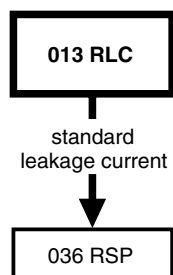


Aluminum Capacitors Radial Low Leakage Current



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
- Low leakage current, low energy consumption
- Lead (Pb)-free versions are RoHS compliant



RoHS
COMPLIANT

APPLICATIONS

- Telecommunication, automotive, audio-video, EDP and industrial
- Coupling, decoupling, buffering, timing, energy storage
- Portable and mobile equipment
- Low surface demand on printed-circuit board

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
- Minus-sign on top to identify the negative terminal
- Series number (013)

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	0.47 to 470 μF
Tolerance on C_R	$\pm 20\%$; $\pm 10\%$ on request
Rated voltage range, U_R	6.3 to 50 V
Category temperature range	- 40 to + 85 °C
Leakage current after 2 minutes: $U_R = 6.3$ to 25 V $U_R = 35$ and 50 V	 0.002 $C_R \times U_R$ or 0.7 μA , whichever is greater 0.002 $C_R \times U_R + 1 \mu\text{A}$
Endurance test at 85 °C	2000 hours
Useful life at 105 °C	750 hours
Useful life at 85 °C	3000 hours
Useful life at 40 °C, 1.4 x I_R applied	80 000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/085/56

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	50
0.47	-	-	-	-	-	5 x 11
1.0	-	-	-	5 x 11	-	5 x 11
2.2	-	-	-	5 x 11	-	5 x 11
3.3	-	-	-	5 x 11	-	5 x 11
4.7	-	-	-	5 x 11	-	5 x 11
10	-	-	-	5 x 11	-	5 x 11
22	-	-	-	5 x 11	-	5 x 11
33	-	-	5 x 11	-	5 x 11	8.2 x 11
47	-	5 x 11	5 x 11	8.2 x 11	-	8.2 x 11
68	-	5 x 11	-	-	-	8.2 x 11
100	-	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**

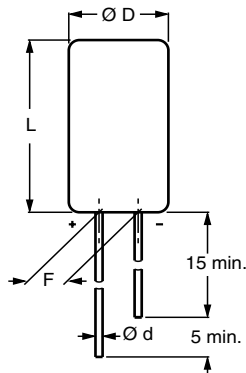


Fig.2 **Form CA:** Long leads

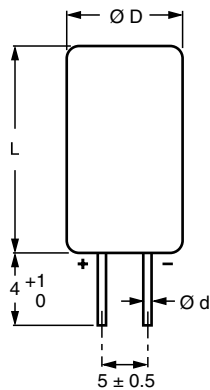
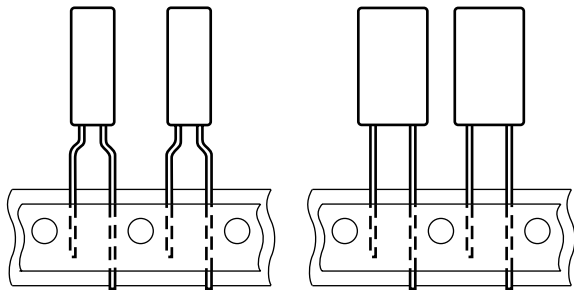
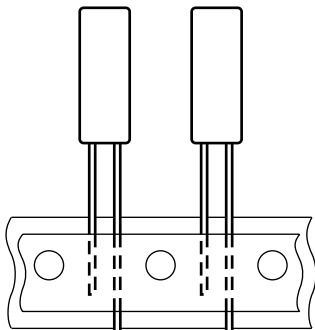


Fig.3 **Form CB:** Cut leads



Case $\varnothing D \times L = 5 \times 11$ and 8.2×11 mm
Pitch $F = 5$ mm

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



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

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

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES								
NOMINAL CASE SIZE $\varnothing D \times L$	CASE CODE	$\varnothing d$	$\varnothing D_{max.}$	$L_{max.}$	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
Detailed tape dimensions see section 'PACKAGING'.



Aluminum Capacitors Radial Low Leakage Current

Vishay BCcomponents

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 Hz, 85 °C
I_{L2}	max. leakage current after 2 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
Z	max. impedance at 10 kHz and + 20 °C

ORDERING EXAMPLE

Electrolytic capacitor 013 series

100 μ F/16 V; $\pm 20\%$ Nominal case size: $\varnothing 8.2 \times 11$ mm; Form TFA

Ordering Code: MAL201335101E3

Former 12NC: 2222 013 35101

Note

Unless otherwise specified, all electrical values in Table 1 apply at
 $T_{amb} = 20\text{ °C}$, $P = 86$ to 106 kPa, RH = 45 to 75 %.

Table 1

ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.3 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	After 2 minutes at U_R : $U_R = 6.3$ to 25 V $U_R = 35$ and 50 V	$I_{L2} \leq 0.002 C_R \times U_R$ or $0.7 \mu\text{A}$, whichever is greater $I_{L2} \leq 0.002 C_R \times U_R + 1 \mu\text{A}$
Inductance		
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
Resistance		
Equivalent series resistance (ESR)	Calculated from $\tan \delta_{\max.}$ and C_R (see Table 1)	$ESR = \tan \delta / 2 \pi f C_R$

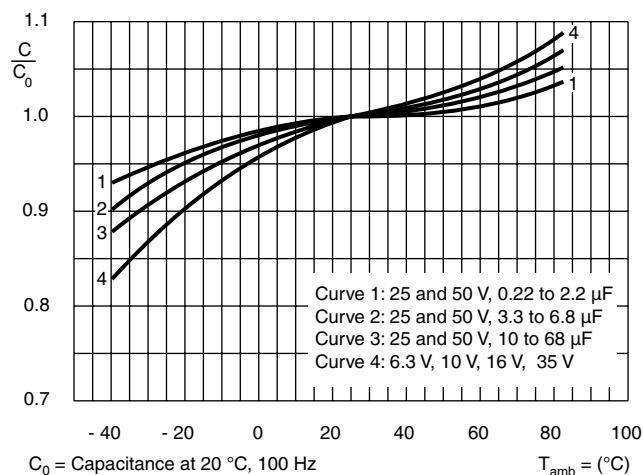
CAPACITANCE (C)

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

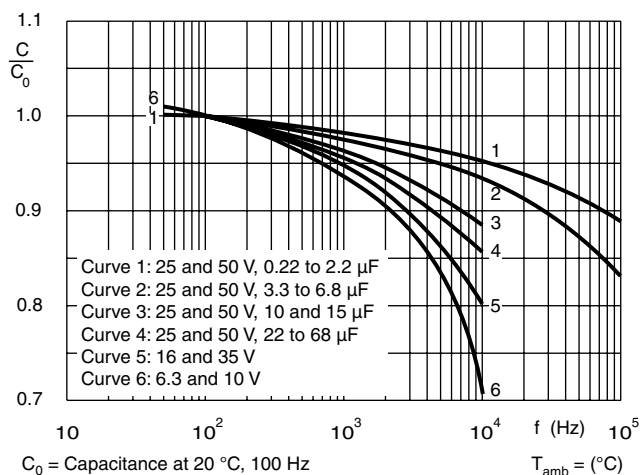


Fig.7 Typical multiplier of capacitance as a function of frequency

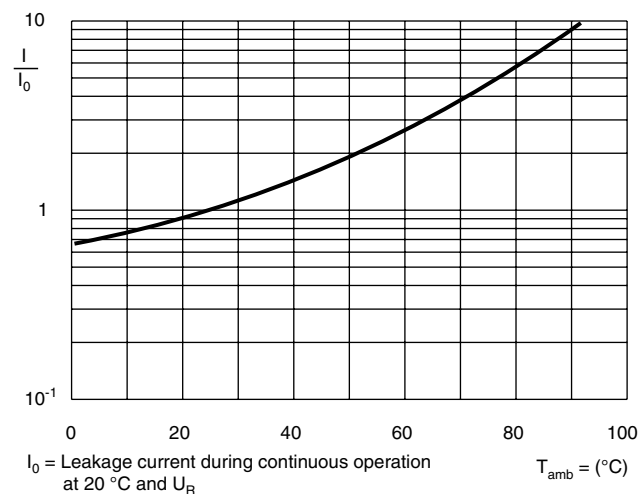
LEAKAGE CURRENT

Fig.8 Typical multiplier of leakage current as a function of ambient temperature

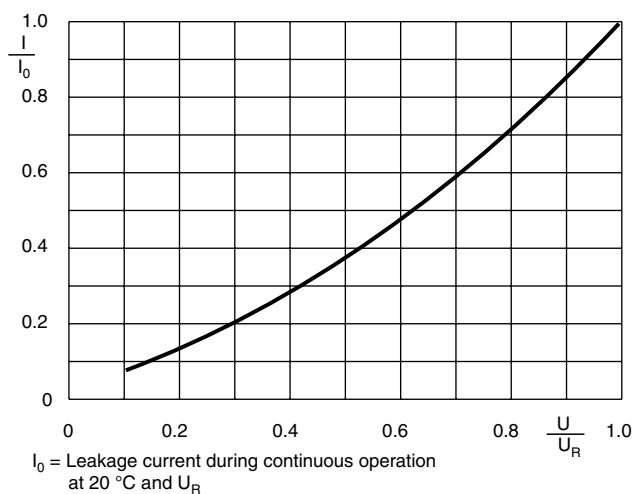
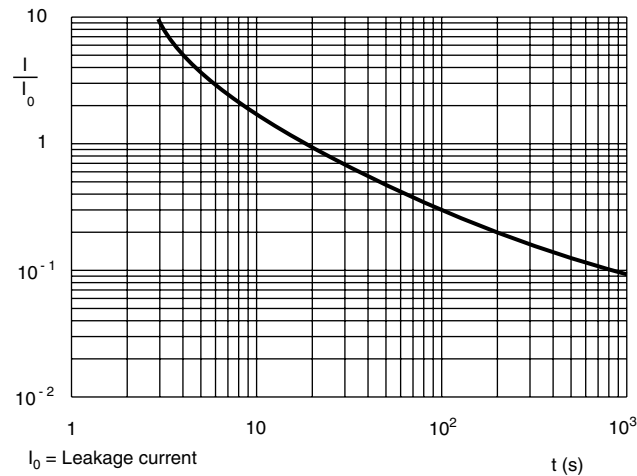
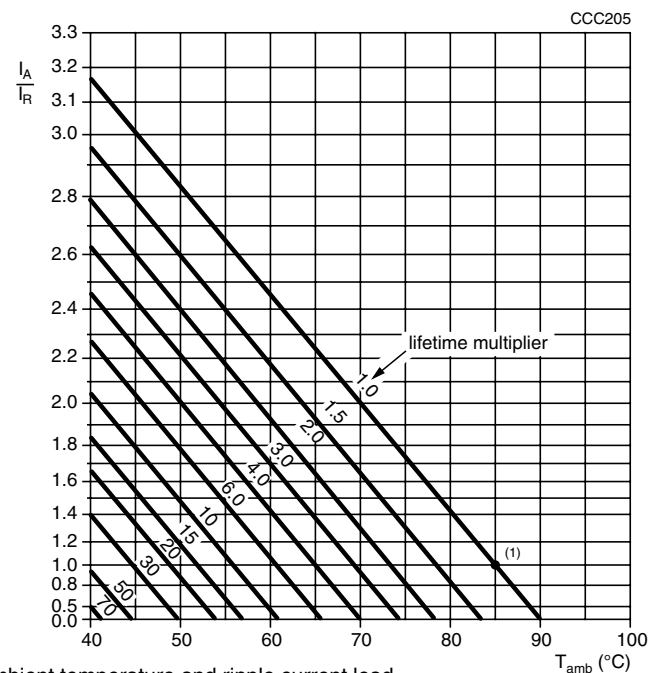


Fig.9 Typical multiplier of leakage current as a function of time

LEAKAGE CURRENT

 Fig.10 Typical multiplier of leakage current
 a function of time

RIPPLE CURRENT AND USEFUL LIFE

 I_A = Actual ripple current at 100 Hz

 I_R = Ripple current at 85 °C, 100 Hz

 (1) Useful life at 85 °C and I_R ripple current load

Fig.11 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 2

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 6.3 \text{ V}$	$U_R = 10, 16 \text{ and } 35 \text{ V}$	$U_R = 25 \text{ and } 50 \text{ V}$
50	0.90	0.85	0.80
100	1.00	1.00	1.00
300	1.12	1.20	1.25
1000	1.20	1.30	1.40
3000	1.25	1.35	1.50
$\geq 10\,000$	1.30	1.40	1.60

Table 3

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300, subclause 4.13	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R applied; 2000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: + 15/- 30 % $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\text{ }%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301, subclause 1.8.1	$T_{amb} = 85\text{ }^{\circ}\text{C}$; U_R and I_R applied; 3000 hours	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: + 45/- 50 % $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\text{ }%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\text{ }%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300, subclause 4.17	$T_{amb} = 85\text{ }^{\circ}\text{C}$; no voltage applied; 500 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 $I_{L2} \leq 2 \times \text{spec. limit}$



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