

## Aluminum Electrolytic Capacitors Axial Standard

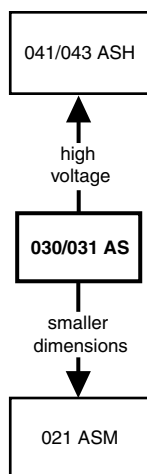
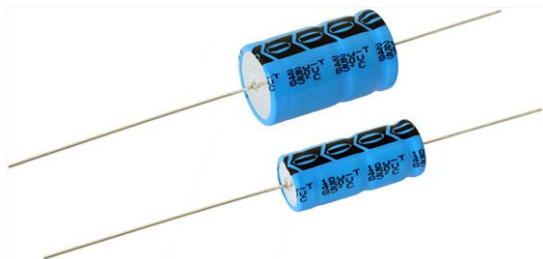


Fig. 1


**RoHS**  
COMPLIANT

### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Taped version available for automatic insertion
- Charge and discharge proof
- Useful life: 3000 h at 85 °C
- Standard dimensions
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

### APPLICATIONS

- General purpose and industrial, automotive, telecommunication, audio-video
- Coupling, decoupling, timing, smoothing, filtering, buffering in SMPS
- Boards with restricted mounting height, vibration, and shock resistant

### MARKING

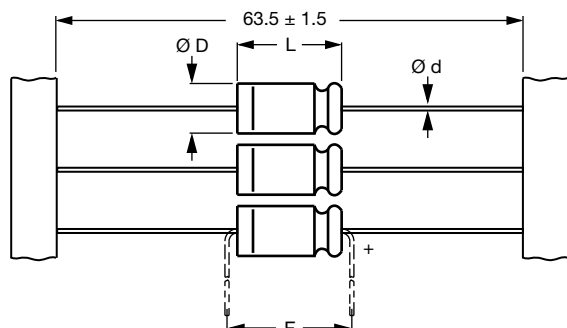
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in  $\mu\text{F}$ )
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (T for -10 % to +50 %)
- Rated voltage (in V)
- Date code in accordance with IEC 60062
- Code factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (030 or 031)

| QUICK REFERENCE DATA                            |                                       |
|-------------------------------------------------|---------------------------------------|
| DESCRIPTION                                     | VALUE                                 |
| Nominal case sizes ( $\varnothing$ D x L in mm) | 4.5 x 10 to 10 x 25                   |
| Rated capacitance range, $C_R$                  | 1 $\mu\text{F}$ to 1000 $\mu\text{F}$ |
| Tolerance on $C_R$                              | -10 % to +50 %                        |
| Rated voltage, $U_R$                            | 6.3 V to 100 V                        |
| Category temperature range                      | -40 °C to +85 °C                      |
| Endurance test at 85 °C                         | 2000 h                                |
| Useful life at 85 °C                            | 3000 h                                |
| Useful life at 40 °C, 1.4 x $I_R$ applied       | 80 000 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  $C_R$ ,  $U_R$  AND RELEVANT NOMINAL CASE SIZES ( $\varnothing D \times L$  in mm)**

| $C_R$<br>( $\mu F$ ) | $U_R$ (V) |          |          |          |          |          |          |
|----------------------|-----------|----------|----------|----------|----------|----------|----------|
|                      | 6.3       | 10       | 16       | 25       | 40       | 63       | 100      |
| 1.0                  | -         | -        | -        | -        | -        | 4.5 x 10 | 4.5 x 10 |
| 2.2                  | -         | -        | -        | -        | -        | 4.5 x 10 | 4.5 x 10 |
| 3.3                  | -         | -        | -        | -        | -        | 4.5 x 10 | 4.5 x 10 |
| 4.7                  | -         | -        | -        | -        | -        | 4.5 x 10 | 6 x 10   |
| 6.8                  | -         | -        | -        | -        | -        | 4.5 x 10 | 6 x 10   |
| 10                   | -         | -        | -        | 4.5 x 10 | 4.5 x 10 | 6 x 10   | 8 x 11   |
|                      | -         | -        | -        | -        | -        | -        | 6.5 x 18 |
| 15                   | -         | -        | -        | -        | 4.5 x 10 | 6 x 10   | -        |
| 22                   | -         | -        | -        | 4.5 x 10 | 6 x 10   | 8 x 11   | 8 x 18   |
|                      | -         | -        | -        | -        | -        | 6.5 x 18 | -        |
| 33                   | -         | -        | 4.5 x 10 | -        | 6 x 10   | -        | 10 x 18  |
| 47                   | -         | 4.5 x 10 | -        | 6 x 10   | 8 x 11   | 8 x 18   | 10 x 25  |
|                      | -         | -        | -        | -        | 6.5 x 18 | -        | -        |
| 68                   | 4.5 x 10  | -        | 6 x 10   | -        | -        | 10 x 18  | -        |
| 100                  | -         | 6 x 10   | -        | 8 x 11   | 8 x 18   | 10 x 25  | -        |
|                      | -         | -        | -        | 6.5 x 18 | -        | -        | -        |
| 150                  | 6 x 10    | -        | 8 x 11   | 8 x 18   | 10 x 18  | -        | -        |
|                      | -         | -        | 6.5 x 18 | -        | -        | -        | -        |
| 220                  | -         | 8 x 11   | 8 x 18   | 10 x 18  | 10 x 25  | -        | -        |
|                      | -         | 6.5 x 18 | -        | -        | -        | -        | -        |
| 330                  | -         | 8 x 18   | 10 x 18  | 10 x 25  | -        | -        | -        |
| 470                  | 8 x 18    | 10 x 18  | 10 x 25  | -        | -        | -        | -        |
| 680                  | 10 x 18   | 10 x 25  | -        | -        | -        | -        | -        |
| 1000                 | 10 x 25   | -        | -        | -        | -        | -        | -        |

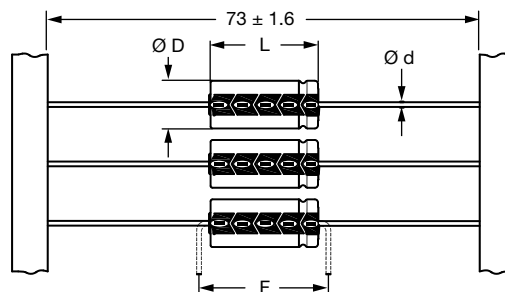
**DIMENSIONS in millimeters AND AVAILABLE FORMS**


**Form BR:** Taped on reel

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

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

Fig. 2 - **Forms BA and BR**



**Form BR:** Taped on reel

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

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

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

Fig. 3 - **Forms BA and BR**

Table 1

| <b>AXIAL; DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES</b> |           |                      |                        |            |            |             |                      |         |
|------------------------------------------------------------------------|-----------|----------------------|------------------------|------------|------------|-------------|----------------------|---------|
| NOMINAL CASE SIZE<br>$\varnothing D \times L$                          | CASE CODE | AXIAL FORM BA AND BR |                        |            |            | MASS<br>(g) | PACKAGING QUANTITIES |         |
|                                                                        |           | $\varnothing d$      | $\varnothing D_{max.}$ | $L_{max.}$ | $F_{min.}$ |             | FORM BA              | FORM BR |
| 4.5 x 10                                                               | 2         | 0.6                  | 5.0                    | 10.5       | 15         | ≈ 0.5       | 1000                 | 3000    |
| 6 x 10                                                                 | 3         | 0.6                  | 6.3                    | 10.5       | 15         | ≈ 0.7       | 1000                 | 1000    |
| 8 x 11                                                                 | 5a        | 0.6                  | 8.5                    | 11.5       | 15         | ≈ 1.1       | 500                  | 500     |
| 6.5 x 18                                                               | 4         | 0.8                  | 6.9                    | 18.5       | 25         | ≈ 1.3       | 1000                 | 1000    |
| 8 x 18                                                                 | 5         | 0.8                  | 8.5                    | 18.5       | 25         | ≈ 1.7       | 500                  | 500     |
| 10 x 18                                                                | 6         | 0.8                  | 10.5                   | 18.5       | 25         | ≈ 2.5       | 500                  | 500     |
| 10 x 25                                                                | 7         | 0.8                  | 10.5                   | 25.0       | 30         | ≈ 3.3       | 500                  | 500     |

**Note**

- Detailed tape dimensions see section "PACKAGING"



| ELECTRICAL DATA |                                                                                           |
|-----------------|-------------------------------------------------------------------------------------------|
| SYMBOL          | DESCRIPTION                                                                               |
| $C_R$           | Rated capacitance at 100 Hz, tolerance -10 % to +50 %                                     |
| $I_R$           | Rated RMS ripple current at 100 Hz, 85 °C                                                 |
| $I_{L1}$        | Max. leakage current after 1 min at $U_R$                                                 |
| $I_{L5}$        | 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 2 apply at  $T_{\text{amb}} = 20\text{ °C}$ ,  $P = 86\text{ kPa}$  to  $106\text{ kPa}$ ,  $RH = 45\text{ %}$  to  $75\text{ %}$ .

Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION |                                      |                                                          |              |                                  |                                        |                                        |                         |                               |                             |                             |                         |
|------------------------------------------|--------------------------------------|----------------------------------------------------------|--------------|----------------------------------|----------------------------------------|----------------------------------------|-------------------------|-------------------------------|-----------------------------|-----------------------------|-------------------------|
| $U_R$<br>(V)                             | $C_R$<br>100 Hz<br>( $\mu\text{F}$ ) | NOMINAL<br>CASE SIZE<br>$\varnothing D \times L$<br>(mm) | CASE<br>CODE | $I_R$<br>100 Hz<br>85 °C<br>(mA) | $I_{L1}$<br>1 min<br>( $\mu\text{A}$ ) | $I_{L5}$<br>5 min<br>( $\mu\text{A}$ ) | $\tan \delta$<br>100 Hz | ESR<br>100 Hz<br>( $\Omega$ ) | Z<br>10 kHz<br>( $\Omega$ ) | ORDERING CODE<br>MAL2.....  |                         |
|                                          |                                      |                                                          |              |                                  |                                        |                                        |                         |                               |                             | TAPED ON<br>REEL<br>FORM BR | TAPED IN BOX<br>FORM BA |
| 6.3                                      | 68                                   | 4.5 x 10                                                 | 2            | 75                               | 22                                     | 5.9                                    | 0.25                    | 5.86                          | 2.90                        | 03023689E3                  | 03033689E3              |
|                                          | 150                                  | 6 x 10                                                   | 3            | 120                              | 10                                     | 6.9                                    | 0.25                    | 2.66                          | 1.30                        | 03023151E3                  | 03033151E3              |
|                                          | 470                                  | 8 x 18                                                   | 5            | 330                              | 22                                     | 11                                     | 0.25                    | 0.85                          | 0.43                        | 03123471E3                  | 03133471E3              |
|                                          | 680                                  | 10 x 18                                                  | 6            | 430                              | 30                                     | 14                                     | 0.25                    | 0.59                          | 0.29                        | 03123681E3                  | 03133681E3              |
|                                          | 1000                                 | 10 x 25                                                  | 7            | 560                              | 42                                     | 18                                     | 0.25                    | 0.40                          | 0.20                        | 03123102E3                  | 03133102E3              |
| 10                                       | 47                                   | 4.5 x 10                                                 | 2            | 70                               | 24                                     | 5.9                                    | 0.20                    | 6.78                          | 3.40                        | 03024479E3                  | 03034479E3              |
|                                          | 100                                  | 6 x 10                                                   | 3            | 110                              | 10                                     | 7.0                                    | 0.20                    | 3.19                          | 1.60                        | 03024101E3                  | 03034101E3              |
|                                          | 220                                  | 8 x 11                                                   | 5a           | 210                              | 18                                     | 9.4                                    | 0.20                    | 1.45                          | 0.73                        | 03024221E3                  | 03034221E3              |
|                                          | 220                                  | 6.5 x 18                                                 | 4            | 210                              | 18                                     | 9.4                                    | 0.20                    | 1.45                          | 0.73                        | 03124221E3                  | 03134221E3              |
|                                          | 330                                  | 8 x 18                                                   | 5            | 310                              | 24                                     | 12                                     | 0.20                    | 0.97                          | 0.48                        | 03124331E3                  | 03134331E3              |
|                                          | 470                                  | 10 x 18                                                  | 6            | 410                              | 33                                     | 14                                     | 0.20                    | 0.68                          | 0.34                        | 03124471E3                  | 03134471E3              |
|                                          | 680                                  | 10 x 25                                                  | 7            | 510                              | 45                                     | 19                                     | 0.20                    | 0.47                          | 0.24                        | 03124681E3                  | 03134681E3              |
| 16                                       | 33                                   | 4.5 x 10                                                 | 2            | 65                               | 27                                     | 6.1                                    | 0.16                    | 7.72                          | 3.60                        | 03025339E3                  | 03035339E3              |
|                                          | 68                                   | 6 x 10                                                   | 3            | 110                              | 11                                     | 7.2                                    | 0.16                    | 3.75                          | 1.80                        | 03025689E3                  | 03035689E3              |
|                                          | 150                                  | 8 x 11                                                   | 5a           | 200                              | 19                                     | 9.8                                    | 0.16                    | 1.70                          | 0.80                        | 03025151E3                  | 03035151E3              |
|                                          | 150                                  | 6.5 x 18                                                 | 4            | 200                              | 19                                     | 9.8                                    | 0.16                    | 1.70                          | 0.80                        | 03125151E3                  | 03135151E3              |
|                                          | 220                                  | 8 x 18                                                   | 5            | 270                              | 26                                     | 12                                     | 0.16                    | 1.16                          | 0.55                        | 03125221E3                  | 03135221E3              |
|                                          | 330                                  | 10 x 18                                                  | 6            | 410                              | 36                                     | 16                                     | 0.16                    | 0.78                          | 0.36                        | 03125331E3                  | 03135331E3              |
|                                          | 470                                  | 10 x 25                                                  | 7            | 480                              | 49                                     | 20                                     | 0.16                    | 0.55                          | 0.26                        | 03125471E3                  | 03135471E3              |
| 25                                       | 10                                   | 4.5 x 10                                                 | 2            | 50                               | 13                                     | 5.5                                    | 0.14                    | 22.3                          | 9.00                        | 03026109E3                  | 03036109E3              |
|                                          | 22                                   | 4.5 x 10                                                 | 2            | 60                               | 28                                     | 6.1                                    | 0.14                    | 10.2                          | 4.10                        | 03026229E3                  | 03036229E3              |
|                                          | 47                                   | 6 x 10                                                   | 3            | 100                              | 12                                     | 7.4                                    | 0.14                    | 4.80                          | 1.90                        | 03026479E3                  | 03036479E3              |
|                                          | 100                                  | 8 x 11                                                   | 5a           | 160                              | 19                                     | 10                                     | 0.14                    | 2.23                          | 0.90                        | 03026101E3                  | 03036101E3              |
|                                          | 100                                  | 6.5 x 18                                                 | 4            | 160                              | 19                                     | 10                                     | 0.14                    | 2.23                          | 0.90                        | 03126101E3                  | 03136101E3              |
|                                          | 150                                  | 8 x 18                                                   | 5            | 240                              | 27                                     | 13                                     | 0.14                    | 1.49                          | 0.60                        | 03126151E3                  | 03136151E3              |
|                                          | 220                                  | 10 x 18                                                  | 6            | 350                              | 37                                     | 16                                     | 0.14                    | 1.02                          | 0.41                        | 03126221E3                  | 03136221E3              |
|                                          | 330                                  | 10 x 25                                                  | 7            | 460                              | 54                                     | 22                                     | 0.14                    | 0.68                          | 0.27                        | 03126331E3                  | 03136331E3              |

**ORDERING EXAMPLE**

Electrolytic capacitor 031 series

330  $\mu\text{F}$  / 10 V; -10 % / +50 %Nominal case size:  $\varnothing 8\text{ mm} \times 18\text{ mm}$ ; form BA

Ordering code: MAL203134331E3

**ELECTRICAL DATA AND ORDERING INFORMATION**

| $U_R$<br>(V) | $C_R$<br>100 Hz<br>( $\mu F$ ) | NOMINAL<br>CASE SIZE<br>$\varnothing D \times L$<br>(mm) | CASE<br>CODE | $I_R$<br>100 Hz<br>85 °C<br>(mA) | $I_{L1}$<br>1 min<br>( $\mu A$ ) | $I_{L5}$<br>5 min<br>( $\mu A$ ) | $\tan \delta$<br>100 Hz | ESR<br>100 Hz<br>( $\Omega$ ) | $Z$<br>10 kHz<br>( $\Omega$ ) | ORDERING CODE<br>MAL2.....  |                         |
|--------------|--------------------------------|----------------------------------------------------------|--------------|----------------------------------|----------------------------------|----------------------------------|-------------------------|-------------------------------|-------------------------------|-----------------------------|-------------------------|
|              |                                |                                                          |              |                                  |                                  |                                  |                         |                               |                               | TAPED ON<br>REEL<br>FORM BR | TAPED IN BOX<br>FORM BA |
| 40           | 10                             | 4.5 x 10                                                 | 2            | 50                               | 20                               | 5.8                              | 0.11                    | 17.6                          | 7.00                          | 03027109E3                  | 03037109E3              |
|              | 15                             | 4.5 x 10                                                 | 2            | 55                               | 30                               | 6.2                              | 0.11                    | 11.7                          | 4.70                          | 03027159E3                  | 03037159E3              |
|              | 22                             | 6 x 10                                                   | 3            | 75                               | 9                                | 6.8                              | 0.11                    | 8.00                          | 3.20                          | 03027229E3                  | 03037229E3              |
|              | 33                             | 6 x 10                                                   | 3            | 95                               | 12                               | 7.7                              | 0.11                    | 5.31                          | 2.10                          | 03027339E3                  | 03037339E3              |
|              | 47                             | 8 x 11                                                   | 5a           | 150                              | 16                               | 8.8                              | 0.11                    | 3.73                          | 1.50                          | 03027479E3                  | 03037479E3              |
|              | 47                             | 6.5 x 18                                                 | 4            | 150                              | 16                               | 8.8                              | 0.11                    | 3.73                          | 1.50                          | 03127479E3                  | 03137479E3              |
|              | 100                            | 8 x 18                                                   | 5            | 220                              | 28                               | 13                               | 0.11                    | 1.75                          | 0.70                          | 03127101E3                  | 03137101E3              |
|              | 150                            | 10 x 18                                                  | 6            | 300                              | 40                               | 17                               | 0.11                    | 1.17                          | 0.47                          | 03127151E3                  | 03137151E3              |
|              | 220                            | 10 x 25                                                  | 7            | 430                              | 57                               | 23                               | 0.11                    | 0.80                          | 0.32                          | 03127221E3                  | 03137221E3              |
| 63           | 1.0                            | 4.5 x 10                                                 | 2            | 13                               | 5                                | 5.1                              | 0.09                    | 143                           | 55.0                          | 03028108E3                  | 03038108E3              |
|              | 2.2                            | 4.5 x 10                                                 | 2            | 25                               | 7                                | 5.3                              | 0.09                    | 65.2                          | 25.0                          | 03028228E3                  | 03038228E3              |
|              | 3.3                            | 4.5 x 10                                                 | 2            | 35                               | 11                               | 5.4                              | 0.09                    | 46.5                          | 17.0                          | 03028338E3                  | 03038338E3              |
|              | 4.7                            | 4.5 x 10                                                 | 2            | 40                               | 15                               | 5.6                              | 0.09                    | 30.5                          | 12.0                          | 03028478E3                  | 03038478E3              |
|              | 6.8                            | 4.5 x 10                                                 | 2            | 46                               | 22                               | 5.9                              | 0.09                    | 21.1                          | 8.10                          | 03028688E3                  | 03038688E3              |
|              | 10                             | 6 x 10                                                   | 3            | 70                               | 7                                | 6.3                              | 0.08                    | 12.8                          | 5.50                          | 03028109E3                  | 03038109E3              |
|              | 15                             | 6 x 10                                                   | 3            | 79                               | 10                               | 6.9                              | 0.08                    | 8.50                          | 3.70                          | 03028159E3                  | 03038159E3              |
|              | 22                             | 8 x 11                                                   | 5a           | 110                              | 13                               | 7.8                              | 0.08                    | 5.79                          | 2.50                          | 03028229E3                  | 03038229E3              |
|              | 22                             | 6.5 x 18                                                 | 4            | 110                              | 13                               | 7.8                              | 0.08                    | 5.79                          | 2.50                          | 03128229E3                  | 03138229E3              |
|              | 47                             | 8 x 18                                                   | 5            | 190                              | 22                               | 11                               | 0.08                    | 2.71                          | 1.20                          | 03128479E3                  | 03138479E3              |
|              | 68                             | 10 x 18                                                  | 6            | 250                              | 30                               | 14                               | 0.08                    | 1.88                          | 0.81                          | 03128689E3                  | 03138689E3              |
|              | 100                            | 10 x 25                                                  | 7            | 300                              | 42                               | 18                               | 0.08                    | 1.28                          | 0.55                          | 03128101E3                  | 03138101E3              |
| 100          | 1.0                            | 4.5 x 10                                                 | 2            | 20                               | 5                                | 4.6                              | 0.08                    | 128                           | 45.0                          | 03029108E3                  | 03039108E3              |
|              | 2.2                            | 4.5 x 10                                                 | 2            | 30                               | 11                               | 5.3                              | 0.08                    | 57.9                          | 21.0                          | 03029228E3                  | 03039228E3              |
|              | 3.3                            | 4.5 x 10                                                 | 2            | 40                               | 17                               | 6.0                              | 0.08                    | 38.6                          | 14.0                          | 03029338E3                  | 03039338E3              |
|              | 4.7                            | 6 x 10                                                   | 3            | 50                               | 13                               | 6.8                              | 0.07                    | 23.7                          | 9.60                          | 03029478E3                  | 03039478E3              |
|              | 6.8                            | 6 x 10                                                   | 3            | 70                               | 18                               | 8.0                              | 0.07                    | 16.4                          | 6.60                          | 03029688E3                  | 03039688E3              |
|              | 10                             | 8 x 11                                                   | 5a           | 90                               | 24                               | 10                               | 0.07                    | 11.2                          | 4.50                          | 03029109E3                  | 03039109E3              |
|              | 10                             | 6.5 x 18                                                 | 4            | 90                               | 24                               | 10                               | 0.07                    | 11.2                          | 4.50                          | 03129109E3                  | 03139109E3              |
|              | 22                             | 8 x 18                                                   | 5            | 120                              | 48                               | 18                               | 0.07                    | 5.07                          | 2.10                          | 03129229E3                  | 03139229E3              |
|              | 33                             | 10 x 18                                                  | 6            | 200                              | 70                               | 24                               | 0.07                    | 3.38                          | 1.40                          | 03129339E3                  | 03139339E3              |
|              | 47                             | 10 x 25                                                  | 7            | 260                              | 98                               | 33                               | 0.07                    | 2.37                          | 0.96                          | 03129479E3                  | 03139479E3              |

| ADDITIONAL ELECTRICAL DATA         |                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                               |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PARAMETER                          | CONDITIONS                                                                                                                                                                                                                              | VALUE                                                                                                                                                                                                                                                                                                         |
| <b>Voltage</b>                     |                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                               |
| Surge voltage                      |                                                                                                                                                                                                                                         | $U_s \leq 1.15 \times U_R$                                                                                                                                                                                                                                                                                    |
| Reverse voltage                    |                                                                                                                                                                                                                                         | $U_{rev} \leq 1 \text{ V}$                                                                                                                                                                                                                                                                                    |
| <b>Current</b>                     |                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                               |
| Leakage current                    | After 1 min at $U_R$ :<br>Case $\varnothing D \times L = 4.5 \text{ mm} \times 10 \text{ mm}$<br>Case $\varnothing D \times L = 6 \text{ mm} \times 10 \text{ mm}$ to $10 \text{ mm} \times 25 \text{ mm}$<br><br>$U_R = 100 \text{ V}$ | $I_{L1} \leq 0.05 C_R \times U_R$ or $5 \mu\text{A}$ , whichever is greater<br>$I_{L1}$ for $CV \leq 1000$ : $\leq 0.01 C_R \times U_R$ or $1 \mu\text{A}$ , whichever is greater<br>$I_{L1}$ for $CV > 1000$ : $\leq 0.006 C_R \times U_R + 4 \mu\text{A}$<br>$I_{L1} = 0.02 C_R \times U_R + 4 \mu\text{A}$ |
|                                    | After 5 min:<br>$U_R = 6.3 \text{ V}$ to $63 \text{ V}$<br>$U_R = 100 \text{ V}$                                                                                                                                                        | $I_{L5} \leq 0.002 C_R \times U_R + 5 \mu\text{A}$<br>$I_{L5} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$                                                                                                                                                                                                      |
| <b>Inductance</b>                  |                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                               |
| Equivalent series inductance (ESL) | Case $\varnothing D \times L$ mm:                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                               |
|                                    | 4.5 x 10                                                                                                                                                                                                                                | typ. 10 nH                                                                                                                                                                                                                                                                                                    |
|                                    | 6 x 10                                                                                                                                                                                                                                  | typ. 22 nH                                                                                                                                                                                                                                                                                                    |
|                                    | 8 x 11                                                                                                                                                                                                                                  | typ. 85 nH                                                                                                                                                                                                                                                                                                    |
|                                    | 6.5 x 18                                                                                                                                                                                                                                | typ. 25 nH                                                                                                                                                                                                                                                                                                    |
|                                    | 8 x 18                                                                                                                                                                                                                                  | typ. 40 nH                                                                                                                                                                                                                                                                                                    |
|                                    | 10 x 18                                                                                                                                                                                                                                 | typ. 61 nH                                                                                                                                                                                                                                                                                                    |
|                                    | 10 x 25                                                                                                                                                                                                                                 | typ. 38 nH                                                                                                                                                                                                                                                                                                    |
| <b>Resistance</b>                  |                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                               |
| Equivalent series resistance (ESR) | Calculated from $\tan \delta_{max}$ and $C_R$ (see table 2)                                                                                                                                                                             | $ESR = \tan \delta / 2\pi f C_R$                                                                                                                                                                                                                                                                              |

## CAPACITANCE (C)

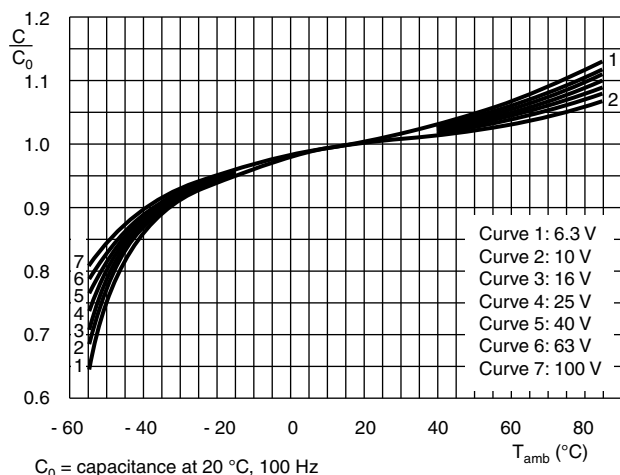


Fig. 4 - Typical multiplier of capacitance as a function of ambient temperature

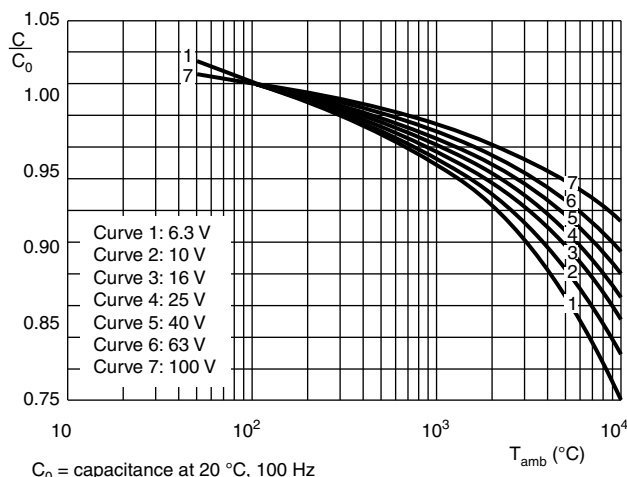


Fig. 5 - Typical multiplier of capacitance as a function of frequency

# EQUIVALENT SERIES RESISTANCE (ESR)

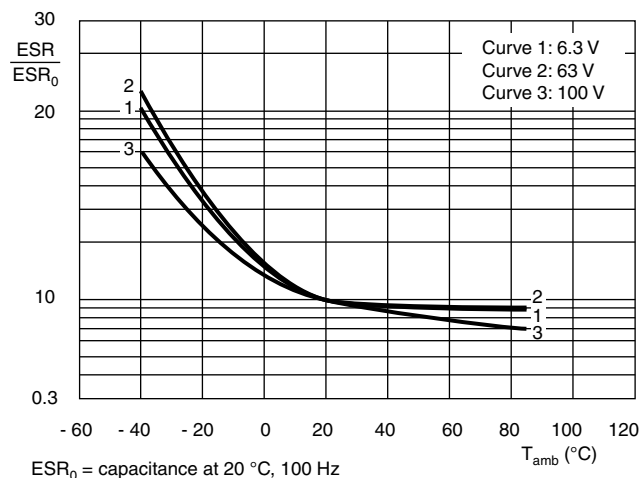


Fig. 6 - Typical multiplier of ESR as a function of ambient temperature

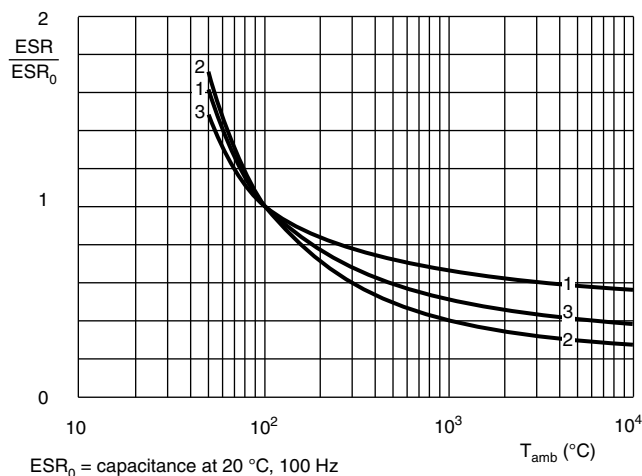


Fig. 7 - Typical multiplier of ESR as a function of frequency

# IMPEDANCE (Z)

Table 3

| $T_{amb}$ | <b>IMPEDANCE VS. CAPACITANCE VALUES AT 10 kHz</b> |        |        |        |       |       |       |
|-----------|---------------------------------------------------|--------|--------|--------|-------|-------|-------|
|           | $Z \times C_R (\Omega \times \mu F)$              |        |        |        |       |       |       |
|           | 6.3 V                                             | 10 V   | 16 V   | 25 V   | 40 V  | 63 V  | 100 V |
| +20 °C    | ≤ 200                                             | ≤ 160  | ≤ 120  | ≤ 90   | ≤ 70  | ≤ 55  | ≤ 45  |
| -25 °C    | ≤ 1200                                            | ≤ 750  | ≤ 560  | ≤ 400  | ≤ 300 | ≤ 180 | ≤ 130 |
| -40 °C    | ≤ 3200                                            | ≤ 2000 | ≤ 1500 | ≤ 1100 | ≤ 900 | ≤ 500 | ≤ 350 |

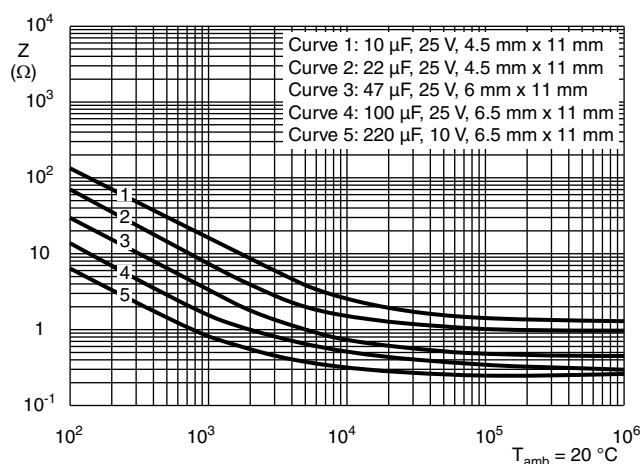


Fig. 8 - Typical impedance as a function of frequency

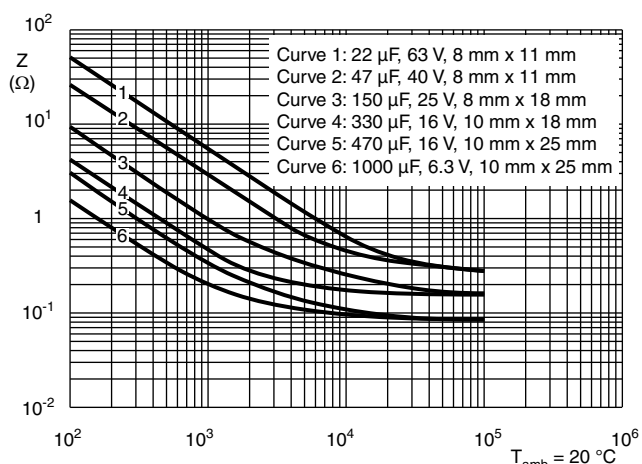


Fig. 9 - Typical impedance as a function of frequency

# RIPPLE CURRENT AND USEFUL LIFE

Table 4

| ENDURANCE TEST DURATION AND USEFUL LIFE |                          |
|-----------------------------------------|--------------------------|
| ENDURANCE AT 85 °C (h)                  | USEFUL LIFE AT 85 °C (h) |
| 2000                                    | 3000                     |

## Note

- Multiplier of useful life code: CCC205

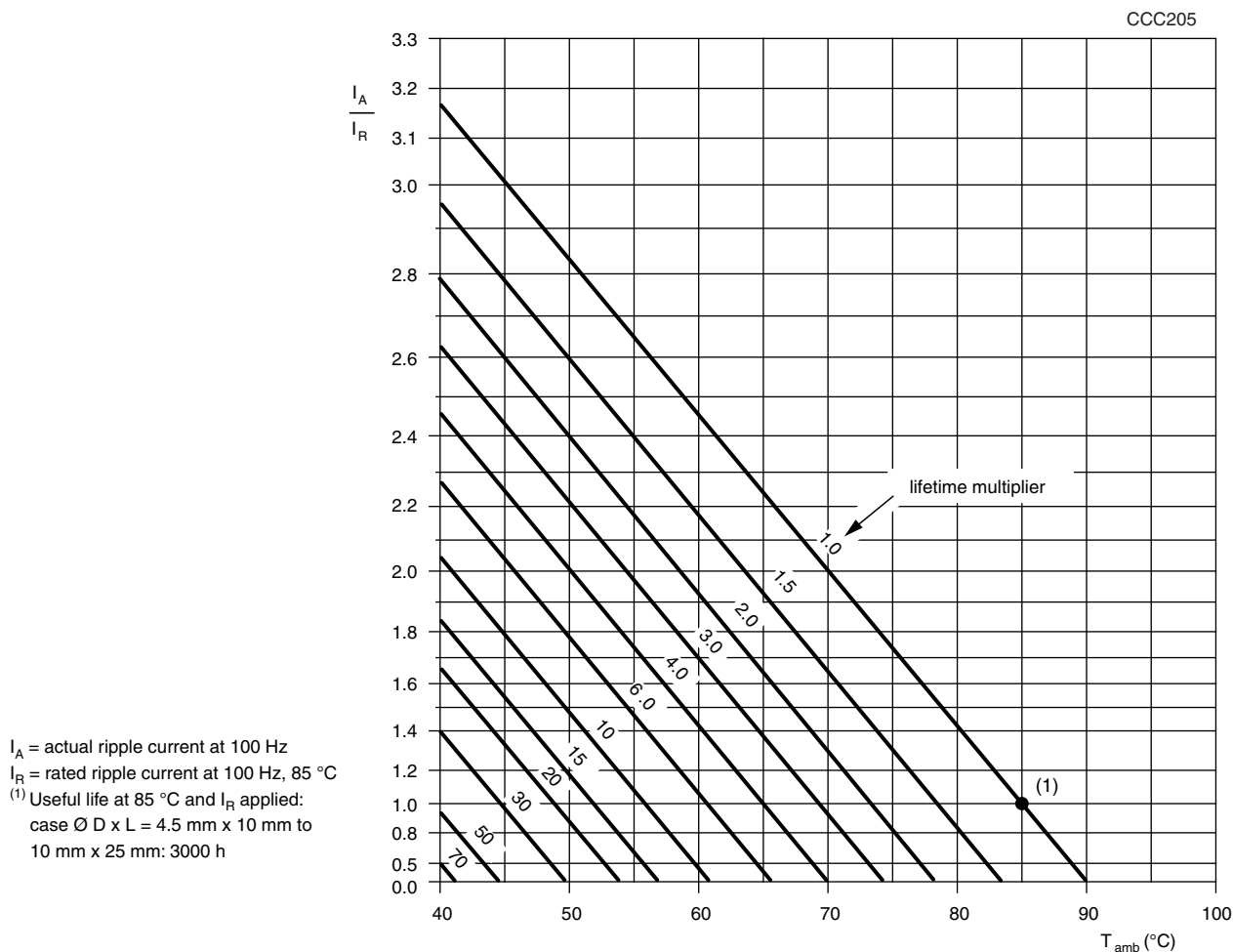


Fig. 10 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 5

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



Table 6

| TEST PROCEDURES AND REQUIREMENTS               |                                           |                                                                                                                                                       |                                                                                                                                                                                                                                      |
|------------------------------------------------|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TEST                                           |                                           | PROCEDURE<br>(quick reference)                                                                                                                        | REQUIREMENTS                                                                                                                                                                                                                         |
| NAME OF TEST                                   | REFERENCE                                 |                                                                                                                                                       |                                                                                                                                                                                                                                      |
| Case Ø D x L = 4.5 mm x 10 mm to 10 mm x 25 mm |                                           |                                                                                                                                                       |                                                                                                                                                                                                                                      |
| Endurance                                      | IEC 384-4 /<br>EN130300<br>subclause 4.13 | T <sub>amb</sub> = 85 °C; U <sub>R</sub> applied;<br>2000 h                                                                                           | U <sub>R</sub> ≤ 6.3 V; ΔC/C: +15 % / -30 %<br>U <sub>R</sub> > 6.3 V; ΔC/C: ± 15 %<br>tan δ ≤ 1.3 x spec. limit<br>Z ≤ 2 x spec. limit<br>I <sub>L</sub> ≤ spec. limit                                                              |
| Useful life                                    | CECC 30301<br>subclause 1.8.1             | T <sub>amb</sub> = 85 °C; U <sub>R</sub> and I <sub>R</sub> applied;<br>3000 h                                                                        | U <sub>R</sub> ≤ 6.3 V; ΔC/C: +45 % / -50 %<br>U <sub>R</sub> > 6.3 V; ΔC/C: ± 45 %<br>tan δ ≤ 3 x spec. limit<br>Z ≤ 3 x spec. limit<br>I <sub>L</sub> ≤ spec. limit<br>no short or open circuit<br>total failure percentage: ≤ 1 % |
| Shelf life<br>(storage at<br>high temperature) | IEC 384-4 /<br>EN130300<br>subclause 4.17 | T <sub>amb</sub> = 85 °C; no voltage applied;<br>500 h<br><br>After test: U <sub>R</sub> to be applied for 30 min,<br>24 h to 48 h before measurement | ΔC/C, tan δ, Z:<br>for requirements<br>see “Endurance test” above<br>I <sub>L</sub> ≤ 2 x spec. limit                                                                                                                                |

Statements about product lifetime are based on calculations and internal testing. They should only be interpreted as estimations. Also due to external factors, the lifetime in the field application may deviate from the calculated lifetime. In general, nothing stated herein shall be construed as a guarantee of durability.





## 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.