

## Aluminum Capacitors Axial Standard

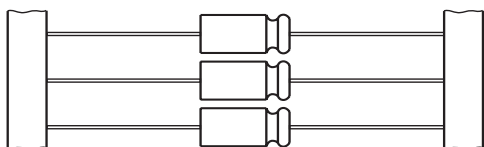
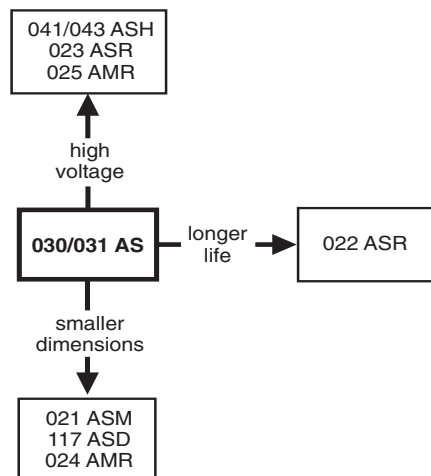


Fig.1 Component outlines



### 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



Available  
**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

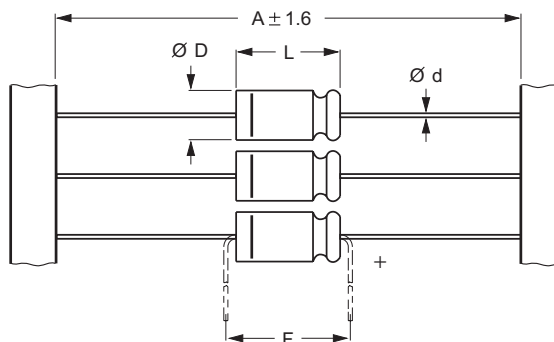
The capacitors are marked (where possible) with the following information:

- 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
- 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 ( $\varnothing D \times L$ in mm) | $3.3 \times 11$      | $4.5 \times 10$<br>to $10 \times 25$ |
| Rated capacitance range, $C_R$                       | 0.47 to 1000 $\mu F$ |                                      |
| Tolerance on $C_R$                                   | $-10$ to $+50$ %     |                                      |
| Rated voltage, $U_R$                                 | 6.3 to 100 V         |                                      |
| Category temperature range                           | $-40$ 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, $1.4 \times I_R$ applied       | 40000 hours          | 80000 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            |                                      |

\* Pb containing terminations are not RoHS compliant, exemptions may apply

| <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      |
| 0.47                                                                                                                                      | –         | –        | –        | –        | –        | –        | 4.5 × 10 |
| 1.0                                                                                                                                       | –         | –        | –        | –        | –        | 4.5 × 10 | 4.5 × 10 |
|                                                                                                                                           | –         | –        | –        | –        | –        | 3.3 × 11 | –        |
| 2.2                                                                                                                                       | –         | –        | –        | –        | 3.3 × 11 | 4.5 × 10 | 4.5 × 10 |
| 3.3                                                                                                                                       | –         | –        | –        | –        | –        | 4.5 × 10 | 4.5 × 10 |
| 4.7                                                                                                                                       | –         | –        | 3.3 × 11 | –        | –        | 4.5 × 10 | 6 × 10   |
| 6.8                                                                                                                                       | –         | –        | –        | –        | –        | 4.5 × 10 | 6 × 10   |
| 10                                                                                                                                        | 3.3 × 11  | –        | –        | 4.5 × 10 | 4.5 × 10 | 6 × 10   | 8 × 11   |
|                                                                                                                                           | –         | –        | –        | –        | –        | –        | 6.5 × 18 |
| 15                                                                                                                                        | –         | –        | –        | –        | 4.5 × 10 | 6 × 10   | –        |
| 22                                                                                                                                        | –         | –        | –        | 4.5 × 10 | 6 × 10   | 8 × 11   | 8 × 18   |
|                                                                                                                                           | –         | –        | –        | –        | –        | 6.5 × 18 | –        |
| 33                                                                                                                                        | –         | –        | 4.5 × 10 | –        | 6 × 10   | –        | 10 × 18  |
| 47                                                                                                                                        | –         | 4.5 × 10 | –        | 6 × 10   | 8 × 11   | 8 × 18   | 10 × 25  |
|                                                                                                                                           | –         | –        | –        | –        | 6.5 × 18 | –        | –        |
| 68                                                                                                                                        | 4.5 × 10  | –        | 6 × 10   | –        | –        | 10 × 18  | –        |
| 100                                                                                                                                       | –         | 6 × 10   | –        | 8 × 11   | 8 × 18   | 10 × 25  | –        |
|                                                                                                                                           | –         | –        | –        | 6.5 × 18 | –        | –        | –        |
| 150                                                                                                                                       | 6 × 10    | –        | 8 × 11   | 8 × 18   | 10 × 18  | –        | –        |
|                                                                                                                                           | –         | –        | 6.5 × 18 | –        | –        | –        | –        |
| 220                                                                                                                                       | –         | 8 × 11   | 8 × 18   | 10 × 18  | 10 × 25  | –        | –        |
|                                                                                                                                           | –         | 6.5 × 18 | –        | –        | –        | –        | –        |
| 330                                                                                                                                       | –         | 8 × 18   | 10 × 18  | 10 × 25  | –        | –        | –        |
| 470                                                                                                                                       | 8 × 18    | 10 × 18  | 10 × 25  | –        | –        | –        | –        |
| 680                                                                                                                                       | 10 × 18   | 10 × 25  | –        | –        | –        | –        | –        |
| 1000                                                                                                                                      | 10 × 25   | –        | –        | –        | –        | –        | –        |

**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**


**Form BR:** Taped on reel,  
non-preferred.

Fig.2 Dimensional outline.

Table 1

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

**Note**

1. 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<br>(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:  $\varnothing 8 \times 18$  mm; Form BA

Catalog number: 2222 031 34331.

\* To ensure delivery of lead (Pb)-free parts during the transition period, please contact your Vishay sales agent.

**Note**

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

**Table 2 Table 2**

| ELECTRICAL DATA AND ORDERING INFORMATION |                               |                                                          |              |                                  |                                 |                                 |                         |                               |                             |                               |                         |
|------------------------------------------|-------------------------------|----------------------------------------------------------|--------------|----------------------------------|---------------------------------|---------------------------------|-------------------------|-------------------------------|-----------------------------|-------------------------------|-------------------------|
| $U_R$<br>(V)                             | $C_R$<br>100 Hz<br>( $\mu$ F) | NOMINAL<br>CASE SIZE<br>$\varnothing D \times L$<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>( $\Omega$ ) | CATALOG<br>NUMBER 2222 ... .. |                         |
|                                          |                               |                                                          |              |                                  |                                 |                                 |                         |                               |                             | TAPED ON<br>REEL<br>FORM BR   | TAPED IN BOX<br>FORM BA |
| 6.3                                      | 10                            | 3.3 $\times$ 11                                          | 1            | 15                               | 5                               | 5.1                             | 0.30                    | 47.8                          | 20                          | 030 23109                     | 030 33109               |
|                                          | 68                            | 4.5 $\times$ 10                                          | 2            | 75                               | 22                              | 5.9                             | 0.25                    | 5.86                          | 2.9                         | 030 23689                     | 030 33689               |
|                                          | 150                           | 6 $\times$ 10                                            | 3            | 120                              | 10                              | 6.9                             | 0.25                    | 2.66                          | 1.3                         | 030 23151                     | 030 33151               |
|                                          | 470                           | 8 $\times$ 18                                            | 5            | 330                              | 22                              | 11                              | 0.25                    | 0.85                          | 0.43                        | 031 23471                     | 031 33471               |
|                                          | 680                           | 10 $\times$ 18                                           | 6            | 430                              | 30                              | 14                              | 0.25                    | 0.59                          | 0.29                        | 031 23681                     | 031 33681               |
|                                          | 1000                          | 10 $\times$ 25                                           | 7            | 560                              | 42                              | 18                              | 0.25                    | 0.40                          | 0.20                        | 031 23102                     | 031 33102               |
| 10                                       | 47                            | 4.5 $\times$ 10                                          | 2            | 70                               | 24                              | 5.9                             | 0.20                    | 6.78                          | 3.4                         | 030 24479                     | 030 34479               |
|                                          | 100                           | 6 $\times$ 10                                            | 3            | 110                              | 10                              | 7.0                             | 0.20                    | 3.19                          | 1.6                         | 030 24101                     | 030 34101               |
|                                          | 220                           | 8 $\times$ 11                                            | 5a           | 210                              | 18                              | 9.4                             | 0.20                    | 1.45                          | 0.73                        | 030 24221                     | 030 34221               |
|                                          | 220                           | 6.5 $\times$ 18                                          | 4            | 210                              | 18                              | 9.4                             | 0.20                    | 1.45                          | 0.73                        | 031 24221                     | 031 34221               |
|                                          | 330                           | 8 $\times$ 18                                            | 5            | 310                              | 24                              | 12                              | 0.20                    | 0.97                          | 0.48                        | 031 24331                     | 031 34331               |
|                                          | 470                           | 10 $\times$ 18                                           | 6            | 410                              | 33                              | 14                              | 0.20                    | 0.68                          | 0.34                        | 031 24471                     | 031 34471               |
|                                          | 680                           | 10 $\times$ 25                                           | 7            | 510                              | 45                              | 19                              | 0.20                    | 0.47                          | 0.24                        | 031 24681                     | 031 34681               |
| 16                                       | 4.7                           | 3.3 $\times$ 11                                          | 1            | 15                               | 5                               | 5.1                             | 0.20                    | 67.8                          | 26                          | 030 25478                     | 030 35478               |
|                                          | 33                            | 4.5 $\times$ 10                                          | 2            | 65                               | 27                              | 6.1                             | 0.16                    | 7.72                          | 3.6                         | 030 25339                     | 030 35339               |
|                                          | 68                            | 6 $\times$ 10                                            | 3            | 110                              | 11                              | 7.2                             | 0.16                    | 3.75                          | 1.8                         | 030 25689                     | 030 35689               |
|                                          | 150                           | 8 $\times$ 11                                            | 5a           | 200                              | 19                              | 9.8                             | 0.16                    | 1.70                          | 0.80                        | 030 25151                     | 030 35151               |
|                                          | 150                           | 6.5 $\times$ 18                                          | 4            | 200                              | 19                              | 9.8                             | 0.16                    | 1.70                          | 0.80                        | 031 25151                     | 031 35151               |
|                                          | 220                           | 8 $\times$ 18                                            | 5            | 270                              | 26                              | 12                              | 0.16                    | 1.16                          | 0.55                        | 031 25221                     | 031 35221               |
|                                          | 330                           | 10 $\times$ 18                                           | 6            | 410                              | 36                              | 16                              | 0.16                    | 0.78                          | 0.36                        | 031 25331                     | 031 35331               |
|                                          | 470                           | 10 $\times$ 25                                           | 7            | 480                              | 49                              | 20                              | 0.16                    | 0.55                          | 0.26                        | 031 25471                     | 031 35471               |
|                                          |                               |                                                          |              |                                  |                                 |                                 |                         |                               |                             |                               |                         |
| 25                                       | 10                            | 4.5 $\times$ 10                                          | 2            | 50                               | 13                              | 5.5                             | 0.14                    | 22.3                          | 9                           | 030 26109                     | 030 36109               |
|                                          | 22                            | 4.5 $\times$ 10                                          | 2            | 60                               | 28                              | 6.1                             | 0.14                    | 10.2                          | 4.1                         | 030 26229                     | 030 36229               |
|                                          | 47                            | 6 $\times$ 10                                            | 3            | 100                              | 12                              | 7.4                             | 0.14                    | 4.8                           | 1.9                         | 030 26479                     | 030 36479               |
|                                          | 100                           | 8 $\times$ 11                                            | 5a           | 160                              | 19                              | 10                              | 0.14                    | 2.23                          | 0.90                        | 030 26101                     | 030 36101               |
|                                          | 100                           | 6.5 $\times$ 18                                          | 4            | 160                              | 19                              | 10                              | 0.14                    | 2.23                          | 0.90                        | 031 26101                     | 031 36101               |
|                                          | 150                           | 8 $\times$ 18                                            | 5            | 240                              | 27                              | 13                              | 0.14                    | 1.49                          | 0.60                        | 031 26151                     | 031 36151               |
|                                          | 220                           | 10 $\times$ 18                                           | 6            | 350                              | 37                              | 16                              | 0.14                    | 1.02                          | 0.41                        | 031 26221                     | 031 36221               |
|                                          | 330                           | 10 $\times$ 25                                           | 7            | 460                              | 54                              | 22                              | 0.14                    | 0.68                          | 0.27                        | 031 26331                     | 031 36331               |
|                                          |                               |                                                          |              |                                  |                                 |                                 |                         |                               |                             |                               |                         |

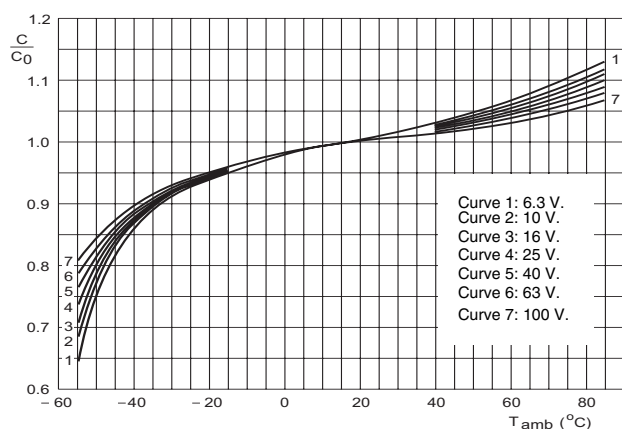
Aluminum Capacitors  
Axial Standard

Vishay BCcomponents

**ELECTRICAL DATA AND ORDERING INFORMATION**

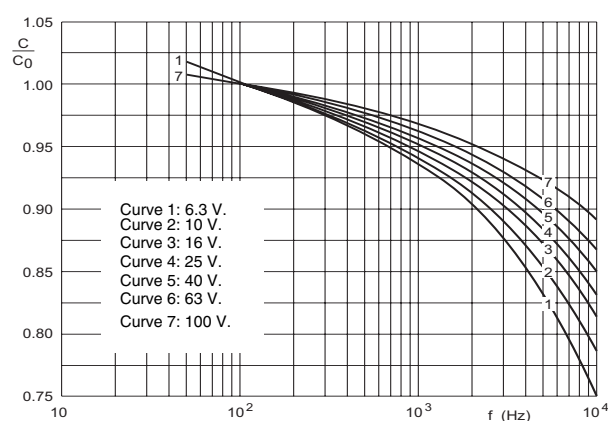
| U <sub>R</sub><br>(V) | C <sub>R</sub><br>100 Hz<br>(μF) | NOMINAL<br>CASE SIZE<br>ØD × L<br>(mm) | CASE<br>CODE | I <sub>R</sub><br>100 Hz<br>85 °C<br>(mA) | I <sub>L1</sub><br>1 min<br>(μA) | I <sub>L5</sub><br>5 min<br>(μA) | Tan d<br>100 Hz | ESR<br>100 Hz<br>(Ω) | Z<br>10 kHz<br>(Ω) | CATALOG<br>NUMBER 2222 ... .. |                         |
|-----------------------|----------------------------------|----------------------------------------|--------------|-------------------------------------------|----------------------------------|----------------------------------|-----------------|----------------------|--------------------|-------------------------------|-------------------------|
|                       |                                  |                                        |              |                                           |                                  |                                  |                 |                      |                    | TAPED ON<br>REEL<br>FORM BR   | TAPED IN BOX<br>FORM BA |
| 40                    | 2.2                              | 3.3 × 11                               | 1            | 15                                        | 5                                | 5.1                              | 0.15            | 109                  | 32                 | 030 27228                     | 030 37228               |
|                       | 10                               | 4.5 × 10                               | 2            | 50                                        | 20                               | 5.8                              | 0.11            | 17.6                 | 7                  | 030 27109                     | 030 37109               |
|                       | 15                               | 4.5 × 10                               | 2            | 55                                        | 30                               | 6.2                              | 0.11            | 11.7                 | 4.7                | 030 27159                     | 030 37159               |
|                       | 22                               | 6 × 10                                 | 3            | 75                                        | 9                                | 6.8                              | 0.11            | 8.0                  | 3.2                | 030 27229                     | 030 37229               |
|                       | 33                               | 6 × 10                                 | 3            | 95                                        | 12                               | 7.7                              | 0.11            | 5.31                 | 2.1                | 030 27339                     | 030 37339               |
|                       | 47                               | 8 × 11                                 | 5a           | 150                                       | 16                               | 8.8                              | 0.11            | 3.73                 | 1.5                | 030 27479                     | 030 37479               |
|                       | 47                               | 6.5 × 18                               | 4            | 150                                       | 16                               | 8.8                              | 0.11            | 3.73                 | 1.5                | 031 27479                     | 031 37479               |
|                       | 100                              | 8 × 18                                 | 5            | 220                                       | 28                               | 13                               | 0.11            | 1.75                 | 0.70               | 031 27101                     | 031 37101               |
|                       | 150                              | 10 × 18                                | 6            | 300                                       | 40                               | 17                               | 0.11            | 1.17                 | 0.47               | 031 27151                     | 031 37151               |
|                       | 220                              | 10 × 25                                | 7            | 430                                       | 57                               | 23                               | 0.11            | 0.80                 | 0.32               | 031 27221                     | 031 37221               |
| 63                    | 1.0                              | 3.3 × 11                               | 1            | 10                                        | 5                                | 5.1                              | 0.12            | 191                  | 55                 | 030 90067                     | 030 90068               |
|                       | 1.0                              | 4.5 × 10                               | 2            | 13                                        | 5                                | 5.1                              | 0.09            | 143                  | 55                 | 030 28108                     | 030 38108               |
|                       | 2.2                              | 4.5 × 10                               | 2            | 25                                        | 7                                | 5.3                              | 0.09            | 65.2                 | 25                 | 030 28228                     | 030 38228               |
|                       | 3.3                              | 4.5 × 10                               | 2            | 35                                        | 11                               | 5.4                              | 0.09            | 46.5                 | 17                 | 030 28338                     | 030 38338               |
|                       | 4.7                              | 4.5 × 10                               | 2            | 40                                        | 15                               | 5.6                              | 0.09            | 30.5                 | 12                 | 030 28478                     | 030 38478               |
|                       | 6.8                              | 4.5 × 10                               | 2            | 46                                        | 22                               | 5.9                              | 0.09            | 21.1                 | 8.1                | 030 28688                     | 030 38688               |
|                       | 10                               | 6 × 10                                 | 3            | 70                                        | 7                                | 6.3                              | 0.08            | 12.8                 | 5.5                | 030 28109                     | 030 38109               |
|                       | 15                               | 6 × 10                                 | 3            | 79                                        | 10                               | 6.9                              | 0.08            | 8.5                  | 3.7                | 030 28159                     | 030 38159               |
|                       | 22                               | 8 × 11                                 | 5a           | 110                                       | 13                               | 7.8                              | 0.08            | 5.79                 | 2.5                | 030 28229                     | 030 38229               |
|                       | 22                               | 6.5 × 18                               | 4            | 110                                       | 13                               | 7.8                              | 0.08            | 5.79                 | 2.5                | 031 28229                     | 031 38229               |
|                       | 47                               | 8 × 18                                 | 5            | 190                                       | 22                               | 11                               | 0.08            | 2.71                 | 1.2                | 031 28479                     | 031 38479               |
|                       | 68                               | 10 × 18                                | 6            | 250                                       | 30                               | 14                               | 0.08            | 1.88                 | 0.81               | 031 28689                     | 031 38689               |
|                       | 100                              | 10 × 25                                | 7            | 300                                       | 42                               | 18                               | 0.08            | 1.28                 | 0.55               | 031 28101                     | 031 38101               |
| 100                   | 0.47                             | 4.5 × 10                               | 2            | 9                                         | 5                                | 4.3                              | 0.08            | 271                  | 96                 | 030 29477                     | 030 39477               |
|                       | 1.0                              | 4.5 × 10                               | 2            | 20                                        | 5                                | 4.6                              | 0.08            | 128                  | 45                 | 030 29108                     | 030 39108               |
|                       | 2.2                              | 4.5 × 10                               | 2            | 30                                        | 11                               | 5.3                              | 0.08            | 57.9                 | 21                 | 030 29228                     | 030 39228               |
|                       | 3.3                              | 4.5 × 10                               | 2            | 40                                        | 17                               | 6.0                              | 0.08            | 38.6                 | 14                 | 030 29338                     | 030 39338               |
|                       | 4.7                              | 6 × 10                                 | 3            | 50                                        | 13                               | 6.8                              | 0.07            | 23.7                 | 9.6                | 030 29478                     | 030 39478               |
|                       | 6.8                              | 6 × 10                                 | 3            | 70                                        | 18                               | 8.0                              | 0.07            | 16.4                 | 6.6                | 030 29688                     | 030 39688               |
|                       | 10                               | 8 × 11                                 | 5a           | 90                                        | 24                               | 10                               | 0.07            | 11.2                 | 4.5                | 030 29109                     | 030 39109               |
|                       | 10                               | 6.5 × 18                               | 4            | 90                                        | 24                               | 10                               | 0.07            | 11.2                 | 4.5                | 031 29109                     | 031 39109               |
|                       | 22                               | 8 × 18                                 | 5            | 120                                       | 48                               | 18                               | 0.07            | 5.07                 | 2.1                | 031 29229                     | 031 39229               |
|                       | 33                               | 10 × 18                                | 6            | 200                                       | 70                               | 24                               | 0.07            | 3.38                 | 1.4                | 031 29339                     | 031 39339               |
|                       | 47                               | 10 × 25                                | 7            | 260                                       | 98                               | 33                               | 0.07            | 2.37                 | 0.96               | 031 29479                     | 031 39479               |

| 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 $\varnothing D \times L = 3.3 \times 11$ and $4.5 \times 10$ mm<br>case $\varnothing D \times L = 6 \times 10$ to $10 \times 25$ 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 minutes:<br>$U_R = 6.3$ 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 × 11<br>4.5 × 10<br>6 × 10<br>8 × 11<br>6.5 × 18<br>8 × 18<br>10 × 18<br>10 × 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)**

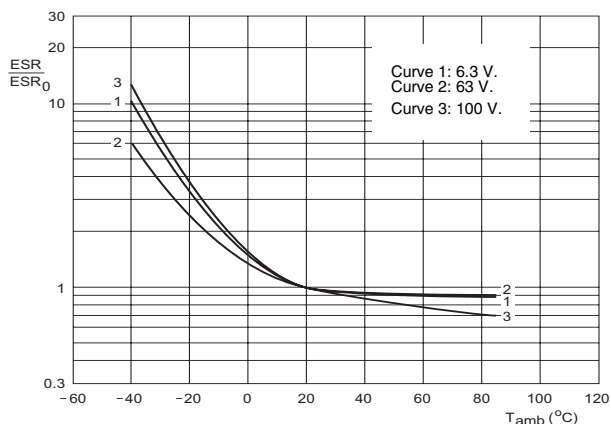
$C_0$  = capacitance at 20 °C, 100 Hz.

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



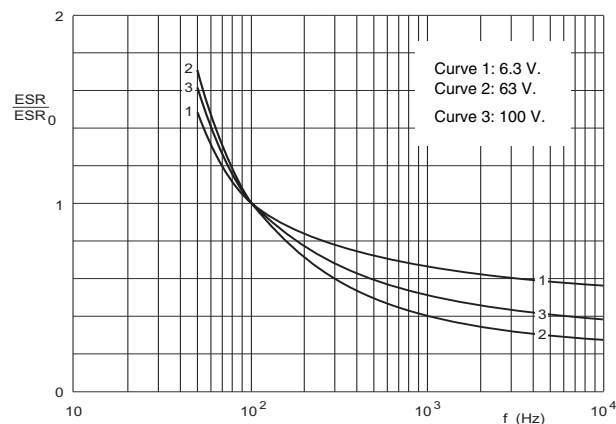
$C_0$  = capacitance at 20 °C, 100 Hz.

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

**EQUIVALENT SERIES RESISTANCE (ESR)**


$ESR_0$  = typical at 20 °C, 100 Hz.

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



$ESR_0$  = typical at 20 °C, 100 Hz.

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

**IMPEDANCE (Z)**

Table 3

| <b>IMPEDANCE × CAPACITANCE VALUES AT 10 KHz</b> |                                   |        |        |        |       |       |       |
|-------------------------------------------------|-----------------------------------|--------|--------|--------|-------|-------|-------|
| $T_{amb}$                                       | $Z \times C_R (\Omega \times MF)$ |        |        |        |       |       |       |
|                                                 | 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 |

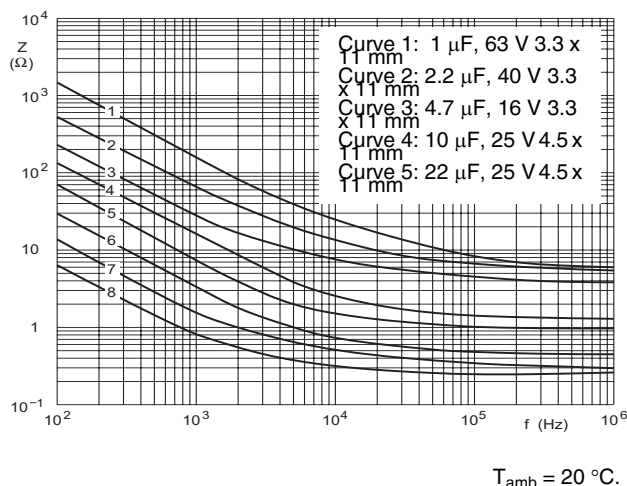


Fig.7 Typical impedance as a function of frequency.

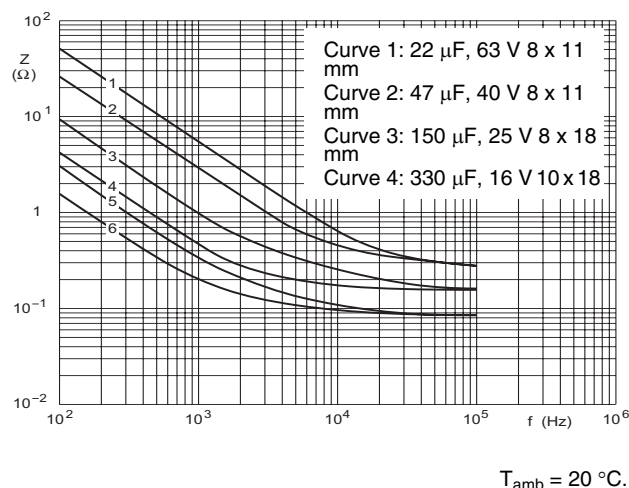


Fig.8 Typical impedance as a function of frequency.

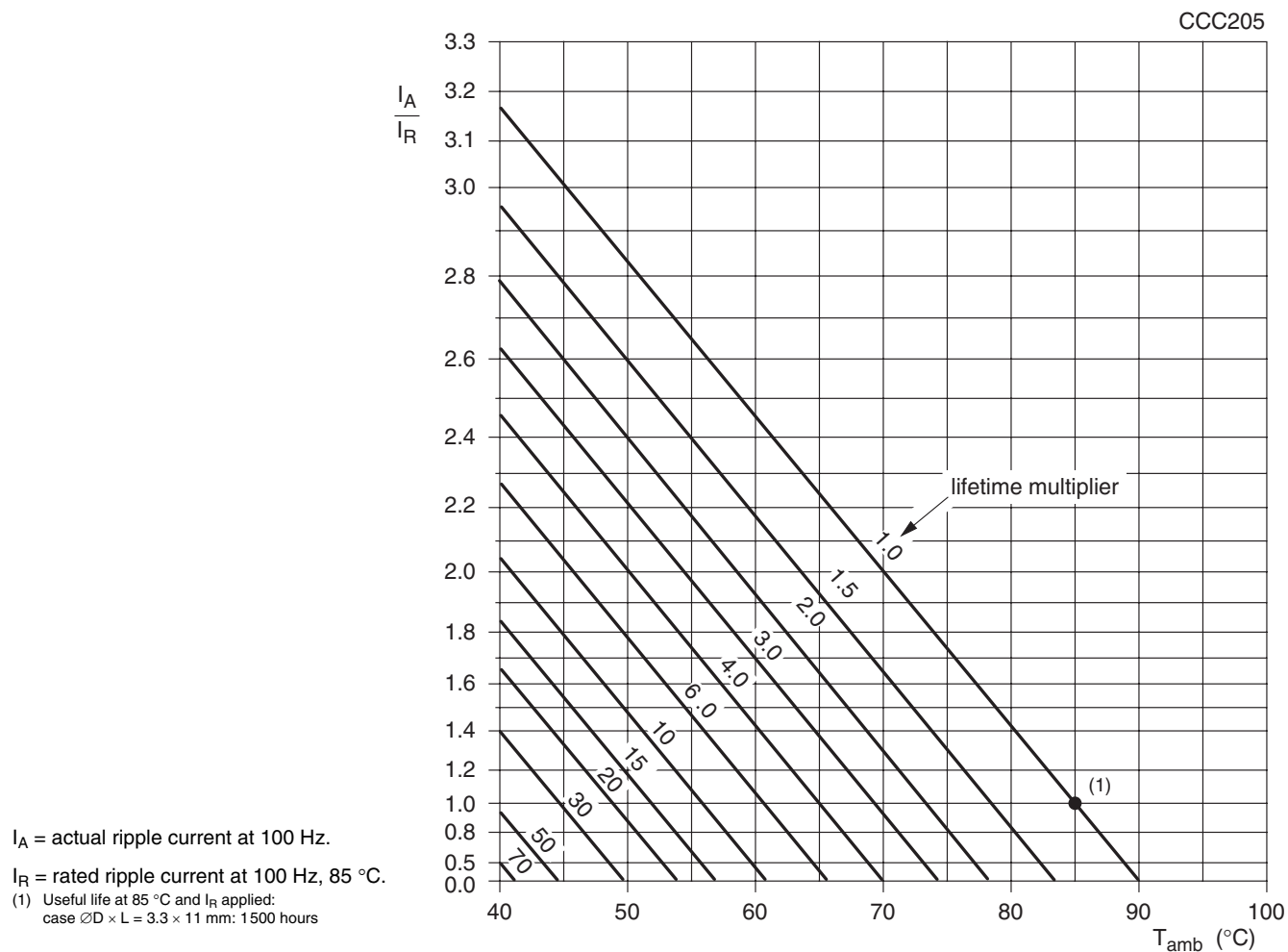
**RIPPLE CURRENT AND USEFUL LIFE**

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

Table 4

| <b>MULTIPLIER OF RIPPLE CURRENT (IR) AS A FUNCTION OF FREQUENCY</b> |                       |                      |                       |
|---------------------------------------------------------------------|-----------------------|----------------------|-----------------------|
| FREQUENCY<br>(HZ)                                                   | $I_R$ MULTIPLIER      |                      |                       |
|                                                                     | $U_R = 6.3$ to $10$ V | $U_R = 16$ to $25$ V | $U_R = 40$ 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                  |
| $\geq 10000$                                                        | 1.20                  | 1.30                 | 1.40                  |

Table 5

| TEST PROCEDURES AND REQUIREMENTS               |                                          |                                                                                                                                                                 |                                                                                                                                                                                                                                                      |
|------------------------------------------------|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TEST                                           |                                          | PROCEDURE<br>(quick reference)                                                                                                                                  | REQUIREMENTS                                                                                                                                                                                                                                         |
| NAME OF TEST                                   | REFERENCE                                |                                                                                                                                                                 |                                                                                                                                                                                                                                                      |
| Case ØD × L = 3.3 × 11 mm                      |                                          |                                                                                                                                                                 |                                                                                                                                                                                                                                                      |
| Endurance                                      | IEC 384-4/<br>EN130300<br>subclause 4.13 | T <sub>amb</sub> = 85 °C; U <sub>R</sub> applied;<br>1 000 hours                                                                                                | ΔC/C: ±20%<br><br>tan δ ≤ 2 × spec. limit<br><br>Z ≤ 3 × spec. limit<br><br>I <sub>L</sub> ≤ spec. limit                                                                                                                                             |
| Useful life                                    | CECC 30301<br>subclause 1.8.1            | T <sub>amb</sub> = 85 °C; U <sub>R</sub> and I <sub>R</sub> applied;<br>1 500 hours                                                                             | ΔC/C: ±50%<br><br>tan δ ≤ 3 × spec. limit<br><br>Z ≤ 3 × spec. limit<br><br>I <sub>L</sub> ≤ spec. limit<br><br>no short or open circuit<br><br>total failure percentage: ≤ 3%                                                                       |
| Shelf life<br>(storage at<br>high temperature) | IEC 384-4/<br>EN130300<br>subclause 4.17 | T <sub>amb</sub> = 85 °C; no voltage applied;<br>500 hours<br><br>after test: U <sub>R</sub> to be applied for 30 minutes,<br>24 to 48 hours before measurement | ΔC/C, tan δ, Z:<br>for requirements<br>see 'Endurance test' above<br><br>I <sub>L</sub> ≤ 2 × spec. limit                                                                                                                                            |
| Case ØD × L = 4.5 × 10 to 10 × 25 mm           |                                          |                                                                                                                                                                 |                                                                                                                                                                                                                                                      |
| Endurance                                      | IEC 384-4/<br>EN130300<br>subclause 4.13 | T <sub>amb</sub> = 85 °C; U <sub>R</sub> applied;<br>2 000 hours                                                                                                | U <sub>R</sub> ≤ 6.3 V; ΔC/C: +15/–30%<br><br>U <sub>R</sub> > 6.3 V; ΔC/C: ±15%<br><br>tan δ ≤ 1.3 × spec. limit<br><br>Z ≤ 2 × spec. limit<br><br>I <sub>L</sub> ≤ spec. limit                                                                     |
| Useful life                                    | CECC 30301<br>subclause 1.8.1            | T <sub>amb</sub> = 85 °C; U <sub>R</sub> and I <sub>R</sub> applied;<br>3 000 hours                                                                             | U <sub>R</sub> ≤ 6.3 V; ΔC/C: +45/–50%<br><br>U <sub>R</sub> > 6.3 V; ΔC/C: ±45%<br><br>tan δ ≤ 3 × spec. limit<br><br>Z ≤ 3 × spec. limit<br><br>I <sub>L</sub> ≤ spec. limit<br><br>no short or open circuit<br><br>total failure percentage: ≤ 1% |
| Shelf life<br>(storage at<br>high temperature) | IEC 384-4/<br>EN130300<br>subclause 4.17 | T <sub>amb</sub> = 85 °C; no voltage applied;<br>500 hours<br><br>after test: U <sub>R</sub> to be applied for 30 minutes,<br>24 to 48 hours before measurement | ΔC/C, tan δ, Z:<br>for requirements<br>see 'Endurance test' above<br><br>I <sub>L</sub> ≤ 2 × spec. limit                                                                                                                                            |





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