

DATA SHEET

116 RLL

Aluminum electrolytic capacitors
Radial Long Life

Product specification
Supersedes data of January 1998
File under BCcomponents, BC01

2000 Jan 18

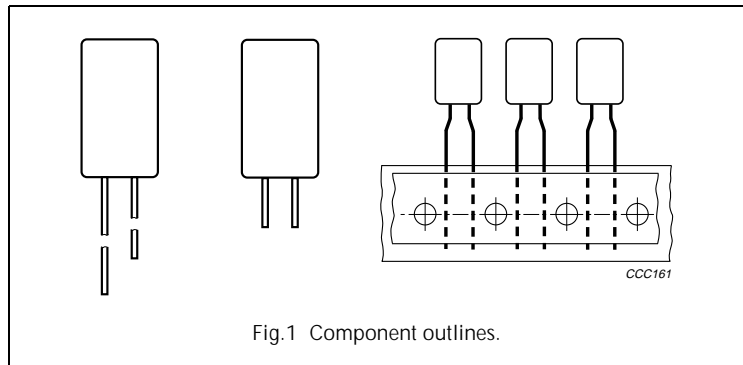
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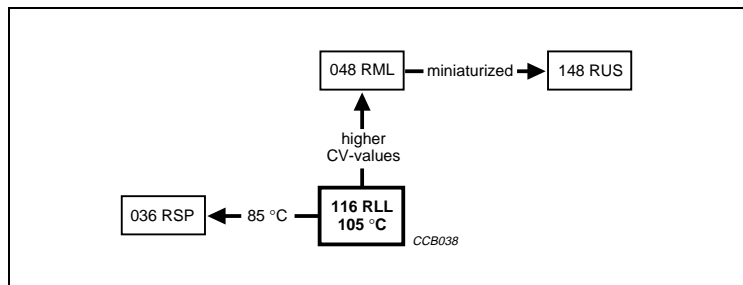
FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, all-insulated (light blue)
- Natural pitch 2.5 mm and 5 mm
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Long useful life: 2000 hours at 105 °C, high reliability.



APPLICATIONS

- Automotive, telecommunication, industrial and EDP
- Stand-by applications in audio and video equipment
- Coupling, decoupling, timing; smoothing, filtering and buffering in DC-DC converters
- Portable and mobile equipment (small size, low mass).



QUICK REFERENCE DATA

| DESCRIPTION | VALUE |
|--|----------------------|
| Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm) | 5 × 11 and 8.2 × 11 |
| Rated capacitance range, C_R | 0.47 to 470 μ F |
| Tolerance on C_R | $\pm 20\%$ |
| Rated voltage range, U_R | 6.3 to 100 V |
| Category temperature range | -55 to +105 °C |
| Endurance test at 105 °C | 1500 hours |
| Endurance test at 85 °C | 5000 hours |
| Useful life at 105 °C | 2000 hours |
| Useful life at 40 °C, $1.3 \times I_R$ applied | 200000 hours |
| Shelf life at 0 V, 105 °C | 1500 hours |
| Based on sectional specification | IEC 60384-4/EN130300 |
| Climatic category IEC 60068 | 55/105/56 |

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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) | | | | | | | | |
|----------------------------|-----------|---------------|-----------------|---------------|-----------------|----------|-----------------|----------|----------|
| | 6.3 | 10 | 16 | 25 | 35 | 40 | 50 | 63 | 100 |
| 0.47 | – | – | – | – | – | – | 5 × 11 | – | – |
| 1.0 | – | – | – | – | – | – | 5 × 11 | – | – |
| 1.5 | – | – | – | – | – | – | 5 × 11 | – | – |
| 2.2 | – | – | – | – | – | – | 5 × 11 | – | 8.2 × 11 |
| 3.3 | – | – | – | – | – | – | 5 × 11 | – | – |
| 4.7 | – | – | – | – | – | – | 5 × 11 | – | 8.2 × 11 |
| 6.8 | – | – | – | – | – | – | 5 × 11 | – | – |
| 10 | – | – | – | – | – | – | 5 × 11 | 8.2 × 11 | 8.2 × 11 |
| | – | – | – | – | – | – | 8.2 × 11 | – | – |
| 15 | – | – | – | – | – | – | 5 × 11 | – | – |
| 22 | – | – | – | – | – | – | 5 × 11 | 8.2 × 11 | – |
| | – | – | – | – | – | – | 8.2 × 11 | – | – |
| 33 | – | – | – | – | 5 × 11 | 5 × 11 | 8.2 × 11 | – | – |
| 47 | – | – | – | 5 × 11 | – | – | 8.2 × 11 | – | – |
| 68 | – | – | 5 × 11 | – | – | – | 8.2 × 11 | – | – |
| 100 | – | 5 × 11 | – | – | 8.2 × 11 | 8.2 × 11 | – | – | – |
| 150 | 5 × 11 | – | – | 8.2 × 11 | – | – | – | – | – |
| 220 | – | – | 8.2 × 11 | – | – | – | – | – | – |
| 330 | – | 8.2 × 11 | – | – | – | – | – | – | – |
| 470 ⁽¹⁾ | 8.2 × 11 | – | – | – | – | – | – | – | – |

Note

1. For higher CV-values see data sheet "048 RML".

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MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES

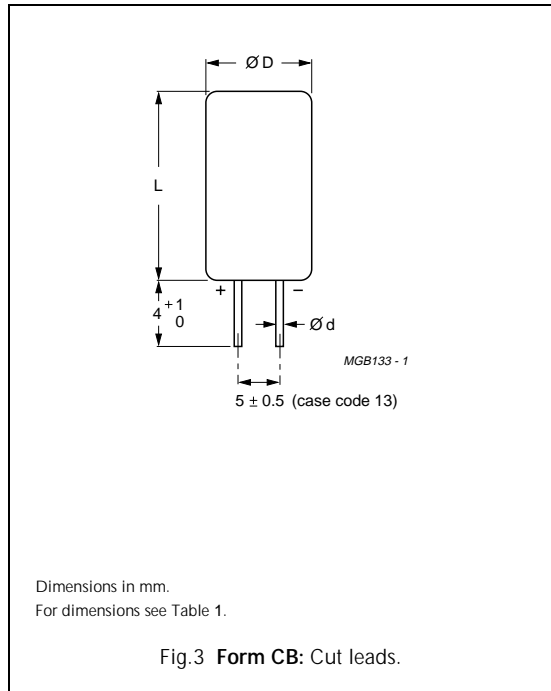
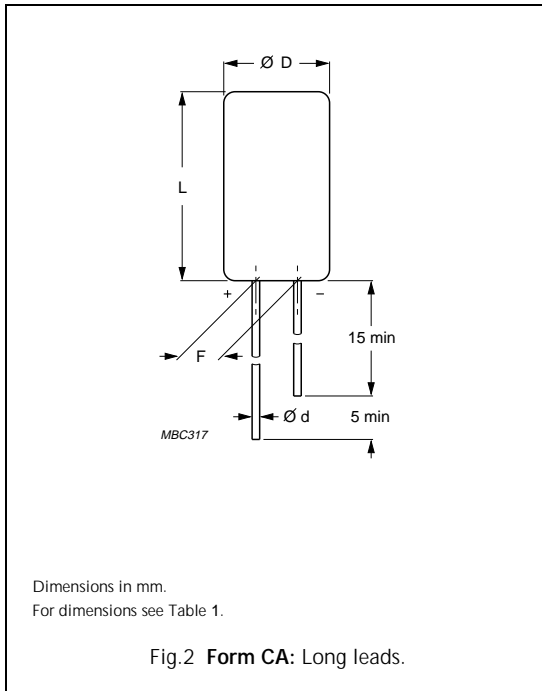


Table 1 Physical dimensions, mass and packaging quantities; see Figs 2 and 3

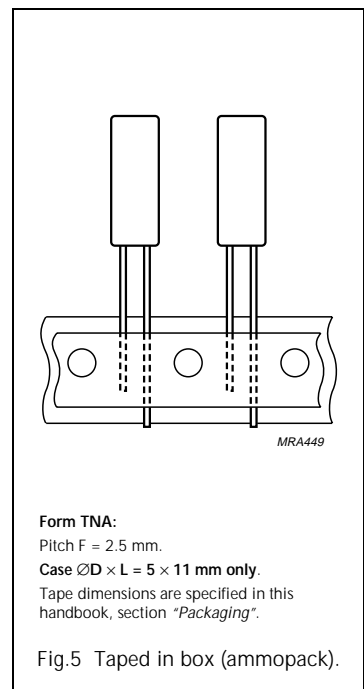
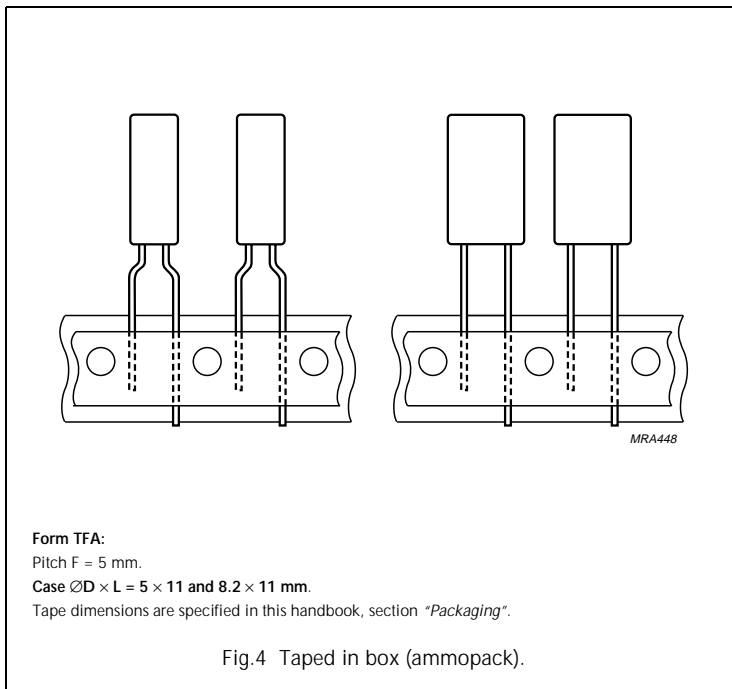
| NOMINAL CASE SIZE ØD × L (mm) | CASE CODE | Ød (mm) | ØD _{max} (mm) | L _{max} (mm) | F (mm) | MASS (g) | PACKAGING QUANTITIES | | |
|-------------------------------------|-----------|---------|------------------------|-----------------------|-----------|----------|----------------------|---------------|---------------|
| | | | | | | | FORM CA, CB | FORM TR+, TN+ | FORM TFA, TNA |
| 5 × 11 | 11 | 0.5 | 5.5 | 12 | 2.5 ± 0.5 | ≈ 0.4 | 1000 | 1000 | 2000 |
| 8.2 × 11 | 13 | 0.6 | 8.7 | 12 | 5 ± 0.5 | ≈ 1.1 | 1000 | 500 | 1000 |

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Taped products



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"
- Rated voltage (in V)
- Group number (116)
- Name of manufacturer
- Date code in accordance with "IEC 60062"
- Code indicating factory of origin
- Minus-sign on top to identify the negative terminal.

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ELECTRICAL DATA

Unless otherwise specified, all electrical values in Tables 2 and 4 apply at $T_{amb} = 20\text{ °C}$, $P = 86$ to 106 kPa , $RH = 45$ to 75% .

| SYMBOL | DESCRIPTION |
|---------------|---|
| C_R | rated capacitance at 100 Hz, tolerance $\pm 20\%$ |
| I_R | rated RMS ripple current at 100 kHz, 105 °C |
| I_{L1} | max. leakage current after 1 minute at U_R |
| I_{L5} | max. leakage current after 5 minutes at U_R |
| $\tan \delta$ | max. dissipation factor at 100 Hz |
| ESR | equivalent series resistance at 100 Hz (calculated from $\tan \delta_{max}$ and C_R) |
| Z_{10} | max. impedance at 10 kHz and 20 or -40 °C |
| Z_{100} | max. impedance at 100 kHz and 20 °C |

Table 2 Electrical data; 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 kHz 105 °C (mA) | I_{L1} 1 min (μA) | I_{L5} 5 min (μA) | $\tan \delta$ 100 Hz | ESR 100 Hz (Ω) | Z_{10} 10 kHz 20 °C (Ω) | Z_{100} 100 kHz 20 °C (Ω) | Z_{10} 10 kHz -40 °C (Ω) |
|--------------|--------------------------------------|--|--------------|---|--|--|-------------------------|-------------------------------|--|--|---|
| 6.3 | 150 | 5 × 11 | 11 | 130 | 8.7 | 3.9 | 0.25 | 2.7 | 2 | 1.3 | 32 |
| | 470 | 8.2 × 11 | 13 | 300 | 21 | 6 | 0.25 | 0.8 | 0.64 | 0.45 | 10 |
| 10 | 100 | 5 × 11 | 11 | 130 | 9 | 4 | 0.2 | 3.2 | 2 | 1.4 | 32 |
| | 330 | 8.2 × 11 | 13 | 280 | 23 | 6.3 | 0.2 | 1.0 | 0.61 | 0.45 | 9.7 |
| 16 | 68 | 5 × 11 | 11 | 130 | 9.5 | 4.1 | 0.16 | 3.7 | 2.4 | 1.5 | 29 |
| | 220 | 8.2 × 11 | 13 | 280 | 24 | 6.5 | 0.16 | 1.2 | 0.73 | 0.5 | 9.1 |
| 25 | 47 | 5 × 11 | 11 | 120 | 10 | 4.2 | 0.14 | 4.7 | 2.6 | 1.6 | 32 |
| | 150 | 8.2 × 11 | 13 | 260 | 26 | 6.8 | 0.14 | 1.5 | 0.8 | 0.5 | 10 |
| 35 | 33 | 5 × 11 | 11 | 110 | 9.9 | 4.2 | 0.12 | 5.8 | 2.7 | 1.7 | 33 |
| | 100 | 8.2 × 11 | 13 | 240 | 24 | 6.5 | 0.12 | 1.9 | 0.9 | 0.55 | 11 |
| 40 | 33 | 5 × 11 | 11 | 110 | 10.9 | 4.3 | 0.12 | 5.8 | 2.7 | 1.7 | 33 |
| | 100 | 8.2 × 11 | 13 | 240 | 27 | 7 | 0.12 | 1.9 | 0.9 | 0.55 | 11 |

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ORDERING INFORMATION

Ordering example

Electrolytic capacitor 116 series

220 $\mu\text{F}/16\text{ V}; \pm 20\%$

Nominal case size: $\varnothing 8.2 \times 11\text{ mm}$; Form TFA

Catalogue number: 2222 116 35221.

Table 3 Ordering information; preferred types in **bold**

| U_R (V) | C_R 100 Hz (μF) | CASE CODE | CATALOGUE NUMBER 2222 | | | | | | | |
|--------------|--------------------------------------|--------------|------------------------------|-----------|------------|-----------|------------------|-----------|-------------|-----------|
| | | | BULK PACKAGING | | | | TAPED AMMOPACK | | | |
| | | | LONG LEADS | | CUT LEADS | | | | | |
| | | | FORM CA | F (mm) | FORM CB | F (mm) | FORM TFA | F (mm) | FORM TNA | F (mm) |
| 6.3 | 150 | 11 | 116 53151 | 2.5 | – | – | 116 33151 | 5.0 | 116 73151 | 2.5 |
| | 470 | 13 | 116 53471 | 5.0 | 116 63471 | 5.0 | 116 33471 | 5.0 | – | – |
| 10 | 100 | 11 | 116 54101 | 2.5 | – | – | 116 34101 | 5.0 | 116 74101 | 2.5 |
| | 330 | 13 | 116 54331 | 5.0 | 116 64331 | 5.0 | 116 34331 | 5.0 | – | – |
| 16 | 68 | 11 | 116 55689 | 2.5 | – | – | 116 35689 | 5.0 | 116 75689 | 2.5 |
| | 220 | 13 | 116 55221 | 5.0 | 116 65221 | 5.0 | 116 35221 | 5.0 | – | – |
| 25 | 47 | 11 | 116 56479 | 2.5 | – | – | 116 36479 | 5.0 | 116 76479 | 2.5 |
| | 150 | 13 | 116 56151 | 5.0 | 116 66151 | 5.0 | 116 36151 | 5.0 | – | – |
| 35 | 33 | 11 | 116 50339 | 2.5 | – | – | 116 30339 | 5.0 | 116 70339 | 2.5 |
| | 100 | 13 | 116 50101 | 5.0 | 116 60101 | 5.0 | 116 30101 | 5.0 | – | – |
| 40 | 33 | 11 | 116 57339 | 2.5 | – | – | 116 37339 | 5.0 | 116 77339 | 2.5 |
| | 100 | 13 | 116 57101 | 5.0 | 116 67101 | 5.0 | 116 37101 | 5.0 | – | – |

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ELECTRICAL DATA (continued)

Table 4 Electrical data continued; preferred types in **bold**

| U_R (V) | C_R 100 Hz (μ F) | NOMINAL CASE SIZE $\varnothing D \times L$ (mm) | CASE CODE | I_R 100 kHz 105 °C (mA) | I_{L1} 1 min (μ A) | I_{L5} 5 min (μ A) | Tan δ 100 Hz | ESR 100 Hz (Ω) | Z_{10} 10 kHz 20 °C (Ω) | Z_{100} 100 kHz 20 °C (Ω) | Z_{10} 10 kHz -40 °C (Ω) |
|--------------|-------------------------------|--|--------------|------------------------------------|---------------------------------|---------------------------------|------------------------|-------------------------------|---|---|--|
| 50 | 0.47 | 5 × 11 | 11 | 30 | 3.1 | 3 | 0.09 | 300 | 150 | 10 | 1900 |
| | 1.0 | 5 × 11 | 11 | 40 | 3.3 | 3.1 | 0.09 | 140 | 70 | 6 | 900 |
| | 1.5 | 5 × 11 | 11 | 50 | 3.5 | 3.1 | 0.09 | 95 | 47 | 4 | 600 |
| | 2.2 | 5 × 11 | 11 | 60 | 3.7 | 3.1 | 0.09 | 65 | 32 | 3.5 | 410 |
| | 3.3 | 5 × 11 | 11 | 65 | 4 | 3.2 | 0.09 | 43 | 21 | 3.1 | 270 |
| | 4.7 | 5 × 11 | 11 | 70 | 4.4 | 3.2 | 0.09 | 30 | 15 | 2.8 | 190 |
| | 6.8 | 5 × 11 | 11 | 75 | 5 | 3.3 | 0.09 | 21 | 10 | 2.5 | 130 |
| | 10 | 5 × 11 | 11 | 80 | 6 | 3.5 | 0.09 | 14 | 7 | 2.2 | 90 |
| | 10 | 8.2 × 11 | 13 | 160 | 6 | 3.5 | 0.05 | 8.0 | 3.6 | 1.0 | 40 |
| | 15 | 5 × 11 | 11 | 90 | 7.5 | 3.8 | 0.09 | 9.5 | 4.7 | 2.0 | 60 |
| | 22 | 5 × 11 | 11 | 110 | 9.6 | 4.1 | 0.09 | 6.5 | 3.2 | 1.9 | 41 |
| | 22 | 8.2 × 11 | 13 | 190 | 9.6 | 4.1 | 0.06 | 4.4 | 2.2 | 0.9 | 29 |
| | 33 | 8.2 × 11 | 13 | 190 | 13 | 4.7 | 0.09 | 4.3 | 2.1 | 0.77 | 27 |
| 47 | 8.2 × 11 | 13 | 210 | 17 | 5.4 | 0.09 | 3.0 | 1.5 | 0.65 | 19 | |
| 68 | 8.2 × 11 | 13 | 240 | 23 | 6.4 | 0.09 | 2.1 | 1.0 | 0.55 | 13 | |
| 63 | 10 | 8.2 × 11 | 13 | 160 | 7 | 3.6 | 0.06 | 9.5 | 3.5 | 1.3 | 45 |
| | 22 | 8.2 × 11 | 13 | 190 | 11 | 4.4 | 0.06 | 4.4 | 1.8 | 0.9 | 23 |
| 100 | 2.2 | 8.2 × 11 | 13 | 60 | 4.3 | 3.2 | 0.06 | 43 | 18 | 4 | 190 |
| | 4.7 | 8.2 × 11 | 13 | 75 | 5.8 | 3.5 | 0.07 | 24 | 12 | 3.5 | 170 |
| | 10 | 8.2 × 11 | 13 | 100 | 9 | 4 | 0.08 | 13 | 4.5 | 3 | 70 |

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 | $I_{L1} \leq 0.006 C_R \times U_R + 3 \mu A$ |
| | after 5 minutes at U_R | $I_{L5} \leq 0.001 C_R \times U_R + 3 \mu A$ |
| Inductance | | |
| Equivalent series inductance (ESL) | case $\varnothing D \times L = 5 \times 11$ mm | typ. 13 nH |
| | case $\varnothing D \times L = 8.2 \times 11$ mm | typ. 16 nH |

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ORDERING INFORMATION (continued)

Table 5 Ordering information continued; preferred types in **bold**

| U _R (V) | C _R 100 H z (μF) | CASE CODE | CATALOGUE NUMBER 2222 | | | | | | | |
|-----------------------|--------------------------------------|--------------|------------------------------|-----------|------------|-----------|------------------|-----------|-------------|-----------|
| | | | BULK PACKAGING | | | | TAPED AMMOPACK | | | |
| | | | LONG LEADS | | CUT LEADS | | FORM TFA | F (mm) | FORM TNA | F (mm) |
| | | | FORM CA | F (mm) | FORM CB | F (mm) | | | | |
| 50 | 0.47 | 11 | 116 51477 | 2.5 | – | 5.0 | 116 31477 | 5.0 | 116 71477 | 2.5 |
| | 1.0 | 11 | 116 51108 | 2.5 | – | 5.0 | 116 31108 | 5.0 | 116 71108 | 2.5 |
| | 1.5 | 11 | 116 51158 | 2.5 | – | 5.0 | 116 31158 | 5.0 | 116 71158 | 2.5 |
| | 2.2 | 11 | 116 51228 | 2.5 | – | 5.0 | 116 31228 | 5.0 | 116 71228 | 2.5 |
| | 3.3 | 11 | 116 51338 | 2.5 | – | 5.0 | 116 31338 | 5.0 | 116 71338 | 2.5 |
| | 4.7 | 11 | 116 51478 | 2.5 | – | 5.0 | 116 31478 | 5.0 | 116 71478 | 2.5 |
| | 6.8 | 11 | 116 51688 | 2.5 | – | 5.0 | 116 31688 | 5.0 | 116 71688 | 2.5 |
| | 10 | 11 | 116 51109 | 2.5 | – | 5.0 | 116 31109 | 5.0 | 116 71109 | 2.5 |
| | 10 | 13 | 116 90084 | 5.0 | 116 90085 | 5.0 | 116 90036 | 5.0 | – | – |
| | 15 | 11 | 116 51159 | 2.5 | – | 5.0 | 116 31159 | 5.0 | 116 71159 | 2.5 |
| | 22 | 11 | 116 51229 | 2.5 | – | 5.0 | 116 31229 | 5.0 | 116 71229 | 2.5 |
| | 22 | 13 | 116 90025 | 5.0 | 116 90086 | 5.0 | 116 90039 | 5.0 | – | – |
| | 33 | 13 | 116 51339 | 5.0 | 116 61339 | 5.0 | 116 31339 | 5.0 | – | – |
| | 47 | 13 | 116 51479 | 5.0 | 116 61479 | 5.0 | 116 31479 | 5.0 | – | – |
| 68 | 13 | 116 51689 | 5.0 | 116 61689 | 5.0 | 116 31689 | 5.0 | – | – | |
| 63 | 10 | 13 | 116 58109 | 5.0 | 116 68109 | 5.0 | 116 38109 | 5.0 | – | – |
| | 22 | 13 | 116 58229 | 5.0 | 116 68229 | 5.0 | 116 38229 | 5.0 | – | – |
| 100 | 2.2 | 13 | 116 59228 | 5.0 | 116 69228 | 5.0 | 116 39228 | 5.0 | – | – |
| | 4.7 | 13 | 116 59478 | 5.0 | 116 69478 | 5.0 | 116 39478 | 5.0 | – | – |
| | 10 | 13 | 116 59109 | 5.0 | 116 69109 | 5.0 | 116 39109 | 5.0 | – | – |

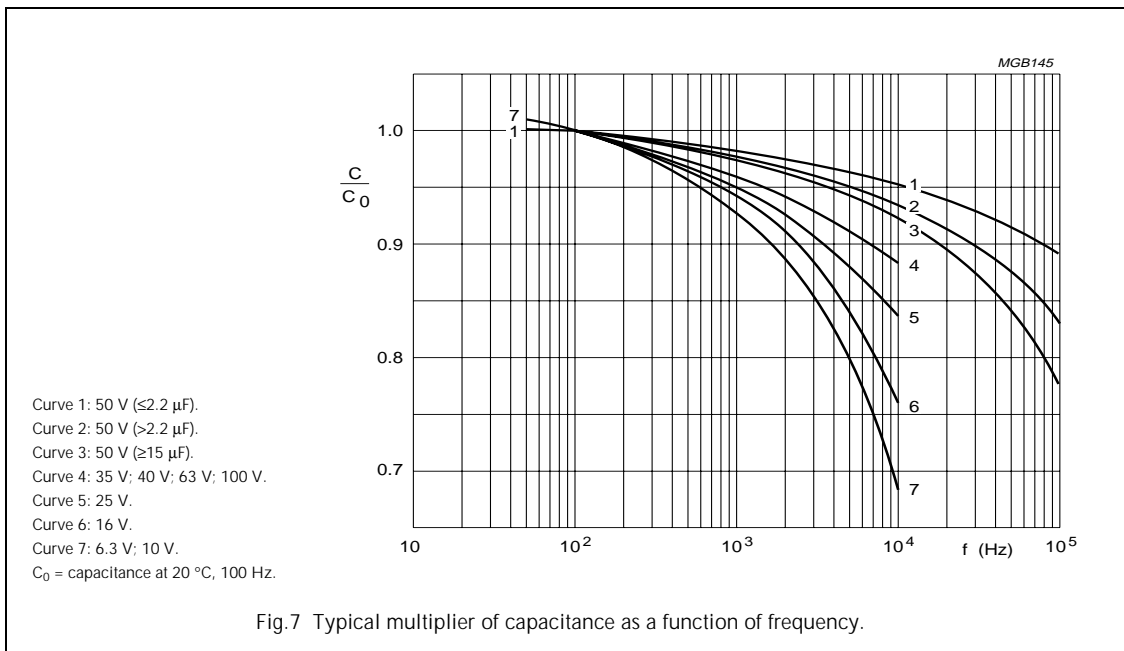
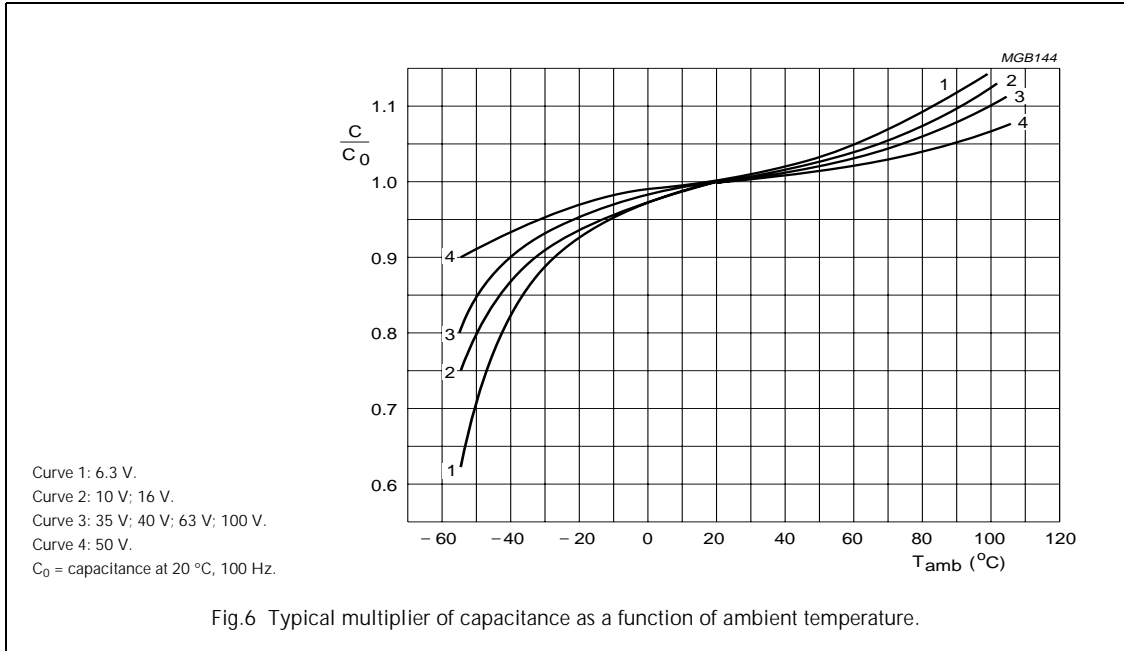
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ELECTRICAL DATA (continued)

Capacitance (C)

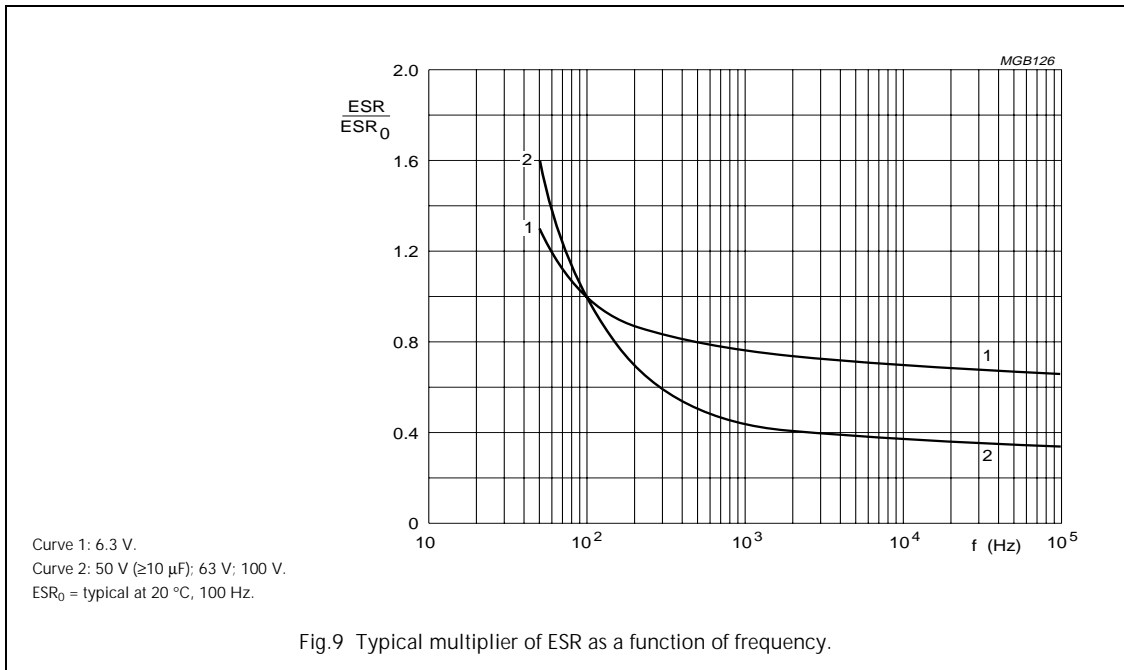
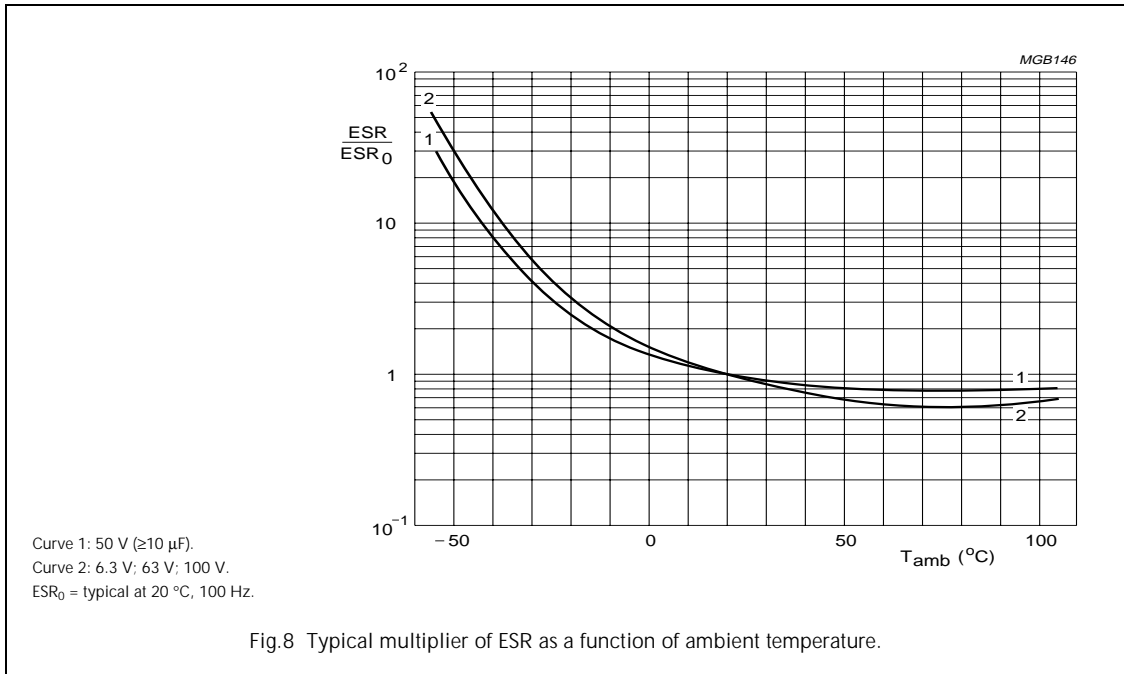


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Equivalent series resistance (ESR)

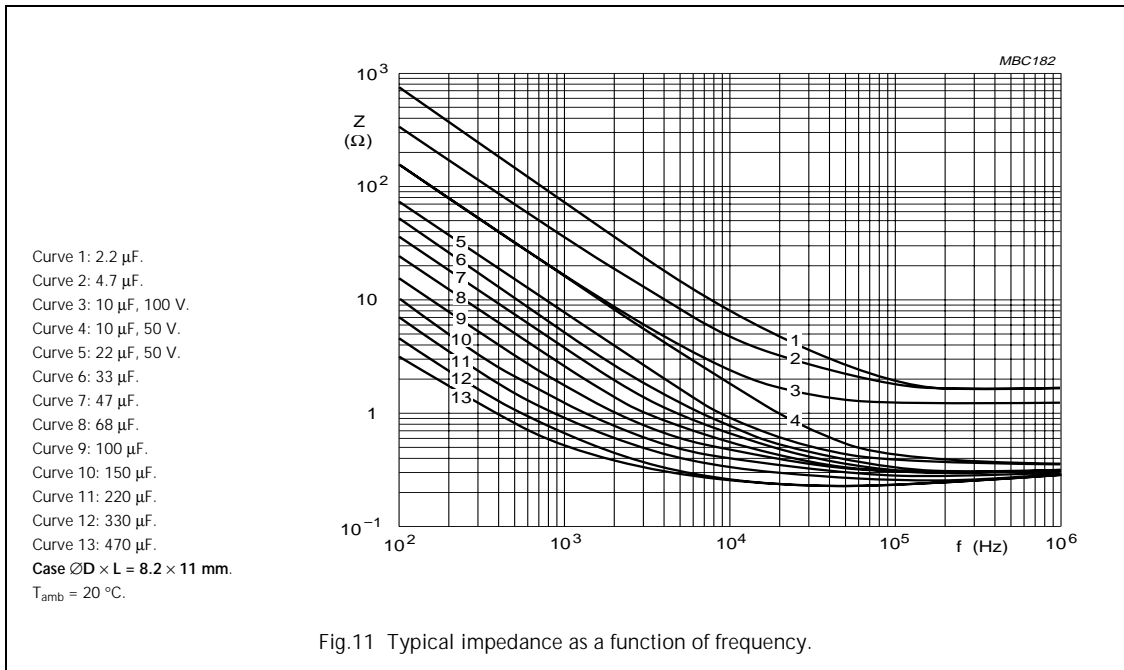
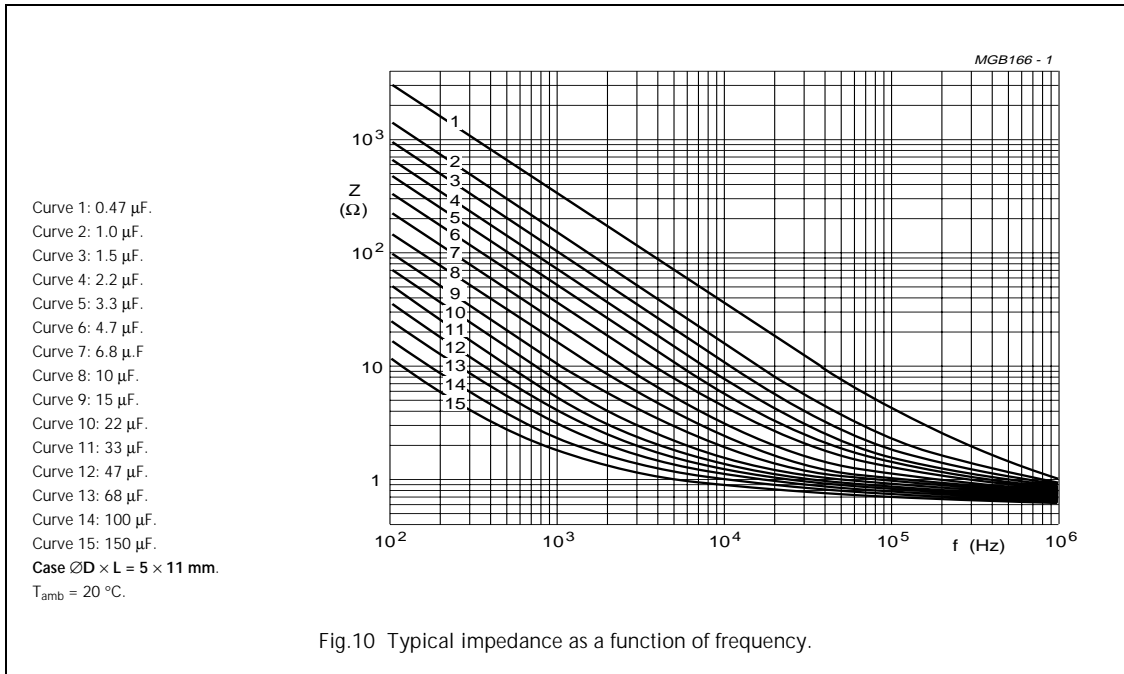


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Impedance (Z)



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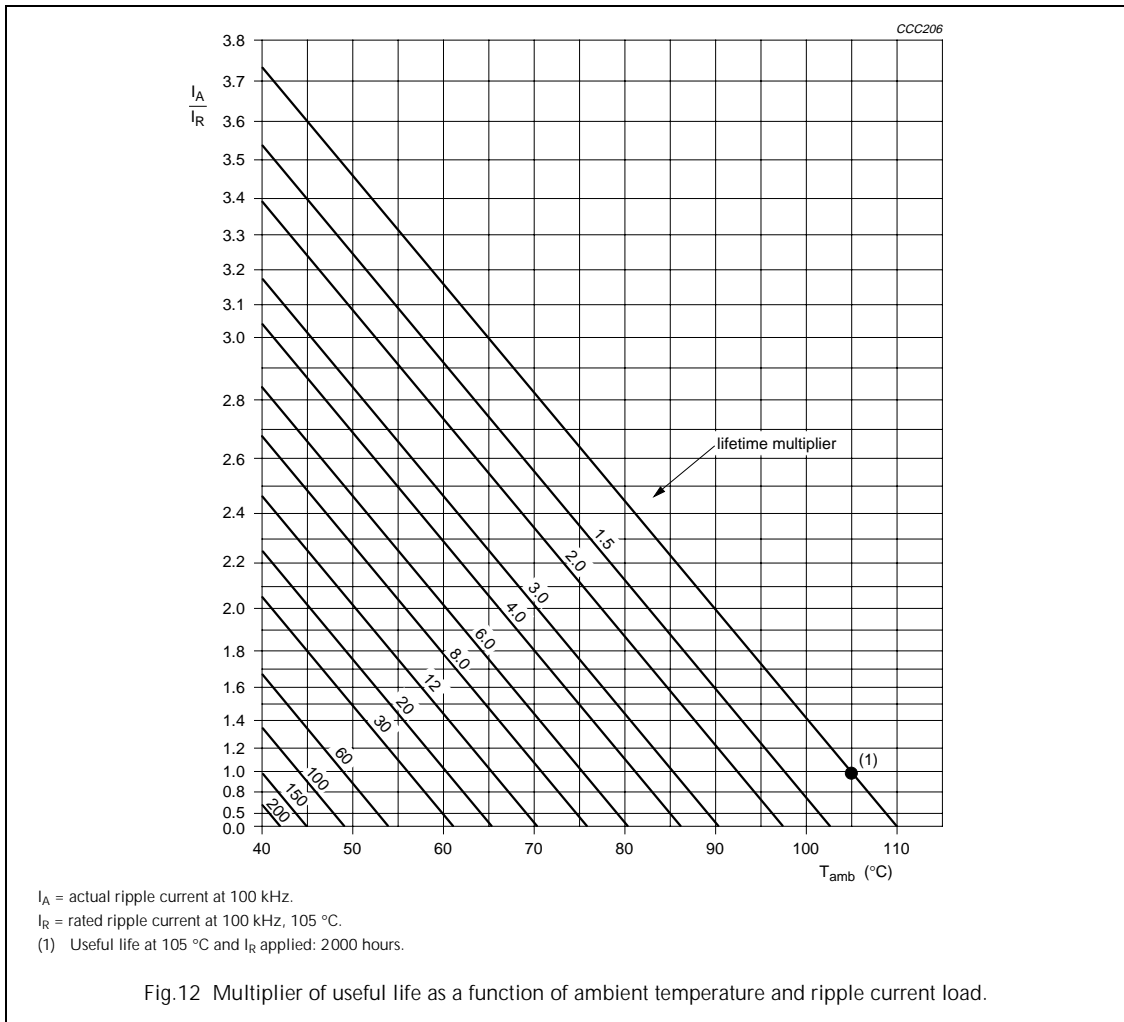
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RIPPLE CURRENT AND USEFUL LIFE

Table 6 Multiplier of ripple current (I_R) as a function of frequency

| FREQUENCY (Hz) | I_R MULTIPLIER | | |
|-------------------|-----------------------|----------------------|---|
| | $U_R = 6.3$ to 10 V | $U_R = 16$ to 35 V | $U_R = 40$ to 100 V ($C_R \geq 10 \mu\text{F}$) |
| 50 | 0.7 | 0.6 | 0.5 |
| 100 | 0.77 | 0.71 | 0.63 |
| 300 | 0.86 | 0.85 | 0.78 |
| 1000 | 0.92 | 0.93 | 0.88 |
| 3000 | 0.96 | 0.96 | 0.94 |
| 10 to 100 k | 1.0 | 1.0 | 1.0 |



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SPECIFIC TESTS AND REQUIREMENTS

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

Table 7 Test procedures and requirements

| TEST | | PROCEDURE (quick reference) | REQUIREMENTS |
|--|--|---|--|
| NAME OF TEST | REFERENCE | | |
| Endurance | IEC 60384-4/ EN130300 subclause 4.13 | $T_{amb} = 105\text{ °C}$; U_R applied; 1500 hours | $U_R \leq 6.3\text{ V}$; $\Delta C/C$: +15/–30% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z_{10} \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ |
| Useful life | CECC 30301 subclause 1.8.1 | $T_{amb} = 105\text{ °C}$; U_R and I_R applied; 2000 hours | $U_R \leq 6.3\text{ V}$; $\Delta C/C$: +45/–50% $U_R > 6.3\text{ V}$; $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z_{10} \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ 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; 1500 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement | $\Delta C/C$, $\tan \delta$, Z : for requirements see 'Endurance test' above $I_{L5} \leq 2 \times \text{spec. limit}$ |