# Non-solid Al - electrolytic capacitors Axial Standard, High Voltage

# ASH 041 - 043

## FEATURES

- Polarized aluminium electrolytic capacitors, non-solid
- Axial leads, cylindrical aluminium case, insulated with a blue sleeve
- Mounting ring version (single ended) not insulated
- Case ∅10 × 30 to 21 × 40 mm with pressure relief
- Taped versions up to case ∅15 × 30 mm available for automatic insertion
- Charge and discharge proof
- Useful life: 5000 to 15000 hours at 85 °C
- High rated voltage: up to 450 V.

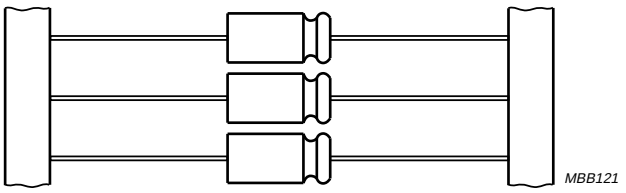
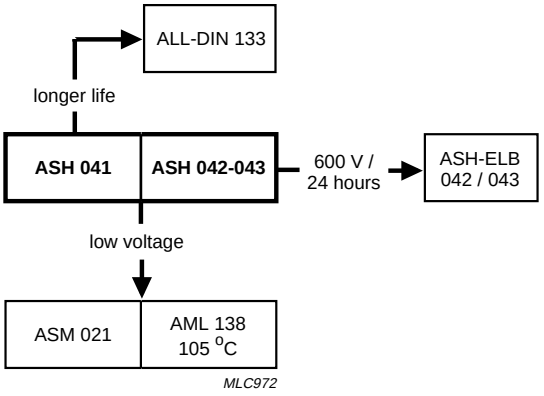



Fig.1 Component outlines.

## APPLICATIONS

- General purpose, industrial, power supply, audio-video and lighting
- Smoothing, filtering, buffering at high voltages
- Boards with restricted mounting height, vibration and shock resistant.




## QUICK REFERENCE DATA

| DESCRIPTION | VALUE | |
|---|---|---|
| Case sizes ($\varnothing D_{nom} \times L_{nom}$ in mm) | 6.5 × 18 to 10 × 25 | 10 × 30 to 21 × 40 |
| Rated capacitance range, $C_R$ | 1 to 220 µF | |
| Tolerance on $C_R$ | –10 to +50% | |
| Rated voltage range, $U_R$ | 160 to 450 V | |
| Category temperature range | –40 to +85 °C (450 V: –25 to +85 °C) | |
| Endurance test at 85 °C | 2000 hours | 8000 hours; 450 V: 2000 hours |
| Useful life at 85 °C | 5000 hours | 15000 hours; 450 V: 5000 hours |
| Useful life at 40 °C | 1.4 × $I_R$ applied: 120000 hours | 1.8 × $I_R$ applied: 240000 hours; 450 V: 120000 hours |
| Shelf life at 0 V, 85 °C | 500 hours | 500 hours |
| Based on sectional specification | IEC 384-4/CECC 30300, LL grade | |
| Climatic category IEC 68 (DIN 40040) | 40/085/56 (450 V: 25/085/56); GPF (450 V: HPF) | |

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

Preferred types in **bold**.

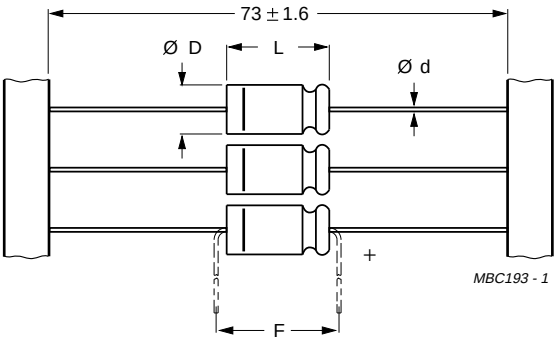
| $C_R$ (μF) | $U_R$ (V) | | | | | |
|---|---|---|---|---|---|---|
| | **160** | **250** | **350** | **385** | **400** | **450** |
| **1.0** | – | – | – | **6.5 × 18** | – | – |
| **2.2** | – | **6.5 × 18** | – | **8 × 18** | – | – |
| **4.7** | 6.5 × 18 | 8 × 18 | **10 × 18** | **10 × 25** | – | – |
| 6.8 | – | – | 10 × 30 | 10 × 30 | 10 × 30 | 10 × 30 |
| **10** | 8 × 18 | **10 × 25** | **12.5 × 30** | **12.5 × 30** | **12.5 × 30** | **12.5 × 30** |
| | – | **10 × 30** | – | – | – | – |
| 15 | – | 12.5 × 30 | 12.5 × 30 | 15 × 30 | 15 × 30 | 12.5 × 30 |
| **22** | 10 × 25 | **12.5 × 30** | **15 × 30** | **18 × 30** | **18 × 30** | **15 × 30** |
| | **10 × 30** | – | – | – | – | – |
| 33 | 12.5 × 30 | 15 × 30 | 18 × 30 | 18 × 40 | 18 × 40 | 18 × 30 |
| **47** | **15 × 30** | **18 × 30** | **18 × 40** | **18 × 40** | **18 × 40** | **18 × 40** |
| 68 | 15 × 30 | 18 × 40 | 21 × 40 | 21 × 40 | 21 × 40 | 21 × 40 |
| **100** | **18 × 30** | **21 × 40** | – | – | – | – |
| 150 | 18 × 40 | – | – | – | – | – |
| **220** | **21 × 40** | – | – | – | – | – |

**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 62"*
- Rated voltage (in V)
- Group number (041, 042 or 043)
- Name of manufacturer (PHILIPS)
- Date code, in accordance with *"IEC 62"*
- Code indicating factory of origin
- Band to identify the negative terminal
- "+" sign to indicate the positive terminal.

## MECHANICAL DATA, AVAILABLE FORMS AND PACKAGING QUANTITIES




Dimensions in mm.

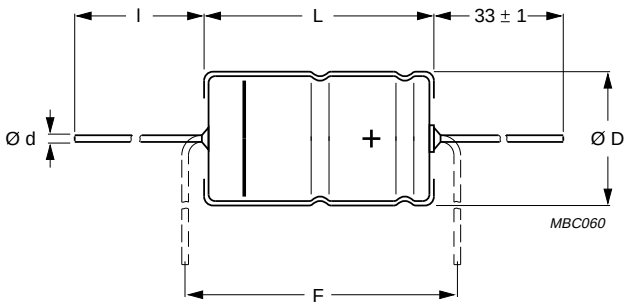
**Form BR:** Taped on reel,
**case ∅D × L = 6.5 × 18 to 15 × 30 mm**.

**Form BA:** Taped in box (ammopack),
**case ∅D × L = 6.5 × 18 to 10 × 25 mm**.

For dimensions see Table 1.

Tape dimensions are specified in this handbook, section *"Packaging".*

Fig.2 Dimensional outline; Forms BA and BR.




Dimensions in mm.

**Form AA:** Axial in box,
**case ∅D × L = 10 × 30 to 21 × 40 mm**

For dimensions see Table 1.

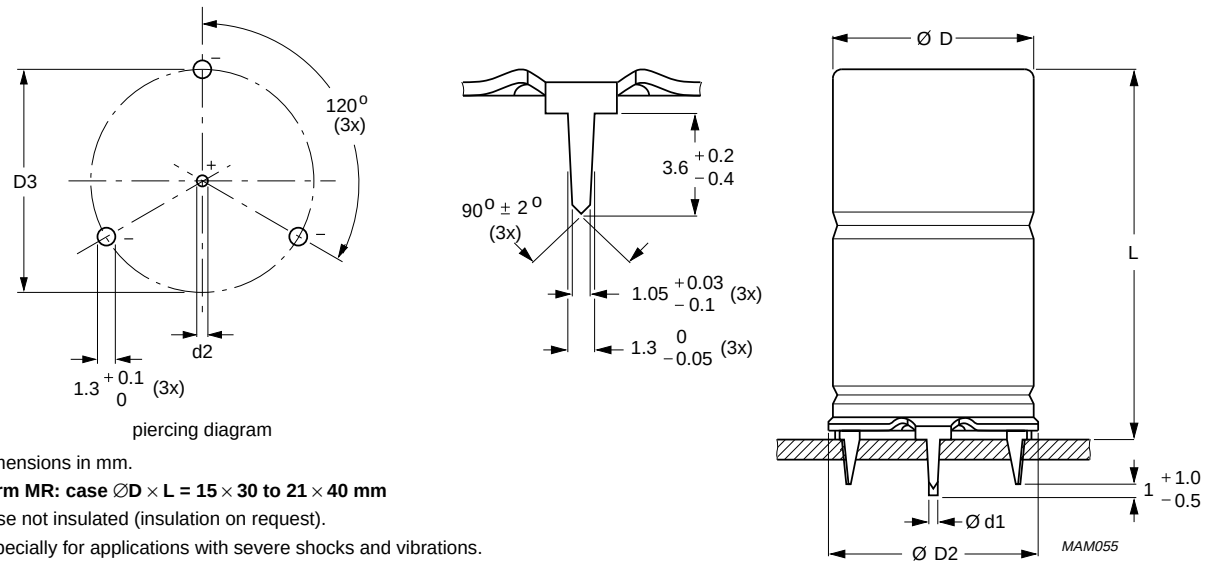
Tape dimensions are specified in this handbook, section *"Packaging".*

For case sizes 18 × 40 mm and 21 × 40 mm, the stated L may be exceeded by 0.7 mm.

Fig.3 Dimensional outline; Form AA.

**Table 1 Axial;** physical dimensions, mass and packaging information; see Figs 2 and 3

| NOMINAL CASE SIZE ∅D × L (mm) | CASE CODE | AXIAL: FORM AA, BA, and BR | | | | | MASS (g) | PACKAGING QUANTITIES | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ∅d (mm) | l (mm) | $\varnothing D_{max}$ (mm) | $L_{max}$ (mm) | $F_{min}$ (mm) | | FORM AA | FORM BA | FORM BR |
| 6.5 × 18 | 4 | 0.8 | – | 6.9 | 18.5 | 25 | ≈1.3 | – | 1000 | 1000 |
| 8 × 18 | 5 | 0.8 | – | 8.5 | 18.5 | 25 | ≈1.7 | – | 500 | 500 |
| 10 × 18 | 6 | 0.8 | – | 10.5 | 18.5 | 25 | ≈2.5 | – | 500 | 500 |
| 10 × 25 | 7 | 0.8 | – | 10.5 | 25.0 | 30 | ≈3.3 | – | 500 | 500 |
| 10 × 30 | 00 | 0.8 | 55 ±1 | 10.5 | 30.5 | 35 | ≈4.8 | 200 | – | 500 |
| 12.5 × 30 | 01 | 0.8 | 55 ±1 | 13.0 | 30.5 | 35 | ≈7.4 | 200 | – | 400 |
| 15 × 30 | 02 | 0.8 | 55 ±1 | 15.5 | 30.5 | 35 | ≈11.7 | 200 | – | 250 |
| 18 × 30 | 03 | 0.8 | 55 ±1 | 18.5 | 30.5 | 35 | ≈12.9 | 200 | – | – |
| 18 × 40 | 04 | 0.8 | 34 ±1 | 18.5 | 41.5 | 45 | ≈19.4 | 100 | – | – |
| 21 × 40 | 05 | 0.8 | 34 ±1 | 21.5 | 41.5 | 45 | ≈24.7 | 100 | – | – |




Dimensions in mm.
**Form MR: case ∅D × L = 15 × 30 to 21 × 40 mm**
Case not insulated (insulation on request).
Especially for applications with severe shocks and vibrations.
For dimensions see Table 2.

Fig.4 Piercing diagram and outline; Form MR; single ended with mounting ring and pins.

**Table 2 Single ended;** physical dimensions, mass and packaging information; see Fig.4

| NOMINAL CASE SIZE ∅D × L (mm) | CASE CODE | SINGLE ENDED WITH MOUNTING RING: FORM MR | | | | | | MASS (g) | PACKAGING QUANTITIES |
|---|---|---|---|---|---|---|---|---|---|
| | | $\varnothing D_1$ (mm) | $\varnothing D_2$ (mm) | $\varnothing D_{max}$ (mm) | $\varnothing D2_{max}$ (mm) | D3 (mm) | $L_{max}$ (mm) | | |
| 15 × 30 | 02 | 0.8 | 1.0 +0.4 | 15.5 | 17.5 | 16.5 ±0.2 | 33 | ≈11.7 | 200 |
| 18 × 30 | 03 | 0.8 | 1.0 +0.4 | 18.5 | 19.5 | 18.5 ±0.2 | 33 | ≈12.9 | 200 |
| 18 × 40 | 04 | 0.8 | 1.0 +0.4 | 18.5 | 19.5 | 18.5 ±0.2 | 45 | ≈19.4 | 100 |
| 21 × 40 | 05 | 0.8 | 1.0 +0.4 | 21.5 | 22.5 | 21.5 ±0.2 | 45 | ≈24.7 | 100 |

## ELECTRICAL DATA AND ORDERING INFORMATION

Unless otherwise specified, all electrical values in Table 3 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 –10 to +50% |
| $I_R$ | rated RMS ripple current at 100 Hz, 85 °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 $\delta_{max}$ and $C_R$) |
| Z | max. impedance at 10 kHz |

**Ordering example**

Electrolytic capacitor ASH 041

10 µF/250 V; –10/+50%

Nominal case size: ∅10 × 25 mm; Form BA

Catalogue number: 2222 041 33109.

**Table 3** 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 85 °C (mA) | $I_{L1}$ 1 min (µA) | $I_{L5}$ 5 min (µA) | Tan δ 100 Hz | ESR 100 Hz (Ω) | Z 10 kHz (Ω) | CATALOGUE NUMBER 2222 ... ..... | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | AXIAL | | | SINGLE ENDED |
| | | | | | | | | | | IN BOX FORM AA | TAPED ON REEL FORM BR | TAPED IN BOX FORM BA | MOUNTING RING FORM MR |
| 160 | 4.7 | 6.5 × 18 | 4 | 50 | 38 | 8 | 0.15 | 51 | 26 | – | 041 21478 | 041 31478 | – |
| | 10 | 8 × 18 | 5 | 70 | 68 | 14 | 0.15 | 24 | 12 | – | 041 21109 | 041 31109 | – |
| | 22 | 10 × 25 | 7 | 150 | 130 | 25 | 0.15 | 11 | 5.5 | – | 041 21229 | 041 31229 | – |
| | **22** | **10 × 30** | **00** | 120 | 42 | 25 | 0.10 | 6.8 | 5.5 | **042 11229** | **042 21229** | – | – |
| | 33 | 12.5 × 30 | 01 | 150 | 58 | 36 | 0.10 | 4.5 | 3.1 | 042 11339 | 042 21339 | – | – |
| | **47** | **15 × 30** | **02** | 190 | 78 | 49 | 0.10 | 3.2 | 2.1 | **042 11479** | **042 21479** | – | **042 41479** |
| | 68 | 15 × 30 | 02 | 230 | 110 | 69 | 0.10 | 2.2 | 1.4 | 042 11689 | 042 21689 | – | 042 41689 |
| | **100** | **18 × 30** | **03** | 350 | 150 | 100 | 0.10 | 1.5 | 1.0 | **042 11101** | – | – | **042 41101** |
| | 150 | 18 × 40 | 04 | 430 | 230 | 150 | 0.10 | 1.0 | 0.7 | 043 11151 | – | – | 043 41151 |
| | **220** | **21 × 40** | **05** | 610 | 330 | 220 | 0.10 | 0.7 | 0.5 | **043 11221** | – | – | **043 41221** |
| 250 | **2.2** | **6.5 × 18** | **4** | 35 | 28 | 6 | 0.10 | 72 | 50 | – | 041 23228 | **041 33228** | – |
| | 4.7 | 8 × 18 | 5 | 55 | 55 | 11 | 0.10 | 34 | 23 | – | 041 23478 | 041 33478 | – |
| | **10** | **10 × 25** | **7** | 90 | 95 | 19 | 0.10 | 16 | 11 | – | 041 23109 | **041 33109** | – |
| | **10** | **10 × 30** | **00** | 72 | 33 | 19 | 0.10 | 15 | 11 | **042 13109** | **042 23109** | – | – |

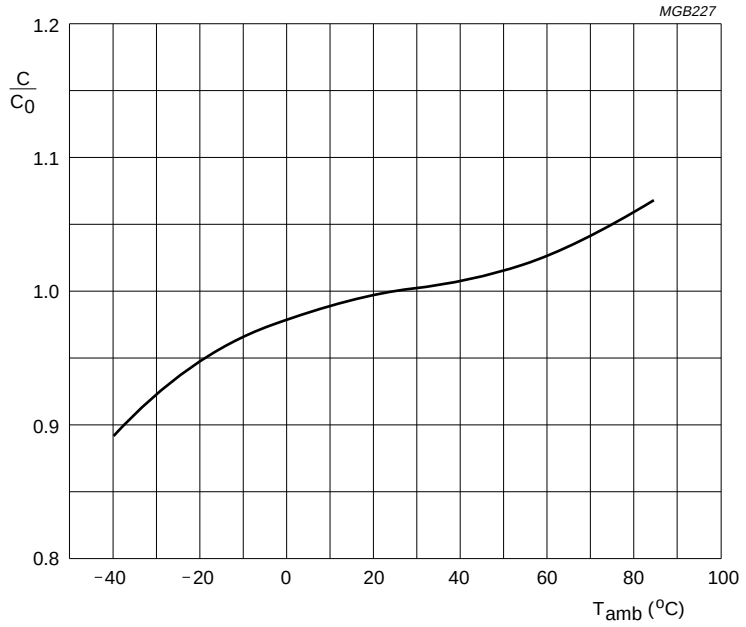
| $U_R$ (V) | $C_R$ 100 Hz (μF) | NOMINAL CASE SIZE ∅D × L (mm) | CASE CODE | $I_R$ 100 Hz 85 °C (mA) | $I_{L1}$ 1 min (μA) | $I_{L5}$ 5 min (μA) | Tan δ 100 Hz | ESR 100 Hz (Ω) | Z 10 kHz (Ω) | CATALOGUE NUMBER 2222 ... ..... | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | AXIAL | | | SINGLE ENDED |
| | | | | | | | | | | IN BOX FORM AA | TAPED ON REEL FORM BR | TAPED IN BOX FORM BA | MOUNTING RING FORM MR |
| 250 | 15 | 12.5 × 30 | 01 | 100 | 44 | 27 | 0.10 | 10 | 7.4 | 042 13159 | 042 23159 | – | – |
| | **22** | **12.5 × 30** | **01** | 130 | 60 | 37 | 0.10 | 6.8 | 5.0 | **042 13229** | **042 23229** | – | – |
| | 33 | 15 × 30 | 02 | 160 | 84 | 54 | 0.10 | 4.5 | 3.4 | 042 13339 | 042 23339 | – | 042 43339 |
| | **47** | **18 × 30** | **03** | 220 | 120 | 75 | 0.10 | 3.2 | 2.3 | **042 13479** | – | – | **042 43479** |
| | 68 | 18 × 40 | 04 | 290 | 160 | 110 | 0.10 | 2.2 | 1.7 | 043 13689 | – | – | 043 43689 |
| | **100** | **21 × 40** | **05** | 390 | 240 | 150 | 0.10 | 1.5 | 1.1 | **043 13101** | – | – | **043 43101** |
| 350 | **4.7** | **10 × 18** | **6** | 60 | 69 | 14 | 0.10 | 34 | 22 | – | 041 25478 | **041 35478** | – |
| | 6.8 | 10 × 30 | 00 | 60 | 32 | 18 | 0.10 | 22 | 14 | 042 15688 | 042 25688 | – | – |
| | **10** | **12.5 × 30** | **01** | 90 | 42 | 25 | 0.10 | 15 | 10 | **042 15109** | **042 25109** | – | – |
| | 15 | 12.5 × 30 | 01 | 100 | 57 | 36 | 0.10 | 10 | 6.7 | 042 15159 | 042 25159 | – | – |
| | **22** | **15 × 30** | **02** | 140 | 79 | 50 | 0.10 | 6.8 | 4.5 | **042 15229** | **042 25229** | – | **042 45229** |
| | 33 | 18 × 30 | 03 | 160 | 110 | 73 | 0.10 | 4.5 | 3.1 | 042 15339 | – | – | 042 45339 |
| | **47** | **18 × 40** | **04** | 270 | 160 | 100 | 0.10 | 3.2 | 2.1 | **043 15479** | – | – | **043 45479** |
| | 68 | 21 × 40 | 05 | 320 | 220 | 150 | 0.10 | 2.2 | 1.4 | 043 15689 | – | – | 043 45689 |
| 385 | **1** | **6.5 × 18** | **4** | 20 | 19 | 4 | 0.10 | 160 | 100 | – | 041 28108 | **041 38108** | – |
| | **2.2** | **8 × 18** | **5** | 40 | 42 | 8 | 0.10 | 72 | 45 | – | 041 28228 | **041 38228** | – |
| | **4.7** | **10 × 25** | **7** | 70 | 71 | 15 | 0.10 | 34 | 22 | – | 041 28478 | **041 38478** | – |
| | 6.8 | 10 × 30 | 00 | 60 | 34 | 20 | 0.10 | 22 | 14 | 042 18688 | 042 28688 | – | – |
| | **10** | **12.5 × 30** | **01** | 90 | 45 | 27 | 0.10 | 15 | 10 | **042 18109** | **042 28109** | – | – |
| | 15 | 15 × 30 | 02 | 110 | 62 | 39 | 0.10 | 10 | 6.0 | 042 18159 | 042 28159 | – | 042 48159 |
| | **22** | **18 × 30** | **03** | 150 | 86 | 55 | 0.10 | 6.8 | 4.1 | **042 18229** | – | – | **042 48229** |
| | 33 | 18 × 40 | 04 | 200 | 120 | 80 | 0.10 | 4.5 | 2.7 | 043 18339 | – | – | 043 48339 |
| | **47** | **18 × 40** | **04** | 270 | 170 | 110 | 0.10 | 3.2 | 2.1 | **043 18479** | – | – | **043 48479** |
| | 68 | 21 × 40 | 05 | 320 | 250 | 160 | 0.10 | 2.2 | 1.4 | 043 18689 | – | – | 043 48689 |

| $U_R$ (V) | $C_R$ 100 Hz (μF) | NOMINAL CASE SIZE ∅D × L (mm) | CASE CODE | $I_R$ 100 Hz 85 °C (mA) | $I_{L1}$ 1 min (μA) | $I_{L5}$ 5 min (μA) | Tan δ 100 Hz | ESR 100 Hz (Ω) | Z 10 kHz (Ω) | CATALOGUE NUMBER 2222 ... ..... | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | AXIAL | | | SINGLE ENDED |
| | | | | | | | | | | IN BOX FORM AA | TAPED ON REEL FORM BR | TAPED IN BOX FORM BA | MOUNTING RING FORM MR |
| 400 | 6.8 | 10 × 30 | 00 | 82 | 220 | 110 | 0.055 | 11.5 | 7.3 | 042 16688 | 042 26688 | – | – |
| | **10** | **12.5 × 30** | **01** | 130 | 240 | 110 | 0.055 | 7.5 | 4.6 | **042 16109** | **042 26109** | – | – |
| | 15 | 15 × 30 | 02 | 160 | 250 | 110 | 0.055 | 5.0 | 3.1 | 042 16159 | 042 26159 | – | 042 46159 |
| | **22** | **18 × 30** | **03** | 210 | 280 | 120 | 0.055 | 3.5 | 2.1 | **042 16229** | – | – | **042 46229** |
| | 33 | 18 × 40 | 04 | 290 | 320 | 130 | 0.055 | 2.3 | 1.4 | 043 16339 | – | – | 043 46339 |
| | **47** | **18 × 40** | **04** | 330 | 370 | 140 | 0.055 | 1.7 | 1.1 | **043 16479** | – | – | **043 46479** |
| | 68 | 21 × 40 | 05 | 430 | 440 | 150 | 0.055 | 1.2 | 0.7 | 043 16689 | – | – | 043 46689 |
| 450 | 6.8 | 10 × 30 | 00 | 60 | 230 | 110 | 0.10 | 22 | 14 | 042 17688 | 042 27688 | – | – |
| | **10** | **12.5 × 30** | **01** | 90 | 240 | 110 | 0.10 | 15 | 10 | **042 17109** | **042 27109** | – | – |
| | 15 | 12.5 × 30 | 01 | 100 | 260 | 110 | 0.10 | 10 | 6 | 042 17159 | 042 27159 | – | – |
| | **22** | **15 × 30** | **02** | 140 | 290 | 120 | 0.10 | 6.8 | 4.1 | **042 17229** | **042 27229** | – | **042 47229** |
| | 33 | 18 × 30 | 03 | 190 | 330 | 130 | 0.10 | 4.5 | 2.7 | 042 17339 | – | – | 042 47339 |
| | **47** | **18 × 40** | **04** | 250 | 390 | 140 | 0.10 | 3.2 | 2.1 | **043 17479** | – | – | **043 47479** |
| | 68 | 21 × 40 | 05 | 330 | 460 | 160 | 0.10 | 2.2 | 1.4 | 043 17689 | – | – | 043 47689 |

**Additional electrical data**

| PARAMETER | CONDITIONS | VALUE | |
|---|---|---|---|
| | | AXIAL | SINGLE ENDED |
| **Voltage** | | | |
| Surge voltage for short periods | $U_R$ = 160 to 250 V | $U_S \leq 1.15 \times U_R$ | |
| | $U_R$ = 350 to 450 V | $U_S \leq 1.1 \times U_R$ | |
| Reverse voltage | | $U_{rev} \leq 1$ V | |
| **Current** | | | |
| Leakage current | after 1 minute:<br>case ∅D × L = 6.5 × 18 to 10 × 25 mm<br>CV ≤ 1000 µC<br>CV > 1000 µC<br>case ∅D × L = 10 × 30 to 21 × 40 mm<br>$U_R$ = 160 to 385 V<br>$U_R$ = 400 and 450 V | <br><br>$I_{L1} \leq 0.05C_R \times U_R$ or 5 µA, whichever is greater<br>$I_{L1} \leq 0.03C_R \times U_R$ + 20 µA<br><br>$I_{L1} \leq 0.009C_R \times U_R$ + 10 µA<br>$I_{L1} \leq 0.009C_R \times U_R$ + 200 µA | |
| | after 5 minutes:<br>$U_R$ = 160 to 385 V<br>CV ≤ 1000 µC<br>CV > 1000 µC<br>$U_R$ = 400 and 450 V | <br><br>$I_{L5} \leq 0.01C_R \times U_R$ or 1 µA, whichever is greater<br>$I_{L5} \leq 0.006C_R \times U_R$ + 4 µA<br>$I_{L5} \leq 0.002C_R \times U_R$ + 100 µA | |
| **Inductance** | | | |
| Equivalent series inductance (ESL) | case ∅D × L mm:<br>6.5 × 18<br>8 × 18<br>10 × 18<br>10 × 25<br>10 × 30<br>12.5 × 30<br>15 × 30<br>18 × 30<br>18 × 40<br>21 × 40 | <br>typ. 15 nH<br>typ. 35 nH<br>typ. 69 nH<br>typ. 38 nH<br>typ. 38 nH<br>typ. 46 nH<br>typ. 48 nH<br>typ. 50 nH<br>typ. 54 nH<br>typ. 59 nH | <br>–<br>–<br>–<br>–<br>–<br>–<br>typ. 39 nH<br>typ. 39 nH<br>typ. 39 nH<br>typ. 39 nH |

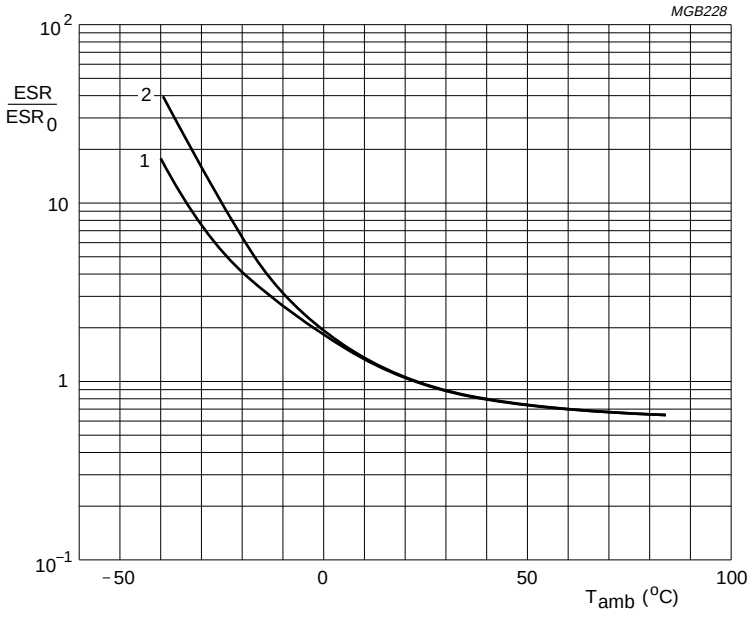
**Capacitance (C)**




$C_0$ = capacitance at 20 °C, 100 Hz.

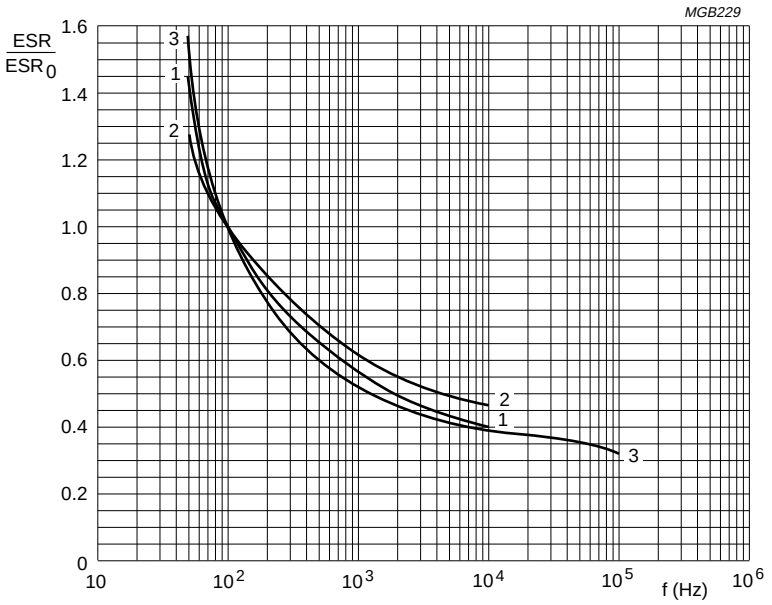
Fig.5 Typical multiplier of capacitance as a function of ambient temperature

**Equivalent series resistance (ESR)**




Curve 1: **case ∅D × L = 10 × 30 to 21 × 40 mm**.
Curve 2: **case ∅D × L = 6.5 × 18 to 10 × 25 mm**.
$ESR_0$ = typical at 20 °C, 100 Hz.

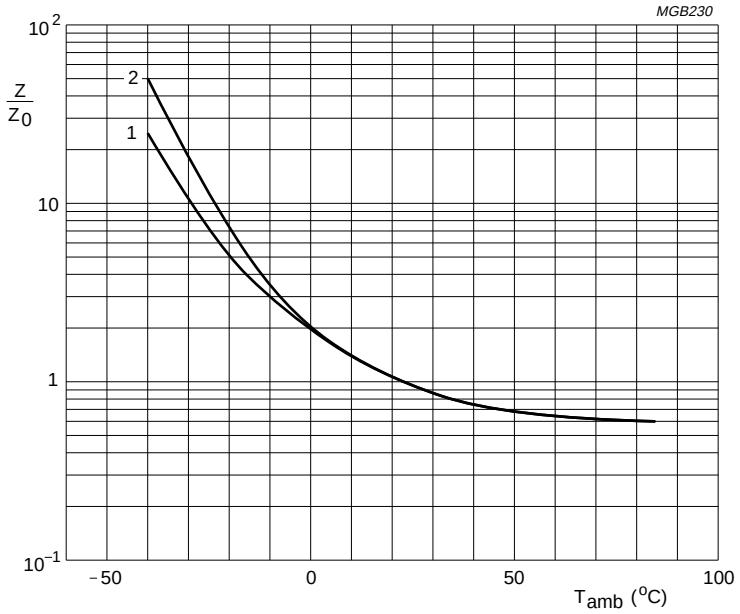
Fig.6 Typical multiplier of ESR as a function of ambient temperature.




Curve 1: **case ∅D × L = 10 × 30 mm**.
Curve 2: **case ∅D × L = 21 × 40 mm**.
Curve 3: **case ∅D × L = 6.5 × 18 to 10 × 25 mm**.
$ESR_0$ = typical at 20 °C, 100 Hz.

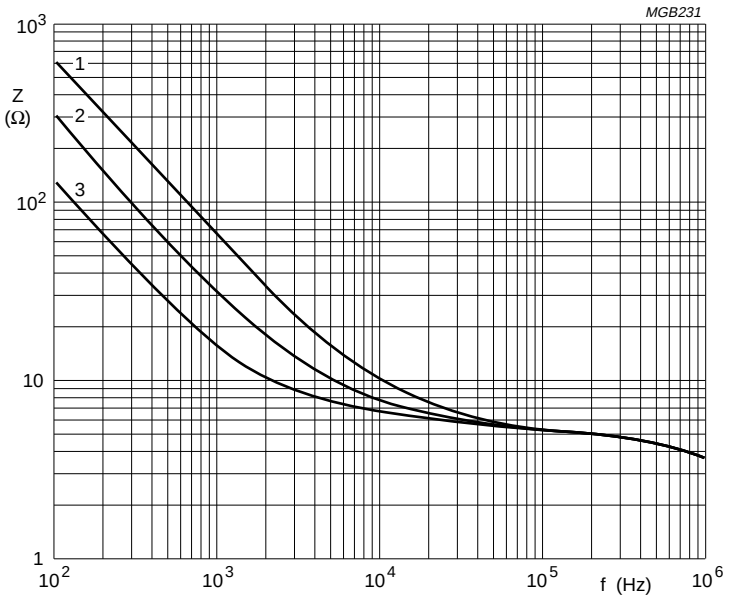
Fig.7 Typical multiplier of ESR as a function of frequency.

**Impedance (Z)**



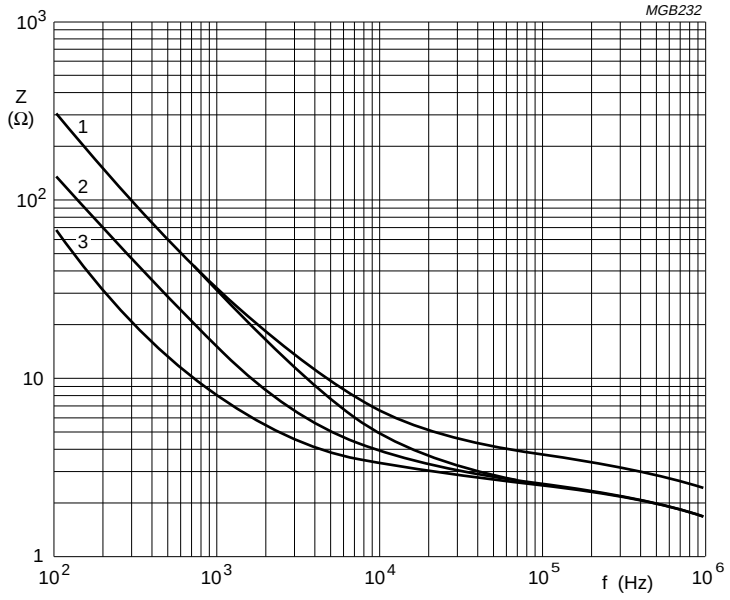

Curve 1: **case ∅D × L = 10 × 30 to 21 × 40 mm**.
Curve 2: **case ∅D × L = 6.5 × 18 to 10 × 25 mm**.
$Z_0$ = impedance at 20 °C, 10 kHz.

Fig.8 Typical multiplier of impedance as a function of ambient temperature.



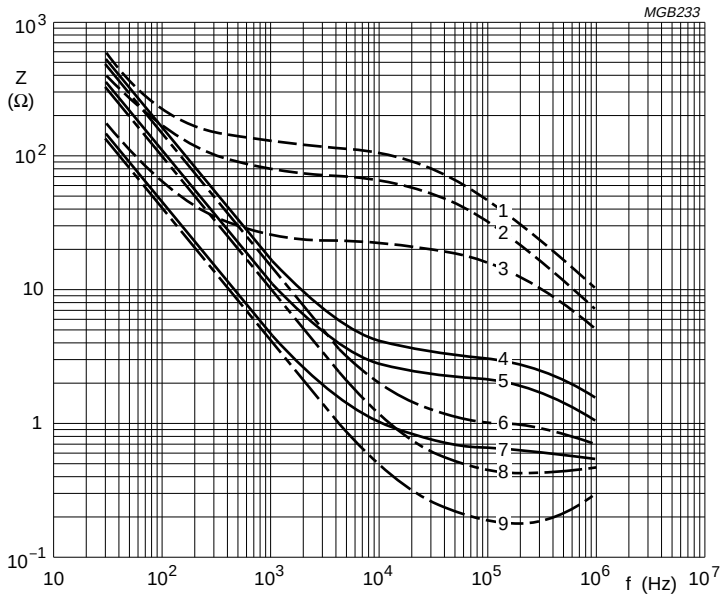

Curve 1: 2.2 μF.
Curve 2: 4.7 μF.
Curve 3: 10 μF.
**Case ∅D × L = 8 × 18 mm**.
$T_{amb}$ = 20 °C.

Fig.9 Typical impedance as a function of frequency.




Curve 1: 4.7 μF.
Curve 2: 10 μF.
Curve 3: 22 μF.
**Case ∅D × L = 10 × 18 and 10 × 25 mm**.
$T_{amb}$ = 20 °C.

Fig.10 Typical impedance as a function of frequency.



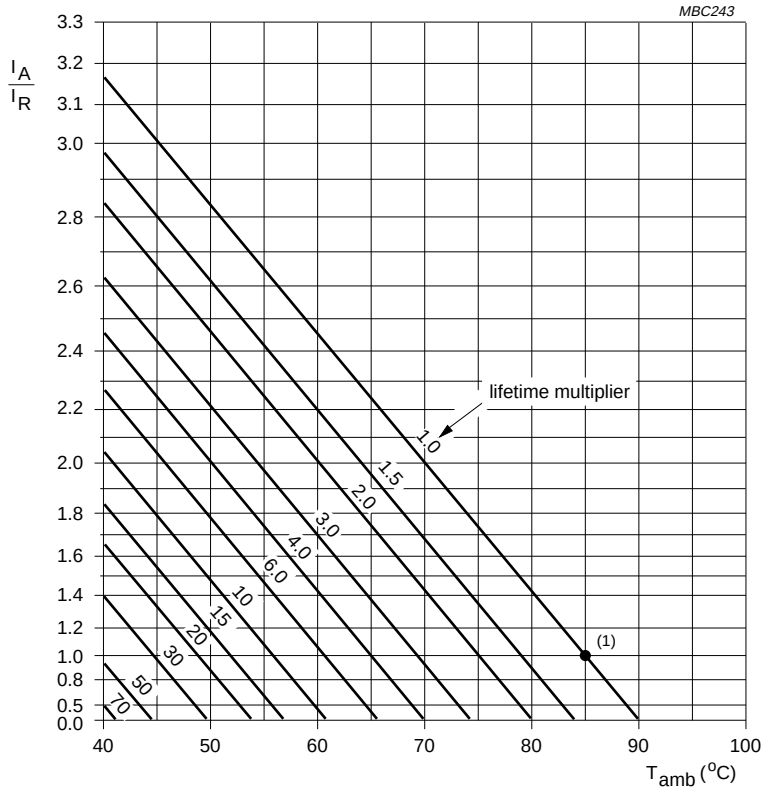

Curve 1: 10 µF, 350 and 385 V; –40 °C.
Curve 2: 15 µF, 250 V; –40 °C.
Curve 3: 33 µF, 160 V; –40 °C.
Curve 4: 10 µF, 350 and 385 V; 20 °C.
Curve 5: 15 µF, 250 V; 20 °C.
Curve 6: 33 µF, 160 V; 20 °C.
Curve 7: 10 µF, 350 and 385 V; 85 °C.
Curve 8: 15 µF, 250 V; 85 °C.
Curve 9: 33 µF, 160 V; 85 °C.
**Case ∅D × L = 12.5 × 30 mm**.

Fig.11 Typical impedance as a function of frequency at different ambient temperatures.

### RIPPLE CURRENT AND USEFUL LIFE

**Table 4** Multiplier of ripple current ($I_R/I_{RO}$) as a function of frequency; $I_{RO}$ = ripple current at 85 °C, 100 Hz

| FREQUENCY (Hz) | $I_R$ MULTIPLIER |
|---|---|
| 50 | 0.75 |
| 100 | 1.0 |
| 300 | 1.15 |
| 1000 | 1.3 |
| 3000 | 1.4 |
| ≥10000 | 1.5 |




$I_A$ = actual ripple current at 100 Hz.

$I_R$ = rated ripple current at 100 Hz, 85 °C.

(1) Useful life at 85 °C and $I_R$ applied;
**case ∅D × L = 6.5 × 18 to 10 × 25 mm**: 5000 hours
**case ∅D × L = 10 × 30 to 21 × 40 mm**: 15000 hours (450 V: 5000 hours).

Fig.12 Multiplier of useful life as a function of ambient temperature and ripple current load.

**SPECIFIC TESTS AND REQUIREMENTS**

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

**Table 5** Test procedures and requirements

| TEST | | PROCEDURE (quick reference) | REQUIREMENTS |
|---|---|---|---|
| **NAME OF TEST** | **REFERENCE** | | |
| Endurance | IEC 384-4/ CECC 30300 subclause 4.13 | $T_{amb}$ = 85 °C; $U_R$ applied; case ∅D × L: 6.5 × 18 to 10 × 25 mm: 2000 hours; 10 × 30 to 21 × 40 mm: 8000 hours (450 V: 2000 hours) | $U_R$ = 160 V; ΔC/C: ±15%<br>$U_R$ = 250 to 450 V; ΔC/C: ±10%<br>tan δ ≤ 1.3 × spec. limit<br>Z ≤ 2 × spec. limit<br>$I_{L5}$ ≤ spec. limit |
| Useful life | CECC 30301 subclause 1.8.1 | $T_{amb}$ = 85 °C; $U_R$ and $I_R$ applied; case ∅D × L: 6.5 × 18 to 10 × 25 mm: 5000 hours; 10 × 30 to 21 × 40 mm: 15000 hours (450 V: 5000 hours) | $U_R$ = 160 V; ΔC/C: ±45%<br>$U_R$ = 250 to 450 V; ΔC/C: ±30%<br>tan δ ≤ 3 × spec. limit<br>Z ≤ 3 × spec. limit<br>$I_{L5}$ ≤ spec. limit<br>no short or open circuit<br>total failure percentage: ≤3% |
| Shelf life (storage at high temperature) | IEC 384-4/ CECC 30300 subclause 4.17 | $T_{amb}$ = 85 °C; no voltage applied; 500 hours; after test: $U_R$ to be applied for 30 minutes, 24 to 48 hours before measurement | ΔC/C, tan δ, Z: for requirements, see 'Endurance test' above<br>$I_{L5}$ ≤ 2 × spec. limit |