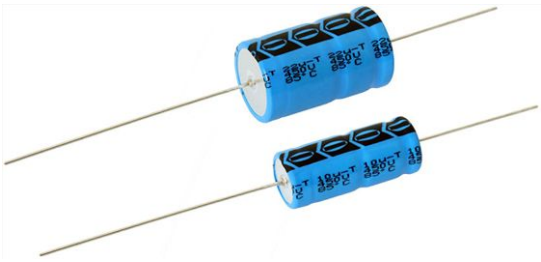
Aluminum Electrolytic Capacitors
Axial Standard



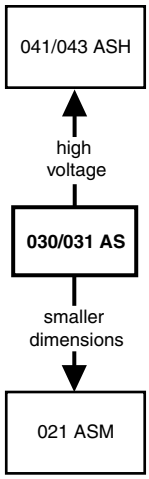


Fig. 1

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Taped version available for automatic insertion
- Charge and discharge proof
- Useful life: 3000 h at 85 °C
- Standard dimensions
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS COMPLIANT

APPLICATIONS

- General purpose and industrial, automotive, telecommunication, audio-video
- Coupling, decoupling, timing, smoothing, filtering, buffering in SMPS
- Boards with restricted mounting height, vibration, and shock resistant

MARKING

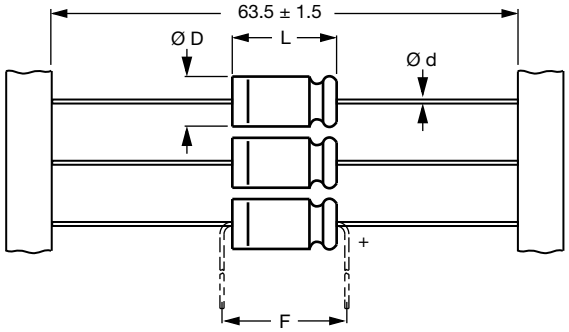
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (T for -10 % to +50 %)
- Rated voltage (in V)
- Date code in accordance with IEC 60062
- Code factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (030 or 031)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	4.5 x 10 to 10 x 25
Rated capacitance range, C_R	1 µF to 1000 µF
Tolerance on C_R	-10 % to +50 %
Rated voltage, U_R	6.3 V to 100 V
Category temperature range	-40 °C to +85 °C
Endurance test at 85 °C	2000 h
Useful life at 85 °C	3000 h
Useful life at 40 °C, 1.4 x I_R applied	80 000 h
Shelf life at 0 V, 85 °C	500 h
Based on sectional specification	IEC 60384-4 / EN130300
Climatic category IEC 60068	40 / 085 / 56

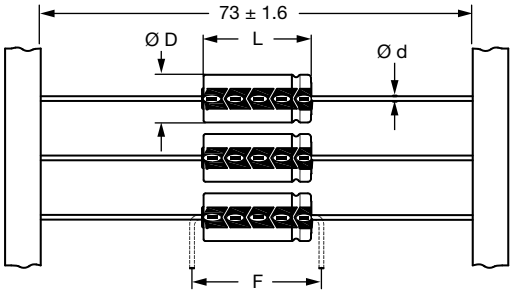
SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)							
C_R (µF)	U_R (V)						
	6.3	10	16	25	40	63	100
1.0	-	-	-	-	-	4.5 x 10	4.5 x 10
2.2	-	-	-	-	-	4.5 x 10	4.5 x 10
3.3	-	-	-	-	-	4.5 x 10	4.5 x 10
4.7	-	-	-	-	-	4.5 x 10	6 x 10
6.8	-	-	-	-	-	4.5 x 10	6 x 10
10	-	-	-	4.5 x 10	4.5 x 10	6 x 10	8 x 11
	-	-	-	-	-	-	6.5 x 18
15	-	-	-	-	4.5 x 10	6 x 10	-
22	-	-	-	4.5 x 10	6 x 10	8 x 11	8 x 18
	-	-	-	-	-	6.5 x 18	-
33	-	-	4.5 x 10	-	6 x 10	-	10 x 18
47	-	4.5 x 10	-	6 x 10	8 x 11	8 x 18	10 x 25
	-	-	-	-	6.5 x 18	-	-
68	4.5 x 10	-	6 x 10	-	-	10 x 18	-
100	-	6 x 10	-	8 x 11	8 x 18	10 x 25	-
	-	-	-	6.5 x 18	-	-	-
150	6 x 10	-	8 x 11	8 x 18	10 x 18	-	-
	-	-	6.5 x 18	-	-	-	-
220	-	8 x 11	8 x 18	10 x 18	10 x 25	-	-
	-	6.5 x 18	-	-	-	-	-
330	-	8 x 18	10 x 18	10 x 25	-	-	-
470	8 x 18	10 x 18	10 x 25	-	-	-	-
680	10 x 18	10 x 25	-	-	-	-	-
1000	10 x 25	-	-	-	-	-	-

DIMENSIONS in millimeters AND AVAILABLE FORMS



Form BR: Taped on reel
Form BA: Taped in box (ammopack)
Case Ø D x L = 4.5 mm x 10 mm to 8 mm x 11 mm

Fig. 2 - **Forms BA** and **BR**



Form BR: Taped on reel
Case Ø D x L = 6.5 mm x 18 mm to 15 mm x 30 mm
Form BA: Taped in box (ammopack)
Case Ø D x L = 6.5 mm x 18 mm to 10 mm x 25 mm

Fig. 3 - **Forms BA** and **BR**

Table 1

AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES								
NOMINAL CASE SIZE Ø D x L	CASE CODE	AXIAL FORM BA AND BR				MASS (g)	PACKAGING QUANTITIES	
		Ø d	Ø $D_{max.}$	$L_{max.}$	$F_{min.}$		FORM BA	FORM BR
4.5 x 10	2	0.6	5.0	10.5	15	≈ 0.5	1000	3000
6 x 10	3	0.6	6.3	10.5	15	≈ 0.7	1000	1000
8 x 11	5a	0.6	8.5	11.5	15	≈ 1.1	500	500
6.5 x 18	4	0.8	6.9	18.5	25	≈ 1.3	1000	1000
8 x 18	5	0.8	8.5	18.5	25	≈ 1.7	500	500
10 x 18	6	0.8	10.5	18.5	25	≈ 2.5	500	500
10 x 25	7	0.8	10.5	25.0	30	≈ 3.3	500	500

Note

- Detailed tape dimensions see section “PACKAGING”

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	Rated capacitance at 100 Hz, tolerance -10 % to +50 %
I_R	Rated RMS ripple current at 100 Hz, 85 °C
I_{L1}	Max. leakage current after 1 min at U_R
I_{L5}	Max. leakage current after 5 min at U_R
tan δ	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

Note

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

ORDERING EXAMPLE

Electrolytic capacitor 031 series

330 µF / 10 V; -10 % / +50 %

Nominal case size: Ø 8 mm x 18 mm; form BA

Ordering code: MAL203134331E3

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION											
U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2.....	
										TAPED ON REEL FORM BR	TAPED IN BOX FORM BA
6.3	68	4.5 x 10	2	75	22	5.9	0.25	5.86	2.90	03023689E3	03033689E3
	150	6 x 10	3	120	10	6.9	0.25	2.66	1.30	03023151E3	03033151E3
	470	8 x 18	5	330	22	11	0.25	0.85	0.43	03123471E3	03133471E3
	680	10 x 18	6	430	30	14	0.25	0.59	0.29	03123681E3	03133681E3
	1000	10 x 25	7	560	42	18	0.25	0.40	0.20	03123102E3	03133102E3
10	47	4.5 x 10	2	70	24	5.9	0.20	6.78	3.40	03024479E3	03034479E3
	100	6 x 10	3	110	10	7.0	0.20	3.19	1.60	03024101E3	03034101E3
	220	8 x 11	5a	210	18	9.4	0.20	1.45	0.73	03024221E3	03034221E3
	220	6.5 x 18	4	210	18	9.4	0.20	1.45	0.73	03124221E3	03134221E3
	330	8 x 18	5	310	24	12	0.20	0.97	0.48	03124331E3	03134331E3
	470	10 x 18	6	410	33	14	0.20	0.68	0.34	03124471E3	03134471E3
	680	10 x 25	7	510	45	19	0.20	0.47	0.24	03124681E3	03134681E3
16	33	4.5 x 10	2	65	27	6.1	0.16	7.72	3.60	03025339E3	03035339E3
	68	6 x 10	3	110	11	7.2	0.16	3.75	1.80	03025689E3	03035689E3
	150	8 x 11	5a	200	19	9.8	0.16	1.70	0.80	03025151E3	03035151E3
	150	6.5 x 18	4	200	19	9.8	0.16	1.70	0.80	03125151E3	03135151E3
	220	8 x 18	5	270	26	12	0.16	1.16	0.55	03125221E3	03135221E3
	330	10 x 18	6	410	36	16	0.16	0.78	0.36	03125331E3	03135331E3
	470	10 x 25	7	480	49	20	0.16	0.55	0.26	03125471E3	03135471E3
25	10	4.5 x 10	2	50	13	5.5	0.14	22.3	9.00	03026109E3	03036109E3
	22	4.5 x 10	2	60	28	6.1	0.14	10.2	4.10	03026229E3	03036229E3
	47	6 x 10	3	100	12	7.4	0.14	4.80	1.90	03026479E3	03036479E3
	100	8 x 11	5a	160	19	10	0.14	2.23	0.90	03026101E3	03036101E3
	100	6.5 x 18	4	160	19	10	0.14	2.23	0.90	03126101E3	03136101E3
	150	8 x 18	5	240	27	13	0.14	1.49	0.60	03126151E3	03136151E3
	220	10 x 18	6	350	37	16	0.14	1.02	0.41	03126221E3	03136221E3
	330	10 x 25	7	460	54	22	0.14	0.68	0.27	03126331E3	03136331E3

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	I_R 100 Hz 85 °C (mA)	I_{L1} 1 min (µA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2.....	
										TAPED ON REEL FORM BR	TAPED IN BOX FORM BA
40	10	4.5 x 10	2	50	20	5.8	0.11	17.6	7.00	03027109E3	03037109E3
	15	4.5 x 10	2	55	30	6.2	0.11	11.7	4.70	03027159E3	03037159E3
	22	6 x 10	3	75	9	6.8	0.11	8.00	3.20	03027229E3	03037229E3
	33	6 x 10	3	95	12	7.7	0.11	5.31	2.10	03027339E3	03037339E3
	47	8 x 11	5a	150	16	8.8	0.11	3.73	1.50	03027479E3	03037479E3
	47	6.5 x 18	4	150	16	8.8	0.11	3.73	1.50	03127479E3	03137479E3
	100	8 x 18	5	220	28	13	0.11	1.75	0.70	03127101E3	03137101E3
	150	10 x 18	6	300	40	17	0.11	1.17	0.47	03127151E3	03137151E3
	220	10 x 25	7	430	57	23	0.11	0.80	0.32	03127221E3	03137221E3
63	1.0	4.5 x 10	2	13	5	5.1	0.09	143	55.0	03028108E3	03038108E3
	2.2	4.5 x 10	2	25	7	5.3	0.09	65.2	25.0	03028228E3	03038228E3
	3.3	4.5 x 10	2	35	11	5.4	0.09	46.5	17.0	03028338E3	03038338E3
	4.7	4.5 x 10	2	40	15	5.6	0.09	30.5	12.0	03028478E3	03038478E3
	6.8	4.5 x 10	2	46	22	5.9	0.09	21.1	8.10	03028688E3	03038688E3
	10	6 x 10	3	70	7	6.3	0.08	12.8	5.50	03028109E3	03038109E3
	15	6 x 10	3	79	10	6.9	0.08	8.50	3.70	03028159E3	03038159E3
	22	8 x 11	5a	110	13	7.8	0.08	5.79	2.50	03028229E3	03038229E3
	22	6.5 x 18	4	110	13	7.8	0.08	5.79	2.50	03128229E3	03138229E3
	47	8 x 18	5	190	22	11	0.08	2.71	1.20	03128479E3	03138479E3
	68	10 x 18	6	250	30	14	0.08	1.88	0.81	03128689E3	03138689E3
	100	10 x 25	7	300	42	18	0.08	1.28	0.55	03128101E3	03138101E3
100	1.0	4.5 x 10	2	20	5	4.6	0.08	128	45.0	03029108E3	03039108E3
	2.2	4.5 x 10	2	30	11	5.3	0.08	57.9	21.0	03029228E3	03039228E3
	3.3	4.5 x 10	2	40	17	6.0	0.08	38.6	14.0	03029338E3	03039338E3
	4.7	6 x 10	3	50	13	6.8	0.07	23.7	9.60	03029478E3	03039478E3
	6.8	6 x 10	3	70	18	8.0	0.07	16.4	6.60	03029688E3	03039688E3
	10	8 x 11	5a	90	24	10	0.07	11.2	4.50	03029109E3	03039109E3
	10	6.5 x 18	4	90	24	10	0.07	11.2	4.50	03129109E3	03139109E3
	22	8 x 18	5	120	48	18	0.07	5.07	2.10	03129229E3	03139229E3
	33	10 x 18	6	200	70	24	0.07	3.38	1.40	03129339E3	03139339E3
	47	10 x 25	7	260	98	33	0.07	2.37	0.96	03129479E3	03139479E3

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 min at U_R: Case Ø D x L = 4.5 mm x 10 mm Case Ø D x L = 6 mm x 10 mm to 10 mm x 25 mm U_R = 100 V	 $I_{L1} \leq 0.05\ C_R \times U_R$ or 5 µA, whichever is greater I_{L1} for CV ≤ 1000: ≤ $0.01\ C_R \times U_R$ or 1 µA, whichever is greater I_{L1} for CV > 1000: ≤ $0.006\ C_R \times U_R$ + 4 µA $I_{L1} = 0.02\ C_R \times U_R$ + 4 µA
	After 5 min: U_R = 6.3 V to 63 V U_R = 100 V	 $I_{L5} \leq 0.002\ C_R \times U_R$ + 5 µA $I_{L5} \leq 0.006\ C_R \times U_R$ + 4 µA
Inductance		
Equivalent series inductance (ESL)	Case Ø D x L mm: 4.5 x 10 6 x 10 8 x 11 6.5 x 18 8 x 18 10 x 18 10 x 25	 typ. 10 nH typ. 22 nH typ. 85 nH typ. 25 nH typ. 40 nH typ. 61 nH typ. 38 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)

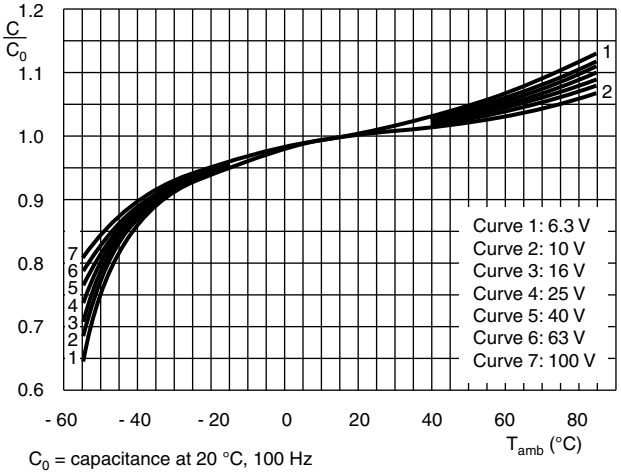


Fig. 4 - Typical multiplier of capacitance as a function of ambient temperature

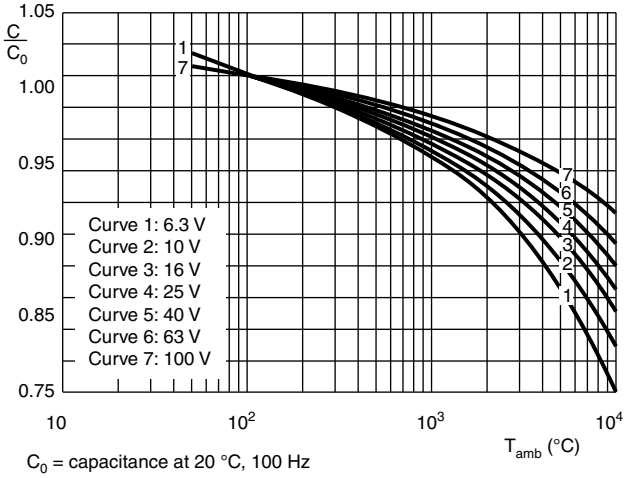


Fig. 5 - Typical multiplier of capacitance as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)

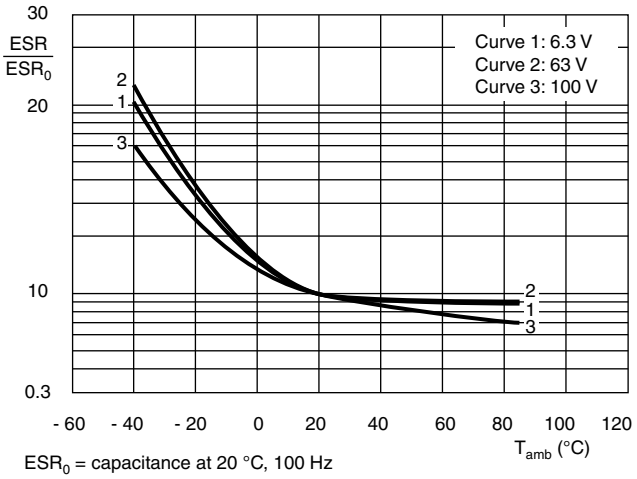


Fig. 6 - Typical multiplier of ESR as a function of ambient temperature

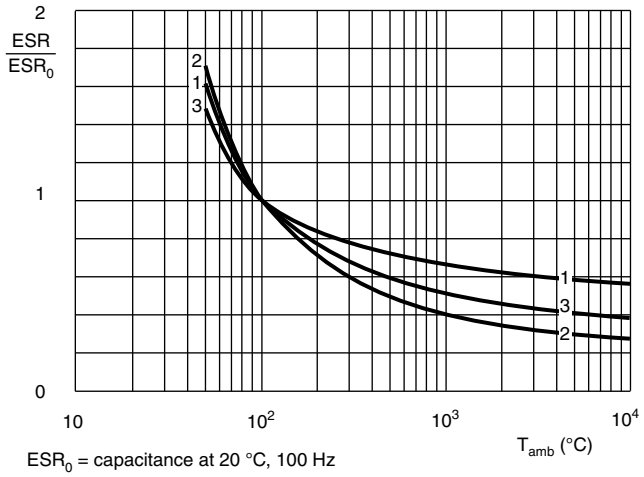


Fig. 7 - Typical multiplier of ESR as a function of frequency

IMPEDANCE (Z)

Table 3

IMPEDANCE VS. CAPACITANCE VALUES AT 10 kHz							
T_{amb}	$Z \times C_R$ (Ω x µF)						
	6.3 V	10 V	16 V	25 V	40 V	63 V	100 V
+20 °C	≤ 200	≤ 160	≤ 120	≤ 90	≤ 70	≤ 55	≤ 45
-25 °C	≤ 1200	≤ 750	≤ 560	≤ 400	≤ 300	≤ 180	≤ 130
-40 °C	≤ 3200	≤ 2000	≤ 1500	≤ 1100	≤ 900	≤ 500	≤ 350

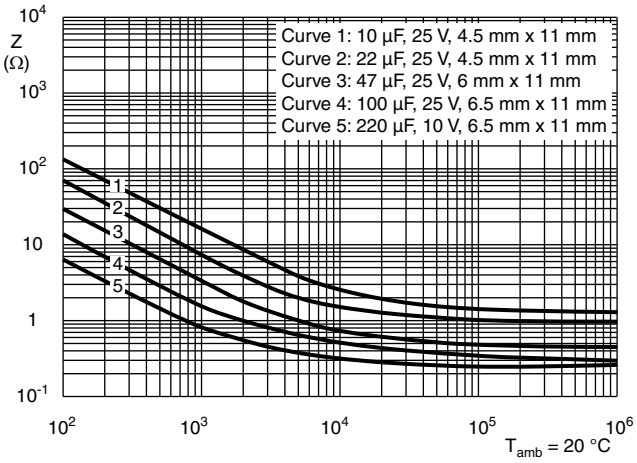


Fig. 8 - Typical impedance as a function of frequency

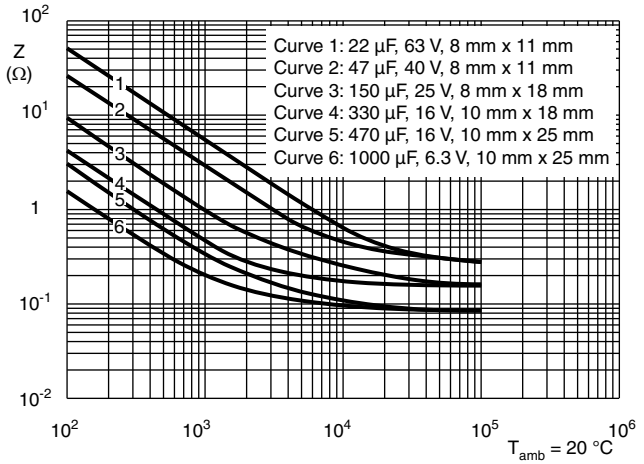


Fig. 9 - Typical impedance as a function of frequency

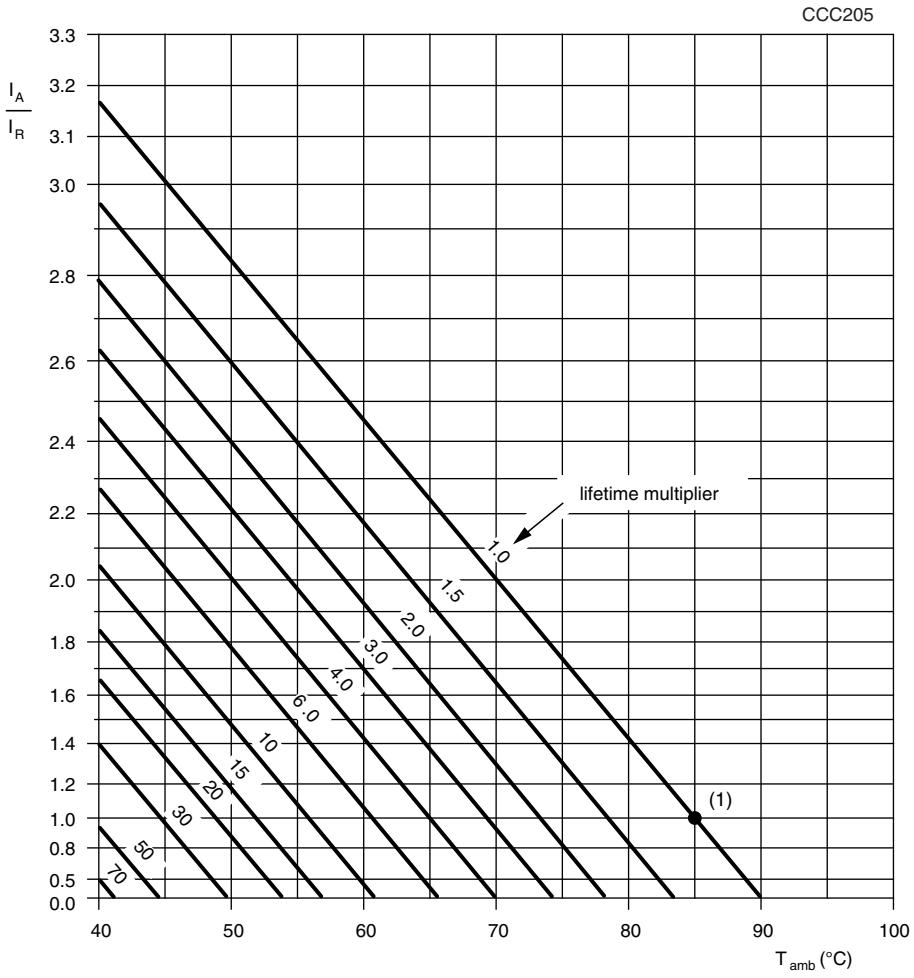
RIPPLE CURRENT AND USEFUL LIFE

Table 4

ENDURANCE TEST DURATION AND USEFUL LIFE	
ENDURANCE AT 85 °C (h)	USEFUL LIFE AT 85 °C (h)
2000	3000

Note

- Multiplier of useful life code: CCC205



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:
case Ø D x L = 4.5 mm x 10 mm to
10 mm x 25 mm: 3000 h

Fig. 10 - 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						
U_R (V)	FREQUENCY (Hz)					
	50	100	300	1000	3000	≥ 10 000
	I_R MULTIPLIER					
6.3	0.95	1.00	1.07	1.12	1.15	1.20
10	0.95	1.00	1.07	1.12	1.15	1.20
16	0.90	1.00	1.12	1.20	1.25	1.30
25	0.90	1.00	1.12	1.20	1.25	1.30
40	0.85	1.00	1.20	1.30	1.35	1.40
63	0.85	1.00	1.20	1.30	1.35	1.40
100	0.85	1.00	1.20	1.30	1.35	1.40

Table 6

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Case Ø D x L = 4.5 mm x 10 mm to 10 mm x 25 mm			
Endurance	IEC 384-4 / EN130300 subclause 4.13	T_{amb} = 85 °C; U_R applied; 2000 h	$U_R \leq$ 6.3 V; ΔC/C: +15 % / -30 % $U_R >$ 6.3 V; ΔC/C: ± 15 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit $I_L \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 3000 h	$U_R \leq$ 6.3 V; ΔC/C: +45 % / -50 % $U_R >$ 6.3 V; ΔC/C: ± 45 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit $I_L \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 384-4 / EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 h After test: U_R to be applied for 30 min, 24 h to 48 h before measurement	ΔC/C, tan δ, Z: for requirements see “Endurance test” above $I_L \leq$ 2 x spec. limit

Statements about product lifetime are based on calculations and internal testing. They should only be interpreted as estimations. Also due to external factors, the lifetime in the field application may deviate from the calculated lifetime. In general, nothing stated herein shall be construed as a guarantee of durability.

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