

Aluminum Capacitors Radial Low Impedance

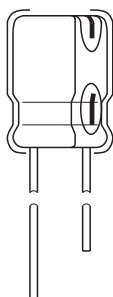
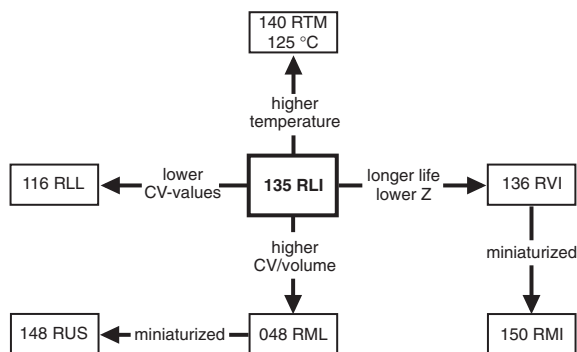


Fig.1 Component outline.



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
- Long useful life:
1500 to 2500 hours at 105 °C
- Low ESR, low impedance, high ripple current capability
- Lead (Pb)-free versions are RoHS compliant.



RoHS*
COMPLIANT

APPLICATIONS

- General industrial, EDP, telecommunication and audio-video
- Smoothing, filtering, buffering in SMPS and DC/DC converters.

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 (135).

QUICK REFERENCE DATA

DESCRIPTION	VALUE	
Nominal case sizes ($\varnothing D \times L$ in mm)	8 × 12 to 8 × 20	10 × 12 to 18 × 40
Rated capacitance range, C_R	22 to 10000 μF	
Tolerance on C_R	$\pm 20\%$	
Rated voltage range, U_R	6.3 to 100 V	
Category temperature range	-55 to +105 °C	
Endurance test at 105 °C	1000 hours	2000 hours
Useful life at 105 °C	1500 hours	2500 hours
Useful life at 40 °C, 1.3 × I_R applied	150000 hours	250000 hours
Shelf life at 0 V, 105 °C	1000 hours	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)							
	6.3	10	16	25	35	50	63	100
22	—	—	—	—	—	—	—	8 × 12
47	—	—	—	—	—	—	8 × 12	—
100	—	—	—	—	8 × 12	10 × 16	—	12.5 × 20
220	—	—	8 × 12	8 × 15	8 × 20	10 × 25	12.5 × 20	16 × 25
330	—	—	8 × 15	—	10 × 20	12.5 × 20	—	16 × 31
	—	—	—	—	—	—	—	18 × 25

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

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

C_R (μF)	U_R (V)							
	6.3	10	16	25	35	50	63	100
470	10 × 12	8 × 15	8 × 20	10 × 20	10 × 30	12.5 × 25	16 × 25	16 × 40
	–	–	–	–	–	18 × 15	–	–
680	10 × 16	–	10 × 20	–	12.5 × 25	–	16 × 31	18 × 40
1000	–	12.5 × 16	10 × 30	12.5 × 25	12.5 × 31	16 × 31	16 × 40	–
	–	–	–	–	16 × 20	–	–	–
1500	–	10 × 30	12.5 × 25	12.5 × 31	12.5 × 40	16 × 40	–	–
2200	12.5 × 20	12.5 × 25	12.5 × 31	12.5 × 40	16 × 35	18 × 40	–	–
	–	18 × 15	16 × 20	18 × 20	18 × 31	–	–	–
3300	–	12.5 × 35	–	16 × 35	18 × 40	–	–	–
	–	16 × 20	–	18 × 31	–	–	–	–
4700	–	16 × 31	16 × 35	18 × 40	–	–	–	–
	–	18 × 25	18 × 31	–	–	–	–	–
6800	16 × 31	16 × 35	18 × 35	–	–	–	–	–
10000	18 × 31	18 × 40	–	–	–	–	–	–

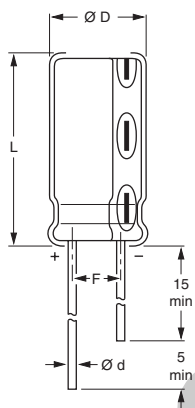
DIMENSIONS in millimeters AND AVAILABLE FORMS

Fig.2 Form CA: Long leads.

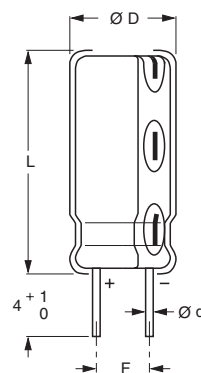


Fig.3 Form CB: Cut leads.

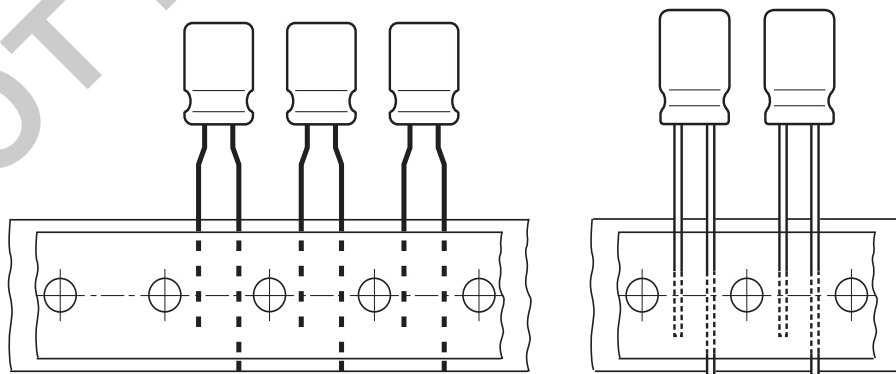
Formed leads for $\varnothing D=8\text{mm}$ with pitch $F=5\text{mm}$

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



Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE $\varnothing D \times L$	CASE CODE	$\varnothing d$	$\varnothing D_{max}$	L_{max}	F	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA
8 × 12	13	0.6	8.5	13.0	3.5 ± 0.5	≈ 1.1	1000	2000	1000
8 × 15	13L	0.6	8.5	16.0	3.5 ± 0.5	≈ 1.3	1000	1000	1000
8 × 20	13LL	0.6	8.5	21.0	3.5 ± 0.5	≈ 1.5	1000	1000	1000
10 × 12	14	0.6	10.5	13.5	5 ± 0.5	≈ 1.6	1000	500	800
10 × 16	15	0.6	10.5	17.5	5 ± 0.5	≈ 1.9	500	500	800
10 × 20	16	0.6	10.5	22.0	5 ± 0.5	≈ 2.2	500	500	800
10 × 25	16L	0.6	10.5	27.0	5 ± 0.5	≈ 3.0	1000	1500	800
10 × 30	16LL	0.6	10.5	32.0	5 ± 0.5	≈ 3.5	1000	750	–
12.5 × 16	17a	0.6	13.0	17.5	5 ± 0.5	≈ 2.7	1000	1500	500
12.5 × 20	17	0.6	13.0	22.0	5 ± 0.5	≈ 4.0	500	500	500
12.5 × 25	18	0.6	13.0	27.0	5 ± 0.5	≈ 5.0	250	250	500
12.5 × 31	18L	0.6	13.0	33.5	5 ± 0.5	≈ 5.5	1000	750	–
12.5 × 35	18LL	0.6	13.0	37.5	5 ± 0.5	≈ 6.0	500	750	–
12.5 × 40	1240	0.6	13.0	42.0	5 ± 0.5	≈ 7.5	500	750	–
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	–
16 × 40	21L	0.8	16.5	42.0	7.5 ± 0.5	≈ 13.0	250	500	–
18 × 15	1815	0.8	18.5	17.0	7.5 ± 0.5	≈ 6.0	500	500	–
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	–
18 × 40	23	0.8	18.5	42.0	7.5 ± 0.5	≈ 16.0	250	500	–

Note

1. Detailed tape dimensions see section 'PACKAGING'.

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 120 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 120 Hz
Z	max. impedance at 100 kHz

Note

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

ORDERING EXAMPLE*

Electrolytic capacitor 135 series

1000 $\mu\text{F}/16\text{V}$; $\pm 20\%$

Nominal case size: $\varnothing 10 \times 30\text{ mm}$; Form CB

Catalog number: 2222 135 65102

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

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION												
U _R (V)	C _R 120 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	I _R 100 kHz 105 °C (mA)	I _{L2} 2 min (μA)	Tan δ 120 Hz	Z 100 kHz (Ω)	CATALOG NUMBER 2222 135					
							BULK PACKAGING				TAPED	
							LONG LEADS		CUT LEADS			
							FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)
6.3	470	10 × 12	510	30	0.22	0.28	53471	5.0	63471	5.0	33471	5.0
	680	10 × 16	640	43	0.22	0.22	53681	5.0	63681	5.0	33681	5.0
	2200	12.5 × 20	1100	140	0.24	0.089	53222	5.0	63222	5.0	33222	5.0
	6800	16 × 31	1800	430	0.32	0.055	53682	7.5	63682	7.5	33682	7.5
	10000	18 × 31	2000	630	0.40	0.047	53103	7.5	63103	7.5	—	—
10	470	8 × 15	500	47	0.19	0.24	54471	3.5	84471	3.5	34471	5.0
	1000	12.5 × 16	970	100	0.19	0.12	54102	5.0	64102	5.0	34102	5.0
	1500	10 × 30	1200	150	0.19	0.093	54152	5.0	64152	5.0	—	—
	2200	12.5 × 25	1300	220	0.21	0.073	54222	5.0	64222	5.0	34222	5.0
	2200	18 × 15	1300	220	0.21	0.080	90001	7.5	90002	7.5	—	—
	3300	12.5 × 35	1800	330	0.23	0.052	54332	5.0	64332	5.0	—	—
	3300	16 × 20	1400	330	0.23	0.075	90025	7.5	90026	7.5	90042	7.5
	4700	16 × 31	1800	470	0.25	0.054	54472	7.5	64472	7.5	34472	7.5
	4700	18 × 25	1800	470	0.25	0.053	90003	7.5	90004	7.5	—	—
	6800	16 × 35	2000	680	0.29	0.046	54682	7.5	64682	7.5	—	—
	10000	18 × 40	2500	1000	0.37	0.037	54103	7.5	64103	7.5	—	—
	16	220	8 × 12	400	35	0.16	0.33	55221	3.5	85221	3.5	35221
330		8 × 15	500	53	0.16	0.23	55331	3.5	85331	3.5	35331	5.0
470		8 × 20	650	75	0.16	0.18	55471	3.5	85471	3.5	35471	5.0
680		10 × 20	860	110	0.16	0.14	55681	5.0	65681	5.0	35681	5.0
1000		10 × 30	1200	160	0.16	0.091	55102	5.0	65102	5.0	—	—
1500		12.5 × 25	1300	240	0.16	0.072	55152	5.0	65152	5.0	35152	5.0
2200		12.5 × 31	1500	350	0.18	0.063	55222	5.0	65222	5.0	—	—
2200		16 × 20	1400	350	0.18	0.073	90007	7.5	90008	7.5	90043	7.5
4700		16 × 35	2000	750	0.22	0.046	55472	7.5	65472	7.5	—	—
4700		18 × 31	2000	750	0.22	0.046	90009	7.5	90011	7.5	—	—
6800		18 × 35	2200	1100	0.26	0.040	55682	7.5	65682	7.5	—	—



ELECTRICAL DATA AND ORDERING INFORMATION

U _R (V)	C _R 120 Hz (μF)	NOMINAL CASE SIZE ØD × L (mm)	I _R 100 kHz 105 °C (mA)	I _{L2} 2 min (μA)	Tan δ 120 Hz	Z 100 kHz (Ω)	CATALOG NUMBER 2222 135					
							BULK PACKAGING				TAPED	
							LONG LEADS		CUT LEADS			
							FORM CA	F (mm)	FORM CB	F (mm)	FORM TFA	F (mm)
25	220	8 × 15	500	55	0.14	0.23	56221	3.5	86221	3.5	36221	5.0
	470	10 × 20	860	120	0.14	0.14	56471	5.0	66471	5.0	36471	5.0
	1000	12.5 × 25	1300	250	0.14	0.071	56102	5.0	66102	5.0	36102	5.0
	1500	12.5 × 31	1500	380	0.14	0.062	56152	5.0	66152	5.0	—	—
	2200	12.5 × 40	2000	550	0.16	0.044	56222	5.0	66222	5.0	—	—
	2200	18 × 20	1600	550	0.16	0.060	90012	7.5	90013	7.5	—	—
	3300	16 × 35	2000	830	0.18	0.045	56332	7.5	66332	7.5	—	—
	3300	18 × 31	2000	830	0.18	0.045	90014	7.5	90015	7.5	—	—
	4700	18 × 40	2500	1200	0.20	0.036	56472	7.5	66472	7.5	—	—
35	100	8 × 12	400	35	0.12	0.32	50101	3.5	80101	3.5	30101	5.0
	220	8 × 20	650	77	0.12	0.18	50221	3.5	80221	3.5	30221	5.0
	330	10 × 20	860	120	0.12	0.13	50331	5.0	60331	5.0	30331	5.0
	470	10 × 30	1200	160	0.12	0.089	50471	5.0	60471	5.0	—	—
	680	12.5 × 25	1300	240	0.12	0.070	50681	5.0	60681	5.0	30681	5.0
	1000	12.5 × 31	1500	350	0.12	0.061	50102	5.0	60102	5.0	—	—
	1000	16 × 20	1370	350	0.12	0.071	90016	7.5	90017	7.5	90044	7.5
	1500	12.5 × 40	2000	530	0.12	0.043	50152	5.0	60152	5.0	—	—
	2200	16 × 35	2000	770	0.14	0.044	50222	7.5	60222	7.5	—	—
	2200	18 × 31	2000	770	0.14	0.044	90018	7.5	90019	7.5	—	—
	3300	18 × 40	2500	1200	0.16	0.035	50332	7.5	60332	7.5	—	—
	50	100	10 × 16	640	50	0.10	0.20	51101	5.0	61101	5.0	31101
220		10 × 25	1000	110	0.10	0.11	51221	5.0	61221	5.0	31221	5.0
330		12.5 × 20	1100	170	0.10	0.081	51331	5.0	61331	5.0	31331	5.0
470		12.5 × 25	1300	240	0.10	0.068	51471	5.0	61471	5.0	31471	5.0
470		18 × 15	1300	240	0.10	0.074	90021	7.5	90022	7.5	—	—
1000		16 × 31	1800	500	0.10	0.050	51102	7.5	61102	7.5	31102	7.5
1500		16 × 40	2300	750	0.10	0.035	51152	7.5	61152	7.5	—	—
2200		18 × 40	2500	1100	0.12	0.034	51222	7.5	61222	7.5	—	—
63	47	8 × 12	300	30	0.08	0.56	58479	3.5	88479	3.5	38479	5.0
	220	12.5 × 20	890	140	0.08	0.16	58221	5.0	68221	5.0	38221	5.0
	470	16 × 25	1400	300	0.08	0.091	58471	7.5	68471	7.5	38471	7.5
	680	16 × 31	1800	430	0.08	0.065	58681	7.5	68681	7.5	38681	7.5
	1000	16 × 40	2200	630	0.08	0.049	58102	7.5	68102	7.5	—	—
100	22	8 × 12	310	22	0.07	0.53	59229	3.5	89229	3.5	39229	5.0
	100	12.5 × 20	890	100	0.07	0.15	59101	5.0	69101	5.0	39101	5.0
	220	16 × 25	1400	220	0.07	0.086	59221	7.5	69221	7.5	—	—
	330	16 × 31	1800	330	0.07	0.062	59331	7.5	69331	7.5	—	—
	330	18 × 25	1700	330	0.07	0.074	90023	7.5	90024	7.5	—	—
	470	16 × 40	2200	470	0.07	0.047	59471	7.5	69471	7.5	—	—
	680	18 × 40	2400	680	0.07	0.043	59681	7.5	69681	7.5	—	—

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15 U_R$
Reverse voltage		$U_{rev} \leq 1 V$
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.03 C_R \times U_R$
	after 2 minutes at U_R	$I_{L2} \leq 0.01 C_R \times U_R$
Capacitance (C)		
Ratio of capacitance at 120 Hz	$U_R = 6.3 V$	$C_{-55^\circ C} / C_{20^\circ C} \geq 0.7$
	$U_R = 10 \text{ to } 100 V$	$C_{-55^\circ C} / C_{20^\circ C} \geq 0.8$
Impedance (Z)		
Ratio of impedance at 120 Hz		$Z_{-55^\circ C} / Z_{20^\circ C} \leq 3$
Resistance		
Equivalent series resistance (ESR)	calculated from $\tan \delta_{max}$ and C_R (see Table 2)	$ESR = \tan \delta / 2\pi f C_R$

RIPPLE CURRENT AND USEFUL LIFE

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:
 $\varnothing D = 8 \text{ mm}$: 1500 hours
 $\varnothing D \geq 10 \text{ mm}$: 2500 hours.

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

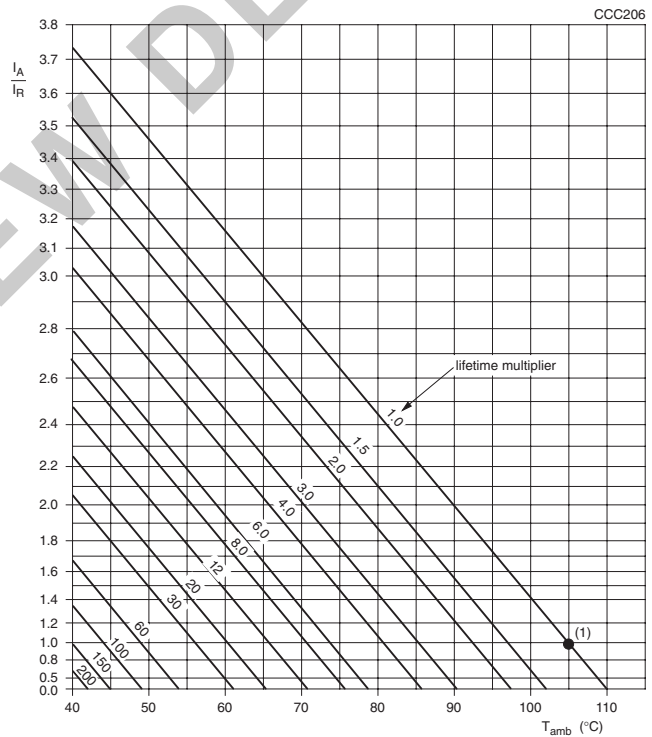


Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY				
FREQUENCY (Hz)	I_R MULTIPLIER			
	22 μF	33 to 330 μF	470 to 1 000 μF	>1 000 μF
50	0.40	0.60	0.65	0.80
120	0.50	0.70	0.80	0.90
300	0.60	0.80	0.90	0.95
1000	0.80	0.90	0.98	0.98
10000	0.90	0.95	1.00	1.00
100000	1.00	1.00	1.00	1.00



Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 105\text{ °C}$; U_R applied; $\varnothing D = 8\text{ mm}$: 1000 hours $\varnothing D \geq 10\text{ mm}$: 2000 hours	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ °C}$; U_R and I_R applied; $\varnothing D = 8\text{ mm}$: 1500 hours $\varnothing D \geq 10\text{ mm}$: 2500 hours	$\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130 300, subclause 4.17	$T_{amb} = 105\text{ °C}$; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$



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