

## Aluminum Electrolytic Capacitors Axial Standard, High Voltage

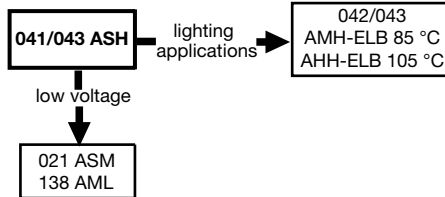


Fig. 1

| QUICK REFERENCE DATA                               |  |
|--|--|
| DESCRIPTION  | VALUE  |
| Nominal case sizes<br>( $\varnothing$ D x L in mm) | 8 x 18 to 10 x 25      10 x 30 to 21 x 38  |
| Rated capacitance range, $C_R$                     | 6.8 $\mu$ F to 220 $\mu$ F   |
| Tolerance on $C_R$                                 | -10 % to +50 %   |
| Rated voltage range, $U_R$                         | 160 V to 450 V   |
| Category temperature range                         | -40 °C to +85 °C<br>(450 V: -25 °C to +85 °C)  |
| Endurance test at 85 °C                            | 2000 h      8000 h<br>(450 V: 5000 h)  |
| Useful life at 85 °C                               | 5000 h      15 000 h<br>(450 V: 10 000 h)  |
| Useful life at 40 °C                               | 1.4 x $I_R$ applied: 120 000 h      1.8 x $I_R$ applied: 240 000 h<br>(450 V: 160 000 h) |
| Shelf life at 0 V, 85 °C                           | 500 h  |
| Based on sectional specification                   | IEC 60384-4 / EN130300   |
| Climatic category IEC 60068                        | 40 / 085 / 56 (450 V: 25 / 085 / 56)   |

### FEATURES

- Useful life: 5000 h to 15 000 h at 85 °C
- High rated voltage: up to 450 V
- Taped versions up to case  $\varnothing$  15 mm x 30 mm available for automatic insertion
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not available in insulated form
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS  
COMPLIANT**

### APPLICATIONS

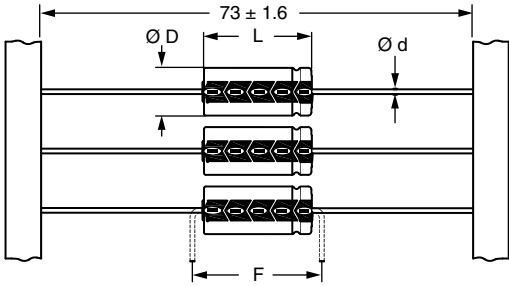
- General purpose, industrial, power supply, audio-video
- Smoothing, filtering, buffering at high voltages
- Boards with restricted mounting height, vibration, and shock resistant

### MARKING

The capacitors are marked (where possible) with the following information:

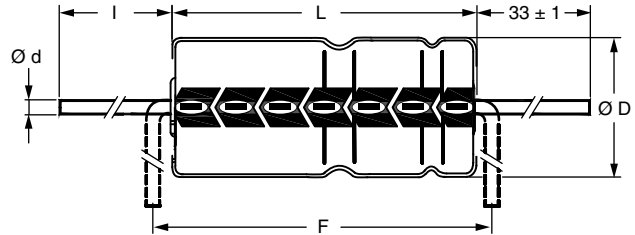
- Rated capacitance (in  $\mu$ F)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (T for -10 % to +50 %)
- Rated voltage (in V)
- Upper category temperature (85 °C)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (041, 042 or 043)

| SELECTION CHART FOR $C_R$ , $U_R$ , AND RELEVANT NOMINAL CASE SIZES ( $\varnothing$ D x L in mm) |           |           |           |           |           |           |
|--|-----------|-----------|-----------|-----------|-----------|-----------|
| $C_R$<br>( $\mu$ F)  | $U_R$ (V) |           |           |           |           |           |
|  | 160       | 250       | 350       | 385       | 400       | 450       |
| 6.8  | -         | -         | 10 x 30   | 10 x 30   | 10 x 30   | 10 x 30   |
| 10   | 8 x 18    | -         | 12.5 x 30 | 12.5 x 30 | 12.5 x 30 | 12.5 x 30 |
|  | -         | 10 x 30   | -         | -         | -         | -         |
| 15   | -         | 12.5 x 30 | 12.5 x 30 | 15 x 30   | 15 x 30   | 12.5 x 30 |
| 22   | 10 x 25   | 12.5 x 30 | 15 x 30   | 18 x 30   | 18 x 30   | 15 x 30   |
|  | 10 x 30   | -         | -         | -         | -         | -         |
| 33   | 12.5 x 30 | 15 x 30   | 18 x 30   | 18 x 38   | 18 x 38   | 18 x 30   |
| 47   | 15 x 30   | 18 x 30   | 18 x 38   | 18 x 38   | 18 x 38   | 18 x 38   |
| 68   | 15 x 30   | 18 x 38   | 21 x 38   | 21 x 38   | 21 x 38   | 21 x 38   |
| 100  | 18 x 30   | 21 x 38   | -         | -         | -         | -         |
| 150  | 18 x 38   | -         | -         | -         | -         | -         |
| 220  | 21 x 38   | -         | -         | -         | -         | -         |

**DIMENSIONS in millimeters AND AVAILABLE FORMS**


**Form BR:** Taped on reel  
Case  $\text{Ø D} \times \text{L} = 8 \text{ mm} \times 18 \text{ mm}$  to  $15 \text{ mm} \times 30 \text{ mm}$   
**Form BA:** Taped in box (ammopack)  
Case  $\text{Ø D} \times \text{L} = 8 \text{ mm} \times 18 \text{ mm}$  to  $10 \text{ mm} \times 25 \text{ mm}$

Fig. 2 - Forms BA and BR



**Form AA:** Axial in box  
Case  $\text{Ø D} \times \text{L} = 10 \text{ mm} \times 30 \text{ mm}$  to  $21 \text{ mm} \times 38 \text{ mm}$

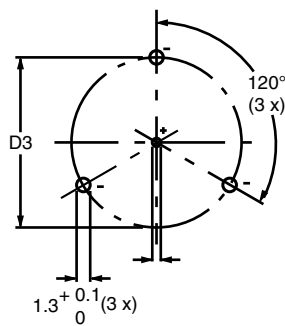
Fig. 3 - Form AA

Table 1

| <b>AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES</b> |           |                            |            |                            |                   |                   |          |                      |         |         |
|--|-----------|----------------------------|------------|----------------------------|-------------------|-------------------|----------|----------------------|---------|---------|
| NOMINAL CASE SIZE<br>$\text{Ø D} \times \text{L}$                      | CASE CODE | AXIAL: FORM AA, BA, AND BR |            |                            |                   |                   | MASS (g) | PACKAGING QUANTITIES |         |         |
|  |           | $\text{Ø d}$               | l          | $\text{Ø D}_{\text{max.}}$ | $L_{\text{max.}}$ | $F_{\text{min.}}$ |          | FORM AA              | FORM BA | FORM BR |
| 8 x 18   | 5         | 0.8                        | -          | 8.5                        | 18.5              | 25                | ≈ 1.7    | -                    | 500     | 500     |
| 10 x 18  | 6         | 0.8                        | -          | 10.5                       | 18.5              | 25                | ≈ 2.5    | -                    | 500     | 500     |
| 10 x 25  | 7         | 0.8                        | -          | 10.5                       | 25.5              | 30                | ≈ 3.3    | -                    | 500     | 500     |
| 10 x 30  | 00        | 0.8                        | $55 \pm 1$ | 10.5                       | 30.5              | 35                | ≈ 4.8    | 340                  | -       | 500     |
| 12.5 x 30  | 01        | 0.8                        | $55 \pm 1$ | 13.0                       | 30.5              | 35                | ≈ 7.4    | 260                  | -       | 400     |
| 15 x 30  | 02        | 0.8                        | $55 \pm 1$ | 15.5                       | 30.5              | 35                | ≈ 11.7   | 200                  | -       | 250     |
| 18 x 30  | 03        | 0.8                        | $55 \pm 1$ | 18.5                       | 30.5              | 35                | ≈ 12.9   | 120                  | -       | -       |
| 18 x 38  | 04        | 0.8                        | $34 \pm 1$ | 18.5                       | 39.5              | 44                | ≈ 19.0   | 125                  | -       | -       |
| 21 x 38  | 05        | 0.8                        | $34 \pm 1$ | 21.5                       | 39.5              | 44                | ≈ 24.0   | 100                  | -       | -       |

**Note**

- For detailed tape dimensions please refer to packaging information: [www.vishay.com/doc?28361](http://www.vishay.com/doc?28361)



**Form MR:**  
Case  $\text{Ø D} \times \text{L} = 15 \text{ mm} \times 30 \text{ mm}$  to  $21 \text{ mm} \times 38 \text{ mm}$   
Especially for applications with severe shocks and vibrations

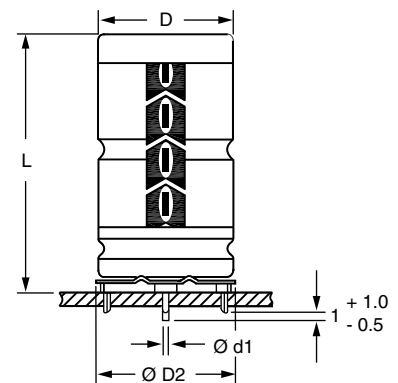
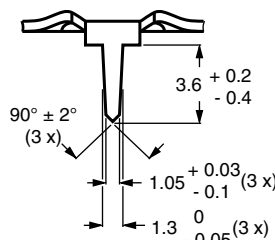

 Fig. 4 - Mounting hole diagram and outline. **Form MR:** With mounting ring and pins

Table 2

| <b>MOUNTING RING; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES</b> |           |                        |               |                            |                             |                |          |                      |                   |
|--|-----------|------------------------|---------------|----------------------------|-----------------------------|----------------|----------|----------------------|-------------------|
| NOMINAL CASE SIZE<br>$\text{Ø D} \times \text{L}$                              | CASE CODE | MOUNTING RING: FORM MR |               |                            |                             |                | MASS (g) | PACKAGING QUANTITIES |                   |
|  |           | $\text{Ø d1}$          | $\text{Ø d2}$ | $\text{Ø D}_{\text{max.}}$ | $\text{Ø D2}_{\text{max.}}$ | D3             |          |                      | $L_{\text{max.}}$ |
| 15 x 30  | 02        | 0.8                    | $1.0 + 0.4$   | 15.5                       | 17.5                        | $16.5 \pm 0.2$ | 33       | ≈ 11.7               | 200               |
| 18 x 30  | 03        | 0.8                    | $1.0 + 0.4$   | 18.5                       | 19.5                        | $18.5 \pm 0.2$ | 33       | ≈ 12.9               | 240               |
| 18 x 38  | 04        | 0.8                    | $1.0 + 0.4$   | 18.5                       | 19.5                        | $18.5 \pm 0.2$ | 42       | ≈ 19.0               | 100               |
| 21 x 38  | 05        | 0.8                    | $1.0 + 0.4$   | 21.5                       | 22.5                        | $21.5 \pm 0.2$ | 42       | ≈ 24.0               | 100               |



| ELECTRICAL DATA |   |
|-----------------|---|
| 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 min at $U_R$   |
| $I_{L5}$        | Max. leakage current after 5 min 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               | Max. impedance at 10 kHz  |

**ORDERING EXAMPLE**

Electrolytic capacitor 041 series  
 10  $\mu$ F / 250 V; -10 % / +50 %  
 Nominal case size:  $\varnothing$  10 mm x 25 mm; Form BA  
 Ordering code: MAL204133109E3  
 Former 12NC: 2222 041 33109

**Note**

- Unless otherwise specified, all electrical values in Table 3 apply at  $T_{amb} = 20$  °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %.

| ELECTRICAL DATA AND ORDERING INFORMATION |                               |  |              |                                  |                                 |                                 |                         |                               |                             |                             |                         |                             |                            |                             |
|--|-------------------------------|--|--------------|----------------------------------|---------------------------------|---------------------------------|-------------------------|-------------------------------|-----------------------------|-----------------------------|-------------------------|-----------------------------|----------------------------|-----------------------------|
| $U_R$<br>(V)                             | $C_R$<br>100 Hz<br>( $\mu$ F) | NOMINAL<br>CASE<br>SIZE<br>$\varnothing$ D x L<br>(mm) | CASE<br>CODE | $I_R$<br>100 Hz<br>85 °C<br>(mA) | $I_{L1}$<br>1 min<br>( $\mu$ A) | $I_{L5}$<br>5 min<br>( $\mu$ A) | $\tan \delta$<br>100 Hz | ESR<br>100 Hz<br>( $\Omega$ ) | Z<br>10 kHz<br>( $\Omega$ ) | LIFE<br>CODE <sup>(1)</sup> | ORDERING CODE MAL2..... |                             |                            |                             |
|  |                               |  |              |                                  |                                 |                                 |                         |                               |                             |                             | IN BOX<br>FORM AA       | TAPED<br>ON REEL<br>FORM BR | TAPED<br>IN BOX<br>FORM BA | MOUNTING<br>RING<br>FORM MR |
| 160                                      | 10                            | 8 x 18   | 5            | 70                               | 68                              | 14                              | 0.15                    | 24                            | 12                          | L1                          | -                       | 04121109E3                  | 04131109E3                 | -                           |
|  | 22                            | 10 x 25  | 7            | 150                              | 130                             | 25                              | 0.15                    | 11                            | 5.5                         | L1                          | -                       | 04121229E3                  | 04131229E3                 | -                           |
|  | 22                            | 10 x 30  | 00           | 190                              | 42                              | 25                              | 0.10                    | 6.8                           | 5.5                         | L2                          | 04211229E3              | 04221229E3                  | -                          | -                           |
|  | 33                            | 12.5 x 30  | 01           | 270                              | 58                              | 36                              | 0.10                    | 4.5                           | 3.1                         | L2                          | 04211339E3              | 04221339E3                  | -                          | -                           |
|  | 47                            | 15 x 30  | 02           | 350                              | 78                              | 49                              | 0.10                    | 3.2                           | 2.1                         | L2                          | 04211479E3              | 04221479E3                  | -                          | 04241479E3                  |
|  | 68                            | 15 x 30  | 02           | 420                              | 110                             | 69                              | 0.10                    | 2.2                           | 1.4                         | L2                          | 04211689E3              | 04221689E3                  | -                          | 04241689E3                  |
|  | 100                           | 18 x 30  | 03           | 580                              | 150                             | 100                             | 0.10                    | 1.5                           | 1.0                         | L2                          | 04211101E3              | -                           | -                          | 04241101E3                  |
|  | 150                           | 18 x 38  | 04           | 760                              | 230                             | 150                             | 0.10                    | 1.0                           | 0.7                         | L2                          | 04311151E3              | -                           | -                          | 04341151E3                  |
| 220                                      | 21 x 38                       | 05   | 940          | 330                              | 220                             | 0.10                            | 0.7                     | 0.5                           | L2                          | 04311221E3                  | -                       | -                           | 04341221E3                 |                             |
| 250                                      | 10                            | 10 x 30  | 00           | 130                              | 33                              | 19                              | 0.10                    | 15                            | 11                          | L2                          | 04213109E3              | 04223109E3                  | -                          | -                           |
|  | 15                            | 12.5 x 30  | 01           | 180                              | 44                              | 27                              | 0.10                    | 10                            | 7.4                         | L2                          | 04213159E3              | 04223159E3                  | -                          | -                           |
|  | 22                            | 12.5 x 30  | 01           | 220                              | 60                              | 37                              | 0.10                    | 6.8                           | 5.0                         | L2                          | 04213229E3              | 04223229E3                  | -                          | -                           |
|  | 33                            | 15 x 30  | 02           | 290                              | 84                              | 54                              | 0.10                    | 4.5                           | 3.4                         | L2                          | 04213339E3              | 04223339E3                  | -                          | 04243339E3                  |
|  | 47                            | 18 x 30  | 03           | 400                              | 120                             | 75                              | 0.10                    | 3.2                           | 2.3                         | L2                          | 04213479E3              | -                           | -                          | 04243479E3                  |
|  | 68                            | 18 x 38  | 04           | 520                              | 160                             | 110                             | 0.10                    | 2.2                           | 1.7                         | L2                          | 04313689E3              | -                           | -                          | 04343689E3                  |
|  | 100                           | 21 x 38  | 05           | 650                              | 240                             | 150                             | 0.10                    | 1.5                           | 1.1                         | L2                          | 04313101E3              | -                           | -                          | 04343101E3                  |
| 350                                      | 6.8                           | 10 x 30  | 00           | 110                              | 32                              | 18                              | 0.10                    | 22                            | 14                          | L2                          | 04215688E3              | 04225688E3                  | -                          | -                           |
|  | 10                            | 12.5 x 30  | 01           | 150                              | 42                              | 25                              | 0.10                    | 15                            | 10                          | L2                          | 04215109E3              | 04225109E3                  | -                          | -                           |
|  | 15                            | 12.5 x 30  | 01           | 180                              | 57                              | 36                              | 0.10                    | 10                            | 6.7                         | L2                          | 04215159E3              | 04225159E3                  | -                          | -                           |
|  | 22                            | 15 x 30  | 02           | 250                              | 79                              | 50                              | 0.10                    | 6.8                           | 4.5                         | L2                          | 04215229E3              | 04225229E3                  | -                          | 04245229E3                  |
|  | 33                            | 18 x 30  | 03           | 350                              | 110                             | 73                              | 0.10                    | 4.5                           | 3.1                         | L2                          | 04215339E3              | -                           | -                          | 04245339E3                  |
|  | 47                            | 18 x 38  | 04           | 450                              | 160                             | 100                             | 0.10                    | 3.2                           | 2.1                         | L2                          | 04315479E3              | -                           | -                          | 04345479E3                  |
| 68                                       | 21 x 38                       | 05   | 560          | 220                              | 150                             | 0.10                            | 2.2                     | 1.4                           | L2                          | 04315689E3                  | -                       | -                           | 04345689E3                 |                             |
| 385                                      | 6.8                           | 10 x 30  | 00           | 110                              | 34                              | 20                              | 0.10                    | 22                            | 14                          | L2                          | 04218688E3              | 04228688E3                  | -                          | -                           |
|  | 10                            | 12.5 x 30  | 01           | 150                              | 45                              | 27                              | 0.10                    | 15                            | 10                          | L2                          | 04218109E3              | 04228109E3                  | -                          | -                           |
|  | 15                            | 15 x 30  | 02           | 210                              | 62                              | 39                              | 0.10                    | 10                            | 6.0                         | L2                          | 04218159E3              | 04228159E3                  | -                          | 04248159E3                  |
|  | 22                            | 18 x 30  | 03           | 290                              | 86                              | 55                              | 0.10                    | 6.8                           | 4.1                         | L2                          | 04218229E3              | -                           | -                          | 04248229E3                  |
|  | 33                            | 18 x 38  | 04           | 380                              | 120                             | 80                              | 0.10                    | 4.5                           | 2.7                         | L2                          | 04318339E3              | -                           | -                          | 04348339E3                  |
|  | 47                            | 18 x 38  | 04           | 450                              | 170                             | 110                             | 0.10                    | 3.2                           | 2.1                         | L2                          | 04318479E3              | -                           | -                          | 04348479E3                  |
| 68                                       | 21 x 38                       | 05   | 570          | 250                              | 160                             | 0.10                            | 2.2                     | 1.4                           | L2                          | 04318689E3                  | -                       | -                           | 04348689E3                 |                             |



| ELECTRICAL DATA AND ORDERING INFORMATION |                            |                                |           |                                  |                            |                            |              |                |              |                          |                         |                       |                      |                       |
|--|----------------------------|--------------------------------|-----------|----------------------------------|----------------------------|----------------------------|--------------|----------------|--------------|--------------------------|-------------------------|-----------------------|----------------------|-----------------------|
| U <sub>R</sub> (V)                       | C <sub>R</sub> 100 Hz (µF) | NOMINAL CASE SIZE Ø D x L (mm) | CASE CODE | I <sub>R</sub> 100 Hz 85 °C (mA) | I <sub>L1</sub> 1 min (µA) | I <sub>L5</sub> 5 min (µA) | tan δ 100 Hz | ESR 100 Hz (Ω) | Z 10 kHz (Ω) | LIFE CODE <sup>(1)</sup> | ORDERING CODE MAL2..... |                       |                      |                       |
|  |                            |                                |           |                                  |                            |                            |              |                |              |                          | IN BOX FORM AA          | TAPED ON REEL FORM BR | TAPED IN BOX FORM BA | MOUNTING RING FORM MR |
| 400                                      | 6.8                        | 10 x 30                        | 00        | 110                              | 220                        | 110                        | 0.055        | 11.5           | 7.3          | L2                       | 04216688E3              | 04226688E3            | -                    | -                     |
|  | 10                         | 12.5 x 30                      | 01        | 150                              | 240                        | 110                        | 0.055        | 7.5            | 4.6          | L2                       | 04216109E3              | 04226109E3            | -                    | -                     |
|  | 15                         | 15 x 30                        | 02        | 210                              | 250                        | 110                        | 0.055        | 5.0            | 3.1          | L2                       | 04216159E3              | 04226159E3            | -                    | 04246159E3            |
|  | 22                         | 18 x 30                        | 03        | 290                              | 280                        | 120                        | 0.055        | 3.5            | 2.1          | L2                       | 04216229E3              | -                     | -                    | 04246229E3            |
|  | 33                         | 18 x 38                        | 04        | 380                              | 320                        | 130                        | 0.055        | 2.3            | 1.4          | L2                       | 04316339E3              | -                     | -                    | 04346339E3            |
|  | 47                         | 18 x 38                        | 04        | 450                              | 370                        | 140                        | 0.055        | 1.7            | 1.1          | L2                       | 04316479E3              | -                     | -                    | 04346479E3            |
|  | 68                         | 21 x 38                        | 05        | 560                              | 440                        | 150                        | 0.055        | 1.2            | 0.7          | L2                       | 04316689E3              | -                     | -                    | 04346689E3            |
| 450                                      | 6.8                        | 10 x 30                        | 00        | 110                              | 230                        | 110                        | 0.10         | 22             | 14           | L3                       | 04217688E3              | 04227688E3            | -                    | -                     |
|  | 10                         | 12.5 x 30                      | 01        | 150                              | 240                        | 110                        | 0.10         | 15             | 10           | L3                       | 04217109E3              | 04227109E3            | -                    | -                     |
|  | 15                         | 12.5 x 30                      | 01        | 180                              | 260                        | 110                        | 0.10         | 10             | 6.0          | L3                       | 04217159E3              | 04227159E3            | -                    | -                     |
|  | 22                         | 15 x 30                        | 02        | 240                              | 290                        | 120                        | 0.10         | 6.8            | 4.1          | L3                       | 04217229E3              | 04227229E3            | -                    | 04247229E3            |
|  | 33                         | 18 x 30                        | 03        | 350                              | 330                        | 130                        | 0.10         | 4.5            | 2.7          | L3                       | 04217339E3              | -                     | -                    | 04247339E3            |
|  | 47                         | 18 x 38                        | 04        | 440                              | 390                        | 140                        | 0.10         | 3.2            | 2.1          | L3                       | 04317479E3              | -                     | -                    | 04347479E3            |
|  | 68                         | 21 x 38                        | 05        | 550                              | 460                        | 160                        | 0.10         | 2.2            | 1.4          | L3                       | 04317689E3              | -                     | -                    | 04347689E3            |

Note

(1) Determines the applicable row in the table "Endurance Test Duration and Useful Life"

| ADDITIONAL ELECTRICAL DATA         |  |   |               |
|------------------------------------|--|---|---------------|
| PARAMETER                          | CONDITIONS   | VALUE   |               |
|                                    |  | AXIAL   | MOUNTING RING |
| <b>Voltage</b>                     |  |   |               |
| Surge voltage                      | U <sub>R</sub> = 160 V to 250 V  | U <sub>s</sub> ≤ 1.15 x U <sub>R</sub>  |               |
|                                    | U <sub>R</sub> = 350 V to 450 V  | U <sub>s</sub> ≤ 1.1 x U <sub>R</sub>   |               |
| Reverse voltage                    |  | U <sub>rev</sub> ≤ 1 V  |               |
| <b>Current</b>                     |  |   |               |
| Leakage current                    | After 1 min:<br>case Ø D x L = 8 mm x 18 mm to 10 mm x 25 mm:<br>CV ≤ 1000 µC<br>CV > 1000 µC<br>case Ø D x L = 10 mm x 30 mm to 21 mm x 38 mm:<br>U <sub>R</sub> = 160 V to 385 V<br>U <sub>R</sub> = 400 V and 450 V | I <sub>L1</sub> ≤ 0.05 C <sub>R</sub> x U <sub>R</sub> or 5 µA, whichever is greater<br>I <sub>L1</sub> ≤ 0.03 C <sub>R</sub> x U <sub>R</sub> + 20 µA<br><br>I <sub>L1</sub> ≤ 0.009 C <sub>R</sub> x U <sub>R</sub> + 10 µA<br>I <sub>L1</sub> ≤ 0.009 C <sub>R</sub> x U <sub>R</sub> + 200 µA |               |
|                                    | After 5 min:<br>U <sub>R</sub> = 160 V to 385 V:<br>CV ≤ 1000 µC<br>CV > 1000 µC<br>U <sub>R</sub> = 400 V and 450 V   | I <sub>L5</sub> ≤ 0.01 C <sub>R</sub> x U <sub>R</sub> or 1 µA, whichever is greater<br>I <sub>L5</sub> ≤ 0.006 C <sub>R</sub> x U <sub>R</sub> + 4 µA<br>I <sub>L5</sub> ≤ 0.002 C <sub>R</sub> x U <sub>R</sub> + 100 µA  |               |
| <b>Inductance</b>                  |  |   |               |
| Equivalent series inductance (ESL) | Case Ø D x L mm:   |   |               |
|                                    | 8 x 18   | Typ. 35 nH  | -             |
|                                    | 10 x 18  | Typ. 69 nH  | -             |
|                                    | 10 x 25  | Typ. 38 nH  | -             |
|                                    | 10 x 30  | Typ. 38 nH  | -             |
|                                    | 12.5 x 30  | Typ. 46 nH  | -             |
|                                    | 15 x 30  | Typ. 48 nH  | Typ. 39 nH    |
|                                    | 18 x 30  | Typ. 50 nH  | Typ. 39 nH    |
|                                    | 18 x 38  | Typ. 54 nH  | Typ. 39 nH    |
| 21 x 38                            | Typ. 59 nH   | Typ. 39 nH  |               |



CAPACITANCE (C)

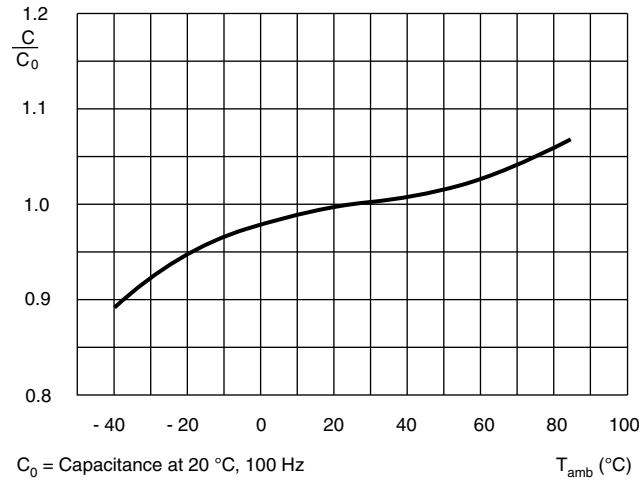


Fig. 5 - Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

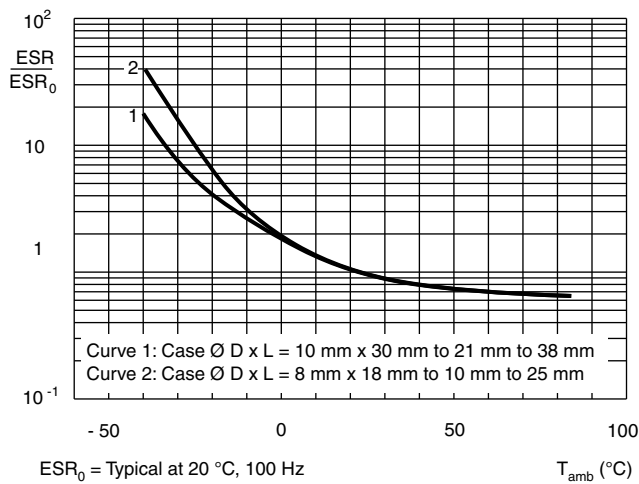


Fig. 6 - Typical multiplier of ESR as a function of ambient temperature

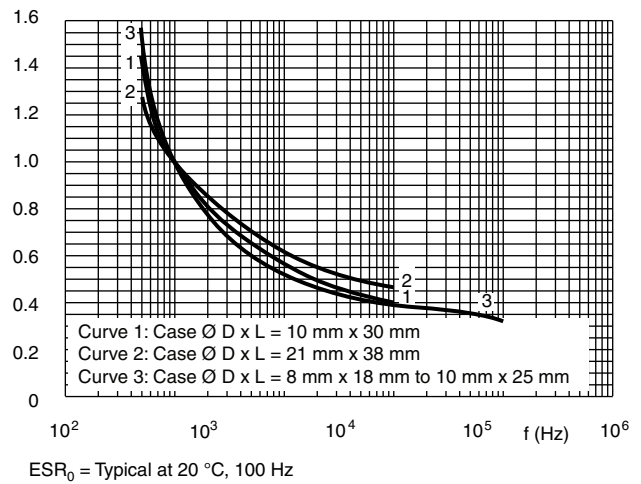


Fig. 7 - Typical multiplier of ESR as a function of frequency

**IMPEDANCE (Z)**

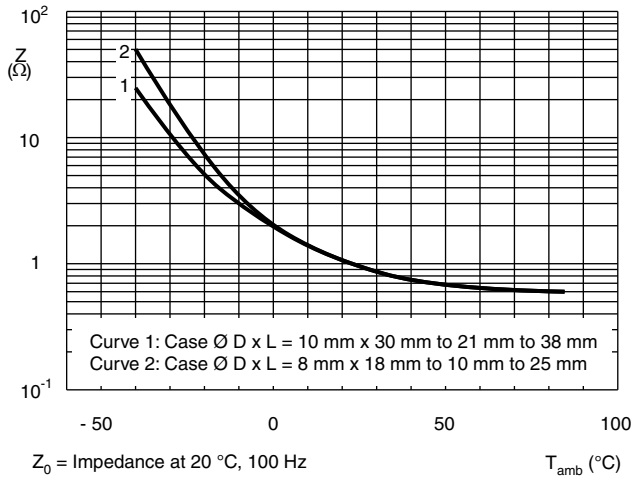


Fig. 8 - Typical impedance of capacitance as a function of ambient temperature

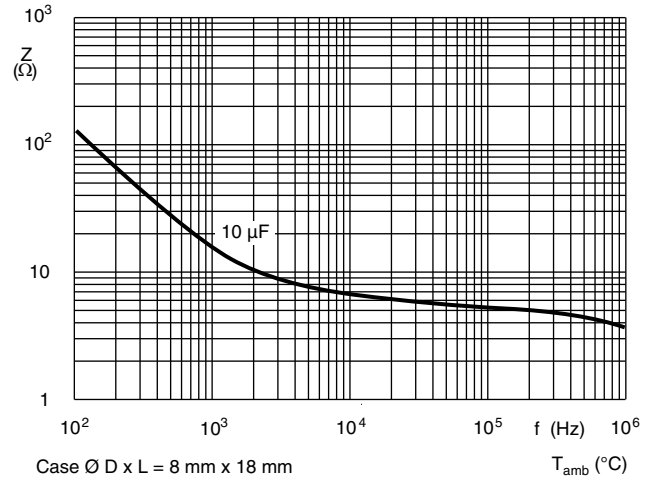


Fig. 9 - Typical impedance as a function of frequency

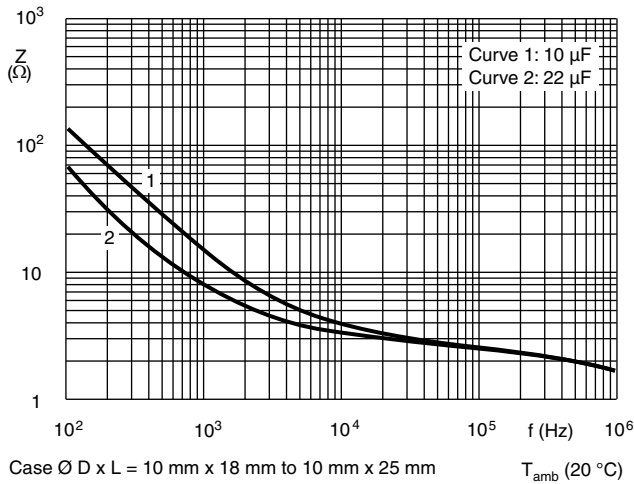


Fig. 10 - Typical impedance as a function of frequency

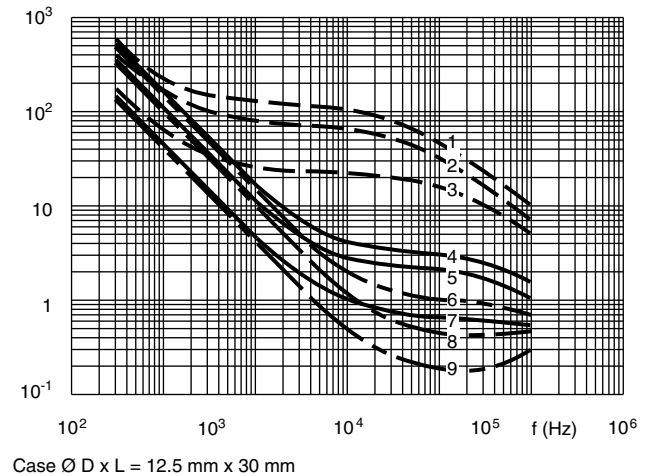


Fig. 11 - Typical impedance as a function of frequency at different ambient temperatures

- Curve 1: 10 µF, 350 V 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 V 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 V and 385 V; 85 °C
- Curve 8: 15 µF, 250 V; 85 °C
- Curve 9: 33 µF, 160 V; 85 °C



**RIPPLE CURRENT AND USEFUL LIFE**

Table 3

| ENDURANCE TEST DURATION AND USEFUL LIFE |                        |                          |
|---|------------------------|--------------------------|
| LIFE CODE                               | ENDURANCE AT 85 °C (h) | USEFUL LIFE AT 85 °C (h) |
| L1                                      | 2000                   | 5000                     |
| L2                                      | 8000                   | 15 000                   |
| L3                                      | 5000                   | 10 000                   |

**Note**

- Multiplier of useful life code: CCC205

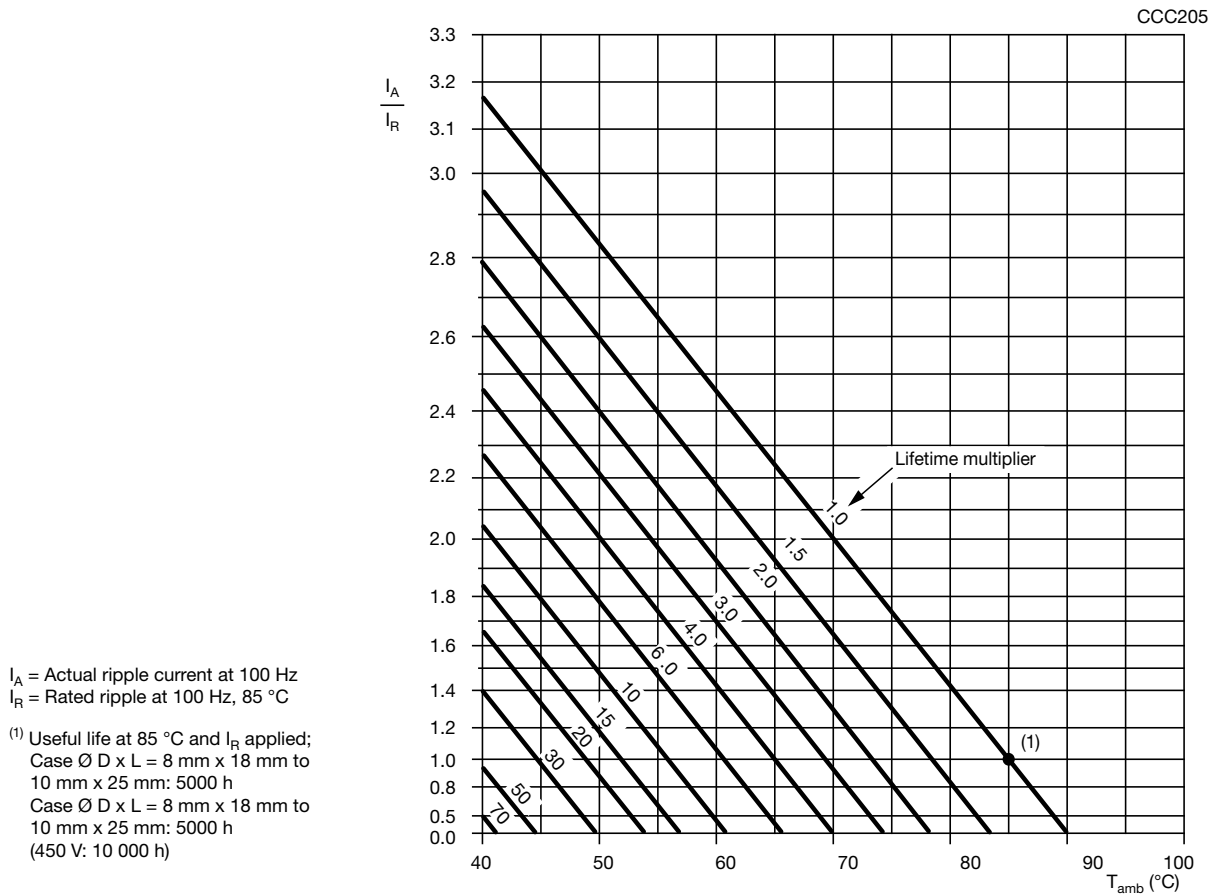


Fig. 12 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |      |      |      |      |          |
|---|------|------|------|------|----------|
| FREQUENCY (Hz)  |      |      |      |      |          |
| 50  | 100  | 300  | 1000 | 3000 | ≥ 10 000 |
| $I_R$ MULTIPLIER  |      |      |      |      |          |
| 0.75  | 1.00 | 1.15 | 1.30 | 1.40 | 1.50     |



Table 5

| TEST PROCEDURE REQUIREMENTS                 |                                       |   |   |
|---|---------------------------------------|---|---|
| TEST  |                                       | PROCEDURE<br>(quick reference)  | REQUIREMENTS  |
| NAME OF TEST                                | REFERENCE                             |   |   |
| Endurance                                   | IEC 60384-4 / EN130300 subclause 4.13 | T <sub>amb</sub> = 85 °C; U <sub>R</sub> applied;<br>Case Ø D x L:<br>8 mm x 18 mm to 10 mm x 25 mm:<br>2000 h;<br>10 mm x 30 mm to 21 mm x 38 mm:<br>8000 h (450 V: 5000 h)                        | U <sub>R</sub> = 160 V; ΔC/C: ± 15 %<br>U <sub>R</sub> = 250 V to 450 V; ΔC/C: ± 10 %<br>tan δ ≤ 1.3 x spec. limit<br>Z ≤ 2 x spec. limit<br>I <sub>L5</sub> ≤ spec. limit  |
| Useful life                                 | CECC 30301 subclause 1.8.1            | T <sub>amb</sub> = 85 °C; U <sub>R</sub> and I <sub>R</sub> applied;<br>Case Ø D x L:<br>8 mm x 18 mm to 10 mm x 25 mm:<br>5000 h;<br>10 mm x 30 mm to 21 mm x 38 mm:<br>15 000 h (450 V: 10 000 h) | U <sub>R</sub> = 160 V; ΔC/C: ± 45 %<br>U <sub>R</sub> = 250 V to 450 V; ΔC/C: ± 30 %<br>tan δ ≤ 3 x spec. limit<br>Z ≤ 3 x spec. limit<br>I <sub>L5</sub> ≤ spec. limit<br>No short or open circuit<br>Total failure percentage: ≤ 3 % |
| Shelf life<br>(storage at high temperature) | IEC 60384-4 / EN130300 subclause 4.17 | T <sub>amb</sub> = 85 °C; no voltage applied;<br>500 h<br>After test: U <sub>R</sub> to be applied for 30 min,<br>24 h to 48 h before measurement   | ΔC/C, tan δ, Z:<br>for requirements<br>see "Endurance test" above<br>I <sub>L5</sub> ≤ 2 x spec. limit  |

Statements about product lifetime are based on calculations and internal testing. They should only be interpreted as estimations. Also due to external factors, the lifetime in the field application may deviate from the calculated lifetime. In general, nothing stated herein shall be construed as a guarantee of durability.





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