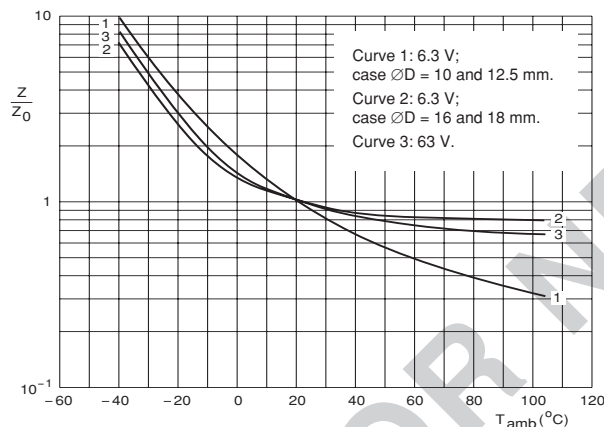


Fig.8 Typical multiplier of ESR as a function of frequency.

IMPEDANCE (Z)



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

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

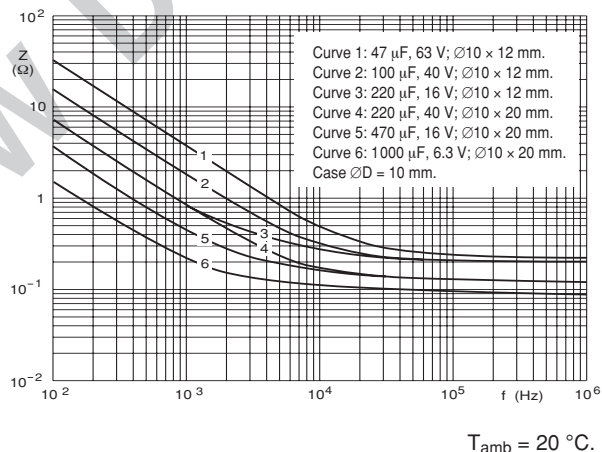


Fig.10 Typical impedance as a function of frequency.

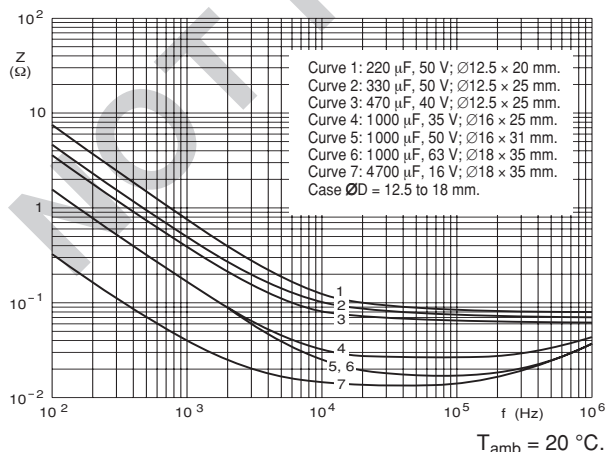


Fig.11 Typical impedance as a function of frequency.

RIPPLE CURRENT AND USEFUL LIFE

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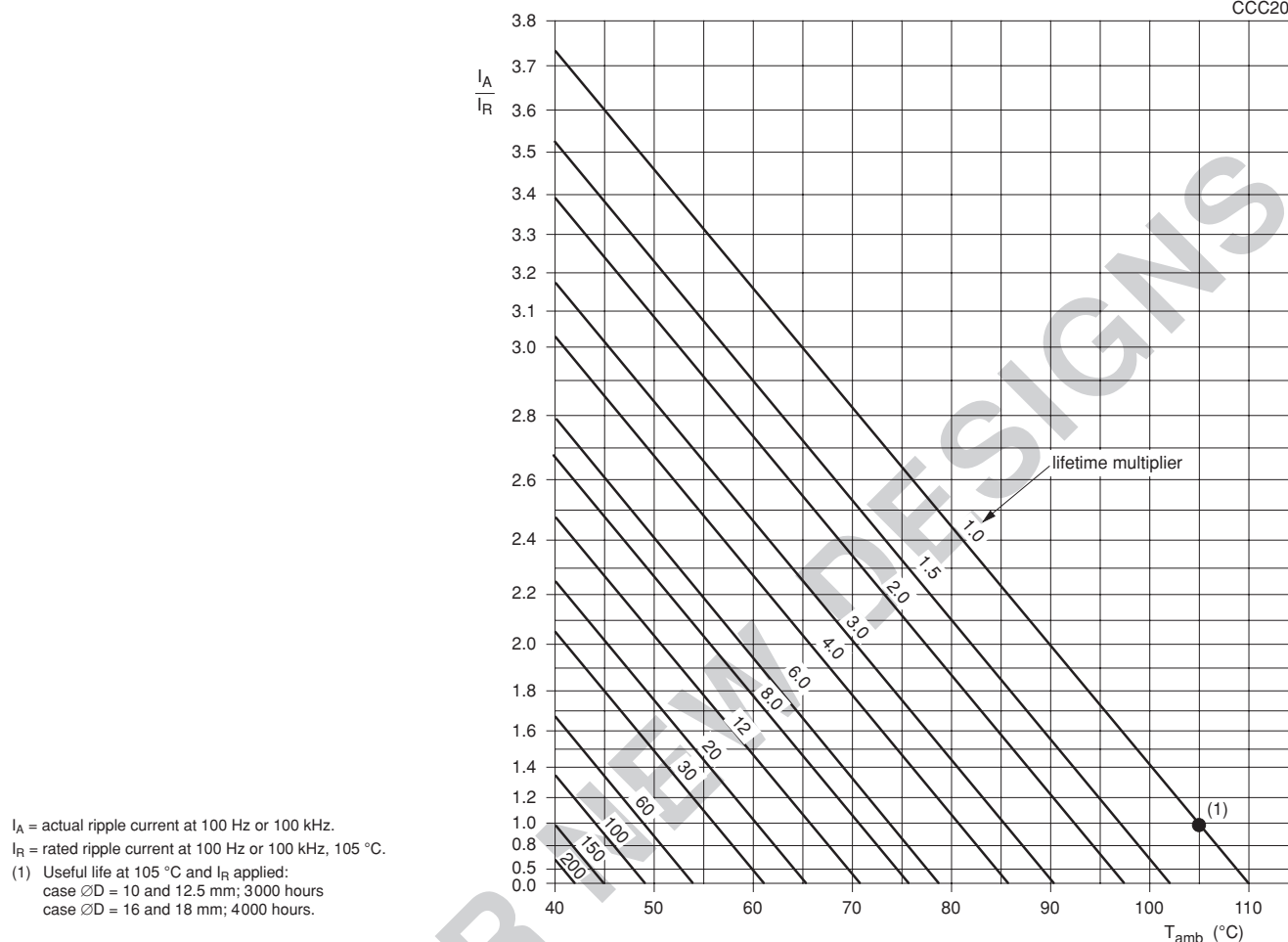


Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load.

Table 3

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; 2000 hours	$U_R = 6.3\text{ V}$; $\Delta C/C: +15/-30\%$ $U_R > 6.3\text{ V}$; $\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ °C}$; U_R and I_R applied; 3000 hours, case $\varnothing D = 10$ and 12.5 mm; 4000 hours, case $\varnothing D = 16$ and 18 mm	$U_R = 6.3\text{ V}$; $\Delta C/C: +45/-50\%$ $U_R > 6.3\text{ V}$; $\Delta C/C: \pm 15\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	$T_{amb} = 105\text{ °C}$; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$U_R = 6.3\text{ V}$; $\Delta C/C: +15/-30\%$ $U_R > 6.3\text{ V}$; $\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$