Aluminum Capacitors
Radial Standard Miniature

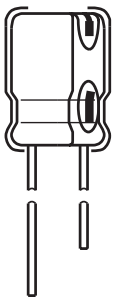
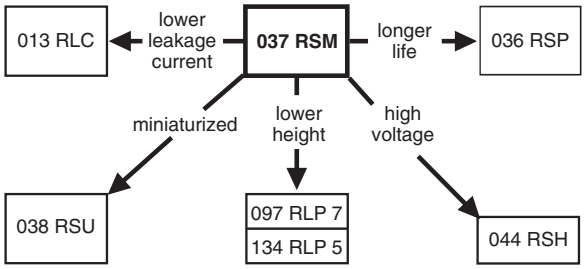


Fig.1 Component outline.



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte.
- Radial leads, cylindrical aluminum case, insulated with a blue vinyl sleeve.
- Pressure relief for case ∅D ≥ 6.3 mm.
- Charge and discharge proof.
- Miniaturized, high CV-product per unit volume.
- Lead (Pb)-Free versions are RoHS compliant.

Pb-free Available

RoHS* COMPLIANT

APPLICATIONS

- General purpose, industrial, automotive and audio-video.
- Coupling, decoupling, timing, smoothing, filtering, buffering in SMPS.
- Portable and mobile equipment (small size, low mass).

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (∅D × L in mm)	5 × 11 to 16 × 31
Rated capacitance range, C_R	0.47 to 10000 µF
Tolerance on C_R	± 20 %; ± 10 % on request
Rated voltage range, U_R	6.3 to 100 V
Category temperature range	– 40 to + 85 °C
Endurance test at 85 °C	2000 hours
Useful life at 85 °C	2500 hours
Useful life at 40 °C, 1.4 × I_R applied	70000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/085/56

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.
- Negative terminal identification.
- Series number (037).

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**	**100**
0.47	–	–	–	–	–	–	–	5 × 11	5 × 11
1.0	–	–	–	–	–	–	–	5 × 11	5 × 11
2.2	–	–	–	–	–	–	–	5 × 11	5 × 11
3.3	–	–	–	–	–	–	–	5 × 11	5 × 11
4.7	–	–	–	–	–	–	–	5 × 11	5 × 11
10	–	–	–	–	–	–	5 × 11	5 × 11	6.3 × 11
22	–	–	–	–	–	–	5 × 11	6.3 × 11	8 × 12
33	–	–	–	–	5 × 11	–	–	6.3 × 11	10 × 12
47	–	–	–	5 × 11	–	–	6.3 × 11	8 × 12	10 × 16
68	–	–	5 × 11	6.3 × 11	–	–	8 × 12	10 × 12	–
100	–	5 × 11	6.3 × 11	6.3 × 11	–	–	8 × 12	10 × 12	10 × 20
150	–	6.3 × 11	–	8 × 12	–	10 × 12	–	10 × 16	–
220	–	6.3 × 11	8 × 12	8 × 12	10 × 12	–	10 × 16	10 × 20	12.5 × 2

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

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	100
330	6.3 × 11	–	8 × 12	10 × 12	10 × 16	–	10 × 20	12.5 × 20	16 × 25
470	–	8 × 12	10 × 12	10 × 16	10 × 20	12.5 × 20	12.5 × 20	12.5 × 25	16 × 31
680	–	–	10 × 16	–	12.5 × 20	12.5 × 25	12.5 × 25	16 × 25	–
1000	10 × 12	10 × 16	10 × 20	12.5 × 20	12.5 × 25	16 × 25	16 × 25	16 × 31	–
1500	10 × 20	–	12.5 × 20	12.5 × 25	16 × 25	–	–	–	–
2200	12.5 × 20	12.5 × 20	12.5 × 25	16 × 25	16 × 31	–	–	–	–
3300	12.5 × 20	12.5 × 25	16 × 25	16 × 31	–	–	–	–	–
4700	–	16 × 25	16 × 31	–	–	–	–	–	–
6800	–	16 × 31	–	–	–	–	–	–	–
10000	16 × 31	–	–	–	–	–	–	–	–

DIMENSIONS in millimeters AND AVAILABLE FORMS

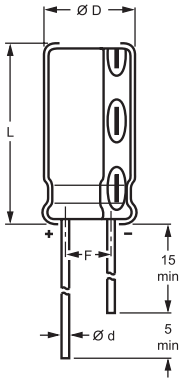


Fig.2 **Form CA**: Long leads.

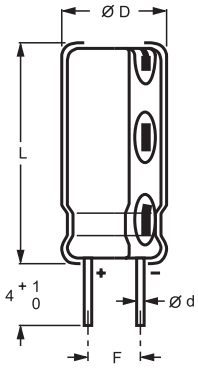
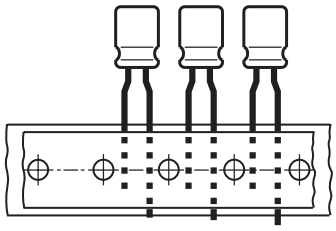
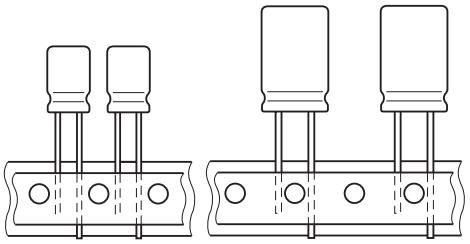


Fig.3 **Form CB**: Cut leads.



Case ∅D = 5 to 8 mm; pitch F = 5 mm.

Fig.4 **Form TFA**: Taped in box (ammopack), formed leads



Pitch F see tables 1 and 2.

Fig.5 **Form TNA**, **Form TFA**: Taped in box (ammopack), straight leads.

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE ∅D × L	CASE CODE	∅d	$\varnothing D_{max}$	L_{max}	F	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA, TNA
5 × 11	11	0.5	5.5	12.5	2.0 ±0.5	≈0.4	3000	–	2000
6.3 × 11	12	0.5	6.8	12.5	2.5 ±0.5	≈0.6	2000	–	2000
8 × 12	13	0.6	8.5	13.0	3.5 ±0.5	≈1.1	1000	–	1000
10 × 12	14	0.6	10.5	13.5	5.0 ±0.5	≈1.6	1000	1000	500
10 × 16	15	0.6	10.5	17.5	5.0 ±0.5	≈1.9	1000	1000	500
10 × 20	16	0.6	10.5	22.0	5.0 ±0.5	≈2.2	1000	500	500
12.5 × 20	17	0.6	13.0	22.0	5.0 ±0.5	≈4.0	1000	2000	500
12.5 × 25	18	0.6	13.0	27.0	5.0 ±0.5	≈5.0	500	2000	500
16 × 25	19	0.8	16.5	27.0	7.5 ±0.5	≈8.0	500	1000	250
16 × 31	20	0.8	16.5	33.5	7.5 ±0.5	≈9.0	200	1000	250

Note

1. Detailed tape dimensions see section ‘PACKAGING’.

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 Hz, 85 °C
I_{L1}	max. leakage current after 1 minute at U_R
Tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 10 kHz

Note

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

ORDERING EXAMPLE*

Electrolytic capacitor 037 series

1000 µF/16 V; ± 20 %

Nominal case size: ∅10 × 20 mm; Form TFA

Catalog number: 2222 037 35102.

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

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

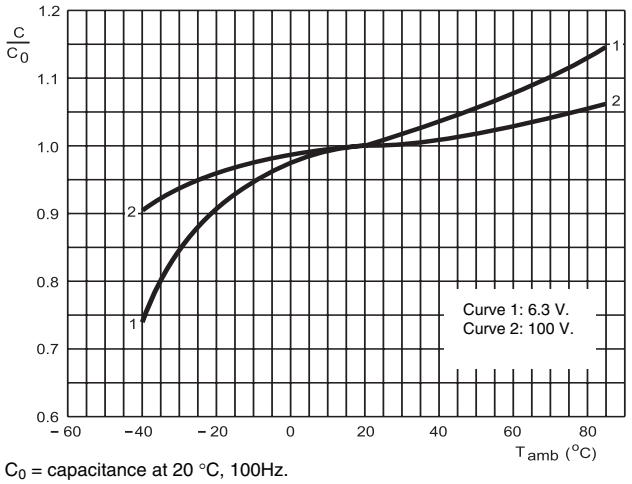
U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D × L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	Tan δ 100 Hz	Z 10 kHz (Ω)	CATALOG NUMBER 2222 037							
							BULK PACKAGING				TAPED AMMOPACK			
							LONG LEADS		CUT LEADS					
							FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	330	6.3 × 11	280	24	0.24	1.8	90021	2.5	–	–	90027	5.0	90028	2.5
	1000	10 × 12	530	66	0.24	0.6	53102	5.0	63102	5.0	33102	5.0	–	–
	1500	10 × 20	730	98	0.25	0.4	53152	5.0	63152	5.0	33152	5.0	–	–
	2200	12.5 × 20	990	140	0.26	0.27	53222	5.0	63222	5.0	33222	5.0	–	–
	3300	12.5 × 20	1150	210	0.28	0.18	53332	5.0	63332	5.0	33332	5.0	–	–
	10000	16 × 31	2250	630	0.42	0.07	53103	7.5	63103	7.5	33103	7.5	–	–
10	100	5 × 11	140	13	0.20	4.5	54101	2.0	–	–	34101	5.0	74101	2.5
	150	6.3 × 11	180	18	0.20	3.0	54151	2.5	–	–	34151	5.0	74151	2.5
	220	6.3 × 11	250	25	0.20	2.0	90029	2.5	–	–	90036	5.0	90037	2.5
	470	8 × 12	410	50	0.20	0.96	54471	3.5	–	–	34471	5.0	74471	3.5
	1000	10 × 16	630	100	0.20	0.45	54102	5.0	64102	5.0	34102	5.0	–	–
	2200	12.5 × 20	1050	220	0.22	0.20	54222	5.0	64222	5.0	34222	5.0	–	–
	3300	12.5 × 25	1350	330	0.24	0.14	54332	5.0	64332	5.0	34332	5.0	–	–
	4700	16 × 25	1800	470	0.28	0.10	54472	7.5	64472	7.5	34472	7.5	–	–
	6800	16 × 31	2200	680	0.32	0.07	54682	7.5	64682	7.5	34682	7.5	–	–
16	68	5 × 11	130	14	0.16	4.7	55689	2.0	–	–	35689	5.0	75689	2.5
	100	6.3 × 11	180	19	0.16	3.2	55101	2.5	–	–	35101	5.0	75101	2.5
	220	8 × 12	300	38	0.16	1.5	55221	3.5	–	–	35221	5.0	75221	3.5
	330	8 × 12	370	56	0.16	0.97	90038	3.5	–	–	90045	5.0	90046	3.5
	470	10 × 12	420	78	0.16	0.68	55471	5.0	65471	5.0	35471	5.0	–	–
	680	10 × 16	520	110	0.16	0.47	55681	5.0	65681	5.0	35681	5.0	–	–
	1000	10 × 20	740	160	0.16	0.32	55102	5.0	65102	5.0	35102	5.0	–	–
	1500	12.5 × 20	900	240	0.17	0.21	55152	5.0	65152	5.0	35152	5.0	–	–
	2200	12.5 × 25	1200	360	0.18	0.15	55222	5.0	65222	5.0	35222	5.0	–	–
	3300	16 × 25	1650	530	0.20	0.10	55332	7.5	65332	7.5	35332	7.5	–	–
	4700	16 × 31	2100	760	0.24	0.07	55472	7.5	65472	7.5	35472	7.5	–	–

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D × L (mm)	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	Tan δ 100 Hz	Z 10 kHz (Ω)	CATALOG NUMBER 2222 037							
							BULK PACKAGING				TAPED AMMOPACK			
							LONG LEADS		CUT LEADS					
							FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
25	47	5 × 11	120	15	0.14	4.7	56479	2.0	–	–	36479	5.0	76479	2.5
	68	6.3 × 11	130	20	0.14	3.2	56689	2.5	–	–	36689	5.0	76689	2.5
	100	6.3 × 11	190	28	0.14	2.2	90047	2.5	–	–	90054	5.0	90055	2.5
	150	8 × 12	230	41	0.14	1.5	56151	3.5	–	–	36151	5.0	76151	3.5
	220	8 × 12	320	58	0.14	1.0	56221	3.5	–	–	36221	5.0	76221	3.5
	330	10 × 12	410	86	0.14	0.67	56331	5.0	66331	5.0	36331	5.0	–	–
	470	10 × 16	510	120	0.14	0.47	56471	5.0	66471	5.0	36471	5.0	–	–
	1000	12.5 × 20	910	250	0.14	0.22	56102	5.0	66102	5.0	36102	5.0	–	–
	1500	12.5 × 25	1100	380	0.15	0.15	56152	5.0	66152	5.0	36152	5.0	–	–
	2200	16 × 25	1500	550	0.16	0.10	56222	7.5	66222	7.5	36222	7.5	–	–
	3300	16 × 31	1900	830	0.18	0.07	56332	7.5	66332	7.5	36332	7.5	–	–
35	33	5 × 11	110	15	0.12	4.5	50339	2.0	–	–	30339	5.0	70339	2.5
	220	10 × 12	330	80	0.12	0.68	50221	5.0	60221	5.0	30221	5.0	–	–
	330	10 × 16	450	120	0.12	0.45	50331	5.0	60331	5.0	30331	5.0	–	–
	470	10 × 20	590	170	0.12	0.32	50471	5.0	60471	5.0	30471	5.0	–	–
	680	12.5 × 20	830	240	0.12	0.22	50681	5.0	60681	5.0	30681	5.0	–	–
	1000	12.5 × 25	1050	350	0.12	0.15	50102	5.0	60102	5.0	30102	5.0	–	–
	1500	16 × 25	1400	530	0.13	0.10	50152	7.5	60152	7.5	30152	7.5	–	–
	2200	16 × 31	1750	770	0.14	0.07	50222	7.5	60222	7.5	30222	7.5	–	–
40	150	10 × 12	250	63	0.12	0.87	57151	5.0	67151	5.0	37151	5.0	–	–
	470	12.5 × 20	670	190	0.12	0.28	57471	5.0	67471	5.0	37471	5.0	–	–
	680	12.5 × 25	850	280	0.12	0.19	57681	5.0	67681	5.0	37681	5.0	–	–
	1000	16 × 25	1200	400	0.12	0.13	57102	7.5	67102	7.5	37102	7.5	–	–
50	10	5 × 11	65	8	0.10	9.5	51109	2.0	–	–	31109	5.0	71109	2.5
	22	5 × 11	95	14	0.10	4.3	90056	2.0	–	–	90063	5.0	90064	2.5
	47	6.3 × 11	150	27	0.10	2.0	90065	2.5	–	–	90072	5.0	90073	2.5
	68	8 × 12	190	37	0.10	1.4	51689	3.5	–	–	31689	5.0	71689	3.5
	100	8 × 12	260	53	0.10	0.95	51101	3.5	–	–	31101	5.0	71101	3.5
	220	10 × 16	400	110	0.10	0.43	51221	5.0	61221	5.0	31221	5.0	–	–
	330	10 × 20	580	170	0.10	0.29	51331	5.0	61331	5.0	31331	5.0	–	–
	470	12.5 × 20	740	240	0.10	0.20	51471	5.0	61471	5.0	31471	5.0	–	–
	680	12.5 × 25	950	340	0.10	0.14	51681	5.0	61681	5.0	31681	5.0	–	–
	1000	16 × 25	1350	500	0.10	0.10	51102	7.5	61102	7.5	31102	7.5	–	–
63	0.47	5 × 11	11	3.3	0.09	170	58477	2.0	–	–	38477	5.0	78477	2.5
	1.0	5 × 11	16	3.6	0.09	80	58108	2.0	–	–	38108	5.0	78108	2.5
	2.2	5 × 11	29	4.4	0.09	36	58228	2.0	–	–	38228	5.0	78228	2.5
	3.3	5 × 11	35	5.1	0.09	24	58338	2.0	–	–	38338	5.0	78338	2.5
	4.7	5 × 11	45	6.0	0.09	17	58478	2.0	–	–	38478	5.0	78478	2.5
	10	5 × 11	70	9.3	0.09	8.0	58109	2.0	–	–	38109	5.0	78109	2.5
	22	6.3 × 11	110	17	0.09	3.6	58229	2.5	–	–	38229	5.0	78229	2.5
	33	6.3 × 11	140	24	0.09	2.4	90074	2.5	–	–	90081	5.0	90082	2.5
	47	8 × 12	190	33	0.09	1.7	58479	3.5	–	–	38479	5.0	78479	3.5
	68	10 × 12	200	46	0.09	1.2	58689	5.0	68689	5.0	38689	5.0	–	–
	100	10 × 12	260	66	0.09	0.80	58101	5.0	68101	5.0	38101	5.0	–	–
	150	10 × 16	320	98	0.09	0.53	58151	5.0	68151	5.0	38151	5.0	–	–
	220	10 × 20	460	140	0.09	0.36	58221	5.0	68221	5.0	38221	5.0	–	–
	330	12.5 × 20	650	210	0.09	0.24	58331	5.0	68331	5.0	38331	5.0	–	–
	470	12.5 × 25	850	300	0.09	0.17	58471	5.0	68471	5.0	38471	5.0	–	–
	680	16 × 25	1150	430	0.09	0.12	58681	7.5	68681	7.5	38681	7.5	–	–
	1000	16 × 31	1550	630	0.09	0.08	58102	7.5	68102	7.5	38102	7.5	–	–
100	0.47	5 × 11	12	3.5	0.07	130	59477	2.0	–	–	39477	5.0	79477	2.5
	1.0	5 × 11	22	4	0.07	60	59108	2.0	–	–	39108	5.0	79108	2.5
	2.2	5 × 11	33	5.2	0.07	27	59228	2.0	–	–	39228	5.0	79228	2.5
	3.3	5 × 11	40	6.3	0.07	18	59338	2.0	–	–	39338	5.0	79338	2.5
	4.7	5 × 11	48	7.7	0.07	13	59478	2.0	–	–	39478	5.0	79478	2.5
	10	6.3 × 11	80	13	0.07	6.0	59109	2.5	–	–	39109	5.0	79109	2.5
	22	8 × 12	130	25	0.07	2.7	59229	3.5	–	–	39229	5.0	79229	3.5
	33	10 × 12	160	36	0.07	1.8	59339	5.0	69339	5.0	39339	5.0	–	–
	47	10 × 16	210	50	0.07	1.3	59479	5.0	69479	5.0	39479	5.0	–	–
	100	10 × 20	350	100	0.07	0.60	59101	5.0	69101	5.0	39101	5.0	–	–
	220	12.5 × 25	580	220	0.07	0.27	59221	5.0	69221	5.0	39221	5.0	–	–
	330	16 × 25	710	330	0.07	0.18	59331	7.5	69331	7.5	39331	7.5	–	–
	470	16 × 31	900	470	0.07	0.13	59471	7.5	69471	7.5	39471	7.5	–	–

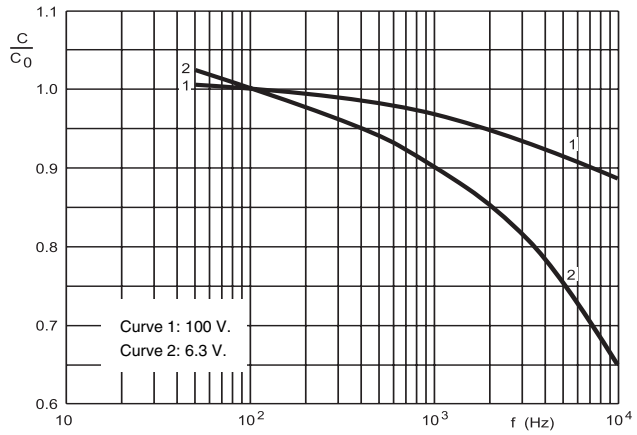
ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.01\ C_R \times U_R + 3\ \mu A$
	after 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3\ \mu A$
Inductance		
Equivalent series inductance (ESL)	case ∅D ≤ 8 mm	typ. 13 nH
	case ∅D = 10 mm	typ. 16 nH
	case ∅D ≥ 12.5 mm	typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	calculated from tan δ_{max} and C_R (see Table 2)	ESR = tan δ / $2\pi f C_R$

CAPACITANCE (C)



C_0 = capacitance at 20 °C, 100Hz.

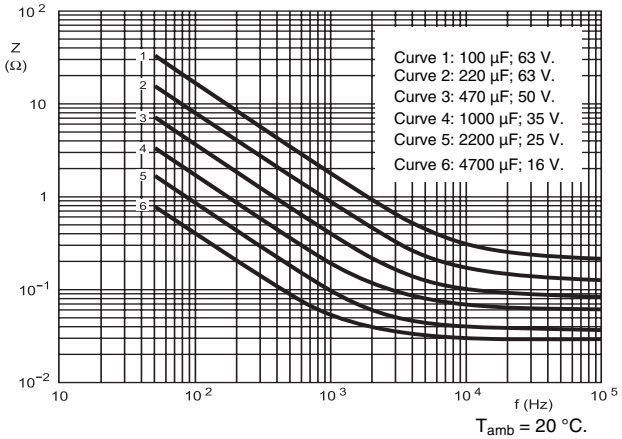
Fig.6 Typical multiplier of capacitance as a function of ambient temperature.



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

Fig.7 Typical multiplier of capacitance as a function of frequency.

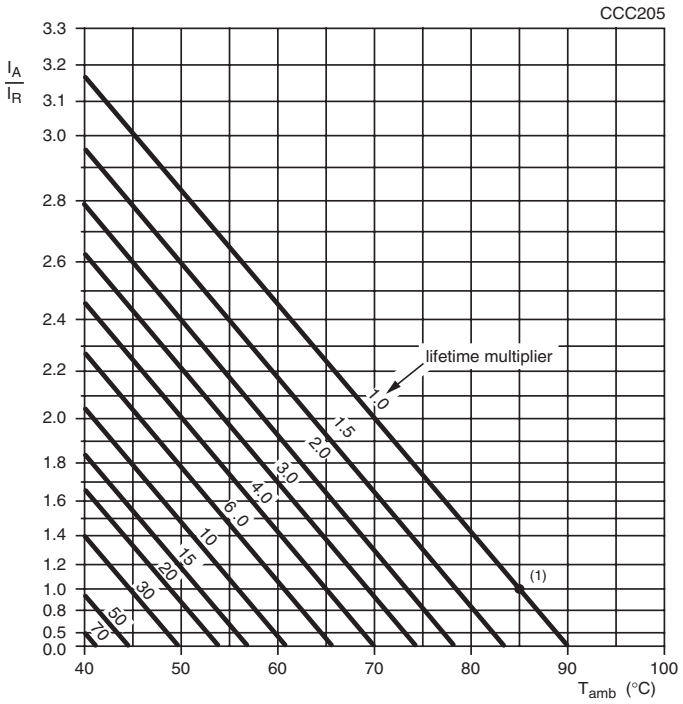
IMPEDANCE (Z)



T_{amb} = 20 °C.

Fig.8 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, 85 °C.

(1) Useful life at 85 °C and I_R applied: 2500 hours.

Fig.9 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 10 V	U_R = 16 to 35 V	U_R = 40 to 100 V
50	0.90	0.85	0.80
100	1.00	1.00	1.00
500	1.12	1.20	1.25
1000	1.20	1.30	1.40
3000	1.25	1.35	1.50
≥ 10000	1.30	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} = 85 °C; U_R applied; 2000 hours	$U_R \leq 6.3$ V; $\Delta C/C$: + 15 /– 30 % $U_R > 6.3$ V; $\Delta C/C$: ± 20 % tan $\delta \leq 1.5 \times$ spec. limit $Z \leq 3 \times$ spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 2500 hours	$U_R \leq 6.3$ V; $\Delta C/C$: + 45 /– 50 % $U_R > 6.3$ V; $\Delta C/C$: ± 50 % 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: ≤ 3 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see 'Endurance test' above $I_{L5} \leq 2 \times$ spec. limit

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