

Aluminum Electrolytic Capacitors Radial Low Leakage Current

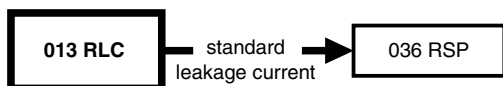


Fig. 1


**RoHS
COMPLIANT**

FEATURES

- Useful life at +85 °C: 3000 h
- Low leakage current, low energy consumption
- 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

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

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes ($\varnothing$ D x L in mm)	8.2 x 11
Rated capacitance range, C_R	33 μF to 470 μF
Tolerance on C_R	$\pm 20\%$; $\pm 10\%$ on request
Rated voltage range, U_R	6.3 V to 50 V
Category temperature range	-40 °C to +85 °C
Leakage current after 2 min: $U_R = 6.3\text{ V to }25\text{ V}$	$0.002 C_R \times U_R$ or 0.7 μA , whichever is greater
$U_R = 35\text{ V and }50\text{ V}$	$0.002 C_R \times U_R + 1\text{ }\mu\text{A}$
Endurance test at 85 °C	2000 h
Useful life at 105 °C	750 h
Useful life at 85 °C	3000 h
Useful life at 40 °C, 1.4 x I_R applied	80 000 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

SELECTION CHART FOR C_R , U_R , AND RELEVANT NOMINAL CASE SIZES ($\varnothing$ D x L in mm)						
C_R (μF)	U_R (V)					
	6.3	10	16	25	35	50
33	-	-	-	-	-	8.2 x 11
47	-	-	-	8.2 x 11	-	8.2 x 11
68	-	-	-	-	-	8.2 x 11
100	-	-	8.2 x 11	-	8.2 x 11	-
220	-	8.2 x 11	-	-	-	-
330	8.2 x 11	-	-	-	-	-
470	8.2 x 11	-	-	-	-	-

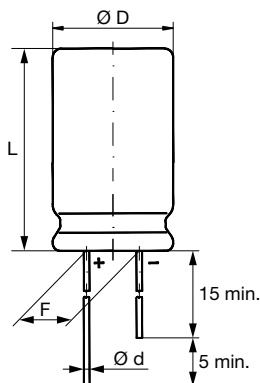
DIMENSIONS in millimeters AND AVAILABLE FORMS


Fig. 2 - Form CA: long leads

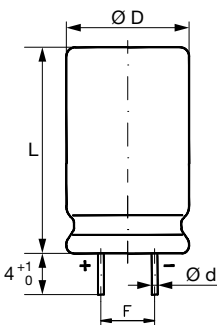


Fig. 3 - Form CB: cut leads

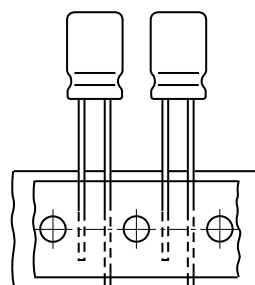

Case Ø D x L = 8.2 mm x 11 mm
Pitch F = 5 mm

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

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES

NOMINAL CASE SIZE Ø D x L	CASE CODE	Ø d	Ø D _{max.}	L _{max.}	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 dimensions, please see www.vishay.com/doc?28360.

ELECTRICAL DATA

SYMBOL	DESCRIPTION
C _R	Rated capacitance at 100 Hz, tolerance ± 20 %
I _R	Rated RMS ripple current at 100 Hz, 85 °C
I _{L2}	Max. leakage current after 2 min at U _R
tan δ	Max. dissipation factor at 100 Hz
Z	Max. impedance at 10 kHz and + 20 °C

Note

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

ORDERING EXAMPLE

Electrolytic capacitor 013 series

100 µF / 16 V; ± 20 %

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

Ordering code: MAL201335101E3

Former 12NC: 2222 013 35101

Table 1

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 _{L2} 2 min (µA)	tan δ 100 Hz	Z 10 kHz (Ω)	ORDERING CODE MAL2013.....					
							BULK PACKAGING				TAPED AMMOPACK	
							LONG LEADS		CUT LEADS		FORM TFA	F (mm)
							FORM CA	F (mm)	FORM CB	F (mm)		
6.3	330	8.2 x 11	210	4.2	0.2	0.9	53331E3	5.0	63331E3	5.0	33331E3	5.0
	470	8.2 x 11	250	5.9	0.2	0.64	53471E3	5.0	63471E3	5.0	33471E3	5.0
10	220	8.2 x 11	190	4.4	0.16	0.9	54221E3	5.0	64221E3	5.0	34221E3	5.0
16	100	8.2 x 11	150	3.2	0.13	1.0	55101E3	5.0	65101E3	5.0	35101E3	5.0
25	47	8.2 x 11	130	2.4	0.08	1.3	56479E3	5.0	66479E3	5.0	36479E3	5.0
35	100	8.2 x 11	150	8.0	0.13	1.0	50101E3	5.0	60101E3	5.0	30101E3	5.0
50	33	8.2 x 11	110	4.3	0.06	1.4	51339E3	5.0	61339E3	5.0	31339E3	5.0
	47	8.2 x 11	130	5.7	0.08	1.3	51479E3	5.0	61479E3	5.0	31479E3	5.0
	68	8.2 x 11	150	7.8	0.08	1.2	51689E3	5.0	61689E3	5.0	31689E3	5.0



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 min at U_R : $U_R = 6.3 \text{ V to } 25 \text{ V}$ $U_R = 35 \text{ V and } 50 \text{ V}$	$I_{L2} \leq 0.002 C_R \times U_R \text{ or } 0.7 \mu\text{A, whichever is greater}$ $I_{L2} \leq 0.002 C_R \times U_R + 1 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	Case $\varnothing D \times L = 8.2 \text{ mm} \times 11 \text{ mm}$	Typ. 16 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from $\tan \delta_{max}$ and C_R (see Table 1)	$ESR = \tan \delta / 2 \pi f C_R$

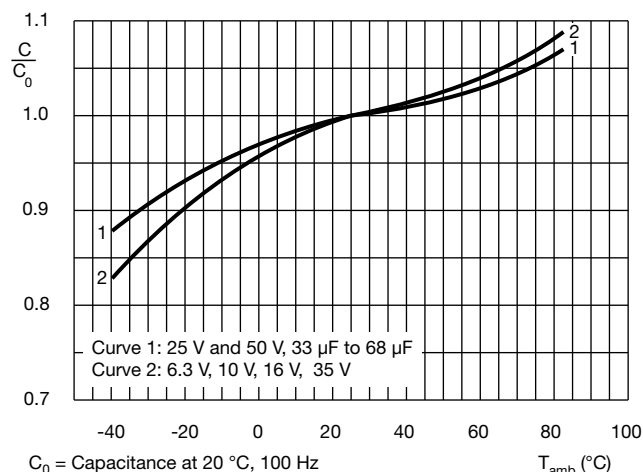
CAPACITANCE (C)

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

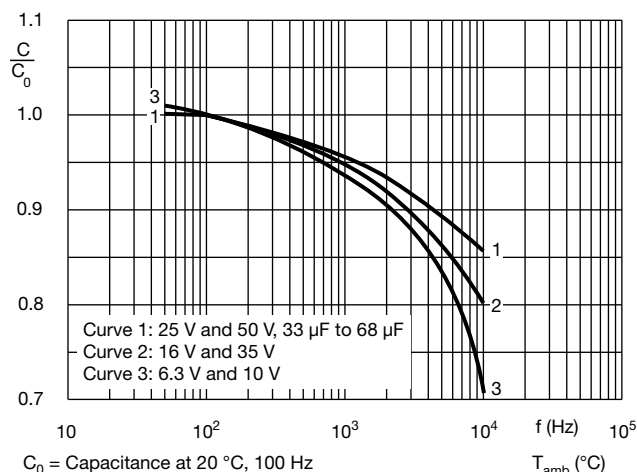


Fig. 6 - Typical multiplier of capacitance as a function of frequency

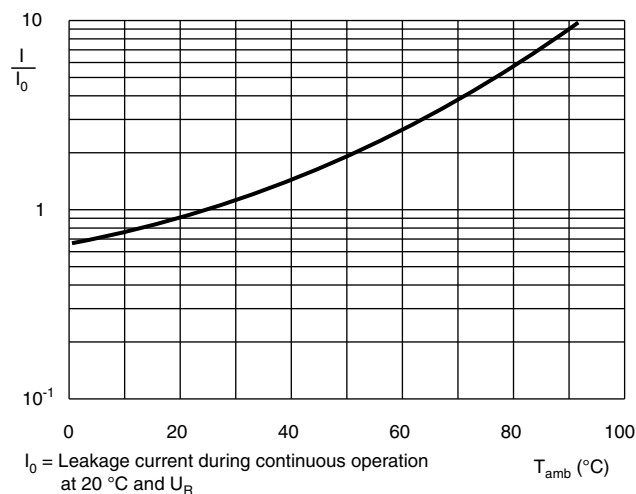
LEAKAGE CURRENT

Fig. 7 - Typical multiplier of leakage current as a function of ambient temperature

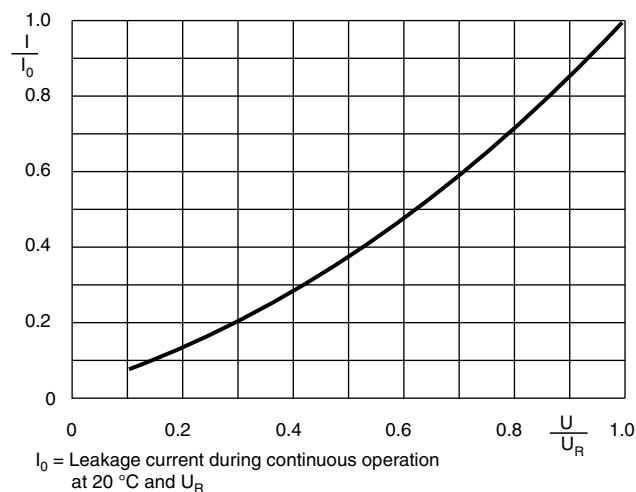


Fig. 8 - Typical multiplier of leakage current as a function of time

LEAKAGE CURRENT

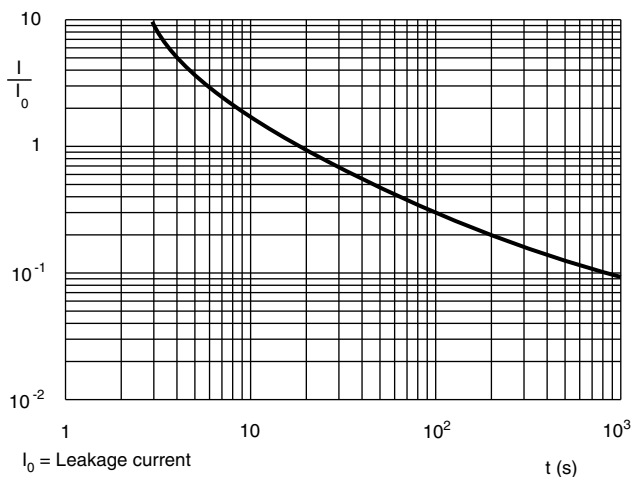


Fig. 9 - Typical multiplier of leakage current as a function of time

RIPPLE CURRENT AND USEFUL LIFE

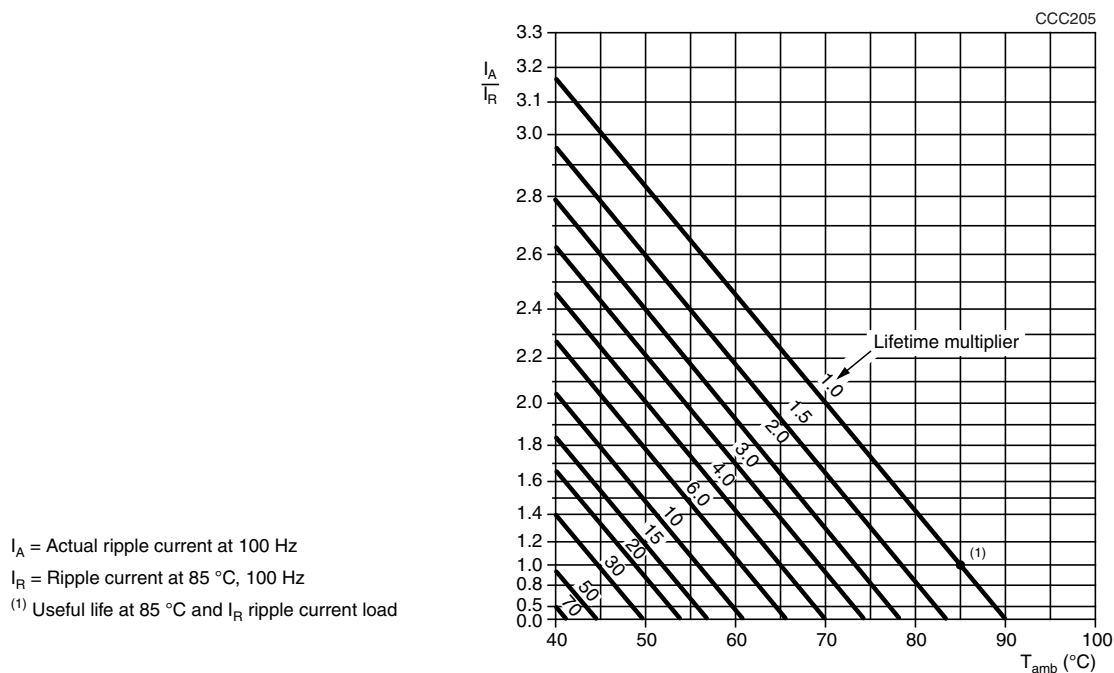


Fig. 10 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 2

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 6.3 \text{ V}$	$U_R = 10 \text{ V, 16 V, and 35 V}$	$U_R = 25 \text{ V and 50 V}$
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 h	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +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 h	$U_R \leq 6.3\text{ V}$; $\Delta C/C$: +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 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 $I_{L2} \leq 2 \times \text{spec. limit}$

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