



**THE DATASHEET OF
MAL217055102E3**



Aluminum Electrolytic Capacitors Radial Miniature, Low Impedance

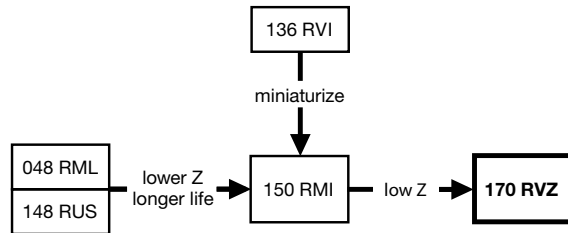
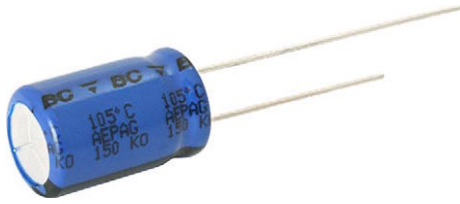


Fig. 1

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes (Ø D x L in mm)	10 x 12 to 18 x 40
Rated capacitance range, C _R	100 µF to 6800 µF
Tolerance on C _R	± 20 %
Rated voltage range, U _R	10 V to 63 V
Category temperature range	-40 °C to +105 °C
Endurance test at 105 °C	3000 h to 6000 h
Useful life at 105 °C	4000 h to 10 000 h
Useful life at 40 °C, 1.8 x I _R applied	200 000 h to 500 000 h
Shelf life at 0 V, 105 °C	1000 h
Based on sectional specification	IEC 60384-4 / EN130300
Climatic category IEC 60068	55 / 105 / 56

FEATURES

- Very long useful life: 4000 h to 10 000 h at 105 °C, high stability, high reliability
- Very low impedance and low ESR in smaller case sizes than the 150 RMI series
- Excellent ripple current capability
- AEC-Q200 qualified
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue sleeve
- Charge and discharge proof
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


RoHS
COMPLIANT

APPLICATIONS

- Power supplies (SMPS, DC/DC converters) for general industrial, EDP, audio-video, automotive, and telecommunications
- Smoothing, filtering, buffering

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 (170)

SELECTION CHART FOR C _R , U _R , AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)						
C _R (µF)	U _R (V)					
	10	16	25	35	50	63
100	-	-	-	-	-	10 x 12
150	-	-	-	-	10 x 12	10 x 16
220	-	-	-	-	10 x 16	10 x 20
	-	-	-	10 x 12	-	-
330	-	-	10 x 12	10 x 16	10 x 20	12.5 x 20
470	-	-	10 x 16	10 x 20	12.5 x 20	12.5 x 25
	-	10 x 12	-	-	-	16 x 20
680	10 x 12	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 20
	-	-	-	-	-	16 x 25
1000	10 x 16	10 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31
	-	-	-	16 x 20	-	-
1200	-	-	-	-	16 x 31	-
1500	-	12.5 x 20	12.5 x 25	16 x 20	16 x 31	-
2200	12.5 x 20	12.5 x 25	16 x 20	16 x 31	-	18 x 40
3300	12.5 x 25	16 x 20	16 x 31	18 x 31	18 x 40	-
4700	16 x 25	16 x 31	16 x 35	18 x 40	-	-
6800	16 x 31	16 x 35	18 x 40	-	-	-
8200	-	18 x 40	-	-	-	-

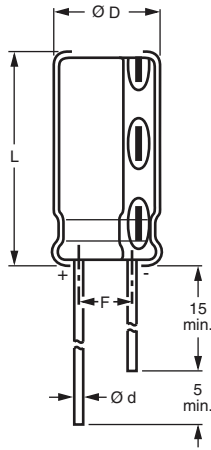
DIMENSIONS in millimeters AND AVAILABLE FORMS


Fig. 2 - Form CA: Long leads

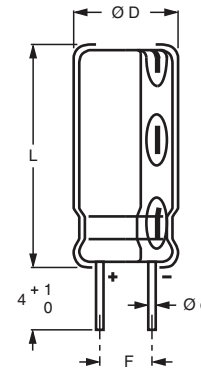


Fig. 3 - Form CB: Cut leads

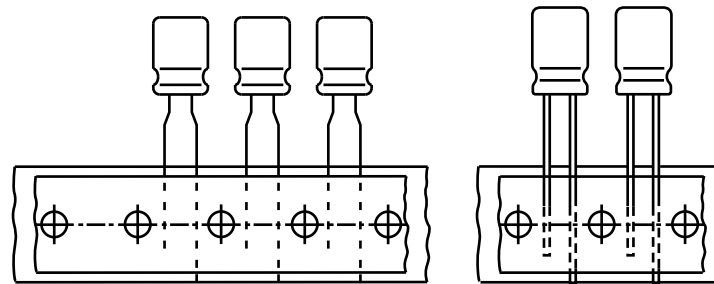

 Formed leads for $\text{Ø } D = 8 \text{ mm}$ with pitch $F = 5 \text{ mm}$

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

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE $\text{Ø } D \times L$	CASE CODE	$\text{Ø } d$	$\text{Ø } D_{\text{max.}}$	$L_{\text{max.}}$	F	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 x 20	19a	0.8	16.5	22.0	7.5 ± 0.5	≈ 6.0	250	250	250
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.0	100	100	-
18 x 31	1831	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	100	100	-
18 x 40	1840	0.8	18.5	42.5	7.5 ± 0.5	≈ 16.5	100	100	-



ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	Rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	Rated RMS ripple current at 100 kHz, 105 °C
I_{L2}	Max. leakage current after 2 min at U_R
$\tan \delta$	Max. dissipation factor at 100 Hz
Z	Max. impedance at 100 kHz

Note

- Unless otherwise specified, all electrical values in Table 2 apply at $T_{amb} = 20\text{ °C}$, $P = 86\text{ kPa}$ 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 x L (mm)	I_R 100 kHz 105 °C (mA)	I_{L2} 2 min (μA)	$\tan \delta$ 100 Hz	Z 100 kHz +20 °C (Ω)	Z 100 kHz -40 °C (Ω)	ORDERING CODE MAL2170.....		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
10	680	10 x 12	770	71	0.19	0.092	0.660	54681E3	64681E3	34681E3
	1000	10 x 16	1100	103	0.19	0.062	0.450	54102E3	64102E3	34102E3
	2200	12.5 x 20	1760	223	0.21	0.033	0.240	54222E3	64222E3	34222E3
	3300	12.5 x 25	2200	333	0.21	0.027	0.190	54332E3	64332E3	34332E3
	4700	16 x 25	2630	473	0.23	0.020	0.140	54472E3	64472E3	34472E3
	6800	16 x 31	3300	683	0.25	0.017	0.120	54682E3	64682E3	34682E3
16	470	10 x 12	770	78	0.16	0.092	0.660	55471E3	65471E3	35471E3
	680	10 x 16	1100	112	0.16	0.062	0.450	55681E3	65681E3	35681E3
	1000	10 x 20	1260	163	0.16	0.046	0.330	55102E3	65102E3	35102E3
	1500	12.5 x 20	1760	243	0.16	0.033	0.240	55152E3	65152E3	35152E3
	2200	12.5 x 25	2200	355	0.18	0.027	0.190	55222E3	65222E3	35222E3
	3300	16 x 20	2100	531	0.20	0.020	0.140	55332E3	65332E3	35332E3
	4700	16 x 31	3300	755	0.22	0.017	0.120	55472E3	65472E3	35472E3
	6800	16 x 35	3550	1091	0.24	0.017	0.120	55682E3	65682E3	-
8200	18 x 40	3800	1315	0.28	0.017	0.120	55822E3	65822E3	-	
25	330	10 x 12	770	86	0.14	0.092	0.660	56331E3	66331E3	36331E3
	470	10 x 16	1100	121	0.14	0.062	0.450	56471E3	66471E3	36471E3
	680	10 x 20	1260	173	0.14	0.046	0.330	56681E3	66681E3	36681E3
	1000	12.5 x 20	1760	253	0.14	0.033	0.240	56102E3	66102E3	36102E3
	1500	12.5 x 25	2200	378	0.14	0.027	0.190	56152E3	66152E3	36152E3
	2200	16 x 20	2100	553	0.16	0.020	0.140	56222E3	66222E3	36222E3
	3300	16 x 31	3300	828	0.16	0.017	0.120	56332E3	66332E3	36332E3
	4700	16 x 35	3550	1178	0.18	0.017	0.120	56472E3	66472E3	-
6800	18 x 40	3800	1703	0.22	0.017	0.120	56682E3	66682E3	-	
35	220	10 x 12	770	80	0.12	0.092	0.660	50221E3	60221E3	30221E3
	330	10 x 16	1100	118	0.12	0.062	0.450	50331E3	60331E3	30331E3
	470	10 x 20	1260	167	0.12	0.046	0.330	50471E3	60471E3	30471E3
	680	12.5 x 20	1760	241	0.12	0.033	0.240	50681E3	60681E3	30681E3
	1000	12.5 x 25	2200	353	0.12	0.027	0.190	50102E3	60102E3	30102E3
	1000	16 x 20	2100	353	0.12	0.020	0.140	90105E3	90106E3	90103E3
	1500	16 x 20	2100	528	0.12	0.020	0.140	50152E3	60152E3	30152E3
	2200	16 x 31	3300	773	0.14	0.017	0.120	50222E3	60222E3	30222E3
	3300	18 x 31	3300	1155	0.16	0.017	0.120	50332E3	60332E3	-
	4700	18 x 40	3700	1648	0.18	0.017	0.120	50472E3	60472E3	-



ELECTRICAL DATA AND ORDERING INFORMATION										
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE Ø D x L (mm)	I _R 100 kHz 105 °C (mA)	I _{L2} 2 min (μA)	tan δ 100 Hz	Z 100 kHz +20 °C (Ω)	Z 100 kHz -40 °C (Ω)	ORDERING CODE MAL2170.....		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
50	150	10 x 12	560	78	0.10	0.155	1.300	51151E3	61151E3	31151E3
	220	10 x 16	900	113	0.10	0.114	0.820	51221E3	61221E3	31221E3
	330	10 x 20	1000	168	0.10	0.086	0.620	51331E3	61331E3	31331E3
	470	12.5 x 20	1320	238	0.10	0.059	0.420	51471E3	61471E3	31471E3
	680	12.5 x 25	1550	343	0.10	0.045	0.320	51681E3	61681E3	31681E3
	1000	16 x 25	2100	503	0.10	0.031	0.220	51102E3	61102E3	31102E3
	1200	16 x 31	2550	603	0.10	0.025	0.180	51122E3	61122E3	31122E3
	1500	16 x 31	2550	753	0.10	0.025	0.180	51152E3	61152E3	31152E3
63	3300	18 x 40	3380	1653	0.14	0.022	0.160	51332E3	61332E3	-
	100	10 x 12	445	66	0.10	0.260	1.860	58101E3	68101E3	38101E3
	150	10 x 16	615	97	0.10	0.181	1.290	58151E3	68151E3	38151E3
	220	10 x 20	770	141	0.10	0.140	1.010	58221E3	68221E3	38221E3
	330	12.5 x 20	1115	211	0.10	0.072	0.520	58331E3	68331E3	38331E3
	470	12.5 x 25	1320	299	0.10	0.064	0.460	58471E3	68471E3	38471E3
	470	16 x 20	1200	299	0.10	0.071	0.510	98475E3	98476E3	98473E3
	680	16 x 20	1200	431	0.10	0.071	0.510	58681E3	68681E3	38681E3
	680	16 x 25	1800	431	0.10	0.048	0.350	98685E3	98686E3	98683E3
	1000	16 x 31	2200	633	0.10	0.040	0.290	58102E3	68102E3	38102E3
	2200	18 x 40	3260	1389	0.12	0.031	0.220	58222E3	68222E3	-

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 2 min at U _R	$I_{L2} \leq 0.01 C_R \times U_R + 3 \mu A$
Inductance		
Equivalent series inductance (ESL)	Case Ø D ≤ 10 mm	Typ. 16 nH
	Case Ø D ≥ 12.5 mm	Typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan δ _{max} and C _R (see Table 2)	$ESR = \tan \delta / 2 \pi f C_R$

CAPACITANCE (C)

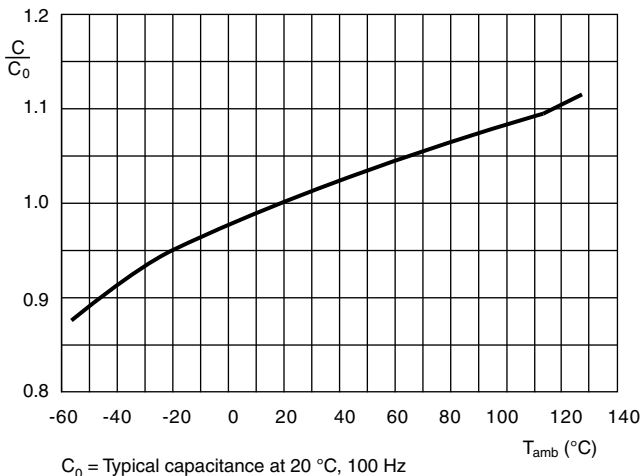


Fig. 5 - Typical multiplier of capacitance as a function of ambient temperature

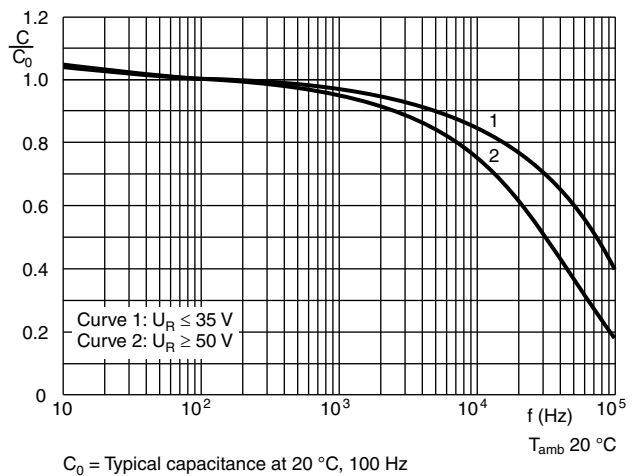


Fig. 6 - Typical multiplier of capacitance as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)

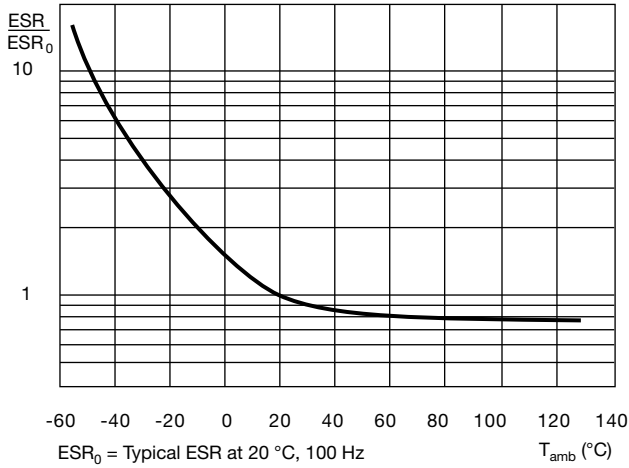


Fig. 7 - Typical multiplier of ESR as a function of ambient temperature

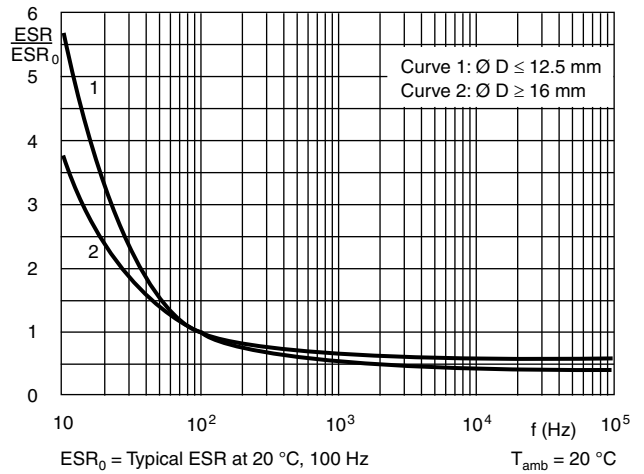


Fig. 8 - Typical multiplier of ESR as a function of frequency

IMPEDANCE (Z)

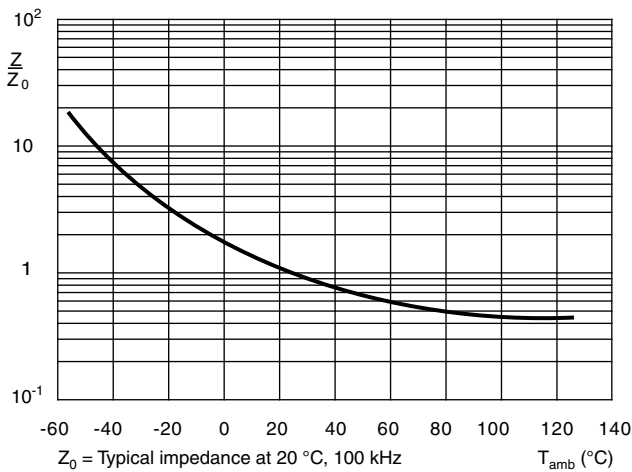


Fig. 9 - Typical multiplier of impedance as a function of ambient temperature

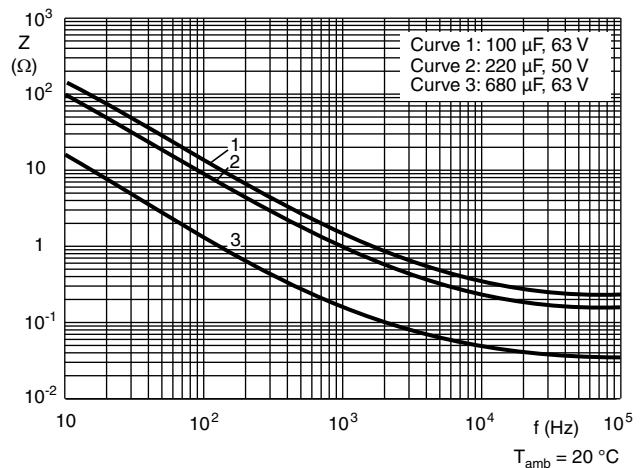


Fig. 10 - Typical impedance as a function of frequency

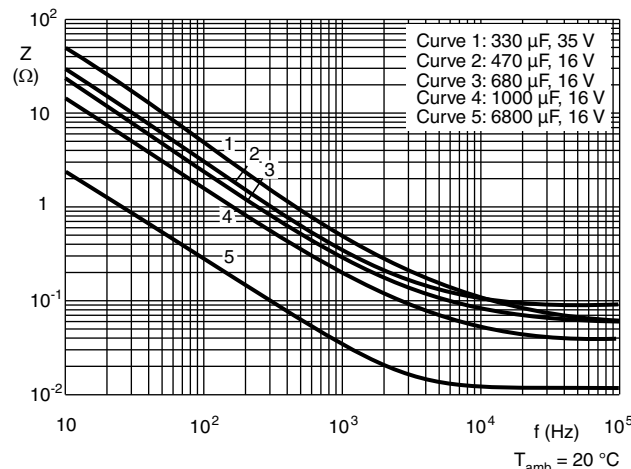


Fig. 11 - Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE

Table 3

ENDURANCE TEST DURATION AND USEFUL LIFE			
NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	ENDURANCE AT 105 °C (h)	USEFUL LIFE AT 105 °C (h)
10 x 12	14	3000	4000
10 x 16	15	3000	6000
10 x 20	16	3000	6000
12.5 x 20	17	3000	7000
12.5 x 25	18	5000	8000
16 x 20	19a	3000	7000
16 x 25	19	5000	10 000
16 x 31	20	5000	10 000
16 x 35	21	5000	10 000
18 x 31	1831	6000	10 000
18 x 40	1840	8000	10 000

Note

- Multiplier of useful life code: CCC206

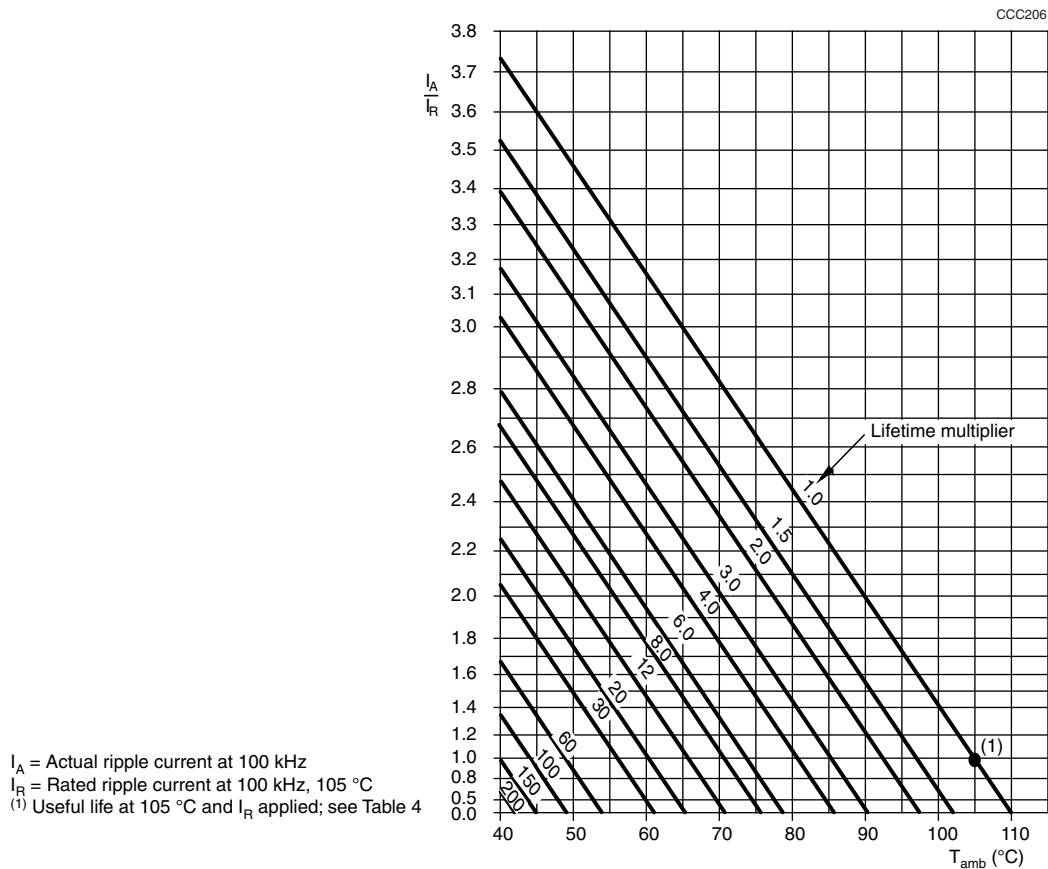


Fig. 12 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY							
NOMINAL CASE SIZE Ø D x L (mm)	FREQUENCY (Hz)						
	100	300	1000	3000	10 000	30 000	100 000
	I_R MULTIPLIER						
10 x 12	0.65	0.76	0.85	0.89	0.90	0.97	1.00
10 x 16	0.65	0.76	0.85	0.89	0.90	0.97	1.00
10 x 20	0.65	0.76	0.85	0.89	0.90	0.97	1.00
12.5 x 20	0.65	0.76	0.85	0.89	0.90	0.97	1.00
12.5 x 25	0.65	0.76	0.85	0.89	0.90	0.97	1.00
16 x 20	0.76	0.85	0.91	0.94	0.96	0.98	1.00
16 x 25	0.76	0.85	0.91	0.94	0.96	0.98	1.00
16 x 31	0.76	0.85	0.91	0.94	0.96	0.98	1.00
16 x 35	0.76	0.85	0.91	0.94	0.96	0.98	1.00
18 x 31	0.76	0.85	0.91	0.94	0.96	0.98	1.00
18 x 40	0.76	0.85	0.91	0.94	0.96	0.98	1.00

Table 5

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; for test duration see Table 3	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ °C}$; U_R and I_R applied; for test duration see Table 3	$\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4 / EN130300 subclause 4.17	$T_{amb} = 105\text{ °C}$; no voltage applied; 1000 h after test: U_R to be applied for 30 min., 24 h to 48 h before measurement	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$

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