Aluminum Capacitors
Radial Semi-Professional

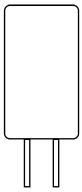
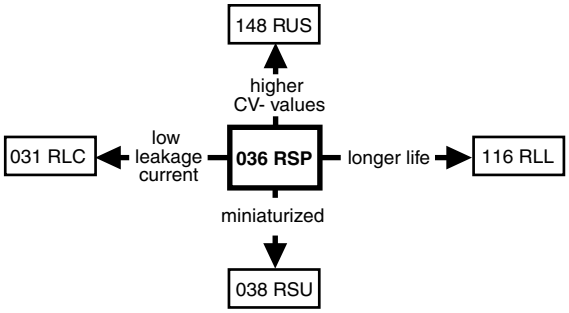


Fig.1 Component outline



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
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	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 x I_R applied	80 000 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 (Ø D x L in mm)

C_R (µF)	U_R (V)									
	6.3	10	16	25	35	40	50	63	100	160
0.47	-	-	-	-	-	-	-	5 x 11	-	-
1.0	-	-	-	-	-	-	-	5 x 11	-	-
2.2	-	-	-	-	-	-	-	5 x 11	-	8.2 x 11
3.3	-	-	-	-	-	-	-	5 x 11	-	-
4.7	-	-	-	-	-	-	-	5 x 11	-	8.2 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**

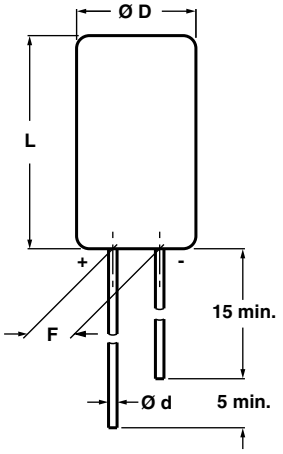
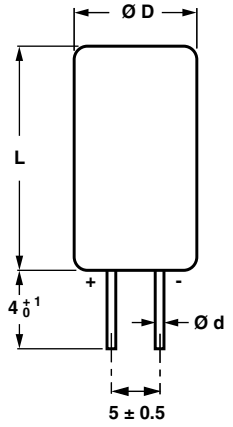
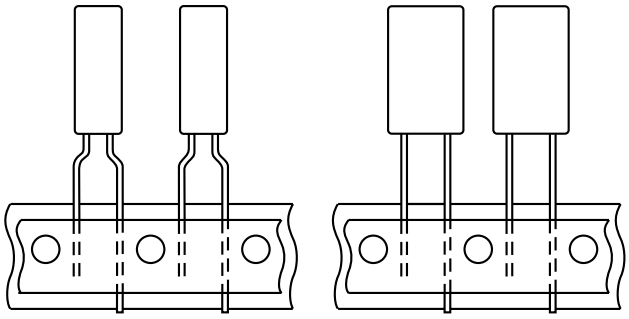


Fig.2 **Form CA:** Long leads



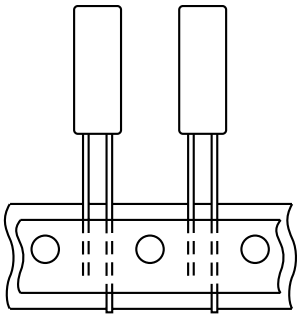
Case Ø D x L = 8.2 x 11 mm only

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



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

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



Pitch F = 2.5 mm
Case Ø D x L = 5 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

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

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: Ø 5 x 11 mm; Form TFA

Ordering code: MAL203635101E3

Former 12NC: 2222 036 35101

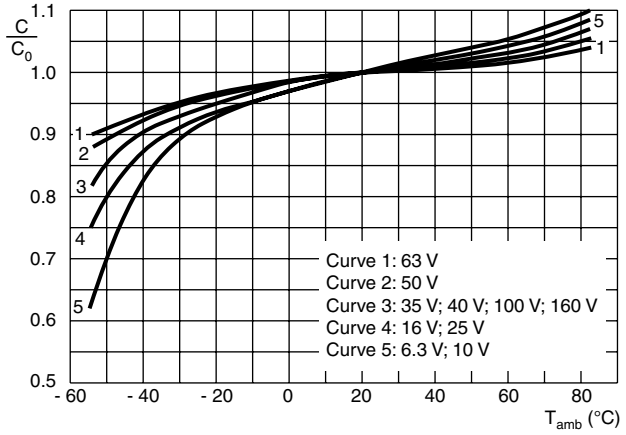
Table 2

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_{L1} 1 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	0.47	5 x 11	5	4	0.06	85	58477E3	2.5	-	-	38477E3	5.0	78477E3	2.5
	1.0	5 x 11	11	4	0.06	40	58108E3	2.5	-	-	38108E3	5.0	78108E3	2.5
	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	-	-
160	2.2	8.2 x 11	45	75	0.05	14	90333E3	5.0	90334E3	5.0	90336E3	5.0	-	-
	4.7	8.2 x 11	62	115	0.07	9.6	90337E3	5.0	90338E3	5.0	90341E3	5.0	-	-

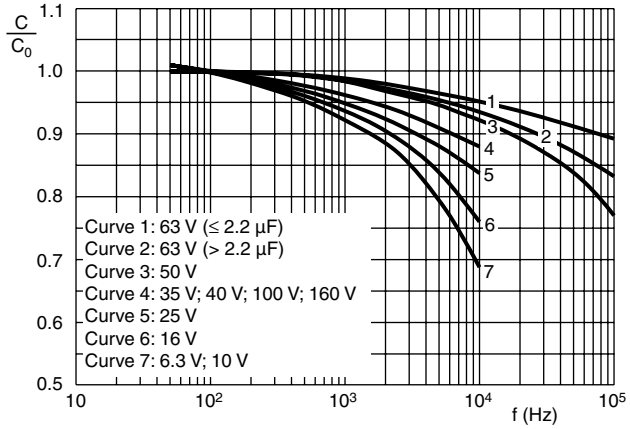
ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15\ U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 1 minute U_R = 6.3 to 100 V U_R = 160 V	 $I_{L1} \leq 0.006\ C_R \times U_R + 3\ \mu A$ $I_{L1} \leq 0.1\ C_R \times U_R + 40\ \mu A$
	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 Ø D x L = 5 x 11 mm	Typ. 13 nH
	Case Ø D x L = 8.2 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

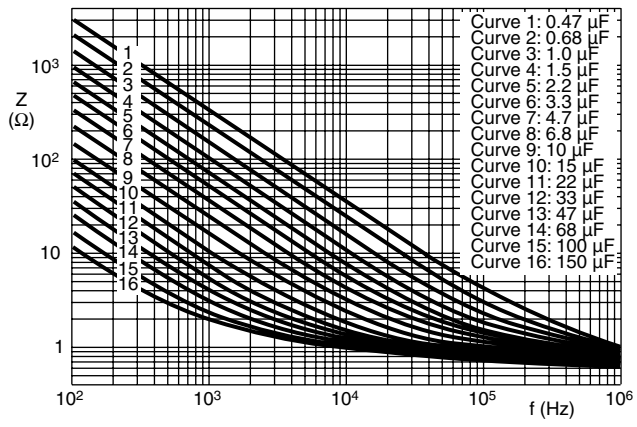
Fig.6 Typical multiplier of capacitance as a function of ambient temperature



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

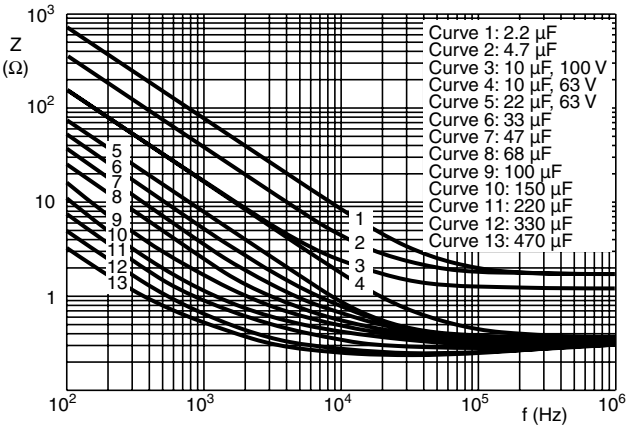
Fig.7 Typical multiplier of capacitance as a function of ambient temperature

IMPEDANCE (Z)



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

Fig.8 Typical impedance as a function of frequency



Case Ø D x L = 8.2 x 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

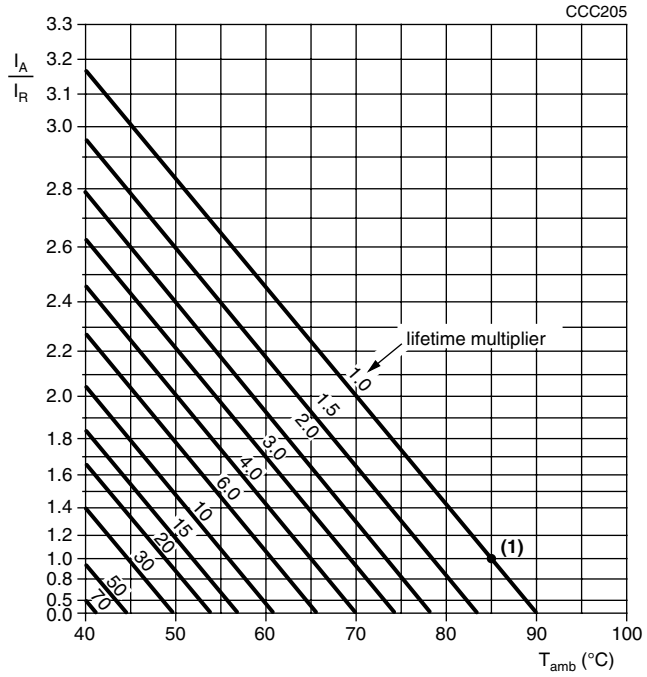


Fig.10 Multiplier of useful life as a function of ambient temperature and ripple current load

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
≥ 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} ≤ 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} ≤ 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 to 48 h before measurement	ΔC/C, tan δ, Z: For requirements See 'Endurance test' above I_{L5} ≤ spec. limit

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