

Aluminum Electrolytic Capacitors Axial Standard Miniature



Fig. 1

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes (Ø D x L in mm)	4.5 x 10 to 10 x 25 10 x 30 to 21 x 38
Rated capacitance range, C _R	1 µF to 15 000 µF
Tolerance on C _R	± 20 %
Rated voltage range, U _R	6.3 V to 100 V
Category temperature range	-40 °C to +85 °C
Endurance test at 85 °C:	
U _R = 6.3 V to 25 V	1000 h 5000 h
U _R = 40 V to 100 V	2000 h 5000 h
Endurance test at 105 °C	- 2000 h
Useful life at 85 °C	2500 h 8000 h
Useful life at 40 °C, 1.4 x I _R applied	70 000 h 200 000 h
Shelf life at 0 V, 85 °C	500 h
Based on sectional specification	IEC 60384-4 / EN 130300
Climatic category IEC 60068	40 / 085 / 56

FEATURES

- Long useful life: 2500 h to 8000 h at 85 °C
- Miniaturized, high CV-product per unit volume
- Charge and discharge proof
- Taped versions up to case Ø 15 mm x 30 mm available for automatic insertion
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not available in insulated form
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


**RoHS
COMPLIANT**
APPLICATIONS

- General purpose, industrial, automotive, audio-video
- Coupling, decoupling, smoothing, filtering, buffering
- Portable and mobile equipment (small size, low mass)
- Low mounting height boards, vibration, and shock resistant

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Upper category temperature (85 °C)
- Date code in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (021)

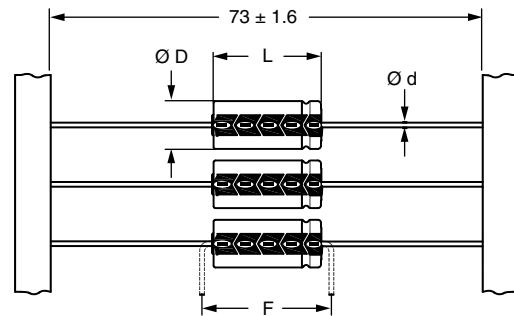
C _R (µF)	U _R (V)						
	6.3	10	16	25	40	63	100
1.0	-	-	-	-	-	4.5 x 10	4.5 x 10
2.2	-	-	-	-	-	4.5 x 10	4.5 x 10
3.3	-	-	-	-	-	4.5 x 10	-
4.7	-	-	-	-	-	4.5 x 10	4.5 x 10
10	-	-	-	-	-	4.5 x 10	6 x 10
15	-	-	-	-	-	4.5 x 10	8 x 11
	-	-	-	-	-	-	6.5 x 18
22	-	-	-	-	4.5 x 10	6 x 10	8 x 11
	-	-	-	-	-	-	6.5 x 18
33	-	-	-	-	-	6 x 10	6.5 x 18
47	-	-	-	4.5 x 10	6 x 10	8 x 11	8 x 18
	-	-	-	-	-	6.5 x 18	-

SELECTION CHART FOR C_R, U_R, AND RELEVANT NOMINAL CASE SIZES ($\varnothing D \times L$ in mm)							
C_R (μF)	U_R (V)						
	6.3	10	16	25	40	63	100
68	-	-	4.5 x 10	-	-	8 x 11	10 x 18
	-	-	-	-	-	6.5 x 18	-
100	-	4.5 x 10	-	6 x 10	8 x 11	8 x 18	10 x 25
	-	-	-	-	6.5 x 18	-	10 x 30
150	-	-	6 x 10	8 x 11	8 x 18	10 x 18	12.5 x 30
	-	-	-	6.5 x 18	-	-	-
220	-	6 x 10	8 x 11	6.5 x 18	10 x 18	10 x 25	12.5 x 30
	-	-	-	-	-	10 x 30	-
330	-	8 x 11	6.5 x 18	8 x 18	10 x 25	12.5 x 30	15 x 30
	8 x 11	6.5 x 18	8 x 18	10 x 18	10 x 25	12.5 x 30	18 x 30
470	-	-	-	-	10 x 30	-	-
	-	8 x 18	10 x 18	10 x 25	12.5 x 30	15 x 30	18 x 38
680	-	-	-	10 x 30	-	-	-
	8 x 18	10 x 18	10 x 25	12.5 x 30	12.5 x 30	18 x 30	21 x 38
1000	-	-	10 x 30	-	-	-	-
	-	10 x 25	12.5 x 30	12.5 x 30	15 x 30	18 x 38	-
1500	-	10 x 30	-	-	-	-	-
	10 x 25	12.5 x 30	12.5 x 30	15 x 30	18 x 30	21 x 38	-
3300	-	12.5 x 30	15 x 30	18 x 30	18 x 38	-	-
	-	15 x 30	18 x 30	18 x 38	21 x 38	-	-
4700	-	18 x 30	18 x 38	21 x 38	-	-	-
	-	18 x 30	18 x 38	21 x 38	-	-	-
6800	-	18 x 38	21 x 38	-	-	-	-
	-	18 x 38	21 x 38	-	-	-	-
10 000	-	21 x 38	-	-	-	-	-
	-	21 x 38	-	-	-	-	-

DIMENSIONS in millimeters AND AVAILABLE FORMS

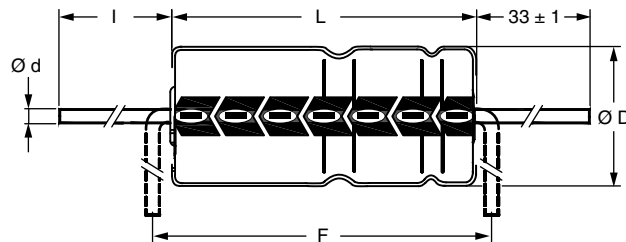

Form BR: Taped on reel
Form BA: Taped in box (ammopack)
 Case $\varnothing D \times L = 4.5 \text{ mm} \times 10 \text{ mm}$ to $8 \text{ mm} \times 11 \text{ mm}$

Fig. 2 - Forms BA and BR



Form BR: Taped on reel
 Case $\varnothing D \times L = 6.5 \text{ mm} \times 18 \text{ mm}$ to $15 \text{ mm} \times 30 \text{ mm}$
Form BA: Taped in box (ammopack)
 Case $\varnothing D \times L = 6.5 \text{ mm} \times 18 \text{ mm}$ to $10 \text{ mm} \times 25 \text{ mm}$

Fig. 3 - Forms BA and BR



Form AA: Axial in box
 Case $\varnothing D \times L = 10 \text{ mm} \times 30 \text{ mm}$ to $21 \text{ mm} \times 38 \text{ mm}$

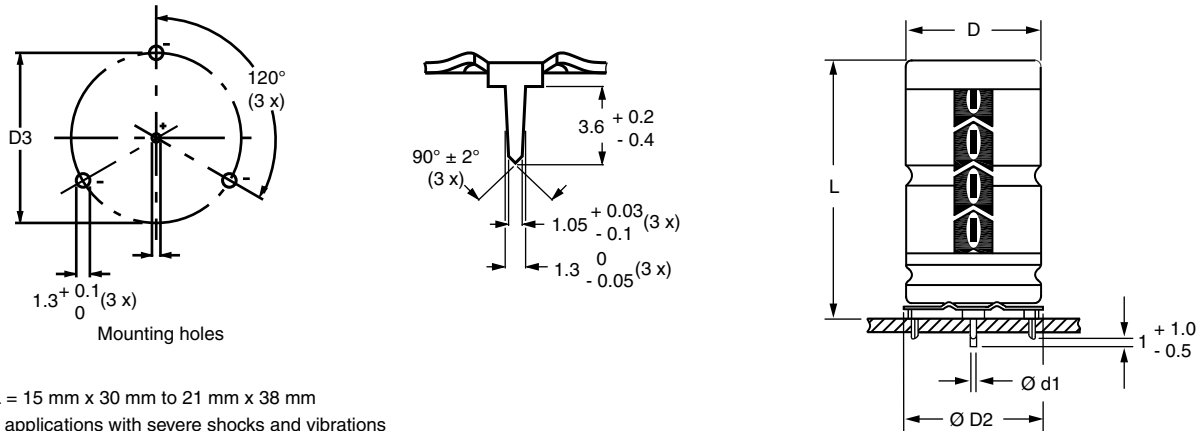
Fig. 4 - Form AA

Table 1

AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES										
NOMINAL CASE SIZE Ø D x L	CASE CODE	AXIAL: FORM AA, BA, AND BR					MASS (g)	PACKAGING QUANTITIES		
		Ø d	l	Ø D _{max.}	L _{max.}	F _{min.}		FORM AA	FORM BA	FORM BR
4.5 x 10	2	0.6	-	5.0	10.5	15	≈ 0.5	-	1000	3000
6 x 10	3	0.6	-	6.3	10.5	15	≈ 0.7	-	1000	1000
8 x 11	5a	0.6	-	8.5	11.5	15	≈ 1.1	-	500	500
6.5 x 18	4	0.8	-	6.9	18.5	25	≈ 1.3	-	1000	1000
8 x 18	5	0.8	-	8.5	18.5	25	≈ 1.7	-	500	500
10 x 18	6	0.8	-	10.5	18.5	25	≈ 2.5	-	500	500
10 x 25	7	0.8	-	10.5	25.5	30	≈ 3.3	-	500	500
10 x 30	00	0.8	55 ± 1	10.5	30.5	35	≈ 4.8	340	-	500
12.5 x 30	01	0.8	55 ± 1	13.0	30.5	35	≈ 7.4	260	-	400
15 x 30	02	0.8	55 ± 1	15.5	30.5	35	≈ 11.7	200	-	250
18 x 30	03	0.8	55 ± 1	18.5	30.5	35	≈ 12.9	120	-	-
18 x 38	04	0.8	34 ± 1	18.5	39.5	44	≈ 19.0	125	-	-
21 x 38	05	0.8	34 ± 1	21.5	39.5	44	≈ 24.0	100	-	-

Note

- For detailed tape dimensions, please see www.vishay.com/doc?28361.


Form MR:

Case Ø D x L = 15 mm x 30 mm to 21 mm x 38 mm

Especially for applications with severe shocks and vibrations

 Fig. 5 - Mounting hole diagram and outline. **Form MR:** With mounting ring and pins

Table 2

MOUNTING RING; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE Ø D x L	CASE CODE	MOUNTING RING: FORM MR					MASS (g)	PACKAGING QUANTITIES	
		Ø d1	Ø d2	Ø D2 _{max.}	D3	L _{max.}			
15 x 30	02	0.8	1.0 + 0.4	17.5	16.5 ± 0.2	33	≈ 11.7	200	
18 x 30	03	0.8	1.0 + 0.4	19.5	18.5 ± 0.2	33	≈ 12.9	240	
18 x 38	04	0.8	1.0 + 0.4	19.5	18.5 ± 0.2	42	≈ 19.0	100	
21 x 38	05	0.8	1.0 + 0.4	22.5	21.5 ± 0.2	42	≈ 24.0	100	



ELECTRICAL DATA AND ORDERING INFORMATION													
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE Ø D x L (mm)	I _R 100 Hz 85 °C (mA)	I _{L5} 5 min (μA)	tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	LIFE CODE ⁽¹⁾	ORDERING CODE MAL2021.....				
									IN BOX FORM AA	TAPED ON REEL FORM BR	TAPED IN BOX FORM BA	MOUNTING RING FORM MR	
40	22	4.5 x 10	60	5.8	0.11	8.000	3.200	L2	-	27229E3	37229E3	-	
	47	6 x 10	110	7.8	0.11	3.800	1.500	L2	-	27479E3	37479E3	-	
	100	8 x 11	170	12	0.11	1.800	0.700	L2	-	90537E3	90538E3	-	
	100	6.5 x 18	190	12	0.11	1.800	0.700	L2	-	27101E3	37101E3	-	
	150	8 x 18	250	16	0.11	1.100	0.470	L2	-	27151E3	37151E3	-	
	220	10 x 18	330	22	0.11	0.800	0.320	L2	-	27221E3	37221E3	-	
	330	10 x 25	430	30	0.11	0.530	0.210	L2	-	27331E3	37331E3	-	
	470	10 x 25	520	42	0.11	0.370	0.180	L2	-	90514E3	90515E3	-	
	470	10 x 30	590	42	0.12	0.404	0.175	L3	17471E3	27471E3	-	-	
	680	12.5 x 30	800	58	0.12	0.297	0.110	L3	17681E3	27681E3	-	-	
	1000	12.5 x 30	900	84	0.12	0.190	0.110	L3	17102E3	27102E3	-	-	
	1500	15 x 30	1120	124	0.15	0.159	0.070	L3	17152E3	27152E3	-	47152E3	
	2200	18 x 30	1390	180	0.17	0.118	0.065	L3	17222E3	-	-	47222E3	
	3300	18 x 38	1810	268	0.19	0.090	0.040	L3	17332E3	-	-	47332E3	
	4700	21 x 38	1940	380	0.21	0.072	0.035	L3	17472E3	-	-	47472E3	
63	1.0	4.5 x 10	12	4.1	0.09	150.0	55.00	L2	-	28108E3	38108E3	-	
	2.2	4.5 x 10	21	4.3	0.09	65.00	25.00	L2	-	28228E3	38228E3	-	
	3.3	4.5 x 10	25	4.4	0.09	44.00	17.00	L2	-	28338E3	38338E3	-	
	4.7	4.5 x 10	31	4.6	0.09	31.00	12.00	L2	-	28478E3	38478E3	-	
	10	4.5 x 10	50	5.3	0.08	13.00	5.500	L2	-	28109E3	38109E3	-	
	15	4.5 x 10	55	5.9	0.08	8.500	3.700	L2	-	28159E3	38159E3	-	
	22	6 x 10	90	6.8	0.08	5.800	2.500	L2	-	28229E3	38229E3	-	
	33	6 x 10	100	8.2	0.08	3.900	1.700	L2	-	28339E3	38339E3	-	
	47	8 x 11	140	10	0.08	2.700	1.200	L2	-	90541E3	90542E3	-	
	47	6.5 x 18	150	10	0.08	2.700	1.200	L2	-	28479E3	38479E3	-	
	68	8 x 11	160	13	0.08	1.900	0.810	L2	-	90544E3	90545E3	-	
	68	6.5 x 18	170	13	0.08	1.900	0.810	L2	-	28689E3	38689E3	-	
	100	8 x 18	250	17	0.08	1.300	0.550	L2	-	28101E3	38101E3	-	
	150	10 x 18	320	23	0.08	0.850	0.370	L2	-	28151E3	38151E3	-	
	220	10 x 25	430	32	0.08	0.600	0.250	L2	-	90511E3	90512E3	-	
	220	10 x 30	480	32	0.08	0.614	0.260	L3	18221E3	28221E3	-	-	
	330	12.5 x 30	610	46	0.08	0.409	0.190	L3	18331E3	28331E3	-	-	
	470	12.5 x 30	700	63	0.08	0.287	0.130	L3	18471E3	28471E3	-	-	
680	15 x 30	890	90	0.08	0.199	0.095	L3	18681E3	28681E3	-	48681E3		
1000	18 x 30	1170	130	0.08	0.135	0.075	L3	18102E3	-	-	48102E3		
1500	18 x 38	1530	193	0.11	0.122	0.045	L3	18152E3	-	-	48152E3		
2200	21 x 38	1780	281	0.13	0.099	0.040	L3	18222E3	-	-	48222E3		
100	1.0	4.5 x 10	14	4.2	0.08	130.0	90.00	L2	-	29108E3	39108E3	-	
	2.2	4.5 x 10	20	4.4	0.08	58.00	41.00	L2	-	29228E3	39228E3	-	
	4.7	4.5 x 10	30	4.9	0.08	27.00	19.00	L2	-	29478E3	39478E3	-	
	10	6 x 10	65	6	0.08	13.00	9.000	L2	-	29109E3	39109E3	-	
	15	8 x 11	77	7	0.08	8.500	6.000	L2	-	90547E3	90548E3	-	
	15	6.5 x 18	85	7	0.08	8.500	6.000	L2	-	29159E3	39159E3	-	
	22	8 x 11	95	8.4	0.08	5.800	4.100	L2	-	90551E3	90552E3	-	
	22	6.5 x 18	100	8.4	0.08	5.800	4.100	L2	-	29229E3	39229E3	-	
	33	6.5 x 18	120	10.6	0.08	3.900	2.700	L2	-	29339E3	39339E3	-	
	47	8 x 18	160	13.4	0.08	2.700	1.900	L2	-	29479E3	39479E3	-	
	68	10 x 18	220	17.6	0.08	1.900	1.300	L2	-	29689E3	39689E3	-	
	100	10 x 25	300	24	0.08	1.300	0.900	L2	-	90531E3	90532E3	-	
	100	10 x 30	340	24	0.07	1.150	1.000	L3	19101E3	29101E3	-	-	
	150	12.5 x 30	490	34	0.07	0.645	0.610	L3	19151E3	29151E3	-	-	
	220	12.5 x 30	560	48	0.08	0.610	0.560	L3	19221E3	29221E3	-	-	
	330	15 x 30	740	70	0.09	0.420	0.400	L3	19331E3	29331E3	-	49331E3	
	470	18 x 30	980	98	0.09	0.310	0.290	L3	19471E3	-	-	49471E3	
	680	18 x 38	1260	140	0.09	0.195	0.180	L3	19681E3	-	-	49681E3	
1000	21 x 38	1470	204	0.10	0.160	0.150	L3	19102E3	-	-	49102E3		

Note

(1) Determines the applicable row in the table "Endurance Test Duration and Useful Life"



ADDITIONAL ELECTRICAL DATA			
PARAMETER	CONDITIONS	VALUE	
		AXIAL	MOUNTING RING
Voltage			
Surge voltage		$U_s \leq 1.15 \times U_R$	
Reverse voltage		$U_{rev} \leq 1 \text{ V}$	
Current			
Leakage current	After 1 min at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$	
	After 5 min at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$	
Inductance			
Equivalent series inductance (ESL)	Case \varnothing D x L mm:		
	4.5 x 10	Typ. 10 nH	-
	6 x 10	Typ. 22 nH	-
	8 x 11	Typ. 85 nH	-
	6.5 x 18	Typ. 25 nH	-
	8 x 18	Typ. 40 nH	-
	10 x 18	Typ. 61 nH	-
	10 x 25	Typ. 38 nH	-
	10 x 30	Typ. 38 nH	-
	12.5 x 30	Typ. 46 nH	-
	15 x 30	Typ. 48 nH	Typ. 39 nH
	18 x 30	Typ. 50 nH	Typ. 39 nH
18 x 38	Typ. 54 nH	Typ. 39 nH	
21 x 38	Typ. 59 nH	Typ. 39 nH	

RIPPLE CURRENT AND USEFUL LIFE

Table 4

ENDURANCE TEST DURATION AND USEFUL LIFE			
LIFE CODE	ENDURANCE AT 85 °C (h)	ENDURANCE AT 105 °C (h)	USEFUL LIFE AT 85 °C (h)
L1	1000	-	2500
L2	2000	-	2500
L3	5000	2000	8000

Note

- Multiplier of useful life code: CCC205

CCC205



I_A = Actual ripple current at 100 Hz
 I_R = Rated ripple current at 100 Hz, 85 °C

(1) Useful life at 85 °C and I_R applied:
 Case \varnothing D x L = 4.5 mm x 10 mm to 10 mm x 25 mm: 2500 h
 Case \varnothing D x L = 10 mm x 30 mm to 21 mm x 38 mm: 8000 h

Fig. 6 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 5

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY						
U_R	FREQUENCY (Hz)					
	50	100	300	1000	3000	$\geq 10\ 000$
	I_R MULTIPLIER					
6.3	0.95	1.00	1.07	1.12	1.15	1.20
10	0.95	1.00	1.07	1.12	1.15	1.20
16	0.95	1.00	1.07	1.12	1.15	1.20
25	0.90	1.00	1.12	1.20	1.25	1.30
40	0.90	1.00	1.12	1.20	1.25	1.30
63	0.85	1.00	1.20	1.30	1.35	1.40
100	0.85	1.00	1.20	1.30	1.35	1.40

Table 6

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; case $\emptyset D \times L = 4.5\text{ mm} \times 10\text{ mm}$ to 10 mm x 25 mm: $U_R = 6.3\text{ V}$ to 25 V: 1000 h; $U_R = 40\text{ V}$ to 100 V: 2000 h; case $\emptyset D \times L = 10\text{ mm} \times 30\text{ mm}$ to 21 mm x 38 mm: $U_R = 6.3\text{ V}$ to 100 V: 5000 h	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +15 % / -30 % $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
		$T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; case $\emptyset D \times L = 10\text{ mm} \times 30\text{ mm}$ to 21 mm x 38 mm: 2000 h	$\Delta C/C$: $\leq \pm 20\%$ $\tan \delta \leq 1.6 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; case $\emptyset D \times L = 4.5\text{ mm} \times 10\text{ mm}$ to 10 mm x 25 mm: 2500 h; case $\emptyset D \times L = 10\text{ mm} \times 30\text{ mm}$ to 21 mm x 38 mm: 8000 h	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +45 % / -50 % $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
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	$\Delta C/C$, $\tan \delta$, Z : for requirements see "Endurance test" above $I_{L5} \leq 2 \times \text{spec. limit}$

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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