Aluminum Capacitors
Radial Semi-Professional

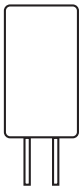
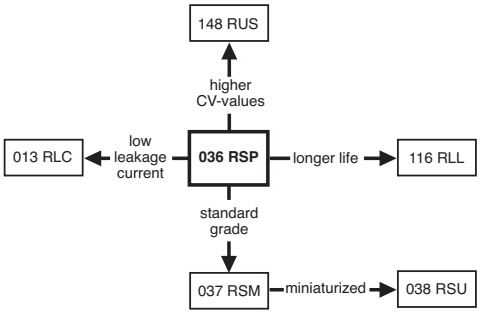


Fig.1 Component outline.



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
- Reduced leakage current
- Lead (Pb)-free versions are RoHS compliant.

Pb-free Available

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 (∅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 160 V
Category temperature range	–55 to +85 °C
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/EN130 300
Climatic category IEC 60068	55/085/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (ØD × L in mm)

C_R (μF)	U_R (V)									
	6.3	**10**	**16**	**25**	**35**	**40**	**50**	**63**	**100**	**160**
0.47	–	–	–	–	–	–	–	5 × 11	–	–
1.0	–	–	–	–	–	–	–	5 × 11	–	–
2.2	–	–	–	–	–	–	–	5 × 11	–	8.2 × 11
3.3	–	–	–	–	–	–	–	5 × 11	–	–
4.7	–	–	–	–	–	–	–	5 × 11	–	8.2 × 11
6.8	–	–	–	–	–	–	–	5 × 11	–	–
10	–	–	–	–	–	–	5 × 11	5 × 11	8.2 × 11	–
	–	–	–	–	–	–	–	8.2 × 11	–	–
15	–	–	–	–	–	5 × 11	–	5 × 11	–	–
22	–	–	–	–	5 × 11	–	–	5 × 11	8.2 × 11	–
	–	–	–	–	–	–	–	8.2 × 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	–	8.2 × 11	–	–
100	5 × 11	–	5 × 11	8.2 × 11	–	–	8.2 × 11	–	–	–
150	–	5 × 11	8.2 × 11	–	8.2 × 11	–	–	–	–	–
220	–	8.2 × 11	8.2 × 11	8.2 × 11	–	–	–	–	–	–
330	8.2 × 11	–	8.2 × 11	–	–	–	–	–	–	–
470	–	8.2 × 11	–	–	–	–	–	–	–	–

DIMENSIONS in millimeters **AND AVAILABLE FORMS**

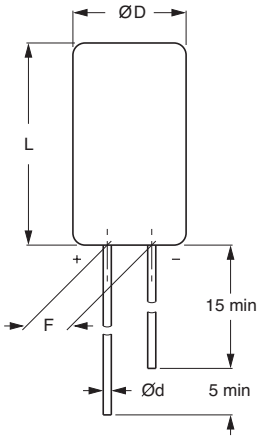
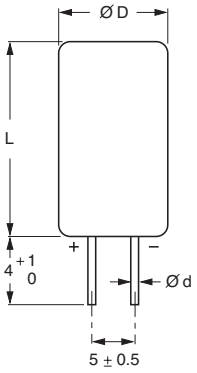
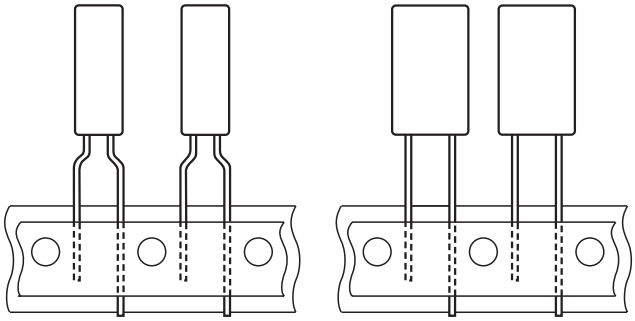


Fig.2 **Form CA:** Long leads



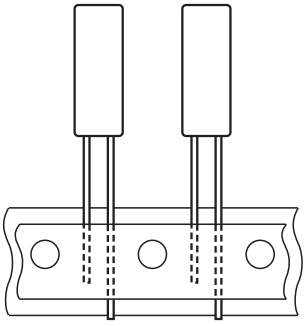
Case ØD x L = 8.2 x 11 mm only

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



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

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



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

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. 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_{L1}	max. leakage current after 1 minute 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 036 series

100 μF/16 V; ±20%

Nominal case size: ∅5 × 11 mm; Form TFA

Catalog number: 2222 036 35101

*Note: For ordering lead (Pb)-free parts, please contact your Vishay sales agent.

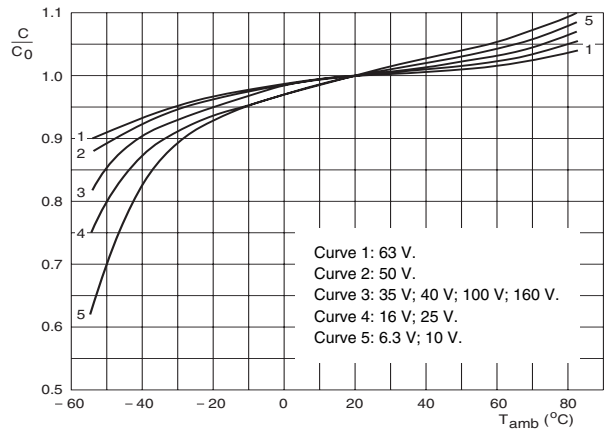
Table 2

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_{L1} 1 min (μA)	Tan δ 100 Hz	Z 10 kHz (Ω)	CATALOG NUMBER 2222 036							
							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 × 11	130	7	0.20	1.7	53101	2.5	–	–	33101	5.0	73101	2.5
	330	8.2 × 11	300	16	0.20	0.52	53331	5.0	63331	5.0	33331	5.0	–	–
10	47	5 × 11	95	6	0.16	2.8	54479	2.5	–	–	34479	5.0	74479	2.5
	150	5 × 11	150	12	0.20	1.3	54151	2.5	–	–	34151	5.0	74151	2.5
	220	8.2 × 11	260	17	0.16	0.59	54221	5.0	64221	5.0	34221	5.0	–	–
	470	8.2 × 11	400	31	0.20	0.43	54471	5.0	64471	5.0	34471	5.0	–	–
16	33	5 × 11	90	7	0.14	2.7	55339	2.5	–	–	35339	5.0	75339	2.5
	100	5 × 11	160	13	0.16	1.6	55101	2.5	–	–	35101	5.0	75101	2.5
	150	8.2 × 11	230	18	0.14	0.6	55151	5.0	65151	5.0	35151	5.0	–	–
	220	8.2 × 11	280	24	0.16	0.55	55221	5.0	65221	5.0	35221	5.0	–	–
	330	8.2 × 11	390	35	0.16	0.48	55331	5.0	65331	5.0	35331	5.0	–	–
25	68	5 × 11	140	13	0.14	1.8	56689	2.5	–	–	36689	5.0	76689	2.5
	100	8.2 × 11	210	18	0.12	0.7	56101	5.0	66101	5.0	36101	5.0	–	–
	220	8.2 × 11	310	36	0.14	0.55	56221	5.0	66221	5.0	36221	5.0	–	–
35	22	5 × 11	87	8	0.10	2.7	90001	2.5	–	–	90027	5.0	90389	2.5
	47	5 × 11	130	13	0.12	1.9	90094	2.5	–	–	90098	5.0	90391	2.5
	150	8.2 × 11	270	35	0.12	0.6	90099	5.0	90101	5.0	90103	5.0	–	–
40	15	5 × 11	72	7	0.10	3.7	57159	2.5	–	–	37159	5.0	77159	2.5
	68	8.2 × 11	180	20	0.10	0.81	57689	5.0	67689	5.0	37689	5.0	–	–
50	10	5 × 11	60	6	0.08	4.5	90004	2.5	–	–	90028	5.0	90392	2.5
	33	5 × 11	110	13	0.10	2.1	90104	2.5	–	–	90108	5.0	90393	2.5
	47	8.2 × 11	160	18	0.08	0.96	90011	5.0	90012	5.0	90031	5.0	–	–
	100	8.2 × 11	250	33	0.10	0.7	90109	5.0	90111	5.0	90113	5.0	–	–
63	0.47	5 × 11	5	4	0.06	85	58477	2.5	–	–	38477	5.0	78477	2.5
	1.0	5 × 11	11	4	0.06	40	58108	2.5	–	–	38108	5.0	78108	2.5
	2.2	5 × 11	25	4	0.06	18	58228	2.5	–	–	38228	5.0	78228	2.5
	3.3	5 × 11	38	5	0.06	12	58338	2.5	–	–	38338	5.0	78338	2.5
	4.7	5 × 11	45	5	0.06	8.5	58478	2.5	–	–	38478	5.0	78478	2.5
	6.8	5 × 11	55	6	0.06	5.9	58688	2.5	–	–	38688	5.0	78688	2.5
	10	5 × 11	70	7	0.06	4.0	58109	2.5	–	–	38109	5.0	78109	2.5
	10	8.2 × 11	120	7	0.04	2.8	90036	5.0	90041	5.0	90181	5.0	–	–
	15	5 × 11	80	9	0.07	3.1	58159	2.5	–	–	38159	5.0	78159	2.5
	22	5 × 11	100	11	0.08	2.7	58229	2.5	–	–	38229	5.0	78229	2.5
	22	8.2 × 11	150	11	0.05	1.4	90117	5.0	90118	5.0	90139	5.0	–	–
	33	8.2 × 11	160	16	0.06	1.2	58339	5.0	68339	5.0	38339	5.0	–	–
	47	8.2 × 11	190	21	0.07	1.0	58479	5.0	68479	5.0	38479	5.0	–	–
	68	8.2 × 11	210	29	0.08	0.88	58689	5.0	68689	5.0	38689	5.0	–	–
100	10	8.2 × 11	80	9	0.06	3.5	59109	5.0	69109	5.0	39109	5.0	–	–
	22	8.2 × 11	110	16	0.06	1.8	59229	5.0	69229	5.0	39229	5.0	–	–
160	2.2	8.2 × 11	45	75	0.05	14	90333	5.0	90334	5.0	90336	5.0	–	–
	4.7	8.2 × 11	62	115	0.07	9.6	90337	5.0	90338	5.0	90341	5.0	–	–

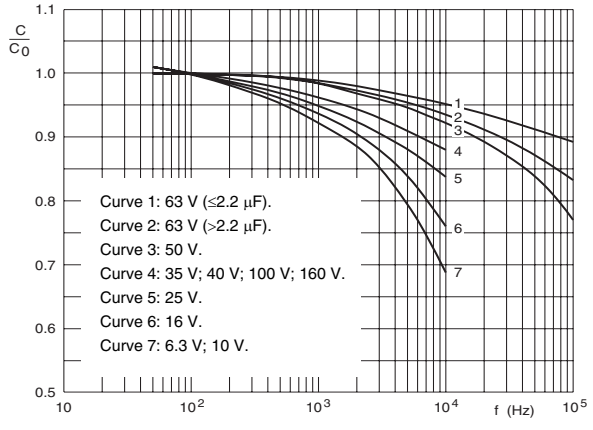
ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15\ U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	after 1 minute: U_R = 6.3 to 100 V U_R = 160 V	 $I_{L1} \leq 0.006\ C_R \times U_R + 3\ \mu A$ $I_{L1} \leq 0.1\ C_R \times U_R + 40\ \mu A$
	after 5 minutes: U_R = 6.3 to 100 V U_R = 160 V	 $I_{L5} \leq 0.001\ C_R \times U_R + 3\ \mu A$ $I_{L5} \leq 0.015\ C_R \times U_R + 10\ \mu A$
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.

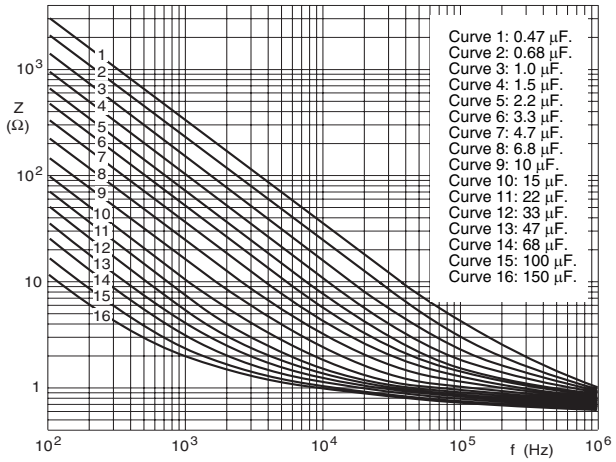
Fig.6 Typical multiplier of capacitance as a function of ambient temperature.



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

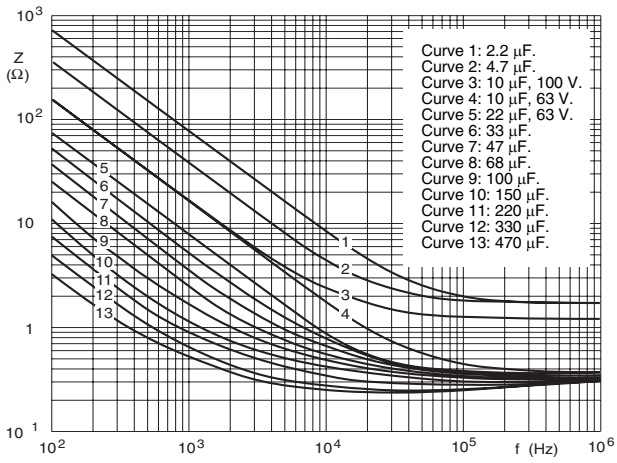
Fig.7 Typical multiplier of capacitance as a function of frequency.

IMPEDANCE (Z)



Case ∅D × L = 5 × 11 mm. T_{amb} = 20 °C.

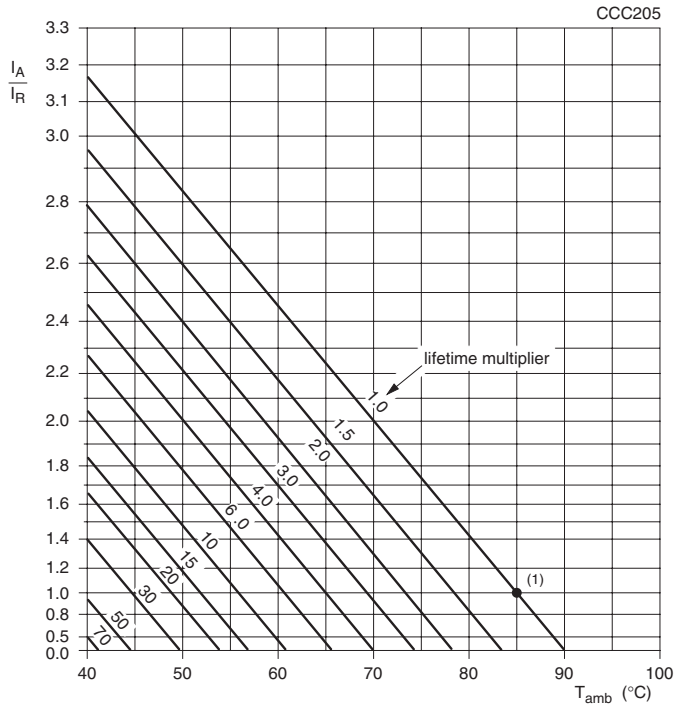
Fig.8 Typical impedance as a function of frequency.



Case ∅D × L = 8.2 × 11 mm. T_{amb} = 20 °C.

Fig.9 Typical impedance as a function of frequency.

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 hours.

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 to 10 V	U_R = 16 to 35 V	U_R = 40 to 160 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 (quick reference)	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; $\Delta C/C$: +15/–30% $U_R > 6.3$ V; $\Delta C/C$: ±15% tan $\delta \leq 1.3 \times$ spec. limit $Z \leq 2 \times$ 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 hours	$U_R \leq 6.3$ V; $\Delta C/C$: +45/–50% $U_R > 6.3$ V; $\Delta C/C$: ±45% tan $\delta \leq 3 \times$ spec. limit $Z \leq 3 \times$ 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 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$, tan δ, Z: for requirements see 'Endurance test' above $I_{L5} \leq$ spec. limit