

## Aluminum Capacitors

### Radial Long-Life, High Voltage

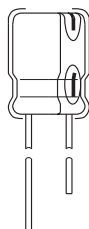
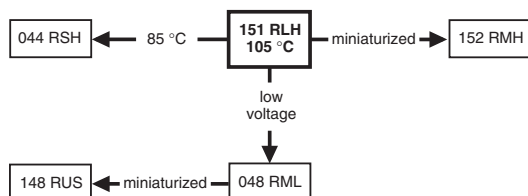


Fig.1 Component outline.



#### QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes ( $\varnothing D \times L$ in mm)	10 $\times$ 12 to 18 $\times$ 35
Rated capacitance range, $C_R$	1 to 220 $\mu F$
Tolerance on $C_R$	$\pm 20\%$
Rated voltage range, $U_R$	160 to 450 V
Category temperature range	-40 to +105 $^{\circ}C$
Endurance test at 105 $^{\circ}C$	2000 hours
Useful life at 105 $^{\circ}C$ : case $\varnothing D = 10$ and 12.5 mm case $\varnothing D = 16$ and 18 mm	3000 hours 4000 hours
Useful life at 40 $^{\circ}C$ , 1.6 $\times I_R$ applied: case $\varnothing D = 10$ and 12.5 mm case $\varnothing D = 16$ and 18 mm	200000 hours 260000 hours
Shelf life at 0 V, 105 $^{\circ}C$	500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/105/56

#### 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
- Long useful life: 3000 to 4000 hours at 105  $^{\circ}C$ , high reliability
- High rated voltage, up to 450 V

#### 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  $\mu F$ ).
- 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  $^{\circ}C$ ).
- Negative terminal identification.
- Series number (151).

#### SELECTION CHART FOR $C_R$ , $U_R$ AND RELEVANT NOMINAL CASE SIZES ( $\varnothing D \times L$ in mm)

$C_R$ ( $\mu F$ )	$U_R$ (V)					
	160	200	250	350	400	450
1.0	—	—	—	—	—	10 $\times$ 12
2.2	—	—	—	—	10 $\times$ 12	10 $\times$ 16
3.3	—	—	—	10 $\times$ 12	10 $\times$ 16	10 $\times$ 20
4.7	—	10 $\times$ 12	10 $\times$ 12	10 $\times$ 16	10 $\times$ 20	12.5 $\times$ 20
10	10 $\times$ 16	10 $\times$ 16	10 $\times$ 20	12.5 $\times$ 20	12.5 $\times$ 20	16 $\times$ 20
22	10 $\times$ 20	10 $\times$ 20	12.5 $\times$ 25	12.5 $\times$ 25	16 $\times$ 25	16 $\times$ 31
	—	—	16 $\times$ 20	16 $\times$ 20	18 $\times$ 20	18 $\times$ 25
33	12.5 $\times$ 20	12.5 $\times$ 20	12.5 $\times$ 25	16 $\times$ 25	16 $\times$ 31	18 $\times$ 35
	—	—	16 $\times$ 20	—	18 $\times$ 25	—
47	12.5 $\times$ 25	12.5 $\times$ 25	16 $\times$ 25	16 $\times$ 35	18 $\times$ 31	—
	16 $\times$ 20	16 $\times$ 20	18 $\times$ 20	18 $\times$ 31	—	—
100	16 $\times$ 25	16 $\times$ 31	16 $\times$ 31	—	—	—
	18 $\times$ 20	18 $\times$ 25	18 $\times$ 25	—	—	—
220	18 $\times$ 35	—	—	—	—	—

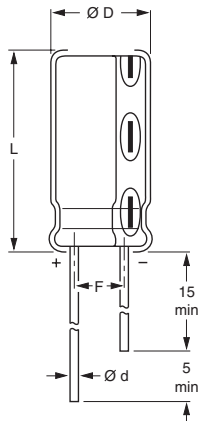
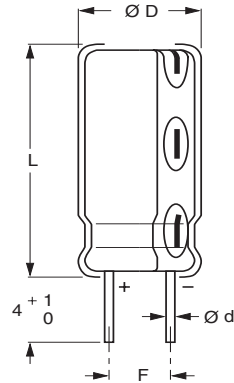
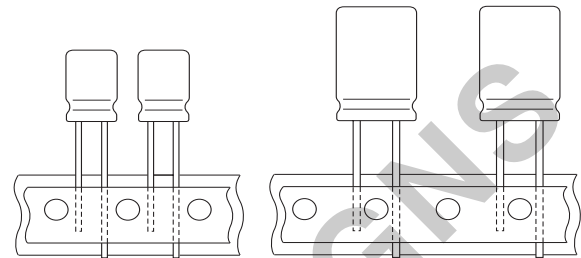
**DIMENSIONS in millimeters AND AVAILABLE FORMS**

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

 Fig.2 **Form CB:** Cut leads.

 Case  $\varnothing D \times L \leq 16 \times 31$  mm.

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

Table 1

<b>DIMENSIONS in millimeters, 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 PER BOX		
							FORM CA	FORM CB	FORM TFA
10 × 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 × 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 × 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 × 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 × 20	19a	0.8	16.5	22.0	7.5 ± 0.5	≈ 6.0	250	250	250
16 × 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 × 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 × 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.0	100	100	–
18 × 20	1820	0.8	18.5	22.0	7.5 ± 0.5	≈ 8.0	100	100	–
18 × 25	1825	0.8	18.5	27.0	7.5 ± 0.5	≈ 10.0	100	100	–
18 × 31	1831	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	100	100	–
18 × 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 minute at $U_R$
$\tan \delta$	max. dissipation factor at 100 Hz
$Z$	max. impedance at 10 kHz

**Note**

1. Unless otherwise specified, all electrical values in Table 2 apply at  $T_{amb} = 20\text{ °C}$ ,  $P = 86$  to  $106\text{ kPa}$ ,  $RH = 45$  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	$Z$ 10 kHz ( $\Omega$ )	CATALOG NUMBER 2222 151 .....		
							BULK PACKAGING		TAPED
							FORM CA	FORM CB	FORM TFA
160	10	10 × 16	95	118	0.12	6.3	51109	61109	31109
	22	10 × 20	145	176	0.12	3.2	51229	61229	31229
	33	12.5 × 20	190	228	0.12	2.3	51339	61339	31339
	47	12.5 × 25	280	296	0.12	1.7	51479	61479	31479
	47	16 × 20	280	296	0.12	1.7	91475	91476	91473
	100	16 × 25	380	550	0.12	1.1	51101	61101	31101
	100	18 × 20	380	550	0.12	1.1	91105	91106	–
	220	18 × 35	630	1126	0.12	0.8	51221	61221	–
200	4.7	10 × 12	60	96	0.12	13.0	52478	62478	32478
	10	10 × 16	95	130	0.12	6.3	52109	62109	32109
	22	10 × 20	145	202	0.12	3.2	52229	62229	32229
	33	12.5 × 20	190	268	0.12	2.3	52339	62339	32339
	47	12.5 × 25	280	352	0.12	1.7	52479	62479	32479
	47	16 × 20	280	352	0.12	1.7	92475	92476	92473
	100	16 × 31	410	670	0.12	1.1	52101	62101	32101
	100	18 × 25	410	670	0.12	1.1	92105	92106	–
250	4.7	10 × 12	60	105	0.12	13.0	53478	63478	33478
	10	10 × 20	105	145	0.12	6.3	53109	63109	33109
	22	12.5 × 25	180	235	0.12	3.2	53229	63229	33229
	22	16 × 20	180	235	0.12	3.2	93225	93226	93223
	33	12.5 × 25	250	318	0.12	2.3	53339	63339	33339
	33	16 × 20	250	318	0.12	2.3	93335	93336	93333
	47	16 × 25	300	423	0.12	1.7	53479	63479	33479
	47	18 × 20	300	423	0.12	1.7	93475	93476	–
	100	16 × 31	410	820	0.12	1.1	53101	63101	33101
	100	18 × 25	410	820	0.12	1.1	93105	93106	–

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Radial Long-Life, High Voltage

Vishay BCcomponents

**ELECTRICAL DATA AND ORDERING INFORMATION**

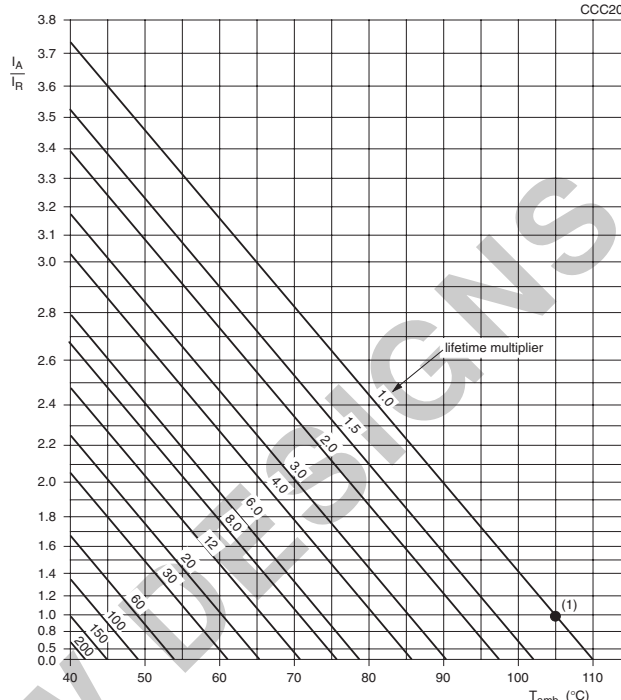
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	I <sub>R</sub> 100 Hz 105 °C (mA)	I <sub>L1</sub> 1 min (μA)	Tan δ 100 Hz	Z 10 kHz (Ω)	CATALOG NUMBER 2222 151 .....		
							BULK PACKAGING		TAPED
							FORM CA	FORM CB	FORM TFA
350	3.3	10 × 12	50	105	0.15	22.0	55338	65338	35338
	4.7	10 × 16	65	119	0.15	16.0	55478	65478	35478
	10	12.5 × 20	120	175	0.15	7.6	55109	65109	35109
	22	12.5 × 25	180	301	0.15	3.8	55229	65229	35229
	22	16 × 20	180	301	0.15	3.8	95225	95226	95223
	33	16 × 25	210	417	0.15	2.6	55339	65339	35339
	47	16 × 35	300	564	0.15	2.0	55479	65479	–
	47	18 × 31	300	564	0.15	2.0	95475	95476	–
400	2.2	10 × 12	40	93	0.15	33.0	56228	66228	36228
	3.3	10 × 16	50	110	0.15	22.0	56338	66338	36338
	4.7	10 × 20	70	126	0.15	16.0	56478	66478	36478
	10	12.5 × 20	120	190	0.15	7.6	56109	66109	36109
	22	16 × 25	200	334	0.15	3.8	56229	66229	36229
	22	18 × 20	200	334	0.15	3.8	96225	96226	–
	33	16 × 31	245	466	0.15	2.6	56339	66339	36339
	33	18 × 25	245	466	0.15	2.6	96335	96336	–
	47	18 × 31	300	634	0.15	2.0	56479	66479	–
450	1.0	10 × 12	30	67	0.2	94.0	57108	67108	37108
	2.2	10 × 16	45	99	0.2	43.0	57228	67228	37228
	3.3	10 × 20	65	115	0.2	29.0	57338	67338	37338
	4.7	12.5 × 20	80	133	0.2	20.0	57478	67478	37478
	10	16 × 20	140	205	0.2	10.0	57109	67109	37109
	22	16 × 31	220	367	0.2	4.6	57229	67229	37229
	22	18 × 25	220	367	0.2	4.6	97225	97226	–
	33	18 × 35	280	516	0.2	3.4	57339	67339	–

**ADDITIONAL ELECTRICAL DATA**

PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage	IEC 60384-4, subclause 4.14: U <sub>R</sub> = 160 to 250 V U <sub>R</sub> = 350 to 400 V	U <sub>s</sub> ≤ 1.15 × U <sub>R</sub> U <sub>s</sub> ≤ 1.10 × 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 minute at U <sub>R</sub> : CV ≤ 1000 μC CV > 1000 μC	I <sub>L1</sub> ≤ 0.06 C <sub>R</sub> × U <sub>R</sub> + 40 μA I <sub>L1</sub> ≤ 0.03 C <sub>R</sub> × U <sub>R</sub> + 70 μA
	after 5 minutes at U <sub>R</sub> : CV ≤ 1000 μC CV > 1000 μC	I <sub>L5</sub> ≤ 0.03 C <sub>R</sub> × U <sub>R</sub> + 15 μA I <sub>L5</sub> ≤ 0.015 C <sub>R</sub> × U <sub>R</sub> + 30 μA
<b>Inductance</b>		
Equivalent series inductance (ESL)	case ØD = 10 mm	typ. 16 nH
	case ØD ≥ 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 / 2πfC <sub>R</sub>

# **RIPPLE CURRENT AND USEFUL LIFE**

CCC206



$I_A$  = 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 ØD = 10 and 12.5 mm: 3000 hours  
case ØD = 16 and 18 mm: 4000 hours.

Fig.3 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
≥10000	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	$T_{amb} = 105\text{ °C}$ ; $U_R$ applied; 2000 hours	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ °C}$ ; $U_R$ and $I_R$ applied; case ØD = 10 and 12.5 mm: 3000 hours; case ØD = 16 and 18 mm: 4000 hours	$\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	$T_{amb} = 105\text{ °C}$ ; no voltage applied; 500 hours after test: $U_R$ to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$