Aluminum Electrolytic Capacitors, Power High Ripple for Traction, Screw Terminals

FEATURES

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

Pb-free

RoHS COMPLIANT

APPLICATIONS

- Traction (metro / subway, light rail, streetcars / tram)
- Heavy duty applications
- Various industrial applications

MARKING

The capacitors are marked with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (Q for -10 % / +30 %)
- Rated voltage (in V)
- Date code (YYMM or in 2 digits according to IEC 60062)
- Name of manufacturer
- Code for factory of origin
- "-" sign to identify the negative terminal, visible from the top and side of the capacitor
- Code number
- Climatic category in accordance with IEC 60068

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case size (Ø D x L in mm)	76 x 146 to 76 x 220 (1)
Rated capacitance range (E6 series), C_R	6000 µF (1)
Tolerance on C_R	-10 % / +30 %
Rated voltage range, U_R	250 V to 450 V (1)
Category temperature range	-40 °C to +85 °C
Endurance test at 85 °C	2000 h
Useful life at 85 °C	> 10 000 h
Useful life at 70 °C	> 40 000 h
Useful life at 40 °C, 1.4 x I_R applied	> 400 000 h
Shelf life at 0 V, 85 °C	500 h
Based on sectional specification	IEC 60384-4 / EN130300
Climatic category IEC 60068	40 / 085 / 056

Note

(1) Other values available on request.

SELECTION CHART FOR C_R, U_R, AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)					
C_R (µF)	U_R (V)				
	250	**300**	**350**	**400**	**450**
6000	76 x 146	76 x 220	76 x 220	76 x 220	76 x 220

Note

- Other values available on request.

DIMENSIONS in millimeters **AND AVAILABLE FORMS**

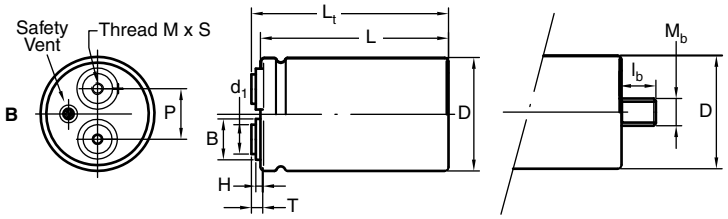


Fig. 1 **A**: High current M5 and M6-13 mm disc: Screw Terminal (ST) and Screw Terminal Bolt nut (STB)

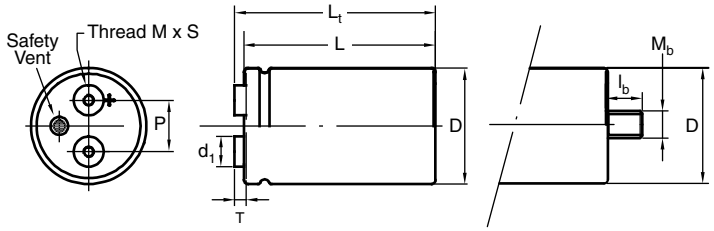


Fig. 1 **B**: High current M6-18 mm disc and 1/4-28 UNF disc: Screw Terminal (ST) and Screw Terminal Bolt nut (STB)

Note

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

Table 1

DIMENSIONS in millimeters, **MASS, AND PACKAGING QUANTITIES**														
DESIGN	**DRAWING**	**L ± 1**	**L_t ± 1**	**D ± 1**	**P ± 0.3**	**T**	**H ± 0.3**	**B ± 0.3**	**d_1 ± 0.1**	**M**	**S ± 1**	**M_b**	**l_b ± 0.1**	**MASS (g)**
76 x 146 M5-13 mm	1A	145.8	150.2	76.4	31.8	5.5	3.5	18.3	13.0	M5	9.5	M12	16	1000
76 x 146 M6-13 mm	1A	145.8	150.2	76.4	31.8	5.5	3.5	18.3	13.0	M6	9.5	M12	16	1000
76 x 146 M6-18 mm	1B	145.8	153.0	76.4	31.8	7.9	n/a	18.3	17.3	M6	10.0	M12	16	1000
76 x 146 1/4-28 UNF	1B	145.8	153.0	76.4	31.8	7.9	n/a	18.3	17.3	1/4-28 UNF	10.0	M12	16	1000
76 x 220 M5-13 mm	1A	219.8	224.2	76.4	31.8	5.5	3.5	18.3	13.0	M5	9.5	M12	16	1500
76 x 220 M6-13 mm	1A	219.8	224.2	76.4	31.8	5.5	3.5	18.3	13.0	M6	9.5	M12	16	1500
76 x 220 M6-18 mm	1B	219.8	227.0	76.4	31.8	7.9	n/a	18.3	17.3	M6	10.0	M12	16	1500
76 x 220 1/4-28 UNF	1B	219.8	227.0	76.4	31.8	7.9	n/a	18.3	17.3	1/4-28 UNF	10.0	M12	16	1500

Note

- For bolt version holds:
  L = L standard -0.5 mm
  L_t = L_t standard -0.5 mm

DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**		
DESIGN	**PACKAGING QUANTITIES (units per box)**	**CARDBOX DIMENSIONS L x W x H (mm)**
76 x 146	12	377 x 375 x 168
76 x 220	18	520 x 270 x 280

Note

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

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	Rated capacitance at 100 Hz, tolerance -10 % / +30 %
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 20 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 %

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION										
U_R (V)	C_R 100 Hz (µF)	CASE SIZE Ø D x L (mm)	I_R 100 Hz 85 °C (A)	I_L 5 min (mA)	ESR (mΩ)		Z (mΩ)		ORDERING CODE [1]	
					MAX.	TYP.	MAX.	TYP.	ST	ST BOLT NUT
250	6000	76 x 146	18.35	3.0	17.6	9.7	11.5	6.9	MAL211013602E3	MAL211023602E3
									MAL211033602E3	MAL211043602E3
									MAL211053602E3	MAL211063602E3
									MAL211073602E3	MAL211083602E3
300	6000	76 x 220	18.35	3.6	25.3	13.9	20.0	12.0	MAL211010602E3	MAL211020602E3
									MAL211030602E3	MAL211040602E3
									MAL211050602E3	MAL211060602E3
									MAL211070602E3	MAL211080602E3
350	6000	76 x 220	18.49	4.2	24.0	13.2	18.6	11.2	MAL211015602E3	MAL211025602E3
									MAL211035602E3	MAL211045602E3
									MAL211055602E3	MAL211065602E3
									MAL211075602E3	MAL211085602E3
400	6000	76 x 220	18.45	4.8	23.8	13.1	18.6	11.2	MAL211016602E3	MAL211026602E3
									MAL211036602E3	MAL211046602E3
									MAL211056602E3	MAL211066602E3
									MAL211076602E3	MAL211086602E3
450	6000	76 x 220	19.76	5.4	19.1	10.5	13.6	8.2	MAL211017602E3	MAL211027602E3
									MAL211037602E3	MAL211047602E3
									MAL211057602E3	MAL211067602E3
									MAL211077602E3	MAL211087602E3

Note

[1] Underlined 8th digit determines form: for details see “Part Number Explanation” table

PART NUMBER EXPLANATION (Example: 350 V, 6000 µF, M6-13 mm disc)

1 2 3 4	5 6 7	8	9	10 11 12	13 14
MAL2	**110**	**3**	**5**	**602**	**E3**
PREFIX	SERIES NAME	FORM	VOLTAGE	CAPACITANCE	

FORM:
- **1** = high current M5-13 mm disc (ST)
- **2** = high current M5-13 mm disc, with mounting bolt (STB)
- **3** = high current M6-13 mm disc (ST)
- **4** = high current M6-13 mm disc, with mounting bolt (STB)
- **5** = high current M6-18 mm disc (ST)
- **6** = high current M6-18 mm disc, with mounting bolt (STB)
- **7** = US tread 1/4-28 UNF (ST)
- **8** = US tread 1/4-28 UNF, with mounting bolt (STB)

VOLTAGE:
- **3** = 250 V
- **0** = 300 V
- **5** = 350 V
- **6** = 400 V
- **7** = 450 V

CAPACITANCE:
- **602** = 6000 µF

13 14:
- Lead (Pb)-free (RoHS-compliant)

Note

- Other values or designs are available on request.
  For more information, please visit the “Product Coding” page: www.vishay.com/doc?28394

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_S = 1.1 \times U_R$
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)		Typ. 20 nH (1)

Note

(1) Low ESL designs available on request

RIPPLE CURRENT AND USEFUL LIFE

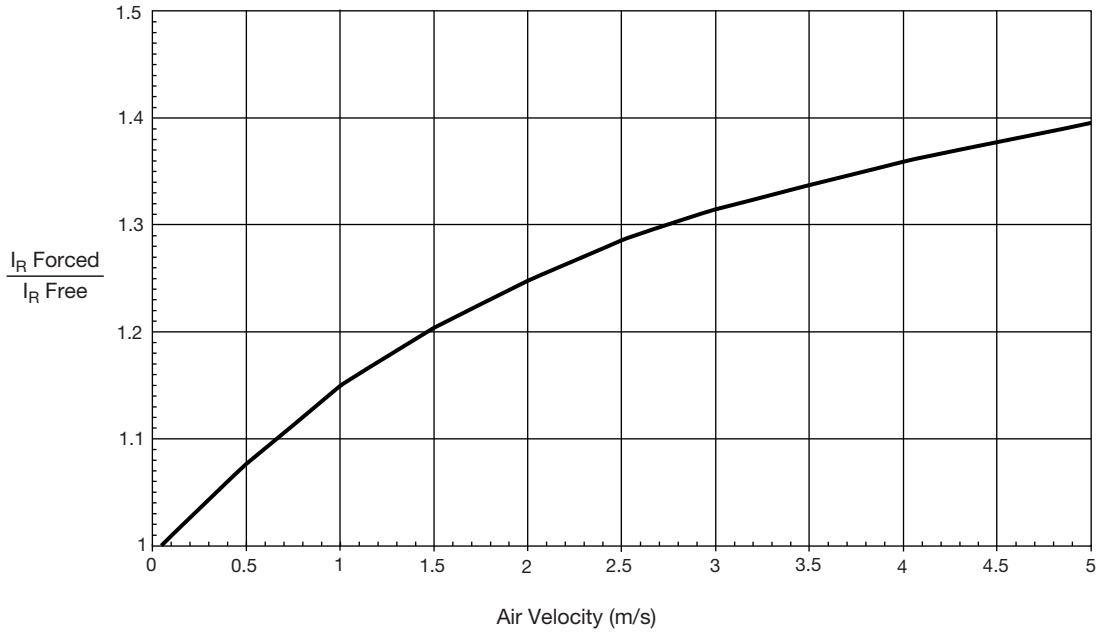


Fig. 2 - Multiplier of ripple current (I_R) as a function of air flow

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

Note

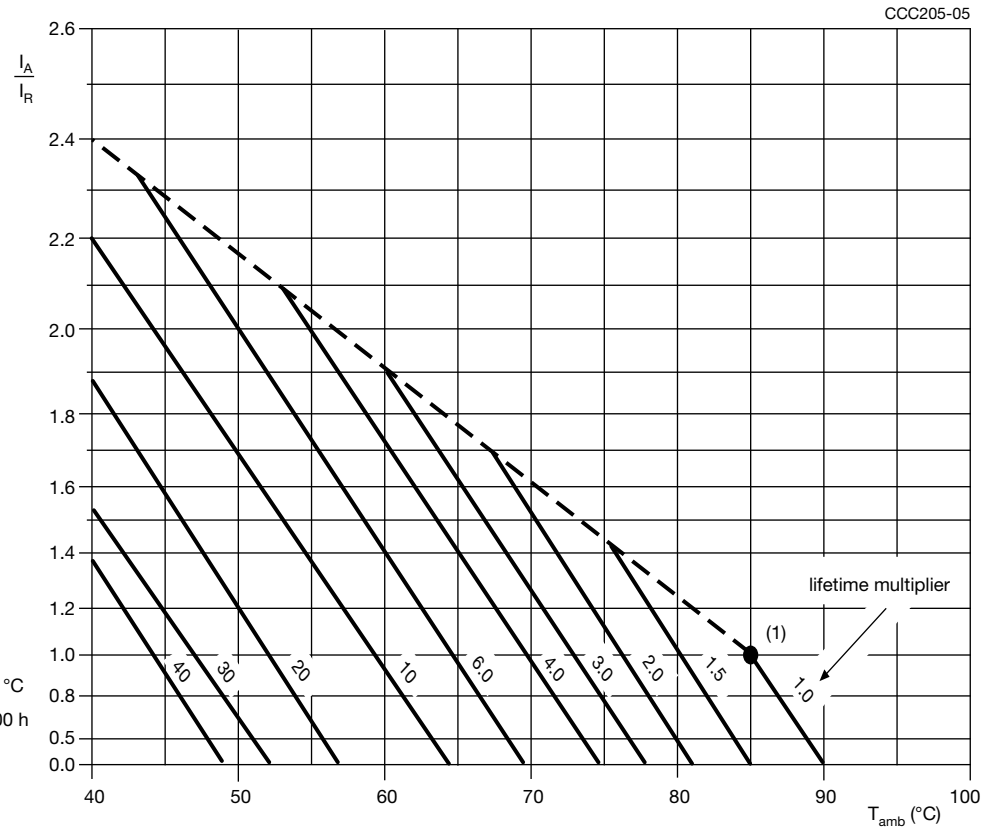
- Calculation example for 110 series. maximum ripple current multiplier = 1.6 x 1.3 x 1.25 = 2.6

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



I_A = Actual ripple current at 100 Hz
I_R = Rated ripple current at 100 Hz and 85 °C
(1) Useful life at 85 °C and I_R applied: 10 000 h

Fig. 3 - 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					
0.90	1.00	1.20	1.30	1.40	1.50

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} = 85 °C; U_R applied; 2000 h	ΔC/C: ± 10 % 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} = 85 °C; U_R and I_R applied	ΔC/C: ± 30 % tan δ ≤ 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 / 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: ± 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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