

## Aluminum Electrolytic Capacitors Radial Long Life

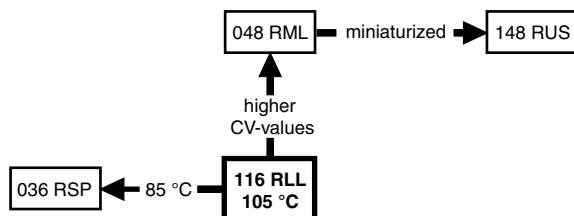
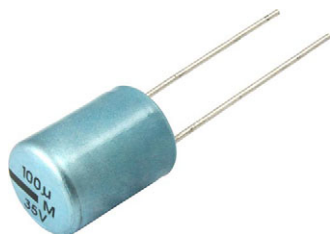


Fig. 1

### QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes (Ø D x L in mm)	8.2 x 11
Rated capacitance range, C <sub>R</sub>	4.7 µF to 470 µF
Tolerance on C <sub>R</sub>	± 20 %
Rated voltage range, U <sub>R</sub>	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 <sub>R</sub> 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

### FEATURES

- Long useful life: 2000 h at 105 °C
- Miniaturized, high CV-product per unit volume
- Natural pitch 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](http://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 ± 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)

### SELECTION CHART FOR C<sub>R</sub>, U<sub>R</sub>, AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C <sub>R</sub> (µF)	U <sub>R</sub> (V)								
	6.3	10	16	25	35	40	50	63	100
4.7	-	-	-	-	-	-	-	-	8.2 x 11
10	-	-	-	-	-	-	8.2 x 11	8.2 x 11	8.2 x 11
22	-	-	-	-	-	-	8.2 x 11	8.2 x 11	-
33	-	-	-	-	-	-	8.2 x 11	-	-
47	-	-	-	-	-	-	8.2 x 11	-	-
68	-	-	-	-	-	-	8.2 x 11	-	-
100	-	-	-	-	8.2 x 11	8.2 x 11	-	-	-
150	-	-	-	8.2 x 11	-	-	-	-	-
220	-	-	8.2 x 11	-	-	-	-	-	-
330	-	8.2 x 11	-	-	-	-	-	-	-
470	8.2 x 11	-	-	-	-	-	-	-	-

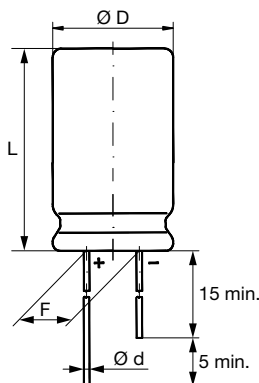
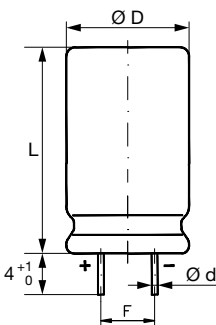
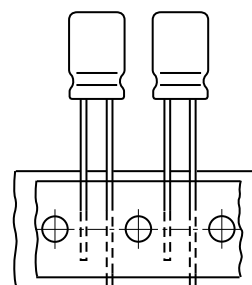
**DIMENSIONS in millimeters AND AVAILABLE FORMS**

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

Fig. 3 - **Form CB:** cut leads

Case Ø D x L = 8.2 mm x 11 mm  
Pitch F = 5 mm

Fig. 4 - **Form TFA:** taped in box (ammopack)

**Table 1**

<b>DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES</b>								
NOMINAL CASE SIZE Ø D x L	CASE CODE	Ø d	Ø D <sub>max.</sub>	L <sub>max.</sub>	F	MASS (g)	PACKAGING QUANTITIES	
							FORM CA, CB	FORM TFA
8.2 x 11	13N	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](http://www.vishay.com/doc?28360)

<b>ELECTRICAL DATA</b>	
SYMBOL	DESCRIPTION
C <sub>R</sub>	Rated capacitance at 100 Hz, tolerance ± 20 %
I <sub>R</sub>	Rated RMS ripple current at 100 kHz, 105 °C
I <sub>L1</sub>	Max. leakage current after 1 min at U <sub>R</sub>
tan δ	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<sub>amb</sub> = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

**ORDERING EXAMPLE**

Electrolytic capacitor 116 series

220 µF / 16 V; ± 20 %

Nominal case size: Ø 8.2 mm x 11 mm; form TFA

Ordering code: MAL211635221E3

Former 12NC: 2222 116 35221



Table 2

ELECTRICAL DATA AND ORDERING INFORMATION												
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (μF)	NOMINAL CASE SIZE Ø D x L (mm)	I <sub>R</sub> 100 kHz 105 °C (mA)	I <sub>L1</sub> 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)
6.3	470	8.2 x 11	300	21	0.25	0.45	53471E3	5.0	63471E3	5.0	33471E3	5.0
10	330	8.2 x 11	280	23	0.20	0.45	54331E3	5.0	64331E3	5.0	34331E3	5.0
16	220	8.2 x 11	280	24	0.16	0.5	55221E3	5.0	65221E3	5.0	35221E3	5.0
25	150	8.2 x 11	260	26	0.14	0.5	56151E3	5.0	66151E3	5.0	36151E3	5.0
35	100	8.2 x 11	240	24	0.12	0.55	50101E3	5.0	60101E3	5.0	30101E3	5.0
40	100	8.2 x 11	240	27	0.12	0.55	57101E3	5.0	67101E3	5.0	37101E3	5.0
50	10	8.2 x 11	160	6.0	0.05	1.0	90084E3	5.0	90085E3	5.0	90036E3	5.0
	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

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

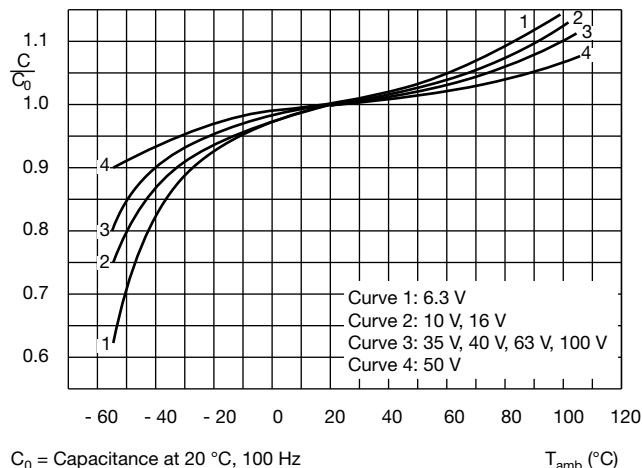
**CAPACITANCE (C)**

Fig. 5 - Typical multiplier of capacitance as a function of ambient temperature

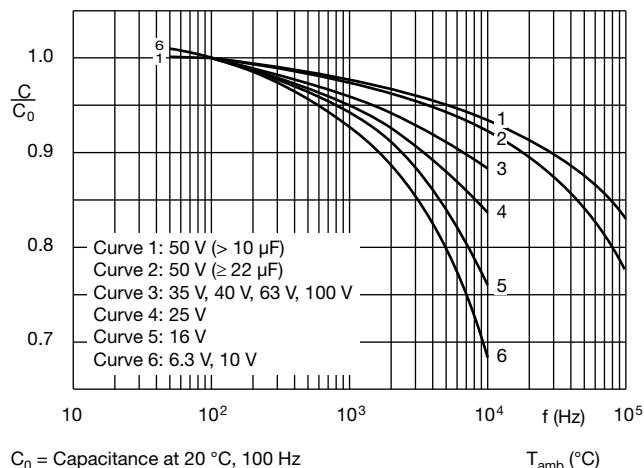


Fig. 6 - Typical multiplier of capacitance as a function of ambient frequency

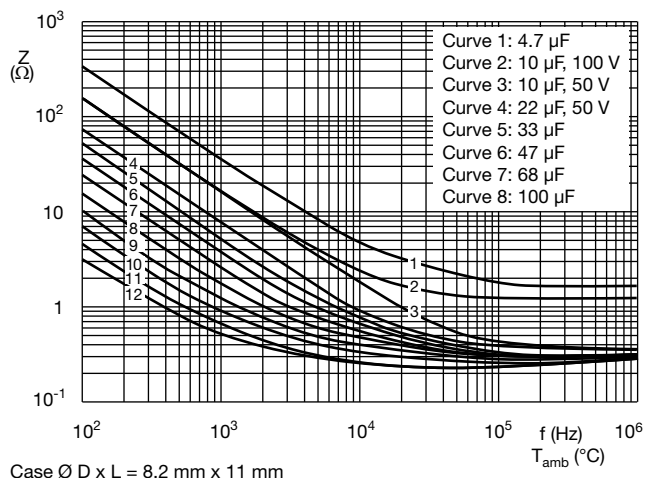
**IMPEDANCE (Z)**

Fig. 7 - Typical impedance as a function of frequency

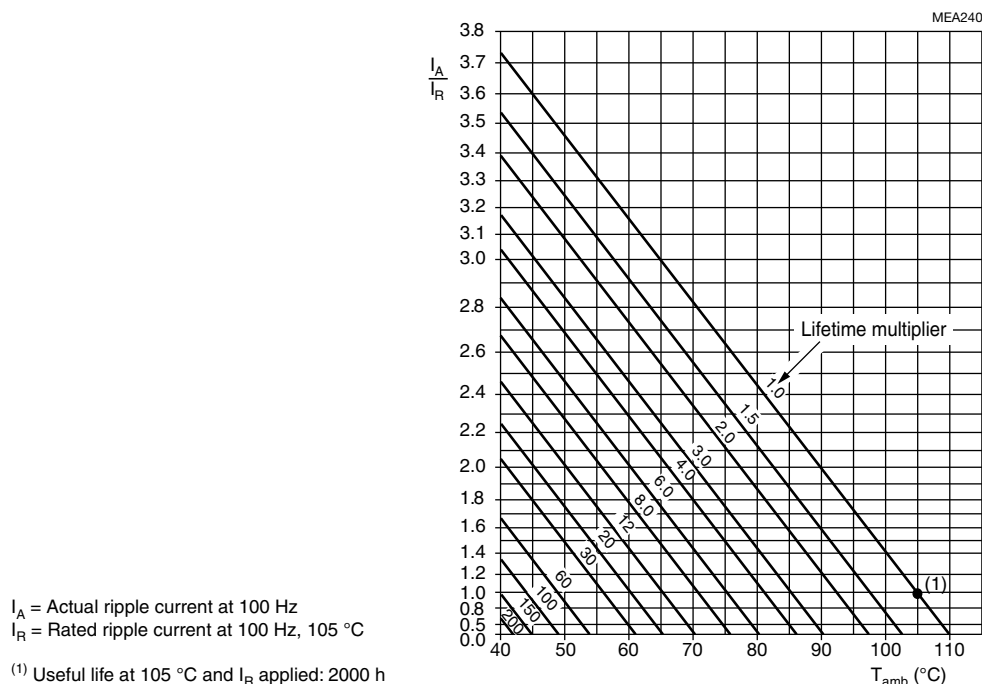
**RIPPLE CURRENT AND USEFUL LIFE**


Fig. 8 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

<b>MULTIPLIER OF RIPPLE CURRENT (<math>I_R</math>) AS A FUNCTION OF FREQUENCY</b>			
<b>FREQUENCY (Hz)</b>	<b><math>I_R</math> MULTIPLIER</b>		
	<b><math>U_R = 6.3 \text{ V TO } 10 \text{ V}</math></b>	<b><math>U_R = 16 \text{ V TO } 35 \text{ V}</math></b>	<b><math>U_R = 40 \text{ V TO } 100 \text{ V (C}_R \geq 10 \mu\text{F)}</math></b>
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

<b>TEST PROCEDURES AND REQUIREMENTS</b>			
<b>TEST</b>		<b>PROCEDURE (quick reference)</b>	<b>REQUIREMENTS</b>
<b>NAME OF TEST</b>	<b>REFERENCE</b>		
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 $I_{L5} \leq 2 \times \text{spec. limit}$

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