

Aluminum Capacitors

Radial, Ultra High CV per Volume, Semi-Professional

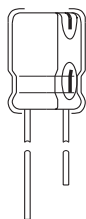
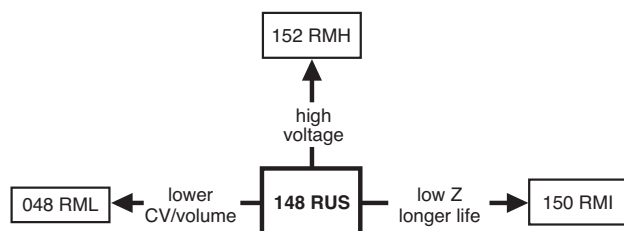


Fig.1 Component outline.


RoHS
COMPLIANT

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminium case with pressure relief, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Miniaturized, ultra high CV-product per unit volume
- Very long useful life: 3000 hours at 105 °C, high reliability
- Lead (Pb)-free versions are 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 value (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 (148).

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes ($\varnothing D \times L$ in mm)	10 × 12 to 18 × 35
Rated capacitance range, C_R	47 to 22000 μF
Tolerance on C_R	$\pm 20\%$
Rated voltage range, U_R	6.3 to 100V
Category temperature range	-40 to +105 °C
Endurance test at 105 °C:	
case $\varnothing D = 10$ mm	1000 hours
case $\varnothing D \geq 12.5$ mm	2000 hours
Useful life at 105 °C:	
case $\varnothing D = 10$ mm	2000 hours
case $\varnothing D \geq 12.5$ mm	3000 hours
Useful life at 40 °C, $1.6 \times I_R$ applied:	
case $\varnothing D = 10$ mm	140000 hours
case $\varnothing D \geq 12.5$ mm	200000 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

SELECTION CHART FOR C_R , U_R AND RELEVANT NOMINAL CASE SIZES ($\varnothing D \times L$ in mm)

C_R (μF)	U_R (V)							
	6.3	10	16	25	35	50	63	100
47	—	—	—	—	—	—	—	10 × 12
68	—	—	—	—	—	—	—	10 × 16
100	—	—	—	—	—	—	10 × 12	10 × 20
150	—	—	—	—	—	—	—	12.5 × 20
220	—	—	—	—	—	10 × 12	10 × 16	12.5 × 25
	—	—	—	—	—	—	—	16 × 20
330	—	—	—	—	10 × 12	10 × 16	12.5 × 20	16 × 25
470	—	—	—	10 × 12	10 × 16	10 × 20	12.5 × 20	16 × 31
680	—	—	10 × 12	10 × 16	10 × 20	12.5 × 20	12.5 × 25	—
	—	—	—	—	—	—	16 × 20	—

SELECTION CHART FOR C_R , U_R AND RELEVANT NOMINAL CASE SIZES ($\varnothing D \times L$ in mm)								
C_R (μF)	U_R (V)							
	6.3	10	16	25	35	50	63	100
1000	–	10 × 12	10 × 16	10 × 20	12.5 × 20	12.5 × 25	16 × 25	–
1500	–	–	–	–	–	16 × 20	–	–
	–	10 × 16	10 × 20	12.5 × 20	12.5 × 25	16 × 25	16 × 31	–
2200	–	–	–	–	16 × 20	–	–	–
	10 × 16	10 × 20	12.5 × 20	12.5 × 25	16 × 25	16 × 31	18 × 35	–
3300	–	–	–	16 × 20	–	–	–	–
	–	12.5 × 20	12.5 × 25	16 × 25	16 × 31	18 × 35	–	–
4700	–	–	16 × 20	–	–	–	–	–
	12.5 × 20	12.5 × 25	16 × 25	16 × 31	18 × 35	–	–	–
6800	–	16 × 20	–	–	–	–	–	–
	16 × 20	16 × 25	16 × 31	18 × 35	–	–	–	–
10000	16 × 25	16 × 31	18 × 35	–	–	–	–	–
15000	16 × 31	18 × 35	–	–	–	–	–	–
22000	18 × 35	–	–	–	–	–	–	–

DIMENSIONS in millimeters, AND AVAILABLE FORMS

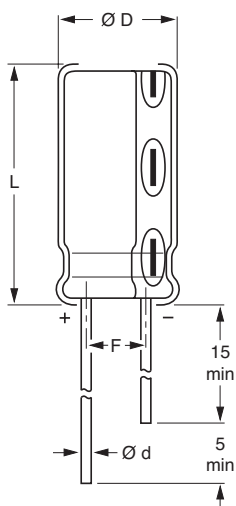


Fig. 2 Form CA: Long leads.

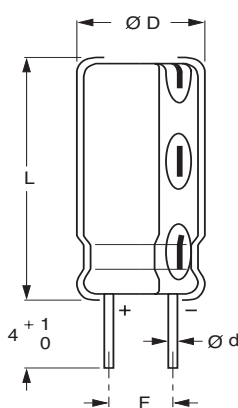


Fig. 3 Form CB: Cut leads.

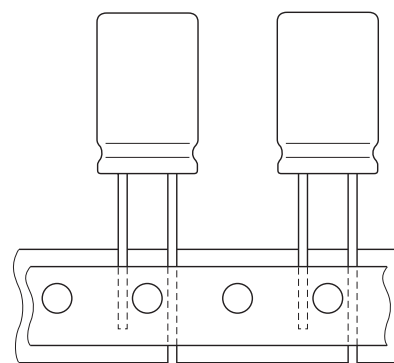


Fig. 4 Form TFA: Taped in box (ammopack)

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 × 20	19a	0.8	16.5	22.0	7.5 ± 0.5	≈ 6.0	250	250	250
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
18 × 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	–

Note

1. 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_{L2}	max. leakage current after 2 minutes 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 1

ELECTRICAL DATA AND ORDERING INFORMATION										
U_R (V)	C_R 100 Hz (MF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 105 °C (mA)	I_{L2} 2 min (MA)	$\tan \Delta$ 100 Hz	Z 100 kHz 20 °C (Ω)	Z 100 kHz -40 °C (Ω)	CATALOG NUMBER 2222 148		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
6.3	2200	10 × 16	720	139	0.30	0.170	1.90	53222	63222	33222
	4700	12.5 × 20	1100	296	0.34	0.085	0.60	53472	63472	33472
	6800	16 × 20	1210	428	0.38	0.060	0.30	53682	63682	33682
	10000	16 × 25	1660	630	0.46	0.045	0.25	53103	63103	33103
	15000	16 × 31	2050	945	0.56	0.033	0.15	53153	63153	33153
	22000	18 × 35	2350	1386	0.66	0.032	0.15	53223	63223	—
10	1000	10 × 12	460	100	0.24	0.240	3.00	54102	64102	34102
	1500	10 × 16	620	150	0.24	0.170	1.90	54152	64152	34152
	2200	10 × 20	750	220	0.26	0.130	1.50	54222	64222	34222
	3300	12.5 × 20	1010	330	0.28	0.085	0.60	54332	64332	34332
	4700	12.5 × 25	1260	470	0.30	0.065	0.50	54472	64472	34472
	4700	16 × 20	1260	470	0.30	0.060	0.30	94475	94476	94473
	6800	16 × 25	1590	680	0.34	0.045	0.25	54682	64682	34682
	10000	16 × 31	1910	1000	0.42	0.033	0.15	54103	64103	34103
	15000	18 × 35	2200	1500	0.52	0.032	0.15	54153	64153	—
16	680	10 × 12	450	109	0.20	0.240	3.00	55681	65681	35681
	1000	10 × 16	570	160	0.20	0.180	2.00	55102	65102	35102
	1500	10 × 20	720	240	0.20	0.130	1.50	55152	65152	35152
	2200	12.5 × 20	930	352	0.22	0.090	0.60	55222	65222	35222
	3300	12.5 × 25	1180	528	0.24	0.065	0.50	55332	65332	35332
	3300	16 × 20	1120	528	0.24	0.060	0.30	95335	95336	95333
	4700	16 × 25	1480	752	0.26	0.045	0.25	55472	65472	35472
	6800	16 × 31	1790	1088	0.30	0.035	0.20	55682	65682	35682
	10000	18 × 35	2100	1600	0.36	0.032	0.20	55103	65103	—
	—	—	—	—	—	—	—	—	—	—
25	470	10 × 12	410	118	0.16	0.260	3.20	56471	66471	36471
	680	10 × 16	550	170	0.16	0.190	2.10	56681	66681	36681
	1000	10 × 20	690	250	0.16	0.130	1.50	56102	66102	36102
	1500	12.5 × 20	850	375	0.16	0.100	0.70	56152	66152	36152
	2200	12.5 × 25	1110	550	0.18	0.070	0.50	56222	66222	36222
	2200	16 × 20	1050	550	0.18	0.060	0.30	96225	96226	96223
	3300	16 × 25	1420	825	0.20	0.045	0.25	56332	66332	36332
	4700	16 × 31	1750	1175	0.22	0.035	0.20	56472	66472	36472
	6800	18 × 35	2050	1700	0.26	0.033	0.20	56682	66682	—
	—	—	—	—	—	—	—	—	—	—

ORDERING EXAMPLE*

Electrolytic capacitor 148 series

470 $\mu\text{F}/25\text{ V}$; $\pm 20\%$ Nominal case size: $\varnothing 10 \times 12\text{ mm}$; Form TFA

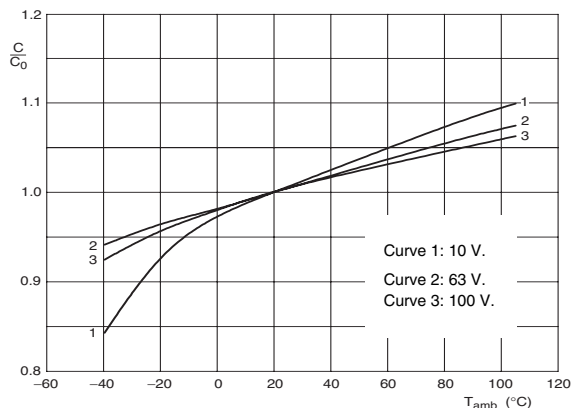
Catalog number: 2222 148 36471

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



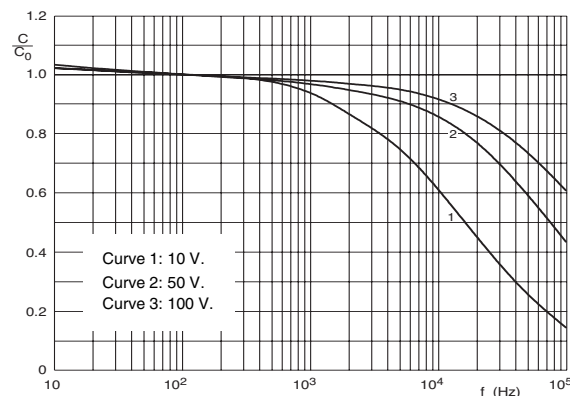
ELECTRICAL DATA AND ORDERING INFORMATION										
U _R (V)	C _R 100 Hz (mF)	NOMINAL CASE SIZE ØD × L (mm)	I _R 100 Hz 105 °C (mA)	I _{L2} 2 min (mA)	Tan Δ 100 Hz	Z 100 kHz 20 °C (Ω)	Z 100 kHz -40 °C (Ω)	CATALOG NUMBER 2222 148		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
35	330	10 × 12	350	116	0.14	0.270	3.30	50331	60331	30331
	470	10 × 16	480	165	0.14	0.190	2.10	50471	60471	30471
	680	10 × 20	580	238	0.14	0.140	1.60	50681	60681	30681
	1000	12.5 × 20	810	350	0.14	0.100	0.70	50102	60102	30102
	1500	12.5 × 25	950	525	0.14	0.070	0.50	50152	60152	30152
	1500	16 × 20	970	525	0.14	0.063	0.30	90155	90156	90153
	2200	16 × 25	1270	770	0.16	0.045	0.25	50222	60222	30222
	3300	16 × 31	1620	1155	0.18	0.037	0.20	50332	60332	30332
	4700	18 × 35	1930	1645	0.20	0.033	0.20	50472	60472	—
50	220	10 × 12	330	110	0.12	0.280	3.40	51221	61221	31221
	330	10 × 16	420	165	0.12	0.200	2.20	51331	61331	31331
	470	10 × 20	530	235	0.12	0.140	1.60	51471	61471	31471
	680	12.5 × 20	720	340	0.12	0.100	0.70	51681	61681	31681
	1000	12.5 × 25	950	500	0.12	0.070	0.50	51102	61102	31102
	1000	16 × 20	880	500	0.12	0.068	0.35	91105	91106	91103
	1500	16 × 25	1180	750	0.12	0.047	0.30	51152	61152	31152
	2200	16 × 31	1520	1100	0.14	0.039	0.20	51222	61222	31222
	3300	18 × 35	1810	1650	0.16	0.035	0.20	51332	61332	—
63	100	10 × 12	230	63	0.10	0.320	3.90	58101	68101	38101
	220	10 × 16	350	139	0.10	0.240	2.70	58221	68221	38221
	330	12.5 × 20	540	208	0.10	0.130	0.90	58331	68331	38331
	470	12.5 × 20	540	296	0.10	0.130	0.90	58471	68471	38471
	680	12.5 × 25	760	428	0.10	0.085	0.65	58681	68681	38681
	680	16 × 20	820	428	0.10	0.070	0.50	98685	98686	98683
	1000	16 × 25	980	630	0.10	0.049	0.25	58102	68102	38102
	1500	16 × 31	1390	945	0.10	0.042	0.20	58152	68152	38152
	2200	18 × 35	1670	1386	0.12	0.038	0.20	58222	68222	—
100	47	10 × 12	165	47	0.08	0.640	19.20	59479	69479	39479
	68	10 × 16	190	68	0.08	0.580	17.40	59689	69689	39689
	100	10 × 20	260	100	0.08	0.380	11.40	59101	69101	39101
	150	12.5 × 20	360	150	0.08	0.260	7.80	59151	69151	39151
	220	12.5 × 25	440	220	0.08	0.170	2.10	59221	69221	39221
	220	16 × 20	590	220	0.08	0.140	1.70	99225	99226	99223
	330	16 × 25	630	330	0.08	0.120	1.50	59331	69331	39331
	470	16 × 31	750	470	0.08	0.100	1.20	59471	69471	39471

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 2 minutes at U_R	$I_{L2} \leq 0.01 C_R \times U_R$
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R$
Inductance		
Equivalent series inductance (ESL)	case ØD = 10 mm	typ. 16 nH
	case ØD ≥ 12.5 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)

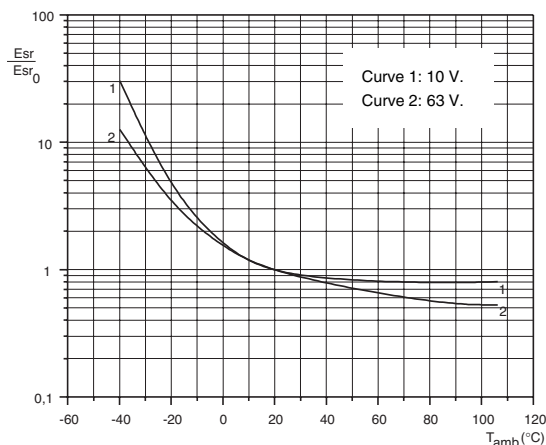
C_0 = typical capacitance at 20 °C, 100 Hz.

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



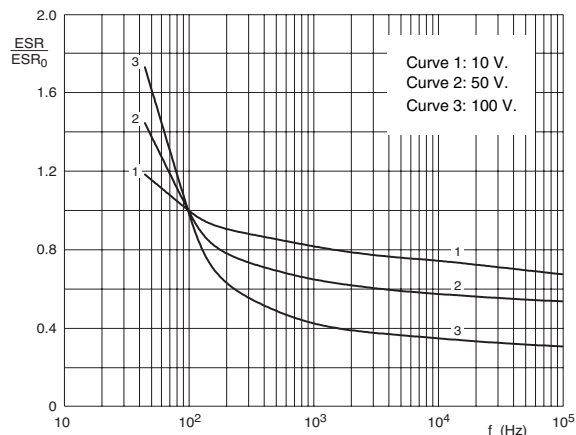
C_0 = typical capacitance at 20 °C, 100 Hz. $T_{amb} = 20$ °C.

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

EQUIVALENT SERIES RESISTANCE (ESR)

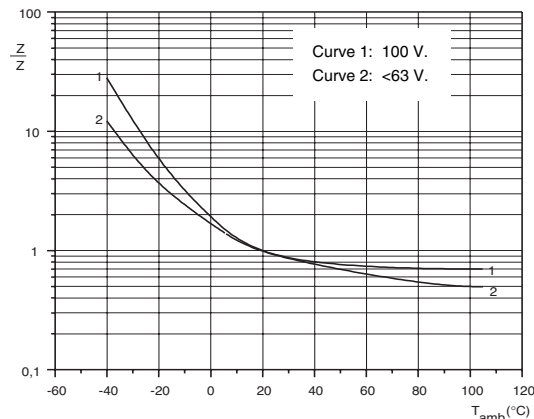
ESR_0 = typical ESR at 20 °C, 100 Hz.

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



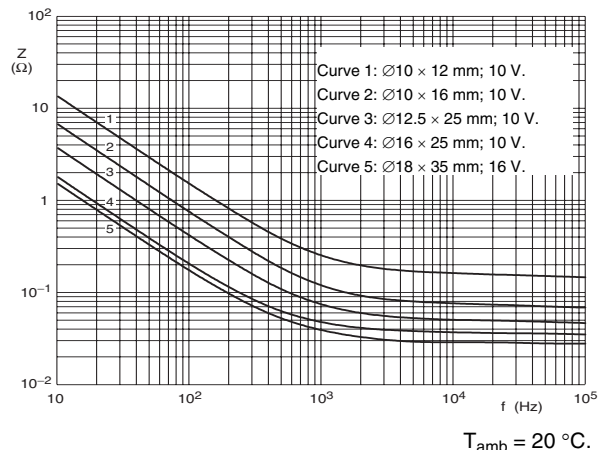
ESR_0 = typical ESR at 20 °C, 100 Hz. $T_{amb} = 20$ °C.

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

IMPEDANCE (Z)

Z_0 = typical impedance at 20 °C, 100 kHz.

Fig.9 Multiplier of impedance as a function of ambient temperature.



$T_{amb} = 20$ °C.

Fig.10 Typical impedance as a function of frequency.

IMPEDANCE (Z)

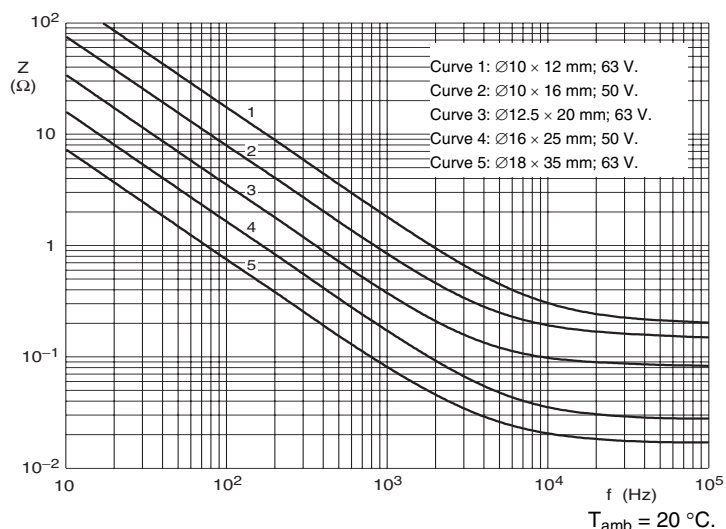


Fig.11 Typical impedance as a function of frequency.

RIPPLE CURRENT AND USEFUL LIFE

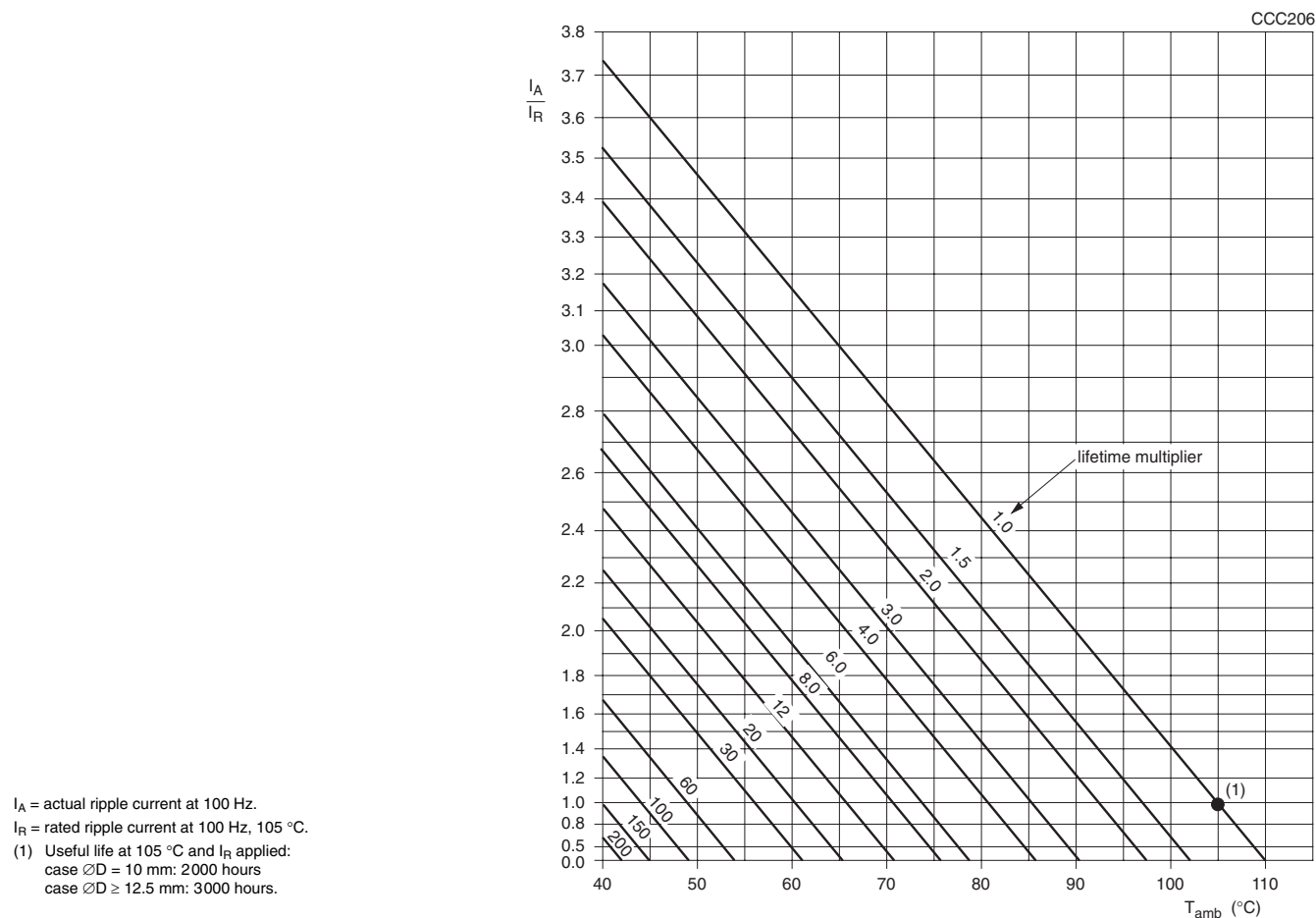


Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load.

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY

FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 6.3$ to 25 V	$U_R = 35$ V	$U_R = 50$ to 100 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

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; case $\varnothing D = 10$ mm: 1000 hours; case $\varnothing D \geq 12.5$ mm: 2000 hours	$U_R = 6.3$ V; $\Delta C/C: +15 / -30$ % $U_R \geq 10$ V; $\Delta C/C: \pm 20$ % $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105$ °C; U_R and I_R applied; case $\varnothing D = 10$ mm: 2000 hours; case $\varnothing D \geq 12.5$ mm: 3000 hours	$U_R = 6.3$ V; $\Delta C/C: +45 / -50$ % $U_R \geq 10$ V; $\Delta C/C: \pm 45$ % $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: ≤ 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	$U_R = 6.3$ V; $\Delta C/C: +15 / -30$ % $U_R \geq 10$ V; $\Delta C/C: \pm 20$ % $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$
Surge	IEC 60384-4/ EN130300 subclause 4.14	from source of $1.15 \times U_R$: $RC = 0.1 \pm 0.05$ s; 1000 cycles of 30 s on, 330 s off, at 105 °C	$\Delta C/C: \pm 20$ % $\tan \delta \leq 1.5 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Reverse voltage	IEC 60384-4/ EN130300 subclause 4.15	$T_{amb} = 105$ °C: 125 hours at $U = -1$ V, followed by 125 hours at U_R	$\Delta C/C: \pm 15$ % $\tan \delta \leq 1.5 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$



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