

## Aluminum Capacitors Axial Standard

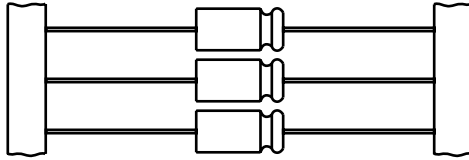
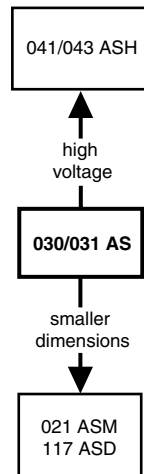


Fig.1 Component outlines



### 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 hours at 85 °C (case  $\varnothing$  D = 3.3 mm: 1500 hours)
- Standard dimensions
- Lead (Pb)-free versions are RoHS compliant
- Compliant to RoHS directive 2002/95/EC


**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  $\mu\text{F}$ )
- 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
- Band to indicate the negative terminal
- '+' sign to identify the positive terminal (not for case sizes  $L < 18$  mm)
- Series number (030 or 031)

| QUICK REFERENCE DATA                               |  |                        |
|--|--|------------------------|
| DESCRIPTION  | VALUE                                    |                        |
| Nominal case sizes<br>( $\varnothing$ D x L in mm) | 3.3 x 11                                 | 4.5 x 10<br>to 10 x 25 |
| Rated capacitance range, $C_R$                     | 0.47 $\mu\text{F}$ to 1000 $\mu\text{F}$ |                        |
| 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                            | 1000 hours                               | 2000 hours             |
| Useful life at 85 °C                               | 1500 hours                               | 3000 hours             |
| Useful life at 40 °C,<br>1.4 x $I_R$ applied       | 40 000 hours                             | 80 000 hours           |
| Shelf life at 0 V, 85 °C                           | 500 hours                                |                        |
| Based on sectional specification                   | IEC 60384-4/EN130300                     |                        |
| Climatic category IEC 60068                        | 40/085/56                                |                        |

| SELECTION CHART FOR C <sub>R</sub> , U <sub>R</sub> AND RELEVANT NOMINAL CASE SIZES (∅ D x L in mm) |                    |          |          |          |          |          |          |
|---|--------------------|----------|----------|----------|----------|----------|----------|
| C <sub>R</sub><br>(μF)  | U <sub>R</sub> (V) |          |          |          |          |          |          |
|   | 6.3                | 10       | 16       | 25       | 40       | 63       | 100      |
| 0.47  | -                  | -        | -        | -        | -        | -        | 4.5 x 10 |
| 1.0   | -                  | -        | -        | -        | -        | 4.5 x 10 | 4.5 x 10 |
|   | -                  | -        | -        | -        | -        | 3.3 x 11 | -        |
| 2.2   | -                  | -        | -        | -        | 3.3 x 11 | 4.5 x 10 | 4.5 x 10 |
| 3.3   | -                  | -        | -        | -        | -        | 4.5 x 10 | 4.5 x 10 |
| 4.7   | -                  | -        | 3.3 x 11 | -        | -        | 4.5 x 10 | 6 x 10   |
| 6.8   | -                  | -        | -        | -        | -        | 4.5 x 10 | 6 x 10   |
| 10  | 3.3 x 11           | -        | -        | 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**

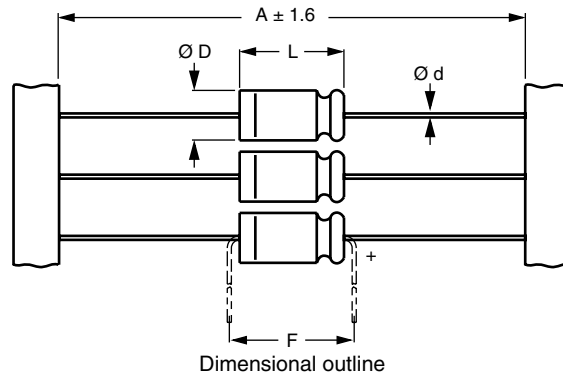


Fig.2 Form BR: Taped on reel, non-preferred

Table 1

| AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES |           |                      |            |                     |                   |                   |          |                      |         |
|---|-----------|----------------------|------------|---------------------|-------------------|-------------------|----------|----------------------|---------|
| NOMINAL CASE SIZE<br>∅ D x L                                    | CASE CODE | AXIAL FORM BA and BR |            |                     |                   |                   | MASS (g) | PACKAGING QUANTITIES |         |
|   |           | ∅ d                  | A          | ∅ D <sub>max.</sub> | L <sub>max.</sub> | F <sub>min.</sub> |          | FORM BA              | FORM BR |
| 3.3 x 11  | 1         | 0.6                  | 63.5 ± 1.5 | 3.5                 | 12                | 17.5              | ≈ 0.35   | 1000                 | 4000    |
| 4.5 x 10  | 2         | 0.6                  | 63.5 ± 1.5 | 5.0                 | 10.5              | 15                | ≈ 0.5    | 1000                 | 3000    |
| 6 x 10  | 3         | 0.6                  | 63.5 ± 1.5 | 6.3                 | 10.5              | 15                | ≈ 0.7    | 1000                 | 1000    |
| 8 x 11  | 5a        | 0.6                  | 63.5 ± 1.5 | 8.5                 | 11.5              | 15                | ≈ 1.1    | 500                  | 500     |
| 6.5 x 18  | 4         | 0.8                  | 73 ± 1.6   | 6.9                 | 18.5              | 25                | ≈ 1.3    | 1000                 | 1000    |
| 8 x 18  | 5         | 0.8                  | 73 ± 1.6   | 8.5                 | 18.5              | 25                | ≈ 1.7    | 500                  | 500     |
| 10 x 18   | 6         | 0.8                  | 73 ± 1.6   | 10.5                | 18.5              | 25                | ≈ 2.5    | 500                  | 500     |
| 10 x 25   | 7         | 0.8                  | 73 ± 1.6   | 10.5                | 25.0              | 30                | ≈ 3.3    | 500                  | 500     |

**Note**

Detailed tape dimensions see section 'PACKAGING'.



| 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 minute at $U_R$  |
| $I_{L5}$        | max. leakage current after 5 minutes at $U_R$   |
| $\tan \delta$   | max. dissipation factor at 100 Hz   |
| ESR             | equivalent series resistance at 100 Hz (calculated from $\tan \delta_{max}$ and $C_R$ ) |
| Z               | max. impedance at 10 kHz  |

**ORDERING EXAMPLE**

Electrolytic capacitor 031 series  
 330  $\mu$ F/10 V; - 10 %/+ 50 %  
 Nominal case size:  $\varnothing$  8 mm x 18 mm; Form BA  
 Ordering code: MAL203134331E3  
 Former 12NC: 2222 031 34331

**Note**

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

Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION |                               |   |              |                                  |                                 |                                 |                         |                               |                             |                             |                         |
|--|-------------------------------|---|--------------|----------------------------------|---------------------------------|---------------------------------|-------------------------|-------------------------------|-----------------------------|-----------------------------|-------------------------|
| $U_R$<br>(V)                             | $C_R$<br>100 Hz<br>( $\mu$ F) | NOMINAL<br>CASE 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>( $\Omega$ ) | ORDERING CODE<br>MAL2.....  |                         |
|  |                               |   |              |                                  |                                 |                                 |                         |                               |                             | TAPED ON<br>REEL<br>FORM BR | TAPED IN BOX<br>FORM BA |
| 6.3                                      | 10                            | 3.3 x 11  | 1            | 15                               | 5                               | 5.1                             | 0.30                    | 47.8                          | 20                          | 03023109E3                  | 03033109E3              |
|  | 68                            | 4.5 x 10  | 2            | 75                               | 22                              | 5.9                             | 0.25                    | 5.86                          | 2.9                         | 03023689E3                  | 03033689E3              |
|  | 150                           | 6 x 10  | 3            | 120                              | 10                              | 6.9                             | 0.25                    | 2.66                          | 1.3                         | 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                          | 3.4                         | 03024479E3                  | 03034479E3              |
|  | 100                           | 6 x 10  | 3            | 110                              | 10                              | 7.0                             | 0.20                    | 3.19                          | 1.6                         | 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              |
|  | 4.7                           | 3.3 x 11  | 1            | 15                               | 5                               | 5.1                             | 0.20                    | 67.8                          | 26                          | 03025478E3                  | 03035478E3              |
|  | 33                            | 4.5 x 10  | 2            | 65                               | 27                              | 6.1                             | 0.16                    | 7.72                          | 3.6                         | 03025339E3                  | 03035339E3              |
|  | 68                            | 6 x 10  | 3            | 110                              | 11                              | 7.2                             | 0.16                    | 3.75                          | 1.8                         | 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              |
| 25                                       | 220                           | 8 x 18  | 5            | 270                              | 26                              | 12                              | 0.16                    | 1.16                          | 0.55                        | 03125221E3                  | 03135221E3              |
|  | 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                           | 03026109E3                  | 03036109E3              |
|  | 22                            | 4.5 x 10  | 2            | 60                               | 28                              | 6.1                             | 0.14                    | 10.2                          | 4.1                         | 03026229E3                  | 03036229E3              |
|  | 47                            | 6 x 10  | 3            | 100                              | 12                              | 7.4                             | 0.14                    | 4.8                           | 1.9                         | 03026479E3                  | 03036479E3              |
| 25                                       | 100                           | 8 x 11  | 5a           | 160                              | 19                              | 10                              | 0.14                    | 2.23                          | 0.90                        | 03026101E3                  | 03036101E3              |
|  | 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                                       | 2.2                              | 3.3 x 11                                | 1            | 15  | 5                                | 5.1                              | 0.15            | 109                  | 32                 | 03027228E3                  | 03037228E3              |
|  | 10                               | 4.5 x 10                                | 2            | 50  | 20                               | 5.8                              | 0.11            | 17.6                 | 7                  | 03027109E3                  | 03037109E3              |
|  | 15                               | 4.5 x 10                                | 2            | 55  | 30                               | 6.2                              | 0.11            | 11.7                 | 4.7                | 03027159E3                  | 03037159E3              |
|  | 22                               | 6 x 10                                  | 3            | 75  | 9                                | 6.8                              | 0.11            | 8.0                  | 3.2                | 03027229E3                  | 03037229E3              |
|  | 33                               | 6 x 10                                  | 3            | 95  | 12                               | 7.7                              | 0.11            | 5.31                 | 2.1                | 03027339E3                  | 03037339E3              |
|  | 47                               | 8 x 11                                  | 5a           | 150                                       | 16                               | 8.8                              | 0.11            | 3.73                 | 1.5                | 03027479E3                  | 03037479E3              |
|  | 47                               | 6.5 x 18                                | 4            | 150                                       | 16                               | 8.8                              | 0.11            | 3.73                 | 1.5                | 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                              | 3.3 x 11                                | 1            | 10  | 5                                | 5.1                              | 0.12            | 191                  | 55                 | 03090067E3                  | 03090068E3              |
|  | 1.0                              | 4.5 x 10                                | 2            | 13  | 5                                | 5.1                              | 0.09            | 143                  | 55                 | 03028108E3                  | 03038108E3              |
|  | 2.2                              | 4.5 x 10                                | 2            | 25  | 7                                | 5.3                              | 0.09            | 65.2                 | 25                 | 03028228E3                  | 03038228E3              |
|  | 3.3                              | 4.5 x 10                                | 2            | 35  | 11                               | 5.4                              | 0.09            | 46.5                 | 17                 | 03028338E3                  | 03038338E3              |
|  | 4.7                              | 4.5 x 10                                | 2            | 40  | 15                               | 5.6                              | 0.09            | 30.5                 | 12                 | 03028478E3                  | 03038478E3              |
|  | 6.8                              | 4.5 x 10                                | 2            | 46  | 22                               | 5.9                              | 0.09            | 21.1                 | 8.1                | 03028688E3                  | 03038688E3              |
|  | 10                               | 6 x 10                                  | 3            | 70  | 7                                | 6.3                              | 0.08            | 12.8                 | 5.5                | 03028109E3                  | 03038109E3              |
|  | 15                               | 6 x 10                                  | 3            | 79  | 10                               | 6.9                              | 0.08            | 8.5                  | 3.7                | 03028159E3                  | 03038159E3              |
|  | 22                               | 8 x 11                                  | 5a           | 110                                       | 13                               | 7.8                              | 0.08            | 5.79                 | 2.5                | 03028229E3                  | 03038229E3              |
|  | 22                               | 6.5 x 18                                | 4            | 110                                       | 13                               | 7.8                              | 0.08            | 5.79                 | 2.5                | 03128229E3                  | 03138229E3              |
|  | 47                               | 8 x 18                                  | 5            | 190                                       | 22                               | 11                               | 0.08            | 2.71                 | 1.2                | 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                                      | 0.47                             | 4.5 x 10                                | 2            | 9   | 5                                | 4.3                              | 0.08            | 271                  | 96                 | 03029477E3                  | 03039477E3              |
|  | 1.0                              | 4.5 x 10                                | 2            | 20  | 5                                | 4.6                              | 0.08            | 128                  | 45                 | 03029108E3                  | 03039108E3              |
|  | 2.2                              | 4.5 x 10                                | 2            | 30  | 11                               | 5.3                              | 0.08            | 57.9                 | 21                 | 03029228E3                  | 03039228E3              |
|  | 3.3                              | 4.5 x 10                                | 2            | 40  | 17                               | 6.0                              | 0.08            | 38.6                 | 14                 | 03029338E3                  | 03039338E3              |
|  | 4.7                              | 6 x 10                                  | 3            | 50  | 13                               | 6.8                              | 0.07            | 23.7                 | 9.6                | 03029478E3                  | 03039478E3              |
|  | 6.8                              | 6 x 10                                  | 3            | 70  | 18                               | 8.0                              | 0.07            | 16.4                 | 6.6                | 03029688E3                  | 03039688E3              |
|  | 10                               | 8 x 11                                  | 5a           | 90  | 24                               | 10                               | 0.07            | 11.2                 | 4.5                | 03029109E3                  | 03039109E3              |
|  | 10                               | 6.5 x 18                                | 4            | 90  | 24                               | 10                               | 0.07            | 11.2                 | 4.5                | 03129109E3                  | 03139109E3              |
|  | 22                               | 8 x 18                                  | 5            | 120                                       | 48                               | 18                               | 0.07            | 5.07                 | 2.1                | 03129229E3                  | 03139229E3              |
|  | 33                               | 10 x 18                                 | 6            | 200                                       | 70                               | 24                               | 0.07            | 3.38                 | 1.4                | 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 minute at $U_R$ :<br>Case $\varnothing D \times L = 3.3 \text{ mm} \times 11 \text{ mm}$ and $4.5 \text{ mm} \times 10 \text{ mm}$ | $I_{L1} \leq 0.05 C_R \times U_R$ or $5 \mu\text{A}$ , whichever is greater  |
|                                    | Case $\varnothing D \times L = 6 \text{ mm} \times 10 \text{ mm}$ to $10 \text{ mm} \times 25 \text{ mm}$<br><br>$U_R = 100 \text{ V}$     | $I_{L1}$ 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 minutes:<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 $\varnothing D \times L$ mm:<br><br>3.3 x 11<br>4.5 x 10<br>6 x 10<br>8 x 11<br>6.5 x 18<br>8 x 18<br>10 x 18<br>10 x 25              | typ. 11 nH<br>typ. 10 nH<br>typ. 22 nH<br>typ. 85 nH<br>typ. 25 nH<br>typ. 40 nH<br>typ. 61 nH<br>typ. 38 nH   |
| <b>Resistance</b>                  |  |  |
| Equivalent series resistance (ESR) | Calculated from $\tan \delta_{max}$ and $C_R$ (see Table 2)  | $ESR = \tan \delta / 2 \pi f C_R$  |

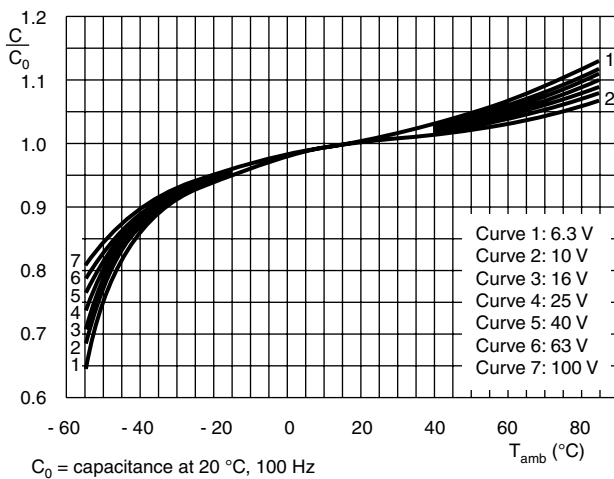
**CAPACITANCE (C)**


Fig.3 Typical multiplier of capacitance as a function of ambient temperature

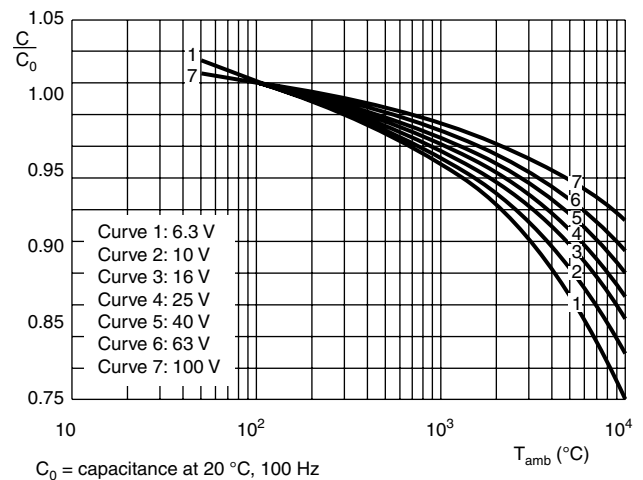


Fig.4 Typical multiplier of capacitance as a function of frequency

**EQUIVALENT SERIES RESISTANCE (ESR)**

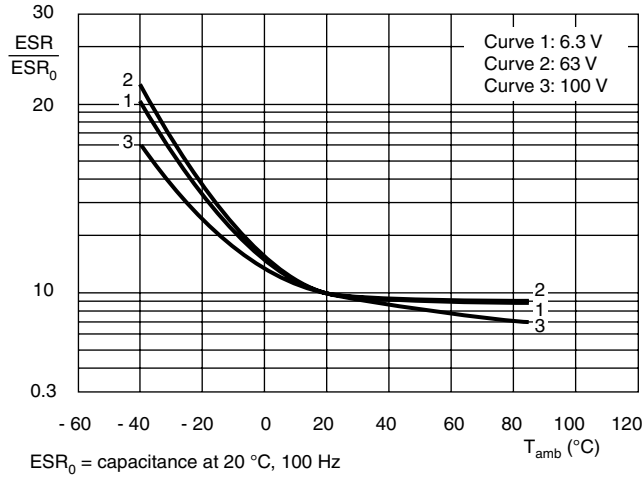


Fig.5 Typical multiplier of ESR as a function of ambient temperature

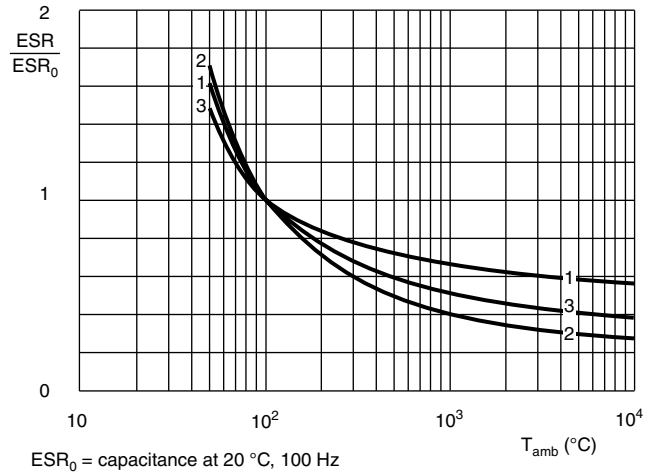


Fig.6 Typical multiplier of ESR as a function of frequency

**IMPEDANCE (Z)**

Table 3

| IMPEDANCE VS. CAPACITANCE VALUES AT 10 kHz |                                      |        |        |        |       |       |       |
|--|--------------------------------------|--------|--------|--------|-------|-------|-------|
| $T_{amb}$                                  | $Z \times C_R (\Omega \times \mu F)$ |        |        |        |       |       |       |
|  | 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 |

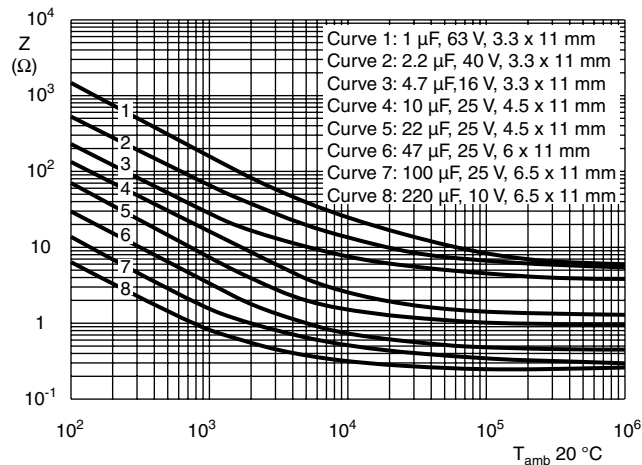


Fig.7 Typical impedance as a function of frequency

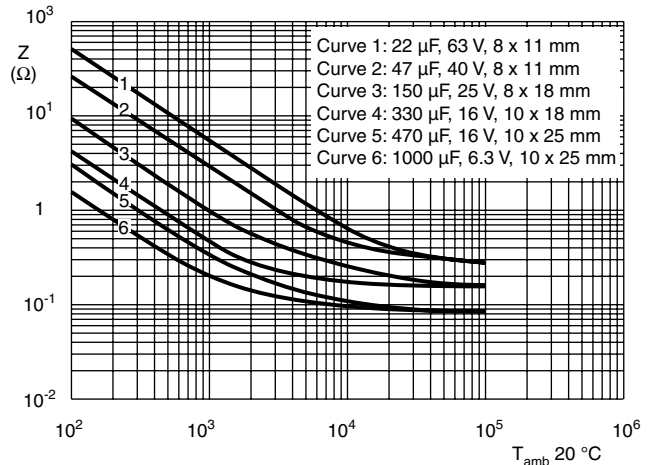


Fig.8 Typical impedance as a function of frequency

**RIPPLE CURRENT AND USEFUL LIFE**

CCC205

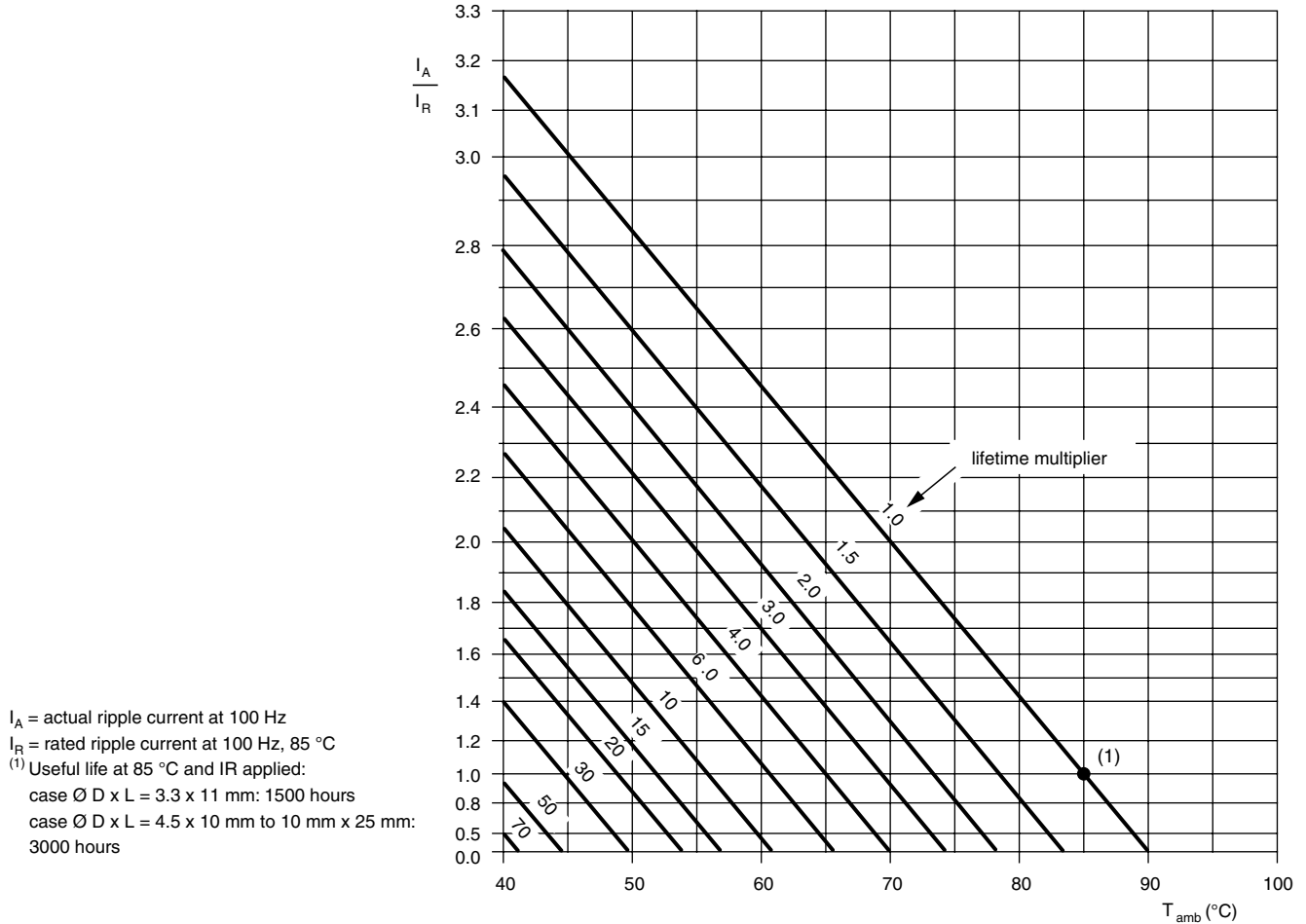


Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

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

Table 5

| <b>TEST PROCEDURES AND REQUIREMENTS</b>             |  |   |   |
|---|--|---|---|
| <b>TEST</b>   |  | <b>PROCEDURE<br/>(quick reference)</b>  | <b>REQUIREMENTS</b>   |
| <b>NAME OF TEST</b>                                 | <b>REFERENCE</b>                         |   |   |
| <b>Case Ø D x L = 3.3 mm x 11 mm</b>                |  |   |   |
| Endurance   | IEC 384-4/<br>EN130300<br>subclause 4.13 | $T_{amb} = 85\text{ °C}$ ; $U_R$ applied;<br>1000 hours   | $\Delta C/C: \pm 20\%$<br>$\tan \delta \leq 2 \times \text{spec. limit}$<br>$Z \leq 3 \times \text{spec. limit}$<br>$I_L \leq \text{spec. limit}$   |
| Useful life   | CECC 30301<br>subclause 1.8.1            | $T_{amb} = 85\text{ °C}$ ; $U_R$ and $I_R$ applied;<br>1500 hours   | $\Delta C/C: \pm 50\%$<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: $\leq 3\%$   |
| Shelf life<br>(storage at<br>high temperature)      | IEC 384-4/<br>EN130300<br>subclause 4.17 | $T_{amb} = 85\text{ °C}$ ; no voltage applied;<br>500 hours<br><br>After test: $U_R$ to be applied for 30 minutes,<br>24 hours to 48 hours before measurement | $\Delta C/C, \tan \delta, Z$ :<br>for requirements<br>see 'Endurance test' above<br>$I_L \leq 2 \times \text{spec. limit}$  |
| <b>Case Ø D L = 4.5 mm x 10 mm to 10 mm x 25 mm</b> |  |   |   |
| Endurance   | IEC 384-4/<br>EN130300<br>subclause 4.13 | $T_{amb} = 85\text{ °C}$ ; $U_R$ applied;<br>2000 hours   | $U_R \leq 6.3\text{ V}$ ; $\Delta C/C: + 15\%/- 30\%$<br>$U_R > 6.3\text{ V}$ ; $\Delta C/C: \pm 15\%$<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<br>subclause 1.8.1            | $T_{amb} = 85\text{ °C}$ ; $U_R$ and $I_R$ applied;<br>3000 hours   | $U_R \leq 6.3\text{ V}$ ; $\Delta C/C: + 45\%/- 50\%$<br>$U_R > 6.3\text{ V}$ ; $\Delta C/C: \pm 45\%$<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: $\leq 1\%$ |
| Shelf life<br>(storage at<br>high temperature)      | IEC 384-4/<br>EN130300<br>subclause 4.17 | $T_{amb} = 85\text{ °C}$ ; no voltage applied;<br>500 hours<br><br>After test: $U_R$ to be applied for 30 minutes,<br>24 hours to 48 hours before measurement | $\Delta C/C, \tan \delta, Z$ :<br>for requirements<br>see 'Endurance test' above<br>$I_L \leq 2 \times \text{spec. limit}$  |





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- Техническая поддержка проекта;
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