Aluminum Capacitors
Radial, High Temperature

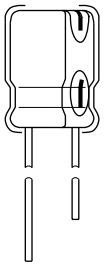
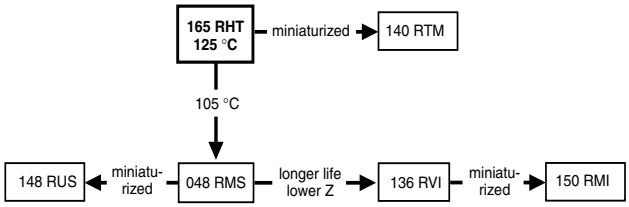


Fig.1 Component outline.



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: 1500 hours at 105 °C , high stability, high reliability
- Extended temperature range up to 125 °C
- High ripple current capability
- Lead (Pb)-Free versions are RoHS compliant

Pb-free Available

RoHS* COMPLIANT

APPLICATIONS

- EDP, telecommunication, industrial, automotive and military
- Smoothing, filtering, buffering in SMPS
- High ambient temperature environments

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 (125 °C)
- Negative terminal identification
- Series number (165)

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes (∅D × L in mm)	10 × 12 to 16 × 35
Rated capacitance range, C_R	22 to 4700 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	10 to 50 V
Category temperature range	– 40 to + 125 °C
Endurance test at 125 °C	1 000 hours
Useful life at 125 °C	1500 hours
Useful life at 40 °C, 1.6 × I_R applied	300 000 hours
Shelf life at 0 V, 125 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/125/56

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (ØD x L in mm)

C_R (µF)	U_R (V)					
	10	16	25	35	40	50
22	–	–	–	–	–	10 × 12
47	–	–	–	–	10 × 12	10 × 16
100	–	–	10 × 12	10 × 16	10 × 20	12.5 × 20
220	10 × 12	10 × 16	10 × 20	–	12.5 × 20	16 × 25
470	10 × 20	12.5 × 20	12.5 × 25	16 × 25	16 × 31	16 × 35
1000	–	12.5 × 25	16 × 31	–	16 × 35	16 × 35
2200	16 × 31	16 × 35	16 × 35	–	–	–
3300	16 × 35	16 × 35	–	–	–	–
4700	16 × 35	–	–	–	–	–

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

DIMENSIONS in millimeters, **AND AVAILABLE FORMS**

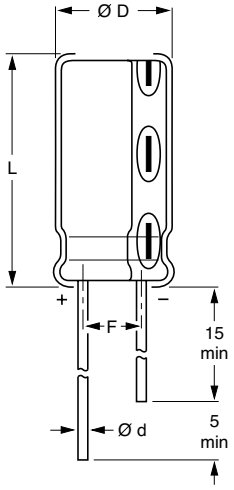


Fig.2 **Form CA**: Long leads.

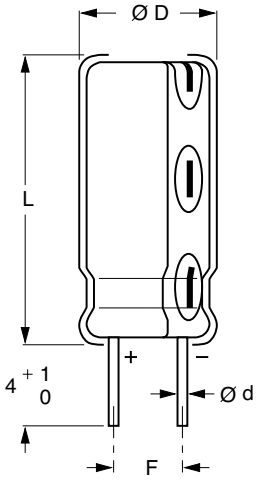
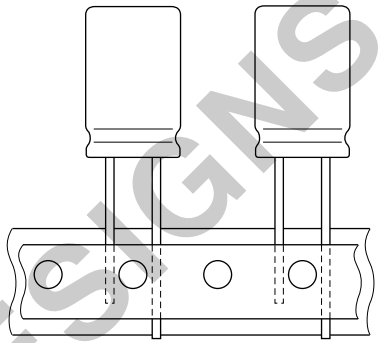


Fig.3 **Form CB**: Cut leads.



Case ØD × L ≤ 16 × 31 mm.

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

Table 1

DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**									
NOMINAL CASE SIZE ∅D × L	**CASE CODE**	**∅D**	**$\varnothing D_{max}$**	**L_{max}**	**F**	**MASS (g)**	**PACKAGING QUANTITIES PER BOX**		
							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 × 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	≈ 11.5	100	100	–

Note

1. Detailed tape dimensions see section ‘PACKAGING’.

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz, tolerance ± 20 %
I_R	rated RMS ripple current at 100 Hz, 125 °C
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
Tan δ	max. dissipation factor at 100 Hz
ESR	equivalent series resistance at 100 Hz (calculated from tan δ_{max} and C_R)
Z	max. impedance at 10 kHz or 100 kHz

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 %.

ORDERING EXAMPLE*

Electrolytic capacitor 165 series

220 µF/25 V; ± 20 %

Nominal case size: ∅10 × 20 mm; Form TFA

Catalog number: 2222 165 36221

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

Table 2

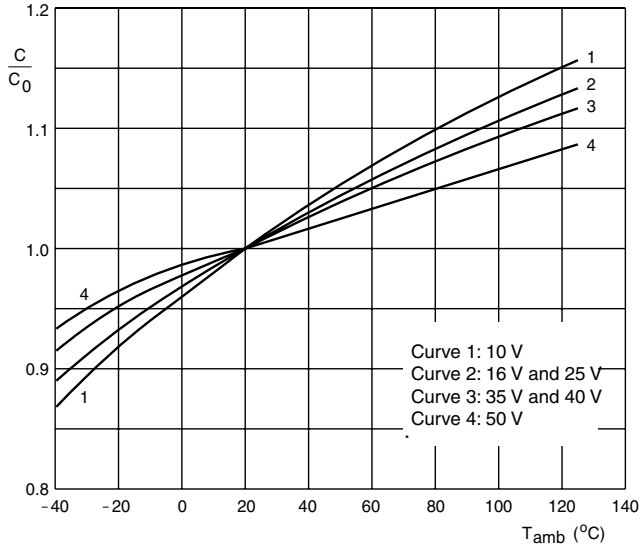
ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D x L (mm)	CASE CODE	I_R 100 Hz 125 °C (mA)	I_{L1} 1 MIN (µA)	I_{L5} 5 MIN (µA)	TAN Δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	CATALOG NUMBER 2222 165		
											BULK PACKAGING		TAPED
											FORM CA	FORM CB	FORM TFA
10	220	10 × 12	14	200	25	7	0.20	1.30	–	0.55	165 54221	165 64221	165 34221
	470	10 × 20	16	340	50	12	0.20	0.61	–	0.26	165 54471	165 64471	165 34471
	2200	16 × 31	20	930	220	47	0.24	0.16	0.07	–	165 54222	165 64222	165 34222
	3300	16 × 35	21	1200	330	69	0.26	0.11	0.05	–	165 54332	165 64332	–
	4700	16 × 35	21	1400	470	97	0.28	0.09	0.04	–	165 90502	165 90507	–
16	220	10 × 16	15	240	38	10	0.16	1.00	–	0.43	165 55221	165 65221	165 35221
	470	12.5 × 20	17	410	78	18	0.16	0.49	–	0.20	165 55471	165 65471	165 35471
	1000	12.5 × 25	18	650	160	35	0.16	0.23	–	0.10	165 55102	165 65102	165 35102
	2200	16 × 35	21	1100	360	73	0.20	0.13	0.05	–	165 55222	165 65222	–
	3300	16 × 35	21	1400	530	110	0.22	0.10	0.04	–	165 90503	165 90508	–
25	100	10 × 12	14	170	28	8	0.14	2.00	–	0.70	165 56101	165 66101	165 36101
	220	10 × 20	16	280	58	14	0.14	0.91	–	0.32	165 56221	165 66221	165 36221
	470	12.5 × 25	18	480	120	27	0.14	0.43	–	0.15	165 56471	165 66471	165 36471
	1000	16 × 31	20	830	250	53	0.14	0.20	–	0.07	165 56102	165 66102	165 36102
	2200	16 × 35	21	1200	550	110	0.18	0.12	0.04	–	165 90504	165 90509	–
35	100	10 × 16	15	200	38	10	0.12	1.70	–	0.65	165 50101	165 60101	165 30101
	470	16 × 25	19	600	170	36	0.12	0.37	–	0.14	165 50471	165 60471	165 30471
40	47	10 × 12	14	130	22	7	0.12	3.70	–	1.30	165 57479	165 67479	165 37479
	100	10 × 20	16	210	43	11	0.12	1.70	–	0.60	165 57101	165 67101	165 37101
	220	12.5 × 20	17	340	91	21	0.12	0.78	–	0.27	165 57221	165 67221	165 37221
	470	16 × 31	20	650	190	41	0.12	0.37	–	0.13	165 57471	165 67471	165 37471
	1000	16 × 35	21	1000	400	83	0.12	0.17	–	0.06	165 57102	165 67102	–
50	22	10 × 12	14	100	14	5	0.10	6.50	–	2.3	165 51229	165 61229	165 31229
	47	10 × 16	15	150	27	8	0.10	3.00	–	1.10	165 51479	165 61479	165 31479
	100	12.5 × 20	17	260	53	13	0.10	1.40	–	0.50	165 51101	165 61101	165 31101
	220	16 × 25	19	450	110	25	0.10	0.65	–	0.23	165 51221	165 61221	165 31221
	470	16 × 35	21	760	240	50	0.10	0.30	–	0.11	165 51471	165 61471	–
	1000	16 × 35	21	1200	500	100	0.10	0.14	–	0.05	165 90506	165 90512	–

ADDITIONAL ELECTRICAL DATA

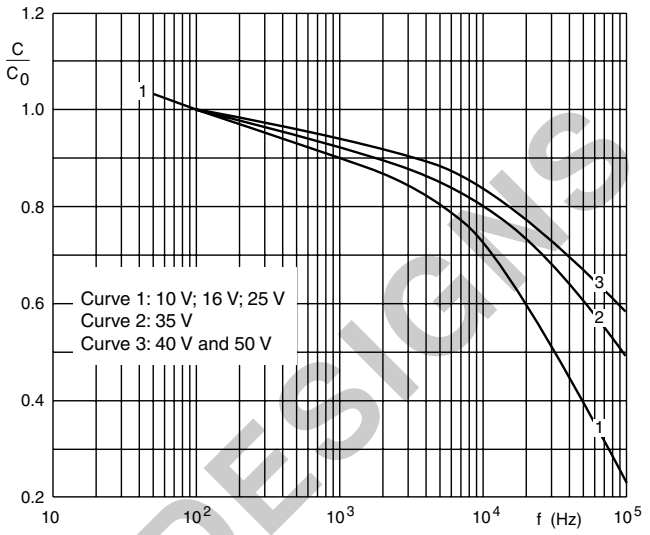
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage		$U_s \leq 1.3\ U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.01\ C_R \times U_R + 3$ µA
	after 5 minutes at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3$ µA
Inductance		
Equivalent series inductance (ESL)	case ∅D = 10 mm	typ. 16 nH
	case ∅D ≥ 12.5 mm	typ. 18 nH

CAPACITANCE (C)



C_0 = capacitance at 20 °C

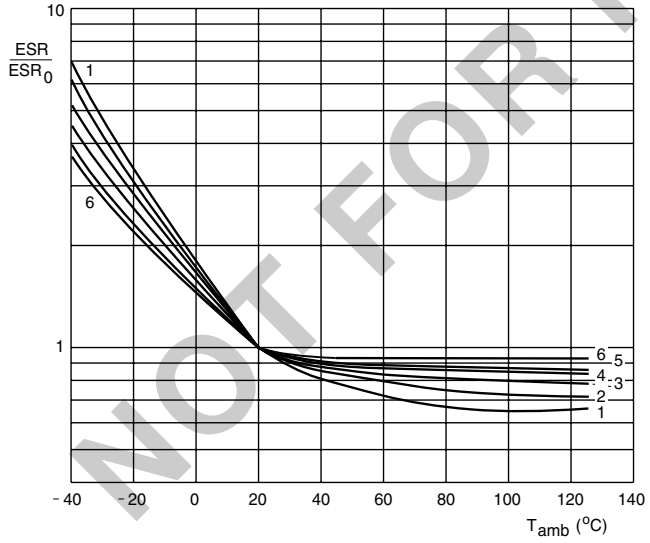
Fig.5 Typical multiplier of capacitance as a function of ambient temperature.



C_0 = capacitance at 20 °C, 100 Hz T_{amb} = 20 °C.

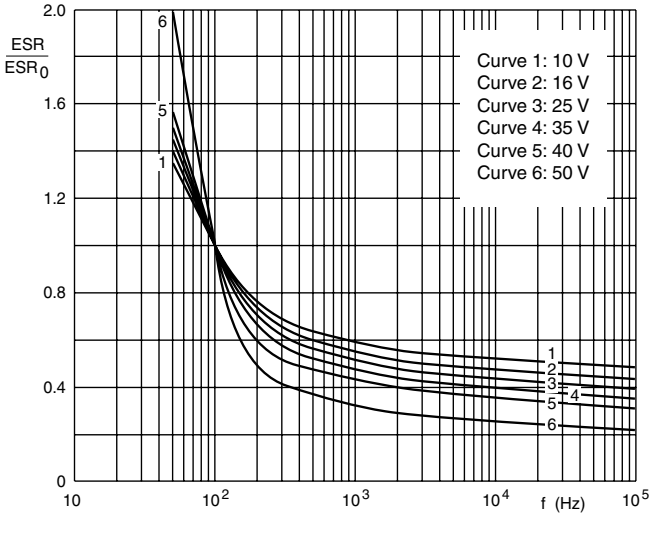
Fig.6 Typical multiplier of capacitance as a function of frequency.

EQUIVALENT SERIES RESISTANCE (ESR)



ESR_0 = typical at 20 °C

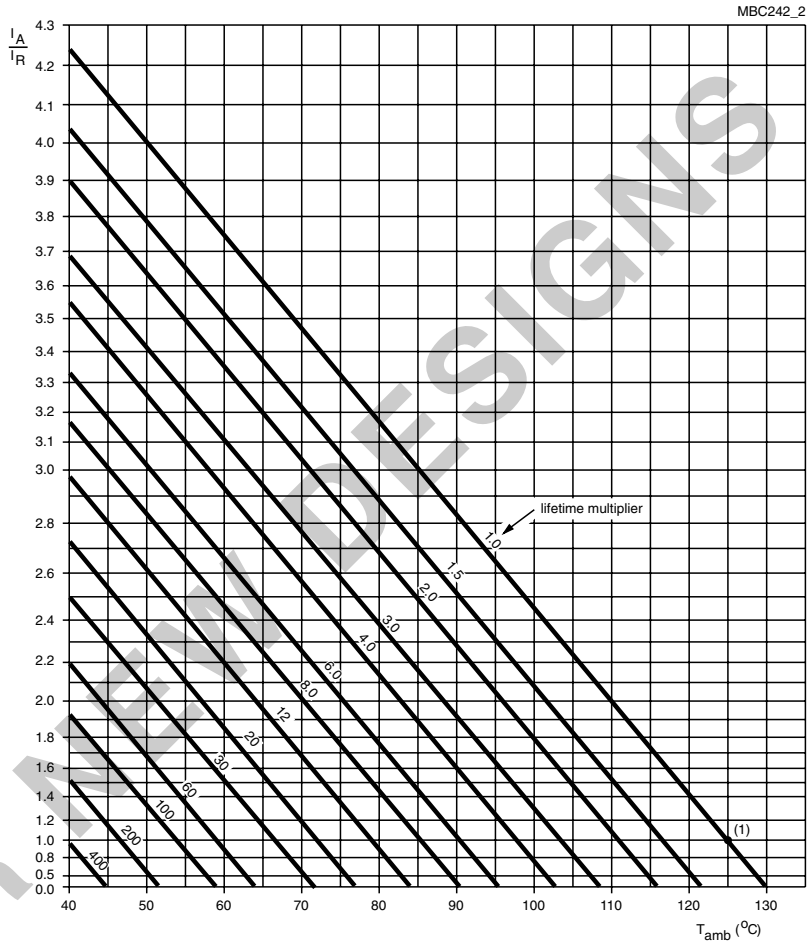
Fig.7 Typical multiplier of ESR as a function of ambient temperature.



ESR_0 = typical at 20 °C, 100 Hz. T_{amb} = 20 °C.

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

RIPPLE CURRENT AND USEFUL LIFE



IA = actual ripple current at 100 Hz

IR = rated ripple current at 100 Hz, 125 °C

(1) Useful life at 125 °C and IR applied: 1500 h

Fig.9 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		
	U_R = 10 to 25 V	U_R = 35 or 40 V	U_R = 50 V
50	0.85	0.80	0.75
100	1.00	1.00	1.00
300	1.20	1.25	1.30
1000	1.30	1.40	1.50
3000	1.35	1.50	1.65
≥ 10000	1.40	1.60	1.80

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} = 125 °C; U_R applied; 1000 hours	$\Delta C/C$: ± 15 % tan $\delta \leq 1.3 \times$ spec. limit $Z \leq 2 \times$ spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 125 °C; U_R and I_R applied; 1500 hours	$\Delta C/C$: ± 45 % tan $\delta \leq 3 \times$ spec. limit $Z \leq 3 \times$ spec. limit $I_{L5} \leq$ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 125 °C; no voltage applied; 500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$: ± 15 % tan $\delta \leq 1.3 \times$ spec. limit $Z \leq 2 \times$ spec. limit $I_{L5} \leq 2 \times$ spec. limit

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