

# Aluminum Capacitors Radial Long Life

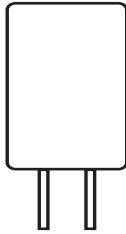
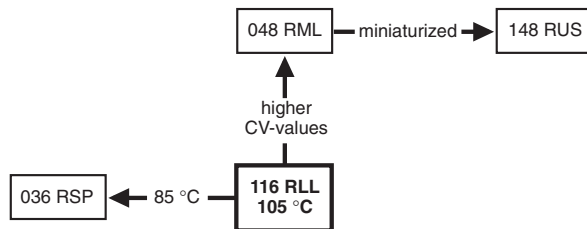


Fig.1 Component outline.



## FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Long useful life: 2000 hours at 105 °C, high reliability.

## 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  $\mu\text{F}$ ).
- 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.
- Minus-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)	$5 \times 11$ and $8.2 \times 11$
Rated capacitance range, $C_R$	0.47 to 470 $\mu\text{F}$
Tolerance on $C_R$	$\pm 20\%$
Rated voltage range, $U_R$	6.3 to 100 V
Category temperature range	$-55$ to $+105$ °C
Endurance test at 105 °C	1500 hours
Endurance test at 85 °C	5000 hours
Useful life at 105 °C	2000 hours
Useful life at 40 °C, $1.3 \times I_R$ applied	200000 hours
Shelf life at 0 V, 105 °C	1500 hours
Based on sectional specification	IEC 60384-4/EN130300
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)									
$C_R$ ( $\mu\text{F}$ )	$U_R$ (V)								
	6.3	10	16	25	35	40	50	63	100
0.47	–	–	–	–	–	–	$5 \times 11$	–	–
1.0	–	–	–	–	–	–	$5 \times 11$	–	–
1.5	–	–	–	–	–	–	$5 \times 11$	–	–
2.2	–	–	–	–	–	–	$5 \times 11$	–	$8.2 \times 11$
3.3	–	–	–	–	–	–	$5 \times 11$	–	–
4.7	–	–	–	–	–	–	$5 \times 11$	–	$8.2 \times 11$
6.8	–	–	–	–	–	–	$5 \times 11$	–	–
10	–	–	–	–	–	–	$5 \times 11$	$8.2 \times 11$	$8.2 \times 11$
	–	–	–	–	–	–	$8.2 \times 11$	–	–
15	–	–	–	–	–	–	$5 \times 11$	–	–
22	–	–	–	–	–	–	$5 \times 11$	$8.2 \times 11$	–
	–	–	–	–	–	–	$8.2 \times 11$	–	–
33	–	–	–	–	$5 \times 11$	$5 \times 11$	$8.2 \times 11$	–	–
47	–	–	–	$5 \times 11$	–	–	$8.2 \times 11$	–	–
68	–	–	$5 \times 11$	–	–	–	$8.2 \times 11$	–	–
100	–	$5 \times 11$	–	–	$8.2 \times 11$	$8.2 \times 11$	–	–	–
150	$5 \times 11$	–	–	$8.2 \times 11$	–	–	–	–	–
220	–	–	$8.2 \times 11$	–	–	–	–	–	–
330	–	$8.2 \times 11$	–	–	–	–	–	–	–
470	$8.2 \times 11$	–	–	–	–	–	–	–	–

**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**

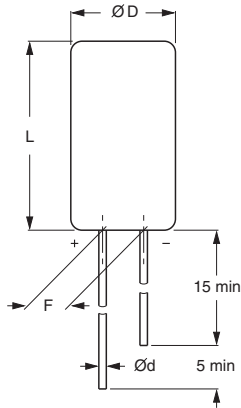
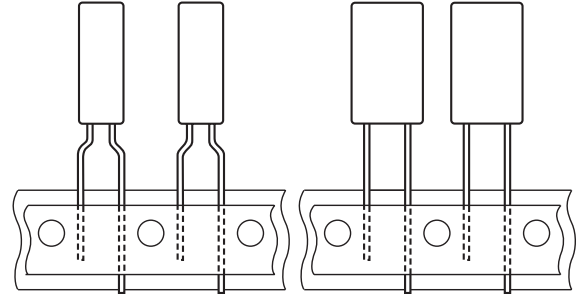
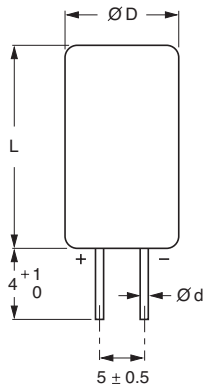


Fig.2 Form CA: Long leads.



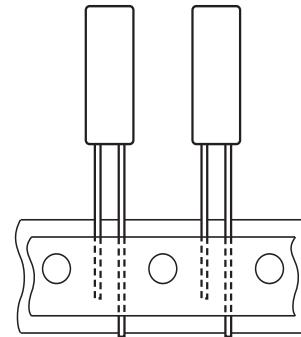
Case  $\text{ØD} \times L = 5 \times 11$  and  $8.2 \times 11$  mm.  
Pitch  $F = 5$  mm.

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



case  $\text{ØD} \times L = 8.2 \times 11$  mm only

Fig.3 Form CB: Cut leads.



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

Fig.4 Form TNA: Taped in box (ammopack)

Table 1

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

**Note**

1. Tape dimension see section 'PACKAGING'.



ELECTRICAL DATA	
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 minute at U <sub>R</sub>
Tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz and 20 °C

**ORDERING EXAMPLE**

Electrolytic capacitor 116 series  
 220 µF/16 V; ±20%  
 Nominal case size: Ø8.2 × 11 mm; Form TFA  
 Catalog number: 2222 116 35221.

**Note**

1. Unless otherwise specified, all electrical values in Table 2 apply at T<sub>amb</sub> = 20 °C, P = 86 to 106 kPa, RH = 45 to 75%.

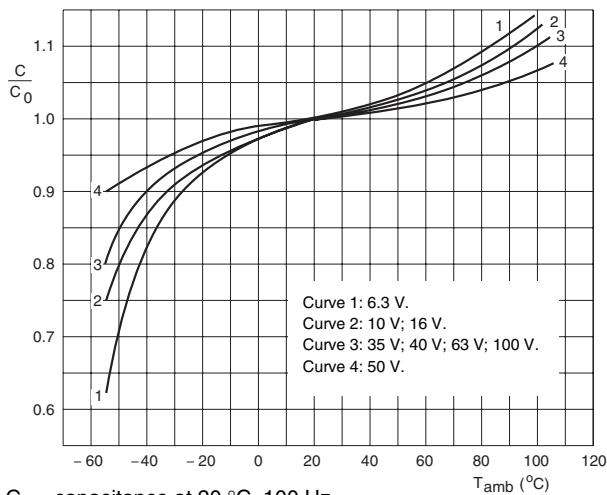
Table 2

ELECTRICAL DATA AND ORDERING INFORMATION														
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (µF)	NOMINAL CASE SIZE ØD × 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)	CATALOG NUMBER 2222 116 .....							
							BULK PACKAGING				TAPED AMMOPACK			
							LONG LEADS		CUT LEADS		FORM TFA		FORM TNA	
							FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	F (mm)
6.3	150	5 × 11	130	8.7	0.25	1.3	53151	2.5	–	–	33151	5.0	73151	2.5
	470	8.2 × 11	300	21	0.25	0.45	53471	5.0	63471	5.0	33471	5.0	–	–
10	100	5 × 11	130	9	0.2	1.4	54101	2.5	–	–	34101	5.0	74101	2.5
	330	8.2 × 11	280	23	0.2	0.45	54331	5.0	64331	5.0	34331	5.0	–	–
16	68	5 × 11	130	9.5	0.16	1.5	55689	2.5	–	–	35689	5.0	75689	2.5
	220	8.2 × 11	280	24	0.16	0.5	55221	5.0	65221	5.0	35221	5.0	–	–
25	47	5 × 11	120	10	0.14	1.6	56479	2.5	–	–	36479	5.0	76479	2.5
	150	8.2 × 11	260	26	0.14	0.5	56151	5.0	66151	5.0	36151	5.0	–	–
35	33	5 × 11	110	9.9	0.12	1.7	50339	2.5	–	–	30339	5.0	70339	2.5
	100	8.2 × 11	240	24	0.12	0.55	50101	5.0	60101	5.0	30101	5.0	–	–
40	33	5 × 11	110	10.9	0.12	1.7	57339	2.5	–	–	37339	5.0	77339	2.5
	100	8.2 × 11	240	27	0.12	0.55	57101	5.0	67101	5.0	37101	5.0	–	–
50	0.47	5 × 11	30	3.1	0.09	10	51477	2.5	–	5.0	31477	5.0	71477	2.5
	1.0	5 × 11	40	3.3	0.09	6	51108	2.5	–	5.0	31108	5.0	71108	2.5
	1.5	5 × 11	50	3.5	0.09	4	51158	2.5	–	5.0	31158	5.0	71158	2.5
	2.2	5 × 11	60	3.7	0.09	3.5	51228	2.5	–	5.0	31228	5.0	71228	2.5
	3.3	5 × 11	65	4	0.09	3.1	51338	2.5	–	5.0	31338	5.0	71338	2.5
	4.7	5 × 11	70	4.4	0.09	2.8	51478	2.5	–	5.0	31478	5.0	71478	2.5
	6.8	5 × 11	75	5	0.09	2.5	51688	2.5	–	5.0	31688	5.0	71688	2.5
	10	5 × 11	80	6	0.09	2.2	51109	2.5	–	5.0	31109	5.0	71109	2.5
	10	8.2 × 11	160	6	0.05	1.0	90084	5.0	90085	5.0	90036	5.0	–	–
	15	5 × 11	90	7.5	0.09	2.0	51159	2.5	–	5.0	31159	5.0	71159	2.5
	22	5 × 11	110	9.6	0.09	1.9	51229	2.5	–	5.0	31229	5.0	71229	2.5
	22	8.2 × 11	190	9.6	0.06	0.9	90025	5.0	90086	5.0	90039	5.0	–	–
63	33	8.2 × 11	190	13	0.09	0.77	51339	5.0	61339	5.0	31339	5.0	–	–
	47	8.2 × 11	210	17	0.09	0.65	51479	5.0	61479	5.0	31479	5.0	–	–
	68	8.2 × 11	240	23	0.09	0.55	51689	5.0	61689	5.0	31689	5.0	–	–
	10	8.2 × 11	160	7	0.06	1.3	58109	5.0	68109	5.0	38109	5.0	–	–
100	2.2	8.2 × 11	60	4.3	0.06	4	59228	5.0	69228	5.0	39228	5.0	–	–
	4.7	8.2 × 11	75	5.8	0.07	3.5	59478	5.0	69478	5.0	39478	5.0	–	–
	10	8.2 × 11	100	9	0.08	3	59109	5.0	69109	5.0	39109	5.0	–	–
	22	8.2 × 11	190	11	0.06	0.9	58229	5.0	68229	5.0	38229	5.0	–	–



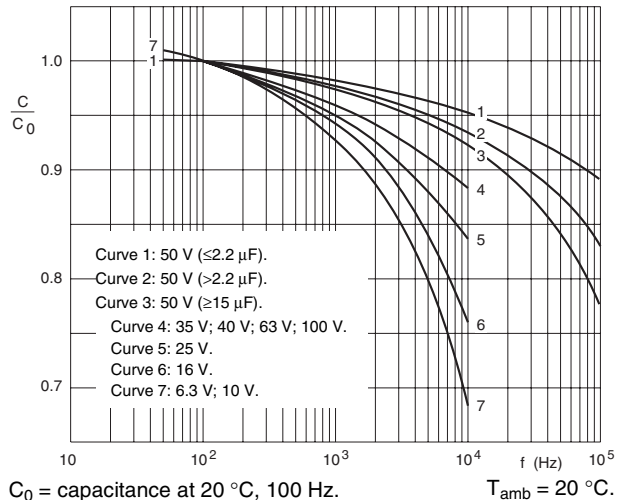
ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage		$U_s \leq 1.3 U_R$
Reverse voltage		$U_{rev} \leq 1 V$
<b>Current</b>		
Leakage current	after 1 minute at $U_R$	$I_{L1} \leq 0.006 C_R \times U_R + 3 \mu A$
	after 5 minutes at $U_R$	$I_{L5} \leq 0.001 C_R \times U_R + 3 \mu A$
<b>Inductance</b>		
Equivalent series inductance (ESL)	case $\varnothing D \times L = 5 \times 11 \text{ mm}$	typ. 13 nH
	case $\varnothing D \times L = 8.2 \times 11 \text{ mm}$	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)**



$C_0$  = capacitance at 20 °C, 100 Hz.

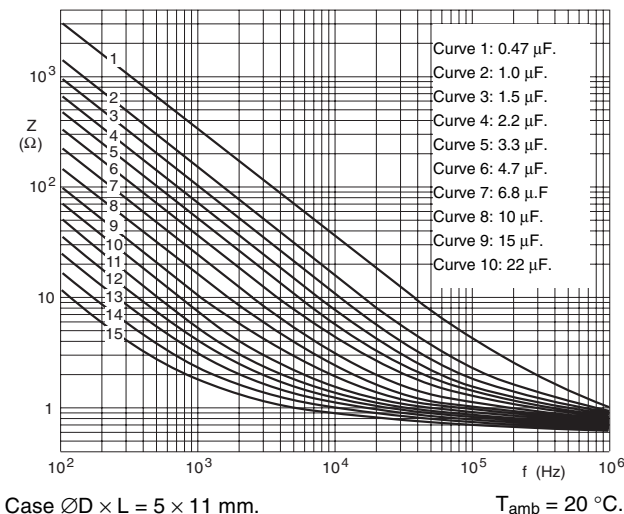
Fig.6 Typical multiplier of capacitance as a function of ambient temperature.



$C_0$  = capacitance at 20 °C, 100 Hz.

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

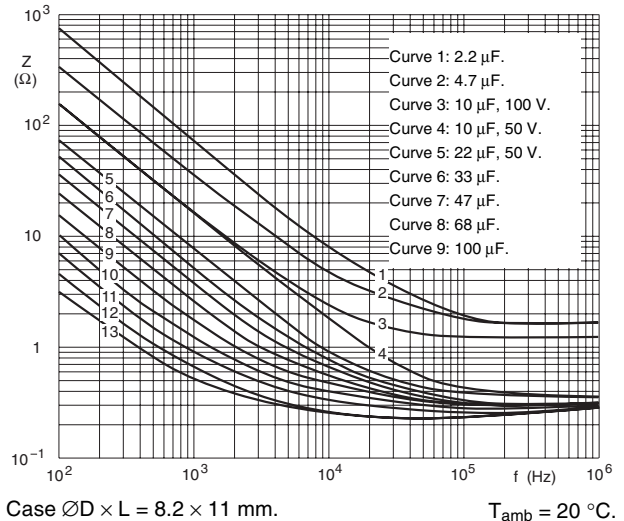
**IMPEDANCE (Z)**



Case  $\varnothing D \times L = 5 \times 11 \text{ mm}$ .

$T_{amb} = 20$  °C.

Fig.8 Typical impedance as a function of frequency.



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

$T_{amb} = 20$  °C.

Fig.9 Typical impedance as a function of frequency.

**RIPPLE CURRENT AND USEFUL LIFE**

$I_A$  = actual ripple current at 100 kHz.  
 $I_R$  = rated ripple current at 100 kHz, 105 °C.  
 (1) Useful life at 105 °C and  $I_R$  applied: 2000 hours.

Fig.10 Multiplier of useful life as a function of ambient temperature and ripple current load.

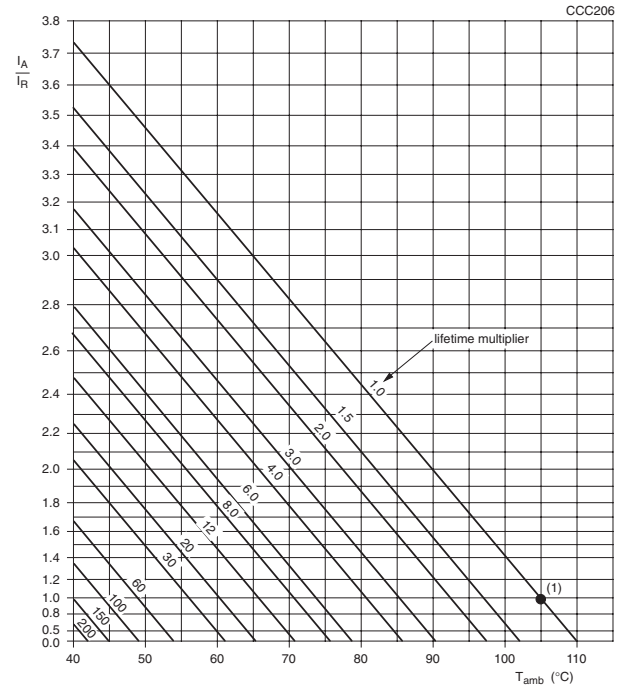


Table 3

<b>MULTIPLIER OF RIPPLE CURRENT (<math>I_R</math>) AS A FUNCTION OF FREQUENCY</b>			
FREQUENCY (Hz)	$I_R$ MULTIPLIER		
	$U_R = 6.3$ to $10$ V	$U_R = 16$ to $35$ V	$U_R = 40$ to $100$ 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
10 to 100 k	1.00	1.00	1.00

Table 4

<b>TEST PROCEDURES AND REQUIREMENTS</b>			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{\text{amb}} = 105$ °C; $U_R$ applied; 1500 hours	$U_R \leq 6.3$ V; $\Delta C/C$ : +15/-30% $U_R > 6.3$ 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	$T_{\text{amb}} = 105$ °C; $U_R$ and $I_R$ applied; 2000 hours	$U_R \leq 6.3$ V; $\Delta C/C$ : +45/-50% $U_R > 6.3$ 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	$T_{\text{amb}} = 105$ °C; no voltage applied; 1500 hours after test: $U_R$ to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$ , $\tan \delta$ , $Z$ : for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$