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Aluminum Electrolytic Capacitors
Axial Miniature, Long-Life



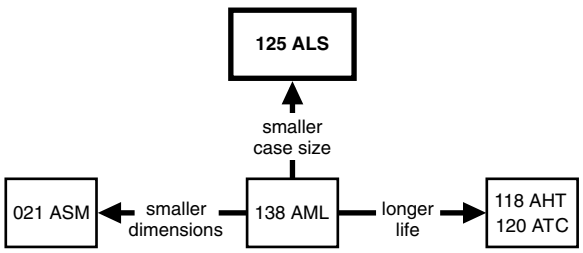


Fig. 1

QUICK REFERENCE DATA		
DESCRIPTION	**VALUE**	
Nominal case sizes (Ø D x L in mm)	6.5 x 18 to 10 x 25	10 x 30 to 21 x 38
Rated capacitance range, C_R	47 µF to 18 000 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	5000 h
Useful life at 105 °C	5000 h	10 000 h
Useful life at 40 °C, I_R applied	1.3 x I_R applied: 200 000 h	1.8 x I_R applied: 500 000 h
Shelf life at 0 V, 105 °C	500 h	
Based on sectional specification	IEC 60384-4 / EN130 300	
Climatic category IEC 60068	40 / 105 / 56	

FEATURES

AUTOMOTIVE GRADE

Pb-free

RoHS COMPLIANT

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not available in insulated form
- Taped versions up to case Ø 15 mm x 30 mm available for automatic insertion
- Charge and discharge proof
- Long useful life: 5000 h to 10 000 h at 105 °C, high reliability
- High ripple current capability
- Miniaturized, high CV-product per unit volume
- AEC-Q200 qualified
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

APPLICATIONS

- Industrial, automotive, EDP and telecommunication
- Smoothing, filtering, buffering in SMPS; coupling, decoupling, timing
- Portable and mobile equipment (small size, low mass)
- Stand-by applications
- Low mounting height boards, 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 (M for ± 20 %)
- Rated voltage (in V)
- Upper category temperature (105 °C)
- Date code, in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (125)

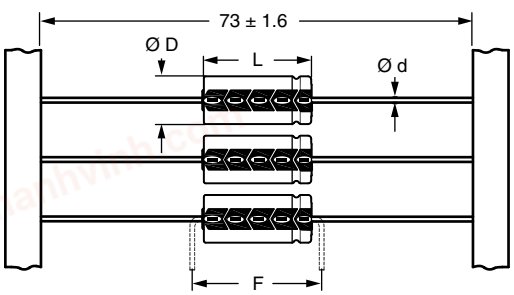
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SELECTION CHART FOR C_R, U_R, AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)					
C_R (µF)	U_R (V)				
	10	16	25	40	63
47	-	-	-	-	6.5 x 18
82	-	-	-	6.5 x 18	-
100	-	-	-	-	8 x 18
120	-	-	-	-	10 x 18
150	-	-	-	8 x 18	-
180	-	-	6.5 x 18	10 x 18	10 x 25
220	-	-	-	-	10 x 30
270	-	-	-	10 x 25	-
330	-	6.5 x 18	-	-	-
390	-	-	10 x 18	10 x 30	-
470	6.5 x 18	-	-	-	12.5 x 30
560	-	8 x 18	-	-	-
680	-	-	-	-	15 x 30
820	8 x 18	-	10 x 25	12.5 x 30	-
1000	10 x 18	10 x 18	10 x 30	15 x 30	18 x 30
1200	-	10 x 25	-	-	-
1500	10 x 25	-	-	18 x 30	18 x 38
1800	-	10 x 30	-	-	-
2200	10 x 30	-	12.5 x 30	18 x 38	21 x 38
2700	-	12.5 x 30	15 x 30	-	-
3300	-	15 x 30	-	21 x 38	-
3900	12.5 x 30	-	18 x 30	-	-
4700	15 x 30	-	-	-	-
5600	-	18 x 30	-	-	-
6800	-	18 x 30	18 x 38	-	-
8200	18 x 30	-	21 x 38	-	-
10 000	-	18 x 38	-	-	-
12 000	18 x 38	-	-	-	-
15 000	-	21 x 38	-	-	-
18 000	21 x 38	-	-	-	-

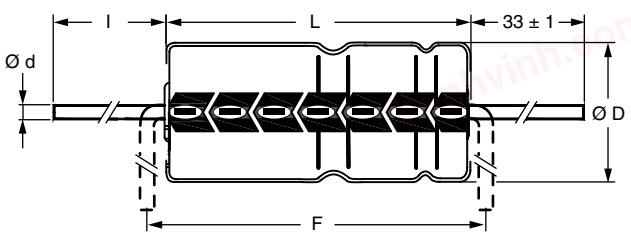
DIMENSIONS in millimeters AND AVAILABLE FORMS



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



Form AA: Axial in box
Case Ø D x L = 10 mm x 30 mm to 21 mm x 38 mm

Fig. 3 - **Form AA**

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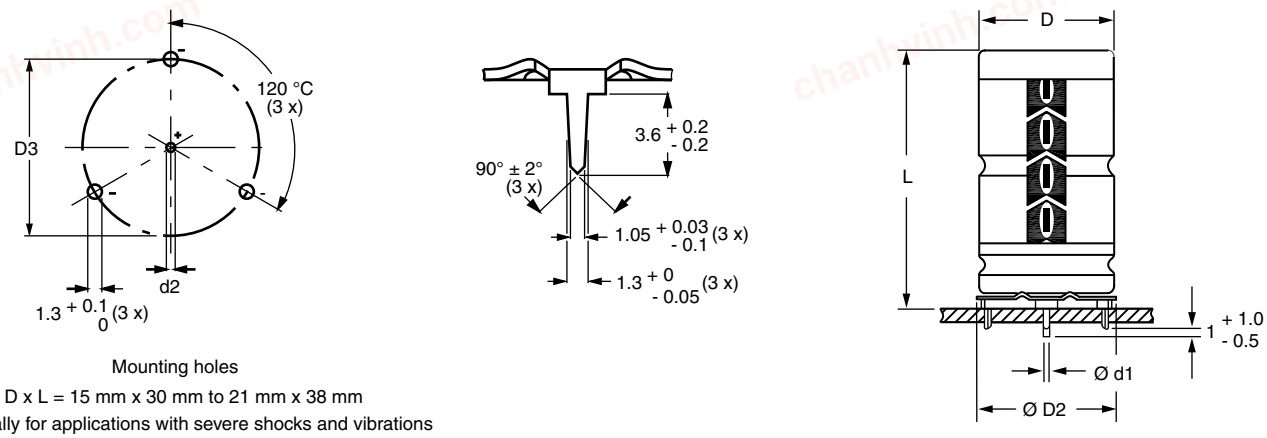
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Table 1

AXIAL; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**										
NOMINAL CASE SIZE Ø D x L (mm)	**CASE CODE**	**AXIAL: FORM AA, BA, AND BR**					**MASS (g)**	**PACKAGING QUANTITIES**		
		Ø d	**l**	**Ø $D_{max.}$**	**$L_{max.}$**	**$F_{min.}$**		**FORM AA**	**FORM BA**	**FORM BR**
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	25.5	30	≈ 3.3	-	500	500
10 x 30	00	0.8	55 ± 1	10.5	30.5	35	≈ 4.8	340	-	500
12.5 x 30	01	0.8	55 ± 1	13.0	30.5	35	≈ 7.4	260	-	400
15 x 30	02	0.8	55 ± 1	15.5	30.5	35	≈ 11.7	200	-	250
18 x 30	03	0.8	55 ± 1	18.5	30.5	35	≈ 12.9	120	-	-
18 x 38	04	0.8	34 ± 1	18.5	39.5	44	≈ 19.0	125	-	-
21 x 38	05	0.8	34 ± 1	21.5	39.5	44	≈ 24.0	100	-	-

Note

- For detailed tape dimensions refer to packaging information: www.vishay.com/doc?28361



Mounting holes
Case Ø D x L = 15 mm x 30 mm to 21 mm x 38 mm
Especially for applications with severe shocks and vibrations

Fig. 4 - Mounting hole diagram and outline; **Form MR:** With mounting ring and pins

Table 2

MOUNTING RING; DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**MOUNTING RING: FORM MR**						**MASS (g)**	**PACKAGING QUANTITIES**
		Ø d1	**Ø d2**	**$D_{max.}$**	**Ø $D2_{max.}$**	**D3**	**$L_{max.}$**		
15 x 30	02	0.8	1.0 + 0.4	15.5	17.5	16.5 ± 0.2	33	≈ 11.7	200
18 x 30	03	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	33	≈ 12.9	240
18 x 38	04	0.8	1.0 + 0.4	18.5	19.5	18.5 ± 0.2	42	≈ 19.0	100
21 x 38	05	0.8	1.0 + 0.4	21.5	22.5	21.5 ± 0.2	42	≈ 24.0	100

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ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	Rated capacitance at 100 Hz, tolerance ± 20 %
I_R	Rated RMS ripple current at 100 Hz, 105 °C
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 or 100 kHz

Note

- Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %.

ORDERING EXAMPLE

Electrolytic capacitor 125 series
470 µF / 10 V; ± 20 %
Nominal case size: Ø 6.5 mm x 18 mm; Form BA
Ordering code: MAL212534471E3

Table 3

ELECTRICAL DATA AND ORDERING INFORMATION											
U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2125.....			
								IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
10	470	6.5 x 18	190	29	0.24	0.564	0.91	-	24471E3	34471E3	-
	820	8 x 18	300	37	0.24	0.308	0.43	-	24821E3	34821E3	-
	1000	10 x 18	420	40	0.26	0.292	0.35	-	24102E3	34102E3	-
	1500	10 x 25	520	50	0.26	0.195	0.2	-	24152E3	34152E3	-
	2200	10 x 30	670	64	0.24	0.145	0.26	14222E3	24222E3	-	-
	3900	12.5 x 30	890	98	0.26	0.088	0.19	14392E3	24392E3	-	-
	4700	15 x 30	1140	114	0.28	0.079	0.13	14472E3	24472E3	-	44472E3
	8200	18 x 30	1450	192	0.36	0.056	0.11	14822E3	-	-	44822E3
	12 000	18 x 38	1880	260	0.44	0.049	0.074	14123E3	-	-	44123E3
	18 000	21 x 38	2200	380	0.56	0.041	0.058	14183E3	-	-	44183E3
16	330	6.5 x 18	180	31	0.20	0.643	1.25	-	25331E3	35331E3	-
	560	8 x 18	230	38	0.20	0.379	0.73	-	25561E3	35561E3	-
	1000	10 x 18	330	52	0.22	0.239	0.34	-	25102E3	35102E3	-
	1200	10 x 25	490	58	0.22	0.199	0.3	-	25122E3	35122E3	-
	1800	10 x 30	630	78	0.18	0.133	0.27	15182E3	25182E3	-	-
	2700	12.5 x 30	860	106	0.20	0.098	0.19	15272E3	25272E3	-	-
	3300	15 x 30	1090	126	0.22	0.088	0.14	15332E3	25332E3	-	45332E3
	5600	18 x 30	1420	199	0.26	0.062	0.1	15562E3	-	-	45562E3
	6800	18 x 30	1480	238	0.28	0.055	0.1	15682E3	-	-	45682E3
	10 000	18 x 38	1930	340	0.36	0.048	0.062	15103E3	-	-	45103E3
	15 000	21 x 38	2100	500	0.46	0.041	0.057	15153E3	-	-	45153E3
25	180	6.5 x 18	160	29	0.18	1.032	1.2	-	26181E3	36181E3	-
	390	10 x 18	270	40	0.18	0.476	0.55	-	26391E3	36391E3	-
	820	10 x 25	440	61	0.18	0.226	0.26	-	26821E3	36821E3	-
	1000	10 x 30	580	70	0.16	0.212	0.26	16102E3	26102E3	-	-
	2200	12.5 x 30	790	130	0.18	0.109	0.18	16222E3	26222E3	-	-
	2700	15 x 30	1320	155	0.18	0.088	0.13	16272E3	26272E3	-	46272E3
	3900	18 x 30	1720	215	0.20	0.068	0.1	16392E3	-	-	46392E3
	6800	18 x 38	1840	360	0.26	0.051	0.071	16682E3	-	-	46682E3
	8200	21 x 38	2100	450	0.30	0.046	0.058	16822E3	-	-	46822E3

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ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L5} 5 min (µA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	ORDERING CODE MAL2125.....			
								IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR
40	82	6.5 x 18	120	27	0.10	1.617	2.1	-	27829E3	37829E3	-
	150	8 x 18	180	32	0.10	0.884	1.2	-	27151E3	37151E3	-
	180	10 x 18	250	34	0.10	0.737	0.615	-	27181E3	37181E3	-
	270	10 x 25	350	42	0.10	0.474	0.41	-	27271E3	37271E3	-
	390	10 x 30	490	51	0.10	0.34	0.32	17391E3	27391E3	-	-
	820	12.5 x 30	750	81	0.10	0.175	0.18	17821E3	27821E3	-	-
	1000	15 x 30	970	100	0.12	0.159	0.12	17102E3	27102E3	-	47102E3
	1500	18 x 30	1250	140	0.12	0.106	0.098	17152E3	-	-	47152E3
	2200	18 x 38	1640	196	0.14	0.084	0.069	17222E3	-	-	47222E3
	3300	21 x 38	1810	284	0.16	0.064	0.061	17332E3	-	-	47332E3
63	47	6.5 x 18	100	26	0.08	2.258	3.6	-	28479E3	38479E3	-
	100	8 x 18	150	33	0.08	1.061	1.7	-	28101E3	38101E3	-
	120	10 x 18	240	35	0.08	0.884	1.2	-	28121E3	38121E3	-
	180	10 x 25	280	43	0.08	0.589	0.8	-	28181E3	38181E3	-
	220	10 x 30	410	48	0.08	0.482	0.44	18221E3	28221E3	-	-
	470	12.5 x 30	660	79	0.08	0.226	0.31	18471E3	28471E3	-	-
	680	15 x 30	860	106	0.08	0.156	0.16	18681E3	28681E3	-	48681E3
	1000	18 x 30	1130	146	0.10	0.133	0.12	18102E3	-	-	48102E3
	1500	18 x 38	1460	209	0.10	0.088	0.086	18152E3	-	-	48152E3
	2200	21 x 38	1680	297	0.12	0.072	0.072	18222E3	-	-	48222E3

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
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	$I_{L1} \leq 0.006\ C_R \times U_R + 20$ µA	
	After 5 min at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 20$ µA	
Inductance			
Equivalent series inductance (ESL)	Case Ø D x L mm:		
	6.5 x 18	Typ. 15 nH	-
	8 x 18	Typ. 35 nH	-
	10 x 18	Typ. 69 nH	-
	10 x 25	Typ. 38 nH	-
	10 x 30	Typ. 38 nH	-
	12.5 x 30	Typ. 46 nH	-
	15 x 30	Typ. 48 nH	Typ. 39 nH
	18 x 30	Typ. 50 nH	Typ. 39 nH
	18 x 38	Typ. 54 nH	Typ. 39 nH
	21 x 38	Typ. 59 nH	Typ. 39 nH

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CAPACITANCE (C)

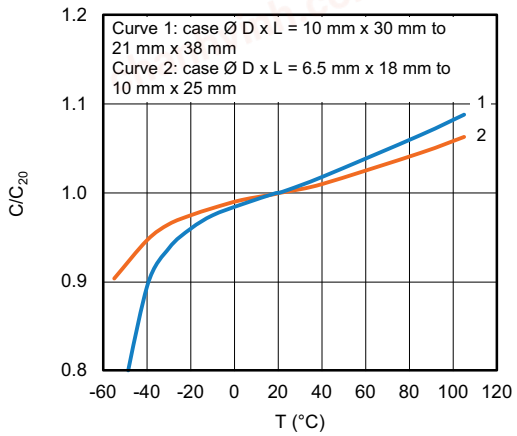


Fig. 5 - Typical multiplier of capacitance as a function of ambient temperature (C_{20} = capacitance at 20 °C, 100 Hz)

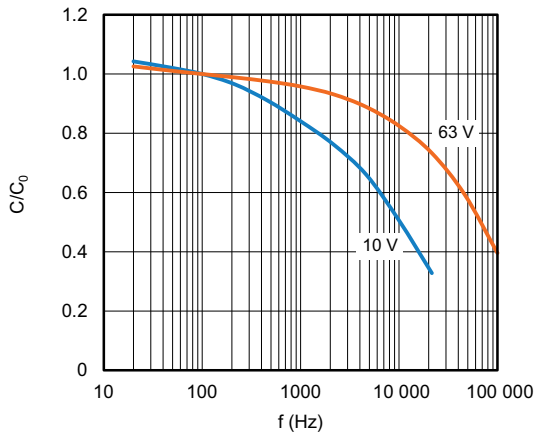


Fig. 6 - Typical multiplier of capacitance as a function of frequency (C_0 = typical capacitance at 100 Hz at 20 °C)

EQUIVALENT SERIES RESISTANCE (ESR)

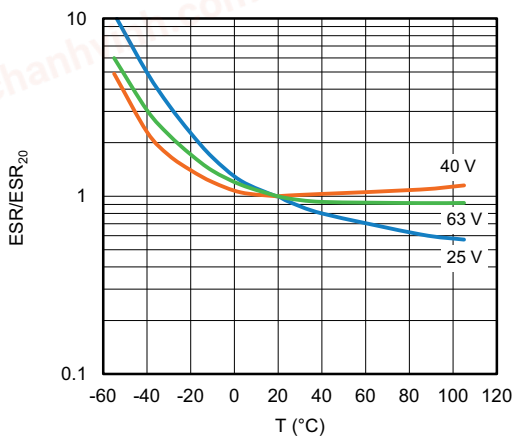


Fig. 7 - Typical multiplier of ESR as a function of ambient temperature (ESR_{20} = typical ESR at 100 Hz at 20 °C)

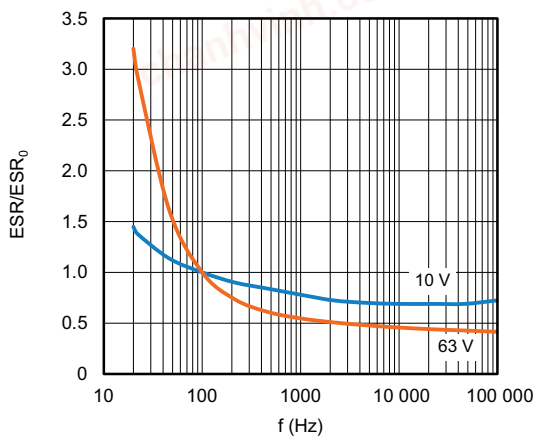


Fig. 8 - Typical multiplier of ESR as a function of frequency (ESR_0 = typical ESR at 100 Hz at 20 °C)

IMPEDANCE (Z)

Table 4

IMPEDANCE VS. CAPACITANCE VALUES (Case Ø D x L = 6.5 mm x 18 mm to 10 mm x 25 mm)					
T_{amb}	**Z x C_R (Ω x µF) AT 10 kHz**				
	10 V	**16 V**	**25 V**	**40 V**	**63 V**
+20 °C	≤ 200	≤ 160	≤ 120	≤ 90	≤ 80
-25 °C	≤ 1200	≤ 750	≤ 560	≤ 450	≤ 550
-40 °C	≤ 3200	≤ 2000	≤ 1500	≤ 1200	≤ 1500

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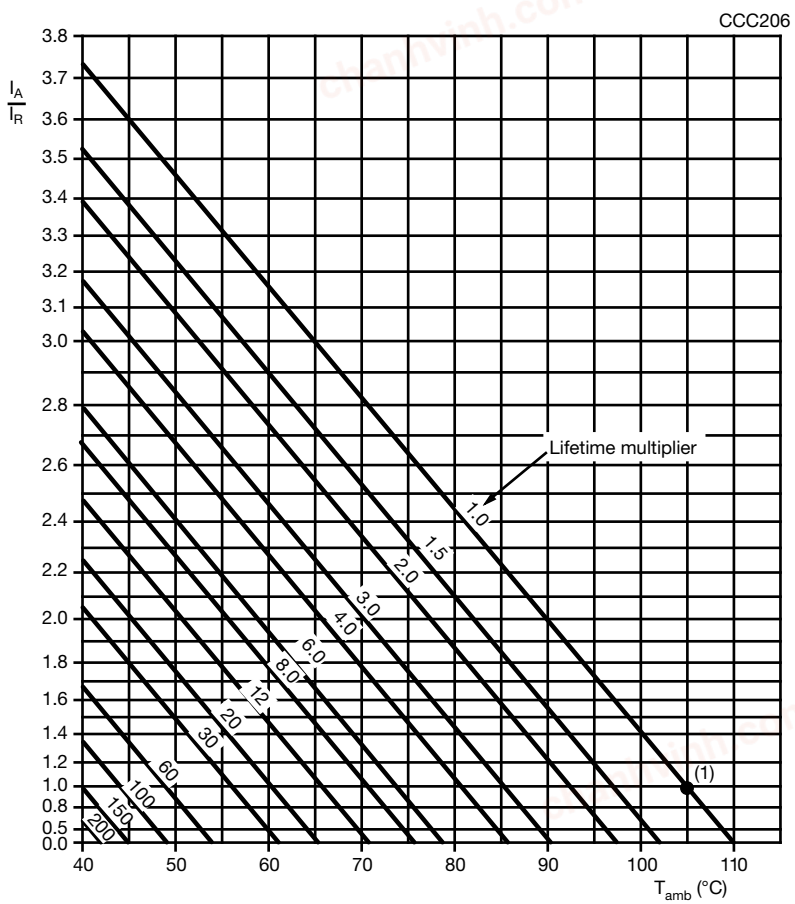
RIPPLE CURRENT AND USEFUL LIFE

Table 5

ENDURANCE TEST DURATION AND USEFUL LIFE		
NOMINAL CASE SIZE Ø D x L (mm)	ENDURANCE AT 105 °C (h)	USEFUL LIFE AT 105 °C (h)
6.5 x 18	3000	5000
8 x 18	3000	5000
10 x 18	3000	5000
10 x 25	3000	5000
10 x 30	5000	10 000
12.5 x 30	5000	10 000
15 x 30	5000	10 000
18 x 30	5000	10 000
18 x 38	5000	10 000
21 x 38	5000	10 000

Note

- Multiplier of useful life code: CCC206



I_A = actual ripple current at 100 Hz
I_R = rated ripple current at 100 Hz, 105 °C

(1) Useful life at 105 °C and I_R applied:
Case Ø D x L = 6.5 mm x 18 mm to 10 mm x 25 mm: 5000 h
Case Ø D x L = 10 mm x 30 mm to 21 mm x 38 mm: 10 000 h

Fig. 9 - Multiplier of useful life as a function of ambient temperature and ripple current load

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Table 6

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					
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

Table 7

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 Ø D x L: 6.5 mm x 18 mm to 10 mm x 25 mm: 3000 h; 10 mm x 30 mm to 21 mm x 38 mm: 5000 h	$U_R \leq 10$ V; ΔC/C: +15 % / -30 % $U_R > 10$ V; ΔC/C: ± 15 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; Case Ø D x L: 6.5 mm x 18 mm to 10 mm x 25 mm: 5000 h; 10 mm x 30 mm to 21 mm x 38 mm: 10 000 h	$U_R \leq 10$ V; ΔC/C: +45 % / -50 % $U_R > 10$ V; ΔC/C: ± 45 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_{L5} ≤ spec. limit no short 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; 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 $I_{L5} \leq 2$ 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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