Aluminium electrolytic capacitors
Radial High Temperature

165 RHT

FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Radial leads, cylindrical aluminium case with pressure relief, insulated with a blue sleeve
- Charge and discharge proof
- Very long useful life:
  1500 hours at 125 °C,
  high stability, high reliability
- Extended temperature range up to 125 °C
- High ripple current capability.

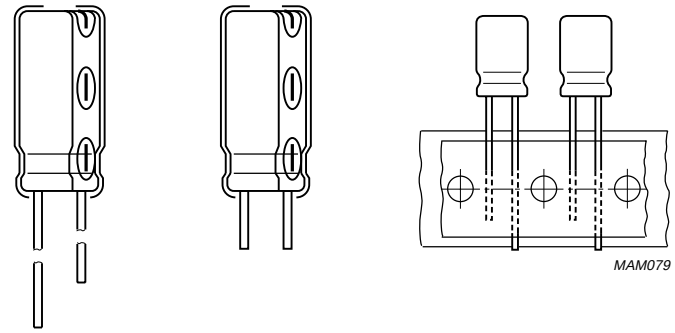
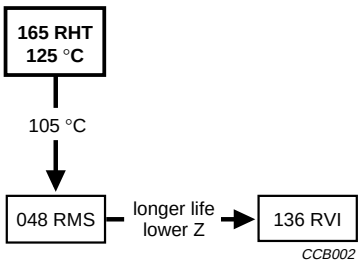


Fig.1 Component outlines.

APPLICATIONS

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



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Case sizes ($\varnothing D_{nom} \times L_{nom}$ 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	1000 hours
Useful life at 125 °C	1500 hours
Useful life at 40 °C, $1.6 \times I_R$ applied	300000 hours
Shelf life at 0 V, 125 °C	500 hours
Based on sectional specification	IEC 384-4/CECC 30300
Climatic category IEC 68	40/125/56

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Selection chart for C_R, U_R and relevant nominal case sizes (∅D × L in mm)

Preferred types in **bold**.

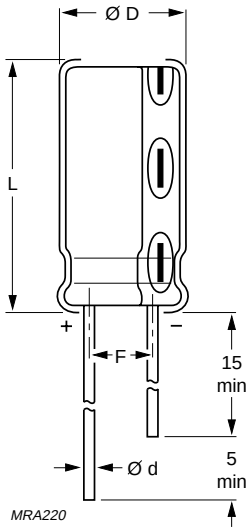
C_R (μF)	U_R (V)					
	10	**16**	**25**	**35**	**40**	**50**
22	–	–	–	–	–	10 × 12
47	–	–	–	–	10 × 12	10 × 16
100	–	–	10 × 12	**10 × 16**	10 × 20	**12.5 × 20**
220	10 × 12	10 × 16	**10 × 20**	–	**12.5 × 20**	16 × 25
470	**10 × 20**	12.5 × 20	**12.5 × 25**	16 × 25	**16 × 31**	16 × 35
1000	–	12.5 × 25	16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

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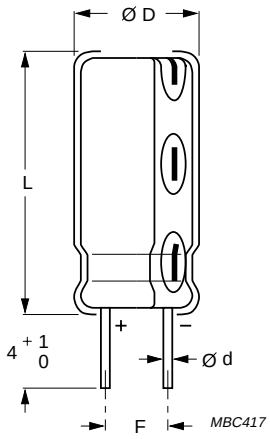
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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES



Dimensions in mm.
For dimensions see Table 1.

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



Dimensions in mm.
For dimensions see Table 1.

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

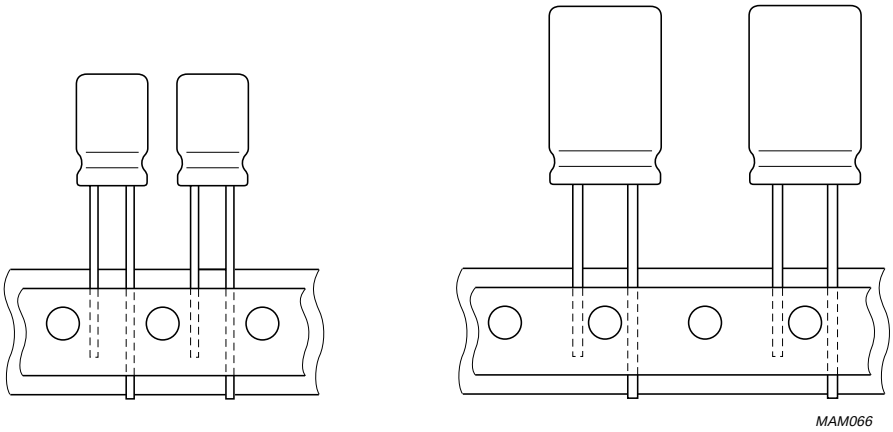
Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

NOMINAL CASE SIZE ∅D × L (mm)	CASE CODE	∅d (mm)	$\varnothing D_{max}$ (mm)	L_{max} (mm)	F (mm)	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	–

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Taped products



Form TFA:
Case ∅D × L ≤ 16 × 31mm.
Tape dimensions are specified in this handbook, Section *"Packaging"*.

Fig.4 Taped in box (ammopack).

MARKING

The capacitors are marked with the following information:

- Rated capacitance value (in μF)
- Tolerance on rated capacitance, code letter in accordance with *"IEC 62"* (M for ±20%)
- Rated voltage (in V)
- Upper category temperature (125 °C)
- Group number (165)
- Code indicating factory of origin
- Name of manufacturer, PHILIPS
- Date code, in accordance with *"IEC 62"*
- Negative terminal identification.

R

ELECTRICAL DATA AND ORDERING INFORMATION

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

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

Ordering example

Electrolytic capacitor 165 series

220 µF/25 V; ±20%

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

Catalogue number: 2222 165 36221.

Table 2 Electrical data and ordering information; preferred types in **bold**

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE ∅D × 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)	CATALOGUE NUMBER 2222		
											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	–

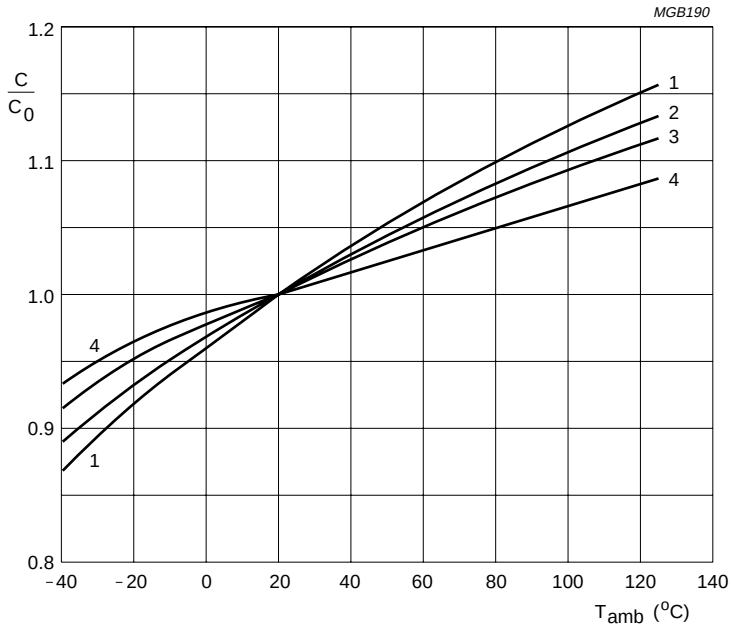
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U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × L (mm)	CASE CODE	I_R 100 Hz 125 °C (mA)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	Tan δ 100 Hz	ESR 100 Hz (Ω)	Z 10 kHz (Ω)	Z 100 kHz (Ω)	CATALOGUE NUMBER 2222		
											BULK PACKAGING		TAPED
											FORM CA	FORM CB	FORM TFA
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

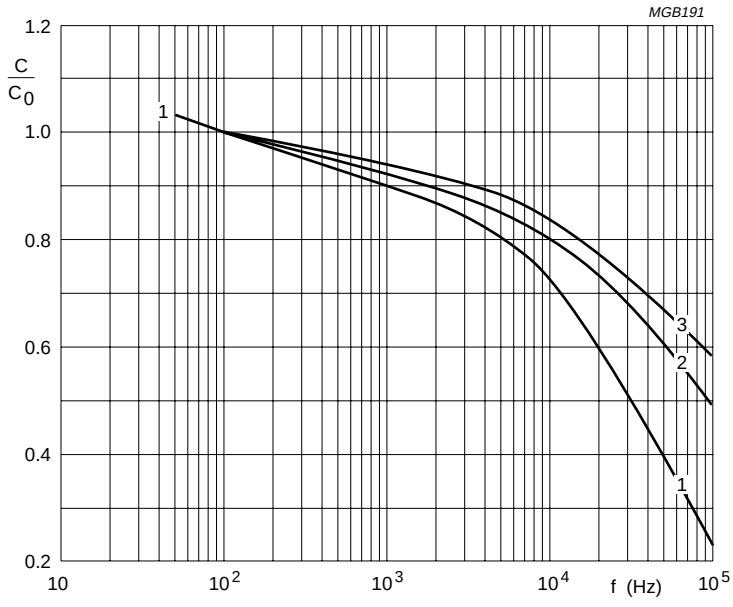
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage for short periods		$U_s \leq 1.3\ U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	after 1 minute at U_R	$I_{L1} \leq 0.01 C_R \times U_R + 3$ μA
	after 5 minutes at U_R	$I_{L5} \leq 0.002 C_R \times U_R + 3$ μA
Inductance		
Equivalent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

Capacitance (C)



Curve 1: 10 V.
Curve 2: 16 and 25 V.
Curve 3: 35 and 40 V.
Curve 4: 50 V.
C_0 = capacitance at 20 °C, 100 Hz.

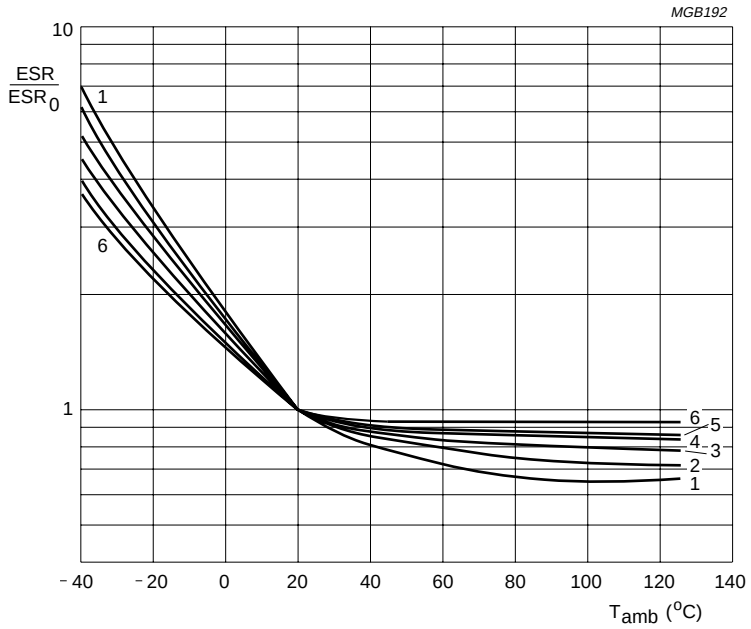
Fig.5 Typical multiplier of capacitance as a function of ambient temperature.



Curve 1: 10 V; 16 V; 25 V.
Curve 2: 35 V.
Curve 3: 40 and 50 V.
C_0 = capacitance at 20 °C, 100 Hz.

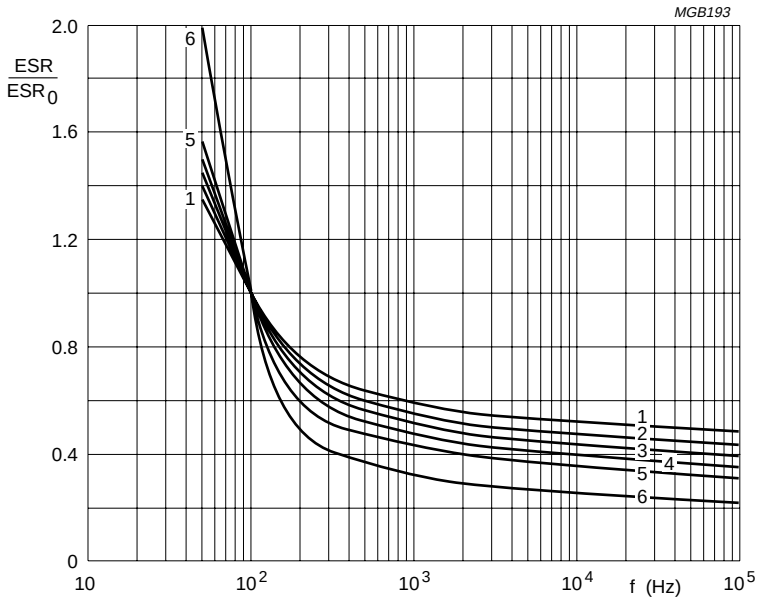
Fig.6 Typical multiplier of capacitance as a function of frequency.

Equivalent series resistance (ESR)



Curve 1: 10 V.
Curve 2: 16 V.
Curve 3: 25 V.
Curve 4: 35 V.
ESR_0 = typical at 20 °C, 100 Hz.

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

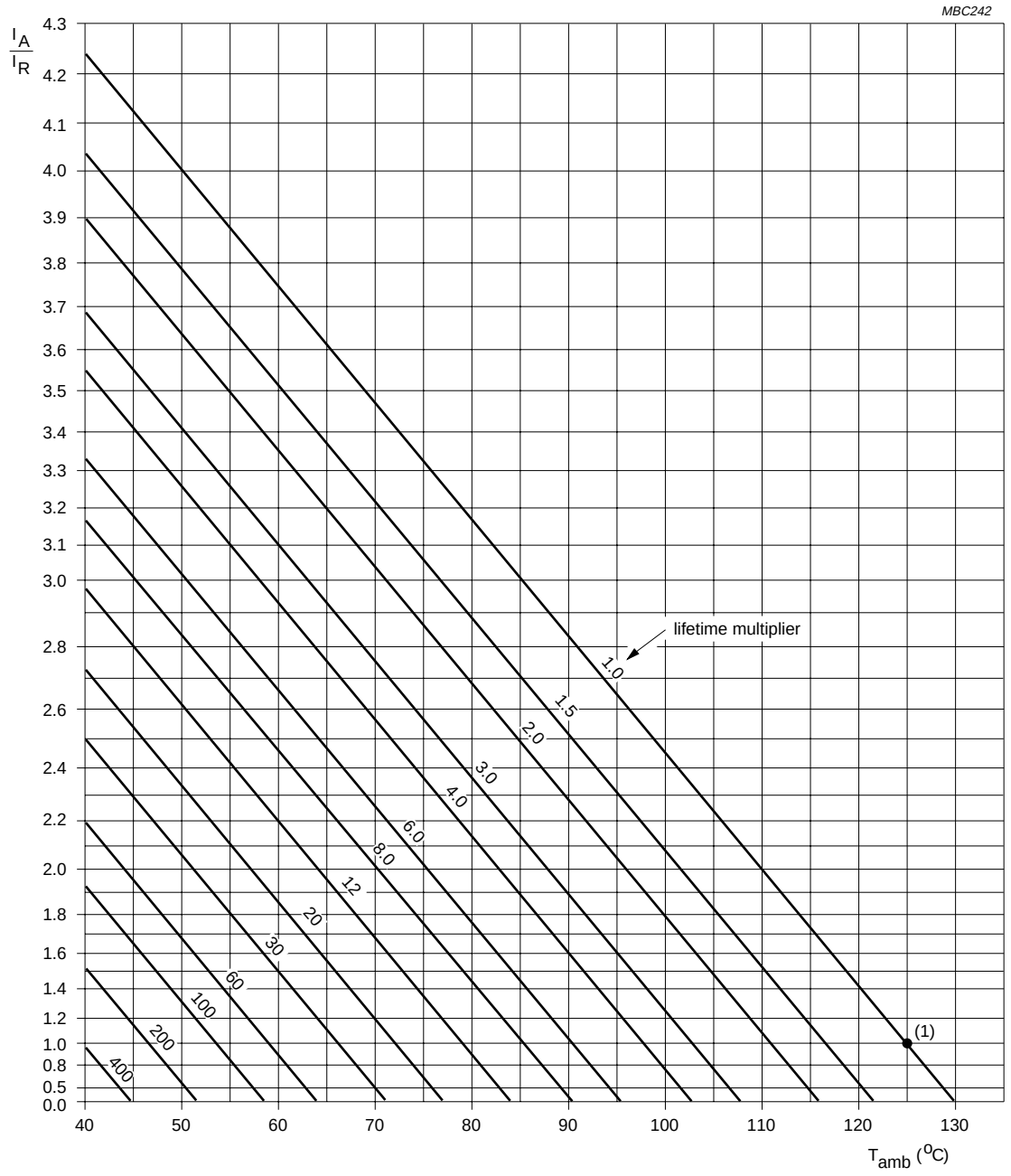


Curve 1: 10 V.
Curve 2: 16 V.
Curve 3: 25 V.
Curve 4: 35 V.
Curve 5: 40 V.
Curve 6: 50 V.
ESR_0 = typical at 20 °C, 100 Hz.

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

R

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 100 Hz.

I_R = rated ripple current at 100 Hz, 125 °C.

(1) Useful life at 125 °C and I_R applied: 1500 hours.

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load; see Table 3.

Table 3 Multiplier of ripple current (I_R/I_{RO}) as a function of frequency; I_{RO} = ripple current at 100 Hz; see Fig.9

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

SPECIFIC TESTS AND REQUIREMENTS

General tests and requirements are specified in this handbook, Section *"Tests and Requirements"*.

Table 4 Test procedures and requirements

TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 384-4/ CECC 30300 subclause 4.13	T_{amb} = 125 °C; U_R applied; 1000 hours	ΔC/C: ±15% tan δ ≤ 1.3 × spec. limit Z ≤ 2 × spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 125 °C; U_R and I_R applied; 1500 hours	ΔC/C: ±45% tan δ ≤ 3 × spec. limit Z ≤ 3 × spec. limit I_{L5} ≤ spec. limit no short or open circuit total failure percentage: ≤1%
Shelf life	IEC 384-4/ CECC 30300 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	ΔC/C: ±15% tan δ ≤ 1.3 × spec. limit Z ≤ 2 × spec. limit I_{L5} ≤ 2 × spec. limit

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