

Aluminum Capacitors

Radial Miniature, Low Impedance

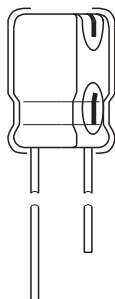
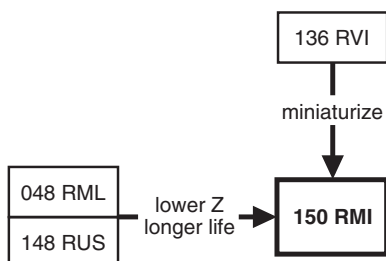


Fig.1 Component outline.



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
- Very long useful life:
4000 to 10000 hours at 105 °C, high stability, high reliability
- Very low impedance or ESR respectively, at smaller case sizes than the 136 RVI series
- Excellent ripple current capability
- Lead (Pb)-free versions are RoHS compliant.



APPLICATIONS

- Power supplies (SMPS, DC/DC converters) for general industrial, EDP, audio-video, automotive and telecommunications
- Smoothing, filtering, buffering.

MARKING

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

- Rated capacitance (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 (150).

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case sizes ($\varnothing D \times L$ in mm)	10 × 12 to 16 × 35
Rated capacitance range, C_R	100 to 6800 μF
Tolerance on C_R	$\pm 20\%$
Rated voltage range, U_R	10 to 63 V
Category temperature range	-55 to +105 °C
Endurance test at 105 °C	3000 to 5000 hours
Useful life at 105 °C	4000 to 10000 hours
Useful life at 40 °C, $1.8 \times I_R$ applied	200000 to 500000 hours
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	55/105/56

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

C_R (μF)	U_R (V)					
	10	16	25	35	50	63
100	—	—	—	—	—	10 × 12
150	—	—	—	—	10 × 12	10 × 16
220	—	—	—	10 × 12	10 × 16	10 × 20
330	—	—	10 × 12	10 × 16	10 × 20	12.5 × 20
470	—	10 × 12	10 × 16	10 × 20	12.5 × 20	12.5 × 25
	—	—	—	—	—	16 × 20
680	10 × 12	10 × 16	10 × 20	12.5 × 20	12.5 × 25	16 × 20
	—	—	—	—	—	16 × 25
1000	10 × 16	10 × 20	12.5 × 20	12.5 × 25	16 × 25	16 × 31
	—	—	—	16 × 20	—	—
1200	—	—	—	—	16 × 31	—
1500	—	12.5 × 20	12.5 × 25	16 × 20	16 × 31	—
2200	12.5 × 20	12.5 × 25	16 × 20	16 × 31	—	—
3300	12.5 × 25	16 × 20	16 × 31	—	—	—
4700	16 × 25	16 × 31	16 × 35	—	—	—
6800	16 × 31	16 × 35	—	—	—	—

* Pb containing terminations are not RoHS compliant, exemptions may apply

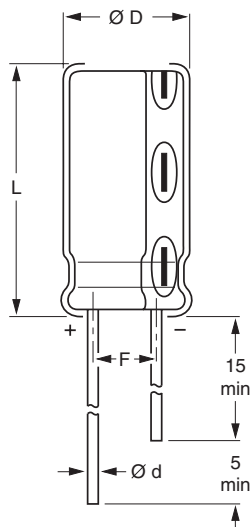
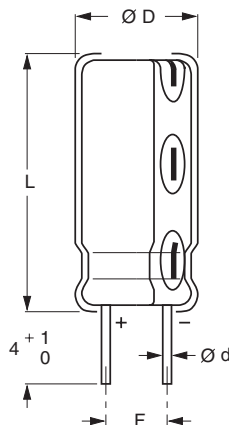
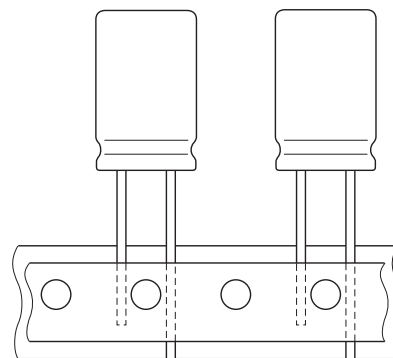
DIMENSIONS in millimeters **AND AVAILABLE FORMS**

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 ØD × L	CASE CODE	Ød	ØD _{max}	L _{max}	F	MASS (g)	PACKAGING QUANTITIES		
							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	—

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 100 Hz, tolerance $\pm 20\%$
I_R	rated RMS ripple current at 100 kHz, 105°C
I_{L2}	max. leakage current after 2 minutes at U_R
$\tan \delta$	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz

Note

1. Unless otherwise specified, all electrical values in Table 2 apply at $T_{amb} = 20^\circ\text{C}$, $P = 86$ 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 kHz 105 °C (mA)	I_{L2} 2 min (μA)	$\tan \delta$ 100 Hz	Z 100 kHz +20 °C (Ω)	Z 100 kHz -40 °C (Ω)	CATALOG NUMBER 2222 150		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
10	680	10 × 12	730	71	0.19	0.097	0.680	54681	64681	34681
	1000	10 × 16	950	103	0.19	0.066	0.460	54102	64102	34102
	2200	12.5 × 20	1460	223	0.21	0.037	0.260	54222	64222	34222
	3300	12.5 × 25	1950	333	0.21	0.029	0.200	54332	64332	34332
	4700	16 × 25	2390	473	0.23	0.022	0.150	54472	64472	34472
	6800	16 × 31	2890	683	0.25	0.019	0.130	54682	64682	34682
16	470	10 × 12	730	78	0.16	0.097	0.680	55471	65471	35471
	680	10 × 16	950	112	0.16	0.066	0.460	55681	65681	35681
	1000	10 × 20	1180	163	0.16	0.049	0.340	55102	65102	35102
	1500	12.5 × 20	1460	243	0.16	0.037	0.260	55152	65152	35152
	2200	12.5 × 25	1950	355	0.18	0.029	0.200	55222	65222	35222
	3300	16 × 20	1840	531	0.20	0.028	0.200	55332	65332	35332
	4700	16 × 31	2890	755	0.22	0.019	0.130	55472	65472	35472
	6800	16 × 35	3100	1091	0.24	0.018	0.130	55682	65682	—
25	330	10 × 12	730	86	0.14	0.097	0.680	56331	66331	36331
	470	10 × 16	950	121	0.14	0.066	0.460	56471	66471	36471
	680	10 × 20	1180	173	0.14	0.049	0.340	56681	66681	36681
	1000	12.5 × 20	1460	253	0.14	0.037	0.260	56102	66102	36102
	1500	12.5 × 25	1950	378	0.14	0.029	0.200	56152	66152	36152
	2200	16 × 20	1840	553	0.16	0.028	0.200	56222	66222	36222
	3300	16 × 31	2890	828	0.16	0.019	0.130	56332	66332	36332
	4700	16 × 35	3100	1178	0.18	0.018	0.130	56472	66472	—
35	220	10 × 12	730	80	0.12	0.097	0.680	50221	60221	30221
	330	10 × 16	950	118	0.12	0.066	0.460	50331	60331	30331
	470	10 × 20	1180	167	0.12	0.049	0.340	50471	60471	30471
	680	12.5 × 20	1460	241	0.12	0.037	0.260	50681	60681	30681
	1000	12.5 × 25	1950	353	0.12	0.029	0.200	50102	60102	30102
	1000	16 × 20	1840	353	0.12	0.028	0.200	90105	90106	90103
	1500	16 × 20	1840	528	0.12	0.028	0.200	50152	60152	30152
	2200	16 × 31	2890	773	0.14	0.019	0.130	50222	60222	30222
50	150	10 × 12	500	78	0.10	0.200	1.400	51151	61151	31151
	220	10 × 16	700	113	0.10	0.120	0.840	51221	61221	31221
	330	10 × 20	900	168	0.10	0.090	0.630	51331	61331	31331
	470	12.5 × 20	1100	238	0.10	0.062	0.430	51471	61471	31471
	680	12.5 × 25	1400	343	0.10	0.048	0.340	51681	61681	31681
	1000	16 × 25	1800	503	0.10	0.034	0.240	51102	61102	31102
	1200	16 × 31	2200	603	0.10	0.027	0.190	51122	61122	31122
	1500	16 × 31	2200	753	0.10	0.027	0.190	51152	61152	31152
63	100	10 × 12	420	66	0.10	0.270	1.890	58101	68101	38101
	150	10 × 16	560	97	0.10	0.190	1.330	58151	68151	38151
	220	10 × 20	700	141	0.10	0.150	1.050	58221	68221	38221
	330	12.5 × 20	930	211	0.10	0.095	0.670	58331	68331	38331
	470	12.5 × 25	1200	299	0.10	0.067	0.470	58471	68471	38471
	470	16 × 20	1100	299	0.10	0.074	0.520	98475	98476	98473
	680	16 × 20	1100	431	0.10	0.074	0.520	58681	68681	38681
	680	16 × 25	1500	431	0.10	0.054	0.380	98685	98686	98683
	1000	16 × 31	1900	633	0.10	0.042	0.295	58102	68102	38102

ORDERING EXAMPLE*

Electrolytic capacitor 150 series

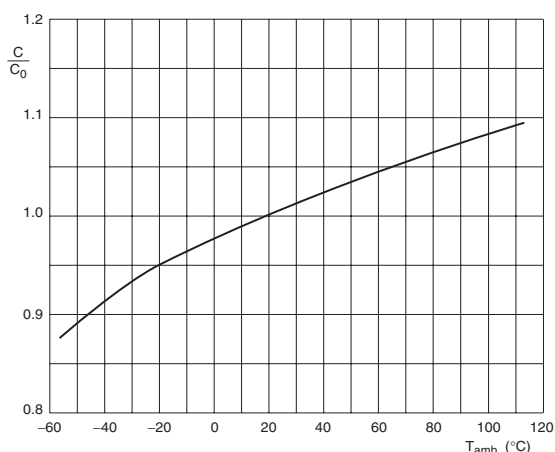
470 μF /16 V; $\pm 20\%$ Nominal case size: $\varnothing 10 \times 12$ mm; Form TFA

Catalog number: 2222 150 35471.

* To ensure delivery of lead (Pb)-free parts during the transition period, please contact your Vishay sales agent.

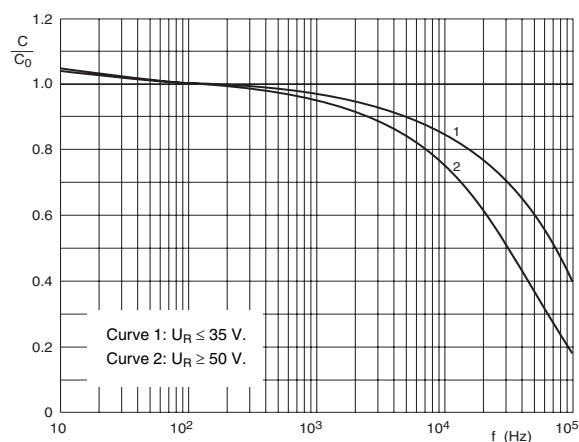


ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 2 minutes at U_R	$I_{L2} \leq 0.01 C_R \times U_R + 3 \mu\text{A}$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 10 \text{ mm}$	typ. 16 nH
	case $\varnothing D \geq 12.5 \text{ mm}$	typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	calculated from $\tan \delta_{\max}$ and C_R (see Table 2)	$\text{ESR} = \tan \delta / 2\pi f C_R$

CAPACITANCE (C)

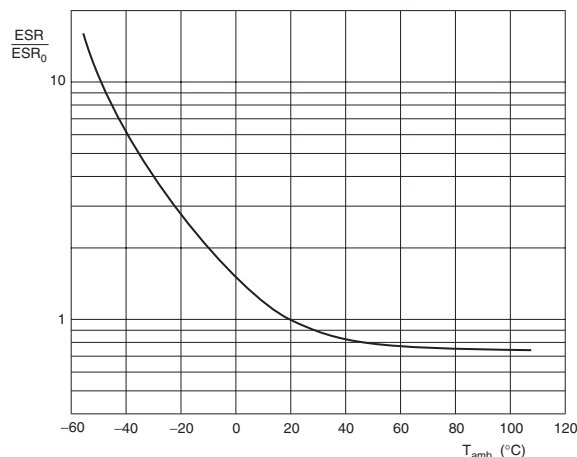
C_0 = typical capacitance at 20 °C, 100 Hz.

Fig.5 Typical multiplier of capacitance as a function of ambient temperature.



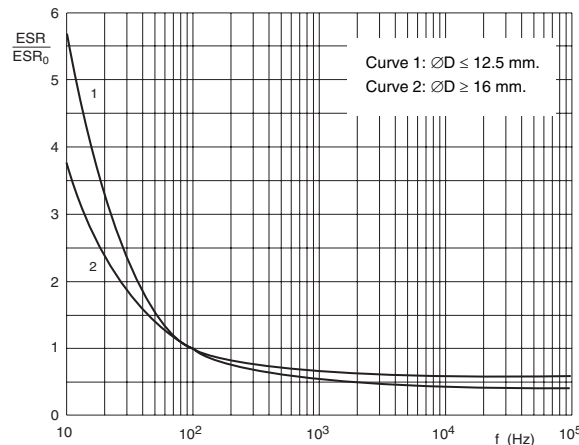
C_0 = typical capacitance at 20 °C, 100 Hz. $T_{\text{amb}} = 20 \text{ °C}$

Fig.6 Typical multiplier of capacitance as a function of frequency.

EQUIVALENT SERIES RESISTANCE (ESR)

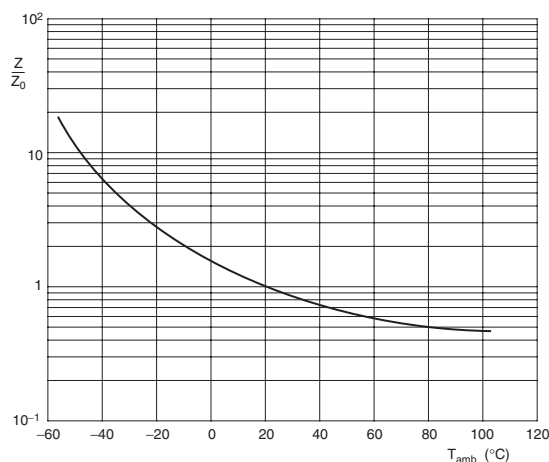
ESR_0 = typical ESR at 20 °C, 100 Hz.

Fig.7 Typical multiplier of ESR as a function of ambient temperature.



ESR_0 = typical ESR at 20 °C, 100 Hz. $T_{\text{amb}} = 20 \text{ °C}$

Fig.8 Typical multiplier of ESR as a function of frequency.

IMPEDANCE (Z)

Z_0 = typical impedance at 20 °C, 100 kHz.

Fig.9 Typical multiplier of impedance as a function of ambient temperature.

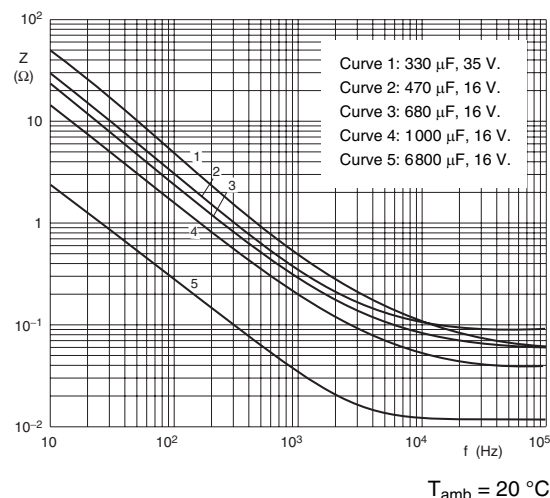


Fig.10 Typical impedance as a function of frequency.

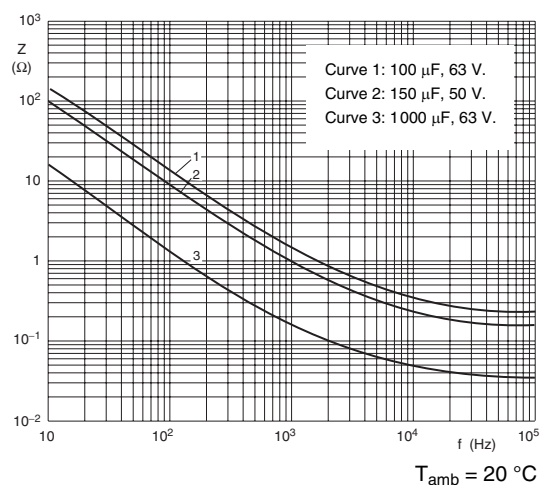


Fig.11 Typical impedance as a function of frequency.

RIPPLE CURRENT AND USEFUL LIFE

Table 3

ENDURANCE TEST DURATION AND USEFUL LIFE AS A FUNCTION OF CASE SIZE			
NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	CASE CODE	ENDURANCE at 105 °C (hours)	USEFUL LIFE at 105 °C (hours)
10 × 12	14	3000	4000
10 × 16	15	3000	6000
10 × 20	16	3000	6000
12.5 × 20	17	3000	7000
12.5 × 25	18	5000	8000
16 × 20	19a	3000	7000
16 × 25	19	5000	10000
16 × 31	20	5000	10000
16 × 35	21	5000	10000

I_A = actual ripple current at 100 kHz.
 I_R = rated ripple current at 100 kHz, 105 °C.
 (1) Useful life at 105 °C and I_R applied; see Table 4.

Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load.

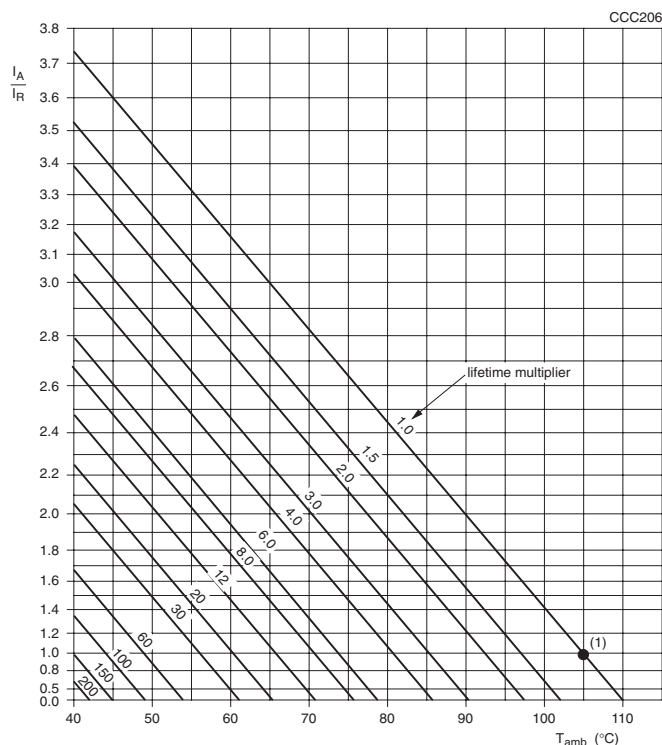


Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY		
FREQUENCY (Hz)	I_R MULTIPLIER	
	$\varnothing = 10$ and 12.5 mm	$\varnothing = 16$ mm
100	0.65	0.76
300	0.76	0.85
1000	0.85	0.91
3000	0.89	0.94
10000	0.90	0.96
30000	0.97	0.98
100000	1.00	1.00

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 105^\circ\text{C}$; U_R applied; for test duration see Table 4	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105^\circ\text{C}$; U_R and I_R applied; for test duration see Table 4	$\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	$T_{amb} = 105^\circ\text{C}$; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$



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