Aluminum Electrolytic Capacitors, Power High Ripple Current, Screw Terminals

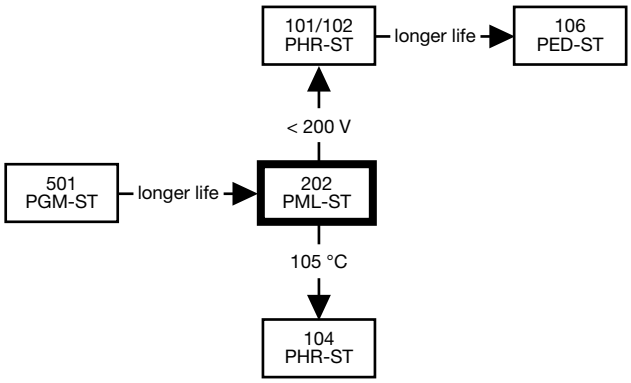

Fig. 1

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case size (Ø D x L in mm)	35 x 60 to 90 x 220
Rated capacitance range, C_R	330 µF to 56 000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	200 V to 450 V
Category temperature range	-40 °C to +85 °C
Endurance test at 85 °C	2000 h
Useful life at 85 °C	10 000 h
Shelf life at 0 V, 85 °C	1000 h
Based on sectional specification	IEC 60384-4 / EN 130300
Climatic category IEC 60068	40 / 085 / 56

FEATURES

Pb-free

RoHS COMPLIANT

- Long useful life: 10 000 h at +85 °C
- Low ESR in smaller case sizes compared to the 102 PHR-ST series
- Available in case sizes up to Ø 90 mm x 220 mm
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, cylindrical aluminum case, insulated with a blue sleeve
- Pressure relief in the terminal disc
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

APPLICATIONS

- Buffering and filtering
- Motor drives, inverters, UPS, and traction systems
- Pulsed power supplies
- Energy storage
- Welding
- Wind turbines
- X-ray equipment

MARKING

The capacitors are marked 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
- Name of manufacturer
- Code for factory of origin
- "-" sign to identify the negative terminal, visible on the side of the capacitor
- Ordering code (relevant part only)
- Climatic category in accordance with IEC 60068

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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)				
	200	250	350	400	450
330	-	-	-	-	35 x 60
390	-	-	-	35 x 60	-
470	-	-	35 x 60	35 x 60	35 x 80
560	-	-	-	35 x 80	-
680	-	-	35 x 80	-	35 x 105
820	-	-	-	35 x 105	-
1000	-	35 x 80	35 x 105	50 x 80	50 x 105
1200	-	-	-	-	50 x 80
1500	35 x 60	35 x 80	50 x 80	50 x 80	-
1800	-	35 x 105	50 x 80	-	50 x 105
2200	35 x 105	50 x 80	50 x 105	50 x 105	65 x 105
2700	-	-	50 x 105	-	-
3300	50 x 80	50 x 80	65 x 105	65 x 105	65 x 105
3900	50 x 80	-	65 x 105	65 x 105	-
4700	50 x 80	50 x 105	65 x 105	76 x 105	76 x 105
5600	50 x 105	-	-	76 x 105	-
6800	50 x 105	-	76 x 105	76 x 146	76 x 146
8200	-	65 x 105	-	76 x 146	-
10 000	65 x 105	76 x 105	76 x 146	76 x 220	76 x 220
12 000	-	76 x 105	-	76 x 220	90 x 195
15 000	76 x 105	76 x 114	76 x 220	90 x 195	90 x 220
18 000	-	76 x 146	-	90 x 220	-
22 000	76 x 146	90 x 146	90 x 220	-	-
33 000	76 x 220	76 x 220	-	-	-
39 000	76 x 220	90 x 220	-	-	-
47 000	90 x 195	-	-	-	-
56 000	90 x 220	-	-	-	-

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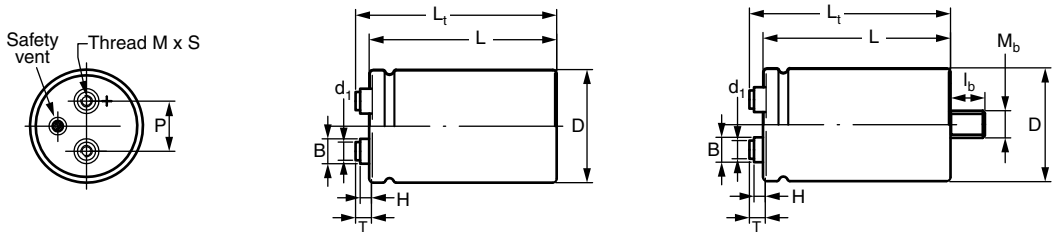
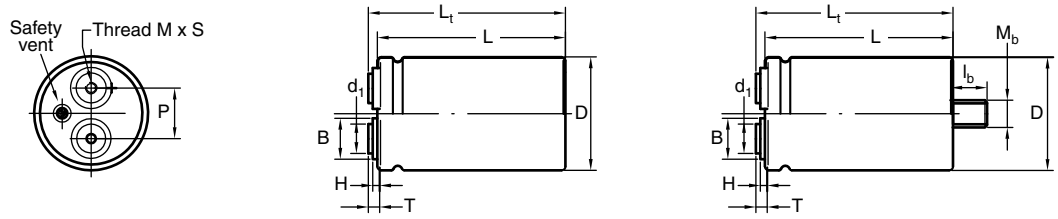
DIMENSIONS in millimeters **AND AVAILABLE FORMS**



Standard M5 disc | Clamp mounting (ST) | Threaded stud mounting (STB)

Fig. 2A - Mechanical drawings for standard M5 disc versions.
For details refer to Table 1



High current M6 disc | Clamp mounting (ST) | Threaded stud mounting (STB)

Fig. 2B - Mechanical drawings for high current M6 disc versions.
For details refer to Table 1

Notes

- Maximum permissible torque which may be applied to the termination screws: 2 Nm for M5; 2.5 Nm for M6
  For accessories refer to document “Mounting Accessories”, see www.vishay.com/doc?28348
  The capacitors are delivered with screws and washers
- High current disc with 1/4 28 UNF (US) thread is available on request

Table 1

DIMENSIONS in millimeters **AND MASS**														
DESIGN	**DRAWING**	**L ± 1**	**L_t ± 1**	**D ± 1**	**P ± 0.3**	**T ± 0.2**	**H ± 0.3**	**B ± 0.3**	**d_1 ± 0.1**	**M**	**S - 0**	**M_b**	**l_b ± 0.1**	**MASS (g)**
35 x 60	2A	63.3	68.7	35.3	12.8	7	4.6	11	7.9	M5	9.5	M8	12	75
35 x 80	2A	81.3	86.7	35.3	12.8	7	4.6	11	7.9	M5	9.5	M8	12	95
35 x 105	2A	103.3	108.7	35.3	12.8	7	4.6	11	7.9	M5	9.5	M8	12	130
50 x 80	2A	82.8	88.8	51	22.2	7.1	4.8	11	7.9	M5	9.5	M12	16	200
50 x 105	2A	104.8	110.8	51	22.2	7.1	4.8	11	7.9	M5	9.5	M12	16	300
65 x 105	2A	104.8	110.7	65	28.5	7	4.6	11.9	7.9	M5	9.5	M12	16	480
65 x 105 HC	2B	104.8	109.2	65	28.5	5.5	3.5	18	13	M6	8.5	M12	16	480
76 x 105	2A	105.8	111.7	76.4	31.8	7	4.6	11.7	7.9	M5	9.5	M12	16	700
76 x 105 HC	2B	105.8	110.2	76.4	31.8	5.5	3.5	18.3	13	M6	8.5	M12	16	700
76 x 114	2A	115.8	121.7	76.4	31.8	7	4.6	11.7	7.9	M5	9.5	M12	16	800
76 x 114 HC	2B	115.8	120.2	76.4	31.8	5.5	3.5	18.3	13	M6	8.5	M12	16	800
76 x 146	2A	145.8	151.7	76.4	31.8	7	4.6	11.7	7.9	M5	9.5	M12	16	1000
76 x 146 HC	2B	145.8	150.2	76.4	31.8	5.5	3.5	18.3	13	M6	8.5	M12	16	1000
76 x 220	2A	219.8	225.7	76.4	31.8	7	4.6	11.7	7.9	M5	9.5	M12	16	1500
76 x 220 HC	2B	219.8	224.2	76.4	31.8	5.5	3.5	18.3	13	M6	8.5	M12	16	1500
90 x 146 HC	2B	150.1	155.4	89.4	31.8	7.9	0	13	13	M6	10	M12	16	1300
90 x 195 HC	2B	192.1	197.4	89.4	31.8	7.9	0	13	13	M6	10	M12	16	1800
90 x 220 HC	2B	218.1	223.4	89.4	31.8	7.9	0	13	13	M6	10	M12	16	2000

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PACKAGING QUANTITIES AND DIMENSIONS in millimeters		
DESIGN	PACKAGING QUANTITIES (units per box)	CARDBOX DIMENSIONS L x W x H
35 x 60	50	377 x 375 x 88
35 x 80	50	377 x 375 x 123
35 x 105	50	377 x 375 x 129
50 x 80	25	377 x 375 x 123
50 x 105	25	377 x 375 x 129
65 x 105	16	377 x 375 x 129
65 x 105 HC	16	377 x 375 x 129
76 x 105	12	377 x 375 x 129
76 x 105 HC	12	377 x 375 x 129
76 x 146	12	377 x 375 x 168
76 x 146 HC	12	377 x 375 x 168
76 x 220	12	377 x 375 x 242
76 x 220 HC	12	377 x 375 x 242
90 x 195 HC	8	377 x 375 x 214
90 x 220 HC	8	377 x 375 x 242

Note

- For bolt version holds:
  H cardbox box: + 10 mm

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_{L5}	Max. leakage current after 5 min at U_R
ESR	Max. equivalent series resistance at 100 Hz
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 202 series

6800 µF / 400 V; ± 20 %

Nominal case size: Ø 76 mm x 146 mm;
ST version, standard M5 disc

Ordering code: MAL220216682E3

Table 2

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 85 °C (A)	I_{L5} 5 min (mA)	ESR TYP. 100 Hz (mΩ)	ESR MAX. 100 Hz (mΩ)	Z MAX. 10 kHz (mΩ)	STANDARD M5 DISC		HIGH CURRENT M6 DISC	
								ST ORDERING CODE MAL2202.....	STB ORDERING CODE MAL2202.....	ST ORDERING CODE MAL2202.....	STB ORDERING CODE MAL2202.....
200	1500	35 x 60	4.86	0.60	54	82	54	12152E3	52152E3	-	-
	2200	35 x 105	6.85	0.88	36	55	35	12222E3	52222E3	-	-
	3300	50 x 80	9.68	1.32	26	40	26	12332E3	52332E3	-	-
	3900	50 x 80	10.2	1.56	23	35	24	12392E3	52392E3	-	-
	4700	50 x 80	10.7	1.88	20	31	22	12472E3	52472E3	-	-
	5600	50 x 105	12.4	2.24	17	26	19	12562E3	52562E3	-	-
	6800	50 x 105	13.0	2.72	15	23	17	12682E3	52682E3	-	-
	10 000	65 x 105	17.8	4.00	11	17	13	12103E3	52103E3	32103E3	72103E3
	15 000	76 x 105	24.3	6.00	7	11	8	12153E3	52153E3	32153E3	72153E3
	22 000	76 x 146	29.5	8.80	5	8	6	12223E3	52223E3	32223E3	72223E3
	33 000	76 x 220	38.9	13.2	4	6	5	12333E3	52333E3	32333E3	72333E3
	39 000	76 x 220	39.4	15.6	3	5	4	12393E3	52393E3	32393E3	72393E3
	47 000	90 x 195	46.9	18.8	3	5	4	-	-	32473E3	72473E3
	56 000	90 x 220	49.6	22.4	2	4	4	-	-	32563E3	72563E3

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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 85 °C (A)	I_{L5} 5 min (mA)	ESR TYP. 100 Hz (mΩ)	ESR MAX. 100 Hz (mΩ)	Z MAX. 10 kHz (mΩ)	STANDARD M5 DISC		HIGH CURRENT M6 DISC	
								ST ORDERING CODE MAL2202.....	STB ORDERING CODE MAL2202.....	ST ORDERING CODE MAL2202.....	STB ORDERING CODE MAL2202.....
250	1000	35 x 80	4.62	0.50	64	98	59	13102E3	53102E3	-	-
	1500	35 x 80	5.57	0.75	48	73	46	13152E3	53152E3	-	-
	1800	35 x 105	6.43	0.90	40	61	37	13182E3	53182E3	-	-
	2200	50 x 80	8.20	1.10	33	34	33	13222E3	53222E3	-	-
	3300	50 x 80	9.70	1.65	24	37	24	13332E3	53332E3	-	-
	4700	50 x 105	11.8	2.35	18	28	19	13472E3	53472E3	-	-
	8200	65 x 105	18.0	4.10	10	16	11	13822E3	53822E3	33822E3	73822E3
	10 000	76 x 105	21.5	5.00	9	14	10	13103E3	53103E3	33103E3	73103E3
	12 000	76 x 105	23.9	6.00	7	11	8	13123E3	53123E3	33123E3	73123E3
	15 000	76 x 114	26.2	7.50	6	10	8	13153E3	53153E3	33153E3	73153E3
	18 000	76 x 146	29.3	9.00	5	8	6	13183E3	53183E3	33183E3	73183E3
	22 000	90 x 146	34.5	11.0	4	7	5	-	-	33223E3	73223E3
	33 000	76 x 220	37.9	16.5	3	5	4	13333E3	53333E3	33333E3	73333E3
	39 000	90 x 220	46.2	19.5	3	5	4	-	-	33393E3	73393E3
350	470	35 x 60	3.18	0.33	163	245	163	15471E3	55471E3	-	-
	680	35 x 80	3.99	0.48	114	172	114	15681E3	55681E3	-	-
	1000	35 x 105	5.02	0.70	79	119	80	15102E3	55102E3	-	-
	1500	50 x 80	7.20	1.05	54	82	55	15152E3	55152E3	-	-
	1800	50 x 80	7.73	1.26	46	70	49	15182E3	55182E3	-	-
	2200	50 x 105	8.30	1.54	38	59	42	15222E3	55222E3	-	-
	2700	50 x 105	9.70	1.89	32	49	35	15272E3	55272E3	-	-
	3300	65 x 105	12.0	2.31	27	41	29	15332E3	55332E3	35332E3	75332E3
	3900	65 x 105	13.4	2.73	22	34	24	15392E3	55392E3	35392E3	75392E3
	4700	65 x 105	14.2	3.29	20	31	22	15472E3	55472E3	35472E3	75472E3
	6800	76 x 105	19.6	4.76	13	20	15	15682E3	55682E3	35682E3	75682E3
	10 000	76 x 146	23.4	7.00	9	14	11	15103E3	55103E3	35103E3	75103E3
	15 000	76 x 220	29.4	10.5	6	10	8	15153E3	55153E3	35153E3	75153E3
	22 000	90 x 220	38.2	15.4	5	8	6	-	-	35223E3	75223E3
400	390	35 x 60	2.95	0.31	181	272	175	16391E3	56391E3	-	-
	470	35 x 60	2.98	0.38	161	241	166	16471E3	56471E3	-	-
	560	35 x 80	3.70	0.45	127	191	123	16561E3	56561E3	-	-
	820	35 x 105	4.65	0.66	88	133	85	16821E3	56821E3	-	-
	1000	50 x 80	5.69	0.80	73	112	73	16102E3	56102E3	-	-
	1500	50 x 80	7.24	1.20	51	77	51	16152E3	56152E3	-	-
	2200	50 x 105	8.99	1.76	35	53	37	16222E3	56222E3	-	-
	3300	65 x 105	12.6	2.64	24	37	26	16332E3	56332E3	36332E3	76332E3
	3900	65 x 105	13.8	3.12	20	31	20	16392E3	56392E3	36392E3	76392E3
	4700	76 x 105	16.9	3.76	17	26	17	16472E3	56472E3	36472E3	76472E3
	5600	76 x 105	18.4	4.48	14	22	15	16562E3	56562E3	36562E3	76562E3
	6800	76 x 146	20.7	5.44	12	19	13	16682E3	56682E3	36682E3	76682E3
	8200	76 x 146	22.0	6.56	10	16	11	16822E3	56822E3	36822E3	76822E3
	10 000	76 x 220	25.0	8.00	9	14	10	16103E3	56103E3	36103E3	76103E3
	12 000	76 x 220	27.5	9.60	7	11	8	16123E3	56123E3	36123E3	76123E3
	15 000	90 x 195	33.6	12.0	6	10	6	-	-	36153E3	76153E3
	18 000	90 x 220	36.1	14.4	5	8	6	-	-	36183E3	76183E3
450	330	35 x 60	2.69	0.30	221	332	218	17331E3	57331E3	-	-
	470	35 x 80	3.36	0.42	156	235	155	17471E3	57471E3	-	-
	680	35 x 105	4.21	0.61	109	164	109	17681E3	57681E3	-	-
	1000	50 x 105	6.00	0.90	76	116	78	17102E3	57102E3	-	-
	1200	50 x 80	6.50	1.08	64	97	65	17122E3	57122E3	-	-
	1800	50 x 105	8.17	1.62	44	67	46	17182E3	57182E3	-	-
	2200	65 x 105	10.3	1.98	35	55	38	17222E3	57222E3	37222E3	77222E3
	3300	65 x 105	12.8	2.97	24	37	26	17332E3	57332E3	37332E3	77332E3
	4700	76 x 105	16.9	4.23	17	26	19	17472E3	57472E3	37472E3	77472E3
	6800	76 x 146	20.3	6.12	12	19	13	17682E3	57682E3	37682E3	77682E3
	10 000	76 x 220	25.5	9.00	9	14	10	17103E3	57103E3	37103E3	77103E3
	12 000	90 x 195	30.7	10.8	7	11	8	-	-	37123E3	77123E3
	15 000	90 x 220	33.5	13.5	6	10	8	-	-	37153E3	77153E3

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ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage	≤ 250 V versions	$U_S = 1.15 \times U_R$
	≥ 350 V versions	$U_S = 1.1 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 1 min at U_R	$I_{L1} \leq 0.006\ C_R \times U_R$
	After 5 min at U_R	$I_{L5} \leq 0.002\ C_R \times U_R$
Inductance		
Equivalent series inductance (ESL)	Case Ø D = 35 mm	Typ. 13 nH
	Case Ø D = 50 mm	Typ. 16 nH
	Case Ø D = 65 mm	Typ. 19 nH
	Case Ø D = 76 mm	Typ. 20 nH
	Case Ø D = 90 mm	Typ. 21 nH

RIPPLE CURRENT AND USEFUL LIFE

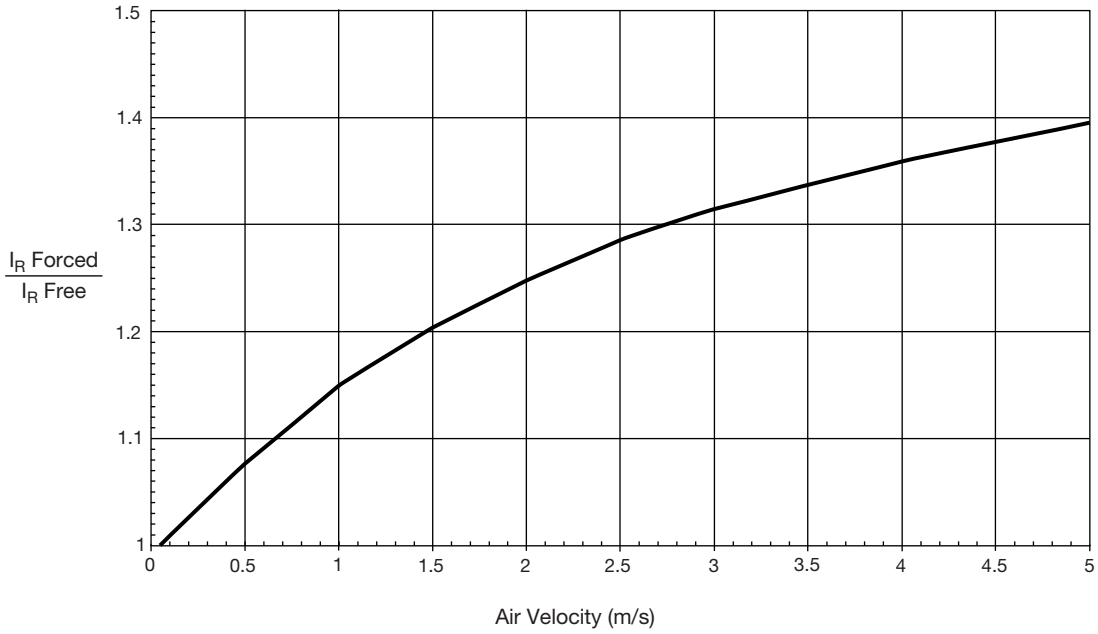

Fig. 3 - Multiplier of ripple current (I_R) as a function of air flow

MAXIMUM RIPPLE CURRENT			
PARAMETER	**CONDITION**	**MAXIMUM RIPPLE CURRENT MULTIPLIER**	**VALUE**
Ambient temperature (T_{amb})	70 °C	From nomogram; see Fig. 4	1.6
Operating frequency (f)	400 Hz	From frequency; see Table 4	1.3
Air flow	2 m/s	From air flow; see Fig. 3	1.25

Note

- Calculation example for 202 PML-ST series. Maximum ripple current multiplier = 1.6 x 1.3 x 1.25 = 2.6

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Table 3

ENDURANCE TEST DURATION AND USEFUL LIFE	
ENDURANCE AT 85 °C (h)	**USEFUL LIFE AT 85 °C (h)**
2000	10 000

Note

- Multiplier of useful life code: CCC205-05

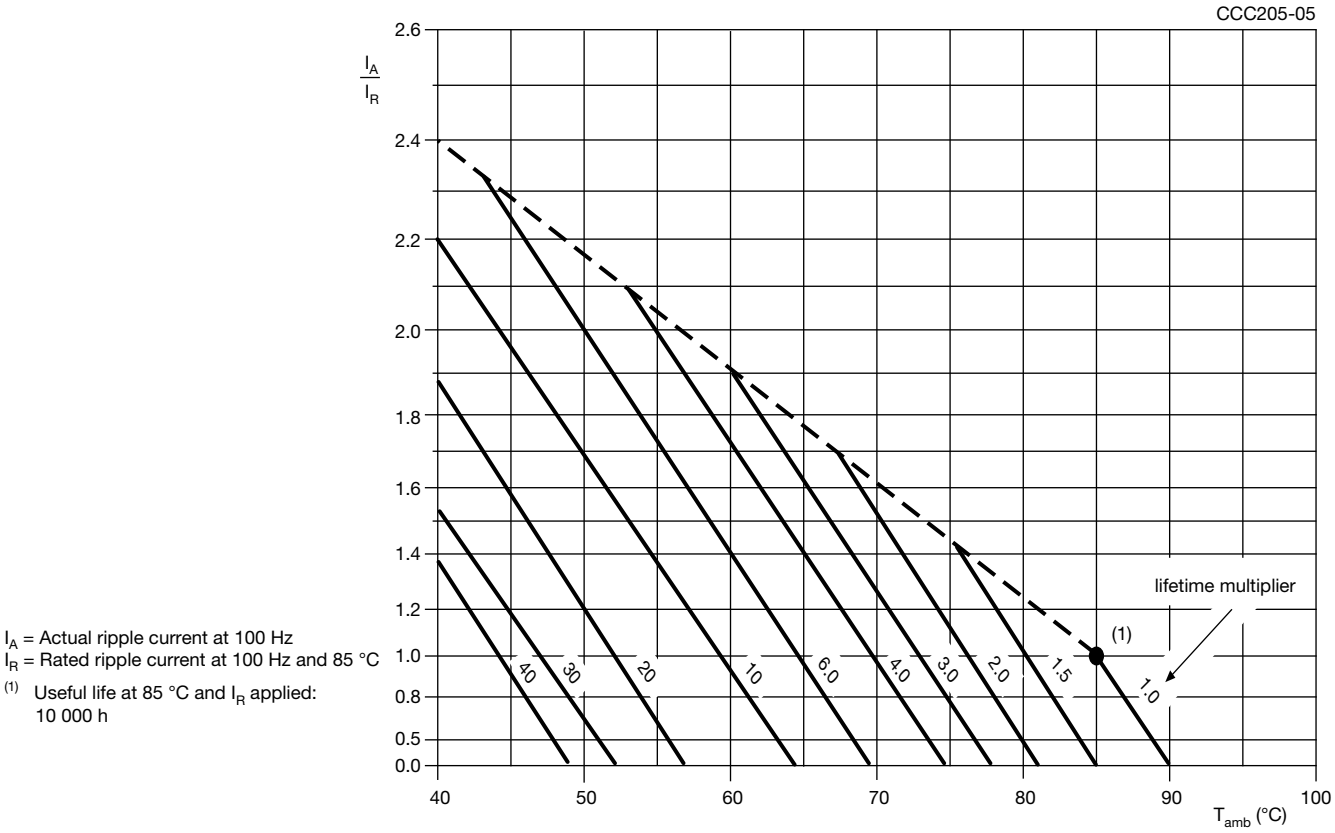

Fig. 4 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY					
FREQUENCY (Hz)					
50	**100**	**200**	**400**	**1000**	**10 000**
I_R MULTIPLIER					
0.80	1.00	1.20	1.30	1.40	1.50

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Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		**PROCEDURE (quick reference)**	**REQUIREMENTS**
NAME OF TEST	**REFERENCE**		
Endurance	IEC 60384-4 / EN 130300 subclause 4.13	T_{amb} = 85 °C; U_R applied; 2000 h	ΔC/C: ± 10 % ESR ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied 10 000 h	ΔC/C: ± 15 % ESR ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_{L5} ≤ spec. limit no short or open circuit, no visible damage Total failure percentage: ≤ 3 %
Shelf life (storage at high temperature)	IEC 60384-4 / EN 130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 1000 h After test: U_R to be applied for 30 min, 24 h to 48 h before measurement	ΔC/C: ± 10 % tan δ ≤ 1.2 x spec. limit I_{L5} ≤ 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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