

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.

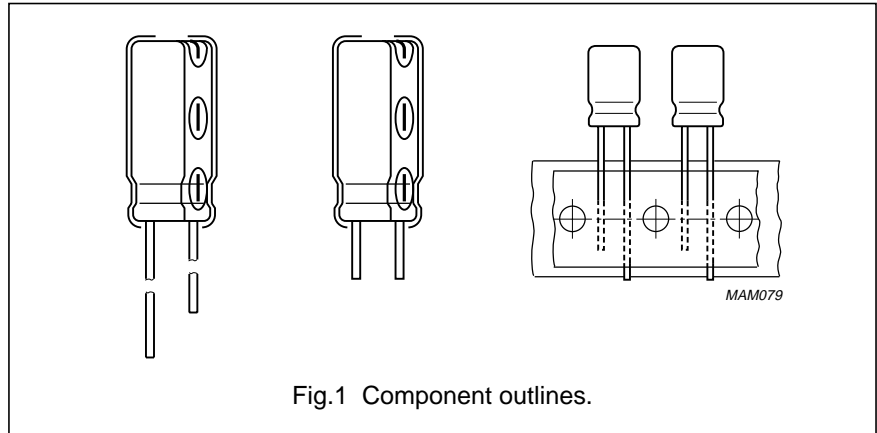
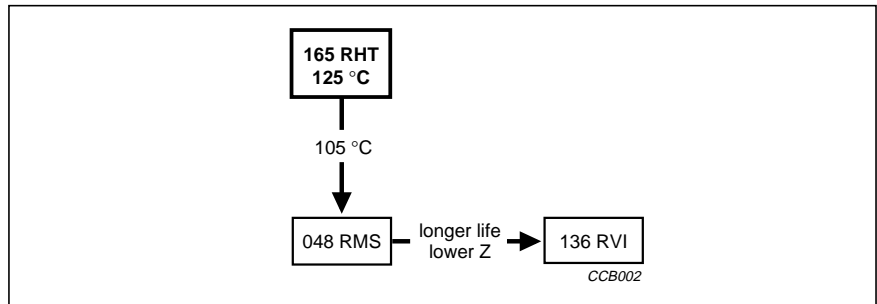


Fig.1 Component outlines.

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 μ F |
| Tolerance on C_R | $\pm 20\%$ |
| 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 | 1 500 hours |
| Useful life at 40 °C, $1.6 \times I_R$ applied | 300 000 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 ($\varnothing D \times L$ 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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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

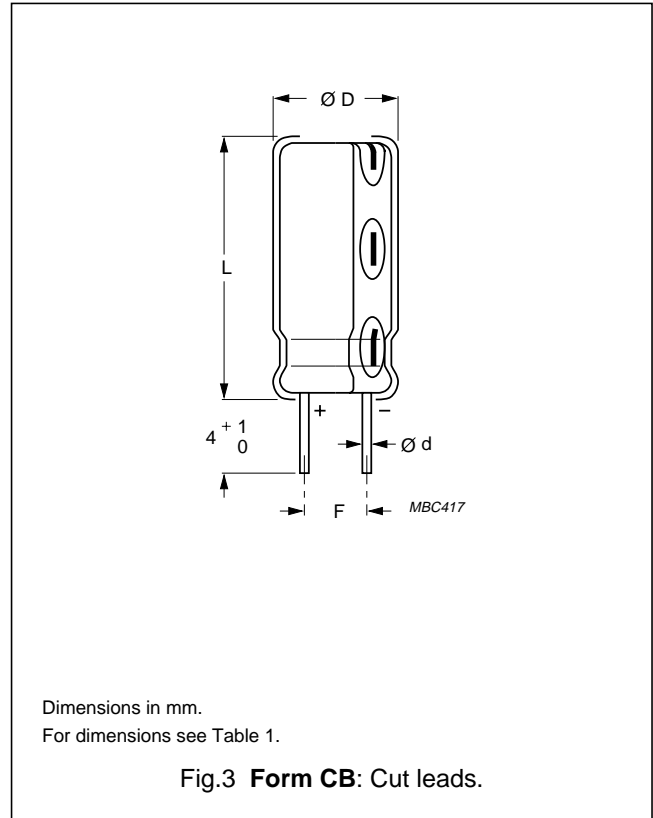
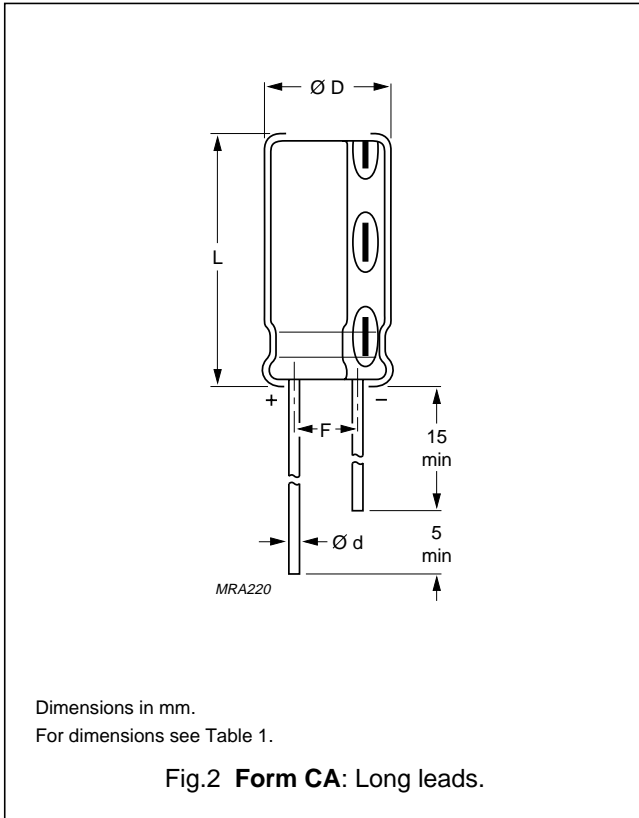


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

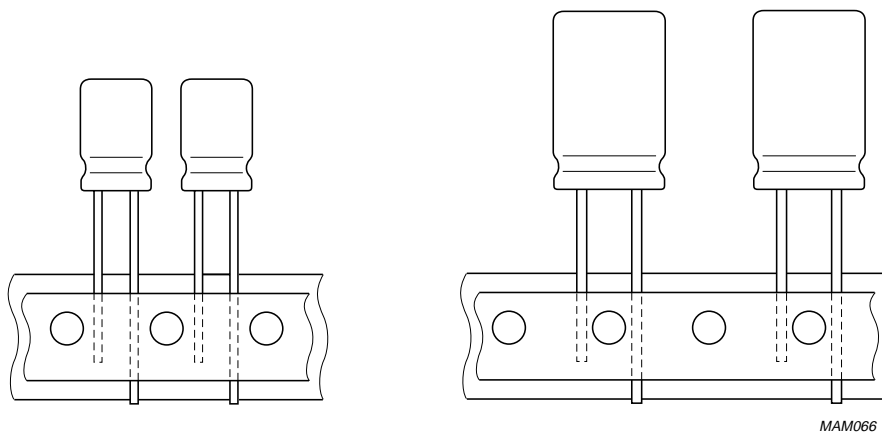
| NOMINAL CASE SIZE ØD × L (mm) | CASE CODE | Ød (mm) | ØD _{max} (mm) | L _{max} (mm) | F (mm) | MASS (g) | PACKAGING QUANTITIES PER BOX | | |
|-------------------------------------|-----------|---------|------------------------|-----------------------|----------|----------|------------------------------|---------|----------|
| | | | | | | | 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 $\varnothing D \times L \leq 16 \times 31\text{mm}$.

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 $\pm 20\%$)
- 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.

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Ordering example

Electrolytic capacitor 165 series

220 $\mu\text{F}/25\text{ V}$; $\pm 20\%$ Nominal case size: $\varnothing 10 \times 20\text{ mm}$; Form TFA

Catalogue number: 2222 165 36221.

ELECTRICAL DATA AND ORDERING INFORMATION

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

| SYMBOL | DESCRIPTION |
|----------------------|---|
| C_R | rated capacitance at 100 Hz, tolerance $\pm 20\%$ |
| I_R | rated RMS ripple current at 100 Hz, $125\text{ }^\circ\text{C}$ |
| I_{L1} | max. leakage current after 1 minute at U_R |
| I_{L5} | max. leakage current after 5 minutes at U_R |
| $\text{Tan } \delta$ | max. dissipation factor at 100 Hz |
| ESR | equivalent series resistance at 100 Hz (calculated from $\text{tan } \delta_{\text{max}}$ and C_R) |
| Z | max. impedance at 10 kHz or 100 kHz |

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

| U_R (V) | C_R 100 Hz (μF) | NOMINAL CASE SIZE $\varnothing D \times L$ (mm) | CASE CODE | I_R 100 Hz 125 $^\circ\text{C}$ (mA) | I_{L1} 1 min (μA) | I_{L5} 5 min (μA) | $\text{Tan } \delta$ 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 \times 12 | 14 | 200 | 25 | 7 | 0.20 | 1.30 | – | 0.55 | 165 54221 | 165 64221 | 165 34221 |
| | 470 | 10 \times 20 | 16 | 340 | 50 | 12 | 0.20 | 0.61 | – | 0.26 | 165 54471 | 165 64471 | 165 34471 |
| | 2200 | 16 \times 31 | 20 | 930 | 220 | 47 | 0.24 | 0.16 | 0.07 | – | 165 54222 | 165 64222 | 165 34222 |
| | 3300 | 16 \times 35 | 21 | 1200 | 330 | 69 | 0.26 | 0.11 | 0.05 | – | 165 54332 | 165 64332 | – |
| | 4700 | 16 \times 35 | 21 | 1400 | 470 | 97 | 0.28 | 0.09 | 0.04 | – | 165 90502 | 165 90507 | – |
| 16 | 220 | 10 \times 16 | 15 | 240 | 38 | 10 | 0.16 | 1.00 | – | 0.43 | 165 55221 | 165 65221 | 165 35221 |
| | 470 | 12.5 \times 20 | 17 | 410 | 78 | 18 | 0.16 | 0.49 | – | 0.20 | 165 55471 | 165 65471 | 165 35471 |
| | 1000 | 12.5 \times 25 | 18 | 650 | 160 | 35 | 0.16 | 0.23 | – | 0.10 | 165 55102 | 165 65102 | 165 35102 |
| | 2200 | 16 \times 35 | 21 | 1100 | 360 | 73 | 0.20 | 0.13 | 0.05 | – | 165 55222 | 165 65222 | – |
| | 3300 | 16 \times 35 | 21 | 1400 | 530 | 110 | 0.22 | 0.10 | 0.04 | – | 165 90503 | 165 90508 | – |
| 25 | 100 | 10 \times 12 | 14 | 170 | 28 | 8 | 0.14 | 2.00 | – | 0.70 | 165 56101 | 165 66101 | 165 36101 |
| | 220 | 10 \times 20 | 16 | 280 | 58 | 14 | 0.14 | 0.91 | – | 0.32 | 165 56221 | 165 66221 | 165 36221 |
| | 470 | 12.5 \times 25 | 18 | 480 | 120 | 27 | 0.14 | 0.43 | – | 0.15 | 165 56471 | 165 66471 | 165 36471 |
| | 1000 | 16 \times 31 | 20 | 830 | 250 | 53 | 0.14 | 0.20 | – | 0.07 | 165 56102 | 165 66102 | 165 36102 |
| | 2200 | 16 \times 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 | – |

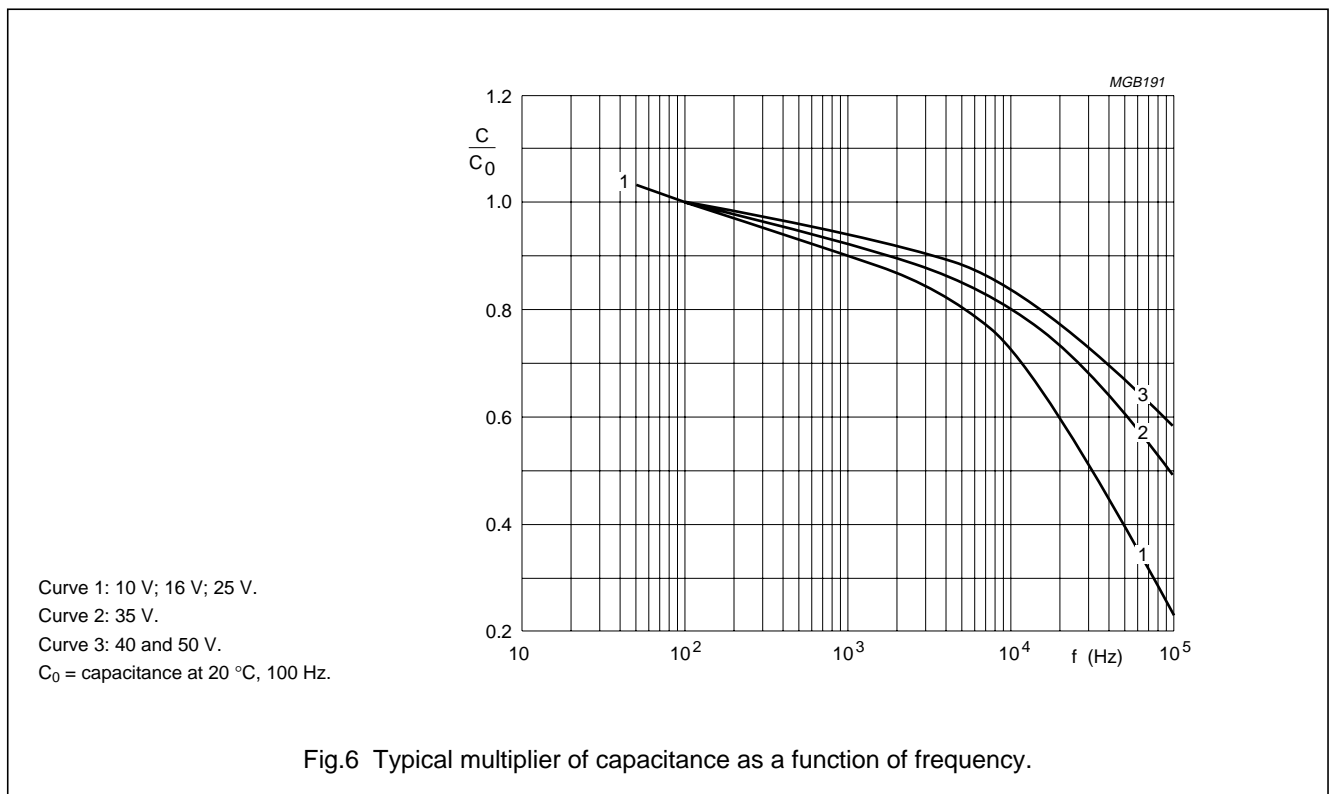
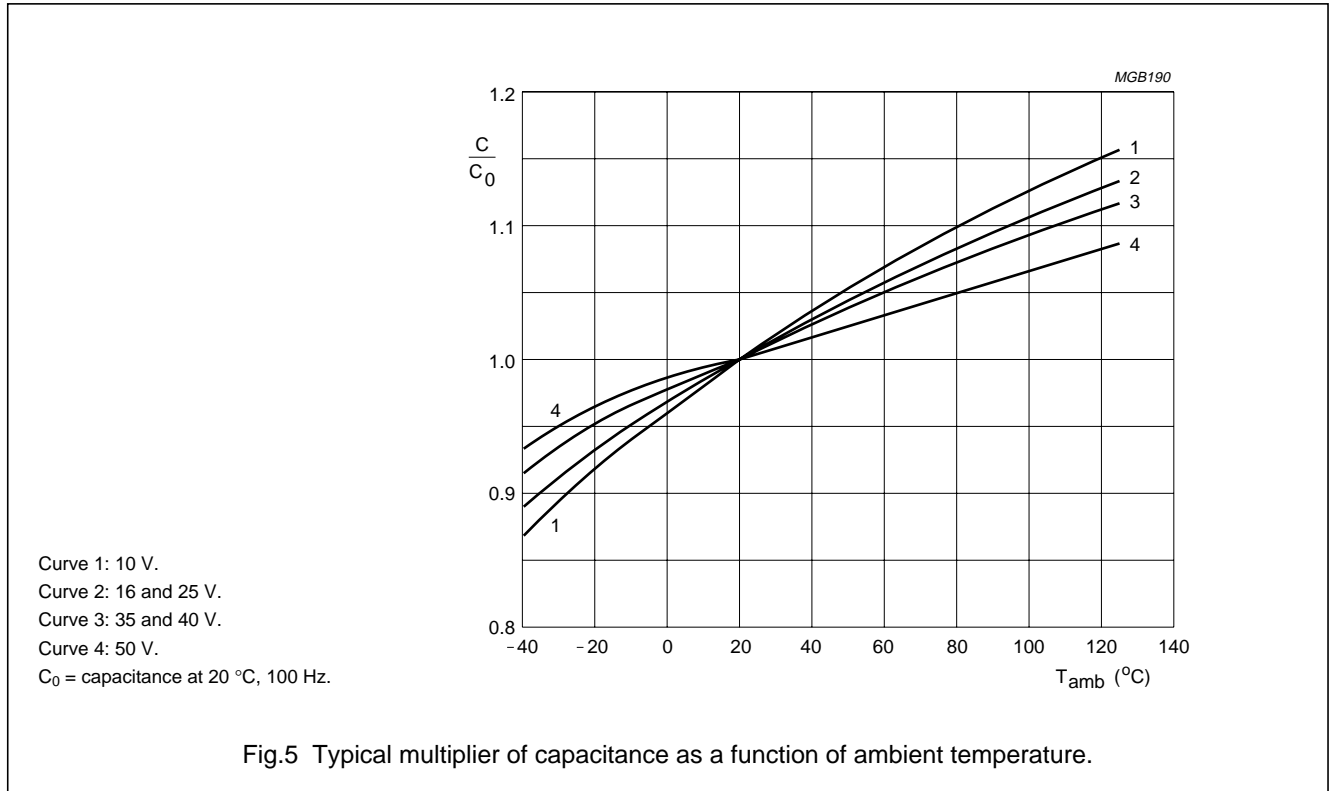
Additional electrical data

| 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 | $I_{L1} \leq 0.01 C_R \times U_R + 3 \mu A$ |
| | after 5 minutes at U _R | $I_{L5} \leq 0.002 C_R \times U_R + 3 \mu A$ |
| Inductance | | |
| Equivalent series inductance (ESL) | case ∅D = 10 mm | typ. 16 nH |
| | case ∅D ≥ 12.5 mm | typ. 18 nH |

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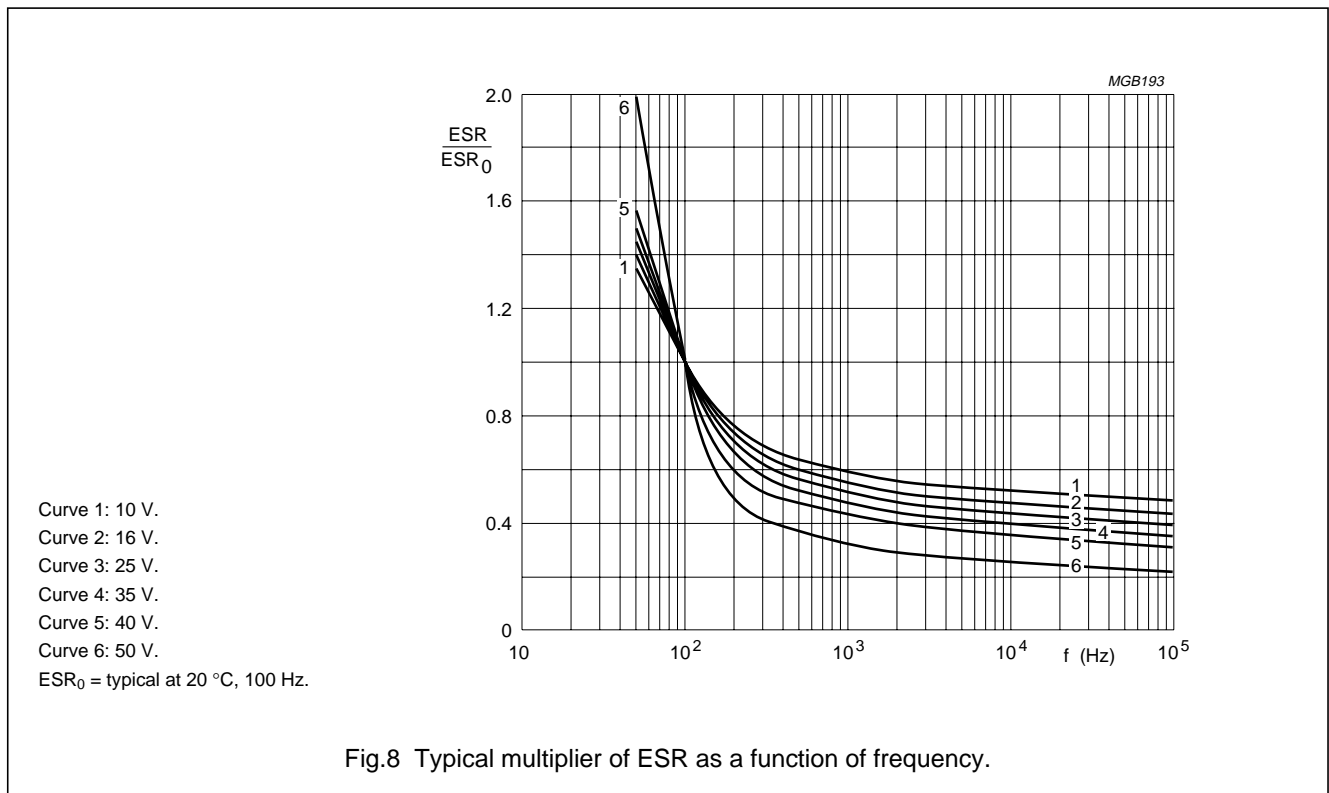
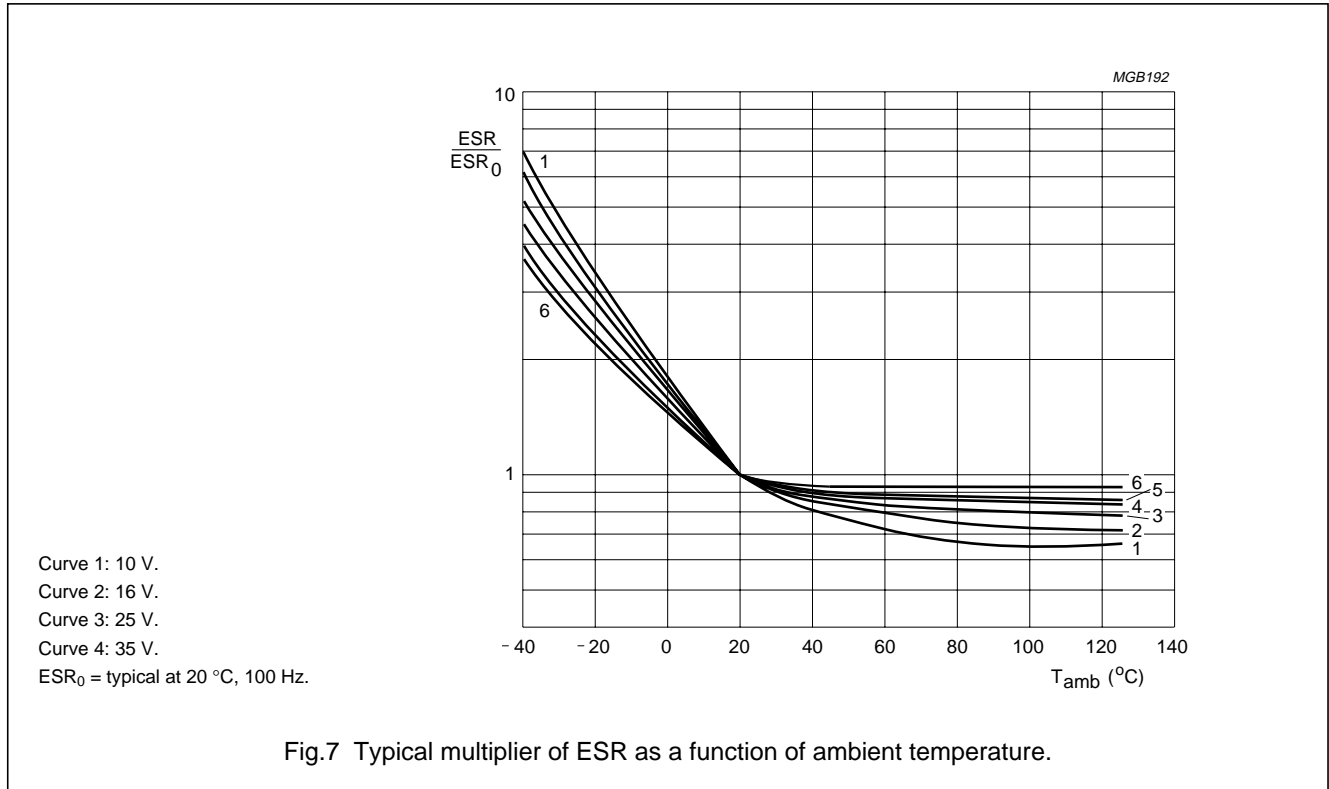
Capacitance (C)



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Equivalent series resistance (ESR)

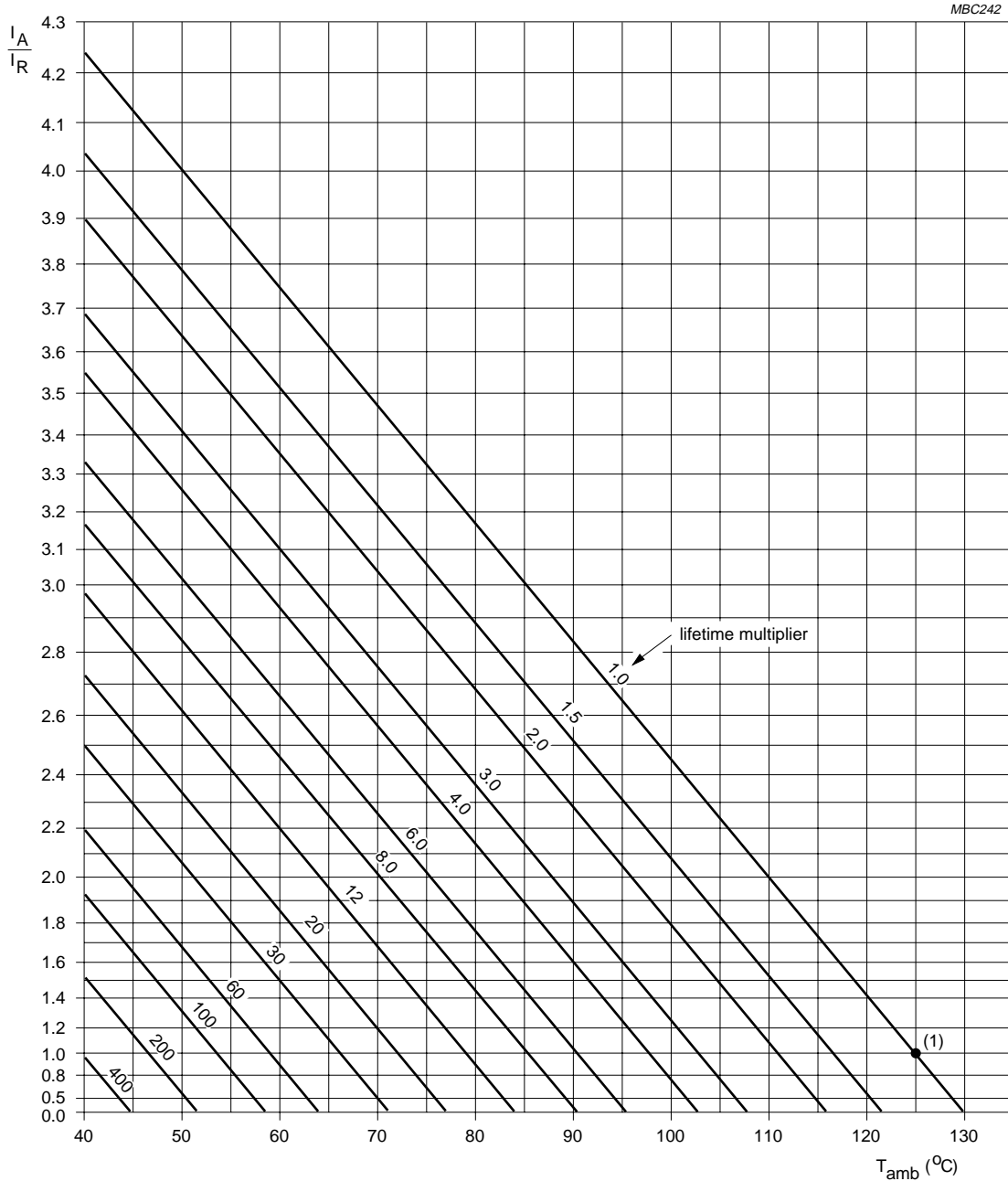


R

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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.

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Table 3 Multiplier of ripple current (I_R/I_{R0}) as a function of frequency; I_{R0} = 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 | $\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ |
| Useful life | CECC 30301 subclause 1.8.1 | $T_{amb} = 125$ °C; U_R and I_R applied; 1500 hours | $\Delta C/C: \pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$ |
| 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 | $\Delta C/C: \pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$ |

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