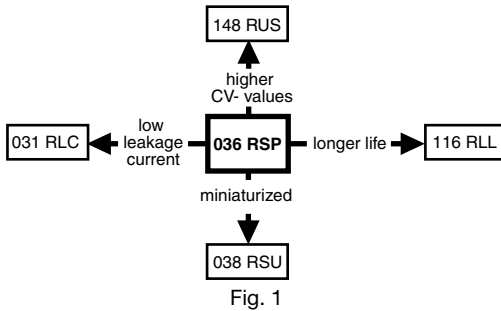
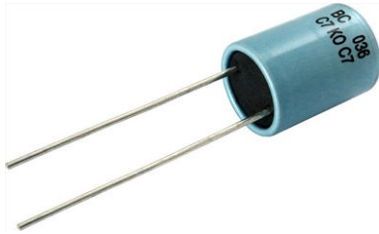


## Aluminum Electrolytic Capacitors Radial Semi-Professional



### FEATURES

- Useful life: 3000 h at +85 °C, 750 h at +105 °C
- Reduced leakage current
- Miniaturized, high CV-product per unit volume
- Natural pitch 2.5 mm and 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](http://www.vishay.com/doc?99912)


**RoHS  
COMPLIANT**

### APPLICATIONS

- Automotive, telecommunication, industrial, EDP, and audio-video
- Coupling, decoupling, smoothing, filtering, buffering, timing
- 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 (036)

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes ( $\varnothing$ D x L in mm)	5 x 11 and 8.2 x 11
Rated capacitance range, $C_R$	2.2 $\mu\text{F}$ to 470 $\mu\text{F}$
Tolerance on $C_R$	$\pm 20\%$ ; $\pm 10\%$ on request
Rated voltage range, $U_R$	6.3 V to 100 V
Category temperature range	-55 °C to +85 °C
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 / EN130300
Climatic category IEC 60068	55 / 085 / 56

SELECTION CHART FOR $C_R$ , $U_R$ , AND RELEVANT NOMINAL CASE SIZES ( $\varnothing$ D x L in mm)									
$C_R$ ( $\mu\text{F}$ )	$U_R$ (V)								
	6.3	10	16	25	35	40	50	63	100
2.2	-	-	-	-	-	-	-	5 x 11	-
3.3	-	-	-	-	-	-	-	5 x 11	-
4.7	-	-	-	-	-	-	-	5 x 11	-
6.8	-	-	-	-	-	-	-	5 x 11	-
10	-	-	-	-	-	-	5 x 11	5 x 11	8.2 x 11
	-	-	-	-	-	-	-	8.2 x 11	-
15	-	-	-	-	-	5 x 11	-	5 x 11	-
22	-	-	-	-	5 x 11	-	-	5 x 11	8.2 x 11
	-	-	-	-	-	-	-	8.2 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	-	8.2 x 11	-
100	5 x 11	-	5 x 11	8.2 x 11	-	-	8.2 x 11	-	-
150	-	5 x 11	8.2 x 11	-	8.2 x 11	-	-	-	-
220	-	8.2 x 11	8.2 x 11	8.2 x 11	-	-	-	-	-
330	8.2 x 11	-	8.2 x 11	-	-	-	-	-	-
470	-	8.2 x 11	-	-	-	-	-	-	-

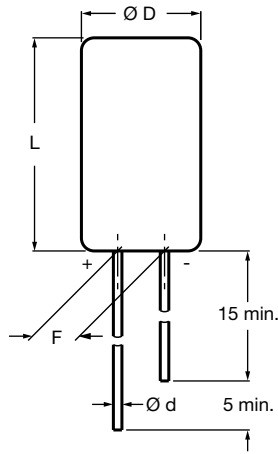
**DIMENSIONS in millimeters AND AVAILABLE FORMS**


Fig. 2 - Form CA: Long leads

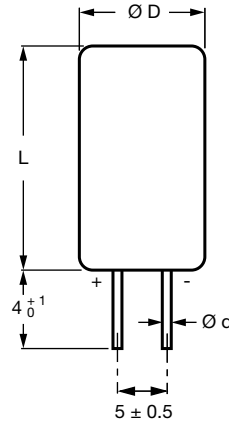

 Case  $\varnothing D \times L = 8.2 \text{ mm} \times 11 \text{ mm}$  only

Fig. 3 - Form CB: Cut leads

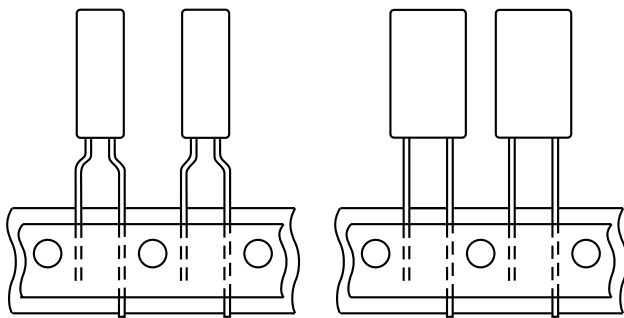

 Pitch  $F = 5 \text{ mm}$   
 Case  $\varnothing D \times L = 5 \text{ mm} \times 11 \text{ mm}$  and  $8.2 \text{ mm} \times 11 \text{ mm}$ 

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

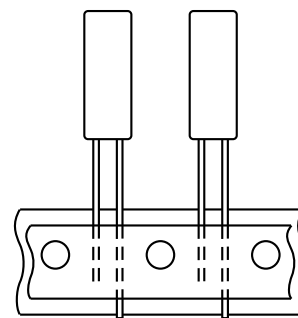

 Pitch  $F = 2.5 \text{ mm}$   
 Case  $\varnothing D \times L = 5 \text{ mm} \times 11 \text{ mm}$  only

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

**Table 1**

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES								
NOMINAL CASE SIZE $\varnothing D \times L$	CASE CODE	$\varnothing d$	$\varnothing D_{\text{max}}$	$L_{\text{max}}$	F	MASS (g)	PACKAGING QUANTITIES	
							FORM CA, CB	FORM TFA, TNA
5 x 11	11	0.5	5.5	12	$2.5 \pm 0.5$	$\approx 0.4$	1000	2000
8.2 x 11	13	0.6	8.7	12	$5.0 \pm 0.5$	$\approx 1.1$	1000	1000

**Note**

- For tape dimensions, please see [www.vishay.com/doc?28360](http://www.vishay.com/doc?28360).



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 Hz, 85 °C
I <sub>L1</sub>	Max. leakage current after 1 min at U <sub>R</sub>
tan δ	Max. dissipation factor at 100 Hz
Z	Max. impedance at 10 kHz and 20 °C

**ORDERING EXAMPLE**

Electrolytic capacitor 036 series  
 100 µF / 16 V; ± 20 %  
 Nominal case size: Ø 5 x 11 mm; Form TFA  
 Ordering code: MAL203635101E3  
 Former 12NC: 2222 036 35101

**Note**

- Unless otherwise specified, all electrical values in Table 2 apply at T<sub>amb</sub> = 20 °C, P = 86 kPa 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 Ø D x L (mm)	I <sub>R</sub> 100 Hz 85 °C (mA)	I <sub>L2</sub> 2 min (µA)	tan δ 100 Hz	Z 10 kHz (Ω)	ORDERING CODE MAL2036.....							
							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	100	5 x 11	130	7	0.20	1.7	53101E3	2.5	-	-	33101E3	5.0	73101E3	2.5
	330	8.2 x 11	300	16	0.20	0.52	53331E3	5.0	63331E3	5.0	33331E3	5.0	-	-
10	47	5 x 11	95	6	0.16	2.8	54479E3	2.5	-	-	34479E3	5.0	74479E3	2.5
	150	5 x 11	150	12	0.20	1.3	54151E3	2.5	-	-	34151E3	5.0	74151E3	2.5
	220	8.2 x 11	260	17	0.16	0.59	54221E3	5.0	64221E3	5.0	34221E3	5.0	-	-
	470	8.2 x 11	400	31	0.20	0.43	54471E3	5.0	64471E3	5.0	34471E3	5.0	-	-
16	33	5 x 11	90	7	0.14	2.7	55339E3	2.5	-	-	35339E3	5.0	75339E3	2.5
	100	5 x 11	160	13	0.16	1.6	55101E3	2.5	-	-	35101E3	5.0	75101E3	2.5
	150	8.2 x 11	230	18	0.14	0.6	55151E3	5.0	65151E3	5.0	35151E3	5.0	-	-
	220	8.2 x 11	280	24	0.16	0.55	55221E3	5.0	65221E3	5.0	35221E3	5.0	-	-
25	330	8.2 x 11	390	35	0.16	0.48	55331E3	5.0	65331E3	5.0	35331E3	5.0	-	-
	68	5 x 11	140	13	0.14	1.8	56689E3	2.5	-	-	36689E3	5.0	76689E3	2.5
	100	8.2 x 11	210	18	0.12	0.7	56101E3	5.0	66101E3	5.0	36101E3	5.0	-	-
	220	8.2 x 11	310	36	0.14	0.55	56221E3	5.0	66221E3	5.0	36221E3	5.0	-	-
35	22	5 x 11	87	8	0.10	2.7	90001E3	2.5	-	-	90027E3	5.0	90389E3	2.5
	47	5 x 11	130	13	0.12	1.9	90094E3	2.5	-	-	90098E3	5.0	90391E3	2.5
	150	8.2 x 11	270	35	0.12	0.6	90099E3	5.0	90101E3	5.0	90103E3	5.0	-	-
40	15	5 x 11	72	7	0.10	3.7	57159E3	2.5	-	-	37159E3	5.0	77159E3	2.5
	68	8.2 x 11	180	20	0.10	0.81	57689E3	5.0	67689E3	5.0	37689E3	5.0	-	-
50	10	5 x 11	60	6	0.08	4.5	90004E3	2.5	-	-	90028E3	5.0	90392E3	2.5
	33	5 x 11	110	13	0.10	2.1	90104E3	2.5	-	-	90108E3	5.0	90393E3	2.5
	47	8.2 x 11	160	18	0.08	0.96	90011E3	5.0	90012E3	5.0	90031E3	5.0	-	-
	100	8.2 x 11	250	33	0.10	0.7	90109E3	5.0	90111E3	5.0	90113E3	5.0	-	-
63	2.2	5 x 11	25	4	0.06	18	58228E3	2.5	-	-	38228E3	5.0	78228E3	2.5
	3.3	5 x 11	38	5	0.06	12	58338E3	2.5	-	-	38338E3	5.0	78338E3	2.5
	4.7	5 x 11	45	5	0.06	8.5	58478E3	2.5	-	-	38478E3	5.0	78478E3	2.5
	6.8	5 x 11	55	6	0.06	5.9	58688E3	2.5	-	-	38688E3	5.0	78688E3	2.5
	10	5 x 11	70	7	0.06	4.0	58109E3	2.5	-	-	38109E3	5.0	78109E3	2.5
	10	8.2 x 11	120	7	0.04	2.8	90036E3	5.0	90041E3	5.0	90181E3	5.0	-	-
	15	5 x 11	80	9	0.07	3.1	58159E3	2.5	-	-	38159E3	5.0	78159E3	2.5
	22	5 x 11	100	11	0.08	2.7	58229E3	2.5	-	-	38229E3	5.0	78229E3	2.5
	22	8.2 x 11	150	11	0.05	1.4	90117E3	5.0	90118E3	5.0	90139E3	5.0	-	-
	33	8.2 x 11	160	16	0.06	1.2	58339E3	5.0	68339E3	5.0	38339E3	5.0	-	-
	47	8.2 x 11	190	21	0.07	1.0	58479E3	5.0	68479E3	5.0	38479E3	5.0	-	-
	68	8.2 x 11	210	29	0.08	0.88	58689E3	5.0	68689E3	5.0	38689E3	5.0	-	-
100	10	8.2 x 11	80	9	0.06	3.5	59109E3	5.0	69109E3	5.0	39109E3	5.0	-	-
	22	8.2 x 11	110	16	0.06	1.8	59229E3	5.0	69229E3	5.0	39229E3	5.0	-	-



ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage		$U_s \leq 1.15 U_R$
Reverse voltage		$U_{rev} \leq 1 V$
<b>Current</b>		
Leakage current	After 1 min $U_R = 6.3 V$ to $100 V$	$I_{L1} \leq 0.006 C_R \times U_R + 3 \mu A$
	After 5 min $U_R = 6.3 V$ to $100 V$	$I_{L5} \leq 0.001 C_R \times U_R + 3 \mu A$
<b>Inductance</b>		
Equivalent series inductance (ESL)	Case $\varnothing D \times L = 5 mm \times 11 mm$	Typ. 13 nH
	Case $\varnothing D \times L = 8.2 mm \times 11 mm$	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)**

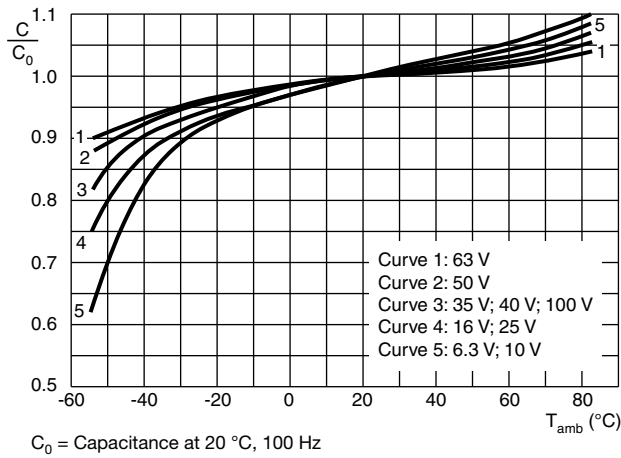


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

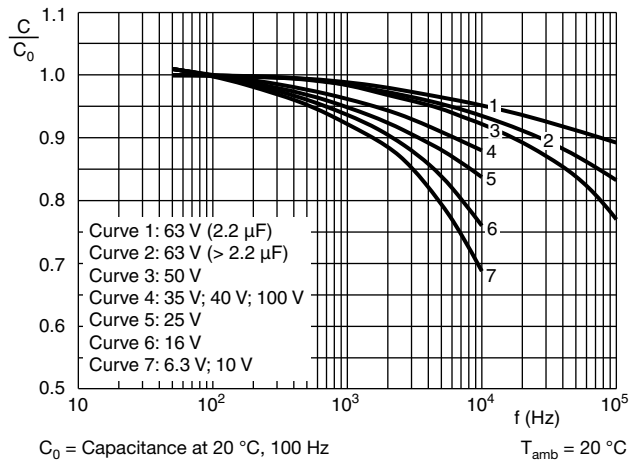


Fig. 7 - Typical multiplier of capacitance as a function of ambient temperature

**IMPEDANCE (Z)**

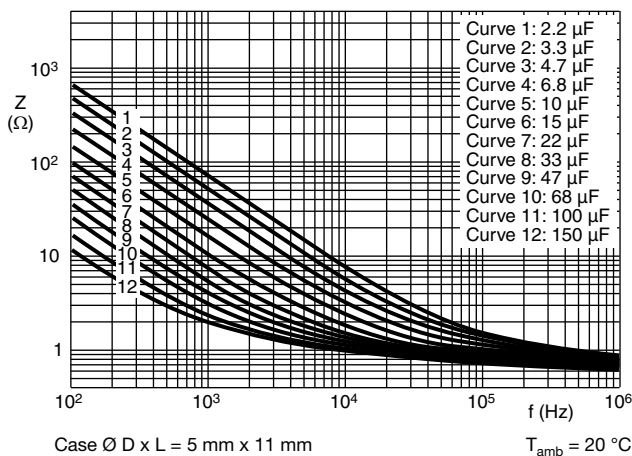


Fig. 8 - Typical impedance as a function of frequency

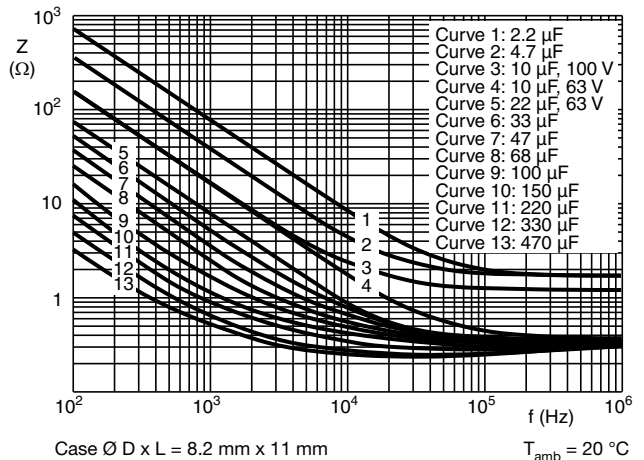


Fig. 9 - Typical impedance as a function of frequency

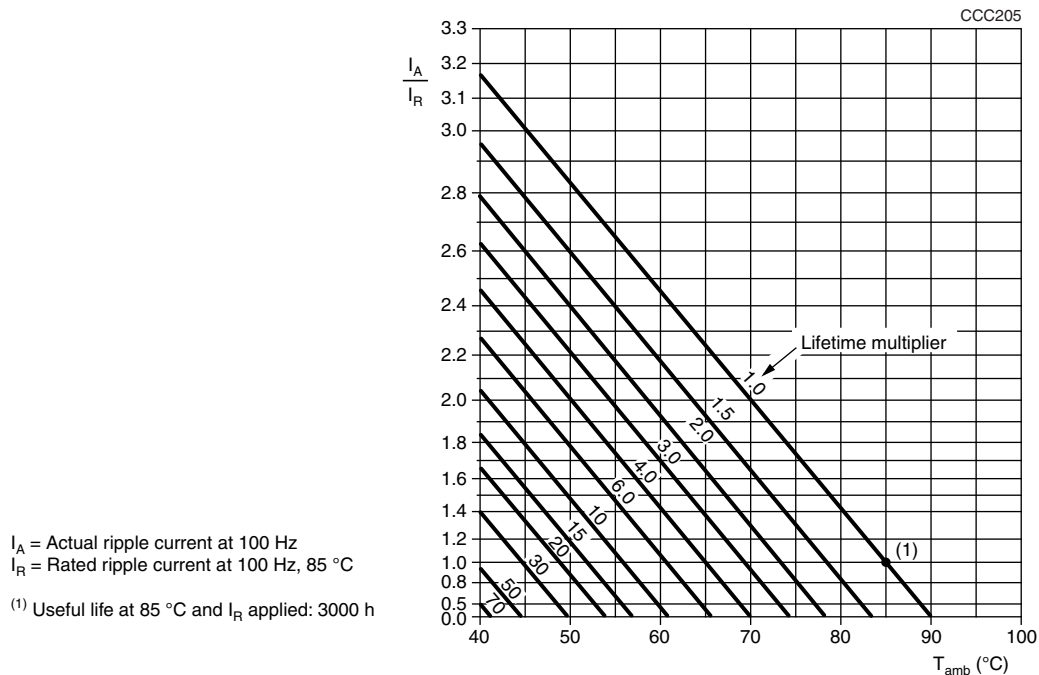
**RIPPLE CURRENT AND USEFUL LIFE**


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		
	$U_R = 6.3 \text{ V TO } 10 \text{ V}$	$U_R = 16 \text{ V TO } 35 \text{ V}$	$U_R = 40 \text{ V TO } 100 \text{ V}$
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 4**

<b>TEST PROCEDURES AND REQUIREMENTS</b>			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4 / EN130300 subclause 4.13	$T_{amb} = 85 \text{ }^\circ\text{C}$ ; $U_R$ applied; 2000 h	$U_R \leq 6.3 \text{ V}$ ; $\Delta C/C$ : +15 % / -30 % $U_R > 6.3 \text{ V}$ ; $\Delta C/C$ : $\pm 15 \%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85 \text{ }^\circ\text{C}$ ; $U_R$ and $I_R$ applied; 3000 h	$U_R \leq 6.3 \text{ V}$ ; $\Delta C/C$ : +45 % / -50 % $U_R > 6.3 \text{ V}$ ; $\Delta C/C$ : $\pm 45 \%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ No short or open circuit Total failure percentage: $\leq 1 \%$
Shelf life (storage at high temperature)	IEC 60384-4 / EN130300 subclause 4.17	$T_{amb} = 85 \text{ }^\circ\text{C}$ ; 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 $I_{L5} \leq \text{spec. limit}$

Statements about product lifetime are based on calculations and internal testing. They should only be interpreted as estimations. Also due to external factors, the lifetime in the field application may deviate from the calculated lifetime. In general, nothing stated herein shall be construed as a guarantee of durability.



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