



## Aluminum Capacitors Axial Long-Life, DIN-Based

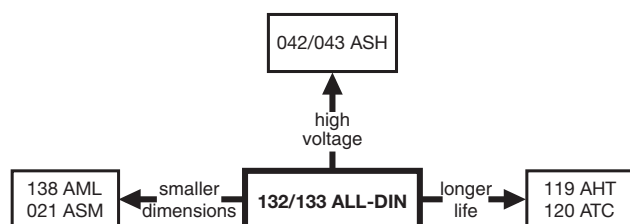


Fig. 1

### QUICK REFERENCE DATA

| DESCRIPTION                                        | VALUE                     |                           |                          |
|----------------------------------------------------|---------------------------|---------------------------|--------------------------|
| Nominal case sizes<br>( $\varnothing$ D x L in mm) | 6.5 x 18<br>and<br>8 x 18 | 10 x 18<br>and<br>10 x 25 | 10 x 30<br>to<br>21 x 38 |
| Rated capacitance range, $C_R$                     | 1 $\mu$ F to 4700 $\mu$ F |                           |                          |
| Tolerance on $C_R$                                 | -10 % to +50 %            |                           |                          |
| Rated voltage range, $U_R$                         | 10 V to 160 V             |                           |                          |
| Category temperature range                         | -40 °C to +85 °C          |                           |                          |
| Endurance test at 105 °C                           | 2000 h                    | 2000 h                    | -                        |
| Endurance test at 85 °C                            | 6000 h                    | 8000 h                    | 8000 h                   |
| Useful life at 105 °C                              | 3000 h                    | 3000 h                    | -                        |
| Useful life at 85 °C                               | 10 000 h                  | 15 000 h                  | 15 000 h                 |
| Useful life at 40 °C,<br>1.8 x $I_R$ applied       | 160 000 h                 | 240 000 h                 | 240 000 h                |
| Shelf life at 0 V, 85 °C                           | 500 h                     |                           |                          |
| Based on sectional<br>specification                | IEC 60384-4/EN130300      |                           |                          |
| Climatic category<br>IEC 60068                     | 40/085/56                 |                           |                          |

### FEATURES

- Long useful life: up to 15 000 h at 85 °C
- Taped versions up to case  $\varnothing$  15 mm x 30 mm available for automatic insertion
- Charge and discharge proof
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Mounting ring version not available in insulated form
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

### APPLICATIONS

- General industrial, power supplies, telecommunication, EDP
- Coupling, decoupling, timing; smoothing, filtering and buffering in SMPS
- For use where low mounting height is important
- Vibration and shock resistant

### MARKING

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

- Rated capacitance (in  $\mu$ F)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (T for -10 % to +50 %)
- Rated voltage (in V)
- 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 (132 or 133)

### 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) |    |          |    |          |          |                        |                          |
|---------------------|-----------|----|----------|----|----------|----------|------------------------|--------------------------|
|                     | 10        | 16 | 25       | 40 | 63       | 100      | 160                    | 250                      |
| 1.0                 | -         | -  | -        | -  | -        | 6.5 x 18 | -                      | -                        |
| 2.2                 | -         | -  | -        | -  | -        | 6.5 x 18 | -                      | -                        |
| 4.7                 | -         | -  | -        | -  | 6.5 x 18 | 6.5 x 18 | -                      | -                        |
| 10                  | -         | -  | -        | -  | 6.5 x 18 | 8 x 18   | -                      | -                        |
|                     | -         | -  | -        | -  | -        | -        | -                      | 10 x 30 <sup>(1)</sup>   |
| 22                  | -         | -  | 6.5 x 18 | -  | 8 x 18   | 10 x 18  | 10 x 25                | 12.5 x 30 <sup>(1)</sup> |
|                     | -         | -  | -        | -  | -        | -        | 10 x 30 <sup>(1)</sup> | -                        |

#### Note

<sup>(1)</sup> For these CV-values see datasheet 041 - 043 ASH ([www.vishay.com/doc?28329](http://www.vishay.com/doc?28329))

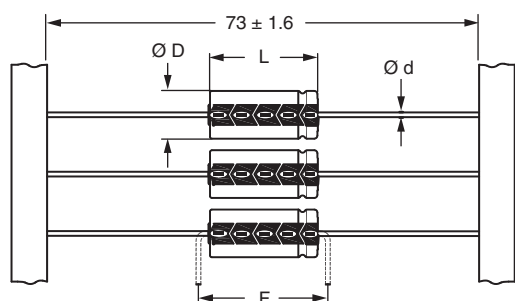


| SELECTION CHART FOR $C_R$ , $U_R$ , AND RELEVANT NOMINAL CASE SIZES ( $\varnothing D \times L$ in mm) |           |           |           |           |         |         |                        |                        |
|-------------------------------------------------------------------------------------------------------|-----------|-----------|-----------|-----------|---------|---------|------------------------|------------------------|
| $C_R$<br>( $\mu F$ )                                                                                  | $U_R$ (V) |           |           |           |         |         |                        |                        |
|                                                                                                       | 10        | 16        | 25        | 40        | 63      | 100     | 160                    | 250                    |
| 47                                                                                                    | -         | 6.5 x 18  | -         | 8 x 18    | 10 x 18 | 10 x 25 | 15 x 30 <sup>(1)</sup> | 18 x 30 <sup>(1)</sup> |
| 68                                                                                                    | -         | -         | -         | -         | -       | 10 x 30 | -                      | -                      |
| 100                                                                                                   | -         | 8 x 18    | -         | 10 x 18   | 10 x 30 | 15 x 30 | 18 x 30 <sup>(1)</sup> | 21 x 38 <sup>(1)</sup> |
| 150                                                                                                   | -         | -         | -         | 12.5 x 30 | 15 x 30 | 18 x 30 | 18 x 38 <sup>(1)</sup> | -                      |
| 220                                                                                                   | 8 x 18    | 10 x 18   | 10 x 25   | 12.5 x 30 | 15 x 30 | 18 x 38 | 21 x 38 <sup>(1)</sup> | -                      |
|                                                                                                       | -         | -         | 12.5 x 30 | -         | -       | -       | -                      | -                      |
| 330                                                                                                   | -         | 10 x 25   | 12.5 x 30 | 15 x 30   | 18 x 30 | 18 x 38 | -                      | -                      |
|                                                                                                       | -         | 12.5 x 30 | -         | -         | -       | -       | -                      | -                      |
| 470                                                                                                   | 12.5 x 30 | 10 x 25   | 12.5 x 30 | 15 x 30   | 18 x 38 | 21 x 38 | -                      | -                      |
|                                                                                                       | -         | 12.5 x 30 | -         | -         | -       | -       | -                      | -                      |
| 680                                                                                                   | 12.5 x 30 | 15 x 30   | 18 x 30   | 18 x 30   | 21 x 38 | -       | -                      | -                      |
| 1000                                                                                                  | 15 x 30   | 15 x 30   | 18 x 30   | 18 x 38   | 21 x 38 | -       | -                      | -                      |
| 1500                                                                                                  | 18 x 30   | 18 x 30   | 18 x 38   | 21 x 38   | -       | -       | -                      | -                      |
| 2200                                                                                                  | 18 x 30   | 18 x 38   | 21 x 38   | 21 x 38   | -       | -       | -                      | -                      |
| 3300                                                                                                  | 18 x 38   | 21 x 38   | -         | -         | -       | -       | -                      | -                      |
| 4700                                                                                                  | 21 x 38   | 21 x 38   | -         | -         | -       | -       | -                      | -                      |

**Note**

<sup>(1)</sup> For these CV-values see datasheet 041 - 043 ASH ([www.vishay.com/doc?28329](http://www.vishay.com/doc?28329))

**DIMENSIONS in millimeters AND AVAILABLE FORMS**



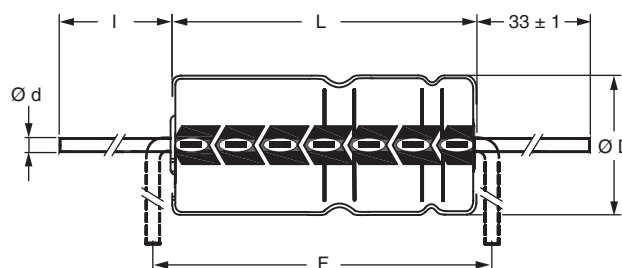
**Form BR:** Taped on reel

Case  $\varnothing D \times L$  = 6.5 mm x 18 mm to 15 mm x 30 mm

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

Case  $\varnothing D \times L$  = 6.5 mm x 18 mm to 10 mm x 25 mm

Fig. 2 - Forms BA and BR



**Form AA:** Axial in box

Case  $\varnothing D \times L$  = 10 mm x 30 mm to 21 mm x 38 mm

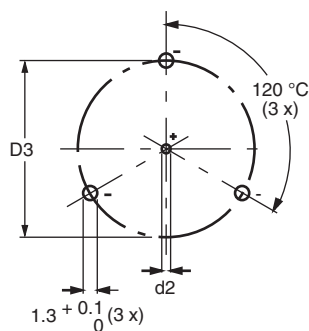
Fig. 3 - Form AA

Table 1

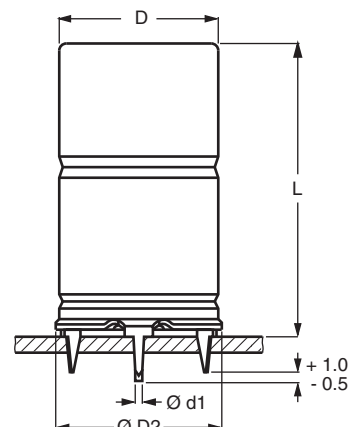
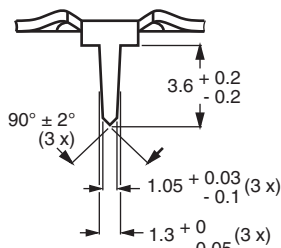
| AXIAL; DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES |           |                           |        |                        |            |            |          |                      |         |         |
|------------------------------------------------------------------|-----------|---------------------------|--------|------------------------|------------|------------|----------|----------------------|---------|---------|
| NOMINAL CASE SIZE<br>$\varnothing D \times L$                    | CASE CODE | AXIAL FORM AA, BA, AND BR |        |                        |            |            | MASS (g) | PACKAGING QUANTITIES |         |         |
|                                                                  |           | $\varnothing d$           | L      | $\varnothing D_{max.}$ | $L_{max.}$ | $F_{min.}$ |          | FORM AA              | FORM BA | FORM BR |
| 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).



Mounting holes



Case  $\varnothing D \times L = 15 \text{ mm} \times 30 \text{ mm}$  to  $21 \text{ mm} \times 38 \text{ mm}$

Case not insulated (insulation on request)

Especially for applications with severe shocks and vibrations

Fig. 4 - Mounting hole diagram and outline; **form MR**: with mounting rings and pins

Table 2

| <b>MOUNTING RING; DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES</b> |              |                        |                  |                               |                                |            |                   |             |                         |
|---------------------------------------------------------------------------------|--------------|------------------------|------------------|-------------------------------|--------------------------------|------------|-------------------|-------------|-------------------------|
| NOMINAL<br>CASE SIZE<br>$\varnothing D \times L$                                | CASE<br>CODE | MOUNTING RING: FORM MR |                  |                               |                                |            |                   | MASS<br>(g) | PACKAGING<br>QUANTITIES |
|                                                                                 |              | $\varnothing d1$       | $\varnothing d2$ | $\varnothing D_{\text{max.}}$ | $\varnothing D2_{\text{max.}}$ | D3         | L <sub>max.</sub> |             |                         |
| 15 x 30                                                                         | 02           | 0.8                    | 1.0 + 0.4        | 15.5                          | 17.5                           | 16.5 ± 0.2 | 33                | ≈ 11.7      | 200                     |
| 18 x 30                                                                         | 03           | 0.8                    | 1.0 + 0.4        | 18.5                          | 19.5                           | 18.5 ± 0.2 | 33                | ≈ 12.9      | 240                     |
| 18 x 38                                                                         | 04           | 0.8                    | 1.0 + 0.4        | 18.5                          | 19.5                           | 18.5 ± 0.2 | 42                | ≈ 19.0      | 100                     |
| 21 x 38                                                                         | 05           | 0.8                    | 1.0 + 0.4        | 21.5                          | 22.5                           | 21.5 ± 0.2 | 42                | ≈ 24.0      | 100                     |

| <b>ELECTRICAL DATA</b> |                                                                                                 |
|------------------------|-------------------------------------------------------------------------------------------------|
| SYMBOL                 | DESCRIPTION                                                                                     |
| $C_R$                  | Rated capacitance at 100 Hz, tolerance -10 %/+50 %                                              |
| $I_R$                  | 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 $\tan \delta_{\text{max.}}$ and $C_R$ ) |
| Z                      | Max. impedance at 10 kHz                                                                        |

**Note**

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

**ORDERING EXAMPLE**

Electrolytic capacitor 132 series

100  $\mu\text{F}/40 \text{ V}$ ; -10 %/+50 %

Nominal case size:  $\varnothing 10 \text{ mm} \times 18 \text{ mm}$ ; form BR

Ordering code: MAL213227101E3

Former 12NC: 2222 132 27101



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) | tan δ<br>100 Hz | ESR<br>100 Hz<br>(Ω) | Z<br>10 kHz<br>(Ω) | Z<br>100 kHz<br>(Ω) | ORDERING CODE MAL2..... |                             |                            |                             |
|                                          |                                  |                                         |                                           |                                  |                 |                      |                    |                     | IN BOX<br>FORM AA       | TAPED<br>ON REEL<br>FORM BR | TAPED<br>IN BOX<br>FORM BA | MOUNTING<br>RING<br>FORM MR |
| 10                                       | 220                              | 8 x 18                                  | 190                                       | 8.4                              | 0.18            | 1.3                  | 0.73               | 0.70                | -                       | 13224221E3                  | 13234221E3                 | -                           |
|                                          | 470                              | 12.5 x 30                               | 350                                       | 9.4                              | 0.18            | 0.61                 | 0.26               | 0.60                | 13214471E3              | 13224471E3                  | -                          | -                           |
|                                          | 680                              | 12.5 x 30                               | 460                                       | 13.6                             | 0.18            | 0.42                 | 0.20               | 0.40                | 13214681E3              | 13224681E3                  | -                          | -                           |
|                                          | 1000                             | 15 x 30                                 | 640                                       | 20                               | 0.18            | 0.28                 | 0.12               | -                   | 13214102E3              | 13224102E3                  | -                          | 13244102E3                  |
|                                          | 1500                             | 18 x 30                                 | 800                                       | 30                               | 0.22            | 0.23                 | 0.10               | -                   | 13214152E3              | -                           | -                          | 13244152E3                  |
|                                          | 2200                             | 18 x 30                                 | 1100                                      | 44                               | 0.22            | 0.16                 | 0.09               | -                   | 13214222E3              | -                           | -                          | 13244222E3                  |
|                                          | 3300                             | 18 x 38                                 | 1300                                      | 66                               | 0.27            | 0.13                 | 0.05               | -                   | 13214332E3              | -                           | -                          | 13244332E3                  |
|                                          | 4700                             | 21 x 38                                 | 1800                                      | 94                               | 0.27            | 0.09                 | 0.05               | -                   | 13214472E3              | -                           | -                          | 13244472E3                  |
| 16                                       | 47                               | 6.5 x 18                                | 95                                        | 5.5                              | 0.14            | 4.7                  | 2.6                | 2.2                 | -                       | 13225479E3                  | 13235479E3                 | -                           |
|                                          | 100                              | 8 x 18                                  | 150                                       | 7.2                              | 0.14            | 2.2                  | 1.2                | 1.1                 | -                       | 13225101E3                  | 13235101E3                 | -                           |
|                                          | 220                              | 10 x 18                                 | 250                                       | 11                               | 0.14            | 1.0                  | 0.55               | 0.55                | -                       | 13225221E3                  | 13235221E3                 | -                           |
|                                          | 330                              | 10 x 25                                 | 320                                       | 14.6                             | 0.14            | 0.67                 | 0.36               | 0.36                | -                       | 13290508E3                  | 13290509E3                 | -                           |
|                                          | 330                              | 12.5 x 30                               | 320                                       | 10.6                             | 0.14            | 0.67                 | 0.36               | 0.60                | 13215331E3              | 13225331E3                  | -                          | -                           |
|                                          | 470                              | 10 x 25                                 | 450                                       | 19                               | 0.14            | 0.47                 | 0.26               | 0.26                | -                       | 13290507E3                  | 13290502E3                 | -                           |
|                                          | 470                              | 12.5 x 30                               | 450                                       | 15                               | 0.14            | 0.47                 | 0.26               | 0.40                | 13215471E3              | 13225471E3                  | -                          | -                           |
|                                          | 680                              | 15 x 30                                 | 550                                       | 22                               | 0.14            | 0.33                 | 0.14               | -                   | 13215681E3              | 13225681E3                  | -                          | 13245681E3                  |
|                                          | 1000                             | 15 x 30                                 | 780                                       | 32                               | 0.14            | 0.22                 | 0.12               | -                   | 13215102E3              | 13225102E3                  | -                          | 13245102E3                  |
|                                          | 1500                             | 18 x 30                                 | 950                                       | 48                               | 0.15            | 0.16                 | 0.10               | -                   | 13215152E3              | -                           | -                          | 13245152E3                  |
|                                          | 2200                             | 18 x 38                                 | 1300                                      | 70                               | 0.15            | 0.11                 | 0.06               | -                   | 13215222E3              | -                           | -                          | 13245222E3                  |
|                                          | 3300                             | 21 x 38                                 | 1600                                      | 110                              | 0.15            | 0.07                 | 0.05               | -                   | 13215332E3              | -                           | -                          | 13245332E3                  |
|                                          | 4700                             | 21 x 38                                 | 2300                                      | 150                              | 0.15            | 0.05                 | 0.05               | -                   | 13215472E3              | -                           | -                          | 13245472E3                  |
| 25                                       | 22                               | 6.5 x 18                                | 60                                        | 5.1                              | 0.11            | 8.0                  | 4.1                | 2.9                 | -                       | 13226229E3                  | 13236229E3                 | -                           |
|                                          | 220                              | 10 x 25                                 | 340                                       | 15                               | 0.11            | 0.80                 | 0.40               | 0.40                | -                       | 13290503E3                  | 13290504E3                 | -                           |
|                                          | 220                              | 12.5 x 30                               | 340                                       | 11                               | 0.11            | 0.80                 | 0.40               | 0.60                | 13216221E3              | 13226221E3                  | -                          | -                           |
|                                          | 330                              | 12.5 x 30                               | 410                                       | 16.5                             | 0.11            | 0.53                 | 0.30               | 0.40                | 13216331E3              | 13226331E3                  | -                          | -                           |
|                                          | 470                              | 12.5 x 30                               | 560                                       | 24                               | 0.11            | 0.37                 | 0.20               | -                   | 13216471E3              | 13226471E3                  | -                          | -                           |
|                                          | 680                              | 18 x 30                                 | 700                                       | 34                               | 0.11            | 0.26                 | 0.10               | -                   | 13216681E3              | -                           | -                          | 13246681E3                  |
|                                          | 1000                             | 18 x 30                                 | 1000                                      | 50                               | 0.11            | 0.17                 | 0.10               | -                   | 13216102E3              | -                           | -                          | 13246102E3                  |
|                                          | 1500                             | 18 x 38                                 | 1100                                      | 75                               | 0.12            | 0.13                 | 0.06               | -                   | 13216152E3              | -                           | -                          | 13246152E3                  |
|                                          | 2200                             | 21 x 38                                 | 1850                                      | 110                              | 0.13            | 0.09                 | 0.05               | -                   | 13216222E3              | -                           | -                          | 13246222E3                  |
| 40                                       | 47                               | 8 x 18                                  | 120                                       | 7.8                              | 0.09            | 3.0                  | 1.6                | 1.4                 | -                       | 13227479E3                  | 13237479E3                 | -                           |
|                                          | 100                              | 10 x 18                                 | 210                                       | 12                               | 0.09            | 1.4                  | 0.75               | 0.75                | -                       | 13227101E3                  | 13237101E3                 | -                           |
|                                          | 150                              | 10 x 25                                 | 310                                       | 16                               | 0.09            | 0.95                 | 0.50               | 0.50                | -                       | 13290511E3                  | 13290512E3                 | -                           |
|                                          | 150                              | 12.5 x 30                               | 310                                       | 12                               | 0.09            | 0.95                 | 0.50               | 0.60                | 13217151E3              | 13227151E3                  | -                          | -                           |
|                                          | 220                              | 12.5 x 30                               | 410                                       | 17.5                             | 0.09            | 0.65                 | 0.34               | 0.40                | 13217221E3              | 13227221E3                  | -                          | -                           |
|                                          | 330                              | 15 x 30                                 | 550                                       | 26                               | 0.09            | 0.43                 | 0.20               | -                   | 13217331E3              | 13227331E3                  | -                          | 13247331E3                  |
|                                          | 470                              | 15 x 30                                 | 700                                       | 38                               | 0.09            | 0.30                 | 0.16               | -                   | 13217471E3              | 13227471E3                  | -                          | 13247471E3                  |
|                                          | 680                              | 18 x 30                                 | 900                                       | 54                               | 0.09            | 0.21                 | 0.10               | -                   | 13217681E3              | -                           | -                          | 13247681E3                  |
|                                          | 1000                             | 18 x 38                                 | 1200                                      | 80                               | 0.09            | 0.14                 | 0.08               | -                   | 13217102E3              | -                           | -                          | 13247102E3                  |
|                                          | 1500                             | 21 x 38                                 | 1500                                      | 120                              | 0.10            | 0.10                 | 0.06               | -                   | 13217152E3              | -                           | -                          | 13247152E3                  |
| 63                                       | 2200                             | 21 x 38                                 | 1900                                      | 180                              | 0.10            | 0.07                 | 0.05               | -                   | 13217222E3              | -                           | -                          | 13247222E3                  |
|                                          | 4.7                              | 6.5 x 18                                | 38                                        | 4.6                              | 0.07            | 24                   | 12                 | 5.0                 | -                       | 13228478E3                  | 13238478E3                 | -                           |
|                                          | 10                               | 6.5 x 18                                | 64                                        | 5.3                              | 0.07            | 11                   | 5.5                | 3.3                 | -                       | 13228109E3                  | 13238109E3                 | -                           |
|                                          | 22                               | 8 x 18                                  | 100                                       | 6.8                              | 0.07            | 5.1                  | 2.5                | 2.1                 | -                       | 13228229E3                  | 13238229E3                 | -                           |
|                                          | 47                               | 10 x 18                                 | 170                                       | 9.9                              | 0.07            | 2.4                  | 1.2                | 1.2                 | -                       | 13228479E3                  | 13238479E3                 | -                           |
|                                          | 68                               | 10 x 25                                 | 210                                       | 12.6                             | 0.07            | 1.6                  | 0.81               | 0.60                | -                       | 13290513E3                  | 13290514E3                 | -                           |
|                                          | 68                               | 10 x 30                                 | 210                                       | 8.6                              | 0.07            | 1.6                  | 0.80               | 0.60                | 13218689E3              | 13228689E3                  | -                          | -                           |
|                                          | 100                              | 10 x 30                                 | 300                                       | 12.6                             | 0.07            | 1.1                  | 0.60               | 0.40                | 13218101E3              | 13228101E3                  | -                          | -                           |
|                                          | 150                              | 15 x 30                                 | 350                                       | 19                               | 0.07            | 0.74                 | 0.37               | -                   | 13218151E3              | 13228151E3                  | -                          | 13248151E3                  |
|                                          | 220                              | 15 x 30                                 | 520                                       | 28                               | 0.07            | 0.50                 | 0.25               | -                   | 13218221E3              | 13228221E3                  | -                          | 13248221E3                  |
|                                          | 330                              | 18 x 30                                 | 600                                       | 42                               | 0.07            | 0.34                 | 0.15               | -                   | 13218331E3              | -                           | -                          | 13248331E3                  |
|                                          | 470                              | 18 x 38                                 | 970                                       | 59                               | 0.07            | 0.24                 | 0.12               | -                   | 13218471E3              | -                           | -                          | 13248471E3                  |
|                                          | 680                              | 21 x 38                                 | 1000                                      | 86                               | 0.07            | 0.16                 | 0.08               | -                   | 13218681E3              | -                           | -                          | 13248681E3                  |
|                                          | 1000                             | 21 x 38                                 | 1600                                      | 130                              | 0.07            | 0.11                 | 0.06               | -                   | 13218102E3              | -                           | -                          | 13248102E3                  |



## ELECTRICAL DATA AND ORDERING INFORMATION

| U <sub>R</sub><br>(V) | C <sub>R</sub><br>100 Hz<br>(μF) | NOMINAL<br>CASE SIZE<br>Ø D x L<br>(mm) | I <sub>R</sub><br>100 Hz<br>85 °C<br>(mA) | I <sub>L5</sub><br>5 min<br>(μA) | tan δ<br>100 Hz | ESR<br>100 Hz<br>(Ω) | Z<br>10 kHz<br>(Ω) | Z<br>100 kHz<br>(Ω) | ORDERING CODE MAL2..... |                             |                            |                             |
|-----------------------|----------------------------------|-----------------------------------------|-------------------------------------------|----------------------------------|-----------------|----------------------|--------------------|---------------------|-------------------------|-----------------------------|----------------------------|-----------------------------|
|                       |                                  |                                         |                                           |                                  |                 |                      |                    |                     | IN BOX<br>FORM AA       | TAPED<br>ON REEL<br>FORM BR | TAPED<br>IN BOX<br>FORM BA | MOUNTING<br>RING<br>FORM MR |
| 100                   | 1.0                              | 6.5 x 18                                | 20                                        | 4.0                              | 0.06            | 95                   | 45                 | 6.0                 | -                       | 13229108E3                  | 13239108E3                 | -                           |
|                       | 2.2                              | 6.5 x 18                                | 30                                        | 4.4                              | 0.06            | 43                   | 20                 | 5.0                 | -                       | 13229228E3                  | 13239228E3                 | -                           |
|                       | 4.7                              | 6.5 x 18                                | 48                                        | 4.9                              | 0.06            | 20                   | 9.6                | 4.0                 | -                       | 13229478E3                  | 13239478E3                 | -                           |
|                       | 10                               | 8 x 18                                  | 73                                        | 6.0                              | 0.06            | 9.5                  | 4.5                | 2.8                 | -                       | 13229109E3                  | 13239109E3                 | -                           |
|                       | 22                               | 10 x 18                                 | 130                                       | 8.4                              | 0.06            | 4.3                  | 2.0                | 1.3                 | -                       | 13229229E3                  | 13239229E3                 | -                           |
|                       | 47                               | 10 x 25                                 | 220                                       | 13.4                             | 0.06            | 2.0                  | 1.0                | 0.90                | -                       | 13290505E3                  | 13290506E3                 | -                           |
|                       | 47                               | 10 x 30                                 | 220                                       | 9.4                              | 0.06            | 2.0                  | 1.0                | 0.90                | 13219479E3              | 13229479E3                  | -                          | -                           |
|                       | 68                               | 12.5 x 30                               | 250                                       | 13.5                             | 0.06            | 1.4                  | 0.80               | -                   | 13219689E3              | 13229689E3                  | -                          | -                           |
|                       | 100                              | 15 x 30                                 | 380                                       | 20                               | 0.06            | 0.95                 | 0.50               | -                   | 13219101E3              | 13229101E3                  | -                          | 13249101E3                  |
|                       | 150                              | 18 x 30                                 | 400                                       | 30                               | 0.06            | 0.64                 | 0.35               | -                   | 13219151E3              | -                           | -                          | 13249151E3                  |
|                       | 220                              | 18 x 38                                 | 660                                       | 44                               | 0.06            | 0.43                 | 0.20               | -                   | 13219221E3              | -                           | -                          | 13249221E3                  |
|                       | 330                              | 18 x 38                                 | 700                                       | 66                               | 0.06            | 0.29                 | 0.15               | -                   | 13219331E3              | -                           | -                          | 13249331E3                  |
|                       | 470                              | 21 x 38                                 | 1200                                      | 94                               | 0.06            | 0.20                 | 0.10               | -                   | 13219471E3              | -                           | -                          | 13249471E3                  |
| 160                   | 22                               | 10 x 25                                 | 120                                       | 20                               | 0.10            | 7.2                  | 5.5                | 2.5                 | -                       | 13390502E3                  | 13390503E3                 | -                           |

## ADDITIONAL ELECTRICAL DATA

| PARAMETER                          | CONDITIONS                                                                                                            | VALUE                                                            |               |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|---------------|
|                                    |                                                                                                                       | AXIAL                                                            | MOUNTING RING |
| Voltage                            |                                                                                                                       |                                                                  |               |
| Surge voltage                      | $U_R = 10\text{ V to }160\text{ V}$                                                                                   | $U_s \leq 1.15 \times U_R$                                       |               |
| Reverse voltage                    |                                                                                                                       | $U_{rev} \leq 1\text{ V}$                                        |               |
| Current                            |                                                                                                                       |                                                                  |               |
| Leakage current                    | After 1 min:                                                                                                          |                                                                  |               |
|                                    | case $\varnothing\text{ D} \times \text{L} = 6.5\text{ mm} \times 18\text{ mm to }10\text{ mm} \times 25\text{ mm}$ : |                                                                  |               |
|                                    | $U_R = 10\text{ V to }100\text{ V}$                                                                                   | $I_{L1} \leq 0.01\text{ C}_R \times U_R + 3\text{ }\mu\text{A}$  |               |
|                                    | $U_R = 160\text{ V}$                                                                                                  | $I_{L1} \leq 50\text{ }\mu\text{A}$                              |               |
|                                    | case $\varnothing\text{ D} \times \text{L} = 10\text{ mm} \times 30\text{ mm to }21\text{ mm} \times 38\text{ mm}$ :  |                                                                  |               |
|                                    | $U_R = 10\text{ V to }100\text{ V}$                                                                                   | $I_{L1} \leq 0.006\text{ C}_R \times U_R + 3\text{ }\mu\text{A}$ |               |
|                                    | After 5 min:                                                                                                          |                                                                  |               |
|                                    | case $\varnothing\text{ D} \times \text{L} = 6.5\text{ mm} \times 18\text{ mm to }10\text{ mm} \times 25\text{ mm}$ : |                                                                  |               |
|                                    | $U_R = 10\text{ V to }100\text{ V}$                                                                                   | $I_{L5} \leq 0.002\text{ C}_R \times U_R + 4\text{ }\mu\text{A}$ |               |
|                                    | $U_R = 160\text{ V}$                                                                                                  | $I_{L5} \leq 20\text{ }\mu\text{A}$                              |               |
|                                    | case $\varnothing\text{ D} \times \text{L} = 10\text{ mm} \times 30\text{ mm to }21\text{ mm} \times 38\text{ mm}$ :  |                                                                  |               |
|                                    | $U_R = 10\text{ V to }100\text{ V}$                                                                                   | $I_{L5} \leq 0.002\text{ C}_R \times U_R + 4\text{ }\mu\text{A}$ |               |
| Inductance                         |                                                                                                                       |                                                                  |               |
| Equivalent series inductance (ESL) | Case $\varnothing\text{ D} \times \text{L mm}$ :                                                                      |                                                                  |               |
|                                    | 6.5 x 18                                                                                                              | Typ. 15 nH                                                       | -             |
|                                    | 8 x 18                                                                                                                | Typ. 35 nH                                                       | -             |
|                                    | 10 x 18                                                                                                               | Typ. 69 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    |



## CAPACITANCE (C)

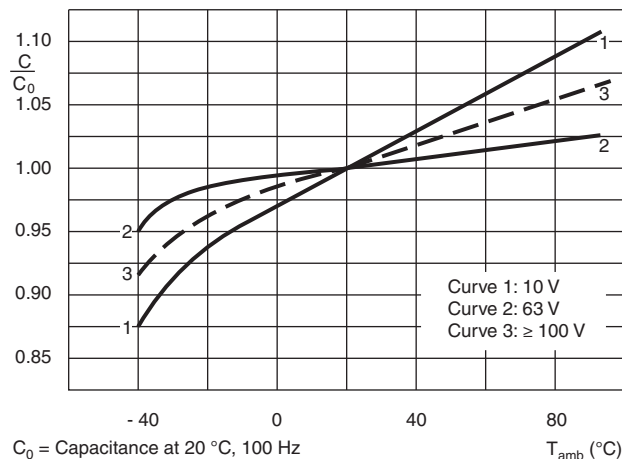


Fig. 5 - Typical multiplier of capacitance as a function of ambient temperature at 10 kHz

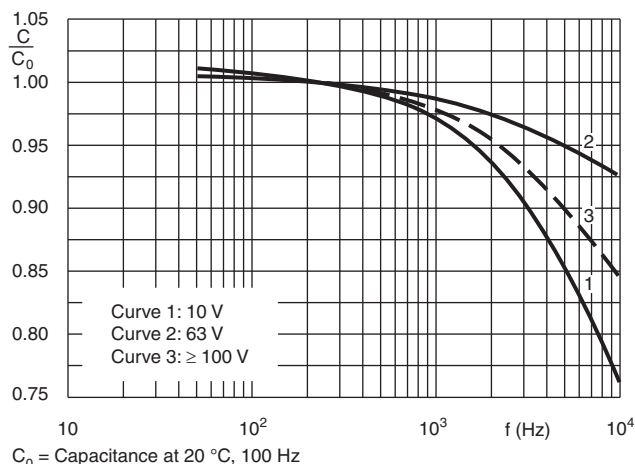


Fig. 6 - Typical multiplier of capacitance as a function of frequency

## DISSIPATION FACTOR ( $\tan \delta$ )

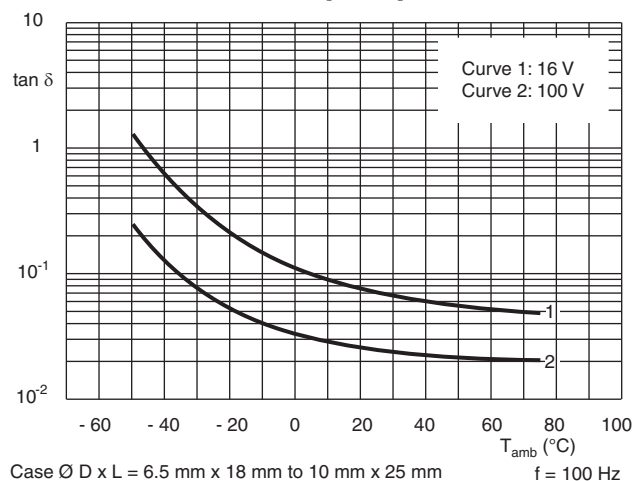


Fig. 7 - Typical  $\tan \delta$  as a function of ambient temperature

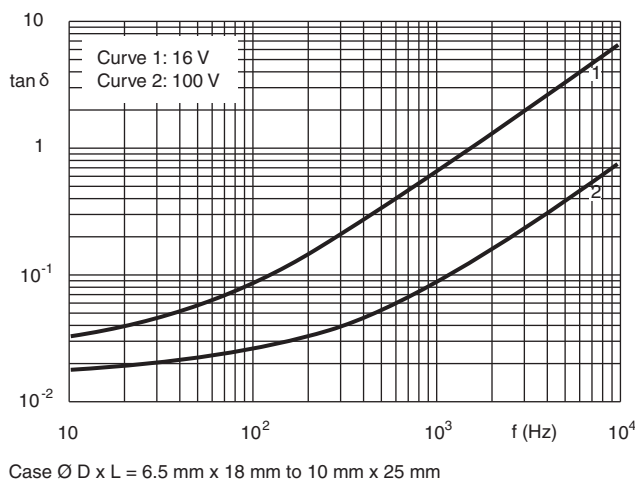


Fig. 8 - Typical  $\tan \delta$  as a function of frequency

## IMPEDANCE (Z)

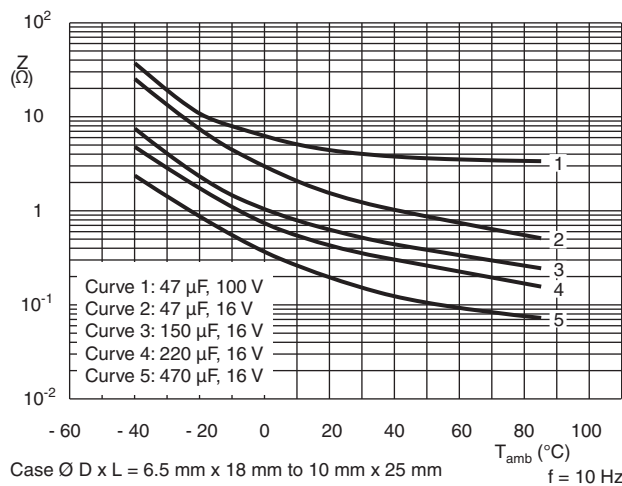


Fig. 9 - Typical impedance as a function of ambient temperature

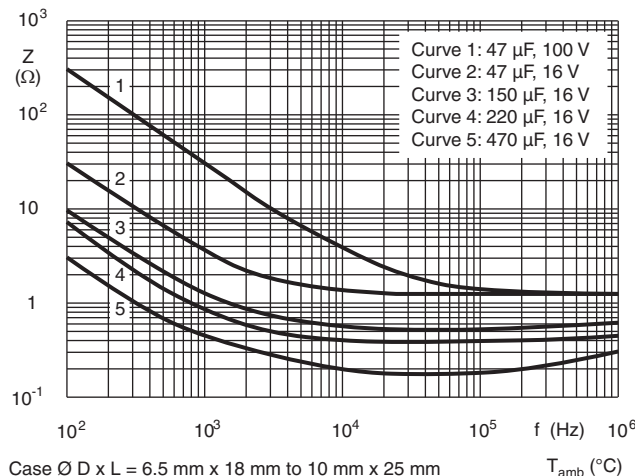


Fig. 10 - Typical impedance as a function of frequency



## RIPPLE CURRENT AND USEFUL LIFE

CCC205

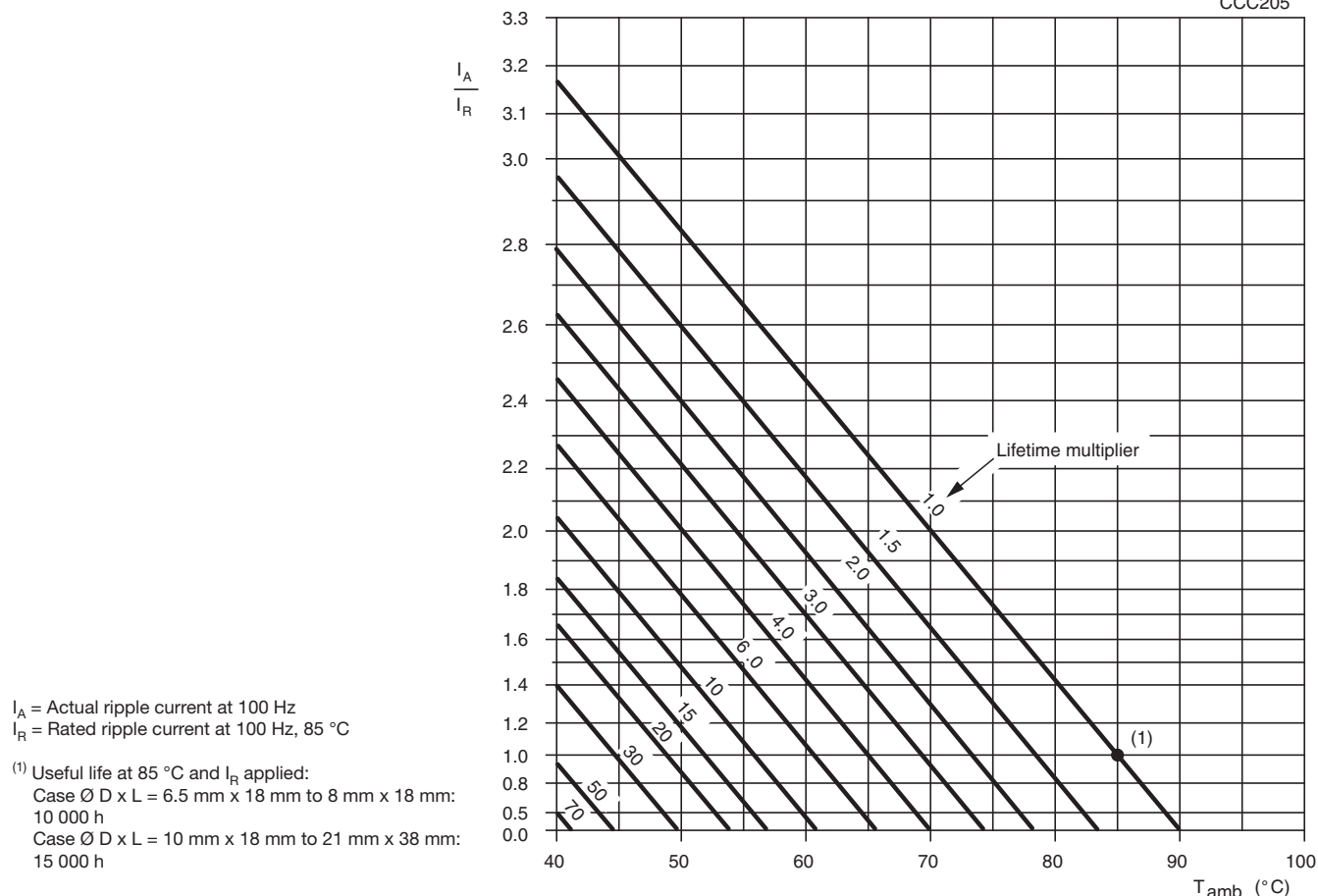


Fig. 11 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |                                        |                                        |                                         |
|-------------------------------------------------------------------|----------------------------------------|----------------------------------------|-----------------------------------------|
| FREQUENCY<br>(Hz)                                                 | $I_R$ MULTIPLIER                       |                                        |                                         |
|                                                                   | $U_R = 10 \text{ V AND } 16 \text{ V}$ | $U_R = 25 \text{ V AND } 63 \text{ V}$ | $U_R = 100 \text{ V TO } 160 \text{ V}$ |
| 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

| TEST PROCEDURES AND REQUIREMENTS               |                                             |                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                  |
|------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TEST                                           |                                             | PROCEDURE<br>(quick reference)                                                                                                                                                                                                                                                                                     | REQUIREMENTS                                                                                                                                                                                                                                                     |
| NAME OF TEST                                   | REFERENCE                                   |                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                  |
| Endurance                                      | IEC 60384-4/<br>EN 130300<br>subclause 4.13 | $T_{amb} = 85\text{ }^{\circ}\text{C}$ ; $U_R$ applied;<br>Case $\varnothing D \times L = 6.5\text{ mm} \times 18\text{ mm}$ to $8\text{ mm} \times 18\text{ mm}$ :<br>6000 h;<br>Case $\varnothing D \times L = 10\text{ mm} \times 18\text{ mm}$ to $21\text{ mm} \times 38\text{ mm}$ :<br>8000 h               | $U_R = 10\text{ V}$ to $160\text{ V}$ ; $\Delta C/C: \pm 15\%$<br>$\tan \delta \leq 1.3 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$                                                                   |
| Useful life                                    | CECC 30301<br>subclause 1.8.1               | $T_{amb} = 85\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied;<br>Case $\varnothing D \times L = 6.5\text{ mm} \times 18\text{ mm}$ to $8\text{ mm} \times 18\text{ mm}$ :<br>10 000 h;<br>Case $\varnothing D \times L = 10\text{ mm} \times 18\text{ mm}$ to $21\text{ mm} \times 38\text{ mm}$ :<br>15 000 h | $U_R = 10\text{ V}$ to $160\text{ V}$ ; $\Delta C/C: \pm 45\%$<br>$\tan \delta \leq 3 \times \text{spec. limit}$<br>$Z \leq 3 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1\%$ |
| Shelf life<br>(storage at high<br>temperature) | IEC 60384-4/<br>EN 130300<br>subclause 4.17 | $T_{amb} = 85\text{ }^{\circ}\text{C}$ ; no voltage applied;<br>500 h;<br><br>After test: $U_R$ to be applied for 30 min,<br>24 h to 48 h before measurement                                                                                                                                                       | $\Delta C/C$ , $\tan \delta$ , $Z$ :<br>for requirements<br>see "Endurance test" above<br><br>$I_{L5} \leq 2 \times \text{spec. limit}$                                                                                                                          |



## 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.

## Material Category Policy

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as RoHS-Compliant fulfill the definitions and restrictions defined under Directive 2011/65/EU of The European Parliament and of the Council of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) - recast, unless otherwise specified as non-compliant.**

**Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.**

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.**