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
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**

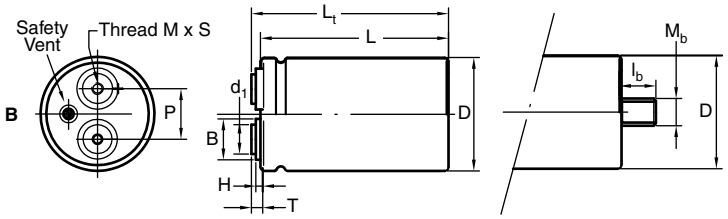


Fig. 1 **A**: High current M5 and M6-13 mm disc: Screw Terminal (ST) and Screw Terminal Bolt nut (STB)

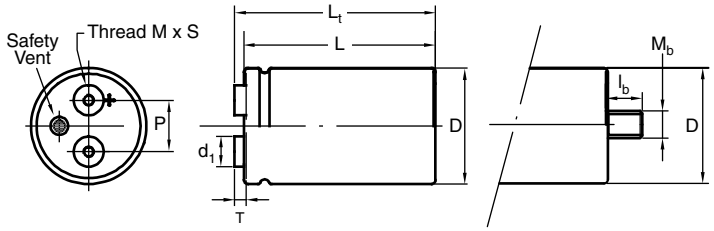


Fig. 1 **B**: High current M6-18 mm disc and 1/4-28 UNF disc: Screw Terminal (ST) and Screw Terminal Bolt nut (STB)

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

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

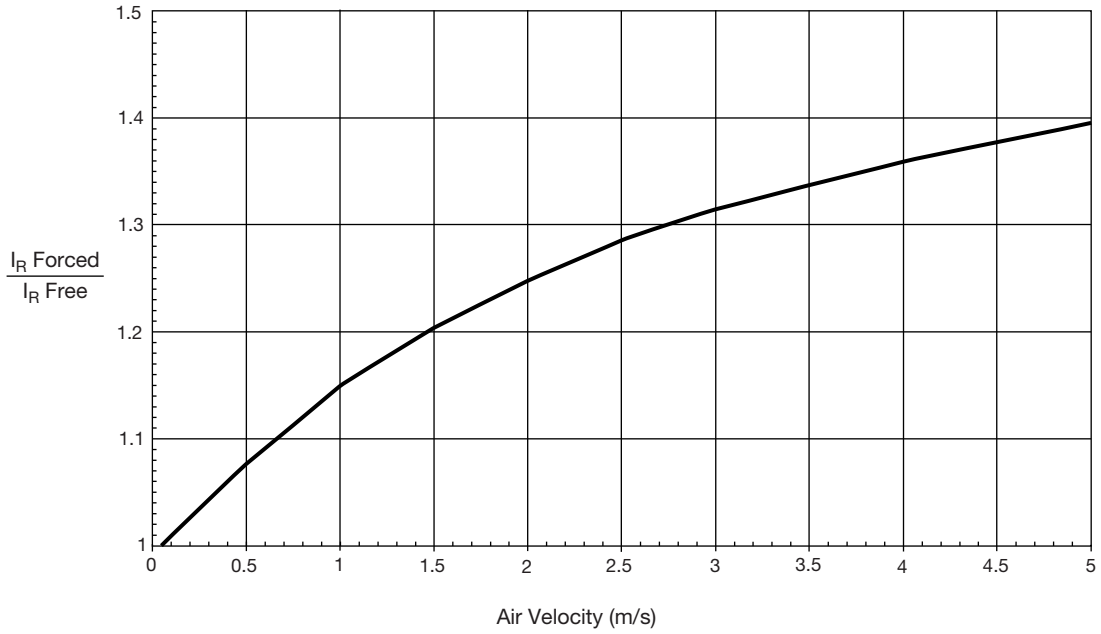
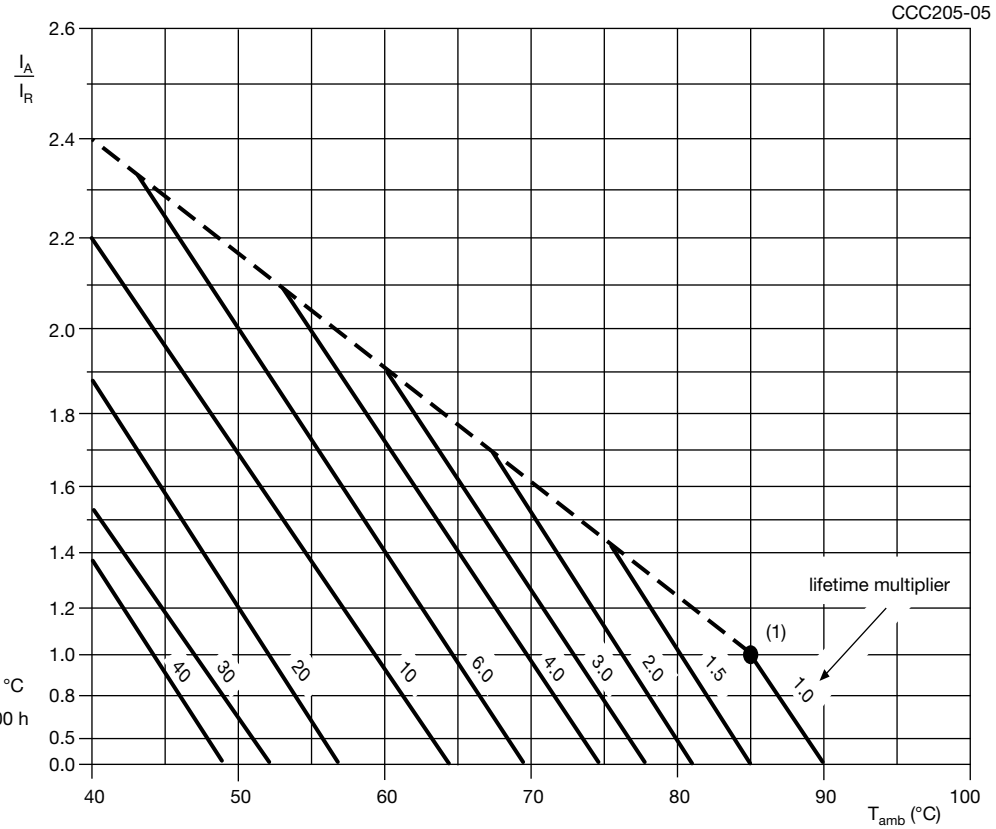


Fig. 2 - Multiplier of ripple current (I_R) as a function of air flow

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



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 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY	
FREQUENCY (Hz)	**I_R MULTIPLIER**
50	0.90
100	1.00
200	1.20
400	1.30
1000	1.40
10 000	1.50

Table 4

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

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