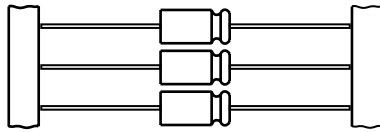
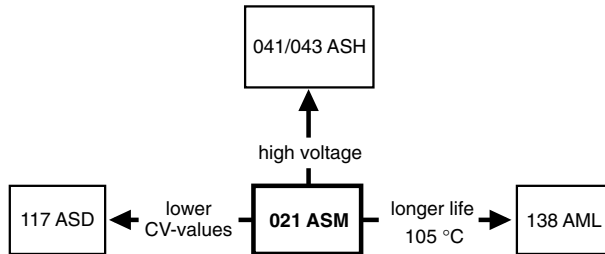


## Aluminum Capacitors Axial Standard Miniature


**Fig.1** Component outlines


| QUICK REFERENCE DATA                               |                        |                       |
|--|------------------------|-----------------------|
| DESCRIPTION  | VALUE                  |                       |
| Nominal case sizes<br>( $\varnothing$ 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, $C_R$                     | 0.47 to 15 000 $\mu$ F |                       |
| Tolerance on $C_R$                                 | $\pm$ 20 %             |                       |
| Rated voltage range, $U_R$                         | 6.3 to 100 V           |                       |
| Category temperature range                         | - 40 to + 85 °C        |                       |
| Endurance test at 85 °C:                           |                        |                       |
| $U_R = 6.3$ to 25 V                                | 1000 hours             | 5000 hours            |
| $U_R = 40$ to 100 V                                | 2000 hours             | 5000 hours            |
| Endurance test at 105 °C                           | -                      | 2000 hours            |
| Useful life at 85 °C                               | 2500 hours             | 8000 hours            |
| Useful life at 40 °C,<br>1.4 x $I_R$ applied       | 70 000 hours           | 200 000 hours         |
| Shelf life at 0 V, 85 °C                           | 500 hours              | 500 hours             |
| Based on sectional specification                   | IEC 60384-4/EN130300   |                       |
| Climatic category IEC 60068                        | 40/085/56              |                       |

**FEATURES.**

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not available in insulated form
- Taped versions up to case  $\varnothing$  15 x 30 mm available for automatic insertion
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Lead (Pb)-free versions are RoHS compliant


**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**

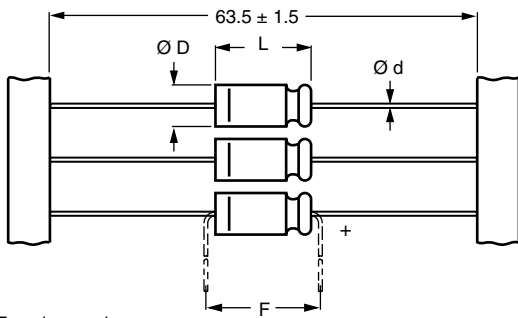
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in  $\mu$ F)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for  $\pm$  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
- Band to indicate the negative terminal
- “+” sign to identify the positive terminal (not for case sizes L < 18 mm)
- Series number (021)

| SELECTION CHART FOR $C_R$ , $U_R$ AND RELEVANT NOMINAL CASE SIZES ( $\varnothing$ D x L in mm) |           |    |    |    |          |          |          |
|--|-----------|----|----|----|----------|----------|----------|
| $C_R$<br>( $\mu$ F)  | $U_R$ (V) |    |    |    |          |          |          |
|  | 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 |

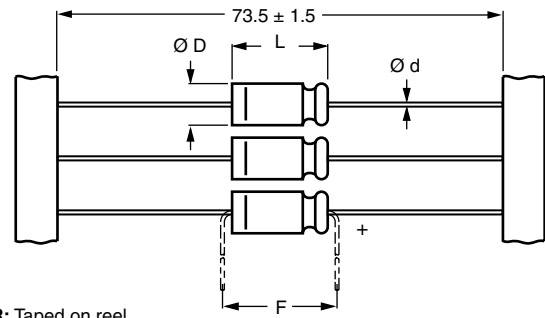
| SELECTION CHART FOR $C_R$ , $U_R$ AND RELEVANT NOMINAL CASE SIZES ( $\varnothing D \times L$ in mm) |           |           |           |           |           |           |           |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| $C_R$<br>( $\mu F$ )  | $U_R$ (V) |           |           |           |           |           |           |
|   | 6.3       | 10        | 16        | 25        | 40        | 63        | 100       |
| 47  | -         | -         | -         | 4.5 x 10  | 6 x 10    | 8 x 11    | 8 x 18    |
| 68  | -         | -         | 4.5 x 10  | -         | -         | 8 x 11    | 10 x 18   |
| 100   | -         | 4.5 x 10  | -         | 6 x 10    | 8 x 11    | 8 x 18    | 10 x 25   |
| 150   | -         | -         | 6 x 10    | 8 x 11    | 8 x 18    | 10 x 18   | 12.5 x 30 |
| 220   | -         | 6 x 10    | 8 x 11    | 6.5 x 18  | 10 x 18   | 10 x 25   | 12.5 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   |
| 680   | -         | 8 x 18    | 10 x 18   | 10 x 25   | 12.5 x 30 | 15 x 30   | 18 x 38   |
| 1000  | 8 x 18    | 10 x 18   | 10 x 25   | 12.5 x 30 | 12.5 x 30 | 18 x 30   | 21 x 38   |
| 1500  | -         | 10 x 25   | 12.5 x 30 | 12.5 x 30 | 15 x 30   | 18 x 38   | -         |
| 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**



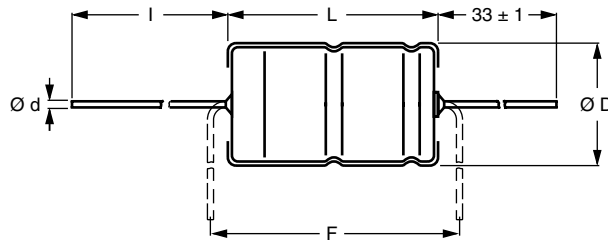
**Form BR:** Taped on reel  
**Form BA:** Taped in box (ammopack)  
Case  $\varnothing D \times L = 4.5 \times 10$  to  $8 \times 11$  mm

**Fig.2 Forms BA and BR**



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

**Fig.3 Forms BA and BR**



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

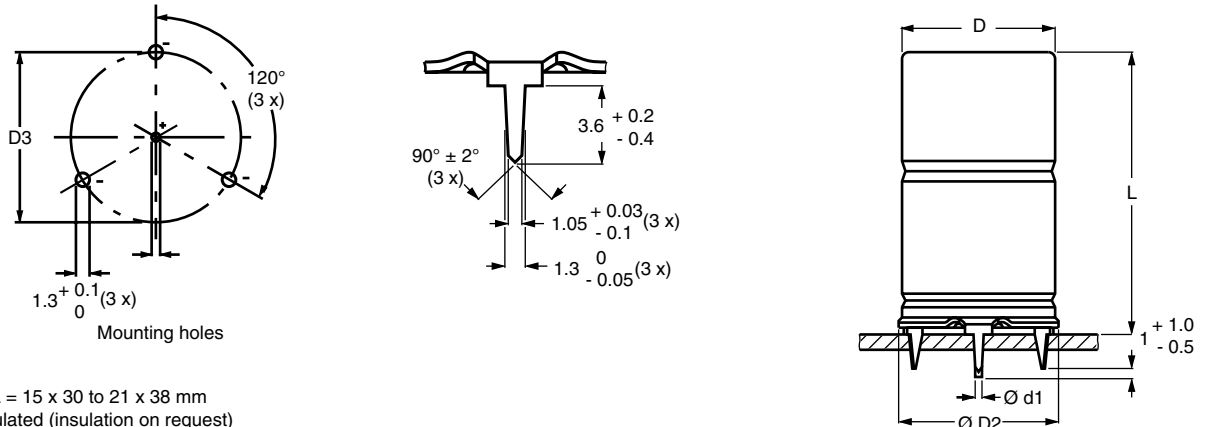
**Fig.4 Form AA**

**Table 1**

| <b>AXIAL; DIMENSIONS</b> in millimeters, <b>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                | ≈ 0.50   | -                    | 1000    | 3000    |
| 6 x 10  | 3         | 0.6                        | -      | 6.3                 | 10.5              | 15                | ≈ 0.70   | -                    | 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**

- Detailed tape dimensions see section "PACKAGING".


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

**Table 2**

| <b>MOUNTING RING; DIMENSIONS</b> in millimeters, <b>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 <sub>R</sub>  | rated capacitance at 100 Hz, tolerance ± 20 %  |
| I <sub>R</sub>  | rated RMS ripple current at 100 Hz, 85 °C  |
| I <sub>L5</sub> | max. leakage current after 5 min at U <sub>R</sub>   |
| Tan δ           | max. dissipation factor at 100 Hz  |
| ESR             | equivalent series resistance at 100 Hz (calculated from tan δ <sub>max.</sub> and C <sub>R</sub> ) |
| Z               | max. impedance at 10 kHz   |

**ORDERING EXAMPLE**

Electrolytic capacitor 021 series

1000 µF/16 V; ± 20 %

Nominal case size: Ø 10 x 25 mm; Form BA

Ordering code: MAL202190518E3

Former 12NC: 2222 021 90518

**Note**

1. Unless otherwise specified, all electrical values in Table 3 apply at T<sub>amb</sub> = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %.

Table 3

| 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) | tanδ<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 |  |
| 6.3                                      | 470                              | 8 x 11                                  | 260                                       | 10                               | 0.25           | 0.85                 | 0.64               | -                           | 23471E3                        | 33471E3                       | -                              |  |
|  | 1000                             | 8 x 18                                  | 440                                       | 17                               | 0.25           | 0.4                  | 0.5                | -                           | 23102E3                        | 33102E3                       | -                              |  |
|  | 2200                             | 10 x 25                                 | 710                                       | 32                               | 0.29           | 0.21                 | 0.16               | -                           | 90588E3                        | 90589E3                       | -                              |  |
| 10                                       | 100                              | 4.5 x 10                                | 100                                       | 6                                | 0.20           | 3.2                  | 2.0                | -                           | 24101E3                        | 34101E3                       | -                              |  |
|  | 220                              | 6 x 10                                  | 160                                       | 8.4                              | 0.20           | 1.5                  | 0.91               | -                           | 24221E3                        | 34221E3                       | -                              |  |
|  | 330                              | 8 x 11                                  | 230                                       | 11                               | 0.20           | 1.0                  | 0.61               | -                           | 24331E3                        | 34331E3                       | -                              |  |
|  | 470                              | 6.5 x 18                                | 310                                       | 13                               | 0.20           | 0.68                 | 0.43               | -                           | 24471E3                        | 34471E3                       | -                              |  |
|  | 680                              | 8 x 18                                  | 400                                       | 18                               | 0.20           | 0.47                 | 0.29               | -                           | 24681E3                        | 34681E3                       | -                              |  |
|  | 1000                             | 10 x 18                                 | 550                                       | 24                               | 0.20           | 0.32                 | 0.20               | -                           | 24102E3                        | 34102E3                       | -                              |  |
|  | 1500                             | 10 x 25                                 | 690                                       | 34                               | 0.23           | 0.25                 | 0.18               | -                           | 90524E3                        | 90525E3                       | -                              |  |
|  | 1500                             | 10 x 30                                 | 740                                       | 34                               | 0.23           | 0.245                | 0.18               | 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                | 0.07               | 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                | 0.04               | 14103E3                     | -                              | -                             | 44103E3                        |  |
|  | 15 000                           | 21 x 38                                 | 2250                                      | 304                              | 0.50           | 0.054                | 0.035              | 14153E3                     | -                              | -                             | 44153E3                        |  |
| 16                                       | 68                               | 4.5 x 10                                | 90  | 6.2                              | 0.16           | 3.8                  | 2.4                | -                           | 25689E3                        | 35689E3                       | -                              |  |
|  | 150                              | 6 x 10                                  | 140                                       | 8.8                              | 0.16           | 1.7                  | 1.1                | -                           | 25151E3                        | 35151E3                       | -                              |  |
|  | 220                              | 8 x 11                                  | 210                                       | 11                               | 0.16           | 1.2                  | 0.73               | -                           | 25221E3                        | 35221E3                       | -                              |  |
|  | 330                              | 6.5 x 18                                | 290                                       | 15                               | 0.16           | 0.77                 | 0.48               | -                           | 25331E3                        | 35331E3                       | -                              |  |
|  | 470                              | 8 x 18                                  | 380                                       | 19                               | 0.16           | 0.55                 | 0.34               | -                           | 25471E3                        | 35471E3                       | -                              |  |
|  | 680                              | 10 x 18                                 | 500                                       | 26                               | 0.16           | 0.38                 | 0.24               | -                           | 25681E3                        | 35681E3                       | -                              |  |
|  | 1000                             | 10 x 25                                 | 660                                       | 36                               | 0.16           | 0.26                 | 0.18               | -                           | 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                | 0.07               | 15332E3                     | 25332E3                        | -                             | 45332E3                        |  |
|  | 4700                             | 18 x 30                                 | 1560                                      | 154                              | 0.25           | 0.087                | 0.065              | 15472E3                     | -                              | -                             | 45472E3                        |  |
|  | 6800                             | 18 x 38                                 | 2040                                      | 222                              | 0.30           | 0.070                | 0.04               | 15682E3                     | -                              | -                             | 45682E3                        |  |
|  | 10 000                           | 21 x 38                                 | 2170                                      | 324                              | 0.36           | 0.058                | 0.035              | 15103E3                     | -                              | -                             | 45103E3                        |  |
| 25                                       | 47                               | 4.5 x 10                                | 80  | 6.4                              | 0.14           | 4.8                  | 2.6                | -                           | 26479E3                        | 36479E3                       | -                              |  |
|  | 100                              | 6 x 10                                  | 150                                       | 9                                | 0.14           | 2.3                  | 1.2                | -                           | 26101E3                        | 36101E3                       | -                              |  |
|  | 150                              | 8 x 11                                  | 190                                       | 12                               | 0.14           | 1.5                  | 0.80               | -                           | 90534E3                        | 90535E3                       | -                              |  |
|  | 150                              | 6.5 x 18                                | 210                                       | 12                               | 0.14           | 1.5                  | 0.80               | -                           | 26151E3                        | 36151E3                       | -                              |  |
|  | 220                              | 6.5 x 18                                | 250                                       | 15                               | 0.14           | 1.0                  | 0.55               | -                           | 26221E3                        | 36221E3                       | -                              |  |
|  | 330                              | 8 x 18                                  | 340                                       | 21                               | 0.14           | 0.68                 | 0.36               | -                           | 26331E3                        | 36331E3                       | -                              |  |
|  | 470                              | 10 x 18                                 | 450                                       | 28                               | 0.14           | 0.48                 | 0.26               | -                           | 26471E3                        | 36471E3                       | -                              |  |
|  | 680                              | 10 x 25                                 | 560                                       | 38                               | 0.14           | 0.33                 | 0.18               | -                           | 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                        | -                             | -                              |  |

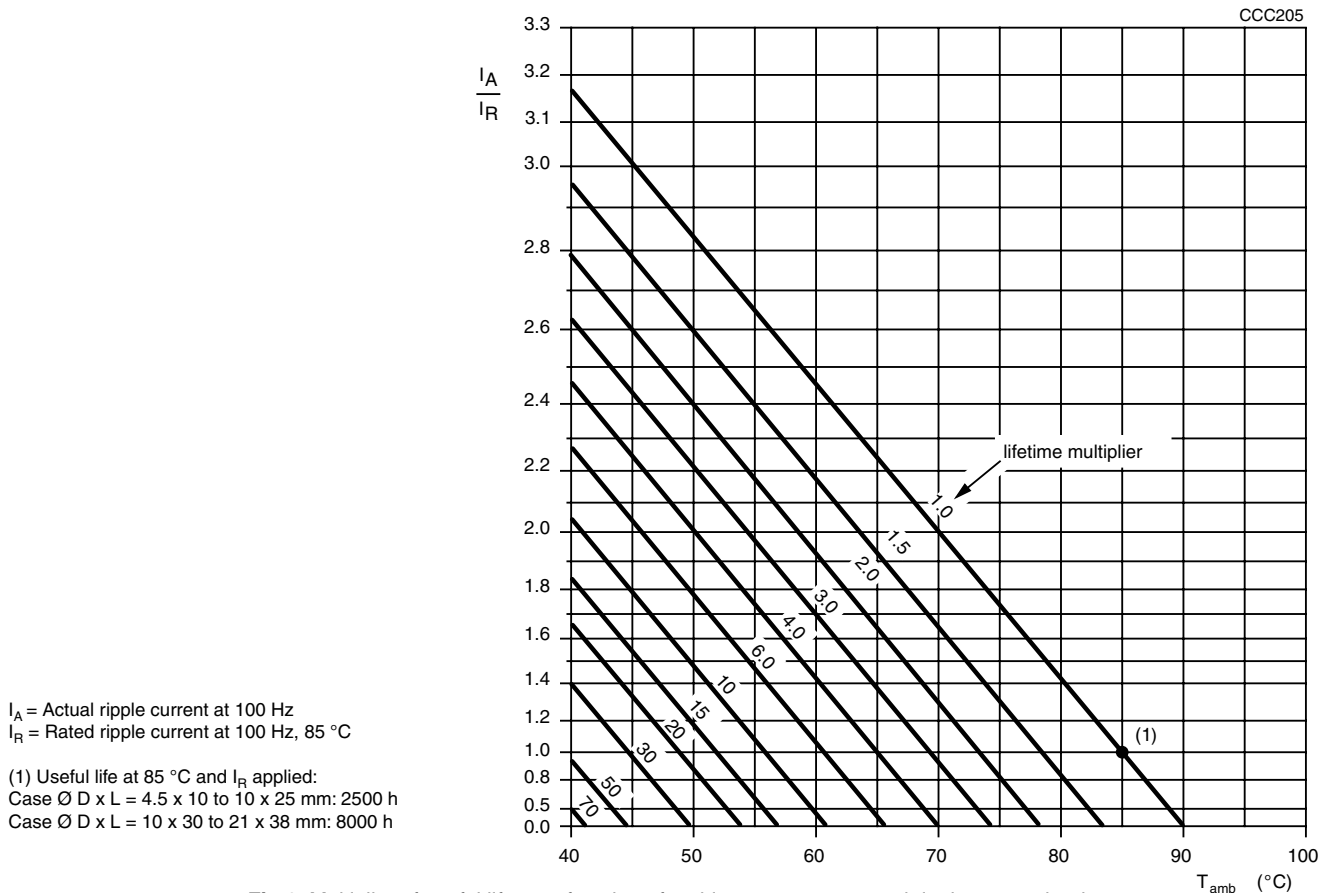


| ELECTRICAL DATA AND ORDERING INFORMATION |                                  |   |   |                                  |                |                      |                    |                             |                                |                               |                                |
|--|----------------------------------|---|---|----------------------------------|----------------|----------------------|--------------------|-----------------------------|--------------------------------|-------------------------------|--------------------------------|
| 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) | tanδ<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 |
| 25                                       | 2200                             | 15 x 30                                 | 1180                                      | 114                              | 0.19           | 0.132                | 0.07               | 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                | 0.04               | 90062E3                     | -                              | -                             | 46472E3                        |
|  | 6800                             | 21 x 38                                 | 2070                                      | 344                              | 0.28           | 0.064                | 0.035              | 16682E3                     | -                              | -                             | 46682E3                        |
| 40                                       | 22                               | 4.5 x 10                                | 60  | 5.8                              | 0.11           | 8.0                  | 3.2                | -                           | 27229E3                        | 37229E3                       | -                              |
|  | 47                               | 6 x 10                                  | 110                                       | 7.8                              | 0.11           | 3.8                  | 1.5                | -                           | 27479E3                        | 37479E3                       | -                              |
|  | 100                              | 8 x 11                                  | 170                                       | 12                               | 0.11           | 1.8                  | 0.70               | -                           | 90537E3                        | 90538E3                       | -                              |
|  | 100                              | 6.5 x 18                                | 190                                       | 12                               | 0.11           | 1.8                  | 0.70               | -                           | 27101E3                        | 37101E3                       | -                              |
|  | 150                              | 8 x 18                                  | 250                                       | 16                               | 0.11           | 1.1                  | 0.47               | -                           | 27151E3                        | 37151E3                       | -                              |
|  | 220                              | 10 x 18                                 | 330                                       | 22                               | 0.11           | 0.8                  | 0.32               | -                           | 27221E3                        | 37221E3                       | -                              |
|  | 330                              | 10 x 25                                 | 430                                       | 30                               | 0.11           | 0.53                 | 0.21               | -                           | 27331E3                        | 37331E3                       | -                              |
|  | 470                              | 10 x 25                                 | 520                                       | 42                               | 0.11           | 0.37                 | 0.18               | -                           | 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                     | 90064E3                        | -                             | -                              |
|  | 1500                             | 15 x 30                                 | 1120                                      | 124                              | 0.15           | 0.159                | 0.07               | 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                | 0.04               | 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                  | 120                | -                           | 28477E3                        | 38477E3                       | -                              |
|  | 1                                | 4.5 x 10                                | 12  | 4.1                              | 0.09           | 150                  | 55                 | -                           | 28108E3                        | 38108E3                       | -                              |
|  | 2.2                              | 4.5 x 10                                | 21  | 4.3                              | 0.09           | 65                   | 25                 | -                           | 28228E3                        | 38228E3                       | -                              |
|  | 3.3                              | 4.5 x 10                                | 25  | 4.4                              | 0.09           | 44                   | 17                 | -                           | 28338E3                        | 38338E3                       | -                              |
|  | 4.7                              | 4.5 x 10                                | 31  | 4.6                              | 0.09           | 31                   | 12                 | -                           | 28478E3                        | 38478E3                       | -                              |
|  | 10                               | 4.5 x 10                                | 50  | 5.3                              | 0.08           | 13                   | 5.5                | -                           | 28109E3                        | 38109E3                       | -                              |
|  | 15                               | 4.5 x 10                                | 55  | 5.9                              | 0.08           | 8.5                  | 3.7                | -                           | 28159E3                        | 38159E3                       | -                              |
|  | 22                               | 6 x 10                                  | 90  | 6.8                              | 0.08           | 5.8                  | 2.5                | -                           | 28229E3                        | 38229E3                       | -                              |
|  | 33                               | 6 x 10                                  | 100                                       | 8.2                              | 0.08           | 3.9                  | 1.7                | -                           | 28339E3                        | 38339E3                       | -                              |
|  | 47                               | 8 x 11                                  | 140                                       | 10                               | 0.08           | 2.7                  | 1.2                | -                           | 90541E3                        | 90542E3                       | -                              |
|  | 47                               | 6.5 x 18                                | 150                                       | 10                               | 0.08           | 2.7                  | 1.2                | -                           | 28479E3                        | 38479E3                       | -                              |
|  | 68                               | 8 x 11                                  | 160                                       | 13                               | 0.08           | 1.9                  | 0.81               | -                           | 90544E3                        | 90545E3                       | -                              |
|  | 68                               | 6.5 x 18                                | 170                                       | 13                               | 0.08           | 1.9                  | 0.81               | -                           | 28689E3                        | 38689E3                       | -                              |
|  | 100                              | 8 x 18                                  | 250                                       | 17                               | 0.08           | 1.3                  | 0.55               | -                           | 28101E3                        | 38101E3                       | -                              |
|  | 150                              | 10 x 18                                 | 320                                       | 23                               | 0.08           | 0.85                 | 0.37               | -                           | 28151E3                        | 38151E3                       | -                              |
|  | 220                              | 10 x 25                                 | 430                                       | 32                               | 0.08           | 0.60                 | 0.25               | -                           | 90511E3                        | 90512E3                       | -                              |
|  | 220                              | 10 x 30                                 | 480                                       | 32                               | 0.08           | 0.614                | 0.26               | 18221E3                     | 28221E3                        | -                             | -                              |
|  | 330                              | 12.5 x 30                               | 610                                       | 46                               | 0.08           | 0.409                | 0.19               | 18331E3                     | 28331E3                        | -                             | -                              |
|  | 470                              | 12.5 x 30                               | 700                                       | 63                               | 0.08           | 0.287                | 0.13               | 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                  | 90                 | -                           | 29108E3                        | 39108E3                       | -                              |
|  | 2.2                              | 4.5 x 10                                | 20  | 4.4                              | 0.08           | 58                   | 41                 | -                           | 29228E3                        | 39228E3                       | -                              |
|  | 4.7                              | 4.5 x 10                                | 30  | 4.9                              | 0.08           | 27                   | 19                 | -                           | 29478E3                        | 39478E3                       | -                              |
|  | 10                               | 6 x 10                                  | 65  | 6                                | 0.08           | 13                   | 9                  | -                           | 29109E3                        | 39109E3                       | -                              |
|  | 15                               | 8 x 11                                  | 77  | 7                                | 0.08           | 8.5                  | 6                  | -                           | 90547E3                        | 90548E3                       | -                              |
|  | 15                               | 6.5 x 18                                | 85  | 7                                | 0.08           | 8.5                  | 6                  | -                           | 29159E3                        | 39159E3                       | -                              |
|  | 22                               | 8 x 11                                  | 95  | 8.4                              | 0.08           | 5.8                  | 4.1                | -                           | 90551E3                        | 90552E3                       | -                              |
|  | 22                               | 6.5 x 18                                | 100                                       | 8.4                              | 0.08           | 5.8                  | 4.1                | -                           | 29229E3                        | 39229E3                       | -                              |
|  | 33                               | 6.5 x 18                                | 120                                       | 10.6                             | 0.08           | 3.9                  | 2.7                | -                           | 29339E3                        | 39339E3                       | -                              |
|  | 47                               | 8 x 18                                  | 160                                       | 13.4                             | 0.08           | 2.7                  | 1.9                | -                           | 29479E3                        | 39479E3                       | -                              |
|  | 68                               | 10 x 18                                 | 220                                       | 17.6                             | 0.08           | 1.9                  | 1.3                | -                           | 29689E3                        | 39689E3                       | -                              |
|  | 100                              | 10 x 25                                 | 300                                       | 24                               | 0.08           | 1.3                  | 0.9                | -                           | 90531E3                        | 90532E3                       | -                              |
|  | 100                              | 10 x 30                                 | 340                                       | 24                               | 0.07           | 1.150                | 1.0                | 19101E3                     | 29101E3                        | -                             | -                              |
|  | 150                              | 12.5 x 30                               | 490                                       | 34                               | 0.07           | 0.645                | 0.61               | 19151E3                     | 29151E3                        | -                             | -                              |
|  | 220                              | 12.5 x 30                               | 560                                       | 48                               | 0.08           | 0.610                | 0.56               | 19221E3                     | 29221E3                        | -                             | -                              |
|  | 330                              | 15 x 30                                 | 740                                       | 70                               | 0.09           | 0.420                | 0.40               | 19331E3                     | 29331E3                        | -                             | 49331E3                        |
|  | 470                              | 18 x 30                                 | 980                                       | 98                               | 0.09           | 0.310                | 0.29               | 19471E3                     | -                              | -                             | 49471E3                        |
|  | 680                              | 18 x 38                                 | 1260                                      | 140                              | 0.09           | 0.195                | 0.18               | 19681E3                     | -                              | -                             | 49681E3                        |
| 1000                                     | 21 x 38                          | 1470                                    | 204                                       | 0.10                             | 0.160          | 0.15                 | 19102E3            | -                           | -                              | 49102E3                       |                                |



| ADDITIONAL ELECTRICAL DATA         |                                   |  |               |
|------------------------------------|-----------------------------------|--|---------------|
| PARAMETER                          | CONDITIONS                        | VALUE  |               |
|                                    |                                   | AXIAL  | MOUNTING RING |
| <b>Voltage</b>                     |                                   |  |               |
| Surge voltage                      |                                   | $U_s \leq 1.15 \times U_R$                         |               |
| Reverse voltage                    |                                   | $U_{rev} \leq 1 \text{ V}$                         |               |
| <b>Current</b>                     |                                   |  |               |
| Leakage current                    | after 1 min at $U_R$              | $I_{L1} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$ |               |
|                                    | after 5 min at $U_R$              | $I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$ |               |
| <b>Inductance</b>                  |                                   |  |               |
| Equivalent series inductance (ESL) | case $\varnothing D \times L$ mm: |  |               |
|                                    | 4.5 x 10                          | typ. 10 nH   | -             |
|                                    | 6 x 10                            | typ. 22 nH   | -             |
|                                    | 8 x 11                            | typ. 85 nH   | -             |
|                                    | 6.5 x 18                          | typ. 25 nH   | -             |
|                                    | 8 x 18                            | typ. 40 nH   | -             |
|                                    | 10 x 18                           | typ. 61 nH   | -             |
|                                    | 10 x 25                           | typ. 38 nH   | -             |
|                                    | 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> |                       |                      |                       |
|---|-----------------------|----------------------|-----------------------|
| FREQUENCY<br>(Hz)   | $I_R$ MULTIPLIER      |                      |                       |
|   | $U_R = 6.3$ to $16$ V | $U_R = 25$ to $40$ V | $U_R = 63$ to $100$ V |
| 50  | 0.95                  | 0.90                 | 0.85                  |
| 100   | 1.00                  | 1.00                 | 1.00                  |
| 300   | 1.07                  | 1.12                 | 1.20                  |
| 1000  | 1.12                  | 1.20                 | 1.30                  |
| 3000  | 1.15                  | 1.25                 | 1.35                  |
| $\geq 10\ 000$  | 1.20                  | 1.30                 | 1.40                  |

Table 5

| <b>TEST PROCEDURES AND REQUIREMENTS</b>        |  |  |   |
|--|--|--|---|
| TEST   |  | PROCEDURE<br>(quick reference)   | REQUIREMENTS  |
| NAME OF TEST                                   | REFERENCE                                  |  |   |
| Endurance                                      | IEC 60384-4/<br>EN130300<br>subclause 4.13 | $T_{amb} = 85\ ^\circ\text{C}$ ; $U_R$ applied;<br>case $\varnothing D \times L = 4.5 \times 10$ to $10 \times 25$ mm:<br>$U_R = 6.3$ to $25$ V: 1000 h;<br>$U_R = 40$ to $100$ V: 2000 h;<br>case $\varnothing D \times L = 10 \times 30$ to $21 \times 38$ mm:<br>$U_R = 6.3$ to $100$ V: 5000 h | $U_R \leq 6.3$ V; $\Delta C/C$ : + 15/- 30 %<br>$U_R > 6.3$ V; $\Delta C/C$ : $\pm 15$ %<br>$\tan \delta \leq 1.3 \times$ spec. limit<br>$Z \leq 2 \times$ spec. limit<br>$I_{L5} \leq$ spec. limit   |
|  |  | $T_{amb} = 105\ ^\circ\text{C}$ ; $U_R$ applied;<br>case $\varnothing D \times L = 10 \times 30$ to $21 \times 38$ mm:<br>2000 h   | $\Delta C/C$ : $\leq \pm 20$ %<br>$\tan \delta \leq 1.6 \times$ spec. limit<br>$Z \leq 2 \times$ spec. limit<br>$I_{L5} \leq$ spec. limit   |
| Useful life                                    | CECC 30301<br>subclause 1.8.1              | $T_{amb} = 85\ ^\circ\text{C}$ ; $U_R$ and $I_R$ applied;<br>case $\varnothing D \times L = 4.5 \times 10$ to $10 \times 25$ mm:<br>2500 h;<br>case $\varnothing D \times L = 10 \times 30$ to $21 \times 38$ mm: 8000 h   | $U_R \leq 6.3$ V; $\Delta C/C$ : + 45/- 50 %<br>$U_R > 6.3$ V; $\Delta C/C$ : $\pm 45$ %<br>$\tan \delta \leq 3 \times$ spec. limit<br>$Z \leq 3 \times$ spec. limit<br>$I_{L5} \leq$ 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 | $T_{amb} = 85\ ^\circ\text{C}$ ; no voltage applied;<br>500 h<br><br>after test: $U_R$ to be applied for 30 min,<br>24 to 48 h before measurement  | $\Delta C/C$ , $\tan \delta$ , $Z$ :<br>for requirements<br>see 'Endurance test' above<br>$I_{L5} \leq 2 \times$ spec. limit  |



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