

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

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.

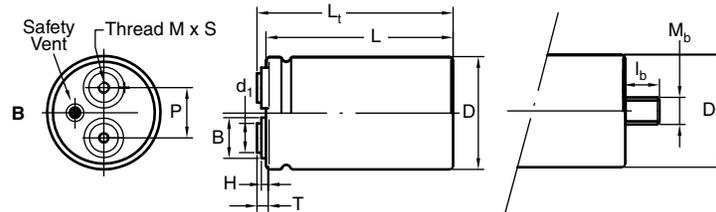
DIMENSIONS in millimeters AND AVAILABLE FORMS


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

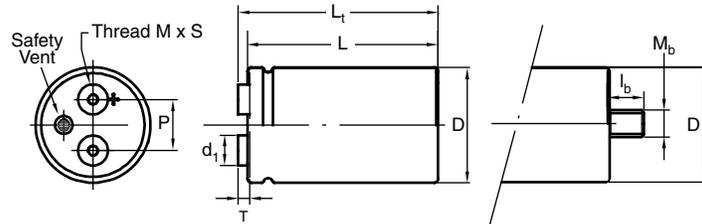


Fig. 1 B: High current M6-18 mm disc and 1/4-28 UNF disc: Screw Terminal (ST) and Screw Terminal Bolt nut (STB)

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	$L \pm 1$	$L_t \pm 1$	$D \pm 1$	$P \pm 0.3$	T	$H \pm 0.3$	$B \pm 0.3$	$d_1 \pm 0.1$	M	$S \pm 1$	M_b	$l_b \pm 0.1$	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:
 $L = L_{\text{standard}} - 0.5 \text{ mm}$
 $L_t = L_{t \text{ standard}} - 0.5 \text{ mm}$

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 box: +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 $T_{amb} = 20\text{ °C}$, $P = 86\text{ kPa}$ to 106 kPa , $RH = 45\text{ %}$ to 75 %

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION										
U_R (V)	C_R 100 Hz (μF)	CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 85 °C (A)	I_L 5 min (mA)	ESR (m Ω)		Z (m Ω)		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	MAL21101 <u>3</u> 602E3	MAL21102 <u>3</u> 602E3
									MAL21103 <u>3</u> 602E3	MAL21104 <u>3</u> 602E3
									MAL21105 <u>3</u> 602E3	MAL21106 <u>3</u> 602E3
									MAL21107 <u>3</u> 602E3	MAL21108 <u>3</u> 602E3
300	6000	76 x 220	18.35	3.6	25.3	13.9	20.0	12.0	MAL211010 <u>6</u> 02E3	MAL211020 <u>6</u> 02E3
									MAL211030 <u>6</u> 02E3	MAL211040 <u>6</u> 02E3
									MAL211050 <u>6</u> 02E3	MAL211060 <u>6</u> 02E3
									MAL211070 <u>6</u> 02E3	MAL211080 <u>6</u> 02E3
350	6000	76 x 220	18.49	4.2	24.0	13.2	18.6	11.2	MAL211015 <u>6</u> 02E3	MAL211025 <u>6</u> 02E3
									MAL211035 <u>6</u> 02E3	MAL211045 <u>6</u> 02E3
									MAL211055 <u>6</u> 02E3	MAL211065 <u>6</u> 02E3
									MAL211075 <u>6</u> 02E3	MAL211085 <u>6</u> 02E3
400	6000	76 x 220	18.45	4.8	23.8	13.1	18.6	11.2	MAL211016 <u>6</u> 02E3	MAL211026 <u>6</u> 02E3
									MAL211036 <u>6</u> 02E3	MAL211046 <u>6</u> 02E3
									MAL211056 <u>6</u> 02E3	MAL211066 <u>6</u> 02E3
									MAL211076 <u>6</u> 02E3	MAL211086 <u>6</u> 02E3
450	6000	76 x 220	19.76	5.4	19.1	10.5	13.6	8.2	MAL211017 <u>6</u> 02E3	MAL211027 <u>6</u> 02E3
									MAL211037 <u>6</u> 02E3	MAL211047 <u>6</u> 02E3
									MAL211057 <u>6</u> 02E3	MAL211067 <u>6</u> 02E3
									MAL211077 <u>6</u> 02E3	MAL211087 <u>6</u> 02E3

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		
		<ul style="list-style-type: none"> 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) 	<ul style="list-style-type: none"> 3 = 250 V 0 = 300 V 5 = 350 V 6 = 400 V 7 = 450 V 	<ul style="list-style-type: none"> 602 = 6000 μF 	<ul style="list-style-type: none"> 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		$U_{rev} \leq 1 \text{ V}$
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

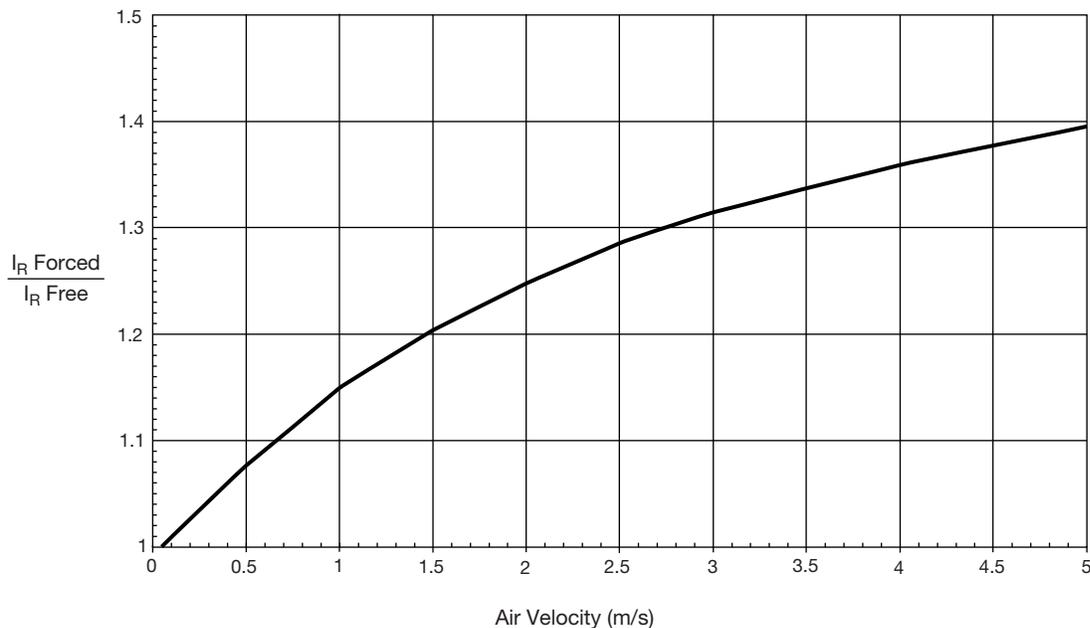


Fig. 2 - Multiplier of ripple current (I_R) as a function of air flow

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 = $1.6 \times 1.3 \times 1.25 = 2.6$



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

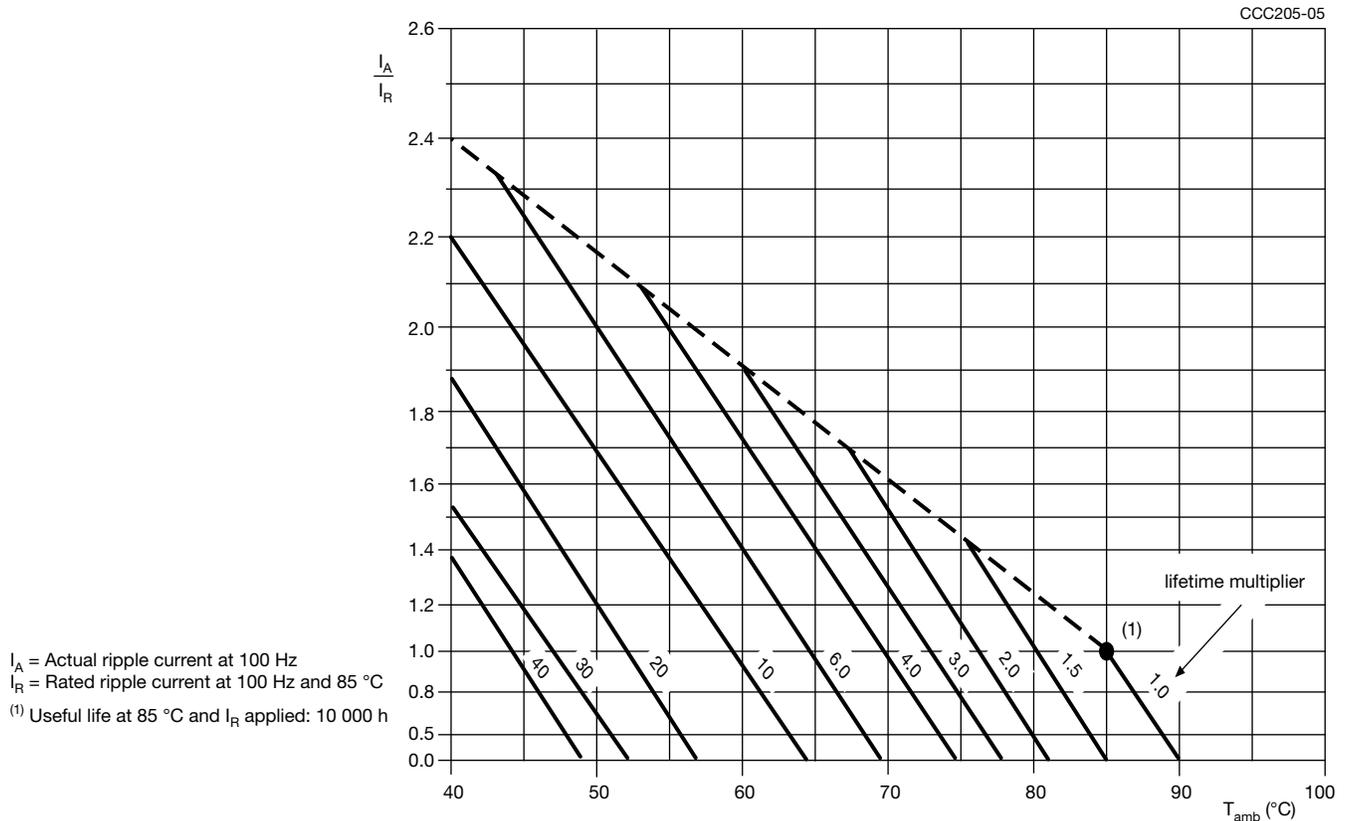


Fig. 3 - Multiplier of useful life as a function of ambient temperature and ripple current load

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	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; 2000 h	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied	$\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage Total failure percentage: $\leq 3\%$
Shelf life (storage at high temperature)	IEC 60384-4 / EN130300 subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 h after test: U_R to be applied for 30 min, 24 h to 48 h before measurement	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$

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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