Aluminum Capacitors
Radial Low Leakage Current

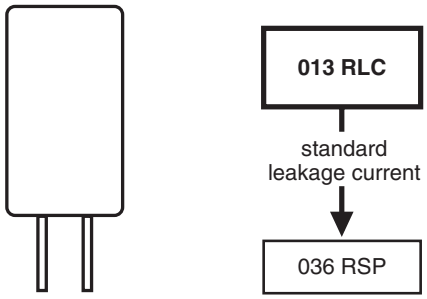


Fig.1 Component outline.

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.

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 ±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 (∅D × L in mm)	5 × 11 and 8.2 × 11
Rated capacitance range, C_R	0.47 to 470 μF
Tolerance on C_R	±20%; ±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	0.002 $C_R \times U_R$ or 0.7 μA, whichever is greater
U_R = 35 and 50 V	0.002 $C_R \times U_R$ + 1 μA
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 × I_R applied	80000 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 (∅D × L in mm)

C_R (μF)	U_R (V)					
	6.3	**10**	**16**	**25**	**35**	**50**
0.47	–	–	–	–	–	5 × 11
1.0	–	–	–	5 × 11	–	5 × 11
2.2	–	–	–	5 × 11	–	5 × 11
3.3	–	–	–	5 × 11	–	5 × 11
4.7	–	–	–	5 × 11	–	5 × 11
10	–	–	–	5 × 11	–	5 × 11
22	–	–	–	5 × 11	–	5 × 11
33	–	–	5 × 11	–	5 × 11	8.2 × 11
47	–	5 × 11	5 × 11	8.2 × 11	–	8.2 × 11
68	–	5 × 11	–	–	–	8.2 × 11
100	–	5 × 11	8.2 × 11	–	8.2 × 11	–
220	–	8.2 × 11	–	–	–	–
330	8.2 × 11	–	–	–	–	–
470	8.2 × 11	–	–	–	–	–

DIMENSIONS in millimeters **AND AVAILABLE FORMS**

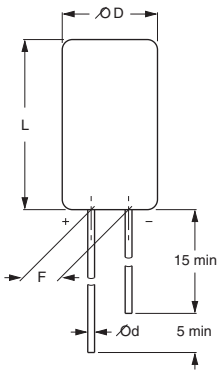
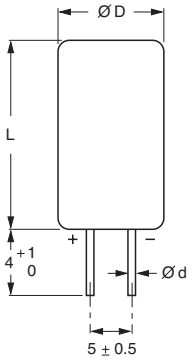
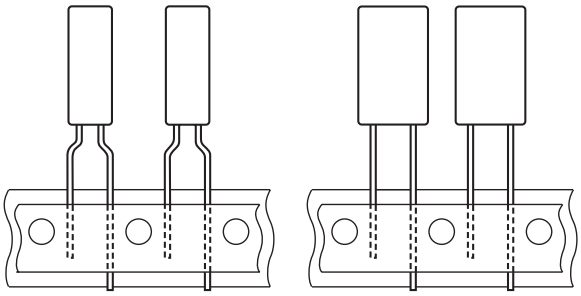


Fig.2 **Form CA:** Long leads.



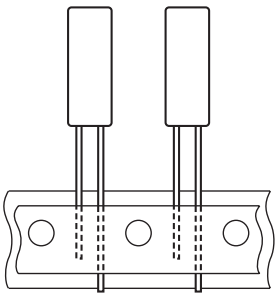
case ØD x L = 8.2 x 11mm only.

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



Case ∅D × L = 5 × 11 and 8.2 × 11 mm.
Pitch F = 5 mm.

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



Case ∅D × L = 5 × 11 mm only.
Pitch F = 2.5 mm.

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

Table 1

DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**								
NOMINAL CASE SIZE ∅D × L	**CASE CODE**	**∅d**	**∅D_{max}**	**L_{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. Detailed tape dimensions see section ‘PACKAGING’.

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 minutes at U_R
Tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 10 kHz and +20 °C

Note

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

ORDERING EXAMPLE

Electrolytic capacitor 013 series

100 µF/16 V; ±20%

Nominal case size: ∅8.2 × 11 mm; Form TFA

Catalog number: 2222 013 35101.

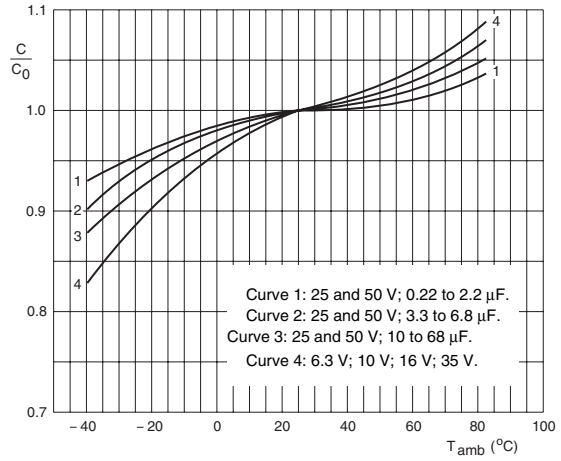
Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D × L (mm)	I_R 100 Hz 85 °C (mA)	I_{L2} 2 min (µA)	TAN δ 100 Hz	Z 10 kHz (Ω)	CATALOG NUMBER 2222 013							
							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	330	8.2 × 11	210	4.2	0.2	0.9	53331	5.0	63331	5.0	33331	5.0	–	–
	470	8.2 × 11	250	5.9	0.2	0.64	53471	5.0	63471	5.0	33471	5.0	–	–
10	47	5 × 11	75	1.0	0.16	2.8	54479	2.5	–	–	34479	5.0	74479	2.5
	68	5 × 11	90	1.4	0.16	2.5	54689	2.5	–	–	34689	5.0	74689	2.5
	100	5 × 11	110	2.0	0.16	1.7	54101	2.5	–	–	34101	5.0	74101	2.5
	220	8.2 × 11	190	4.4	0.16	0.9	54221	5.0	64221	5.0	34221	5.0	–	–
16	33	5 × 11	70	1.1	0.13	2.8	55339	2.5	–	–	35339	5.0	75339	2.5
	47	5 × 11	85	1.5	0.13	2.1	55479	2.5	–	–	35479	5.0	75479	2.5
	100	8.2 × 11	150	3.2	0.13	1.0	55101	5.0	65101	5.0	35101	5.0	–	–
25	1.0	5 × 11	5	0.7	0.06	40	56108	2.5	–	–	36108	5.0	76108	2.5
	2.2	5 × 11	10	0.7	0.06	18	56228	2.5	–	–	36228	5.0	76228	2.5
	3.3	5 × 11	18	0.7	0.06	12	56338	2.5	–	–	36338	5.0	76338	2.5
	4.7	5 × 11	25	0.7	0.06	8.5	56478	2.5	–	–	36478	5.0	76478	2.5
	10	5 × 11	50	0.7	0.06	4.0	56109	2.5	–	–	36109	5.0	76109	2.5
	22	5 × 11	75	1.1	0.08	2.7	56229	2.5	–	–	36229	5.0	76229	2.5
	47	8.2 × 11	130	2.4	0.08	1.3	56479	5.0	66479	5.0	36479	5.0	–	–
35	33	5 × 11	70	3.3	0.13	2.8	50339	5.0	–	–	30339	5.0	70339	2.5
	100	8.2 × 11	150	8.0	0.13	1.0	50101	5.0	60101	5.0	30101	5.0	–	–
50	0.47	5 × 11	5	1.1	0.06	85	51477	2.5	–	–	31477	5.0	71477	2.5
	1.0	5 × 11	10	1.1	0.06	40	51108	2.5	–	–	31108	5.0	71108	2.5
	2.2	5 × 11	20	1.2	0.06	18	51228	2.5	–	–	31228	5.0	71228	2.5
	3.3	5 × 11	32	1.3	0.06	12	51338	2.5	–	–	31338	5.0	71338	2.5
	4.7	5 × 11	38	1.5	0.06	8.5	51478	2.5	–	–	31478	5.0	71478	2.5
	10	5 × 11	55	2.0	0.06	4.0	51109	2.5	–	–	31109	5.0	71109	2.5
	22	5 × 11	75	3.2	0.08	2.7	51229	2.5	–	–	31229	5.0	71229	2.5
	33	8.2 × 11	110	4.3	0.06	1.4	51339	5.0	61339	5.0	31339	5.0	–	–
	47	8.2 × 11	130	5.7	0.08	1.3	51479	5.0	61479	5.0	31479	5.0	–	–
	68	8.2 × 11	150	7.8	0.08	1.2	51689	5.0	61689	5.0	31689	5.0	–	–

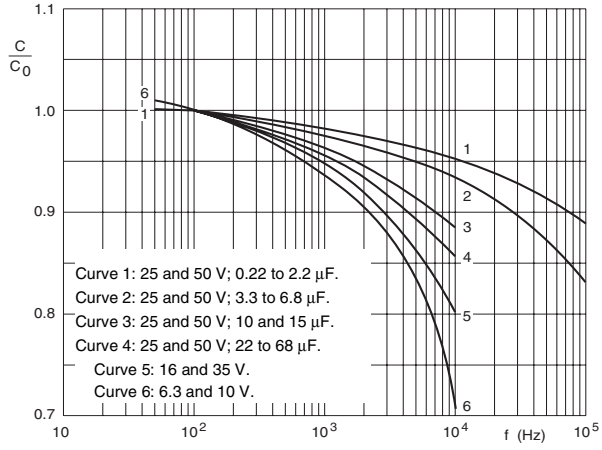
ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.3 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	after 2 minutes at U_R: U_R = 6.3 to 25 V U_R = 35 and 50 V	 $I_{L2} \leq 0.002\ C_R \times U_R$ or 0.7 µA, whichever is greater $I_{L2} \leq 0.002\ C_R \times U_R + 1$ µA
Inductance		
Equivalent series inductance (ESL)	case ∅D × L = 5 × 11 mm	typ. 13 nH
	case ∅D × L = 8.2 × 11 mm	typ. 16 nH
Resistance		
Equivalent series resistance (ESR)	calculated from tan δ_{max} and C_R (see Table 2)	ESR = tan δ / $2\pi f C_R$

CAPACITANCE (C)



C_0 = capacitance at 20 °C, 100 Hz.

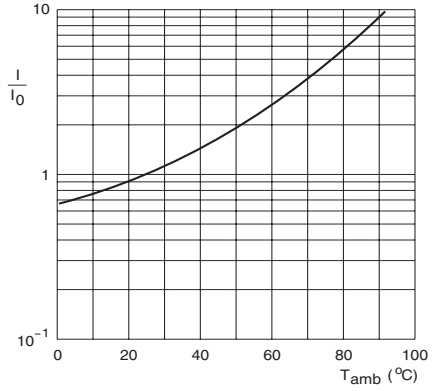
Fig.6 Typical multiplier of capacitance as a function of ambient temperature.



C_0 = capacitance at 20 °C, 100 Hz. T_{amb} = 20 °C.

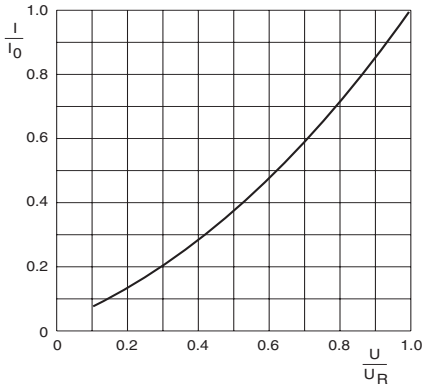
Fig.7 Typical multiplier of capacitance as a function of frequency.

LEAKAGE CURRENT



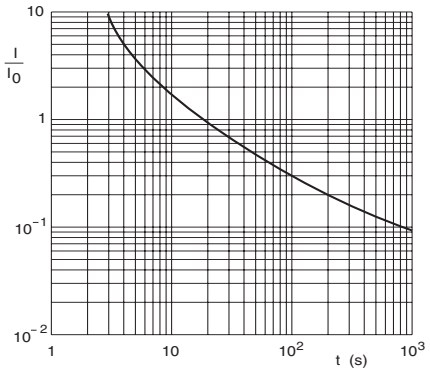
I_0 = leakage current during continuous operation at 20 °C and U_R.

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



I_0 = leakage current during continuous operation at 20 °C and U_R.

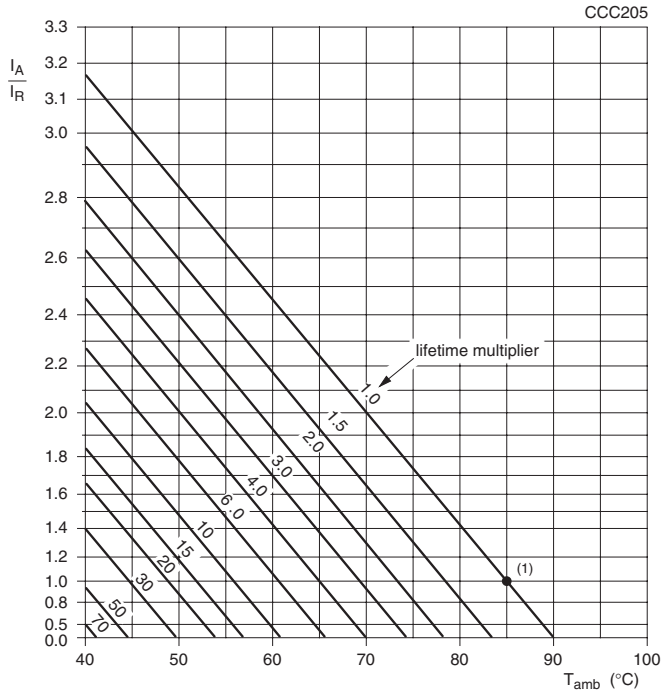
Fig.9 Typical multiplier of leakage current as a function of U/U_R.



I_0 = leakage current.

Fig.10 Typical multiplier of leakage current as 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 applied: 3000 hours

Fig.11 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 V	U_R = 10, 16 and 35 V	U_R = 25 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
≥10000	1.30	1.40	1.60

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300, subclause 4.13	T_{amb} = 85 °C; U_R applied; 2000 hours	$U_R \leq 6.3$ V; ΔC/C: +15/–30% $U_R > 6.3$ V; ΔC/C: ±15% tan δ ≤ 1.3 × spec. limit Z ≤ 2 × spec. limit I_{L2} ≤ spec. limit
Useful life	CECC 30301, subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 3000 hours	$U_R \leq 6.3$ V; ΔC/C: +45/–50% $U_R > 6.3$ V; ΔC/C: ±45% tan δ ≤ 3 × spec. limit Z ≤ 3 × spec. limit I_{L2} ≤ spec. limit no short or open circuit total failure percentage: ≤ 1%
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300, subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C, tan δ, Z: for requirements see 'Endurance test' above $I_{L2} \leq 2 \times$ spec. limit