



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

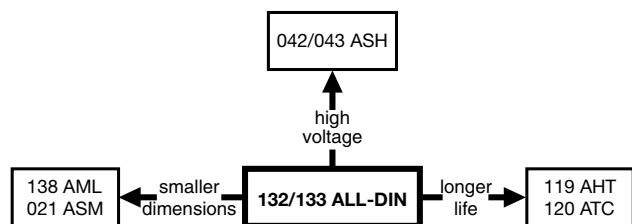


Fig. 1

| QUICK REFERENCE DATA                               |                      |                     |                    |
|--|----------------------|---------------------|--------------------|
| DESCRIPTION  | VALUE                |                     |                    |
| Nominal case sizes (Ø D x L in mm)                 | 6.5 x 18 and 8 x 18  | 10 x 18 and 10 x 25 | 10 x 30 to 21 x 38 |
| Rated capacitance range, C <sub>R</sub>            | 1 µF to 4700 µF      |                     |                    |
| Tolerance on C <sub>R</sub>                        | -10 % to +50 %       |                     |                    |
| Rated voltage range, U <sub>R</sub>                | 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, 1.8 x I <sub>R</sub> applied | 160 000 h            | 240 000 h           | 240 000 h          |
| Shelf life at 0 V, 85 °C                           | 500 h                |                     |                    |
| Based on sectional specification                   | IEC 60384-4/EN130300 |                     |                    |
| Climatic category IEC 60068                        | 40/085/56            |                     |                    |

| SELECTION CHART FOR C <sub>R</sub> , U <sub>R</sub> , AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm) |                    |    |          |    |          |          |                        |                          |
|---|--------------------|----|----------|----|----------|----------|------------------------|--------------------------|
| C <sub>R</sub> (µF)   | U <sub>R</sub> (V) |    |          |    |          |          |                        |                          |
|   | 10                 | 16 | 25       | 40 | 63       | 100      | 160                    | 250                      |
| 1.0   | -                  | -  | -        | -  | -        | 6.5 x 18 | -                      | -                        |
| 2.2   | -                  | -  | -        | -  | -        | -        | -                      | -                        |
| 4.7   | -                  | -  | -        | -  | 6.5 x 18 | 6.5 x 18 | -                      | -                        |
| 10  | -                  | -  | -        | -  | 6.5 x 18 | -        | -                      | -                        |
|   | -                  | -  | -        | -  | -        | -        | -                      | 10 x 30 <sup>(1)</sup>   |
| 22  | -                  | -  | 6.5 x 18 | -  | 8 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))

**FEATURES**

- Long useful life: up to 15 000 h at 85 °C
- Taped versions up to case Ø 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 µF)
- 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)

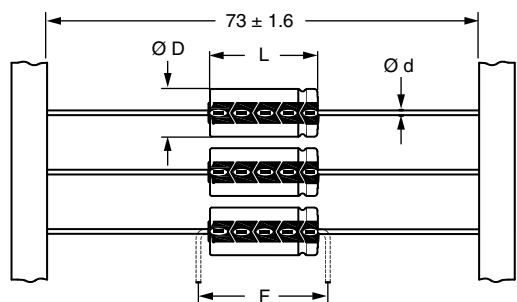


| SELECTION CHART FOR $C_R$ , $U_R$ , AND RELEVANT NOMINAL CASE SIZES ( $\varnothing D \times L$ in mm) |           |           |           |           |         |           |                        |                        |
|---|-----------|-----------|-----------|-----------|---------|-----------|------------------------|------------------------|
| $C_R$<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> |
|   | -         | -         | -         | -         | -       | 10 x 30   | -                      | -                      |
| 68  | -         | -         | -         | -         | 10 x 30 | 12.5 x 30 | 15 x 30 <sup>(1)</sup> | 18 x 38 <sup>(1)</sup> |
| 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   | -         | 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**

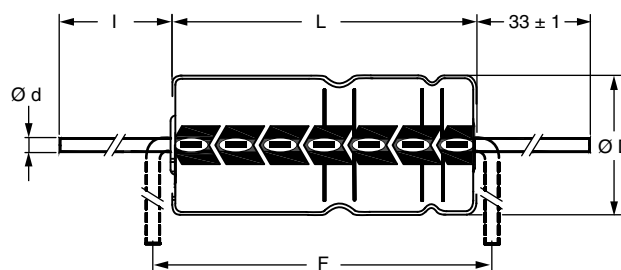
(1) For these CV-values see datasheet 041 - 043 ASH ([www.vishay.com/doc?28329](http://www.vishay.com/doc?28329))

**DIMENSIONS in millimeters AND AVAILABLE FORMS**



**Form BR:** Taped on reel  
Case  $\varnothing D \times L = 6.5 \text{ mm} \times 18 \text{ mm}$  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. 2 - Forms BA and BR



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

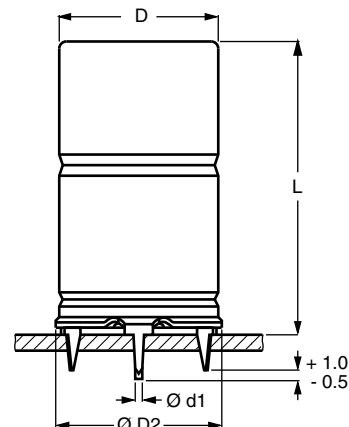
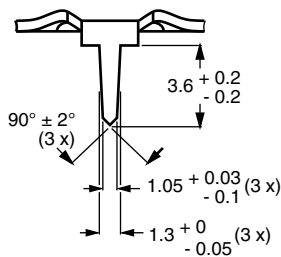
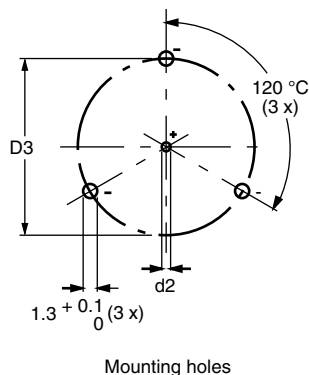
Fig. 3 - Form AA

Table 1

| AXIAL; DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES |           |                           |        |                        |            |            |          |                      |         |         |
|--|-----------|---------------------------|--------|------------------------|------------|------------|----------|----------------------|---------|---------|
| NOMINAL CASE SIZE $\varnothing D \times L$                       | 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

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

| ELECTRICAL DATA |  |
|-----------------|--|
| 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 $\tan \delta_{max.}$ 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  $106 \text{ kPa}$ ,  $RH = 45 \text{ \%}$  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                                       | 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                  |
| 2200                                     | 21 x 38                          | 1900                                    | 180                                       | 0.10                             | 0.07            | 0.05                 | -                  | 13217222E3          | -                       | -                           | 13247222E3                 |                             |
| 63                                       | 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                 | -                           |
|  | 4.7                              | 6.5 x 18                                | 48  | 4.9                              | 0.06            | 20                   | 9.6                | 4.0                 | -                       | 13229478E3                  | 13239478E3                 | -                           |
|  | 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 |
| <b>Voltage</b>                                 |  |  |               |
| Surge voltage                                  | U <sub>R</sub> = 10 V to 160 V                                 | U <sub>s</sub> ≤ 1.15 x U <sub>R</sub>                         |               |
| Reverse voltage                                |  | U <sub>rev</sub> ≤ 1 V   |               |
| <b>Current</b>                                 |  |  |               |
| Leakage current                                | After 1 min:   |  |               |
|  | case Ø D x L = 6.5 mm x 18 mm to 10 mm x 25 mm:                |  |               |
|  | U <sub>R</sub> = 10 V to 100 V                                 | I <sub>L1</sub> ≤ 0.01 C <sub>R</sub> x U <sub>R</sub> + 3 μA  |               |
|  | U <sub>R</sub> = 160 V   | I <sub>L1</sub> ≤ 50 μA  |               |
|  | case Ø D x L = 10 mm x 30 mm to 21 mm x 38 mm:                 |  |               |
|  | U <sub>R</sub> = 10 V to 100 V                                 | I <sub>L1</sub> ≤ 0.006 C <sub>R</sub> x U <sub>R</sub> + 3 μA |               |
|  | After 5 min:   |  |               |
|  | case Ø D x L = 6.5 mm x 18 mm to 10 mm x 25 mm:                |  |               |
|  | U <sub>R</sub> = 10 V to 100 V                                 | I <sub>L5</sub> ≤ 0.002 C <sub>R</sub> x U <sub>R</sub> + 4 μA |               |
|  | U <sub>R</sub> = 160 V   | I <sub>L5</sub> ≤ 20 μA  |               |
| case Ø D x L = 10 mm x 30 mm to 21 mm x 38 mm: |  |  |               |
| U <sub>R</sub> = 10 V to 100 V                 | I <sub>L5</sub> ≤ 0.002 C <sub>R</sub> x U <sub>R</sub> + 4 μA |  |               |
| <b>Inductance</b>                              |  |  |               |
| Equivalent series inductance (ESL)             | Case Ø D x 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)**

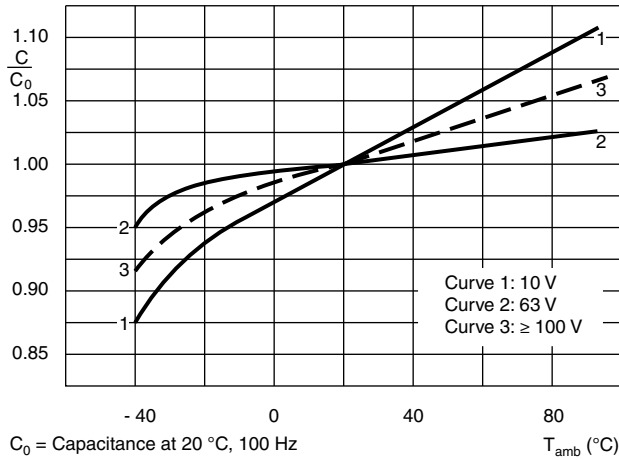


Fig. 5 - Typical multiplier of capacitance as a function of ambient temperature at 10 kHz

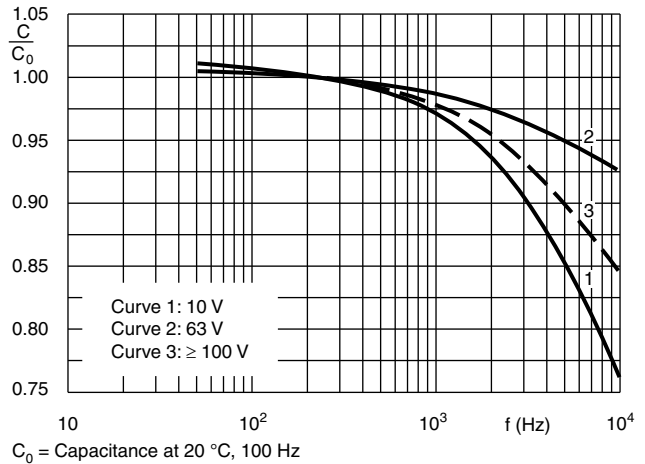


Fig. 6 - Typical multiplier of capacitance as a function of frequency

**DISSIPATION FACTOR (tan δ)**

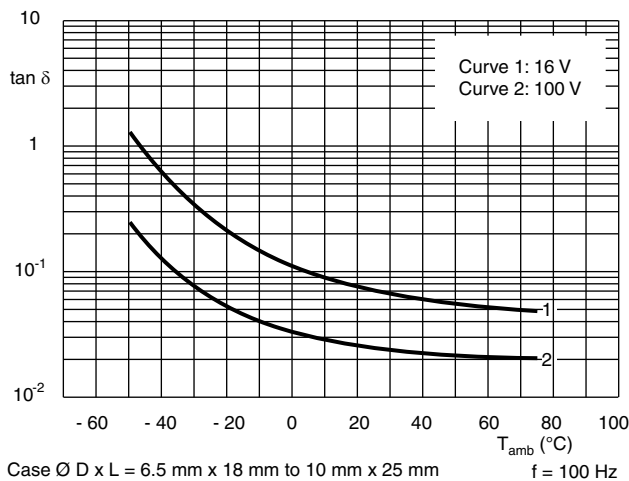


Fig. 7 - Typical tan δ as a function of ambient temperature

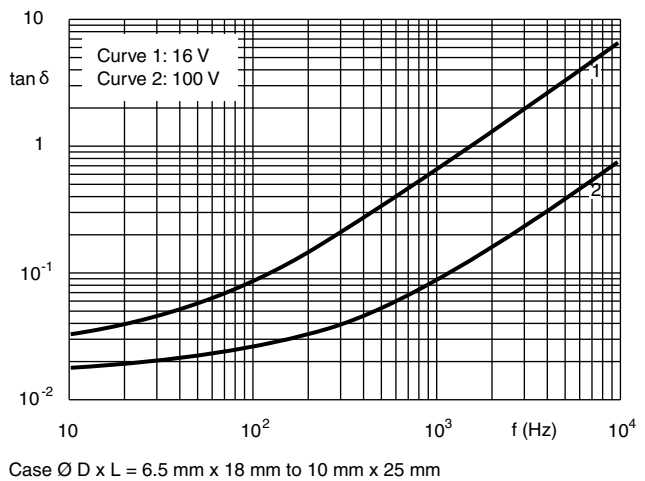


Fig. 8 - Typical tan δ as a function of frequency

**IMPEDANCE (Z)**

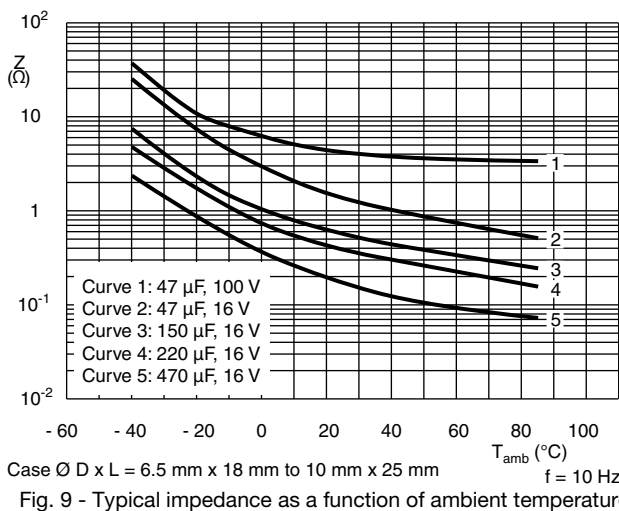


Fig. 9 - Typical impedance as a function of ambient temperature

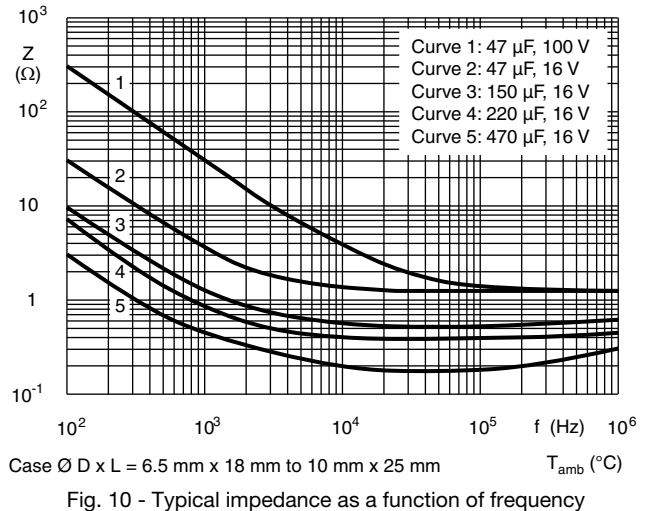


Fig. 10 - Typical impedance as a function of frequency



**RIPPLE CURRENT AND USEFUL LIFE**

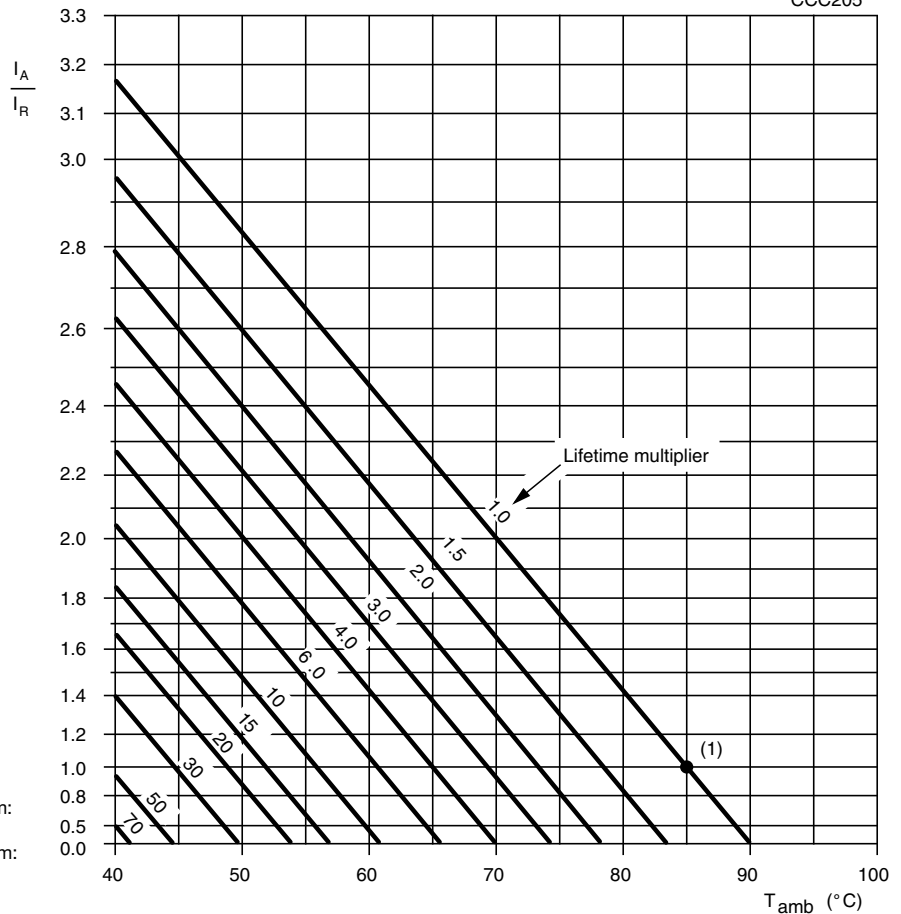
Table 4

| ENDURANCE TEST DURATION AND USEFUL LIFE |                              |                                |
|---|------------------------------|--------------------------------|
| NOMINAL CASE SIZE<br>Ø D x L<br>(mm)    | ENDURANCE<br>AT 85 °C<br>(h) | USEFUL LIFE<br>AT 85 °C<br>(h) |
| 6.5 x 18                                | 6000                         | 10 000                         |
| 8 x 18                                  | 6000                         | 10 000                         |
| 10 x 18                                 | 6000                         | 10 000                         |
| 10 x 25                                 | 6000                         | 10 000                         |
| 10 x 30                                 | 8000                         | 15 000                         |
| 12.5 x 30                               | 8000                         | 15 000                         |
| 15 x 30                                 | 8000                         | 15 000                         |
| 18 x 30                                 | 8000                         | 15 000                         |
| 18 x 38                                 | 8000                         | 15 000                         |
| 21 x 38                                 | 8000                         | 15 000                         |

**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 Ø D x L = 6.5 mm x 18 mm to 8 mm x 18 mm:  
 10 000 h  
 Case Ø D x L = 10 mm x 18 mm to 21 mm x 38 mm:  
 15 000 h

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



Table 5

| <b>MULTIPLIER OF RIPPLE CURRENT (<math>I_R</math>) AS A FUNCTION OF FREQUENCY</b> |                |      |      |      |      |                |
|---|----------------|------|------|------|------|----------------|
| $U_R$<br>(V)  | FREQUENCY (Hz) |      |      |      |      |                |
|   | 50             | 100  | 300  | 1000 | 3000 | $\geq 10\ 000$ |
| $I_R$ MULTIPLIER  |                |      |      |      |      |                |
| 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  | 0.90           | 1.00 | 1.12 | 1.20 | 1.25 | 1.30           |
| 100   | 0.85           | 1.00 | 1.20 | 1.30 | 1.35 | 1.40           |
| 160   | 0.85           | 1.00 | 1.20 | 1.30 | 1.35 | 1.40           |
| 250   | 0.85           | 1.00 | 1.20 | 1.30 | 1.35 | 1.40           |

Table 6

| <b>TEST PROCEDURES AND REQUIREMENTS</b>        |   |  |  |
|--|---|--|--|
| TEST   |   | PROCEDURE<br>(quick reference)   | REQUIREMENTS   |
| NAME OF TEST                                   | REFERENCE                                   |  |  |
| Endurance                                      | IEC 60384-4/<br>EN 130300<br>subclause 4.13 | $T_{amb} = 85\ ^\circ\text{C}$ ; $U_R$ 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               | $T_{amb} = 85\ ^\circ\text{C}$ ; $U_R$ 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 | $T_{amb} = 85\ ^\circ\text{C}$ ; 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>$I_{L5} \leq 2 \times \text{spec. limit}$  |





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