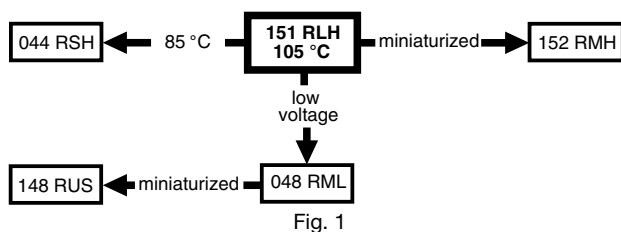




Aluminum Capacitors Radial Long-Life, High Voltage



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



RoHS
COMPLIANT

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:

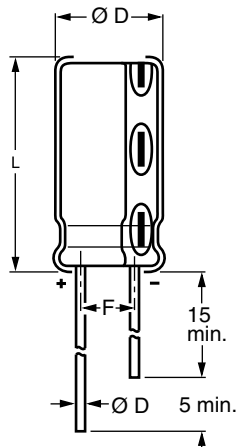
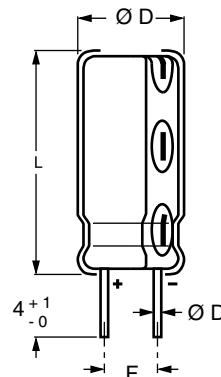
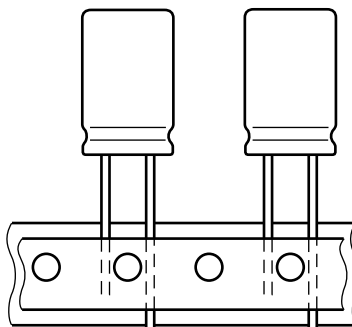
- Rated capacitance value (in μF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for $\pm 20\%$)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Upper category temperature (105 °C)
- Negative 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 μF to 220 μF
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 Case $\varnothing$ D = 16 mm and 18 mm	3000 h 4000 h
Useful life at 40 °C, 1.6 x I_R applied: Case $\varnothing$ D = 10 mm and 12.5 mm Case $\varnothing$ D = 16 mm and 18 mm	200 000 h 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 (μF)	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
33	-	-	16 x 20	16 x 20	18 x 20	18 x 25
	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 leadsFig. 3 - **Form CB:** Cut leadsFig. 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 _{max.}	L _{max.}	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

Note

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

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION									
U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (μA)	$\tan \delta$ 100 Hz	Z 10 kHz (Ω)	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	-

ORDERING EXAMPLE

Electrolytic capacitor 151 series

4.7 μF /400 V; $\pm 20\%$ Nominal case size: $\varnothing 10\text{ mm} \times 20\text{ mm}$; Form TFA

Ordering code: MAL215136478E3

Former 12NC: 2222 151 36478

**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 105 °C (mA)	I _{L1} 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	-
	47	18 x 31	300	634	0.15	2.0	56479E3	66479E3	-
450	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
Voltage		
Surge voltage	IEC 60384-4, subclause 4.14: U _R = 160 V to 250 V U _R = 350 V to 400 V	U _s ≤ 1.15 x U _R U _s ≤ 1.10 x U _R
Reverse voltage	IEC 60384-4, subclause 4.15	U _{rev} ≤ 1 V
Current		
Leakage current	After 1 min at U _R : CV ≤ 1000 μC CV > 1000 μC	I _{L1} ≤ 0.06 C _R x U _R + 40 μA I _{L1} ≤ 0.03 C _R x U _R + 70 μA
	After 5 min at U _R : CV ≤ 1000 μC CV > 1000 μC	I _{L5} ≤ 0.03 C _R x U _R + 15 μA I _{L5} ≤ 0.015 C _R x U _R + 30 μA
Inductance		
Equivalent series inductance (ESL)	Case Ø D = 10 mm	Typ. 16 nH
	Case Ø D ≥ 12.5 mm	Typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan δ _{max} and C _R (see Table 2)	ESR = tan δ/2 πf C _R



RIPPLE CURRENT AND USEFUL LIFE

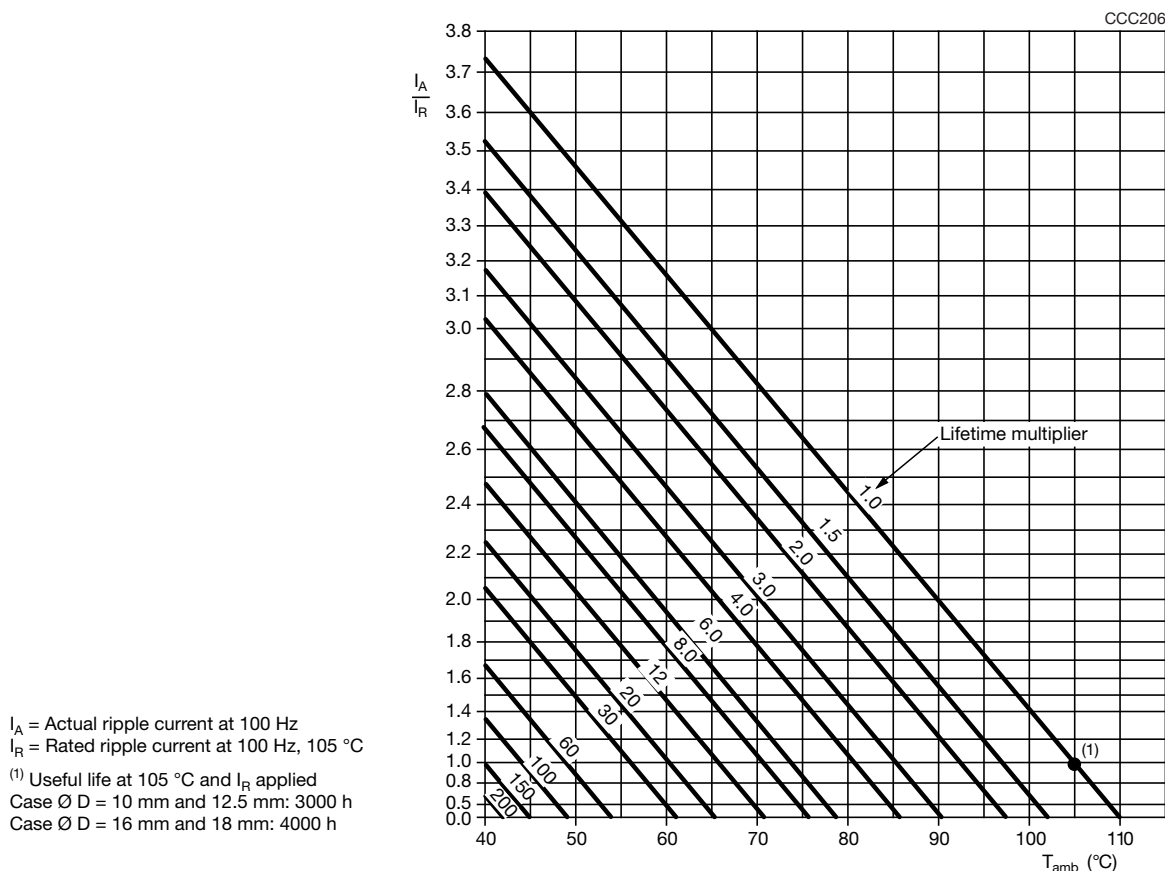


Fig. 5 - Multiplier of useful life as a function of ambient temperature and ripple current load

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 mm : 3000 h; Case $\varnothing D = 16\text{ mm}$ and 18 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	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$



Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.