



**THE DATASHEET OF  
MAL202115682E3**



## Aluminum Electrolytic Capacitors Axial Standard Miniature

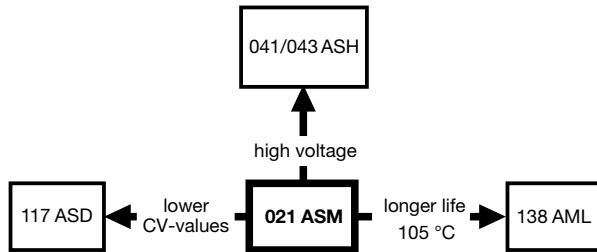


Fig. 1


**RoHS  
COMPLIANT**

### 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)

### 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

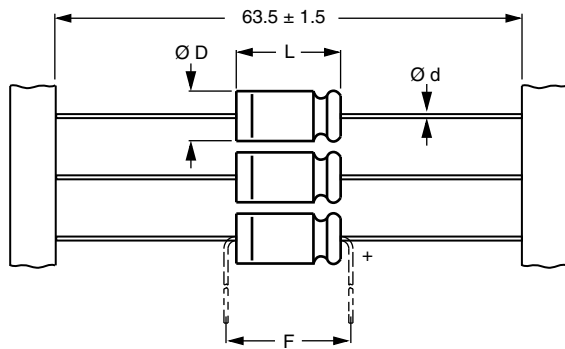
The capacitors are marked (where possible) with the following information:

- 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)

| QUICK REFERENCE DATA                                  |                         |                       |
|---|-------------------------|-----------------------|
| DESCRIPTION   | VALUE                   |                       |
| Nominal case sizes (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>               | 1 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 / EN 130300 |                       |
| Climatic category IEC 60068                           | 40 / 085 / 56           |                       |

| C <sub>R</sub><br>(µF) | U <sub>R</sub> (V) |    |    |          |          |          |          |
|------------------------|--------------------|----|----|----------|----------|----------|----------|
|                        | 6.3                | 10 | 16 | 25       | 40       | 63       | 100      |
| 1.0                    | -                  | -  | -  | -        | -        | 4.5 x 10 | 4.5 x 10 |
| 2.2                    | -                  | -  | -  | -        | -        | 4.5 x 10 | 4.5 x 10 |
| 3.3                    | -                  | -  | -  | -        | -        | 4.5 x 10 | -        |
| 4.7                    | -                  | -  | -  | -        | -        | 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   |
|  | 8 x 11    | 6.5 x 18  | 8 x 18    | 10 x 18   | 10 x 25   | 12.5 x 30 | 18 x 30   |
| 470  | -         | -         | -         | -         | 10 x 30   | -         | -         |
|  | -         | 8 x 18    | 10 x 18   | 10 x 25   | 12.5 x 30 | 15 x 30   | 18 x 38   |
| 680  | -         | -         | -         | 10 x 30   | -         | -         | -         |
|  | 8 x 18    | 10 x 18   | 10 x 25   | 12.5 x 30 | 12.5 x 30 | 18 x 30   | 21 x 38   |
| 1000   | -         | -         | 10 x 30   | -         | -         | -         | -         |
|  | -         | 10 x 25   | 12.5 x 30 | 12.5 x 30 | 15 x 30   | 18 x 38   | -         |
| 1500   | -         | 10 x 30   | -         | -         | -         | -         | -         |
|  | 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   | -         | -         |
|  | -         | 15 x 30   | 18 x 30   | 18 x 38   | 21 x 38   | -         | -         |
| 4700   | -         | 18 x 30   | 18 x 38   | 21 x 38   | -         | -         | -         |
|  | -         | 18 x 30   | 18 x 38   | 21 x 38   | -         | -         | -         |
| 6800   | -         | 18 x 38   | 21 x 38   | -         | -         | -         | -         |
|  | -         | 18 x 38   | 21 x 38   | -         | -         | -         | -         |
| 10 000   | -         | 21 x 38   | -         | -         | -         | -         | -         |
|  | -         | 21 x 38   | -         | -         | -         | -         | -         |

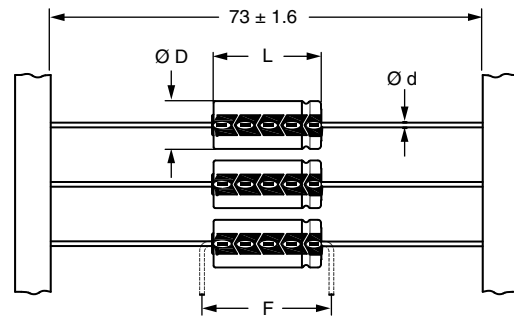
**DIMENSIONS in millimeters AND AVAILABLE FORMS**


**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



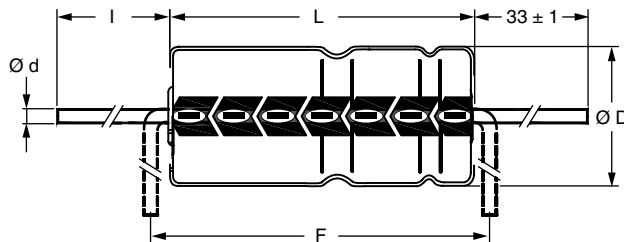
**Form BR:** Taped on reel

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  $21 \text{ mm} \times 38 \text{ mm}$

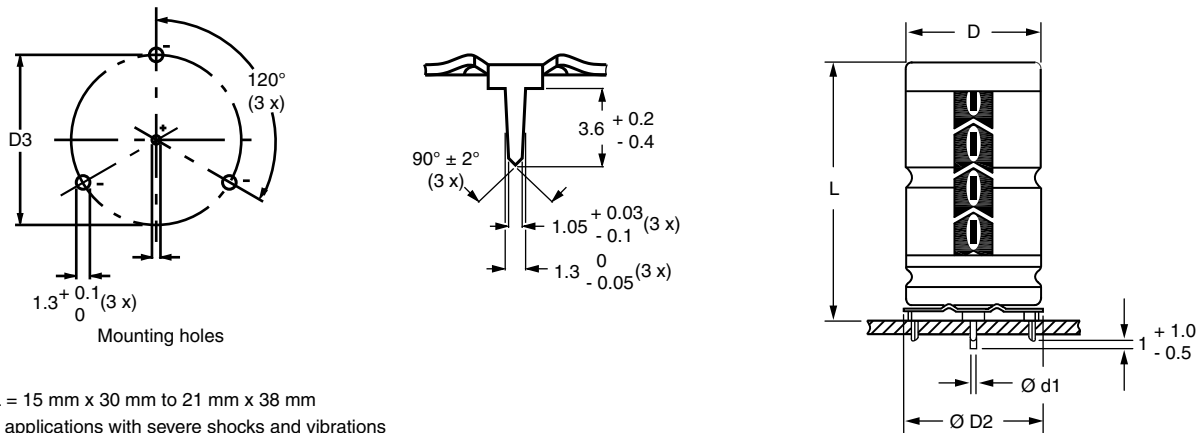
Fig. 4 - Form AA

**Table 1**

| <b>AXIAL; DIMENSIONS</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                | ≈ 0.5    | -                    | 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</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   |
| $C_R$           | 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  $T_{amb} = 20\text{ °C}$ ,  $P = 86\text{ kPa}$  to  $106\text{ kPa}$ ,  $RH = 45\%$  to  $75\%$ .

ORDERING EXAMPLE

Electrolytic capacitor 021 series

1000  $\mu\text{F}$  / 16 V;  $\pm 20\%$

Nominal case size:  $\varnothing 10\text{ mm} \times 25\text{ mm}$ ; Form BA

Ordering code: MAL202190518E3

Former 12 NC: 2222 021 90518

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>( $\Omega$ ) | LIFE<br>CODE (1) | 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                       | L1               | -                          | 23471E3                        | 33471E3                       | -                              |         |
|  | 1000                                 | 8 x 18   | 440                              | 17                                     | 0.25                    | 0.400                         | 0.500                       | L1               | -                          | 23102E3                        | 33102E3                       | -                              |         |
|  | 2200                                 | 10 x 25  | 710                              | 32                                     | 0.29                    | 0.210                         | 0.160                       | L1               | -                          | 90588E3                        | 90589E3                       | -                              |         |
| 10                                       | 100                                  | 4.5 x 10   | 100                              | 6                                      | 0.20                    | 3.200                         | 2.000                       | L1               | -                          | 24101E3                        | 34101E3                       | -                              |         |
|  | 220                                  | 6 x 10   | 160                              | 8.4                                    | 0.20                    | 1.500                         | 0.910                       | L1               | -                          | 24221E3                        | 34221E3                       | -                              |         |
|  | 330                                  | 8 x 11   | 230                              | 11                                     | 0.20                    | 1.000                         | 0.610                       | L1               | -                          | 24331E3                        | 34331E3                       | -                              |         |
|  | 470                                  | 6.5 x 18   | 310                              | 13                                     | 0.20                    | 0.680                         | 0.430                       | L1               | -                          | 24471E3                        | 34471E3                       | -                              |         |
|  | 680                                  | 8 x 18   | 400                              | 18                                     | 0.20                    | 0.470                         | 0.290                       | L1               | -                          | 24681E3                        | 34681E3                       | -                              |         |
|  | 1000                                 | 10 x 18  | 550                              | 24                                     | 0.20                    | 0.320                         | 0.200                       | L1               | -                          | 24102E3                        | 34102E3                       | -                              |         |
|  | 1500                                 | 10 x 25  | 690                              | 34                                     | 0.23                    | 0.250                         | 0.180                       | L1               | -                          | 90524E3                        | 90525E3                       | -                              |         |
|  | 1500                                 | 10 x 30  | 740                              | 34                                     | 0.23                    | 0.245                         | 0.180                       | L3               | 14152E3                    | 24152E3                        | -                             |                                |         |
|  | 2200                                 | 12.5 x 30  | 980                              | 48                                     | 0.25                    | 0.177                         | 0.095                       | L3               | 14222E3                    | 24222E3                        | -                             |                                |         |
|  | 3300                                 | 12.5 x 30  | 1090                             | 70                                     | 0.27                    | 0.128                         | 0.095                       | L3               | 14332E3                    | 24332E3                        | -                             |                                |         |
|  | 4700                                 | 15 x 30  | 1320                             | 98                                     | 0.29                    | 0.100                         | 0.070                       | L3               | 14472E3                    | 24472E3                        | -                             |                                |         |
|  | 6800                                 | 18 x 30  | 1590                             | 140                                    | 0.34                    | 0.079                         | 0.065                       | L3               | 14682E3                    | -                              | -                             | 44472E3                        |         |
| 10 000                                   | 18 x 38                              | 2090   | 204                              | 0.40                                   | 0.064                   | 0.040                         | L3                          | 14103E3          | -                          | -                              | -                             | 44103E3                        |         |
| 15 000                                   | 21 x 38                              | 2250   | 304                              | 0.50                                   | 0.054                   | 0.035                         | L3                          | 14153E3          | -                          | -                              | -                             | -                              | 44153E3 |
| 16                                       | 68                                   | 4.5 x 10   | 90                               | 6.2                                    | 0.16                    | 3.800                         | 2.400                       | L1               | -                          | 25689E3                        | 35689E3                       | -                              |         |
|  | 150                                  | 6 x 10   | 140                              | 8.8                                    | 0.16                    | 1.700                         | 1.100                       | L1               | -                          | 25151E3                        | 35151E3                       | -                              |         |
|  | 220                                  | 8 x 11   | 210                              | 11                                     | 0.16                    | 1.200                         | 0.730                       | L1               | -                          | 25221E3                        | 35221E3                       | -                              |         |
|  | 330                                  | 6.5 x 18   | 290                              | 15                                     | 0.16                    | 0.770                         | 0.480                       | L1               | -                          | 25331E3                        | 35331E3                       | -                              |         |
|  | 470                                  | 8 x 18   | 380                              | 19                                     | 0.16                    | 0.550                         | 0.340                       | L1               | -                          | 25471E3                        | 35471E3                       | -                              |         |
|  | 680                                  | 10 x 18  | 500                              | 26                                     | 0.16                    | 0.380                         | 0.240                       | L1               | -                          | 25681E3                        | 35681E3                       | -                              |         |
|  | 1000                                 | 10 x 25  | 660                              | 36                                     | 0.16                    | 0.260                         | 0.180                       | L1               | -                          | 90517E3                        | 90518E3                       | -                              |         |
|  | 1000                                 | 10 x 30  | 700                              | 36                                     | 0.16                    | 0.260                         | 0.175                       | L3               | 15102E3                    | 25102E3                        | -                             | -                              |         |
|  | 1500                                 | 12.5 x 30  | 950                              | 52                                     | 0.19                    | 0.205                         | 0.095                       | L3               | 15152E3                    | 25152E3                        | -                             | -                              |         |
|  | 2200                                 | 12.5 x 30  | 1040                             | 74                                     | 0.21                    | 0.150                         | 0.095                       | L3               | 15222E3                    | 25222E3                        | -                             | -                              |         |
|  | 3300                                 | 15 x 30  | 1290                             | 110                                    | 0.23                    | 0.111                         | 0.070                       | L3               | 15332E3                    | 25332E3                        | -                             | -                              |         |
|  | 4700                                 | 18 x 30  | 1560                             | 154                                    | 0.25                    | 0.087                         | 0.065                       | L3               | 15472E3                    | -                              | -                             | -                              |         |
| 6800                                     | 18 x 38                              | 2040   | 222                              | 0.30                                   | 0.070                   | 0.040                         | L3                          | 15682E3          | -                          | -                              | -                             |                                |         |
| 10 000                                   | 21 x 38                              | 2170   | 324                              | 0.36                                   | 0.058                   | 0.035                         | L3                          | 15103E3          | -                          | -                              | -                             |                                |         |
| 25                                       | 47                                   | 4.5 x 10   | 80                               | 6.4                                    | 0.14                    | 4.800                         | 2.600                       | L1               | -                          | 26479E3                        | 36479E3                       | -                              |         |
|  | 100                                  | 6 x 10   | 150                              | 9                                      | 0.14                    | 2.300                         | 1.200                       | L1               | -                          | 26101E3                        | 36101E3                       | -                              |         |
|  | 150                                  | 8 x 11   | 190                              | 12                                     | 0.14                    | 1.500                         | 0.800                       | L1               | -                          | 90534E3                        | 90535E3                       | -                              |         |
|  | 150                                  | 6.5 x 18   | 210                              | 12                                     | 0.14                    | 1.500                         | 0.800                       | L1               | -                          | 26151E3                        | 36151E3                       | -                              |         |
|  | 220                                  | 6.5 x 18   | 250                              | 15                                     | 0.14                    | 1.000                         | 0.550                       | L1               | -                          | 26221E3                        | 36221E3                       | -                              |         |
|  | 330                                  | 8 x 18   | 340                              | 21                                     | 0.14                    | 0.680                         | 0.360                       | L1               | -                          | 26331E3                        | 36331E3                       | -                              |         |
|  | 470                                  | 10 x 18  | 450                              | 28                                     | 0.14                    | 0.480                         | 0.260                       | L1               | -                          | 26471E3                        | 36471E3                       | -                              |         |
|  | 680                                  | 10 x 25  | 560                              | 38                                     | 0.14                    | 0.330                         | 0.180                       | L1               | -                          | 90527E3                        | 90528E3                       | -                              |         |
|  | 680                                  | 10 x 30  | 640                              | 38                                     | 0.14                    | 0.323                         | 0.175                       | L3               | 16681E3                    | 26681E3                        | -                             | -                              |         |
|  | 1000                                 | 12.5 x 30  | 840                              | 54                                     | 0.14                    | 0.220                         | 0.095                       | L3               | 16102E3                    | 26102E3                        | -                             | -                              |         |
|  | 1500                                 | 12.5 x 30  | 950                              | 79                                     | 0.17                    | 0.179                         | 0.095                       | L3               | 16152E3                    | 26152E3                        | -                             | -                              |         |
|  | 2200                                 | 15 x 30  | 1180                             | 114                                    | 0.19                    | 0.132                         | 0.070                       | L3               | 16222E3                    | 26222E3                        | -                             | -                              |         |
|  | 3300                                 | 18 x 30  | 1470                             | 169                                    | 0.21                    | 0.099                         | 0.065                       | L3               | 16332E3                    | -                              | -                             | -                              |         |
|  | 4700                                 | 18 x 38  | 1920                             | 239                                    | 0.23                    | 0.079                         | 0.040                       | L3               | 16472E3                    | -                              | -                             | -                              |         |
| 6800                                     | 21 x 38                              | 2070   | 344                              | 0.28                                   | 0.064                   | 0.035                         | L3                          | 16682E3          | -                          | -                              | -                             |                                |         |



| ELECTRICAL DATA AND ORDERING INFORMATION |                            |                                |                                  |                            |              |                |              |               |                            |                       |                      |                       |
|--|----------------------------|--------------------------------|----------------------------------|----------------------------|--------------|----------------|--------------|---------------|----------------------------|-----------------------|----------------------|-----------------------|
| U <sub>R</sub> (V)                       | C <sub>R</sub> 100 Hz (μF) | NOMINAL CASE SIZE Ø D x L (mm) | I <sub>R</sub> 100 Hz 85 °C (mA) | I <sub>L5</sub> 5 min (μA) | tan δ 100 Hz | ESR 100 Hz (Ω) | Z 10 kHz (Ω) | LIFE CODE (1) | ORDERING CODE MAL2021..... |                       |                      |                       |
|  |                            |                                |                                  |                            |              |                |              |               | IN BOX FORM AA             | TAPED ON REEL FORM BR | TAPED IN BOX FORM BA | MOUNTING RING FORM MR |
| 40                                       | 22                         | 4.5 x 10                       | 60                               | 5.8                        | 0.11         | 8.000          | 3.200        | L2            | -                          | 27229E3               | 37229E3              | -                     |
|  | 47                         | 6 x 10                         | 110                              | 7.8                        | 0.11         | 3.800          | 1.500        | L2            | -                          | 27479E3               | 37479E3              | -                     |
|  | 100                        | 8 x 11                         | 170                              | 12                         | 0.11         | 1.800          | 0.700        | L2            | -                          | 90537E3               | 90538E3              | -                     |
|  | 100                        | 6.5 x 18                       | 190                              | 12                         | 0.11         | 1.800          | 0.700        | L2            | -                          | 27101E3               | 37101E3              | -                     |
|  | 150                        | 8 x 18                         | 250                              | 16                         | 0.11         | 1.100          | 0.470        | L2            | -                          | 27151E3               | 37151E3              | -                     |
|  | 220                        | 10 x 18                        | 330                              | 22                         | 0.11         | 0.800          | 0.320        | L2            | -                          | 27221E3               | 37221E3              | -                     |
|  | 330                        | 10 x 25                        | 430                              | 30                         | 0.11         | 0.530          | 0.210        | L2            | -                          | 27331E3               | 37331E3              | -                     |
|  | 470                        | 10 x 25                        | 520                              | 42                         | 0.11         | 0.370          | 0.180        | L2            | -                          | 90514E3               | 90515E3              | -                     |
|  | 470                        | 10 x 30                        | 590                              | 42                         | 0.12         | 0.404          | 0.175        | L3            | 17471E3                    | 27471E3               | -                    | -                     |
|  | 680                        | 12.5 x 30                      | 800                              | 58                         | 0.12         | 0.297          | 0.110        | L3            | 17681E3                    | 27681E3               | -                    | -                     |
|  | 1000                       | 12.5 x 30                      | 900                              | 84                         | 0.12         | 0.190          | 0.110        | L3            | 17102E3                    | 27102E3               | -                    | -                     |
|  | 1500                       | 15 x 30                        | 1120                             | 124                        | 0.15         | 0.159          | 0.070        | L3            | 17152E3                    | 27152E3               | -                    | 47152E3               |
|  | 2200                       | 18 x 30                        | 1390                             | 180                        | 0.17         | 0.118          | 0.065        | L3            | 17222E3                    | -                     | -                    | 47222E3               |
|  | 3300                       | 18 x 38                        | 1810                             | 268                        | 0.19         | 0.090          | 0.040        | L3            | 17332E3                    | -                     | -                    | 47332E3               |
| 4700                                     | 21 x 38                    | 1940                           | 380                              | 0.21                       | 0.072        | 0.035          | L3           | 17472E3       | -                          | -                     | 47472E3              |                       |
| 63                                       | 1.0                        | 4.5 x 10                       | 12                               | 4.1                        | 0.09         | 150.0          | 55.00        | L2            | -                          | 28108E3               | 38108E3              | -                     |
|  | 2.2                        | 4.5 x 10                       | 21                               | 4.3                        | 0.09         | 65.00          | 25.00        | L2            | -                          | 28228E3               | 38228E3              | -                     |
|  | 3.3                        | 4.5 x 10                       | 25                               | 4.4                        | 0.09         | 44.00          | 17.00        | L2            | -                          | 28338E3               | 38338E3              | -                     |
|  | 4.7                        | 4.5 x 10                       | 31                               | 4.6                        | 0.09         | 31.00          | 12.00        | L2            | -                          | 28478E3               | 38478E3              | -                     |
|  | 10                         | 4.5 x 10                       | 50                               | 5.3                        | 0.08         | 13.00          | 5.500        | L2            | -                          | 28109E3               | 38109E3              | -                     |
|  | 15                         | 4.5 x 10                       | 55                               | 5.9                        | 0.08         | 8.500          | 3.700        | L2            | -                          | 28159E3               | 38159E3              | -                     |
|  | 22                         | 6 x 10                         | 90                               | 6.8                        | 0.08         | 5.800          | 2.500        | L2            | -                          | 28229E3               | 38229E3              | -                     |
|  | 33                         | 6 x 10                         | 100                              | 8.2                        | 0.08         | 3.900          | 1.700        | L2            | -                          | 28339E3               | 38339E3              | -                     |
|  | 47                         | 8 x 11                         | 140                              | 10                         | 0.08         | 2.700          | 1.200        | L2            | -                          | 90541E3               | 90542E3              | -                     |
|  | 47                         | 6.5 x 18                       | 150                              | 10                         | 0.08         | 2.700          | 1.200        | L2            | -                          | 28479E3               | 38479E3              | -                     |
|  | 68                         | 8 x 11                         | 160                              | 13                         | 0.08         | 1.900          | 0.810        | L2            | -                          | 90544E3               | 90545E3              | -                     |
|  | 68                         | 6.5 x 18                       | 170                              | 13                         | 0.08         | 1.900          | 0.810        | L2            | -                          | 28689E3               | 38689E3              | -                     |
|  | 100                        | 8 x 18                         | 250                              | 17                         | 0.08         | 1.300          | 0.550        | L2            | -                          | 28101E3               | 38101E3              | -                     |
|  | 150                        | 10 x 18                        | 320                              | 23                         | 0.08         | 0.850          | 0.370        | L2            | -                          | 28151E3               | 38151E3              | -                     |
|  | 220                        | 10 x 25                        | 430                              | 32                         | 0.08         | 0.600          | 0.250        | L2            | -                          | 90511E3               | 90512E3              | -                     |
|  | 220                        | 10 x 30                        | 480                              | 32                         | 0.08         | 0.614          | 0.260        | L3            | 18221E3                    | 28221E3               | -                    | -                     |
|  | 330                        | 12.5 x 30                      | 610                              | 46                         | 0.08         | 0.409          | 0.190        | L3            | 18331E3                    | 28331E3               | -                    | -                     |
|  | 470                        | 12.5 x 30                      | 700                              | 63                         | 0.08         | 0.287          | 0.130        | L3            | 18471E3                    | 28471E3               | -                    | -                     |
| 680                                      | 15 x 30                    | 890                            | 90                               | 0.08                       | 0.199        | 0.095          | L3           | 18681E3       | 28681E3                    | -                     | 48681E3              |                       |
| 1000                                     | 18 x 30                    | 1170                           | 130                              | 0.08                       | 0.135        | 0.075          | L3           | 18102E3       | -                          | -                     | 48102E3              |                       |
| 1500                                     | 18 x 38                    | 1530                           | 193                              | 0.11                       | 0.122        | 0.045          | L3           | 18152E3       | -                          | -                     | 48152E3              |                       |
| 2200                                     | 21 x 38                    | 1780                           | 281                              | 0.13                       | 0.099        | 0.040          | L3           | 18222E3       | -                          | -                     | 48222E3              |                       |
| 100                                      | 1.0                        | 4.5 x 10                       | 14                               | 4.2                        | 0.08         | 130.0          | 90.00        | L2            | -                          | 29108E3               | 39108E3              | -                     |
|  | 2.2                        | 4.5 x 10                       | 20                               | 4.4                        | 0.08         | 58.00          | 41.00        | L2            | -                          | 29228E3               | 39228E3              | -                     |
|  | 4.7                        | 4.5 x 10                       | 30                               | 4.9                        | 0.08         | 27.00          | 19.00        | L2            | -                          | 29478E3               | 39478E3              | -                     |
|  | 10                         | 6 x 10                         | 65                               | 6                          | 0.08         | 13.00          | 9.000        | L2            | -                          | 29109E3               | 39109E3              | -                     |
|  | 15                         | 8 x 11                         | 77                               | 7                          | 0.08         | 8.500          | 6.000        | L2            | -                          | 90547E3               | 90548E3              | -                     |
|  | 15                         | 6.5 x 18                       | 85                               | 7                          | 0.08         | 8.500          | 6.000        | L2            | -                          | 29159E3               | 39159E3              | -                     |
|  | 22                         | 8 x 11                         | 95                               | 8.4                        | 0.08         | 5.800          | 4.100        | L2            | -                          | 90551E3               | 90552E3              | -                     |
|  | 22                         | 6.5 x 18                       | 100                              | 8.4                        | 0.08         | 5.800          | 4.100        | L2            | -                          | 29229E3               | 39229E3              | -                     |
|  | 33                         | 6.5 x 18                       | 120                              | 10.6                       | 0.08         | 3.900          | 2.700        | L2            | -                          | 29339E3               | 39339E3              | -                     |
|  | 47                         | 8 x 18                         | 160                              | 13.4                       | 0.08         | 2.700          | 1.900        | L2            | -                          | 29479E3               | 39479E3              | -                     |
|  | 68                         | 10 x 18                        | 220                              | 17.6                       | 0.08         | 1.900          | 1.300        | L2            | -                          | 29689E3               | 39689E3              | -                     |
|  | 100                        | 10 x 25                        | 300                              | 24                         | 0.08         | 1.300          | 0.900        | L2            | -                          | 90531E3               | 90532E3              | -                     |
|  | 100                        | 10 x 30                        | 340                              | 24                         | 0.07         | 1.150          | 1.000        | L3            | 19101E3                    | 29101E3               | -                    | -                     |
|  | 150                        | 12.5 x 30                      | 490                              | 34                         | 0.07         | 0.645          | 0.610        | L3            | 19151E3                    | 29151E3               | -                    | -                     |
|  | 220                        | 12.5 x 30                      | 560                              | 48                         | 0.08         | 0.610          | 0.560        | L3            | 19221E3                    | 29221E3               | -                    | -                     |
|  | 330                        | 15 x 30                        | 740                              | 70                         | 0.09         | 0.420          | 0.400        | L3            | 19331E3                    | 29331E3               | -                    | 49331E3               |
|  | 470                        | 18 x 30                        | 980                              | 98                         | 0.09         | 0.310          | 0.290        | L3            | 19471E3                    | -                     | -                    | 49471E3               |
|  | 680                        | 18 x 38                        | 1260                             | 140                        | 0.09         | 0.195          | 0.180        | L3            | 19681E3                    | -                     | -                    | 49681E3               |
| 1000                                     | 21 x 38                    | 1470                           | 204                              | 0.10                       | 0.160        | 0.150          | L3           | 19102E3       | -                          | -                     | 49102E3              |                       |

**Note**

(1) Determines the applicable row in the table "Endurance Test Duration and Useful Life"



| 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 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**

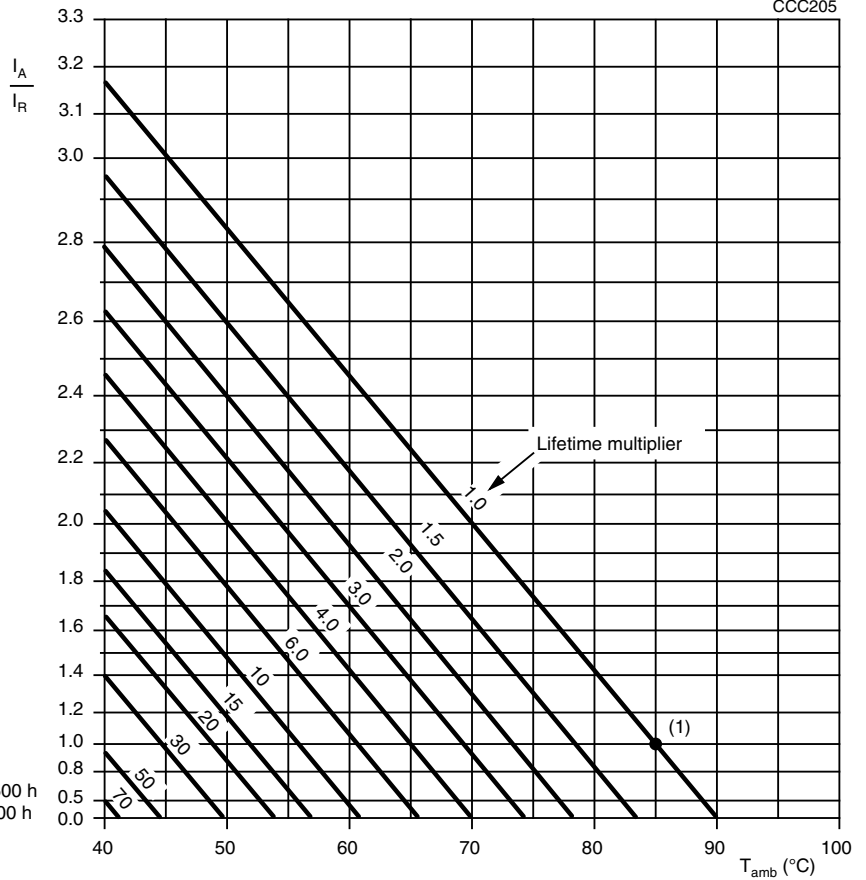
Table 4

| ENDURANCE TEST DURATION AND USEFUL LIFE |                        |                         |                          |
|---|------------------------|-------------------------|--------------------------|
| LIFE CODE                               | ENDURANCE AT 85 °C (h) | ENDURANCE AT 105 °C (h) | USEFUL LIFE AT 85 °C (h) |
| L1                                      | 1000                   | -                       | 2500                     |
| L2                                      | 2000                   | -                       | 2500                     |
| L3                                      | 5000                   | 2000                    | 8000                     |

**Note**

- Multiplier of useful life code: CCC205

CCC205



$I_A$  = Actual ripple current at 100 Hz  
 $I_R$  = Rated ripple current at 100 Hz, 85 °C

(1) Useful life at 85 °C and  $I_R$  applied:  
 Case  $\varnothing$  D x L = 4.5 mm x 10 mm to 10 mm x 25 mm: 2500 h  
 Case  $\varnothing$  D x L = 10 mm x 30 mm to 21 mm x 38 mm: 8000 h

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

Table 5

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





## **Disclaimer**

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.

## Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

 [View MAL202115682E3 on WIN SOURCE](#)

 [Vishay Information](#)

## Optimize Your Supply Chain with WIN SOURCE Solutions

-  Global Sourcing Solution
-  Obsolete Management
-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management