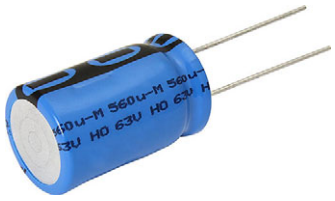
Aluminum Electrolytic Capacitors
Radial Miniature, Low Impedance, High Vibration Capability



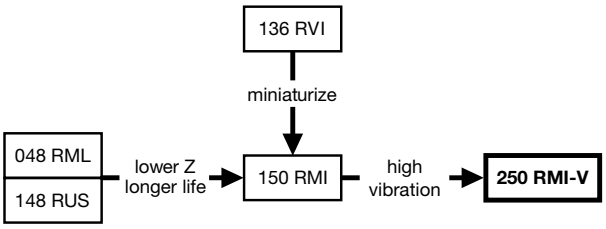


Fig. 1

FEATURES

AUTOMOTIVE GRADE

Pb-free

RoHS COMPLIANT

- Very long useful life: 7000 h to 10 000 h at 105 °C, high stability, high reliability
- Very low impedance and low ESR in smaller case sizes than the 136 RVI series
- Excellent ripple current capability
- High vibration resistance up to 50 *g*
- AEC-Q200 qualified
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue sleeve
- Charge and discharge proof
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

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 ± 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 (250)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	16 x 20 to 18 x 40
Rated capacitance range, C_R	330 µF to 8200 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	10 V to 100 V
Category temperature range	-55 °C to +105 °C
Endurance test at 105 °C	3000 h to 7000 h
Useful life at 105 °C	7000 h to 10 000 h
Useful life at 40 °C, 1.8 x I_R applied	200 000 h to 500 000 h
Shelf life at 0 V, 105 °C	1000 h
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 (Ø D x L in mm)

C_R (µF)	U_R (V)						
	10	**16**	**25**	**35**	**50**	**63**	**100**
330	-	-	-	-	-	-	18 x 20
470	-	-	-	-	-	16 x 20	-
680	-	-	-	-	-	16 x 20	-
	-	-	-	-	-	16 x 25	-
1000	-	-	-	-	16 x 25	16 x 31	-
	-	-	-	16 x 20	-	-	-
1200	-	-	-	-	16 x 31	-	-
1500	-	-	-	16 x 20	16 x 31	-	-
2200	-	-	16 x 20	16 x 31	-	18 x 40	-
3300	-	16 x 20	16 x 31	18 x 31	18 x 40	-	-
4700	16 x 25	16 x 31	16 x 35	18 x 40	-	-	-
6800	16 x 31	16 x 35	18 x 40	-	-	-	-
8200	-	18 x 40	-	-	-	-	-

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DIMENSIONS in millimeters **AND AVAILABLE FORMS**

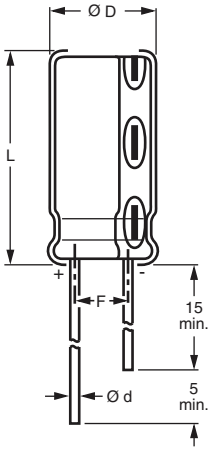

Fig. 2 - **Form CA:** Long leads

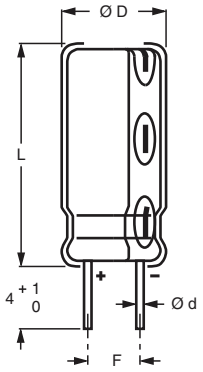

Fig. 3 - **Form CB:** Cut leads

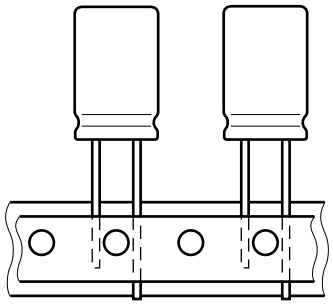

Fig. 4 - **Form TFA:** Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE Ø D x L	**CASE CODE**	**Ø d**	**Ø $D_{max.}$**	**$L_{max.}$**	**F**	**MASS (g)**	**PACKAGING QUANTITIES**		
							FORM CA	**FORM CB**	**FORM TFA**
16 x 20	19a	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 31	1831	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	100	100	-
18 x 40	1840	0.8	18.5	42.5	7.5 ± 0.5	≈ 16.5	100	100	-

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ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	Rated capacitance at 100 Hz, tolerance ± 20 %
I_R	Rated RMS ripple current at 100 kHz, 105 °C
I_{L2}	Maximum leakage current after 2 min at U_R
tan δ	Maximum dissipation factor at 100 Hz
Z	Maximum impedance at 100 kHz

Note

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

ORDERING EXAMPLE

Electrolytic capacitor 250 RMI-V series, high vibration resistance

4700 µF / 16 V; ± 20 %

Nominal case size: Ø 16 mm x 31 mm; Form TFA

Ordering code: MAL225035472E3

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 kHz 105 °C (mA)	I_{L2} 2 min (µA)	tan δ 100 Hz	Z 100 kHz +20 °C (Ω)	Z 100 kHz -40 °C (Ω)	ORDERING CODE MAL2250.....		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
10	4700	16 x 25	2390	473	0.23	0.022	0.150	54472E3	64472E3	34472E3
	6800	16 x 31	2890	683	0.25	0.019	0.130	54682E3	64682E3	34682E3
16	3300	16 x 20	1840	531	0.20	0.028	0.200	55332E3	65332E3	35332E3
	4700	16 x 31	2890	755	0.22	0.019	0.130	55472E3	65472E3	35472E3
	6800	16 x 35	3100	1091	0.24	0.018	0.130	55682E3	65682E3	-
	8200	18 x 40	3500	1315	0.28	0.018	0.130	55822E3	65822E3	-
25	2200	16 x 20	1840	553	0.16	0.028	0.200	56222E3	66222E3	36222E3
	3300	16 x 31	2890	828	0.16	0.019	0.130	56332E3	66332E3	36332E3
	4700	16 x 35	3100	1178	0.18	0.018	0.130	56472E3	66472E3	-
	6800	18 x 40	3500	1703	0.22	0.018	0.130	56682E3	66682E3	-
35	1000	16 x 20	1840	353	0.12	0.028	0.200	90105E3	90106E3	90103E3
	1500	16 x 20	1840	528	0.12	0.028	0.200	50152E3	60152E3	30152E3
	2200	16 x 31	2890	773	0.14	0.019	0.130	50222E3	60222E3	30222E3
	3300	18 x 31	3000	1155	0.16	0.019	0.130	50332E3	60332E3	-
	4700	18 x 40	3300	1648	0.18	0.018	0.130	50472E3	60472E3	-
50	1000	16 x 25	1800	503	0.10	0.034	0.240	51102E3	61102E3	31102E3
	1200	16 x 31	2200	603	0.10	0.027	0.190	51122E3	61122E3	31122E3
	1500	16 x 31	2200	753	0.10	0.027	0.190	51152E3	61152E3	31152E3
	3300	18 x 40	3200	1653	0.14	0.024	0.168	51332E3	61332E3	-
63	470	16 x 20	1100	299	0.10	0.074	0.520	98475E3	98476E3	98473E3
	680	16 x 20	1100	431	0.10	0.074	0.520	58681E3	68681E3	38681E3
	680	16 x 25	1500	431	0.10	0.054	0.380	98685E3	98686E3	98683E3
	1000	16 x 31	1900	633	0.10	0.042	0.295	58102E3	68102E3	38102E3
	2200	18 x 40	3100	1389	0.12	0.033	0.231	58222E3	68222E3	-
100	330	18 x 20	1700	330	0.07	0.074	2.0	90183E3	90185E3	-

Table 3

EXTENDED VIBRATION SPECIFICATIONS

PARAMETER	PROCEDURE	REQUIREMENTS
Vibration specifications	From 10 *g* to 50 *g*	No visible damage; no leakage of electrolyte; marking legible ΔC/C: ± 5 % with respect to initial measurements
Vibration frequency range	10 Hz to 2 kHz	
Vibration profile	• Constant sinus sweep (1 oct./min.) • 3 directions • 8 h per direction	

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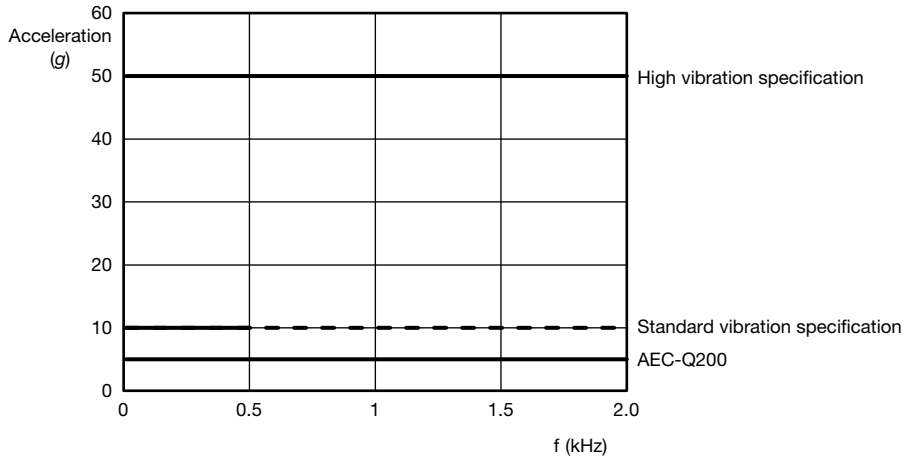

Fig. 5 - Vibration profile

Table 4

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 2 min at U_R	$I_{L2} \leq 0.01\ C_R \times U_R + 3$ µA
Inductance		
Equivalent series inductance (ESL)	Case Ø D ≥ 16 mm	Typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\ \pi\ f\ C_R$

CAPACITANCE (C)

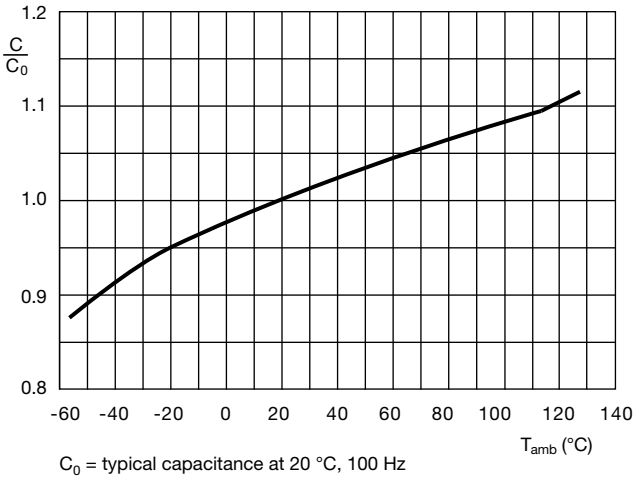

Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

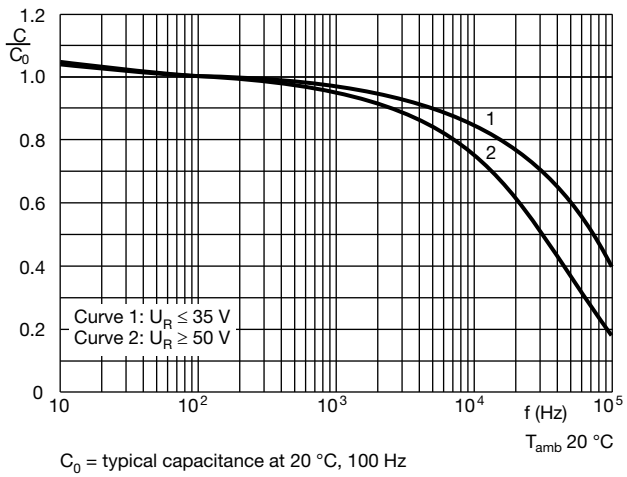

Fig. 7 - Typical multiplier of capacitance as a function of frequency

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EQUIVALENT SERIES RESISTANCE (ESR)

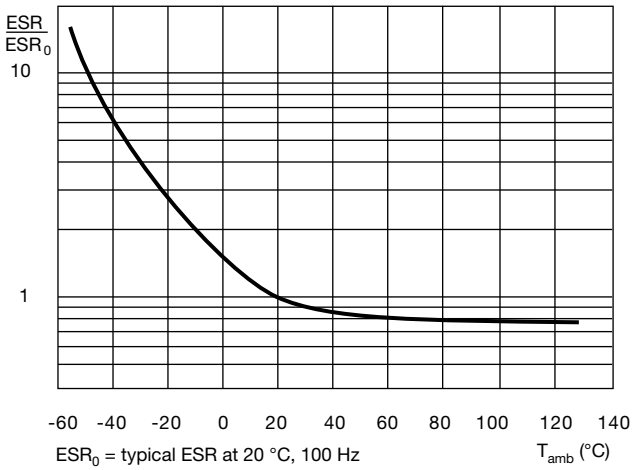

Fig. 8 - Typical multiplier of ESR as a function of ambient temperature

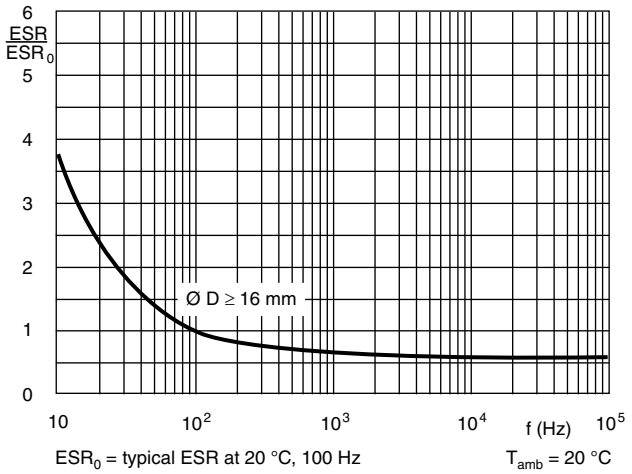

Fig. 9 - Typical multiplier of ESR as a function of frequency

IMPEDANCE (Z)

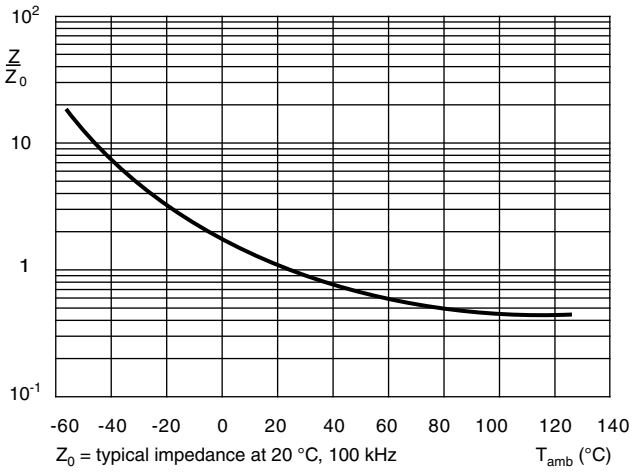

Fig. 10 - Typical multiplier of impedance as a function of ambient temperature

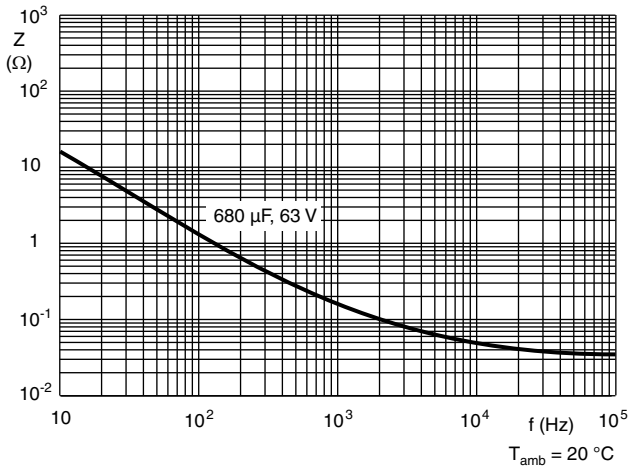

Fig. 11 - Typical impedance as a function of frequency

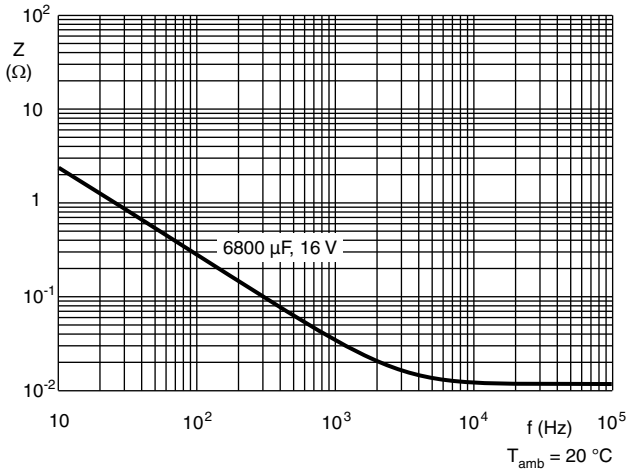

Fig. 12 - Typical impedance as a function of frequency

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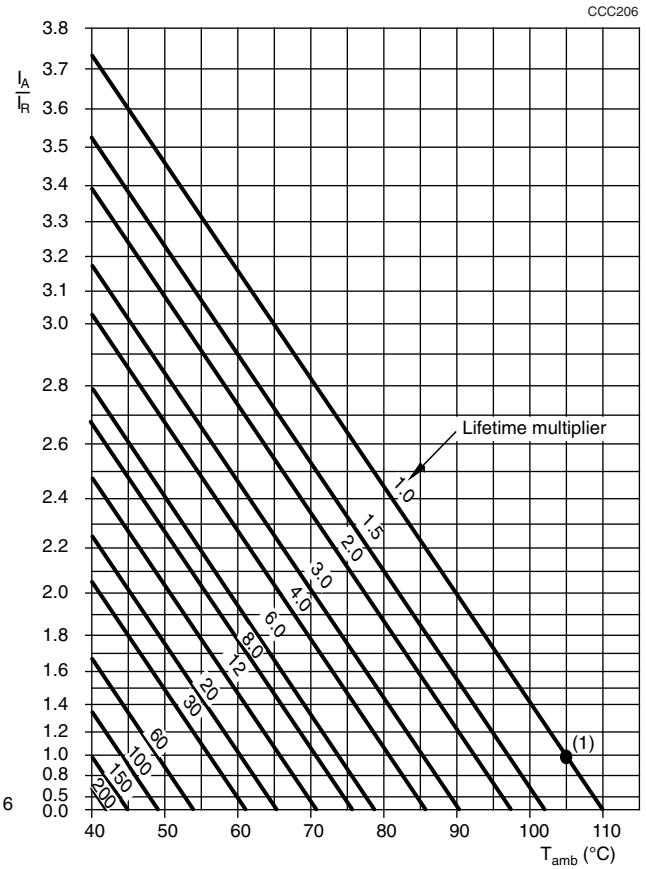
RIPPLE CURRENT AND USEFUL LIFE

Table 5

ENDURANCE TEST DURATION AND USEFUL LIFE AS A FUNCTION OF CASE SIZE			
NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	ENDURANCE AT 105 °C (h)	USEFUL LIFE AT 105 °C (h)
16 x 20	19a	3000	7000
16 x 25	19	5000	10 000
16 x 31	20	5000	10 000
16 x 35	21	5000	10 000
18 x 20	1820	3000	7000
18 x 31	1831	6000	10 000
18 x 40	1840	8000	10 000

Note

- Multiplier of useful life code: CCC206



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 6

Fig. 13 - Multiplier of useful life as a function of ambient temperature and ripple current load

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Table 6

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY						
FREQUENCY (Hz)						
100	300	1000	3000	10 000	30 000	100 000
I_R MULTIPLIER						
0.76	0.85	0.91	0.94	0.96	0.98	1.00

Table 7

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4 / EN130300 subclause 4.13	T_{amb} = 105 °C; U_R applied; for test duration see Table 5	ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit I_{L2} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; for test duration see Table 5	ΔC/C: ± 30 % tan δ ≤ 3 x spec. limit I_{L2} ≤ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4 / EN130300 subclause 4.17	T_{amb} = 105 °C; no voltage applied; 1000 h after test: U_R to be applied for 30 min., 24 h to 48 h before measurement	ΔC/C: ± 20 % tan δ ≤ 2 x spec. limit I_{L2} ≤ spec. limit

Statements about product lifetime are based on calculations and internal testing. They should only be interpreted as estimations. Also due to external factors, the lifetime in the field application may deviate from the calculated lifetime. In general, nothing stated herein shall be construed as a guarantee of durability.

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