

# Aluminum Capacitors Axial Standard Miniature

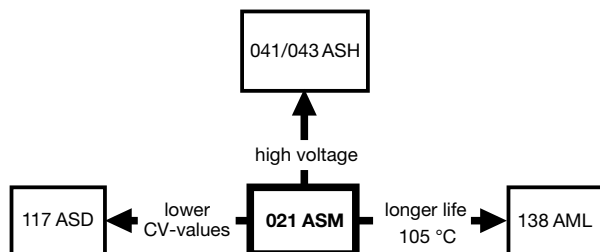


Fig. 1

## QUICK REFERENCE DATA

| DESCRIPTION                                           | VALUE                  |                       |
|-------------------------------------------------------|------------------------|-----------------------|
| Nominal case sizes<br>(Ø D x L in mm)                 | 4.5 x 10<br>to 10 x 25 | 10 x 30<br>to 21 x 38 |
| Rated capacitance range, C <sub>R</sub>               | 0.47 µF to 15 000 µF   |                       |
| Tolerance on C <sub>R</sub>                           | ± 20 %                 |                       |
| Rated voltage range, U <sub>R</sub>                   | 6.3 V to 100 V         |                       |
| Category temperature range                            | - 40 °C to + 85 °C     |                       |
| Endurance test at 85 °C:                              |                        |                       |
| U <sub>R</sub> = 6.3 V to 25 V                        | 1000 h                 | 5000 h                |
| U <sub>R</sub> = 40 V to 100 V                        | 2000 h                 | 5000 h                |
| Endurance test at 105 °C                              | -                      | 2000 h                |
| Useful life at 85 °C                                  | 2500 h                 | 8000 h                |
| Useful life at 40 °C,<br>1.4 x I <sub>R</sub> applied | 70 000 h               | 200 000 h             |
| Shelf life at 0 V, 85 °C                              | 500 h                  |                       |
| Based on sectional specification                      | IEC 60384-4/EN130300   |                       |
| Climatic category IEC 60068                           | 40/085/56              |                       |

## FEATURES

- Long useful life: 2500 h to 8000 h at 85 °C
- Miniaturized, high CV-product per unit volume
- Charge and discharge proof
- Taped versions up to case Ø 15 mm x 30 mm available for automatic insertion
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not available in insulated form
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

## APPLICATIONS

- General purpose, industrial, automotive, audio-video
- Coupling, decoupling, smoothing, filtering, buffering
- Portable and mobile equipment (small size, low mass)
- Low mounting height boards, vibration and shock resistant

## MARKING

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

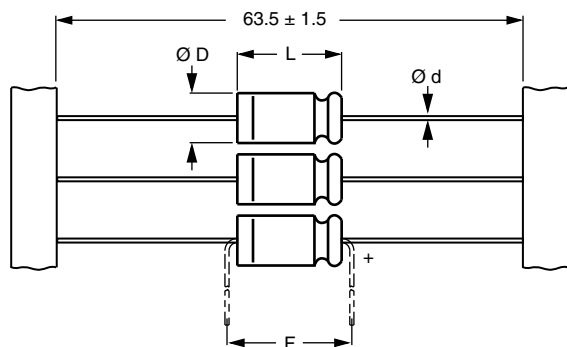
- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Upper category temperature (85 °C)
- Date code in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (021)

## SELECTION CHART FOR C<sub>R</sub>, U<sub>R</sub>, AND RELEVANT NOMINAL CASE SIZES (Ø 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 |
| 2.2                    | -                  | -  | -  | -        | -        | 4.5 x 10 | 4.5 x 10 |
| 3.3                    | -                  | -  | -  | -        | -        | 4.5 x 10 | -        |
| 4.7                    | -                  | -  | -  | -        | -        | 4.5 x 10 | 4.5 x 10 |
| 10                     | -                  | -  | -  | -        | -        | 4.5 x 10 | 6 x 10   |
| 15                     | -                  | -  | -  | -        | -        | 4.5 x 10 | 8 x 11   |
|                        | -                  | -  | -  | -        | -        | -        | 6.5 x 18 |
| 22                     | -                  | -  | -  | -        | 4.5 x 10 | 6 x 10   | 8 x 11   |
|                        | -                  | -  | -  | -        | -        | -        | 6.5 x 18 |
| 33                     | -                  | -  | -  | -        | -        | 6 x 10   | 6.5 x 18 |
| 47                     | -                  | -  | -  | 4.5 x 10 | 6 x 10   | 8 x 11   | 8 x 18   |
|                        | -                  | -  | -  | -        | -        | 6.5 x 18 | -        |

| <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       |
| 68                                                                                                                                         | -         | -         | 4.5 x 10  | -         | -         | 8 x 11    | 10 x 18   |
|                                                                                                                                            | -         | -         | -         | -         | -         | 6.5 x 18  | -         |
| 100                                                                                                                                        | -         | 4.5 x 10  | -         | 6 x 10    | 8 x 11    | 8 x 18    | 10 x 25   |
|                                                                                                                                            | -         | -         | -         | -         | 6.5 x 18  | -         | 10 x 30   |
| 150                                                                                                                                        | -         | -         | 6 x 10    | 8 x 11    | 8 x 18    | 10 x 18   | 12.5 x 30 |
|                                                                                                                                            | -         | -         | -         | 6.5 x 18  | -         | -         | -         |
| 220                                                                                                                                        | -         | 6 x 10    | 8 x 11    | 6.5 x 18  | 10 x 18   | 10 x 25   | 12.5 x 30 |
|                                                                                                                                            | -         | -         | -         | -         | -         | 10 x 30   | -         |
| 330                                                                                                                                        | -         | 8 x 11    | 6.5 x 18  | 8 x 18    | 10 x 25   | 12.5 x 30 | 15 x 30   |
| 470                                                                                                                                        | 8 x 11    | 6.5 x 18  | 8 x 18    | 10 x 18   | 10 x 25   | 12.5 x 30 | 18 x 30   |
|                                                                                                                                            | -         | -         | -         | -         | 10 x 30   | -         | -         |
| 680                                                                                                                                        | -         | 8 x 18    | 10 x 18   | 10 x 25   | 12.5 x 30 | 15 x 30   | 18 x 38   |
|                                                                                                                                            | -         | -         | -         | 10 x 30   | -         | -         | -         |
| 1000                                                                                                                                       | 8 x 18    | 10 x 18   | 10 x 25   | 12.5 x 30 | 12.5 x 30 | 18 x 30   | 21 x 38   |
|                                                                                                                                            | -         | -         | 10 x 30   | -         | -         | -         | -         |
| 1500                                                                                                                                       | -         | 10 x 25   | 12.5 x 30 | 12.5 x 30 | 15 x 30   | 18 x 38   | -         |
|                                                                                                                                            | -         | 10 x 30   | -         | -         | -         | -         | -         |
| 2200                                                                                                                                       | 10 x 25   | 12.5 x 30 | 12.5 x 30 | 15 x 30   | 18 x 30   | 21 x 38   | -         |
| 3300                                                                                                                                       | -         | 12.5 x 30 | 15 x 30   | 18 x 30   | 18 x 38   | -         | -         |
| 4700                                                                                                                                       | -         | 15 x 30   | 18 x 30   | 18 x 38   | 21 x 38   | -         | -         |
| 6800                                                                                                                                       | -         | 18 x 30   | 18 x 38   | 21 x 38   | -         | -         | -         |
| 10 000                                                                                                                                     | -         | 18 x 38   | 21 x 38   | -         | -         | -         | -         |
| 15 000                                                                                                                                     | -         | 21 x 38   | -         | -         | -         | -         | -         |

# DIMENSIONS in millimeters AND AVAILABLE FORMS

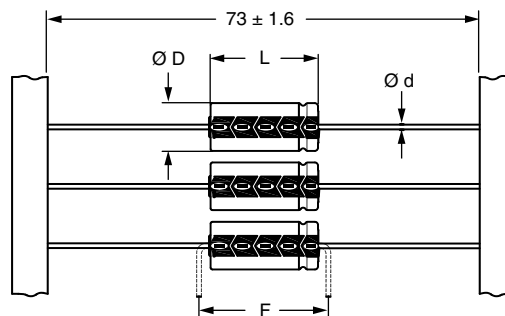


**Form BR:** Taped on reel

**Form BA:** Taped in box (ammopack)

Case  $\varnothing D \times L = 4.5 \text{ mm} \times 10 \text{ mm}$  to  $8 \text{ mm} \times 11 \text{ mm}$

Fig. 2 - Forms BA and BR



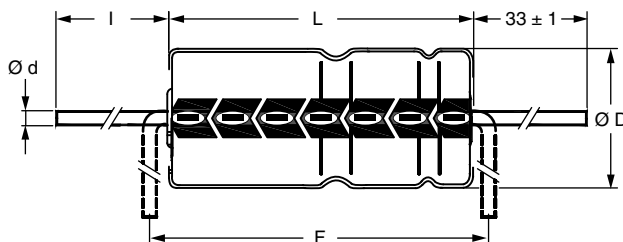
**Form BR:** Taped on reel

Case  $\varnothing D \times L = 6.5 \text{ mm} \times 18 \text{ mm}$  to  $15 \text{ mm} \times 30 \text{ mm}$

**Form BA:** Taped in box (ammopack)

Case  $\varnothing D \times L = 6.5 \text{ mm} \times 18 \text{ mm}$  to  $10 \text{ mm} \times 25 \text{ mm}$

Fig. 3 - Forms BA and BR



**Form AA:** Axial in box

Case  $\varnothing D \times L = 10 \text{ mm} \times 30 \text{ mm}$  to  $21 \text{ mm} \times 38 \text{ mm}$

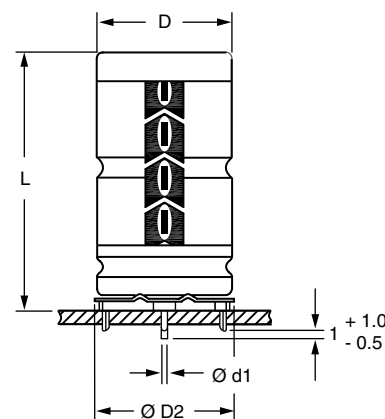
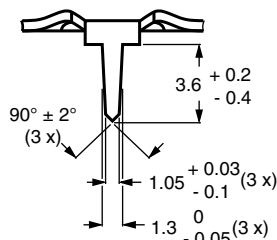
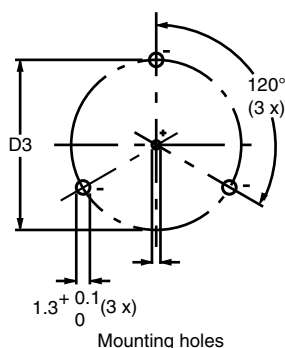
Fig. 4 - Form AA

**Table 1**

| <b>AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES</b> |           |                            |        |                     |                   |                   |          |                      |         |         |
|------------------------------------------------------------------------|-----------|----------------------------|--------|---------------------|-------------------|-------------------|----------|----------------------|---------|---------|
| NOMINAL CASE SIZE<br>Ø D x L                                           | CASE CODE | AXIAL: FORM AA, BA, AND BR |        |                     |                   |                   | MASS (g) | PACKAGING QUANTITIES |         |         |
|                                                                        |           | Ø d                        | l      | Ø D <sub>max.</sub> | L <sub>max.</sub> | F <sub>min.</sub> |          | FORM AA              | FORM BA | FORM BR |
| 4.5 x 10                                                               | 2         | 0.6                        | -      | 5.0                 | 10.5              | 15                | ≈ 0.5    | -                    | 1000    | 3000    |
| 6 x 10                                                                 | 3         | 0.6                        | -      | 6.3                 | 10.5              | 15                | ≈ 0.7    | -                    | 1000    | 1000    |
| 8 x 11                                                                 | 5a        | 0.6                        | -      | 8.5                 | 11.5              | 15                | ≈ 1.1    | -                    | 500     | 500     |
| 6.5 x 18                                                               | 4         | 0.8                        | -      | 6.9                 | 18.5              | 25                | ≈ 1.3    | -                    | 1000    | 1000    |
| 8 x 18                                                                 | 5         | 0.8                        | -      | 8.5                 | 18.5              | 25                | ≈ 1.7    | -                    | 500     | 500     |
| 10 x 18                                                                | 6         | 0.8                        | -      | 10.5                | 18.5              | 25                | ≈ 2.5    | -                    | 500     | 500     |
| 10 x 25                                                                | 7         | 0.8                        | -      | 10.5                | 25.5              | 30                | ≈ 3.3    | -                    | 500     | 500     |
| 10 x 30                                                                | 00        | 0.8                        | 55 ± 1 | 10.5                | 30.5              | 35                | ≈ 4.8    | 340                  | -       | 500     |
| 12.5 x 30                                                              | 01        | 0.8                        | 55 ± 1 | 13.0                | 30.5              | 35                | ≈ 7.4    | 260                  | -       | 400     |
| 15 x 30                                                                | 02        | 0.8                        | 55 ± 1 | 15.5                | 30.5              | 35                | ≈ 11.7   | 200                  | -       | 250     |
| 18 x 30                                                                | 03        | 0.8                        | 55 ± 1 | 18.5                | 30.5              | 35                | ≈ 12.9   | 120                  | -       | -       |
| 18 x 38                                                                | 04        | 0.8                        | 34 ± 1 | 18.5                | 39.5              | 44                | ≈ 19.0   | 125                  | -       | -       |
| 21 x 38                                                                | 05        | 0.8                        | 34 ± 1 | 21.5                | 39.5              | 44                | ≈ 24.0   | 100                  | -       | -       |

**Note**

- For detailed tape dimensions, please see [www.vishay.com/doc?28361](http://www.vishay.com/doc?28361).


**Form MR:**

Case Ø D x L = 15 mm x 30 mm to 21 mm x 38 mm

Especially for applications with severe shocks and vibrations

Fig. 5 - Mounting hole diagram and outline. **Form MR:** With mounting ring and pins

**Table 2**

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

| ELECTRICAL DATA |                                                                                          |
|-----------------|------------------------------------------------------------------------------------------|
| SYMBOL          | DESCRIPTION                                                                              |
| $C_R$           | Rated capacitance at 100 Hz, tolerance $\pm 20\%$                                        |
| $I_R$           | Rated RMS ripple current at 100 Hz, 85 °C                                                |
| $I_{L5}$        | Max. leakage current after 5 min at $U_R$                                                |
| $\tan \delta$   | Max. dissipation factor at 100 Hz                                                        |
| ESR             | Equivalent series resistance at 100 Hz (calculated from $\tan \delta_{\max}$ and $C_R$ ) |
| Z               | Max. impedance at 10 kHz                                                                 |

**Note**

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

**Table 3**

| ELECTRICAL DATA AND ORDERING INFORMATION |                                      |                                                          |                                  |                                        |                         |                               |                             |                            |                                |                               |                                |
|------------------------------------------|--------------------------------------|----------------------------------------------------------|----------------------------------|----------------------------------------|-------------------------|-------------------------------|-----------------------------|----------------------------|--------------------------------|-------------------------------|--------------------------------|
| $U_R$<br>(V)                             | $C_R$<br>100 Hz<br>( $\mu\text{F}$ ) | NOMINAL<br>CASE SIZE<br>$\varnothing D \times L$<br>(mm) | $I_R$<br>100 Hz<br>85 °C<br>(mA) | $I_{L5}$<br>5 min<br>( $\mu\text{A}$ ) | $\tan \delta$<br>100 Hz | ESR<br>100 Hz<br>( $\Omega$ ) | Z<br>10 kHz<br>( $\Omega$ ) | ORDERING CODE MAL2021..... |                                |                               |                                |
|                                          |                                      |                                                          |                                  |                                        |                         |                               |                             | IN BOX<br>FORM<br>AA       | TAPED<br>ON REEL<br>FORM<br>BR | TAPED<br>IN BOX<br>FORM<br>BA | MOUNTING<br>RING<br>FORM<br>MR |
| 6.3                                      | 470                                  | 8 x 11                                                   | 260                              | 10                                     | 0.25                    | 0.850                         | 0.640                       | -                          | 23471E3                        | 33471E3                       | -                              |
|                                          | 1000                                 | 8 x 18                                                   | 440                              | 17                                     | 0.25                    | 0.400                         | 0.500                       | -                          | 23102E3                        | 33102E3                       | -                              |
|                                          | 2200                                 | 10 x 25                                                  | 710                              | 32                                     | 0.29                    | 0.210                         | 0.160                       | -                          | 90588E3                        | 90589E3                       | -                              |
| 10                                       | 100                                  | 4.5 x 10                                                 | 100                              | 6                                      | 0.20                    | 3.200                         | 2.000                       | -                          | 24101E3                        | 34101E3                       | -                              |
|                                          | 220                                  | 6 x 10                                                   | 160                              | 8.4                                    | 0.20                    | 1.500                         | 0.910                       | -                          | 24221E3                        | 34221E3                       | -                              |
|                                          | 330                                  | 8 x 11                                                   | 230                              | 11                                     | 0.20                    | 1.000                         | 0.610                       | -                          | 24331E3                        | 34331E3                       | -                              |
|                                          | 470                                  | 6.5 x 18                                                 | 310                              | 13                                     | 0.20                    | 0.680                         | 0.430                       | -                          | 24471E3                        | 34471E3                       | -                              |
|                                          | 680                                  | 8 x 18                                                   | 400                              | 18                                     | 0.20                    | 0.470                         | 0.290                       | -                          | 24681E3                        | 34681E3                       | -                              |
|                                          | 1000                                 | 10 x 18                                                  | 550                              | 24                                     | 0.20                    | 0.320                         | 0.200                       | -                          | 24102E3                        | 34102E3                       | -                              |
|                                          | 1500                                 | 10 x 25                                                  | 690                              | 34                                     | 0.23                    | 0.250                         | 0.180                       | -                          | 90524E3                        | 90525E3                       | -                              |
|                                          | 1500                                 | 10 x 30                                                  | 740                              | 34                                     | 0.23                    | 0.245                         | 0.180                       | 14152E3                    | 24152E3                        | -                             | -                              |
|                                          | 2200                                 | 12.5 x 30                                                | 980                              | 48                                     | 0.25                    | 0.177                         | 0.095                       | 14222E3                    | 24222E3                        | -                             | -                              |
|                                          | 3300                                 | 12.5 x 30                                                | 1090                             | 70                                     | 0.27                    | 0.128                         | 0.095                       | 14332E3                    | 24332E3                        | -                             | -                              |
|                                          | 4700                                 | 15 x 30                                                  | 1320                             | 98                                     | 0.29                    | 0.100                         | 0.070                       | 14472E3                    | 24472E3                        | -                             | 44472E3                        |
|                                          | 6800                                 | 18 x 30                                                  | 1590                             | 140                                    | 0.34                    | 0.079                         | 0.065                       | 14682E3                    | -                              | -                             | 44682E3                        |
|                                          | 10 000                               | 18 x 38                                                  | 2090                             | 204                                    | 0.40                    | 0.064                         | 0.040                       | 14103E3                    | -                              | -                             | 44103E3                        |
| 16                                       | 15 000                               | 21 x 38                                                  | 2250                             | 304                                    | 0.50                    | 0.054                         | 0.035                       | 14153E3                    | -                              | -                             | 44153E3                        |
|                                          | 68                                   | 4.5 x 10                                                 | 90                               | 6.2                                    | 0.16                    | 3.800                         | 2.400                       | -                          | 25689E3                        | 35689E3                       | -                              |
|                                          | 150                                  | 6 x 10                                                   | 140                              | 8.8                                    | 0.16                    | 1.700                         | 1.100                       | -                          | 25151E3                        | 35151E3                       | -                              |
|                                          | 220                                  | 8 x 11                                                   | 210                              | 11                                     | 0.16                    | 1.200                         | 0.730                       | -                          | 25221E3                        | 35221E3                       | -                              |
|                                          | 330                                  | 6.5 x 18                                                 | 290                              | 15                                     | 0.16                    | 0.770                         | 0.480                       | -                          | 25331E3                        | 35331E3                       | -                              |
|                                          | 470                                  | 8 x 18                                                   | 380                              | 19                                     | 0.16                    | 0.550                         | 0.340                       | -                          | 25471E3                        | 35471E3                       | -                              |
|                                          | 680                                  | 10 x 18                                                  | 500                              | 26                                     | 0.16                    | 0.380                         | 0.240                       | -                          | 25681E3                        | 35681E3                       | -                              |
|                                          | 1000                                 | 10 x 25                                                  | 660                              | 36                                     | 0.16                    | 0.260                         | 0.180                       | -                          | 90517E3                        | 90518E3                       | -                              |
|                                          | 1000                                 | 10 x 30                                                  | 700                              | 36                                     | 0.16                    | 0.260                         | 0.175                       | 15102E3                    | 25102E3                        | -                             | -                              |
|                                          | 1500                                 | 12.5 x 30                                                | 950                              | 52                                     | 0.19                    | 0.205                         | 0.095                       | 15152E3                    | 25152E3                        | -                             | -                              |
|                                          | 2200                                 | 12.5 x 30                                                | 1040                             | 74                                     | 0.21                    | 0.150                         | 0.095                       | 15222E3                    | 25222E3                        | -                             | -                              |
|                                          | 3300                                 | 15 x 30                                                  | 1290                             | 110                                    | 0.23                    | 0.111                         | 0.070                       | 15332E3                    | 25332E3                        | -                             | 45332E3                        |
|                                          | 4700                                 | 18 x 30                                                  | 1560                             | 154                                    | 0.25                    | 0.087                         | 0.065                       | 15472E3                    | -                              | -                             | 45472E3                        |
| 25                                       | 6800                                 | 18 x 38                                                  | 2040                             | 222                                    | 0.30                    | 0.070                         | 0.040                       | 15682E3                    | -                              | -                             | 45682E3                        |
|                                          | 10 000                               | 21 x 38                                                  | 2170                             | 324                                    | 0.36                    | 0.058                         | 0.035                       | 15103E3                    | -                              | -                             | 45103E3                        |
|                                          | 47                                   | 4.5 x 10                                                 | 80                               | 6.4                                    | 0.14                    | 4.800                         | 2.600                       | -                          | 26479E3                        | 36479E3                       | -                              |
|                                          | 100                                  | 6 x 10                                                   | 150                              | 9                                      | 0.14                    | 2.300                         | 1.200                       | -                          | 26101E3                        | 36101E3                       | -                              |
|                                          | 150                                  | 8 x 11                                                   | 190                              | 12                                     | 0.14                    | 1.500                         | 0.800                       | -                          | 90534E3                        | 90535E3                       | -                              |
|                                          | 150                                  | 6.5 x 18                                                 | 210                              | 12                                     | 0.14                    | 1.500                         | 0.800                       | -                          | 26151E3                        | 36151E3                       | -                              |
|                                          | 220                                  | 6.5 x 18                                                 | 250                              | 15                                     | 0.14                    | 1.000                         | 0.550                       | -                          | 26221E3                        | 36221E3                       | -                              |
|                                          | 330                                  | 8 x 18                                                   | 340                              | 21                                     | 0.14                    | 0.680                         | 0.360                       | -                          | 26331E3                        | 36331E3                       | -                              |
|                                          | 470                                  | 10 x 18                                                  | 450                              | 28                                     | 0.14                    | 0.480                         | 0.260                       | -                          | 26471E3                        | 36471E3                       | -                              |
|                                          | 680                                  | 10 x 25                                                  | 560                              | 38                                     | 0.14                    | 0.330                         | 0.180                       | -                          | 90527E3                        | 90528E3                       | -                              |
|                                          | 680                                  | 10 x 30                                                  | 640                              | 38                                     | 0.14                    | 0.323                         | 0.175                       | 16681E3                    | 26681E3                        | -                             | -                              |
|                                          | 1000                                 | 12.5 x 30                                                | 840                              | 54                                     | 0.14                    | 0.220                         | 0.095                       | 16102E3                    | 26102E3                        | -                             | -                              |
|                                          | 1500                                 | 12.5 x 30                                                | 950                              | 79                                     | 0.17                    | 0.179                         | 0.095                       | 16152E3                    | 26152E3                        | -                             | -                              |
| 25                                       | 2200                                 | 15 x 30                                                  | 1180                             | 114                                    | 0.19                    | 0.132                         | 0.070                       | 16222E3                    | 26222E3                        | -                             | 46222E3                        |
|                                          | 3300                                 | 18 x 30                                                  | 1470                             | 169                                    | 0.21                    | 0.099                         | 0.065                       | 16332E3                    | -                              | -                             | 46332E3                        |
|                                          | 4700                                 | 18 x 38                                                  | 1920                             | 239                                    | 0.23                    | 0.079                         | 0.040                       | 16472E3                    | -                              | -                             | 46472E3                        |
|                                          | 6800                                 | 21 x 38                                                  | 2070                             | 344                                    | 0.28                    | 0.064                         | 0.035                       | 16682E3                    | -                              | -                             | 46682E3                        |



| 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) | I <sub>R</sub><br>100 Hz<br>85 °C<br>(mA) | 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 MAL2021..... |                                |                               |                                |
|                                          |                                  |                                         |                                           |                                  |                 |                      |                    | IN BOX<br>FORM<br>AA       | TAPED<br>ON REEL<br>FORM<br>BR | TAPED<br>IN BOX<br>FORM<br>BA | MOUNTING<br>RING<br>FORM<br>MR |
| 40                                       | 22                               | 4.5 x 10                                | 60                                        | 5.8                              | 0.11            | 8.000                | 3.200              | -                          | 27229E3                        | 37229E3                       | -                              |
|                                          | 47                               | 6 x 10                                  | 110                                       | 7.8                              | 0.11            | 3.800                | 1.500              | -                          | 27479E3                        | 37479E3                       | -                              |
|                                          | 100                              | 8 x 11                                  | 170                                       | 12                               | 0.11            | 1.800                | 0.700              | -                          | 90537E3                        | 90538E3                       | -                              |
|                                          | 100                              | 6.5 x 18                                | 190                                       | 12                               | 0.11            | 1.800                | 0.700              | -                          | 27101E3                        | 37101E3                       | -                              |
|                                          | 150                              | 8 x 18                                  | 250                                       | 16                               | 0.11            | 1.100                | 0.470              | -                          | 27151E3                        | 37151E3                       | -                              |
|                                          | 220                              | 10 x 18                                 | 330                                       | 22                               | 0.11            | 0.800                | 0.320              | -                          | 27221E3                        | 37221E3                       | -                              |
|                                          | 330                              | 10 x 25                                 | 430                                       | 30                               | 0.11            | 0.530                | 0.210              | -                          | 27331E3                        | 37331E3                       | -                              |
|                                          | 470                              | 10 x 25                                 | 520                                       | 42                               | 0.11            | 0.370                | 0.180              | -                          | 90514E3                        | 90515E3                       | -                              |
|                                          | 470                              | 10 x 30                                 | 590                                       | 42                               | 0.12            | 0.404                | 0.175              | 17471E3                    | 27471E3                        | -                             | -                              |
|                                          | 680                              | 12.5 x 30                               | 800                                       | 58                               | 0.12            | 0.297                | 0.110              | 17681E3                    | 27681E3                        | -                             | -                              |
|                                          | 1000                             | 12.5 x 30                               | 900                                       | 84                               | 0.12            | 0.190                | 0.110              | 17102E3                    | 27102E3                        | -                             | -                              |
|                                          | 1500                             | 15 x 30                                 | 1120                                      | 124                              | 0.15            | 0.159                | 0.070              | 17152E3                    | 27152E3                        | -                             | 47152E3                        |
|                                          | 2200                             | 18 x 30                                 | 1390                                      | 180                              | 0.17            | 0.118                | 0.065              | 17222E3                    | -                              | -                             | 47222E3                        |
|                                          | 3300                             | 18 x 38                                 | 1810                                      | 268                              | 0.19            | 0.090                | 0.040              | 17332E3                    | -                              | -                             | 47332E3                        |
|                                          | 4700                             | 21 x 38                                 | 1940                                      | 380                              | 0.21            | 0.072                | 0.035              | 17472E3                    | -                              | -                             | 47472E3                        |
| 63                                       | 0.47                             | 4.5 x 10                                | 8                                         | 4.1                              | 0.09            | 310.0                | 120.0              | -                          | 28477E3                        | 38477E3                       | -                              |
|                                          | 1                                | 4.5 x 10                                | 12                                        | 4.1                              | 0.09            | 150.0                | 55.00              | -                          | 28108E3                        | 38108E3                       | -                              |
|                                          | 2.2                              | 4.5 x 10                                | 21                                        | 4.3                              | 0.09            | 65.00                | 25.00              | -                          | 28228E3                        | 38228E3                       | -                              |
|                                          | 3.3                              | 4.5 x 10                                | 25                                        | 4.4                              | 0.09            | 44.00                | 17.00              | -                          | 28338E3                        | 38338E3                       | -                              |
|                                          | 4.7                              | 4.5 x 10                                | 31                                        | 4.6                              | 0.09            | 31.00                | 12.00              | -                          | 28478E3                        | 38478E3                       | -                              |
|                                          | 10                               | 4.5 x 10                                | 50                                        | 5.3                              | 0.08            | 13.00                | 5.500              | -                          | 28109E3                        | 38109E3                       | -                              |
|                                          | 15                               | 4.5 x 10                                | 55                                        | 5.9                              | 0.08            | 8.500                | 3.700              | -                          | 28159E3                        | 38159E3                       | -                              |
|                                          | 22                               | 6 x 10                                  | 90                                        | 6.8                              | 0.08            | 5.800                | 2.500              | -                          | 28229E3                        | 38229E3                       | -                              |
|                                          | 33                               | 6 x 10                                  | 100                                       | 8.2                              | 0.08            | 3.900                | 1.700              | -                          | 28339E3                        | 38339E3                       | -                              |
|                                          | 47                               | 8 x 11                                  | 140                                       | 10                               | 0.08            | 2.700                | 1.200              | -                          | 90541E3                        | 90542E3                       | -                              |
|                                          | 47                               | 6.5 x 18                                | 150                                       | 10                               | 0.08            | 2.700                | 1.200              | -                          | 28479E3                        | 38479E3                       | -                              |
|                                          | 68                               | 8 x 11                                  | 160                                       | 13                               | 0.08            | 1.900                | 0.810              | -                          | 90544E3                        | 90545E3                       | -                              |
|                                          | 68                               | 6.5 x 18                                | 170                                       | 13                               | 0.08            | 1.900                | 0.810              | -                          | 28689E3                        | 38689E3                       | -                              |
|                                          | 100                              | 8 x 18                                  | 250                                       | 17                               | 0.08            | 1.300                | 0.550              | -                          | 28101E3                        | 38101E3                       | -                              |
|                                          | 150                              | 10 x 18                                 | 320                                       | 23                               | 0.08            | 0.850                | 0.370              | -                          | 28151E3                        | 38151E3                       | -                              |
|                                          | 220                              | 10 x 25                                 | 430                                       | 32                               | 0.08            | 0.600                | 0.250              | -                          | 90511E3                        | 90512E3                       | -                              |
|                                          | 220                              | 10 x 30                                 | 480                                       | 32                               | 0.08            | 0.614                | 0.260              | 18221E3                    | 28221E3                        | -                             | -                              |
|                                          | 330                              | 12.5 x 30                               | 610                                       | 46                               | 0.08            | 0.409                | 0.190              | 18331E3                    | 28331E3                        | -                             | -                              |
|                                          | 470                              | 12.5 x 30                               | 700                                       | 63                               | 0.08            | 0.287                | 0.130              | 18471E3                    | 28471E3                        | -                             | -                              |
|                                          | 680                              | 15 x 30                                 | 890                                       | 90                               | 0.08            | 0.199                | 0.095              | 18681E3                    | 28681E3                        | -                             | 48681E3                        |
|                                          | 1000                             | 18 x 30                                 | 1170                                      | 130                              | 0.08            | 0.135                | 0.075              | 18102E3                    | -                              | -                             | 48102E3                        |
|                                          | 1500                             | 18 x 38                                 | 1530                                      | 193                              | 0.11            | 0.122                | 0.045              | 18152E3                    | -                              | -                             | 48152E3                        |
|                                          | 2200                             | 21 x 38                                 | 1780                                      | 281                              | 0.13            | 0.099                | 0.040              | 18222E3                    | -                              | -                             | 48222E3                        |
| 100                                      | 1                                | 4.5 x 10                                | 14                                        | 4.2                              | 0.08            | 130.0                | 90.00              | -                          | 29108E3                        | 39108E3                       | -                              |
|                                          | 2.2                              | 4.5 x 10                                | 20                                        | 4.4                              | 0.08            | 58.00                | 41.00              | -                          | 29228E3                        | 39228E3                       | -                              |
|                                          | 4.7                              | 4.5 x 10                                | 30                                        | 4.9                              | 0.08            | 27.00                | 19.00              | -                          | 29478E3                        | 39478E3                       | -                              |
|                                          | 10                               | 6 x 10                                  | 65                                        | 6                                | 0.08            | 13.00                | 9.000              | -                          | 29109E3                        | 39109E3                       | -                              |
|                                          | 15                               | 8 x 11                                  | 77                                        | 7                                | 0.08            | 8.500                | 6.000              | -                          | 90547E3                        | 90548E3                       | -                              |
|                                          | 15                               | 6.5 x 18                                | 85                                        | 7                                | 0.08            | 8.500                | 6.000              | -                          | 29159E3                        | 39159E3                       | -                              |
|                                          | 22                               | 8 x 11                                  | 95                                        | 8.4                              | 0.08            | 5.800                | 4.100              | -                          | 90551E3                        | 90552E3                       | -                              |
|                                          | 22                               | 6.5 x 18                                | 100                                       | 8.4                              | 0.08            | 5.800                | 4.100              | -                          | 29229E3                        | 39229E3                       | -                              |
|                                          | 33                               | 6.5 x 18                                | 120                                       | 10.6                             | 0.08            | 3.900                | 2.700              | -                          | 29339E3                        | 39339E3                       | -                              |
|                                          | 47                               | 8 x 18                                  | 160                                       | 13.4                             | 0.08            | 2.700                | 1.900              | -                          | 29479E3                        | 39479E3                       | -                              |
|                                          | 68                               | 10 x 18                                 | 220                                       | 17.6                             | 0.08            | 1.900                | 1.300              | -                          | 29689E3                        | 39689E3                       | -                              |
|                                          | 100                              | 10 x 25                                 | 300                                       | 24                               | 0.08            | 1.300                | 0.900              | -                          | 90531E3                        | 90532E3                       | -                              |
|                                          | 100                              | 10 x 30                                 | 340                                       | 24                               | 0.07            | 1.150                | 1.000              | 19101E3                    | 29101E3                        | -                             | -                              |
|                                          | 150                              | 12.5 x 30                               | 490                                       | 34                               | 0.07            | 0.645                | 0.610              | 19151E3                    | 29151E3                        | -                             | -                              |
|                                          | 220                              | 12.5 x 30                               | 560                                       | 48                               | 0.08            | 0.610                | 0.560              | 19221E3                    | 29221E3                        | -                             | -                              |
|                                          | 330                              | 15 x 30                                 | 740                                       | 70                               | 0.09            | 0.420                | 0.400              | 19331E3                    | 29331E3                        | -                             | 49331E3                        |
|                                          | 470                              | 18 x 30                                 | 980                                       | 98                               | 0.09            | 0.310                | 0.290              | 19471E3                    | -                              | -                             | 49471E3                        |
|                                          | 680                              | 18 x 38                                 | 1260                                      | 140                              | 0.09            | 0.195                | 0.180              | 19681E3                    | -                              | -                             | 49681E3                        |
|                                          | 1000                             | 21 x 38                                 | 1470                                      | 204                              | 0.10            | 0.160                | 0.150              | 19102E3                    | -                              | -                             | 49102E3                        |

| ADDITIONAL ELECTRICAL DATA         |                      |                                              |               |
|------------------------------------|----------------------|----------------------------------------------|---------------|
| PARAMETER                          | CONDITIONS           | VALUE                                        |               |
|                                    |                      | AXIAL                                        | MOUNTING RING |
| Voltage                            |                      |                                              |               |
| Surge voltage                      |                      | $U_s \leq 1.15 \times U_R$                   |               |
| Reverse voltage                    |                      | $U_{rev} \leq 1 \text{ V}$                   |               |
| Current                            |                      |                                              |               |
| Leakage current                    | After 1 min at $U_R$ | $I_{L1} \leq 0.006 C_R \times U_R + 4 \mu A$ |               |
|                                    | After 5 min at $U_R$ | $I_{L5} \leq 0.002 C_R \times U_R + 4 \mu A$ |               |
| Inductance                         |                      |                                              |               |
| Equivalent series inductance (ESL) | Case Ø D x L mm:     |                                              |               |
|                                    | 4.5 x 10             | Typ. 10 nH                                   | -             |
|                                    | 6 x 10               | Typ. 22 nH                                   | -             |
|                                    | 8 x 11               | Typ. 85 nH                                   | -             |
|                                    | 6.5 x 18             | Typ. 25 nH                                   | -             |
|                                    | 8 x 18               | Typ. 40 nH                                   | -             |
|                                    | 10 x 18              | Typ. 61 nH                                   | -             |
|                                    | 10 x 25              | Typ. 38 nH                                   | -             |
|                                    | 10 x 30              | Typ. 38 nH                                   | -             |
|                                    | 12.5 x 30            | Typ. 46 nH                                   | -             |
|                                    | 15 x 30              | Typ. 48 nH                                   | Typ. 39 nH    |
|                                    | 18 x 30              | Typ. 50 nH                                   | Typ. 39 nH    |
|                                    | 18 x 38              | Typ. 54 nH                                   | Typ. 39 nH    |
|                                    | 21 x 38              | Typ. 59 nH                                   | Typ. 39 nH    |

## RIPPLE CURRENT AND USEFUL LIFE

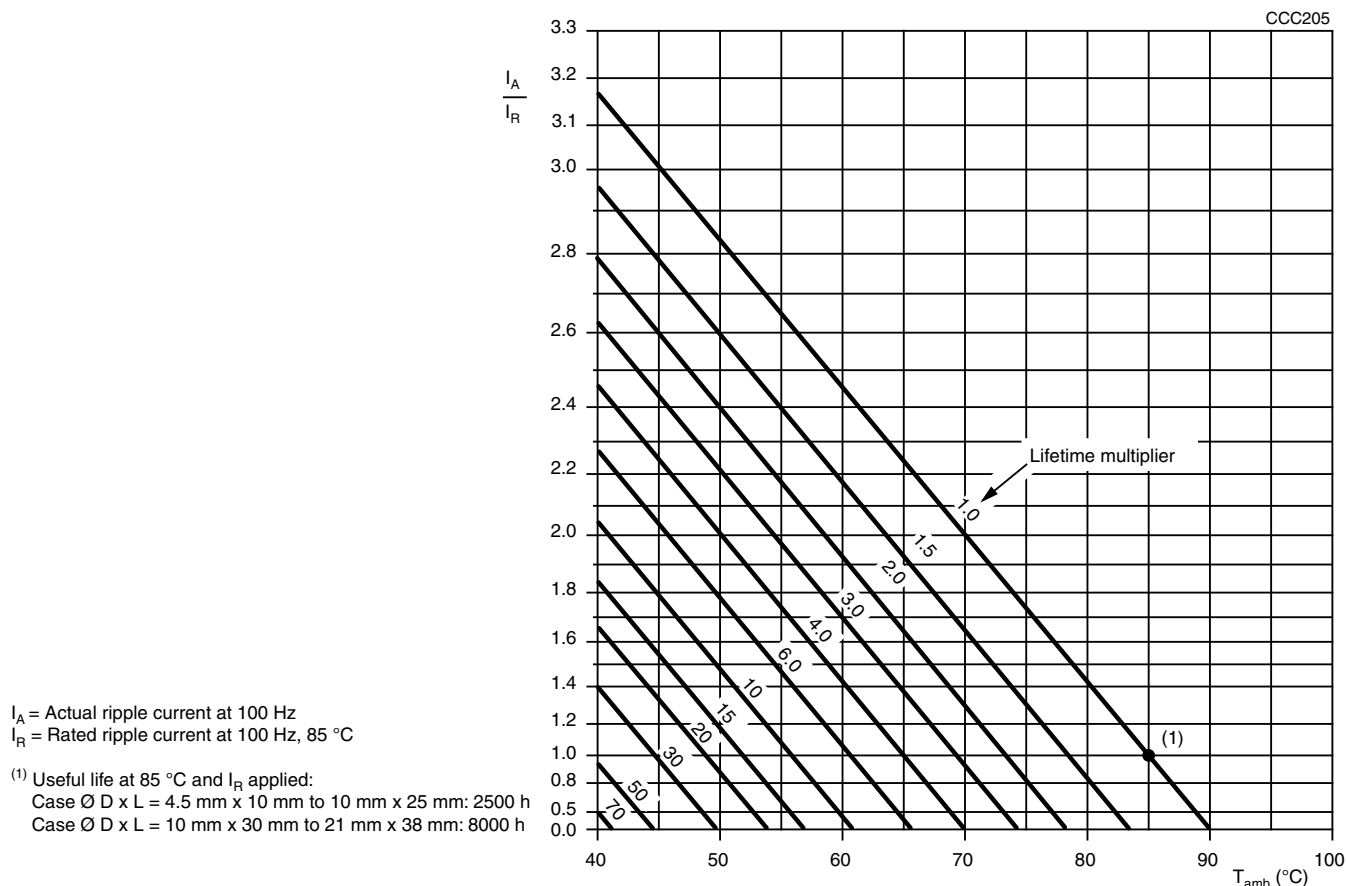


Fig. 6 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

| <b>MULTIPLIER OF RIPPLE CURRENT (<math>I_R</math>) AS A FUNCTION OF FREQUENCY</b> |                                                          |                                                         |                                                          |
|-----------------------------------------------------------------------------------|----------------------------------------------------------|---------------------------------------------------------|----------------------------------------------------------|
| <b>FREQUENCY<br/>(Hz)</b>                                                         | <b><math>I_R</math> MULTIPLIER</b>                       |                                                         |                                                          |
|                                                                                   | <b><math>U_R = 6.3 \text{ V TO } 16 \text{ V}</math></b> | <b><math>U_R = 25 \text{ V TO } 40 \text{ V}</math></b> | <b><math>U_R = 63 \text{ V TO } 100 \text{ V}</math></b> |
| 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>                           |                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                  |
| Endurance                                      | IEC 60384-4/<br>EN130300<br>subclause 4.13 | $T_{amb} = 85 \text{ }^\circ\text{C}$ ; $U_R$ applied;<br>case $\varnothing D \times L = 4.5 \text{ mm} \times 10 \text{ mm}$ to<br>10 mm x 25 mm:<br>$U_R = 6.3 \text{ V to } 25 \text{ V}$ : 1000 h;<br>$U_R = 40 \text{ V to } 100 \text{ V}$ : 2000 h;<br>case $\varnothing D \times L = 10 \text{ mm} \times 30 \text{ mm}$ to<br>21 mm x 38 mm:<br>$U_R = 6.3 \text{ V to } 100 \text{ V}$ : 5000 h | $U_R \leq 6.3 \text{ V}$ ; $\Delta C/C$ : + 15 %/- 30 %<br>$U_R > 6.3 \text{ V}$ ; $\Delta C/C$ : $\pm 15 \%$<br>$\tan \delta \leq 1.3 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$                                                                    |
|                                                |                                            | $T_{amb} = 105 \text{ }^\circ\text{C}$ ; $U_R$ applied;<br>case $\varnothing D \times L = 10 \text{ mm} \times 30 \text{ mm}$ to<br>21 mm x 38 mm: 2000 h                                                                                                                                                                                                                                                 | $\Delta C/C$ : $\leq \pm 20 \%$<br>$\tan \delta \leq 1.6 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$                                                                                                                                                  |
| Useful life                                    | CECC 30301<br>subclause 1.8.1              | $T_{amb} = 85 \text{ }^\circ\text{C}$ ; $U_R$ and $I_R$ applied;<br>case $\varnothing D \times L = 4.5 \text{ mm} \times 10 \text{ mm}$ to<br>10 mm x 25 mm: 2500 h;<br>case $\varnothing D \times L = 10 \text{ mm} \times 30 \text{ mm}$ to<br>21 mm x 38 mm: 8000 h                                                                                                                                    | $U_R \leq 6.3 \text{ V}$ ; $\Delta C/C$ : + 45 %/- 50 %<br>$U_R > 6.3 \text{ V}$ ; $\Delta C/C$ : $\pm 45 \%$<br>$\tan \delta \leq 3 \times \text{spec. limit}$<br>$Z \leq 3 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1 \%$ |
| Shelf life<br>(storage at<br>high temperature) | IEC 60384-4/<br>EN130300<br>subclause 4.17 | $T_{amb} = 85 \text{ }^\circ\text{C}$ ; no voltage applied;<br>500 h<br>after test: $U_R$ to be applied for 30 min,<br>24 h to 48 h before measurement                                                                                                                                                                                                                                                    | $\Delta C/C$ , $\tan \delta$ , $Z$ :<br>for requirements<br>see "Endurance test" above<br>$I_{L5} \leq 2 \times \text{spec. limit}$                                                                                                                                                                              |



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