

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


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.

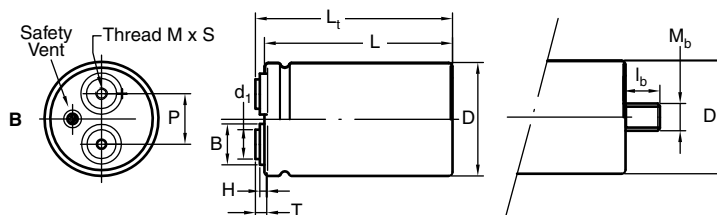
DIMENSIONS in millimeters AND AVAILABLE FORMS


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

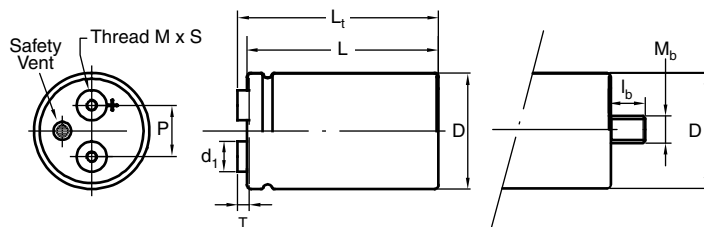


Fig. 1 B: High current M6-18 mm disc and 1/4-28 UNF disc: Screw Terminal (ST) and Screw Terminal Bolt nut (STB)

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	$L \pm 1$	$L_t \pm 1$	$D \pm 1$	$P \pm 0.3$	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	MAL21101 <u>0</u> 602E3	MAL21102 <u>0</u> 602E3
									MAL21103 <u>0</u> 602E3	MAL21104 <u>0</u> 602E3
									MAL21105 <u>0</u> 602E3	MAL21106 <u>0</u> 602E3
									MAL21107 <u>0</u> 602E3	MAL21108 <u>0</u> 602E3
350	6000	76 x 220	18.49	4.2	24.0	13.2	18.6	11.2	MAL21101 <u>5</u> 602E3	MAL21102 <u>5</u> 602E3
									MAL21103 <u>5</u> 602E3	MAL21104 <u>5</u> 602E3
									MAL21105 <u>5</u> 602E3	MAL21106 <u>5</u> 602E3
									MAL21107 <u>5</u> 602E3	MAL21108 <u>5</u> 602E3
400	6000	76 x 220	18.45	4.8	23.8	13.1	18.6	11.2	MAL21101 <u>6</u> 602E3	MAL21102 <u>6</u> 602E3
									MAL21103 <u>6</u> 602E3	MAL21104 <u>6</u> 602E3
									MAL21105 <u>6</u> 602E3	MAL21106 <u>6</u> 602E3
									MAL21107 <u>6</u> 602E3	MAL21108 <u>6</u> 602E3
450	6000	76 x 220	19.76	5.4	19.1	10.5	13.6	8.2	MAL21101 <u>7</u> 602E3	MAL21102 <u>7</u> 602E3
									MAL21103 <u>7</u> 602E3	MAL21104 <u>7</u> 602E3
									MAL21105 <u>7</u> 602E3	MAL21106 <u>7</u> 602E3
									MAL21107 <u>7</u> 602E3	MAL21108 <u>7</u> 602E3

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	
		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)	3 = 250 V 0 = 300 V 5 = 350 V 6 = 400 V 7 = 450 V	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		$U_{rev} \leq 1 \text{ V}$
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

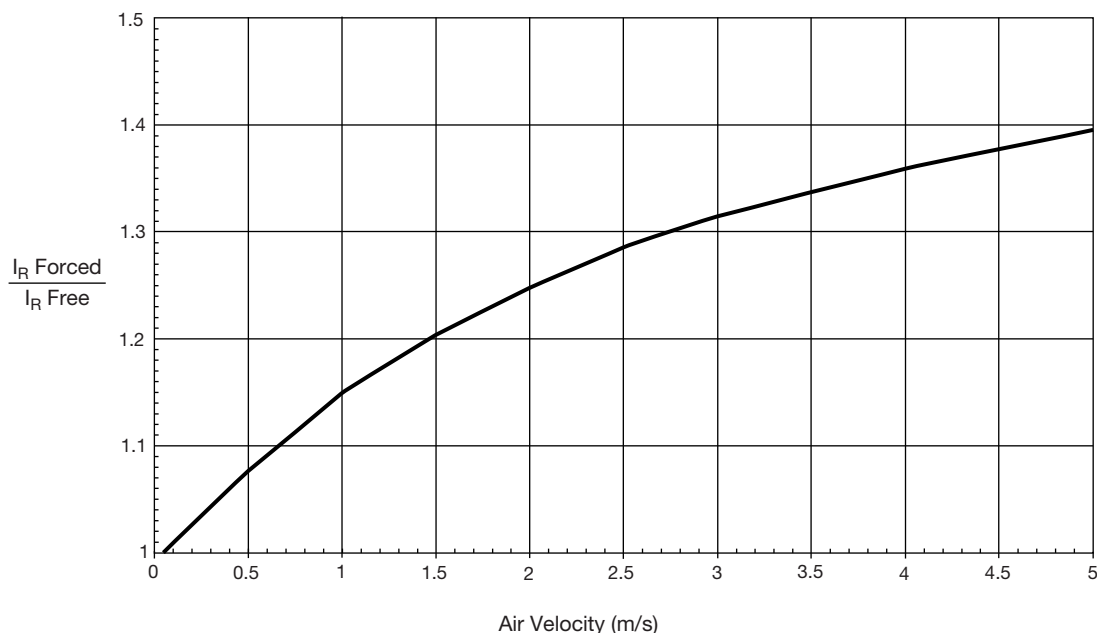
RIPPLE CURRENT AND USEFUL LIFE

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

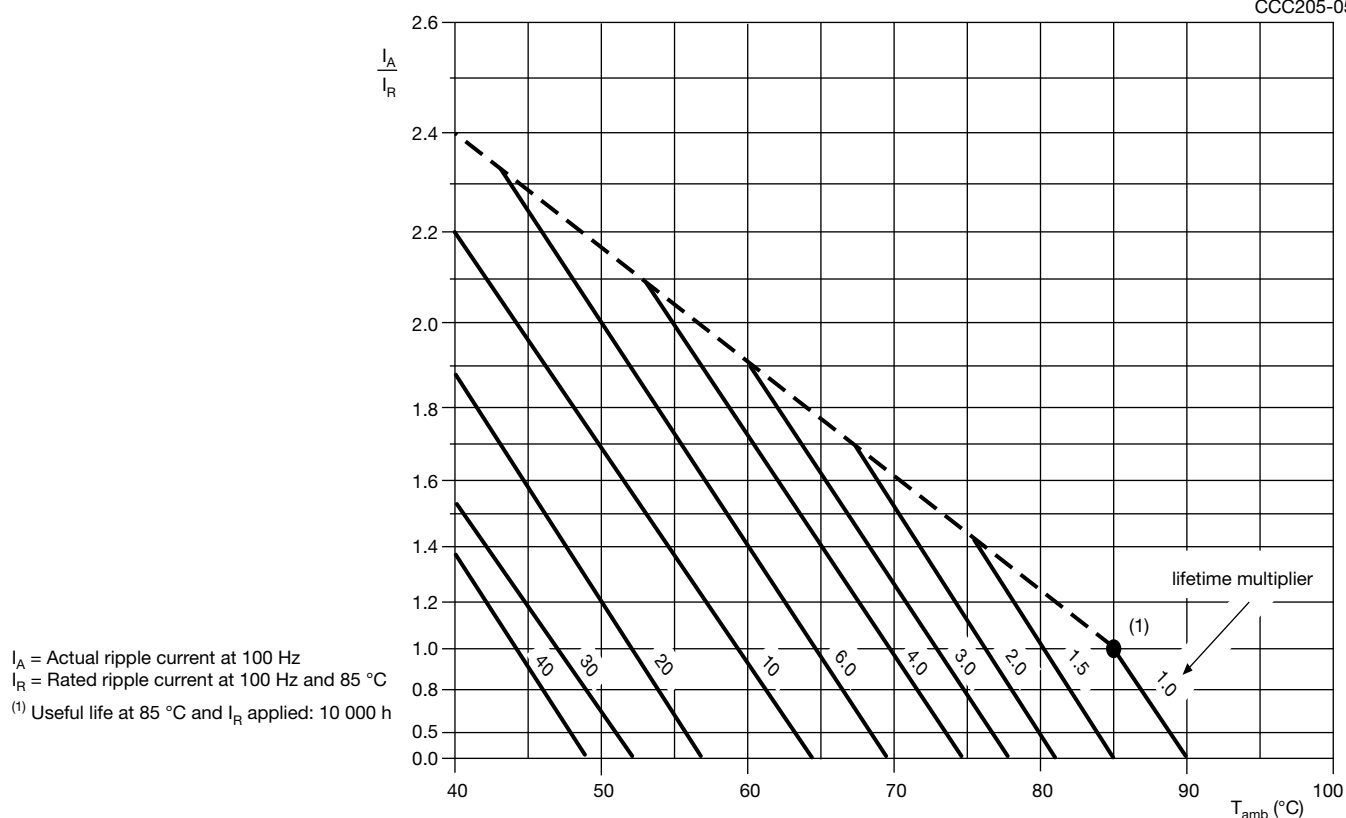


Fig. 3 - Multiplier of useful life as a function of ambient temperature and ripple current load

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	$\Delta C/C: \pm 10\%$ $\tan \delta \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$



Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and/or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.

Material Category Policy

Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as RoHS-Compliant fulfill the definitions and restrictions defined under Directive 2011/65/EU of The European Parliament and of the Council of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) - recast, unless otherwise specified as non-compliant.

Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.

Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.