

## Aluminum Capacitors Radial Miniature Semi-Professional

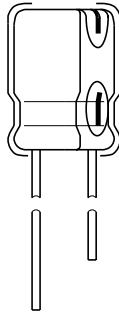
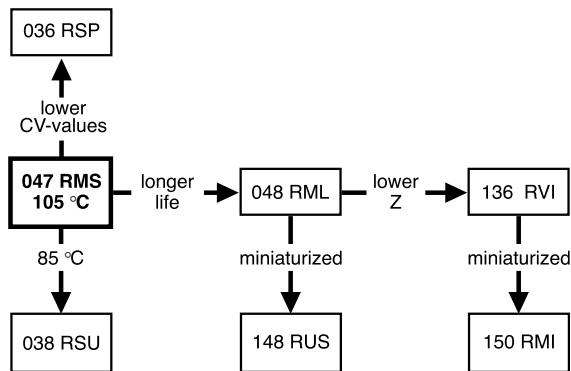


Fig.1 Component outline.



### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue vinyl sleeve
- Charge and discharge proof
- Long useful life: 1500 h at 105 °C
- Miniaturized, high CV-product per unit volume
- Lead (Pb)-free versions are RoHS compliant
- Compliant to RoHS directive 2002/95/EC



RoHS  
COMPLIANT

### APPLICATIONS

- EDB, telecommunication, industrial, automotive and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Portable and mobile equipment (small size, low mass)

### MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance value (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
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (047)

### QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes ( $\varnothing$ D x L in mm)	10 x 12 to 18 x 35
Rated capacitance range, $C_R$	100 $\mu\text{F}$ to 10 000 $\mu\text{F}$
Tolerance on $C_R$	$\pm 20\%$
Rated voltage range, $U_R$	16 V to 63 V
Category temperature range	- 40 °C to + 105 °C
Endurance test at 105 °C	1000 h
Useful life at 105 °C	1500 h
Useful life at 40 °C, 1.3 x $I_R$ applied	150 000 h
Shelf life at 0 V, 105 °C	500 h
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/105/56

### 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)					
	16	25	35	40	50	63
100	-	-	-	-	-	10 x 12
220	-	-	10 x 12	-	10 x 16	10 x 20
330	-	-	10 x 16	10 x 20	-	12.5 x 20
470	10 x 12	10 x 16	10 x 20	-	12.5 x 20	12.5 x 25
1000	10 x 20	12.5 x 20	12.5 x 25	-	16 x 25	16 x 31
2200	12.5 x 25	16 x 25	16 x 31	16 x 35	18 x 35	18 x 35
3300	16 x 25	16 x 31	18 x 35	18 x 35	18 x 35	-

<b>SELECTION CHART FOR <math>C_R</math>, <math>U_R</math> AND RELEVANT NOMINAL CASE SIZES (<math>\varnothing D \times L</math> in mm)</b>						
$C_R$ ( $\mu F$ )	$U_R$ (V)					
	16	25	35	40	50	63
4700	16 x 31	18 x 35	18 x 35	-	-	-
6800	16 x 35	18 x 35	-	-	-	-
10 000	18 x 35	-	-	-	-	-

**DIMENSIONS** in millimeters, **AND AVAILABLE FORMS**

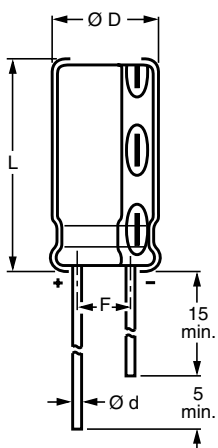


Fig.2 Form CA: Long leads

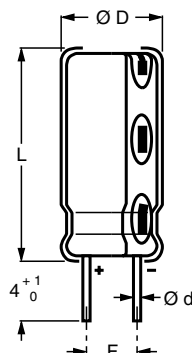


Fig.3 Form CB: Cut leads

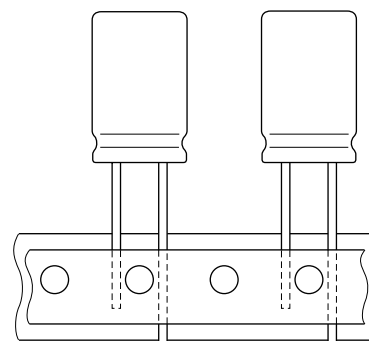


Fig.4 Form TFA: Taped in box (ammopack)

Table 1

<b>DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b>									
NOMINAL CASE SIZE $\varnothing D \times L$	CASE CODE	$\varnothing d$	$\varnothing D_{max.}$	$L_{max.}$	F	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA
10 x 12	14	0.6	10.5	13.5	$5.0 \pm 0.5$	$\approx 1.6$	1000	500	800
10 x 16	15	0.6	10.5	17.5	$5.0 \pm 0.5$	$\approx 1.9$	500	500	800
10 x 20	16	0.6	10.5	22.0	$5.0 \pm 0.5$	$\approx 2.2$	500	500	800
12.5 x 20	17	0.6	13.0	22.0	$5.0 \pm 0.5$	$\approx 4.0$	500	500	500
12.5 x 25	18	0.6	13.0	27.0	$5.0 \pm 0.5$	$\approx 5.0$	250	250	500
16 x 25	19	0.8	16.5	27.0	$7.5 \pm 0.5$	$\approx 8.0$	250	250	250
16 x 31	20	0.8	16.5	33.5	$7.5 \pm 0.5$	$\approx 9.0$	100	100	250
16 x 35	21	0.8	16.5	37.5	$7.5 \pm 0.5$	$\approx 11.5$	100	100	-
18 x 35	22	0.8	18.5	37.5	$7.5 \pm 0.5$	$\approx 14.5$	100	100	-



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ELECTRICAL DATA	
SYMBOL	DESCRIPTION
$C_R$	rated capacitance at 100 Hz, tolerance $\pm 20\%$
$I_R$	rated RMS ripple current at 100 Hz, 105 °C
$I_{L1}$	max. leakage current after 1 min at $U_R$
$\tan \delta$	max. dissipation factor at 100 Hz
Z	max. impedance at 10 kHz or 100 kHz

**ORDERING EXAMPLE**

Electrolytic capacitor 047 series

1000  $\mu\text{F}/35\text{ V}$ ;  $\pm 20$ Nominal case size:  $\varnothing 12.5\text{ mm} \times 25\text{ mm}$ ; Form TFA

Ordering code: MAL204730102E3

**Note**

- Unless otherwise specified, all electrical values in Table 2 apply at  $T_{\text{amb}} = 20\text{ °C}$ ,  $P = 86\text{ kPa}$  to  $106\text{ kPa}$ ,  $\text{RH} = 45\%$  to  $75\%$

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION									
$U_R$ (V)	$C_R$ 100 Hz ( $\mu\text{F}$ )	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	$I_R$ 100 Hz 105 °C (mA)	$I_{L1}$ 1 min ( $\mu\text{A}$ )	$\tan \delta$ 100 Hz	Z 100 kHz ( $\Omega$ )	ORDERING CODE MAL2047...		
							BULK PACKAGING		TAPED
							FORM CA	FORM CB	FORM TFA
16	470	10 x 12	330	78	0.16	0.33	55471E3	65471E3	35471E3
	1000	10 x 20	540	160	0.16	0.17	55102E3	65102E3	35102E3
	2200	12.5 x 25	830	360	0.20	0.10	55222E3	65222E3	35222E3
	3300	16 x 25	1100	530	0.22	0.08	55332E3	65332E3	35332E3
	4700	16 x 31	1300	760	0.24	0.07	55472E3	65472E3	35472E3
	6800	16 x 35	1600	1100	0.28	0.06	55682E3	65682E3	-
	10 000	18 x 35	1800	1600	0.36	0.05	55103E3	65103E3	-
25	470	10 x 16	360	120	0.14	0.25	56471E3	66471E3	36471E3
	1000	12.5 x 20	630	250	0.14	0.13	56102E3	66102E3	36102E3
	2200	16 x 25	990	550	0.18	0.08	56222E3	66222E3	36222E3
	3300	16 x 31	1200	830	0.20	0.07	56332E3	66332E3	36332E3
	4700	18 x 35	1500	1200	0.22	0.05	56472E3	66472E3	-
	6800	18 x 35	1700	1700	0.26	0.04	56682E3	66682E3	-
35	220	10 x 12	270	80	0.12	0.38	50221E3	60221E3	30221E3
	330	10 x 16	350	120	0.12	0.28	50331E3	60331E3	30331E3
	470	10 x 20	450	170	0.12	0.22	50471E3	60471E3	30471E3
	1000	12.5 x 25	780	350	0.12	0.12	50102E3	60102E3	30102E3
	2200	16 x 31	1200	770	0.16	0.07	50222E3	60222E3	30222E3
	3300	18 x 35	1500	1200	0.18	0.05	50332E3	60332E3	-
	4700	18 x 35	1800	1600	0.20	0.04	50472E3	60472E3	-
40	330	10 x 20	380	140	0.12	0.26	57331E3	67331E3	37331E3
	2200	16 x 35	1200	880	0.16	0.06	57222E3	67222E3	-
	3300	18 x 35	1500	1300	0.18	0.04	57332E3	67332E3	-
50	220	10 x 16	310	110	0.10	0.33	51221E3	61221E3	31221E3
	470	12.5 x 20	540	240	0.10	0.17	51471E3	61471E3	31471E3
	1000	16 x 25	940	500	0.10	0.09	51102E3	61102E3	31102E3
	2200	18 x 35	1400	1100	0.14	0.05	51222E3	61222E3	-
	3300	18 x 35	1600	1700	0.16	0.04	51332E3	61332E3	-
63	100	10 x 12	210	66	0.09	0.65	58101E3	68101E3	38101E3
	220	10 x 20	350	140	0.09	0.32	58221E3	68221E3	38221E3
	330	12.5 x 20	470	210	0.09	0.22	58331E3	68331E3	38331E3
	470	12.5 x 25	620	300	0.09	0.16	58471E3	68471E3	38471E3
	1000	16 x 31	1100	630	0.09	0.08	58102E3	68102E3	38102E3
	2200	18 x 35	1500	1400	0.13	0.04	58222E3	68222E3	-



ADDITIONAL ELECTRICAL DATA		
DESCRIPTION	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 at $U_R$	$I_{L1} \leq 0.01 C_R \times U_R + 3 \mu A$
	after 5 min at $U_R$	$I_{L5} \leq 0.002 C_R \times U_R + 3 \mu A$
<b>Inductance</b>		
Equivalent series inductance (ESL)	case $\varnothing D = 10 \text{ mm}$	typ. 16 nH
	case $\varnothing D \geq 12.5 \text{ mm}$	typ. 18 nH
<b>Resistance</b>		
Equivalent series resistance (ESR)	calculated from $\tan \delta_{max}$ and $C_R$ (see Table 2)	$ESR = \tan \delta / 2\pi f C_R$

**RIPPLE CURRENT AND USEFUL LIFE**

$I_A$  = actual ripple current at 100 Hz  
 $I_R$  = rated ripple current at 100 Hz, 105 °C  
 (1) Useful life at 105 °C and  $I_R$  applied: 1500 h

Fig.5 Multiplier of useful life as a function of ambient temperature and ripple current load

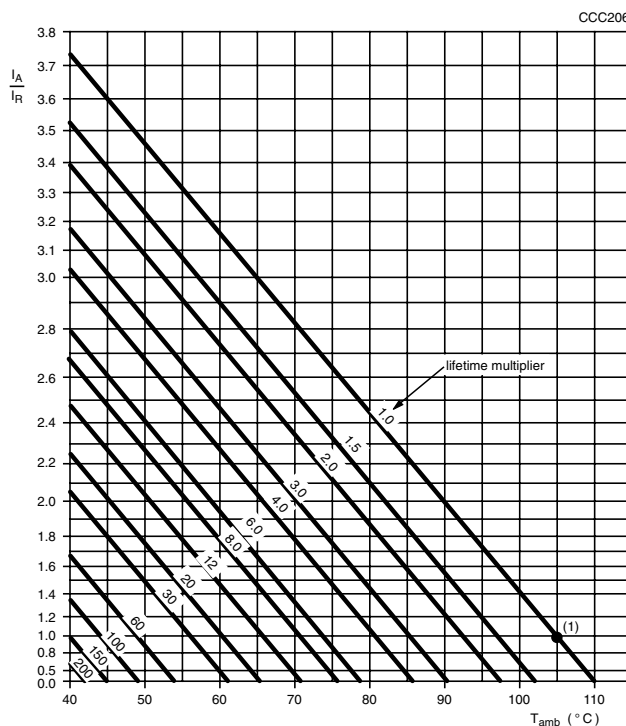


Table 3

MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	$I_R$ MULTIPLIER		
	$U_R = 16 V$ and $25 V$	$U_R = 35 V$ and $40 V$	$U_R = 50 V$ and $63 V$
50	0.95	0.85	0.80
100	1.00	1.00	1.00
300	1.07	1.20	1.25
1000	1.12	1.30	1.40
3000	1.15	1.35	1.50
$\geq 10\ 000$	1.20	1.40	1.60



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Table 4

<b>TEST PROCEDURES AND REQUIREMENTS</b>			
<b>TEST</b>		<b>PROCEDURE (quick reference)</b>	<b>REQUIREMENTS</b>
<b>NAME OF TEST</b>	<b>REFERENCE</b>		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 105\text{ °C}$ ; $U_R$ applied; 1000 h	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ °C}$ ; $U_R$ and $I_R$ applied; 1500 h	$\Delta C/C: \pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300, subclause 4.17	$T_{amb} = 105\text{ °C}$ ; no voltage applied; 500 h  after test: $U_R$ to be applied for 30 min, 24 h to 48 h before measurement	$\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$



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