

## Aluminum Electrolytic Capacitors Axial Standard

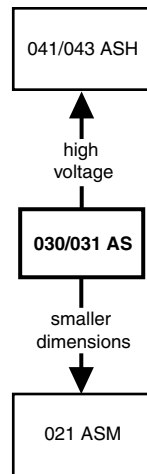


Fig. 1

| QUICK REFERENCE DATA                      |                           |
|---|---------------------------|
| DESCRIPTION                               | VALUE                     |
| Nominal case sizes (Ø D x L in mm)        | 4.5 x 10 to 10 x 25       |
| Rated capacitance range, $C_R$            | 1 $\mu$ F to 1000 $\mu$ F |
| Tolerance on $C_R$                        | -10 % to +50 %            |
| Rated voltage, $U_R$                      | 6.3 V to 100 V            |
| Category temperature range                | -40 °C to +85 °C          |
| Endurance test at 85 °C                   | 2000 h                    |
| Useful life at 85 °C                      | 3000 h                    |
| Useful life at 40 °C, 1.4 x $I_R$ applied | 80 000 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             |

### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Taped version available for automatic insertion
- Charge and discharge proof
- Useful life: 3000 h at 85 °C
- Standard dimensions
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS  
COMPLIANT**

### APPLICATIONS

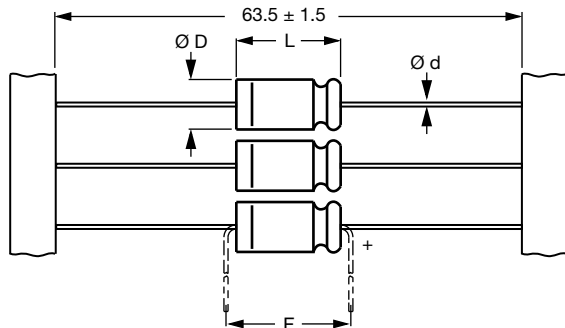
- General purpose and industrial, automotive, telecommunication, audio-video
- Coupling, decoupling, timing, smoothing, filtering, buffering in SMPS
- Boards with restricted mounting height, vibration, and shock resistant

### MARKING

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

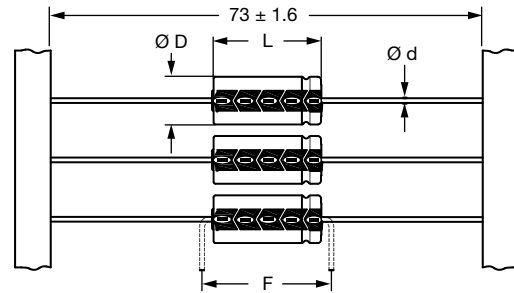
- Rated capacitance (in  $\mu$ F)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (T for -10 % to +50 %)
- Rated voltage (in V)
- Date code in accordance with IEC 60062
- Code factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (030 or 031)

| <b>SELECTION CHART FOR <math>C_R</math>, <math>U_R</math> AND RELEVANT NOMINAL CASE SIZES (<math>\varnothing D \times L</math> in mm)</b> |           |          |          |          |          |          |          |
|---|-----------|----------|----------|----------|----------|----------|----------|
| $C_R$<br>( $\mu F$ )  | $U_R$ (V) |          |          |          |          |          |          |
|   | 6.3       | 10       | 16       | 25       | 40       | 63       | 100      |
| 1.0   | -         | -        | -        | -        | -        | 4.5 x 10 | 4.5 x 10 |
| 2.2   | -         | -        | -        | -        | -        | 4.5 x 10 | 4.5 x 10 |
| 3.3   | -         | -        | -        | -        | -        | 4.5 x 10 | 4.5 x 10 |
| 4.7   | -         | -        | -        | -        | -        | 4.5 x 10 | 6 x 10   |
| 6.8   | -         | -        | -        | -        | -        | 4.5 x 10 | 6 x 10   |
| 10  | -         | -        | -        | 4.5 x 10 | 4.5 x 10 | 6 x 10   | 8 x 11   |
|   | -         | -        | -        | -        | -        | -        | 6.5 x 18 |
| 15  | -         | -        | -        | -        | 4.5 x 10 | 6 x 10   | -        |
| 22  | -         | -        | -        | 4.5 x 10 | 6 x 10   | 8 x 11   | 8 x 18   |
|   | -         | -        | -        | -        | -        | 6.5 x 18 | -        |
| 33  | -         | -        | 4.5 x 10 | -        | 6 x 10   | -        | 10 x 18  |
| 47  | -         | 4.5 x 10 | -        | 6 x 10   | 8 x 11   | 8 x 18   | 10 x 25  |
|   | -         | -        | -        | -        | 6.5 x 18 | -        | -        |
| 68  | 4.5 x 10  | -        | 6 x 10   | -        | -        | 10 x 18  | -        |
| 100   | -         | 6 x 10   | -        | 8 x 11   | 8 x 18   | 10 x 25  | -        |
|   | -         | -        | -        | 6.5 x 18 | -        | -        | -        |
| 150   | 6 x 10    | -        | 8 x 11   | 8 x 18   | 10 x 18  | -        | -        |
|   | -         | -        | 6.5 x 18 | -        | -        | -        | -        |
| 220   | -         | 8 x 11   | 8 x 18   | 10 x 18  | 10 x 25  | -        | -        |
|   | -         | 6.5 x 18 | -        | -        | -        | -        | -        |
| 330   | -         | 8 x 18   | 10 x 18  | 10 x 25  | -        | -        | -        |
| 470   | 8 x 18    | 10 x 18  | 10 x 25  | -        | -        | -        | -        |
| 680   | 10 x 18   | 10 x 25  | -        | -        | -        | -        | -        |
| 1000  | 10 x 25   | -        | -        | -        | -        | -        | -        |

**DIMENSIONS in millimeters AND AVAILABLE FORMS**


**Form BR:** Taped on reel  
**Form BA:** Taped in box (ammopack)  
 Case  $\varnothing D \times L = 4.5 \text{ mm} \times 10 \text{ mm}$  to  $8 \text{ mm} \times 11 \text{ mm}$

Fig. 2 - Forms BA and BR



**Form BR:** Taped on reel  
 Case  $\varnothing D \times L = 6.5 \text{ mm} \times 18 \text{ mm}$  to  $15 \text{ mm} \times 30 \text{ mm}$   
**Form BA:** Taped in box (ammopack)  
 Case  $\varnothing D \times L = 6.5 \text{ mm} \times 18 \text{ mm}$  to  $10 \text{ mm} \times 25 \text{ mm}$

Fig. 3 - Forms BA and BR

Table 1

| <b>AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES</b> |           |                      |                        |            |            |          |                      |         |  |
|--|-----------|----------------------|------------------------|------------|------------|----------|----------------------|---------|--|
| NOMINAL CASE SIZE<br>$\varnothing D \times L$                          | CASE CODE | AXIAL FORM BA AND BR |                        |            |            | MASS (g) | PACKAGING QUANTITIES |         |  |
|  |           | $\varnothing d$      | $\varnothing D_{max.}$ | $L_{max.}$ | $F_{min.}$ |          | FORM BA              | FORM BR |  |
| 4.5 x 10   | 2         | 0.6                  | 5.0                    | 10.5       | 15         | ≈ 0.5    | 1000                 | 3000    |  |
| 6 x 10   | 3         | 0.6                  | 6.3                    | 10.5       | 15         | ≈ 0.7    | 1000                 | 1000    |  |
| 8 x 11   | 5a        | 0.6                  | 8.5                    | 11.5       | 15         | ≈ 1.1    | 500                  | 500     |  |
| 6.5 x 18   | 4         | 0.8                  | 6.9                    | 18.5       | 25         | ≈ 1.3    | 1000                 | 1000    |  |
| 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                   | 25.0       | 30         | ≈ 3.3    | 500                  | 500     |  |

**Note**

- Detailed tape dimensions see section "PACKAGING"



| ELECTRICAL DATA |  |
|-----------------|--|
| SYMBOL          | DESCRIPTION  |
| C <sub>R</sub>  | Rated capacitance at 100 Hz, tolerance -10 % to +50 %  |
| I <sub>R</sub>  | Rated RMS ripple current at 100 Hz, 85 °C  |
| I <sub>L1</sub> | Max. leakage current after 1 min at U <sub>R</sub>   |
| I <sub>L5</sub> | Max. leakage current after 5 min at U <sub>R</sub>   |
| tan δ           | Max. dissipation factor at 100 Hz  |
| ESR             | Equivalent series resistance at 100 Hz (calculated from tan δ <sub>max.</sub> and C <sub>R</sub> ) |
| Z               | Max. impedance at 10 kHz   |

**ORDERING EXAMPLE**

Electrolytic capacitor 031 series

330 µF / 10 V; -10 % / +50 %

Nominal case size: Ø 8 mm x 18 mm; form BA

Ordering code: MAL203134331E3

**Note**

- Unless otherwise specified, all electrical values in Table 2 apply at T<sub>amb</sub> = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %.

Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION |                                  |   |              |   |                                  |                                  |                 |                      |                    |                             |                         |
|--|----------------------------------|---|--------------|---|----------------------------------|----------------------------------|-----------------|----------------------|--------------------|-----------------------------|-------------------------|
| U <sub>R</sub><br>(V)                    | C <sub>R</sub><br>100 Hz<br>(µF) | NOMINAL<br>CASE SIZE<br>Ø D x L<br>(mm) | CASE<br>CODE | I <sub>R</sub><br>100 Hz<br>85 °C<br>(mA) | I <sub>L1</sub><br>1 min<br>(µA) | I <sub>L5</sub><br>5 min<br>(µA) | tan δ<br>100 Hz | ESR<br>100 Hz<br>(Ω) | Z<br>10 kHz<br>(Ω) | ORDERING CODE<br>MAL2.....  |                         |
|  |                                  |   |              |   |                                  |                                  |                 |                      |                    | TAPED ON<br>REEL<br>FORM BR | TAPED IN BOX<br>FORM BA |
| 6.3                                      | 68                               | 4.5 x 10                                | 2            | 75  | 22                               | 5.9                              | 0.25            | 5.86                 | 2.90               | 03023689E3                  | 03033689E3              |
|  | 150                              | 6 x 10                                  | 3            | 120                                       | 10                               | 6.9                              | 0.25            | 2.66                 | 1.30               | 03023151E3                  | 03033151E3              |
|  | 470                              | 8 x 18                                  | 5            | 330                                       | 22                               | 11                               | 0.25            | 0.85                 | 0.43               | 03123471E3                  | 03133471E3              |
|  | 680                              | 10 x 18                                 | 6            | 430                                       | 30                               | 14                               | 0.25            | 0.59                 | 0.29               | 03123681E3                  | 03133681E3              |
|  | 1000                             | 10 x 25                                 | 7            | 560                                       | 42                               | 18                               | 0.25            | 0.40                 | 0.20               | 03123102E3                  | 03133102E3              |
| 10                                       | 47                               | 4.5 x 10                                | 2            | 70  | 24                               | 5.9                              | 0.20            | 6.78                 | 3.40               | 03024479E3                  | 03034479E3              |
|  | 100                              | 6 x 10                                  | 3            | 110                                       | 10                               | 7.0                              | 0.20            | 3.19                 | 1.60               | 03024101E3                  | 03034101E3              |
|  | 220                              | 8 x 11                                  | 5a           | 210                                       | 18                               | 9.4                              | 0.20            | 1.45                 | 0.73               | 03024221E3                  | 03034221E3              |
|  | 220                              | 6.5 x 18                                | 4            | 210                                       | 18                               | 9.4                              | 0.20            | 1.45                 | 0.73               | 03124221E3                  | 03134221E3              |
|  | 330                              | 8 x 18                                  | 5            | 310                                       | 24                               | 12                               | 0.20            | 0.97                 | 0.48               | 03124331E3                  | 03134331E3              |
|  | 470                              | 10 x 18                                 | 6            | 410                                       | 33                               | 14                               | 0.20            | 0.68                 | 0.34               | 03124471E3                  | 03134471E3              |
| 16                                       | 680                              | 10 x 25                                 | 7            | 510                                       | 45                               | 19                               | 0.20            | 0.47                 | 0.24               | 03124681E3                  | 03134681E3              |
|  | 33                               | 4.5 x 10                                | 2            | 65  | 27                               | 6.1                              | 0.16            | 7.72                 | 3.60               | 03025339E3                  | 03035339E3              |
|  | 68                               | 6 x 10                                  | 3            | 110                                       | 11                               | 7.2                              | 0.16            | 3.75                 | 1.80               | 03025689E3                  | 03035689E3              |
|  | 150                              | 8 x 11                                  | 5a           | 200                                       | 19                               | 9.8                              | 0.16            | 1.70                 | 0.80               | 03025151E3                  | 03035151E3              |
|  | 150                              | 6.5 x 18                                | 4            | 200                                       | 19                               | 9.8                              | 0.16            | 1.70                 | 0.80               | 03125151E3                  | 03135151E3              |
|  | 220                              | 8 x 18                                  | 5            | 270                                       | 26                               | 12                               | 0.16            | 1.16                 | 0.55               | 03125221E3                  | 03135221E3              |
| 25                                       | 330                              | 10 x 18                                 | 6            | 410                                       | 36                               | 16                               | 0.16            | 0.78                 | 0.36               | 03125331E3                  | 03135331E3              |
|  | 470                              | 10 x 25                                 | 7            | 480                                       | 49                               | 20                               | 0.16            | 0.55                 | 0.26               | 03125471E3                  | 03135471E3              |
|  | 10                               | 4.5 x 10                                | 2            | 50  | 13                               | 5.5                              | 0.14            | 22.3                 | 9.00               | 03026109E3                  | 03036109E3              |
|  | 22                               | 4.5 x 10                                | 2            | 60  | 28                               | 6.1                              | 0.14            | 10.2                 | 4.10               | 03026229E3                  | 03036229E3              |
|  | 47                               | 6 x 10                                  | 3            | 100                                       | 12                               | 7.4                              | 0.14            | 4.80                 | 1.90               | 03026479E3                  | 03036479E3              |
|  | 100                              | 8 x 11                                  | 5a           | 160                                       | 19                               | 10                               | 0.14            | 2.23                 | 0.90               | 03026101E3                  | 03036101E3              |
| 25                                       | 100                              | 6.5 x 18                                | 4            | 160                                       | 19                               | 10                               | 0.14            | 2.23                 | 0.90               | 03126101E3                  | 03136101E3              |
|  | 150                              | 8 x 18                                  | 5            | 240                                       | 27                               | 13                               | 0.14            | 1.49                 | 0.60               | 03126151E3                  | 03136151E3              |
|  | 220                              | 10 x 18                                 | 6            | 350                                       | 37                               | 16                               | 0.14            | 1.02                 | 0.41               | 03126221E3                  | 03136221E3              |
|  | 330                              | 10 x 25                                 | 7            | 460                                       | 54                               | 22                               | 0.14            | 0.68                 | 0.27               | 03126331E3                  | 03136331E3              |



| ELECTRICAL DATA AND ORDERING INFORMATION |                                  |   |              |   |                                  |                                  |                 |                      |                    |                             |                         |
|--|----------------------------------|---|--------------|---|----------------------------------|----------------------------------|-----------------|----------------------|--------------------|-----------------------------|-------------------------|
| U <sub>R</sub><br>(V)                    | C <sub>R</sub><br>100 Hz<br>(μF) | NOMINAL<br>CASE SIZE<br>Ø D x L<br>(mm) | CASE<br>CODE | I <sub>R</sub><br>100 Hz<br>85 °C<br>(mA) | I <sub>L1</sub><br>1 min<br>(μA) | I <sub>L5</sub><br>5 min<br>(μA) | tan δ<br>100 Hz | ESR<br>100 Hz<br>(Ω) | Z<br>10 kHz<br>(Ω) | ORDERING CODE<br>MAL2.....  |                         |
|  |                                  |   |              |   |                                  |                                  |                 |                      |                    | TAPED ON<br>REEL<br>FORM BR | TAPED IN BOX<br>FORM BA |
| 40                                       | 10                               | 4.5 x 10                                | 2            | 50  | 20                               | 5.8                              | 0.11            | 17.6                 | 7.00               | 03027109E3                  | 03037109E3              |
|  | 15                               | 4.5 x 10                                | 2            | 55  | 30                               | 6.2                              | 0.11            | 11.7                 | 4.70               | 03027159E3                  | 03037159E3              |
|  | 22                               | 6 x 10                                  | 3            | 75  | 9                                | 6.8                              | 0.11            | 8.00                 | 3.20               | 03027229E3                  | 03037229E3              |
|  | 33                               | 6 x 10                                  | 3            | 95  | 12                               | 7.7                              | 0.11            | 5.31                 | 2.10               | 03027339E3                  | 03037339E3              |
|  | 47                               | 8 x 11                                  | 5a           | 150                                       | 16                               | 8.8                              | 0.11            | 3.73                 | 1.50               | 03027479E3                  | 03037479E3              |
|  | 47                               | 6.5 x 18                                | 4            | 150                                       | 16                               | 8.8                              | 0.11            | 3.73                 | 1.50               | 03127479E3                  | 03137479E3              |
|  | 100                              | 8 x 18                                  | 5            | 220                                       | 28                               | 13                               | 0.11            | 1.75                 | 0.70               | 03127101E3                  | 03137101E3              |
|  | 150                              | 10 x 18                                 | 6            | 300                                       | 40                               | 17                               | 0.11            | 1.17                 | 0.47               | 03127151E3                  | 03137151E3              |
|  | 220                              | 10 x 25                                 | 7            | 430                                       | 57                               | 23                               | 0.11            | 0.80                 | 0.32               | 03127221E3                  | 03137221E3              |
| 63                                       | 1.0                              | 4.5 x 10                                | 2            | 13  | 5                                | 5.1                              | 0.09            | 143                  | 55.0               | 03028108E3                  | 03038108E3              |
|  | 2.2                              | 4.5 x 10                                | 2            | 25  | 7                                | 5.3                              | 0.09            | 65.2                 | 25.0               | 03028228E3                  | 03038228E3              |
|  | 3.3                              | 4.5 x 10                                | 2            | 35  | 11                               | 5.4                              | 0.09            | 46.5                 | 17.0               | 03028338E3                  | 03038338E3              |
|  | 4.7                              | 4.5 x 10                                | 2            | 40  | 15                               | 5.6                              | 0.09            | 30.5                 | 12.0               | 03028478E3                  | 03038478E3              |
|  | 6.8                              | 4.5 x 10                                | 2            | 46  | 22                               | 5.9                              | 0.09            | 21.1                 | 8.10               | 03028688E3                  | 03038688E3              |
|  | 10                               | 6 x 10                                  | 3            | 70  | 7                                | 6.3                              | 0.08            | 12.8                 | 5.50               | 03028109E3                  | 03038109E3              |
|  | 15                               | 6 x 10                                  | 3            | 79  | 10                               | 6.9                              | 0.08            | 8.50                 | 3.70               | 03028159E3                  | 03038159E3              |
|  | 22                               | 8 x 11                                  | 5a           | 110                                       | 13                               | 7.8                              | 0.08            | 5.79                 | 2.50               | 03028229E3                  | 03038229E3              |
|  | 22                               | 6.5 x 18                                | 4            | 110                                       | 13                               | 7.8                              | 0.08            | 5.79                 | 2.50               | 03128229E3                  | 03138229E3              |
|  | 47                               | 8 x 18                                  | 5            | 190                                       | 22                               | 11                               | 0.08            | 2.71                 | 1.20               | 03128479E3                  | 03138479E3              |
|  | 68                               | 10 x 18                                 | 6            | 250                                       | 30                               | 14                               | 0.08            | 1.88                 | 0.81               | 03128689E3                  | 03138689E3              |
|  | 100                              | 10 x 25                                 | 7            | 300                                       | 42                               | 18                               | 0.08            | 1.28                 | 0.55               | 03128101E3                  | 03138101E3              |
| 100                                      | 1.0                              | 4.5 x 10                                | 2            | 20  | 5                                | 4.6                              | 0.08            | 128                  | 45.0               | 03029108E3                  | 03039108E3              |
|  | 2.2                              | 4.5 x 10                                | 2            | 30  | 11                               | 5.3                              | 0.08            | 57.9                 | 21.0               | 03029228E3                  | 03039228E3              |
|  | 3.3                              | 4.5 x 10                                | 2            | 40  | 17                               | 6.0                              | 0.08            | 38.6                 | 14.0               | 03029338E3                  | 03039338E3              |
|  | 4.7                              | 6 x 10                                  | 3            | 50  | 13                               | 6.8                              | 0.07            | 23.7                 | 9.60               | 03029478E3                  | 03039478E3              |
|  | 6.8                              | 6 x 10                                  | 3            | 70  | 18                               | 8.0                              | 0.07            | 16.4                 | 6.60               | 03029688E3                  | 03039688E3              |
|  | 10                               | 8 x 11                                  | 5a           | 90  | 24                               | 10                               | 0.07            | 11.2                 | 4.50               | 03029109E3                  | 03039109E3              |
|  | 10                               | 6.5 x 18                                | 4            | 90  | 24                               | 10                               | 0.07            | 11.2                 | 4.50               | 03129109E3                  | 03139109E3              |
|  | 22                               | 8 x 18                                  | 5            | 120                                       | 48                               | 18                               | 0.07            | 5.07                 | 2.10               | 03129229E3                  | 03139229E3              |
|  | 33                               | 10 x 18                                 | 6            | 200                                       | 70                               | 24                               | 0.07            | 3.38                 | 1.40               | 03129339E3                  | 03139339E3              |
|  | 47                               | 10 x 25                                 | 7            | 260                                       | 98                               | 33                               | 0.07            | 2.37                 | 0.96               | 03129479E3                  | 03139479E3              |

| ADDITIONAL ELECTRICAL DATA         |   |   |
|------------------------------------|---|---|
| PARAMETER                          | CONDITIONS  | VALUE   |
| <b>Voltage</b>                     |   |   |
| Surge voltage                      |   | $U_s \leq 1.15 \times U_R$  |
| Reverse voltage                    |   | $U_{rev} \leq 1 \text{ V}$  |
| <b>Current</b>                     |   |   |
| Leakage current                    | After 1 min at $U_R$ :<br>Case $\emptyset D \times L = 4.5 \text{ mm} \times 10 \text{ mm}$<br>Case $\emptyset D \times L = 6 \text{ mm} \times 10 \text{ mm}$ to $10 \text{ mm} \times 25 \text{ mm}$<br><br>$U_R = 100 \text{ V}$ | $I_{L1} \leq 0.05 C_R \times U_R$ or $5 \mu\text{A}$ , whichever is greater<br>$I_{L1}$ for $CV \leq 1000$ : $\leq 0.01 C_R \times U_R$ or $1 \mu\text{A}$ , whichever is greater<br>$I_{L1}$ for $CV > 1000$ : $\leq 0.006 C_R \times U_R + 4 \mu\text{A}$<br>$I_{L1} = 0.02 C_R \times U_R + 4 \mu\text{A}$ |
|                                    | After 5 min:<br>$U_R = 6.3 \text{ V}$ to $63 \text{ V}$<br>$U_R = 100 \text{ V}$  | $I_{L5} \leq 0.002 C_R \times U_R + 5 \mu\text{A}$<br>$I_{L5} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$  |
| <b>Inductance</b>                  |   |   |
| Equivalent series inductance (ESL) | Case $\emptyset D \times L$ mm:   |   |
|                                    | 4.5 x 10  | typ. 10 nH  |
|                                    | 6 x 10  | typ. 22 nH  |
|                                    | 8 x 11  | typ. 85 nH  |
|                                    | 6.5 x 18  | typ. 25 nH  |
|                                    | 8 x 18  | typ. 40 nH  |
|                                    | 10 x 18   | typ. 61 nH  |
| 10 x 25                            | typ. 38 nH  |   |
| <b>Resistance</b>                  |   |   |
| Equivalent series resistance (ESR) | Calculated from $\tan \delta_{max.}$ and $C_R$ (see table 2)  | $ESR = \tan \delta / 2\pi f C_R$  |

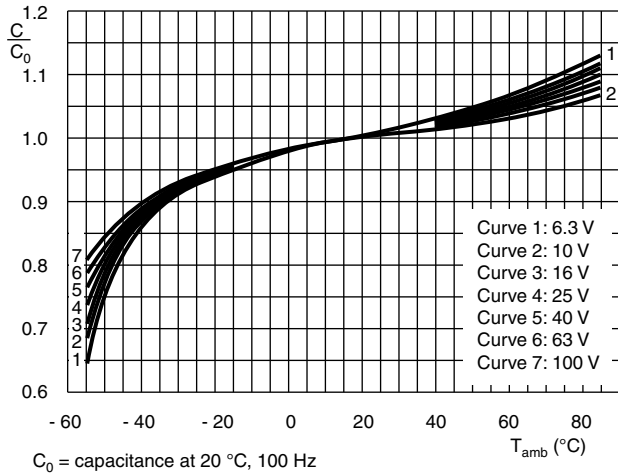
**CAPACITANCE (C)**


Fig. 4 - Typical multiplier of capacitance as a function of ambient temperature



Fig. 5 - Typical multiplier of capacitance as a function of frequency

**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)**

Table 3

| T <sub>amb</sub> | Z x C <sub>R</sub> (Ω x μF) |        |        |        |       |       |       |
|------------------|-----------------------------|--------|--------|--------|-------|-------|-------|
|                  | 6.3 V                       | 10 V   | 16 V   | 25 V   | 40 V  | 63 V  | 100 V |
| +20 °C           | ≤ 200                       | ≤ 160  | ≤ 120  | ≤ 90   | ≤ 70  | ≤ 55  | ≤ 45  |
| -25 °C           | ≤ 1200                      | ≤ 750  | ≤ 560  | ≤ 400  | ≤ 300 | ≤ 180 | ≤ 130 |
| -40 °C           | ≤ 3200                      | ≤ 2000 | ≤ 1500 | ≤ 1100 | ≤ 900 | ≤ 500 | ≤ 350 |

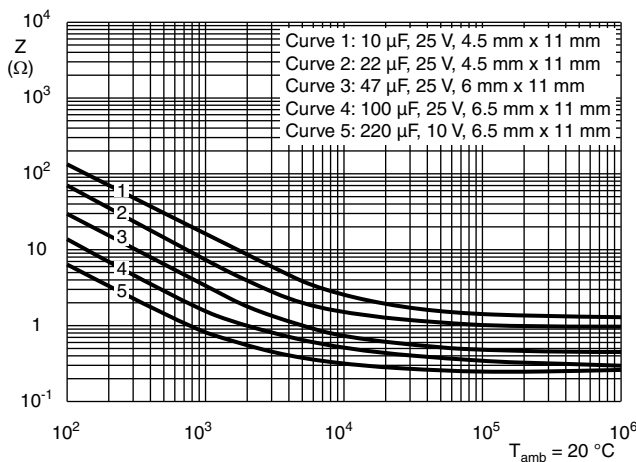


Fig. 8 - Typical impedance as a function of frequency

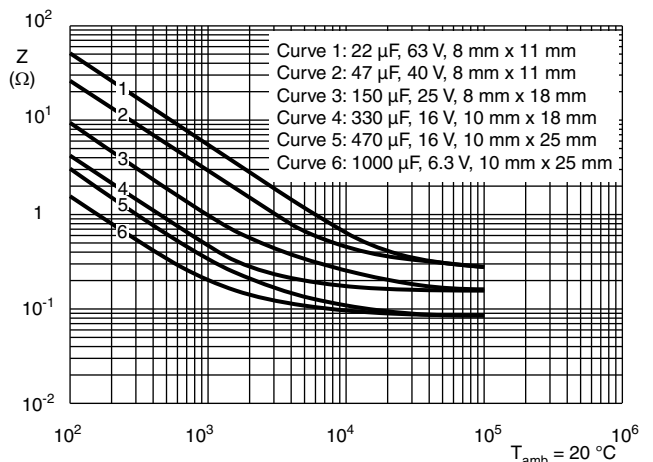


Fig. 9 - Typical impedance as a function of frequency

**RIPPLE CURRENT AND USEFUL LIFE**

Table 4

| ENDURANCE TEST DURATION AND USEFUL LIFE |                          |
|---|--------------------------|
| ENDURANCE AT 85 °C (h)                  | USEFUL LIFE AT 85 °C (h) |
| 2000                                    | 3000                     |

**Note**

- Multiplier of useful life code: CCC205



Fig. 10 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 5

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |                |      |      |      |      |                |
|---|----------------|------|------|------|------|----------------|
| $U_R$<br>(V)  | FREQUENCY (Hz) |      |      |      |      |                |
|   | 50             | 100  | 300  | 1000 | 3000 | $\geq 10\,000$ |
| $I_R$ MULTIPLIER  |                |      |      |      |      |                |
| 6.3   | 0.95           | 1.00 | 1.07 | 1.12 | 1.15 | 1.20           |
| 10  | 0.95           | 1.00 | 1.07 | 1.12 | 1.15 | 1.20           |
| 16  | 0.90           | 1.00 | 1.12 | 1.20 | 1.25 | 1.30           |
| 25  | 0.90           | 1.00 | 1.12 | 1.20 | 1.25 | 1.30           |
| 40  | 0.85           | 1.00 | 1.20 | 1.30 | 1.35 | 1.40           |
| 63  | 0.85           | 1.00 | 1.20 | 1.30 | 1.35 | 1.40           |
| 100   | 0.85           | 1.00 | 1.20 | 1.30 | 1.35 | 1.40           |



Table 6

| TEST PROCEDURES AND REQUIREMENTS                           |                                     |   |   |
|--|-------------------------------------|---|---|
| TEST   |                                     | PROCEDURE<br>(quick reference)  | REQUIREMENTS  |
| NAME OF TEST   | REFERENCE                           |   |   |
| Case $\varnothing$ D x L = 4.5 mm x 10 mm to 10 mm x 25 mm |                                     |   |   |
| Endurance  | IEC 384-4 / EN130300 subclause 4.13 | $T_{amb} = 85\text{ }^{\circ}\text{C}$ ; $U_R$ applied; 2000 h  | $U_R \leq 6.3\text{ V}$ ; $\Delta C/C$ : +15 % / -30 %<br>$U_R > 6.3\text{ V}$ ; $\Delta C/C$ : $\pm 15\text{ }%$<br>$\tan \delta \leq 1.3 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_L \leq \text{spec. limit}$  |
| Useful life  | CECC 30301 subclause 1.8.1          | $T_{amb} = 85\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied; 3000 h  | $U_R \leq 6.3\text{ V}$ ; $\Delta C/C$ : +45 % / -50 %<br>$U_R > 6.3\text{ V}$ ; $\Delta C/C$ : $\pm 45\text{ }%$<br>$\tan \delta \leq 3 \times \text{spec. limit}$<br>$Z \leq 3 \times \text{spec. limit}$<br>$I_L \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1\text{ }%$ |
| Shelf life (storage at high temperature)                   | IEC 384-4 / EN130300 subclause 4.17 | $T_{amb} = 85\text{ }^{\circ}\text{C}$ ; no voltage applied; 500 h<br>After test: $U_R$ to be applied for 30 min, 24 h to 48 h before measurement | $\Delta C/C$ , $\tan \delta$ , Z:<br>for requirements see "Endurance test" above<br>$I_L \leq 2 \times \text{spec. limit}$  |

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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