

## Aluminum Capacitors Radial Miniature, High Voltage

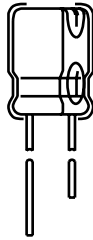
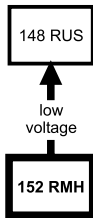


Fig.1 Component outline


**FEATURES**

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue vinyl sleeve
- Pressure relief
- Charge and discharge proof
- Miniaturized, ultra high CV-product per unit volume
- Long useful life:  
3000 to 4000 h at 105 °C, high reliability
- Lead (Pb)-Free versions are RoHS compliant


**RoHS  
COMPLIANT**
**APPLICATIONS**

- High-reliability and professional applications
- Lighting, monitors, consumer electronics, general industrial
- Filtering of high voltages in power supplies

**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 (152)

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes ( $\varnothing$ D x L in mm)	10 x 12 to 18 x 35
Rated capacitance range, $C_R$	1.0 to 220 $\mu\text{F}$
Tolerance on $C_R$	$\pm 20\%$
Rated voltage range, $U_R$	200 to 450 V
Category temperature range	- 40 to + 105 °C
Endurance test at 105 °C	2000 hours
Useful life at 105 °C:	
Case $\varnothing$ D = 10 and 12.5 mm	3000 hours
Case $\varnothing$ D = 16 and 18 mm	4000 hours
Useful life at 40 °C, $1.6 \times I_R$ applied:	
Case $\varnothing$ D = 10 and 12.5 mm	200 000 hours
Case $\varnothing$ D = 16 and 18 mm	260 000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 60384-4/EN 130300
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)			
	200	250	400	450
1.0	-	-	-	10 x 12
2.2	-	-	10 x 12	10 x 16
4.7	-	-	10 x 16	10 x 20
	-	-	10 x 12	-
6.8	-	-	10 x 16	12.5 x 20
10	10 x 12	10 x 16	10 x 20	12.5 x 20
	10 x 16	12.5 x 20	12.5 x 25	16 x 25
22	-	-	16 x 20	18 x 20
	10 x 20	12.5 x 20	16 x 20	16 x 35
33	-	-	-	18 x 25
	12.5 x 20	12.5 x 25	16 x 25	18 x 35
47	-	16 x 20	-	-
	12.5 x 25	-	16 x 35	-
100	16 x 20	16 x 25	18 x 35	-
220	16 x 35	-	-	-

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

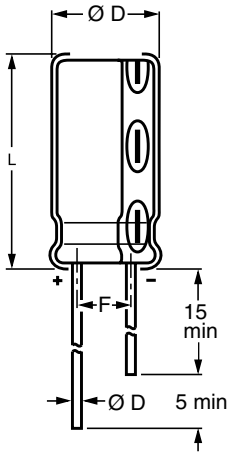


Fig.2 Form CA: Long leads

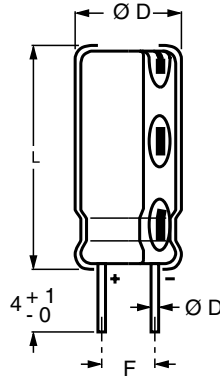


Fig.3 Form CB: Cut leads

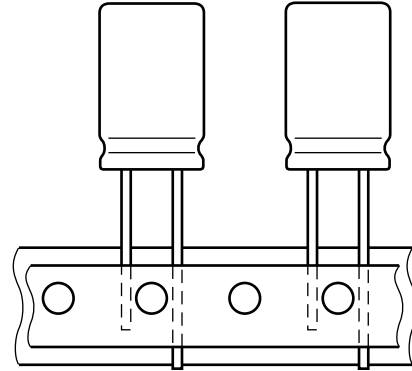


Fig.4 Form TFA: Taped in box (ammopack)

Table 1

<b>DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b>									
NOMINAL CASE SIZE Ø D x L	CASE CODE	Ø D	Ø D <sub>max.</sub>	L <sub>max.</sub>	F	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 x 20	19a	0.8	16.5	22.0	7.5 ± 0.5	≈ 6.0	250	250	250
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 x 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.0	100	100	-
18 x 20	1820	0.8	18.5	22.0	7.5 ± 0.5	≈ 8.0	100	100	-
18 x 25	1825	0.8	18.5	27.0	7.5 ± 0.5	≈ 10.0	100	100	-
18 x 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	-

**Note**

1. Detailed tape dimensions see section 'PACKAGING'.



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 minute at $U_R$
$\tan \delta$	max. dissipation factor at 100 Hz
$Z$	max. impedance at 10 kHz

**Note**

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

**ORDERING EXAMPLE**

Electrolytic capacitor 152 series  
4.7  $\mu\text{F}/400\text{ V}$ ;  $\pm 20\%$   
Nominal case size:  $\varnothing 10 \times 16\text{ mm}$ ; Form TFA

Ordering Code: MAL215236478E3  
Former 12NC: 2222 152 36478

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	$Z$ 10 kHz ( $\Omega$ )	ORDERING CODE MAL2152 .....		
							BULK PACKAGING		TAPED
							FORM CA	FORM CB	FORM TFA
200	10	10 x 12	85	130	0.12	6.3	52109E3	62109E3	32109E3
	22	10 x 16	120	202	0.12	3.2	52229E3	62229E3	32229E3
	33	10 x 20	150	268	0.12	2.3	52339E3	62339E3	32339E3
	47	12.5 x 20	240	352	0.12	0.9	52479E3	62479E3	32479E3
	68	12.5 x 25	310	478	0.12	0.6	52689E3	62689E3	32689E3
	100	16 x 20	340	670	0.12	0.4	52101E3	62101E3	32101E3
	220	16 x 35	630	1390	0.12	0.2	52221E3	62221E3	-
250	10	10 x 16	105	145	0.12	6.3	53109E3	63109E3	33109E3
	22	12.5 x 20	180	235	0.12	2.3	53229E3	63229E3	33229E3
	33	12.5 x 20	180	318	0.12	1.5	53339E3	63339E3	33339E3
	47	12.5 x 25	310	423	0.12	0.9	53479E3	63479E3	33479E3
	47	16 x 20	310	423	0.12	0.9	93475E3	93476E3	93473E3
	100	16 x 25	340	820	0.12	0.4	53101E3	63101E3	33101E3
400	2.2	10 x 12	44	96	0.15	28.0	56228E3	66228E3	36228E3
	4.7	10 x 12	48	127	0.15	24.0	96475E3	96476E3	96473E3
	4.7	10 x 16	65	126	0.15	18.0	56478E3	66478E3	36478E3
	6.8	10 x 16	65	152	0.15	12.0	56688E3	66688E3	36688E3
	10	10 x 20	80	190	0.15	9.0	56109E3	66109E3	36109E3
	22	12.5 x 25	150	334	0.15	3.8	56229E3	66229E3	36229E3
	22	16 x 20	150	334	0.15	3.8	96225E3	96226E3	96223E3
	33	16 x 20	190	466	0.15	2.6	56339E3	66339E3	36339E3
	47	16 x 25	240	634	0.15	2.0	56479E3	66479E3	36479E3
	68	16 x 35	310	886	0.15	1.7	56689E3	66689E3	-
100	18 x 35	380	1270	0.15	0.9	56101E3	66101E3	-	
450	1.0	10 x 12	30	67	0.20	94.0	57108E3	67108E3	37108E3
	2.2	10 x 16	50	99	0.20	26.0	57228E3	67228E3	37228E3
	4.7	10 x 20	65	133	0.20	20.0	57478E3	67478E3	37478E3
	6.8	12.5 x 20	80	162	0.20	16.0	57688E3	67688E3	37688E3
	10	12.5 x 20	90	205	0.20	10.0	57109E3	67109E3	37109E3
	22	16 x 25	150	367	0.20	4.6	57229E3	67229E3	37229E3
	22	18 x 20	150	367	0.20	4.6	97225E3	97226E3	-
	33	16 x 35	200	516	0.20	3.4	57339E3	67339E3	-
	33	18 x 25	200	516	0.20	3.4	97335E3	97336E3	-
	47	18 x 35	260	705	0.20	2.0	57479E3	67479E3	-



ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage	$U_R = 200$ to $250$ V	$U_s \leq 1.15 \times U_R$
	$U_R = 400$ to $450$ V	$U_s \leq 1.10 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
<b>Current</b>		
Leakage current	After 1 minute at $U_R$	$I_{L1} \leq 0.03 C_R \times U_R + 70 \mu A$
	After 5 minutes at $U_R$	$I_{L5} \leq 0.015 C_R \times U_R + 30 \mu A$
<b>Inductance</b>		
Equivalent series inductance (ESL)	Case $\varnothing D = 10$ mm	typ. 16 nH
	Case $\varnothing D \geq 12.5$ mm	typ. 18 nH
<b>Resistance</b>		
Equivalent series resistance (ESR)	Calculated from $\tan \delta_{max.}$ and $C_R$ (see Table 2)	$ESR = \tan \delta / 2 \pi f C_R$

Table 3

MULTIPLIER OF RIPPLE CURRENT ( $I_R$ )		
FREQUENCY (Hz)	$I_R$ MULTIPLIER	
	$U_R \leq 250$ V	$U_R > 250$ V
50	0.75	0.75
100	1.00	1.00
300	1.50	1.30
1000	2.00	1.60
3000	2.20	1.90
10 000	2.50	2.20
$\geq 100\ 000$	3.00	2.50

**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  
 case  $\varnothing D = 10$  and 12.5: 3000h  
 case  $\varnothing D = 16$  and 18: 4000h

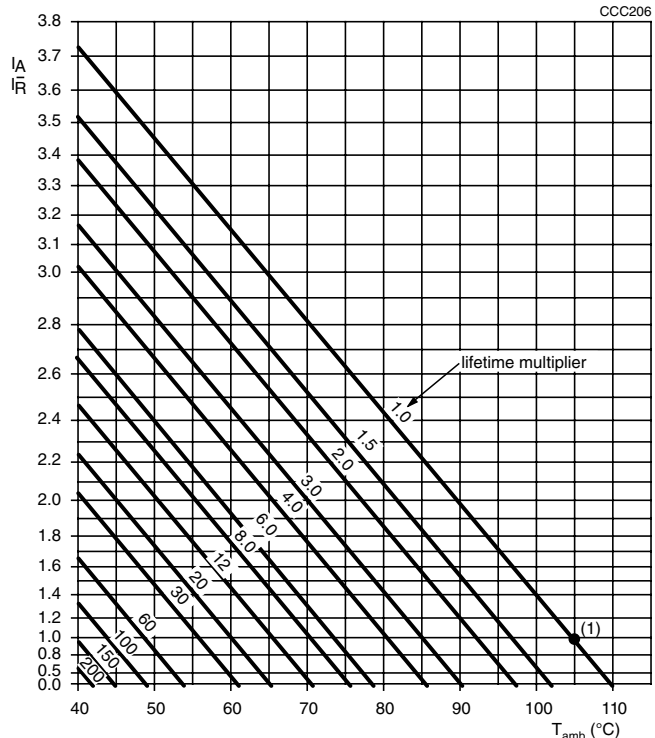


Fig.5 Multiplier of useful life as a function of ambient temperature and ripple current load

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	$T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ applied; 2000 h	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied; case $\emptyset D = 10$ and $12.5$ : 3000 h case $\emptyset D = 16$ and $18$ : 4000 h	$\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	$T_{amb} = 105\text{ }^{\circ}\text{C}$ ; no voltage applied; 1000 h after test: $U_R$ to be applied for 30 min, 24 to 48 h before measurement	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$
Reverse voltage	IEC 60384-4/ EN130300 subclause 4.15	$T_{amb} = 105\text{ }^{\circ}\text{C}$ : 125 h at $U = -1\text{ V}$ , followed by 125 h at $U_R$	$\Delta C/C: \pm 15\%$ $I_{L5} \leq \text{spec. limit}$ $\tan \delta \leq \text{spec. limit}$



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