

Aluminum Capacitors Radial Very Low Impedance

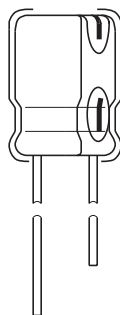
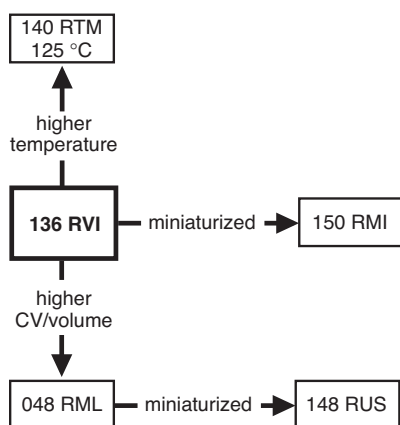


Fig.1 Component outline.



Available
RoHS*
COMPLIANT

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, very high reliability
- Very low impedance or ESR respectively, which is significantly lower than the RLI 135 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 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 (136).

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes ($\varnothing D \times L$ in mm)	10 × 12 to 18 × 35
Rated capacitance range, C_R	22 to 10000 μF
Tolerance on C_R	$\pm 20\%$
Rated voltage range, C_R	10 to 100 V
Category temperature range	-55 to +105 °C
Endurance test at 105 °C	3000 to 5000 hours (dependent on case size)
Useful life at 105 °C	4000 to 10000 hours (dependent on case size)
Useful life at 40 °C, 1.8 × I_R applied	200000 to 500000 hours (dependent on case size)
Shelf life at 0 V, 105 °C	1000 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	55/105/56

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



SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (ØD × L in mm)							
C _R (µF)	U _R (V)						
	10	16	25	35	50	63	100
22	-	-	-	-	-	-	10 × 12
33	-	-	-	-	-	-	10 × 12
47	-	-	-	-	-	10 × 12	10 × 16
56	-	-	-	-	-	10 × 12	-
68	-	-	-	-	-	10 × 16	10 × 20
82	-	-	-	-	10 × 12	-	-
100	-	-	-	-	10 × 12	10 × 16	12.5 × 20
120	-	-	-	10 × 12	10 × 16	10 × 20	-
	-	-	-	-	-	12.5 × 16	-
150	-	-	-	10 × 12	10 × 20	10 × 25	16 × 20
180	-	-	10 × 12	-	10 × 20	10 × 30	-
	-	-	-	-	12.5 × 16	-	-
220	-	-	10 × 12	10 × 16	10 × 25	12.5 × 20	16 × 25
270	-	10 × 12	-	-	-	12.5 × 25	-
330	-	10 × 12	10 × 16	10 × 20	10 × 30	16 × 20	16 × 31
	-	-	-	12.5 × 16	12.5 × 20	-	-
390	10 × 12	-	-	10 × 25	-	12.5 × 31	-
470	10 × 12	10 × 16	10 × 20	12.5 × 20	12.5 × 25	16 × 25	16 × 35
	-	-	12.5 × 16	-	-	-	18 × 31
560	-	-	10 × 25	10 × 30	12.5 × 31	-	-
	-	-	-	12.5 × 20	-	-	-
680	10 × 16	10 × 20	-	12.5 × 25	16 × 20	16 × 31	18 × 35
	-	12.5 × 16	-	-	-	18 × 25	-
820	-	10 × 25	10 × 30	-	16 × 25	16 × 35	-
	-	-	12.5 × 20	-	-	-	-
1000	10 × 20	12.5 × 20	12.5 × 25	12.5 × 31	16 × 31	18 × 31	-
	12.5 × 16	-	-	16 × 20	18 × 20	-	-
1200	10 × 25	10 × 30	-	16 × 25	16 × 35	-	-
	-	12.5 × 20	-	-	-	-	-
1500	10 × 30	12.5 × 25	12.5 × 31	16 × 25	18 × 31	18 × 35	-
	12.5 × 20	-	16 × 20	-	-	-	-
1800	12.5 × 20	-	16 × 25	16 × 31	-	-	-
2200	12.5 × 25	12.5 × 31	16 × 31	16 × 35	18 × 35	-	-
	-	16 × 20	18 × 20	18 × 31	-	-	-
2700	12.5 × 31	16 × 25	16 × 31	-	-	-	-
3300	16 × 20	16 × 25	16 × 35	18 × 35	-	-	-
	-	-	18 × 31	-	-	-	-
3900	16 × 25	16 × 31	-	-	-	-	-
4700	16 × 31	16 × 35	18 × 35	-	-	-	-
	-	18 × 31	-	-	-	-	-
5600	16 × 31	-	-	-	-	-	-
	18 × 25	-	-	-	-	-	-
6800	16 × 35	18 × 35	-	-	-	-	-
	18 × 31	-	-	-	-	-	-
10000	18 × 35	-	-	-	-	-	-

DIMENSIONS in millimeters **AND AVAILABLE FORMS**

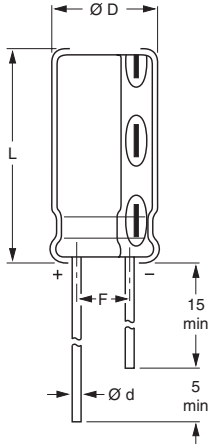


Fig.2 Form CA: Long Leads.

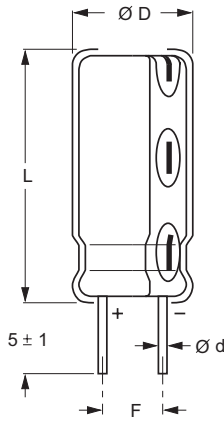


Fig.3 Form CB: Cut leads.

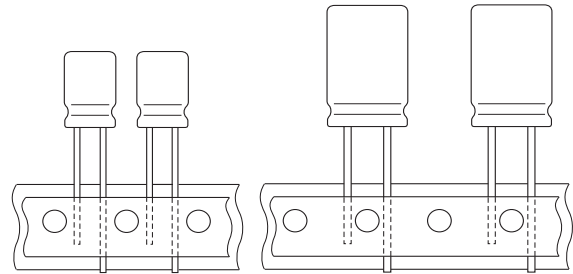


Fig.4 Form TFA: Taped in box (ammopack).

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
10 × 25	16L	0.6	10.5	27.0	5.0 ±0.5	≈3.0	1000	1500	800
10 × 30	16LL	0.6	10.5	32.0	5.0 ±0.5	≈3.5	1000	750	–
12.5 × 16	17a	0.6	13.0	17.5	5.0 ±0.5	≈2.7	1000	1500	500
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
12.5 × 31	18L	0.6	13.0	33.5	5.0 ±0.5	≈5.5	1000	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	–
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	–

Note

1. Detailed tape dimensions see section 'PACKAGING'.



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Vishay BCcomponents

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}	max. leakage current after 2 minutes at U _R
Tan δ	max. dissipation factor at 100 Hz
Z	max. impedance at 100 kHz

ORDERING EXAMPLE*

Electrolytic capacitor 136 series

1000 µF/25 V; ±20%

Nominal case size: Ø12.5 × 25 mm; Form TFA

Catalog number: 2222 136 36102.

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

Note

1. Unless otherwise specified, all electrical values in Table 2 apply at
T_{amb} = 20 °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 ØD × L (mm)	I _R 100 kHz 105 °C (mA)	I _{L2} 2 min (µA)	Tan δ 100 Hz	Z 100 kHz +20 °C (mΩ)	Z 100 kHz -10 °C (mΩ)	CATALOG NUMBER 2222 136		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
10	390	10 × 12	630	39	0.19	120	240	54391	64391	34391
	470	10 × 12	630	47	0.19	120	240	54471	64471	34471
	680	10 × 16	830	68	0.19	84	170	54681	64681	34681
	1000	10 × 20	1000	100	0.19	62	130	54102	64102	34102
	1000	12.5 × 16	940	100	0.19	76	160	94105	94106	94103
	1200	10 × 25	1300	120	0.19	52	110	54122	64122	34122
	1500	10 × 30	1400	150	0.19	44	88	94155	94156	-
	1500	12.5 × 20	1300	150	0.19	46	92	54152	64152	34152
	1800	12.5 × 20	1340	180	0.19	46	92	54182	64182	34182
	2200	12.5 × 25	1700	220	0.21	34	68	54222	64222	34222
	2700	12.5 × 31	2000	270	0.21	30	60	54272	64272	-
	3300	16 × 20	1600	330	0.23	38	76	54332	64332	34332
	3900	16 × 25	2100	390	0.23	28	56	54392	64392	34392
	4700	16 × 31	2400	470	0.25	25	50	54472	64472	34472
	5600	16 × 31	2400	560	0.27	25	50	54562	64562	34562
	5600	18 × 25	2270	560	0.27	25	50	94565	94566	-
	6800	16 × 35	2600	680	0.29	22	44	54682	64682	-
	6800	18 × 31	2760	680	0.29	23	46	94685	94686	-
10000	18 × 35	3180	1000	0.31	21	42	54103	64103	-	
16	270	10 × 12	630	43	0.16	120	240	55271	65271	35271
	330	10 × 12	630	53	0.16	120	240	55331	65331	35331
	470	10 × 16	830	75	0.16	84	170	55471	65471	35471
	680	10 × 20	1000	110	0.16	62	130	55681	65681	35681
	680	12.5 × 16	940	110	0.16	76	160	95685	95686	95683
	820	10 × 25	1300	130	0.16	52	110	55821	65821	35821
	1000	12.5 × 20	1300	160	0.16	48	96	55102	65102	35102
	1200	10 × 30	1400	190	0.16	44	88	95125	95126	-
	1200	12.5 × 20	1300	190	0.16	46	92	55122	65122	35122
	1500	12.5 × 25	1700	240	0.16	34	68	55152	65152	35152
	2200	12.5 × 31	2000	350	0.18	30	60	95225	95226	-
	2200	16 × 20	1600	350	0.18	38	76	55222	65222	35222
	2700	16 × 25	2100	430	0.18	28	56	55272	65272	35272
	3300	16 × 25	2100	530	0.20	28	56	55332	65332	35332
	3900	16 × 31	2400	620	0.20	25	50	55392	65392	35392
	4700	16 × 35	2600	750	0.22	22	44	55472	65472	-
	4700	18 × 31	2560	750	0.22	23	46	95475	95476	-
	6800	18 × 35	3000	1090	0.24	21	42	55682	65682	-

ELECTRICAL DATA AND ORDERING INFORMATION										
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × L (mm)	I _R 100 kHz 105 °C (mA)	I _{L2} 2 min (μA)	Tan δ 100 Hz	Z 100 kHz +20 °C (mΩ)	Z 100 kHz -10 °C (mΩ)	CATALOG NUMBER 2222 136		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
25	180	10 × 12	630	45	0.14	120	240	56181	66181	36181
	220	10 × 12	630	55	0.14	120	240	56221	66221	36221
	330	10 × 16	830	83	0.14	84	170	56331	66331	36331
	470	10 × 20	1000	120	0.14	62	130	56471	66471	36471
	470	12.5 × 16	940	120	0.14	76	160	96475	96476	96473
	560	10 × 25	1300	140	0.14	52	110	56561	66561	36561
	820	10 × 30	1400	210	0.14	44	88	96825	96826	–
	820	12.5 × 20	1300	210	0.14	46	92	56821	66821	36821
	1000	12.5 × 25	1700	250	0.14	34	68	56102	66102	36102
	1500	12.5 × 31	2000	380	0.14	30	60	96155	96156	–
	1500	16 × 20	1700	380	0.14	38	76	56152	66152	36152
	1800	16 × 25	2100	450	0.14	28	56	56182	66182	36182
	2200	16 × 31	2400	550	0.16	25	50	56222	66222	36222
	2200	18 × 20	1680	550	0.16	28	56	96225	96226	–
	2700	16 × 31	2400	680	0.16	25	50	56272	66272	36272
	3300	16 × 35	2600	830	0.18	22	44	56332	66332	–
	3300	18 × 31	2490	830	0.18	27	54	96335	96336	–
4700	18 × 35	3000	1180	0.20	21	42	56472	66472	–	
35	120	10 × 12	630	42	0.12	120	240	50121	60121	30121
	150	10 × 12	630	53	0.12	120	240	50151	60151	30151
	220	10 × 16	830	77	0.12	84	170	50221	60221	30221
	330	10 × 20	1000	120	0.12	62	130	50331	60331	30331
	330	12.5 × 16	940	120	0.12	76	160	90335	90336	90333
	390	10 × 25	1300	140	0.12	52	110	50391	60391	30391
	470	12.5 × 20	1300	170	0.12	48	96	50471	60471	30471
	560	10 × 30	1400	200	0.12	44	88	90565	90566	–
	560	12.5 × 20	1300	200	0.12	46	92	50561	60561	30561
	680	12.5 × 25	1700	240	0.12	34	68	50681	60681	30681
	1000	12.5 × 31	2000	350	0.12	30	60	90105	90106	–
	1000	16 × 20	1700	350	0.12	38	76	50102	60102	30102
	1200	16 × 25	2100	420	0.12	28	56	50122	60122	30122
	1500	16 × 25	2100	530	0.12	28	56	50152	60152	30152
	1800	16 × 31	2400	630	0.12	25	50	50182	60182	30182
	2200	16 × 35	2600	770	0.14	22	44	50222	60222	–
	2200	18 × 31	2320	770	0.14	27	54	90225	90226	–
3300	18 × 35	2890	1160	0.16	21	42	50332	60332	–	
50	82	10 × 12	480	41	0.10	200	400	51829	61829	31829
	100	10 × 12	480	50	0.10	200	400	51101	61101	31101
	120	10 × 16	760	60	0.10	100	200	51121	61121	31121
	150	10 × 20	850	75	0.10	90	180	51151	61151	31151
	180	10 × 20	950	90	0.10	75	150	51181	61181	31181
	180	12.5 × 16	780	90	0.10	59	120	91185	91186	91183
	220	10 × 25	1200	110	0.10	63	130	51221	61221	31221
	330	10 × 30	1300	170	0.10	54	110	91335	91336	–
	330	12.5 × 20	1200	170	0.10	59	120	51331	61331	31331
	470	12.5 × 25	1500	240	0.10	44	88	51471	61471	31471
	560	12.5 × 31	1700	280	0.10	39	78	51561	61561	–
	680	16 × 20	1400	340	0.10	50	100	51681	61681	31681
	820	16 × 25	1900	410	0.10	34	68	51821	61821	31821
	1000	16 × 31	2200	500	0.10	30	60	51102	61102	31102
	1000	18 × 20	1510	500	0.10	41	82	91105	91106	–
	1200	16 × 35	2300	600	0.10	27	54	51122	61122	–
	1500	18 × 31	2200	750	0.10	31	62	51152	61152	–
2200	18 × 35	2650	1100	0.12	27	54	51222	61222	–	



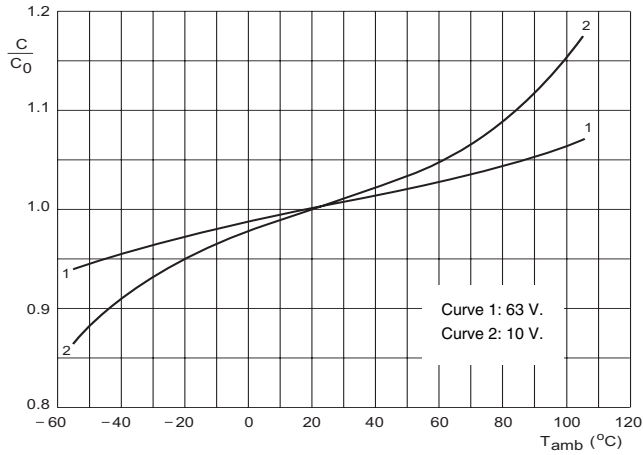
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ELECTRICAL DATA AND ORDERING INFORMATION										
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × L (mm)	I _R 100 kHz 105 °C (mA)	I _{L2} 2 min (μA)	Tan δ 100 Hz	Z 100 kHz +20 °C (mΩ)	Z 100 kHz -10 °C (mΩ)	CATALOG NUMBER 2222 136		
								BULK PACKAGING		TAPED
								FORM CA	FORM CB	FORM TFA
63	47	10 × 12	380	30	0.10	300	750	58479	68479	38479
	56	10 × 12	420	35	0.10	270	680	58569	68569	38569
	68	10 × 16	520	43	0.10	210	530	58689	68689	38689
	100	10 × 16	580	63	0.10	190	480	58101	68101	38101
	120	10 × 20	650	76	0.10	160	400	58121	68121	38121
	120	12.5 × 16	610	76	0.10	180	450	98125	98126	98123
	150	10 × 25	780	95	0.10	130	330	58151	68151	38151
	180	10 × 30	960	110	0.10	100	250	58181	68181	-
	220	12.5 × 20	870	140	0.10	110	280	58221	68221	38221
	270	12.5 × 25	1200	170	0.10	74	190	58271	68271	38271
	330	16 × 20	1100	210	0.10	85	220	58331	68331	38331
	390	12.5 × 31	1300	250	0.10	68	170	58391	68391	-
	470	16 × 25	1500	300	0.10	55	140	58471	68471	38471
	680	16 × 31	1700	430	0.10	46	120	58681	68681	38681
	680	18 × 25	1470	430	0.10	54	108	98685	98686	-
	820	16 × 35	1900	520	0.10	40	100	58821	68821	-
1000	18 × 31	1950	630	0.10	39	78	58102	68102	-	
1500	18 × 35	2350	950	0.10	33	66	58152	68152	-	
100	22	10 × 12	300	22	0.07	450	2300	59229	69229	39229
	33	10 × 12	320	33	0.07	390	2000	59339	69339	39339
	47	10 × 16	450	47	0.07	320	1600	59479	69479	39479
	68	10 × 20	520	68	0.07	240	1200	59689	69689	39689
	100	12.5 × 20	800	100	0.07	150	750	59101	69101	39101
	150	16 × 20	1000	150	0.07	110	550	59151	69151	39151
	220	16 × 25	1300	220	0.07	81	400	59221	69221	39221
	330	16 × 31	1600	330	0.07	58	290	59331	69331	39331
	470	16 × 35	1800	470	0.07	45	230	59471	69471	-
	470	18 × 31	1800	470	0.07	45	230	99475	99476	-
	680	18 × 35	2000	680	0.07	39	200	59681	69681	-

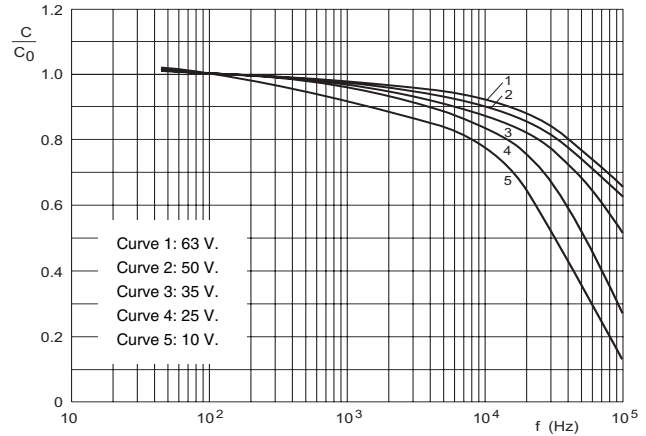
ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
Current		
Leakage current	after 2 minutes at U_R	$I_{L2} \leq 0.01 C_R \times U_R$
Inductance		
Equivalent series inductance (ESL)	case $\varnothing D = 10 \text{ mm}$	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)	$ESR = \tan \delta / 2\pi f C_R$

CAPACITANCE (C)



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

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

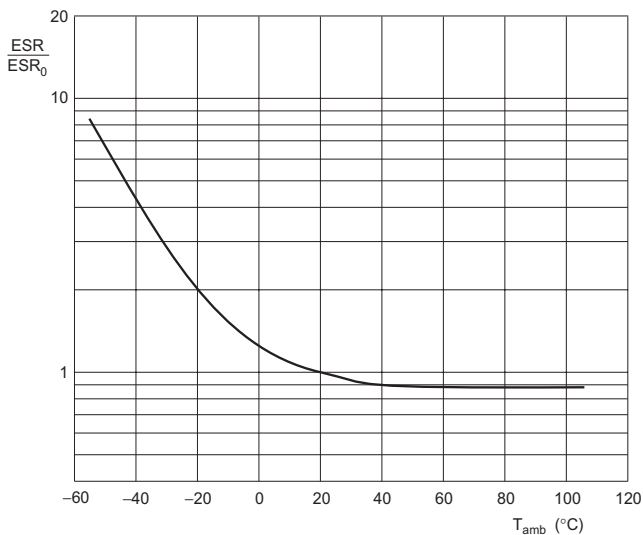


C_0 = typical capacitance at 20 °C, 100 Hz.

$T_{amb} = 20$ °C.

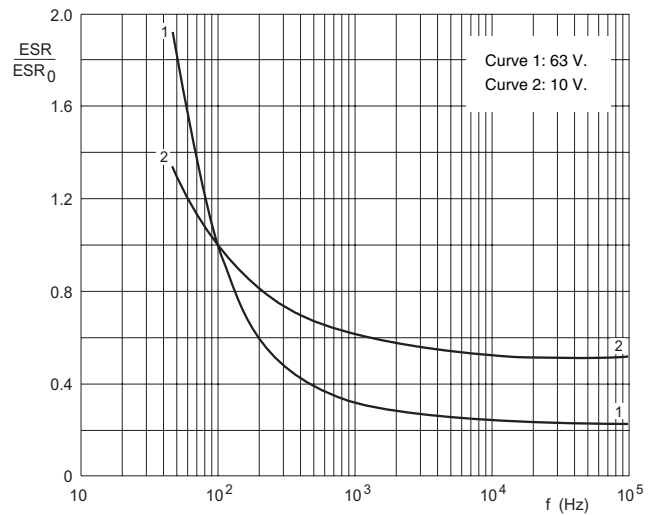
Fig.6 Typical multiplier of capacitance as a function of frequency.

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.

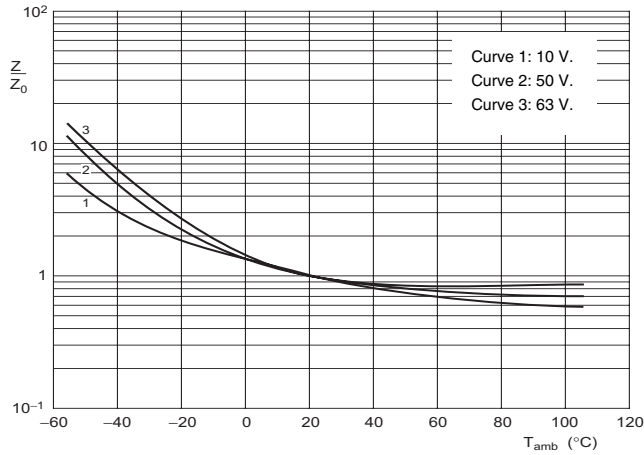


ESR_0 = typical ESR at 20 °C, 100 Hz.

$T_{amb} = 20$ °C.

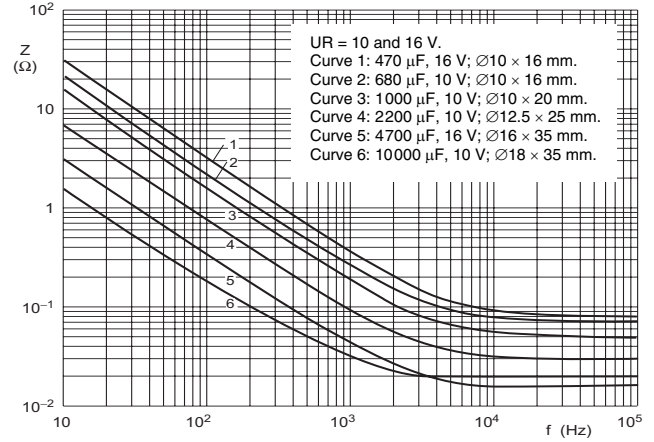
Fig.8 Typical multiplier of ESR as a function of frequency.

IMPEDANCE (Z)



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

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



$T_{amb} = 20$ °C.

Fig.10 Typical impedance as a function of frequency.

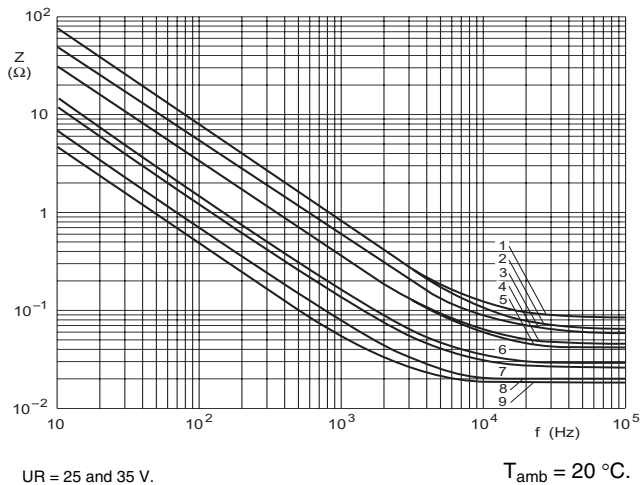


Fig.11 Typical impedance as a function of frequency.

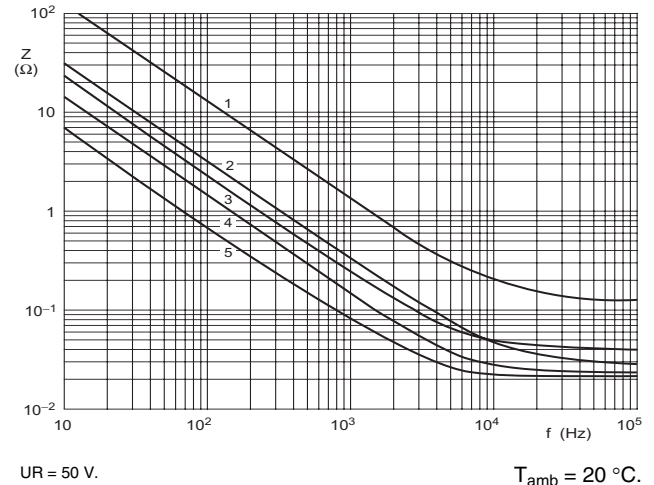
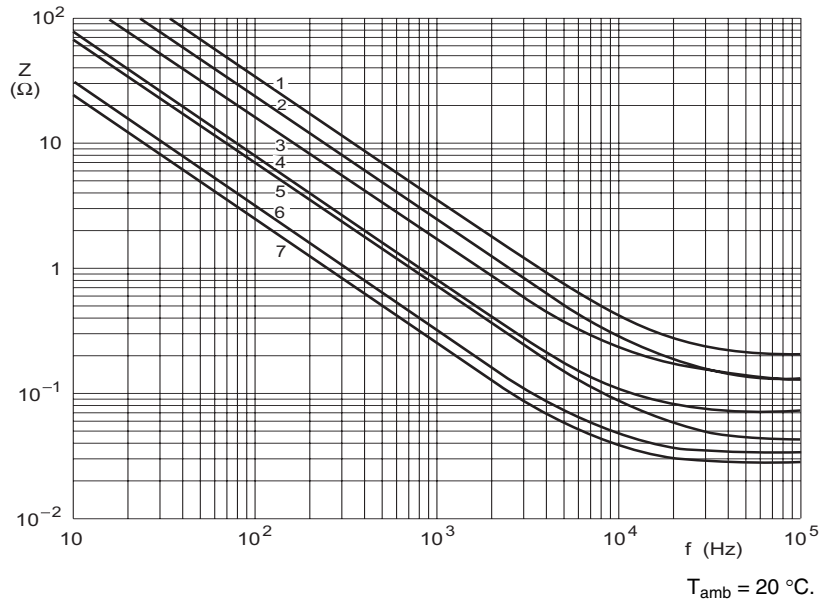


Fig.12 Typical impedance as a function of frequency.



UR = 63 V.
 Curve 1: 47 μ F, 63 V; \varnothing 10 \times 12 mm.
 Curve 2: 68 μ F, 63 V; \varnothing 10 \times 16 mm.
 Curve 3: 100 μ F, 63 V; \varnothing 10 \times 20 mm.
 Curve 4: 220 μ F, 63 V; \varnothing 12.5 \times 20 mm.
 Curve 5: 270 μ F, 63 V; \varnothing 12.5 \times 25 mm.
 Curve 6: 470 μ F, 63 V; \varnothing 16 \times 25 mm.
 Curve 7: 680 μ F, 63 V; \varnothing 16 \times 31 mm.

T_{amb} = 20 °C.

Fig.13 Typical impedance as a function of frequency.

RIPPLE CURRENT AND USEFUL LIFE

Table 3

ENDURANCE TEST AND USEFUL LIFE AS A FUNCTION OF CASE SIZE			
NOMINAL CASE SIZE \varnothing D \times L (mm)	CASE CODE	ENDURANCE TEST at 105 °C (hours)	USEFUL LIFE at 105 °C (hours)
10 \times 12	14	3000	4000
10 \times 16	15	3000	6000
10 \times 20	16	3000	6000
10 \times 25	16L	5000	7000
10 \times 30	16LL	5000	7000
12.5 \times 16	17a	3000	5000
12.5 \times 20	17	3000	7000
12.5 \times 25	18	5000	8000
12.5 \times 31	18L	5000	8000
16 \times 20	19a	3000	7000
16 \times 25	19	5000	10000
16 \times 31	20	5000	10000
16 \times 35	21	5000	10000
18 \times 20	1820	3000	7000
18 \times 25	1825	5000	10000
18 \times 31	1831	5000	10000
18 \times 35	22	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 3.

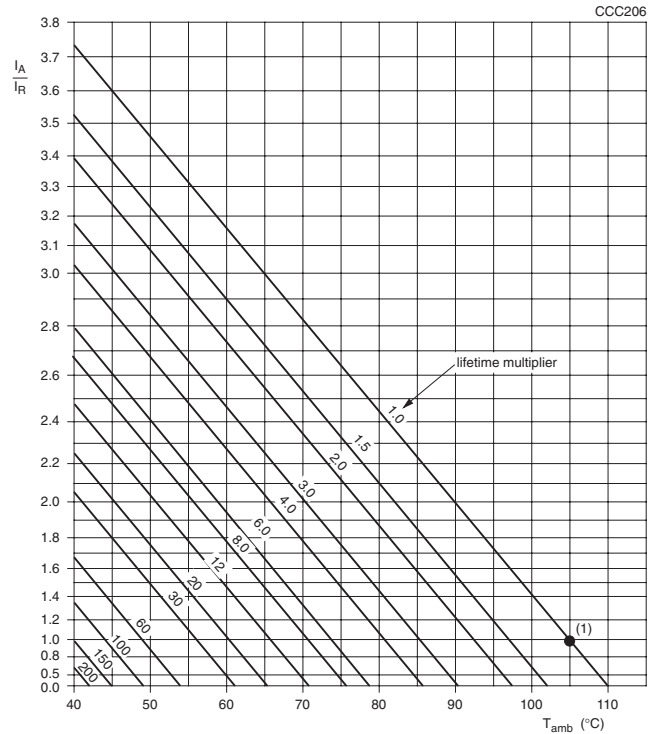


Fig.13 Multiplier of useful life as a function of ambient temperature and ripple current load.

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY								
FREQUENCY (Hz)	I_R MULTIPLIER							
	$U_R = 10\text{ V}$		$U_R = 16\text{ and }25\text{ V}$		$U_R = 35\text{ and }50\text{ V}$		$U_R = 63\text{ and }100\text{ V}$	
	$\varnothing \leq 12.5$	$\varnothing \geq 16$	$\varnothing \leq 12.5$	$\varnothing \geq 16$	$\varnothing \leq 12.5$	$\varnothing \geq 16$	$\varnothing \leq 12.5$	$\varnothing \geq 16$
100	0.70	0.83	0.63	0.69	0.50	0.60	0.35	0.50
300	0.80	0.90	0.72	0.79	0.61	0.71	0.51	0.64
1000	0.88	0.95	0.80	0.87	0.72	0.80	0.66	0.74
3000	0.92	0.98	0.88	0.92	0.81	0.88	0.76	0.83
10000	0.96	0.99	0.92	0.96	0.88	0.93	0.85	0.90
30000	0.99	1.00	0.98	0.99	0.94	0.96	0.92	0.95
100000	1.00	1.00	1.00	1.00	1.00	1.00	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	$T_{amb} = 105\text{ °C}$; U_R applied; for test duration see Table 3	$\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\text{ °C}$; U_R and I_R applied; for test duration see Table 3	$\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	$T_{amb} = 105\text{ °C}$; 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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