

Aluminum Electrolytic Capacitors Radial Long Life

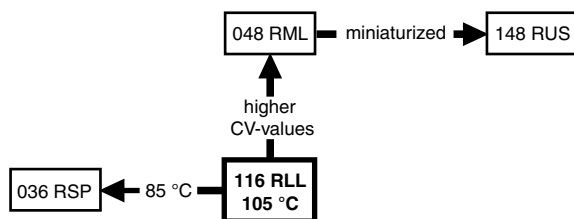
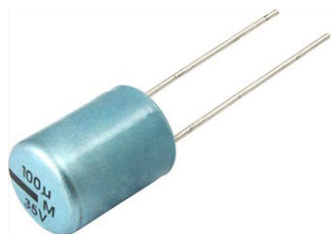


Fig. 1

FEATURES

- Long useful life: 2000 h at 105 °C
- Miniaturized, high CV-product per unit volume
- Natural pitch 2.5 mm and 5 mm
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, all-insulated (light blue)
- Charge and discharge proof
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


RoHS
COMPLIANT

APPLICATIONS

- Automotive, telecommunication, industrial and EDP
- Stand-by applications in audio and video equipment
- Coupling, decoupling, timing, smoothing, filtering and buffering in DC/DC converters
- Portable and mobile equipment (small size, low mass)

MARKING

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

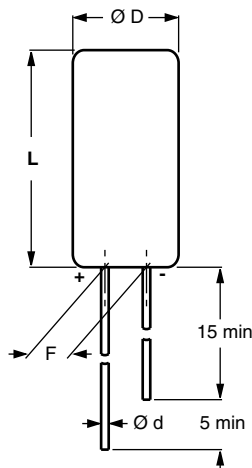
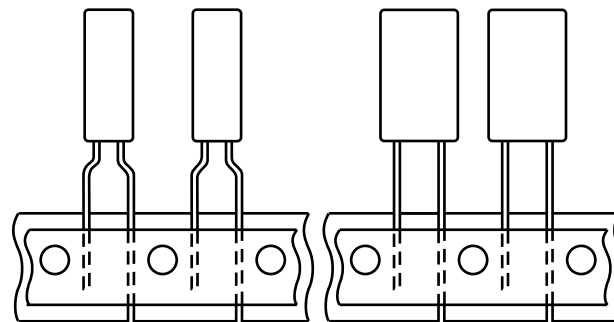
- Rated capacitance (in μF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for $\pm 20\%$)
- Rated voltage (in V)
- Date code in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- “-”-sign on top to identify the negative terminal
- Series number (116)

QUICK REFERENCE DATA

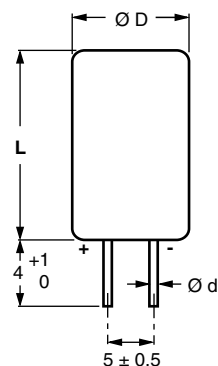
DESCRIPTION	VALUE
Nominal case sizes ($\varnothing D \times L$ in mm)	5 x 11 and 8.2 x 11
Rated capacitance range, C_R	1.5 μF to 470 μF
Tolerance on C_R	$\pm 20\%$
Rated voltage range, U_R	6.3 V to 100 V
Category temperature range	-55 °C to +105 °C
Endurance test at 105 °C	1500 h
Endurance test at 85 °C	5000 h
Useful life at 105 °C	2000 h
Useful life at 40 °C, 1.3 x I_R applied	200 000 h
Shelf life at 0 V, 105 °C	1500 h
Based on sectional specification	IEC 60384-4 / EN 130300
Climatic category IEC 60068	55 / 105 / 56

SELECTION CHART FOR C_R , U_R , AND RELEVANT NOMINAL CASE SIZES ($\varnothing D \times L$ in mm)

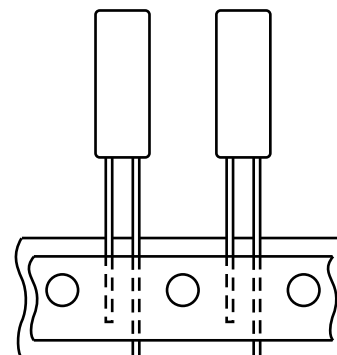
C_R (μF)	U_R (V)								
	6.3	10	16	25	35	40	50	63	100
1.5	-	-	-	-	-	-	5 x 11	-	-
3.3	-	-	-	-	-	-	5 x 11	-	-
4.7	-	-	-	-	-	-	5 x 11	-	8.2 x 11
6.8	-	-	-	-	-	-	5 x 11	-	-
10	-	-	-	-	-	-	5 x 11	8.2 x 11	8.2 x 11
	-	-	-	-	-	-	8.2 x 11	-	-
15	-	-	-	-	-	-	5 x 11	-	-
22	-	-	-	-	-	-	5 x 11	8.2 x 11	-
	-	-	-	-	-	-	8.2 x 11	-	-
33	-	-	-	-	5 x 11	5 x 11	8.2 x 11	-	-
47	-	-	-	5 x 11	-	-	8.2 x 11	-	-
68	-	-	5 x 11	-	-	-	8.2 x 11	-	-
100	-	5 x 11	-	-	8.2 x 11	8.2 x 11	-	-	-
150	5 x 11	-	-	8.2 x 11	-	-	-	-	-
220	-	-	8.2 x 11	-	-	-	-	-	-
330	-	8.2 x 11	-	-	-	-	-	-	-
470	8.2 x 11	-	-	-	-	-	-	-	-

DIMENSIONS in millimeters AND AVAILABLE FORMS

Fig. 2 - **Form CA:** Long leads


Case $\varnothing D \times L = 5 \text{ mm} \times 11 \text{ mm}$ and $8.2 \text{ mm} \times 11 \text{ mm}$
Pitch $F = 5 \text{ mm}$

Fig. 3 - **Form TFA:** Taped in box (ammopack)


Case $\varnothing D \times L = 8.2 \text{ mm} \times 11 \text{ mm}$ only

Fig. 4 - **Form CB:** Cut leads


Case $\varnothing D \times L = 5 \text{ mm} \times 11 \text{ mm}$ only
Pitch $F = 2.5 \text{ mm}$

Fig. 5 - **Form TNA:** Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES								
NOMINAL CASE SIZE $\varnothing D \times L$	CASE CODE	$\varnothing d$	$\varnothing D_{\text{max.}}$	$L_{\text{max.}}$	F	MASS (g)	PACKAGING QUANTITIES	
							FORM CA, CB	FORM TFA, TNA
5 x 11	11	0.5	5.5	12	2.5 ± 0.5	≈ 0.4	1000	2000
8.2 x 11	13	0.6	8.7	12	5.0 ± 0.5	≈ 1.1	1000	1000

Note

- For detailed tape dimension please see www.vishay.com/doc?28360

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	Rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	Rated RMS ripple current at 100 kHz, 105 °C
I_{L1}	Max. leakage current after 1 min at U_R
$\tan \delta$	Max. dissipation factor at 100 Hz
Z	Max. impedance at 100 kHz and 20 °C

Note

- Unless otherwise specified, all electrical values in Table 2 apply at $T_{amb} = 20\text{ °C}$, $P = 86\text{ kPa}$ to 106 kPa , $RH = 45\%$ to 75% .

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION														
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE Ø D x L (mm)	I _R 100 kHz 105 °C (mA)	I _{L1} 1 min (μA)	tan δ 100 Hz	Z 100 kHz (Ω)	ORDERING CODE MAL2116							
							BULK PACKAGING				TAPED AMMOPACK			
							LONG LEADS		CUT LEADS					
							FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	150	5 x 11	130	8.7	0.25	1.3	53151E3	2.5	-	-	33151E3	5.0	73151E3	2.5
	470	8.2 x 11	300	21	0.25	0.45	53471E3	5.0	63471E3	5.0	33471E3	5.0	-	-
10	100	5 x 11	130	9.0	0.20	1.4	54101E3	2.5	-	-	34101E3	5.0	74101E3	2.5
	330	8.2 x 11	280	23	0.20	0.45	54331E3	5.0	64331E3	5.0	34331E3	5.0	-	-
16	68	5 x 11	130	9.5	0.16	1.5	55689E3	2.5	-	-	35689E3	5.0	75689E3	2.5
	220	8.2 x 11	280	24	0.16	0.5	55221E3	5.0	65221E3	5.0	35221E3	5.0	-	-
25	47	5 x 11	120	10	0.14	1.6	56479E3	2.5	-	-	36479E3	5.0	76479E3	2.5
	150	8.2 x 11	260	26	0.14	0.5	56151E3	5.0	66151E3	5.0	36151E3	5.0	-	-
35	33	5 x 11	110	9.9	0.12	1.7	50339E3	2.5	-	-	30339E3	5.0	70339E3	2.5
	100	8.2 x 11	240	24	0.12	0.55	50101E3	5.0	60101E3	5.0	30101E3	5.0	-	-
40	33	5 x 11	110	10.9	0.12	1.7	57339E3	2.5	-	-	37339E3	5.0	77339E3	2.5
	100	8.2 x 11	240	27	0.12	0.55	57101E3	5.0	67101E3	5.0	37101E3	5.0	-	-
50	1.5	5 x 11	50	3.5	0.09	4.0	51158E3	2.5	-	5.0	31158E3	5.0	71158E3	2.5
	2.2	5 x 11	60	3.7	0.09	3.5	51228E3	2.5	-	5.0	31228E3	5.0	71228E3	2.5
	3.3	5 x 11	65	4.0	0.09	3.1	51338E3	2.5	-	5.0	31338E3	5.0	71338E3	2.5
	4.7	5 x 11	70	4.4	0.09	2.8	51478E3	2.5	-	5.0	31478E3	5.0	71478E3	2.5
	6.8	5 x 11	75	5.0	0.09	2.5	51688E3	2.5	-	5.0	31688E3	5.0	71688E3	2.5
	10	5 x 11	80	6.0	0.09	2.2	51109E3	2.5	-	5.0	31109E3	5.0	71109E3	2.5
	10	8.2 x 11	160	6.0	0.05	1.0	90084E3	5.0	90085E3	5.0	90036E3	5.0	-	-
	15	5 x 11	90	7.5	0.09	2.0	51159E3	2.5	-	5.0	31159E3	5.0	71159E3	2.5
	22	5 x 11	110	9.6	0.09	1.9	51229E3	2.5	-	5.0	31229E3	5.0	71229E3	2.5
	22	8.2 x 11	190	9.6	0.06	0.9	90025E3	5.0	90086E3	5.0	90039E3	5.0	-	-
	33	8.2 x 11	190	13	0.09	0.77	51339E3	5.0	61339E3	5.0	31339E3	5.0	-	-
	47	8.2 x 11	210	17	0.09	0.65	51479E3	5.0	61479E3	5.0	31479E3	5.0	-	-
	68	8.2 x 11	240	23	0.09	0.55	51689E3	5.0	61689E3	5.0	31689E3	5.0	-	-
63	10	8.2 x 11	160	7.0	0.06	1.3	58109E3	5.0	68109E3	5.0	38109E3	5.0	-	-
	22	8.2 x 11	190	11	0.06	0.9	58229E3	5.0	68229E3	5.0	38229E3	5.0	-	-
100	4.7	8.2 x 11	75	5.8	0.07	3.5	59478E3	5.0	69478E3	5.0	39478E3	5.0	-	-
	10	8.2 x 11	100	9.0	0.08	3.0	59109E3	5.0	69109E3	5.0	39109E3	5.0	-	-

ORDERING EXAMPLE

Electrolytic capacitor 116 series

220 μF / 16 V; $\pm 20\%$

Nominal case size: $\varnothing 8.2\text{ mm} \times 11\text{ mm}$; form TFA

Ordering code: MAL211635221E3

Former 12NC: 2222 116 35221

ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.3 U_R$
Reverse voltage		$U_{rev} \leq 1 V$
Current		
Leakage current	After 1 min at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 3 \mu A$
	After 5 min at U_R	$I_{L5} \leq 0.001 C_R \times U_R + 3 \mu A$
Inductance		
Equivalent series inductance (ESL)	Case $\varnothing D \times L = 5 \text{ mm} \times 11 \text{ mm}$	Typ. 13 nH
	Case $\varnothing D \times L = 8.2 \text{ mm} \times 11 \text{ mm}$	Typ. 16 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from $\tan \delta_{max}$ and C_R (see Table 2)	$ESR = \tan \delta / 2 \pi f C_R$

CAPACITANCE (C)

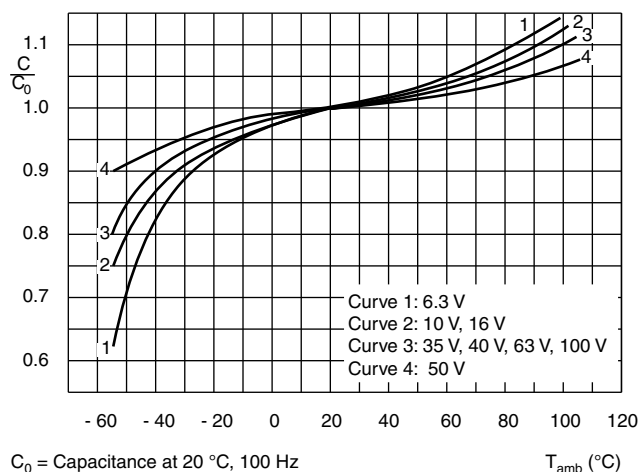


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

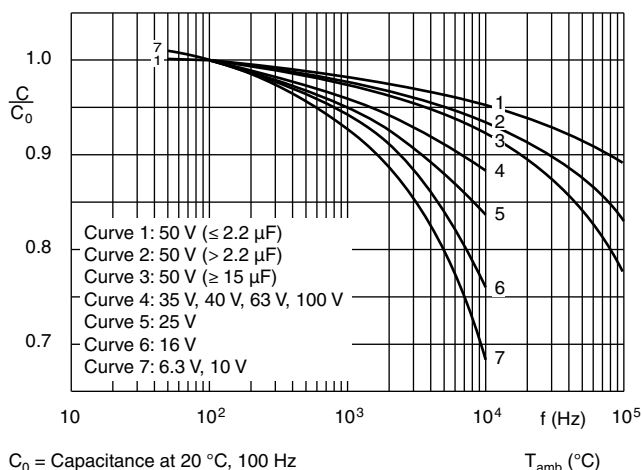


Fig. 7 - Typical multiplier of capacitance as a function of ambient frequency

IMPEDANCE (Z)

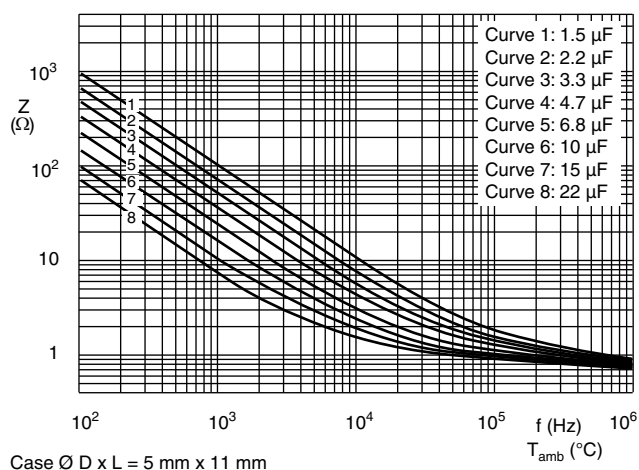


Fig. 8 - Typical impedance as a function of frequency

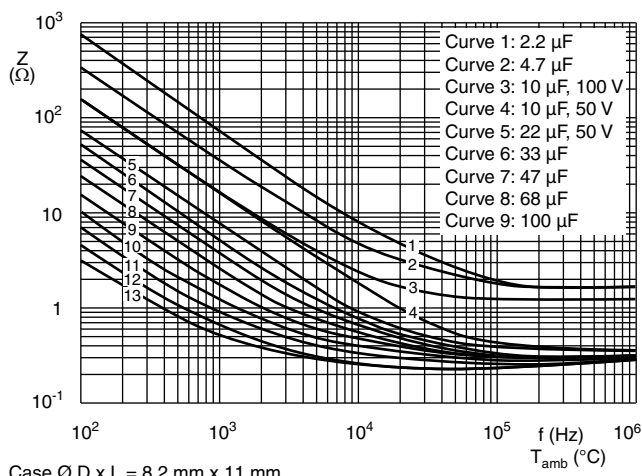


Fig. 9 - Typical impedance as a function of frequency

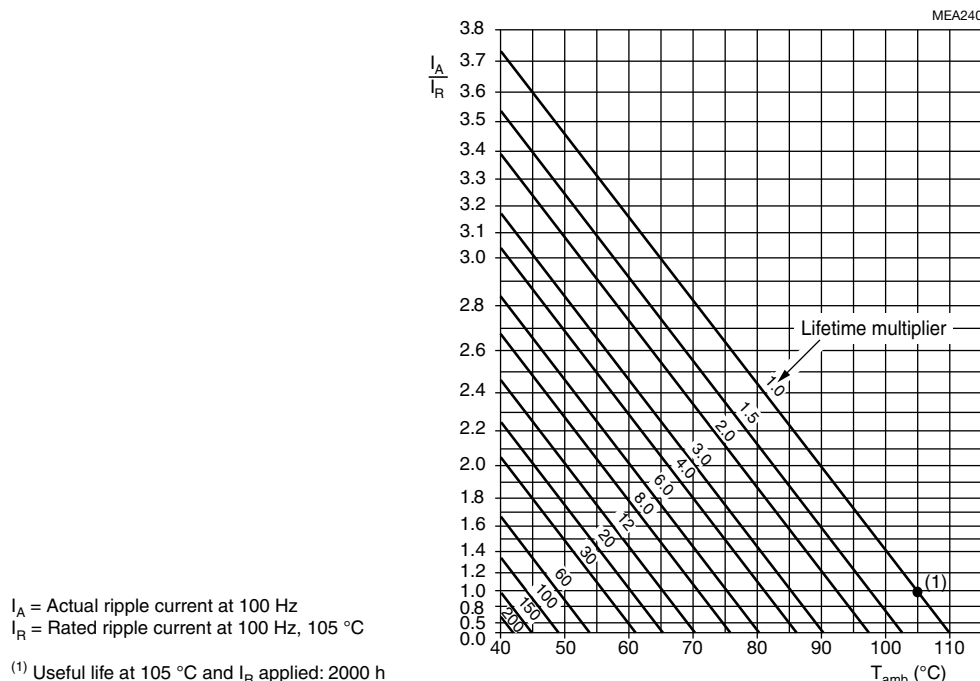
RIPPLE CURRENT AND USEFUL LIFE


Fig. 10 - 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		
	$U_R = 6.3 \text{ V TO } 10 \text{ V}$	$U_R = 16 \text{ V TO } 35 \text{ V}$	$U_R = 40 \text{ V TO } 100 \text{ V (C}_R \geq 10 \mu\text{F)}$
50	0.70	0.60	0.50
100	0.77	0.71	0.63
300	0.86	0.85	0.78
1000	0.92	0.93	0.88
3000	0.96	0.96	0.94
10K to 100K	1.00	1.00	1.00

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4 / EN 130300 subclause 4.13	$T_{amb} = 105 \text{ °C}$; U_R applied; 1500 h	$U_R \leq 6.3 \text{ V}$; $\Delta C/C$: +15 % / -30 % $U_R > 6.3 \text{ V}$; $\Delta C/C$: $\pm 15 \%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105 \text{ °C}$; U_R and I_R applied; 2000 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 / EN 130300 subclause 4.17	$T_{amb} = 105 \text{ °C}$; no voltage applied; 1500 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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