



## Aluminum Capacitors Radial Long-Life, High Voltage

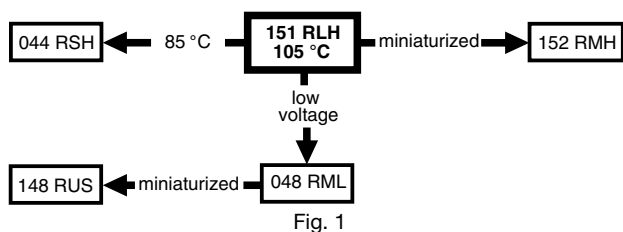


Fig. 1



RoHS  
COMPLIANT

### FEATURES

- Long useful life: 3000 h to 4000 h at 105 °C
- High rated voltage, up to 450 V
- Charge and discharge proof
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue sleeve
- Pressure relief
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

### APPLICATIONS

- 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 (151)

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes ( $\varnothing$ D x L in mm)	10 x 12 to 18 x 35
Rated capacitance range, $C_R$	2.2 $\mu\text{F}$ to 220 $\mu\text{F}$
Tolerance on $C_R$	$\pm 20\%$
Rated voltage range, $U_R$	160 V to 450 V
Category temperature range	-40 °C to +105 °C
Endurance test at 105 °C	2000 h
Useful life at 105 °C:	
Case $\varnothing$ D = 10 mm and 12.5 mm	3000 h
Case $\varnothing$ D = 16 mm and 18 mm	4000 h
Useful life at 40 °C, 1.6 x $I_R$ applied:	
Case $\varnothing$ D = 10 mm and 12.5 mm	200 000 h
Case $\varnothing$ D = 16 mm and 18 mm	260 000 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)					
	160	200	250	350	400	450
2.2	-	-	-	-	10 x 12	10 x 16
3.3	-	-	-	10 x 12	10 x 16	10 x 20
4.7	-	10 x 12	10 x 12	10 x 16	10 x 20	12.5 x 20
10	10 x 16	10 x 16	10 x 20	12.5 x 20	12.5 x 20	16 x 20
22	10 x 20	10 x 20	12.5 x 25	12.5 x 25	16 x 25	16 x 31
	-	-	16 x 20	16 x 20	18 x 20	18 x 25
33	12.5 x 20	12.5 x 20	12.5 x 25	16 x 25	16 x 31	18 x 35
	-	-	16 x 20	-	18 x 25	-
47	12.5 x 25	12.5 x 25	16 x 25	16 x 35	18 x 31	-
	16 x 20	16 x 20	18 x 20	18 x 31	-	-
100	16 x 25	16 x 31	16 x 31	-	-	-
	18 x 20	18 x 25	18 x 25	-	-	-
220	18 x 35	-	-	-	-	-



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

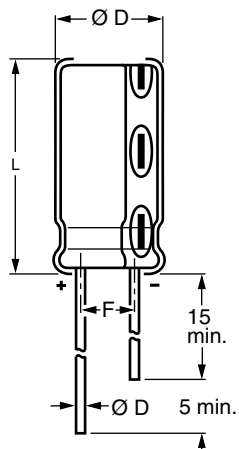


Fig. 2 - Form CA: Long leads

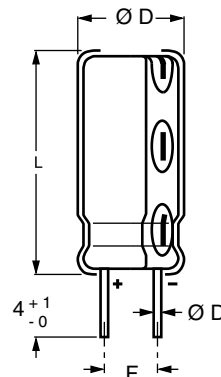


Fig. 3 - Form CB: Cut leads

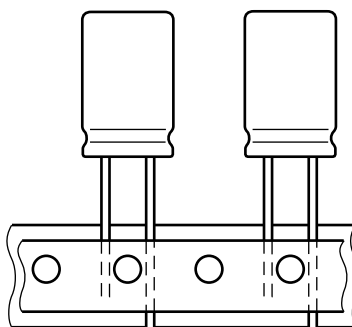


Fig. 4 - Form TFA: Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
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 PER BOX		
							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	19 a	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 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	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 31	1831	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	100	100	-
18 x 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	-



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

**ORDERING EXAMPLE**

Electrolytic capacitor 151 series  
 4.7  $\mu$ F/400 V;  $\pm 20\%$   
 Nominal case size:  $\varnothing$  10 mm x 20 mm; Form TFA  
 Ordering code: MAL215136478E3  
 Former 12NC: 2222 151 36478

**Note**

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

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION									
$U_R$ (V)	$C_R$ 100 Hz ( $\mu$ F)	NOMINAL CASE SIZE $\varnothing$ D x L (mm)	$I_R$ 100 Hz 105 °C (mA)	$I_{L1}$ 1 min ( $\mu$ A)	$\tan \delta$ 100 Hz	Z 10 kHz ( $\Omega$ )	ORDERING CODE MAL2151.....		
							BULK PACKAGING		TAPED
							FORM CA	FORM CB	FORM TFA
160	10	10 x 16	95	118	0.12	6.3	51109E3	61109E3	31109E3
	22	10 x 20	145	176	0.12	3.2	51229E3	61229E3	31229E3
	33	12.5 x 20	190	228	0.12	2.3	51339E3	61339E3	31339E3
	47	12.5 x 25	280	296	0.12	1.7	51479E3	61479E3	31479E3
	47	16 x 20	280	296	0.12	1.7	91475E3	91476E3	91473E3
	100	16 x 25	380	550	0.12	1.1	51101E3	61101E3	31101E3
	100	18 x 20	380	550	0.12	1.1	91105E3	91106E3	-
	220	18 x 35	630	1126	0.12	0.8	51221E3	61221E3	-
200	4.7	10 x 12	60	96	0.12	13.0	52478E3	62478E3	32478E3
	10	10 x 16	95	130	0.12	6.3	52109E3	62109E3	32109E3
	22	10 x 20	145	202	0.12	3.2	52229E3	62229E3	32229E3
	33	12.5 x 20	190	268	0.12	2.3	52339E3	62339E3	32339E3
	47	12.5 x 25	280	352	0.12	1.7	52479E3	62479E3	32479E3
	47	16 x 20	280	352	0.12	1.7	92475E3	92476E3	92473E3
	100	16 x 31	410	670	0.12	1.1	52101E3	62101E3	32101E3
	100	18 x 25	410	670	0.12	1.1	92105E3	92106E3	-
250	4.7	10 x 12	60	105	0.12	13.0	53478E3	63478E3	33478E3
	10	10 x 20	105	145	0.12	6.3	53109E3	63109E3	33109E3
	22	12.5 x 25	180	235	0.12	3.2	53229E3	63229E3	33229E3
	22	16 x 20	180	235	0.12	3.2	93225E3	93226E3	93223E3
	33	12.5 x 25	250	318	0.12	2.3	53339E3	63339E3	33339E3
	33	16 x 20	250	318	0.12	2.3	93335E3	93336E3	93333E3
	47	16 x 25	300	423	0.12	1.7	53479E3	63479E3	33479E3
	47	18 x 20	300	423	0.12	1.7	93475E3	93476E3	-
	100	16 x 31	410	820	0.12	1.1	53101E3	63101E3	33101E3
	100	18 x 25	410	820	0.12	1.1	93105E3	93106E3	-
350	3.3	10 x 12	50	105	0.15	22.0	55338E3	65338E3	35338E3
	4.7	10 x 16	65	119	0.15	16.0	55478E3	65478E3	35478E3
	10	12.5 x 20	120	175	0.15	7.6	55109E3	65109E3	35109E3
	22	12.5 x 25	180	301	0.15	3.8	55229E3	65229E3	35229E3
	22	16 x 20	180	301	0.15	3.8	95225E3	95226E3	95223E3
	33	16 x 25	210	417	0.15	2.6	55339E3	65339E3	35339E3
	47	16 x 35	300	564	0.15	2.0	55479E3	65479E3	-
	47	18 x 31	300	564	0.15	2.0	95475E3	95476E3	-



ELECTRICAL DATA AND ORDERING INFORMATION									
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (μF)	NOMINAL CASE SIZE Ø D x L (mm)	I <sub>R</sub> 100 Hz 105 °C (mA)	I <sub>L1</sub> 1 min (μA)	tan δ 100 Hz	Z 10 kHz (Ω)	ORDERING CODE MAL2151.....		
							BULK PACKAGING		TAPED
							FORM CA	FORM CB	FORM TFA
400	2.2	10 x 12	40	93	0.15	33.0	56228E3	66228E3	36228E3
	3.3	10 x 16	50	110	0.15	22.0	56338E3	66338E3	36338E3
	4.7	10 x 20	70	126	0.15	16.0	56478E3	66478E3	36478E3
	10	12.5 x 20	120	190	0.15	7.6	56109E3	66109E3	36109E3
	22	16 x 25	200	334	0.15	3.8	56229E3	66229E3	36229E3
	22	18 x 20	200	334	0.15	3.8	96225E3	96226E3	-
	33	16 x 31	245	466	0.15	2.6	56339E3	66339E3	36339E3
	33	18 x 25	245	466	0.15	2.6	96335E3	96336E3	-
450	47	18 x 31	300	634	0.15	2.0	56479E3	66479E3	-
	2.2	10 x 16	45	99	0.2	43.0	57228E3	67228E3	37228E3
	3.3	10 x 20	65	115	0.2	29.0	57338E3	67338E3	37338E3
	4.7	12.5 x 20	80	133	0.2	20.0	57478E3	67478E3	37478E3
	10	16 x 20	140	205	0.2	10.0	57109E3	67109E3	37109E3
	22	16 x 31	220	367	0.2	4.6	57229E3	67229E3	37229E3
	22	18 x 25	220	367	0.2	4.6	97225E3	97226E3	-
	33	18 x 35	280	516	0.2	3.4	57339E3	67339E3	-

ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage	IEC 60384-4, subclause 4.14: U <sub>R</sub> = 160 V to 250 V U <sub>R</sub> = 350 V to 400 V	U <sub>s</sub> ≤ 1.15 x U <sub>R</sub> U <sub>s</sub> ≤ 1.10 x U <sub>R</sub>
Reverse voltage	IEC 60384-4, subclause 4.15	U <sub>rev</sub> ≤ 1 V
<b>Current</b>		
Leakage current	After 1 min at U <sub>R</sub> : CV ≤ 1000 μC CV > 1000 μC	I <sub>L1</sub> ≤ 0.06 C <sub>R</sub> x U <sub>R</sub> + 40 μA I <sub>L1</sub> ≤ 0.03 C <sub>R</sub> x U <sub>R</sub> + 70 μA
	After 5 min at U <sub>R</sub> : CV ≤ 1000 μC CV > 1000 μC	I <sub>L5</sub> ≤ 0.03 C <sub>R</sub> x U <sub>R</sub> + 15 μA I <sub>L5</sub> ≤ 0.015 C <sub>R</sub> x U <sub>R</sub> + 30 μA
<b>Inductance</b>		
Equivalent series inductance (ESL)	Case Ø D = 10 mm	Typ. 16 nH
	Case Ø D ≥ 12.5 mm	Typ. 18 nH
<b>Resistance</b>		
Equivalent series resistance (ESR)	Calculated from tan δ <sub>max</sub> and C <sub>R</sub> (see Table 2)	ESR = tan δ/2 πf C <sub>R</sub>



**RIPPLE CURRENT AND USEFUL LIFE**

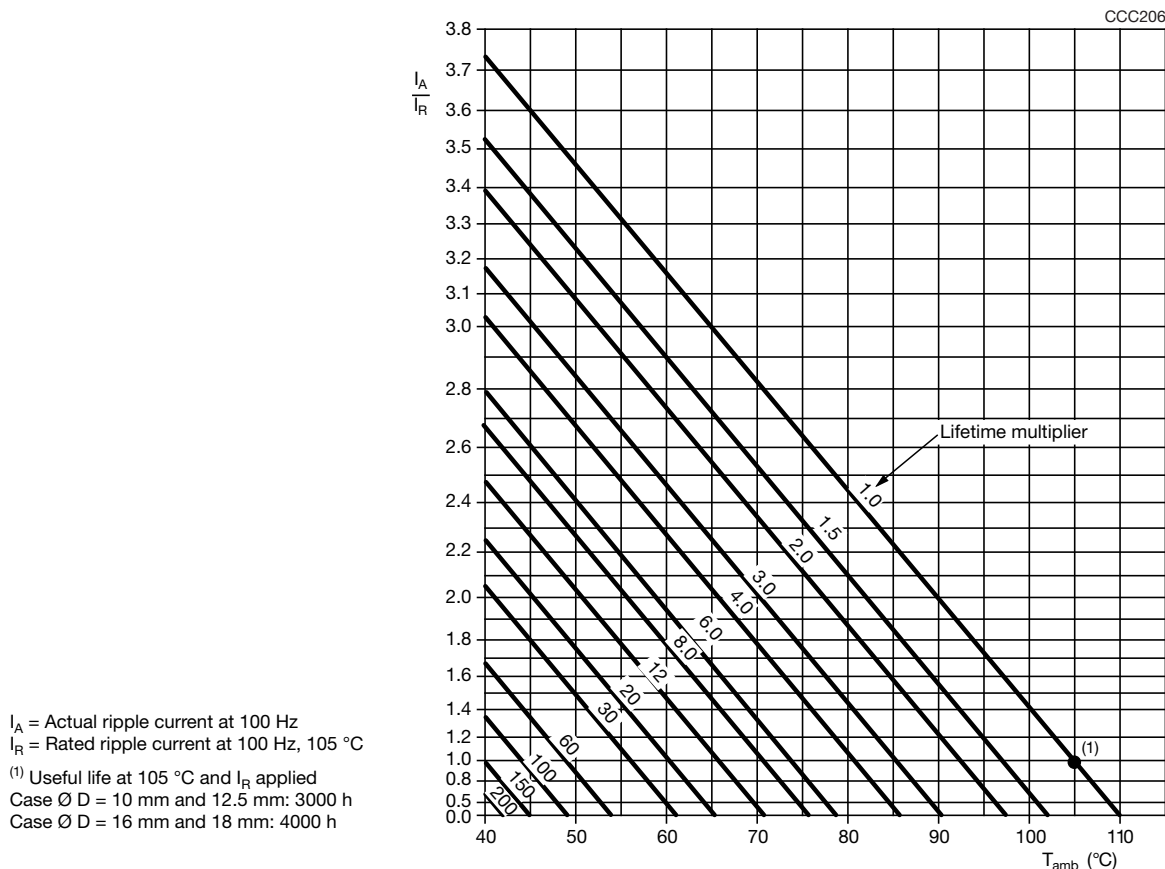


Fig. 5 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY	
FREQUENCY (Hz)	$I_R$ MULTIPLIER
50	0.75
100	1.00
300	1.20
1000	1.35
3000	1.45
$\geq 10\ 000$	1.50



Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.15	$T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ 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 $\varnothing D = 10\text{ mm}$ and $12.5\text{ mm}$ : 3000 h; Case $\varnothing D = 16\text{ mm}$ and $18\text{ mm}$ : 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; 500 h After test: $U_R$ to be applied for 30 min, 24 h to 48 h before measurement	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$



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