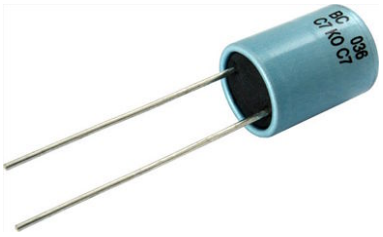
Aluminum Electrolytic Capacitors
Radial Semi-Professional



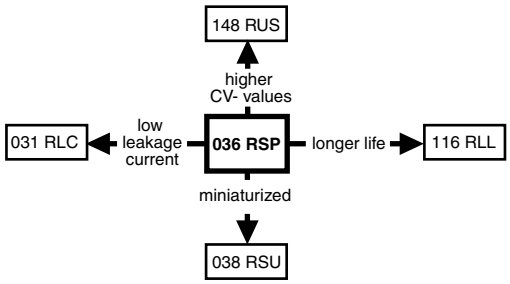


Fig. 1

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

Pb-free

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 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 (036)

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 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 (Ø D x L in mm)

C_R (µF)	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	-	-	-	-	-	-	-

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DIMENSIONS in millimeters **AND AVAILABLE FORMS**

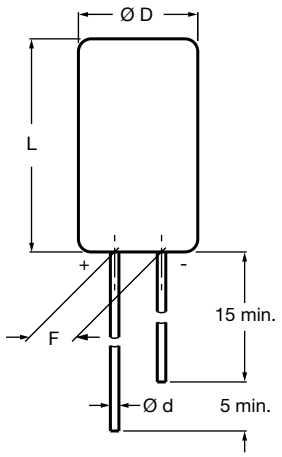
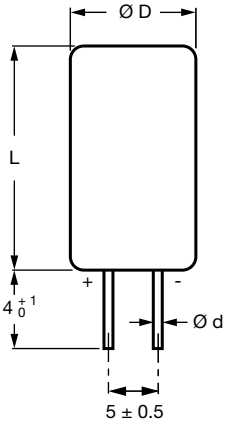
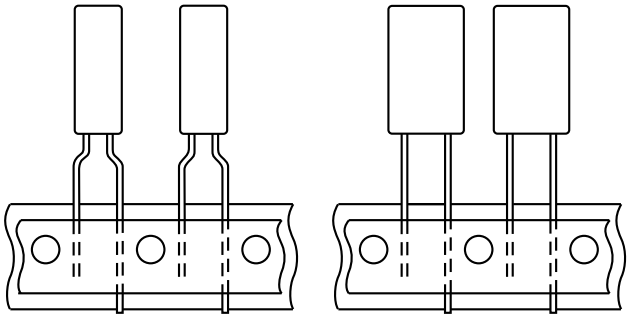


Fig. 2 - **Form CA:** Long leads



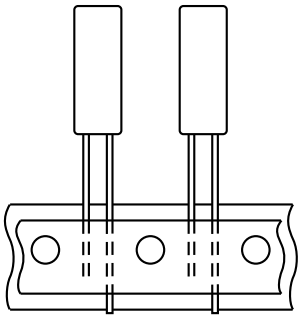
Case Ø D x L = 8.2 mm x 11 mm only

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



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

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



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

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

Table 1

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, 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 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_{L1}	Max. leakage current after 1 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 2 apply at T_{amb} = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

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

Table 2

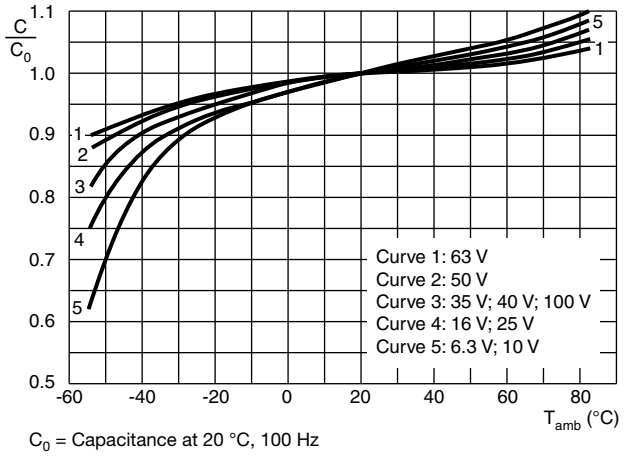
ELECTRICAL DATA AND ORDERING INFORMATION

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 MAL2036.....							
							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	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	-	-
	330	8.2 x 11	390	35	0.16	0.48	55331E3	5.0	65331E3	5.0	35331E3	5.0	-	-
25	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	-	-

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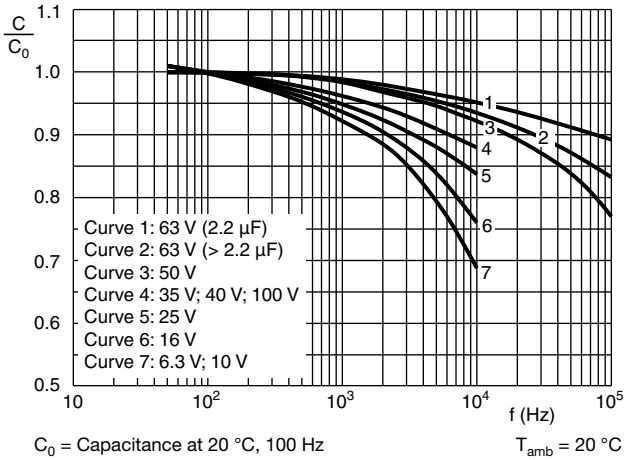
ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15\ U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 1 min U_R = 6.3 V to 100 V	$I_{L1} \leq 0.006\ C_R \times U_R + 3\ \mu A$
	After 5 min U_R = 6.3 V to 100 V	$I_{L5} \leq 0.001\ C_R \times U_R + 3\ \mu A$
Inductance		
Equivalent series inductance (ESL)	Case Ø D x L = 5 mm x 11 mm	Typ. 13 nH
	Case Ø D x L = 8.2 mm x 11 mm	Typ. 16 nH
Resistance		
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)



C_0 = Capacitance at 20 °C, 100 Hz

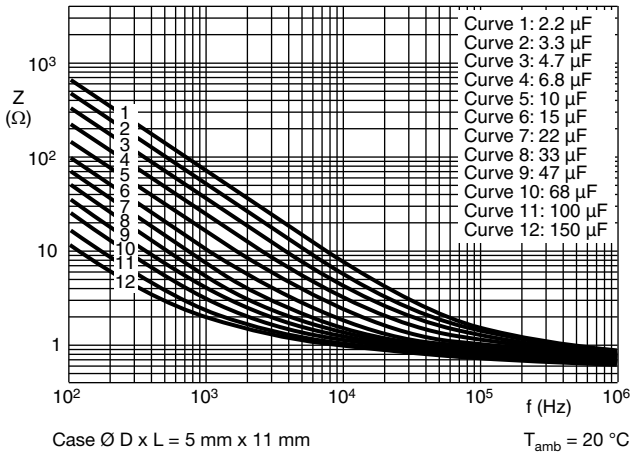
Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature



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

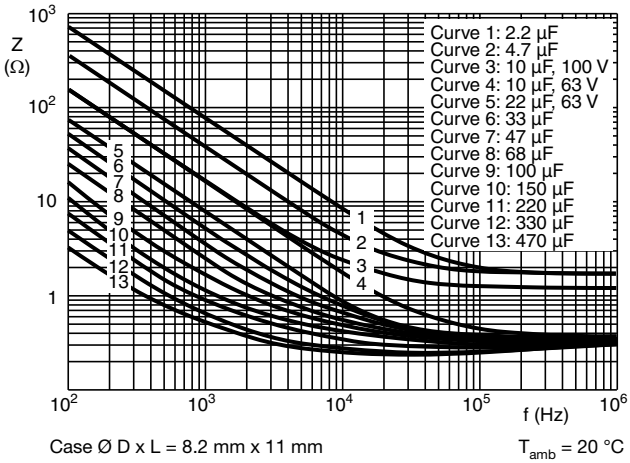
Fig. 7 - Typical multiplier of capacitance as a function of ambient temperature

IMPEDANCE (Z)



Case Ø D x L = 5 mm x 11 mm T_{amb} = 20 °C

Fig. 8 - Typical impedance as a function of frequency

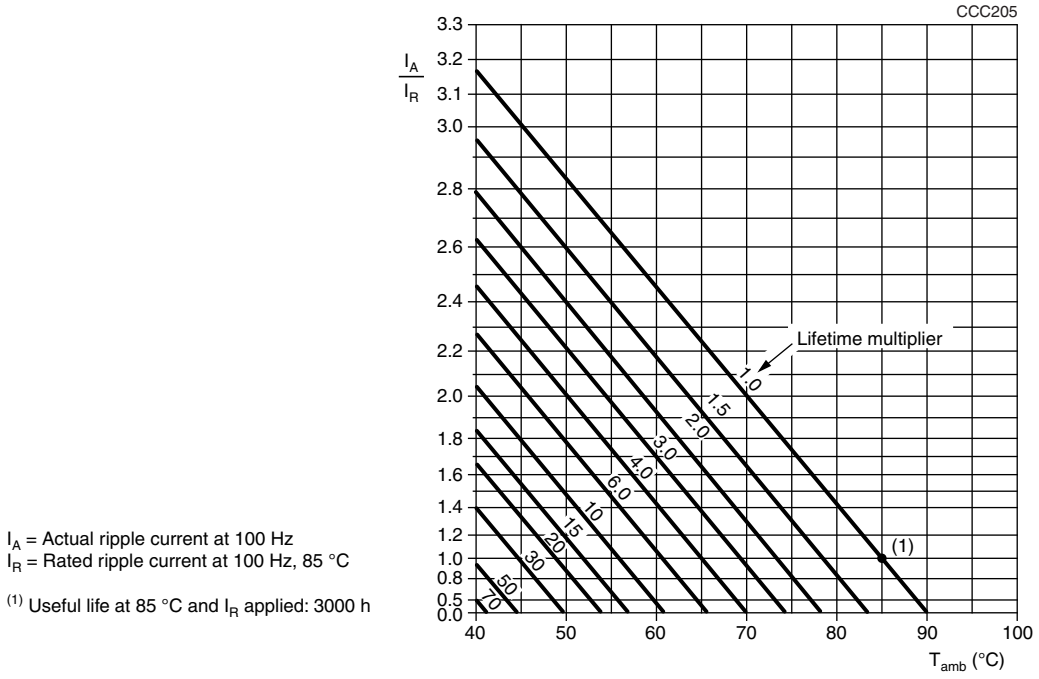


Case Ø D x L = 8.2 mm x 11 mm T_{amb} = 20 °C

Fig. 9 - Typical impedance as a function of frequency

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RIPPLE CURRENT AND USEFUL LIFE



I_A = Actual ripple current at 100 Hz
I_R = Rated ripple current at 100 Hz, 85 °C

(1) Useful life at 85 °C and I_R applied: 3000 h

Fig. 10 - 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 TO 10 V	U_R = 16 V TO 35 V	U_R = 40 V TO 100 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

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4 / EN130300 subclause 4.13	T_{amb} = 85 °C; U_R applied; 2000 h	$U_R \leq$ 6.3 V; ΔC/C: +15 % / -30 % $U_R >$ 6.3 V; ΔC/C: ± 15 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 3000 h	$U_R \leq$ 6.3 V; ΔC/C: +45 % / -50 % $U_R >$ 6.3 V; ΔC/C: ± 45 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit $I_{L5} \leq$ 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 h After test: U_R to be applied for 30 min, 24 h to 48 h before measurement	ΔC/C, tan δ, Z: for requirements see “Endurance test” above $I_{L5} \leq$ 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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