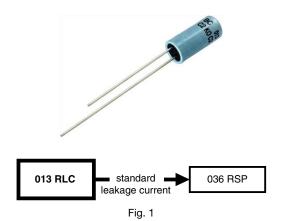


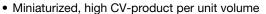
Aluminum Electrolytic Capacitors Radial Low Leakage Current

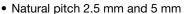


QUICK REFERENCE DATA					
DESCRIPTION	VALUE				
Nominal case sizes (Ø D x L in mm)	5 x 11 and 8.2 x 11				
Rated capacitance range, C _R	2.2 μF to 470 μF				
Tolerance on C _R	± 20 %; ± 10 % on request				
Rated voltage range, U _R	6.3 V to 50 V				
Category temperature range	-40 °C to +85 °C				
Leakage current after 2 min:					
U _R = 6.3 V to 25 V	$0.002~C_R~x~U_R~or~0.7~\mu A,$ whichever is greater				
U _R = 35 V and 50 V	$0.002 C_R \times U_R + 1 \mu A$				
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				

FEATURES

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





- 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 <u>www.vishay.com/doc?99912</u>

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

SELECTIO	SELECTION CHART FOR C _R , U _R , AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)									
C _R	U _R (V)									
(μ F)	6.3	10	16	25	35	50				
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**

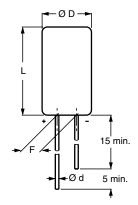


Fig. 2 - Form CA: Long leads

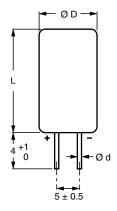
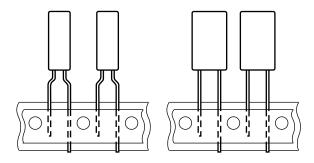
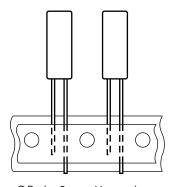


Fig. 3 - Form CB: Cut leads



Case \emptyset D x L = 5 mm x 11 mm and 8.2 mm x 11 mm Pitch F = 5 mm



Case \emptyset D x L = 5 mm x 11 mm only Pitch F = 2.5 mm

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

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

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES										
NOMINAL	AL CASE		MASS		CASE		MACC		PACKAGING (QUANTITIES
CASE SIZE Ø D x L	CODE	Ød	Ø D _{max} .	L _{max} .	F	(g)		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

• For detailed tape dimensions, please see www.vishay.com/doc?28360.



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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						

ORDERING EXAMPLE

Electrolytic capacitor 013 series

100 μF / 16 V; \pm 20 %

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

Ordering Code: MAL201335101E3 Former 12NC: 2222 013 35101

Note

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

Table 1

EL	ELECTRICAL DATA AND ORDERING INFORMATION													
		NOMINAL . ORDERING CODE MAL2013												
U _R	C _R	CASE	IR IL2 tan 8		tan S	z	BULK PACKAGING				TAPED AMMOPACK			
(V)	100 Hz (μF)	SIZE Ø D x L	85 °C	2 min 100 Hz	10 kHz (Ω)	LONG L	EADS	CUT LE	ADS	IA	F LD AN	MINIOPACK		
	(μΓ)	(mm)	(mA)	(μΑ)		(52)	FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)	FORM TNA	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	-	-
0.3	470	8.2 x 11	250	5.9	0.2	0.64	53471E3	5.0	63471E3	5.0	33471E3	5.0	-	-
	47	5 x 11	75	1.0	0.16	2.8	54479E3	2.5	-	=	34479E3	5.0	74479E3	2.5
10	68	5 x 11	90	1.4	0.16	2.5	54689E3	2.5	-	-	34689E3	5.0	74689E3	2.5
10	100	5 x 11	110	2.0	0.16	1.7	54101E3	2.5	-	-	34101E3	5.0	74101E3	2.5
	220	8.2 x 11	190	4.4	0.16	0.9	54221E3	5.0	64221E3	5.0	34221E3	5.0	-	-
	33	5 x 11	70	1.1	0.13	2.8	55339E3	2.5	-	-	35339E3	5.0	75339E3	2.5
16	47	5 x 11	85	1.5	0.13	2.1	55479E3	2.5	-	-	35479E3	5.0	75479E3	2.5
	100	8.2 x 11	150	3.2	0.13	1.0	55101E3	5.0	65101E3	5.0	35101E3	5.0	-	-
	2.2	5 x 11	10	0.7	0.06	18	56228E3	2.5	-	-	36228E3	5.0	76228E3	2.5
	3.3	5 x 11	18	0.7	0.06	12	56338E3	2.5	-	-	36338E3	5.0	76338E3	2.5
0.5	4.7	5 x 11	25	0.7	0.06	8.5	56478E3	2.5	-	-	36478E3	5.0	76478E3	2.5
25	10	5 x 11	50	0.7	0.06	4.0	56109E3	2.5	-	-	36109E3	5.0	76109E3	2.5
	22	5 x 11	75	1.1	0.08	2.7	56229E3	2.5	-	-	36229E3	5.0	76229E3	2.5
	47	8.2 x 11	130	2.4	0.08	1.3	56479E3	5.0	66479E3	5.0	36479E3	5.0	-	-
0.5	33	5 x 11	70	3.3	0.13	2.8	50339E3	2.5	-	-	30339E3	5.0	70339E3	2.5
35	100	8.2 x 11	150	8.0	0.13	1.0	50101E3	5.0	60101E3	5.0	30101E3	5.0	-	-
	2.2	5 x 11	20	1.2	0.06	18	51228E3	2.5	-	-	31228E3	5.0	71228E3	2.5
	3.3	5 x 11	32	1.3	0.06	12	51338E3	2.5	-	-	31338E3	5.0	71338E3	2.5
	4.7	5 x 11	38	1.5	0.06	8.5	51478E3	2.5	-	-	31478E3	5.0	71478E3	2.5
	10	5 x 11	55	2.0	0.06	4.0	51109E3	2.5	-	-	31109E3	5.0	71109E3	2.5
50	22	5 x 11	75	3.2	0.08	2.7	51229E3	2.5	-	-	31229E3	5.0	71229E3	2.5
	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	-	-

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ADDITIONAL ELECTRICAL DATA						
PARAMETER	CONDITIONS	VALUE				
Voltage						
Surge voltage		$U_s \le 1.3 \times U_R$				
Reverse voltage		$U_{rev} \le 1 \text{ V}$				
Current						
	After 2 min at U _R :					
Leakage current	U _R = 6.3 V to 25 V	$I_{L2} \leq 0.002~C_R~x~U_R$ or 0.7 $\mu A,~whichever~is~greater$				
	U _R = 35 V and 50 V	$I_{L2} \le 0.002 C_R \times U_R + 1 \mu A$				
Inductance						
Equivalent perios industance (ESL)	Case Ø D x L = 5 mm x 11 mm	Typ. 13 nH				
Equivalent series inductance (ESL)	Case Ø D x L = 8.2 mm x 11 mm	Typ. 16 nH				
Resistance						
Equivalent series resistance (ESR)	Calculated from tan $\delta_{\text{max.}}$ and C_{R} (see Table 1)	ESR = $\tan \delta/2 \pi f C_R$				

CAPACITANCE (C)

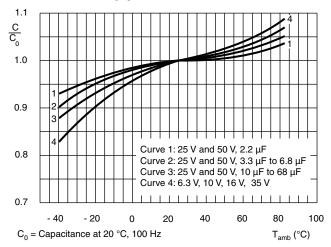


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

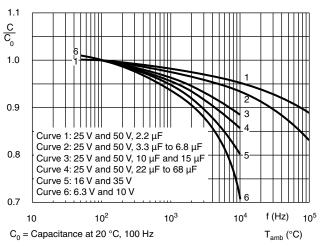


Fig. 7 - Typical multiplier of capacitance as a function of frequency

LEAKAGE CURRENT

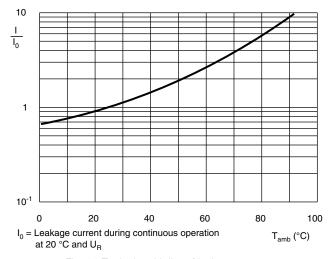


Fig. 8 - Typical multiplier of leakage current as a function of ambient temperature

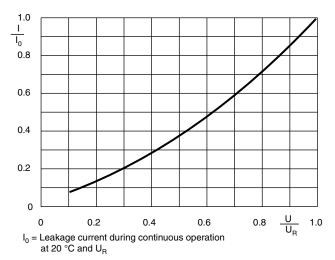


Fig. 9 - Typical multiplier of leakage current as a function of time



LEAKAGE CURRENT

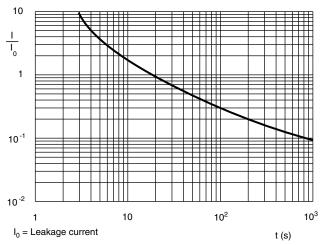


Fig. 10 - Typical multiplier of leakage current as a function of time

RIPPLE CURRENT AND USEFUL LIFE

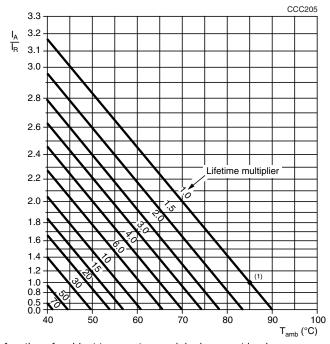


Fig. 11 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 2

MULTIPLIER OF RIPPLE CURRENT (I _R) AS A FUNCTION OF FREQUENCY							
FREQUENCY	I _R MULTIPLIER						
(Hz)	U _R = 6.3 V	U _R = 10 V, 16 V, and 35 V	U _R = 25 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				
≥ 10 000	1.30	1.40	1.60				

 $I_A = Actual ripple current at 100 Hz$

 I_R = Ripple current at 85 °C, 100 Hz

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



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Table 3

TEST PROCEDURES AND REQUIREMENTS							
	TEST	PROCEDURE	REQUIREMENTS				
NAME OF TEST	REFERENCE	PROCEDURE	REQUIREMENTS				
Endurance	IEC 60384-4 / EN130300, subclause 4.13	T _{amb} = 85 °C; U _R applied; 2000 h	$\begin{array}{l} U_{R} \leq 6.3 \text{ V; } \Delta C/C\text{: } +15 \text{ % } / \text{-}30 \text{ %} \\ U_{R} > 6.3 \text{ V; } \Delta C/C\text{: } \pm 15 \text{ %} \\ \tan \delta \leq 1.3 \text{ x spec. limit} \\ Z \leq 2 \text{ x spec. limit} \\ I_{L2} \leq \text{spec. limit} \end{array}$				
Useful life	CECC 30301, subclause 1.8.1	T _{amb} = 85 °C; U _R and I _R applied; 3000 h	$\begin{array}{l} U_R \leq 6.3 \text{ V; } \Delta \text{C/C: } +45 \text{ % / -50 \%} \\ U_R > 6.3 \text{ V; } \Delta \text{C/C: } \pm 45 \text{ %} \\ \tan \delta \leq 3 \text{ x spec. limit} \\ Z \leq 3 \text{ x spec. limit} \\ I_{L2} \leq \text{spec. limit} \\ \text{no short or open circuit} \\ \text{total failure percentage: } \leq 1 \text{ %} \\ \end{array}$				
Shelf life (storage at high temperature)	IEC 60384-4 / EN130300, subclause 4.17	T _{amb} = 85 °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 $I_{L2} \le 2$ x spec. limit				

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