

Aluminum 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
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.

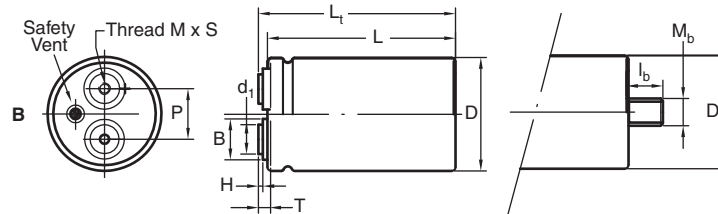
DIMENSIONS in millimeters AND AVAILABLE FORMS


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

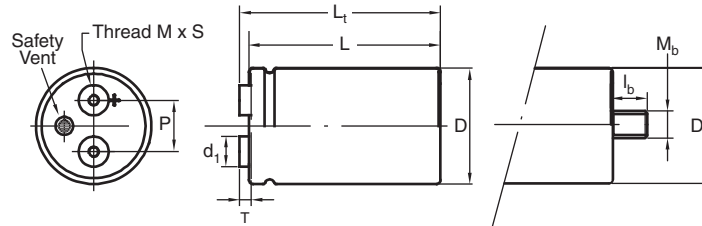


Fig. 1 B: High current M6-18 mm disc and 1/4-28 UNF disc: Screw Terminal (ST) and Screw Terminal Bolt nut (STB)

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	4.4	2.0	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	4.4	2.0	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	7.2	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	7.2	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	4.4	2.0	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	4.4	2.0	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	7.2	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	7.2	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

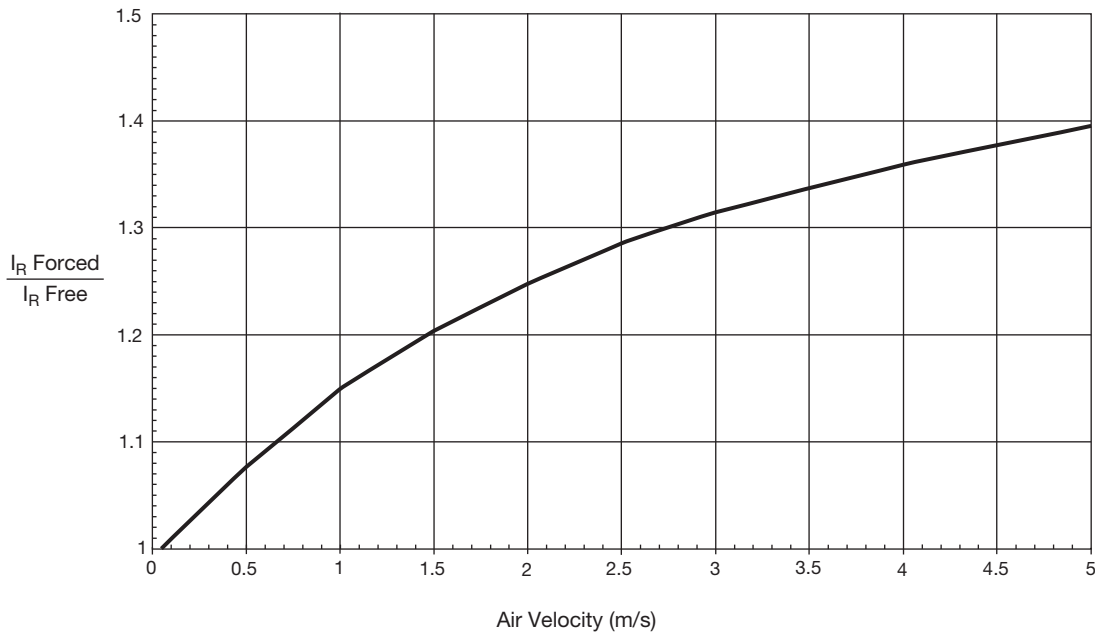


Fig. 2 - Multiplier of ripple current (I_R) as a function of air flow

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



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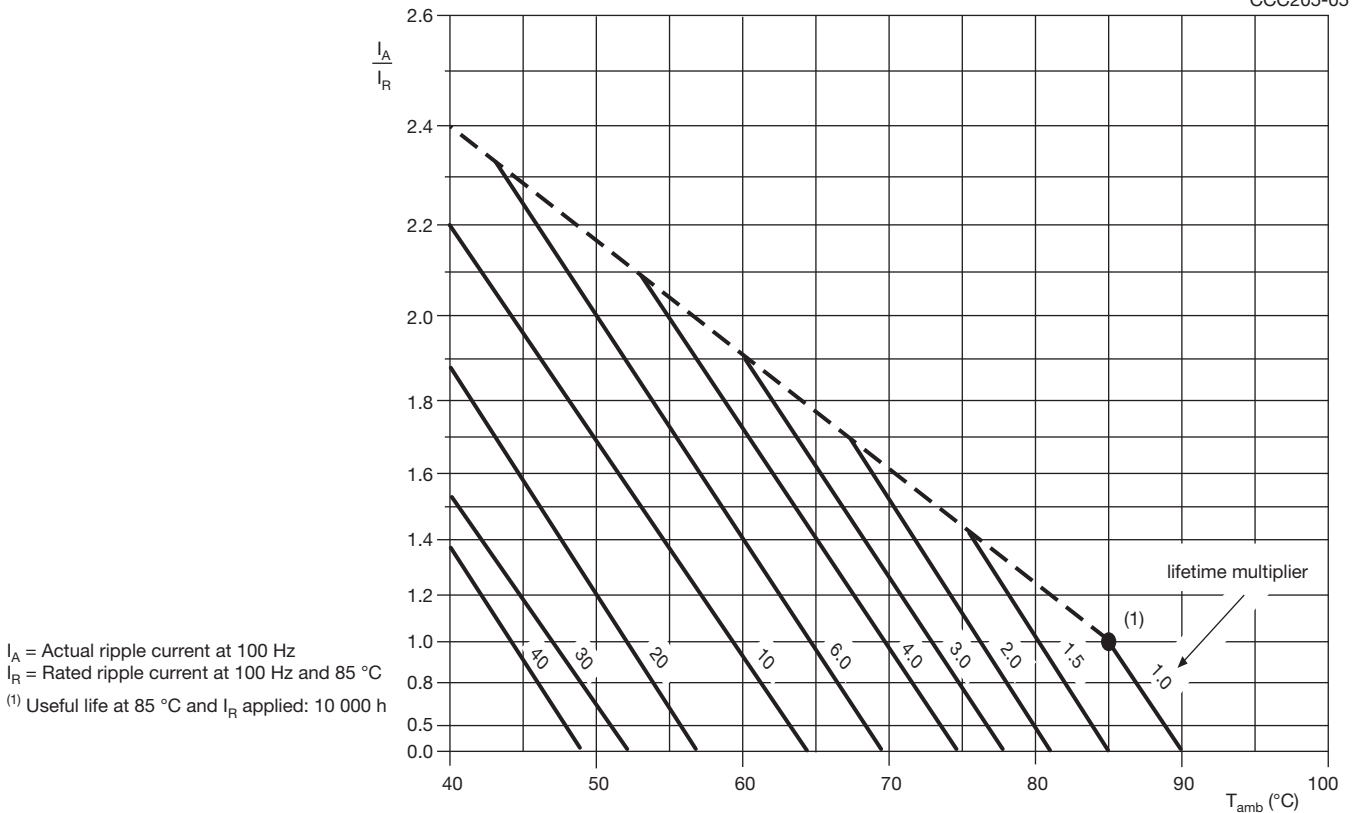


Fig. 3 - Multiplier of useful life as a function of ambient temperature and ripple current load

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	$T_{amb} = 85\text{ }^{\circ}\text{C}$; 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	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$



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