

# Aluminum Capacitors

## Axial, Miniature, Long-Life

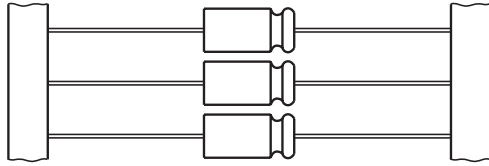
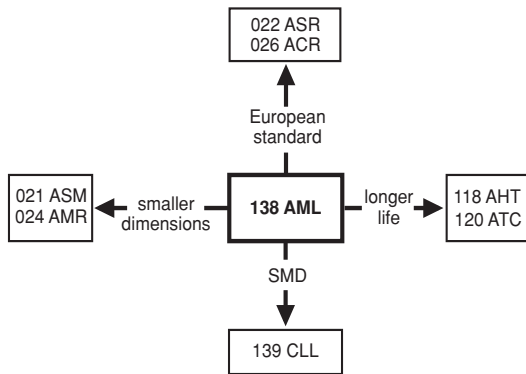


Fig.1 Component outlines



### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte.
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve (case  $\varnothing 6.3 \times 12.7$  and  $7.7 \times 12.7$  mm are moulded with flame retardant plastic material).
- Mounting ring version not available in insulated form.
- Taped versions up to case  $\varnothing 15 \times 30$  mm available for automatic insertion.
- Charge and discharge proof.
- Long useful life: 2000 to 10000 hours at 105 °C, high reliability.
- High ripple current capability.
- Miniaturized, high CV-product per unit volume.

### APPLICATIONS

- Industrial, automotive, EDP and telecommunication
- Smoothing, filtering, buffering in SMPS; coupling, decoupling, timing
- Portable and mobile equipment (small size, low mass)
- Stand-by applications
- Low mounting height boards, vibration and shock resistant.

### MARKING

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

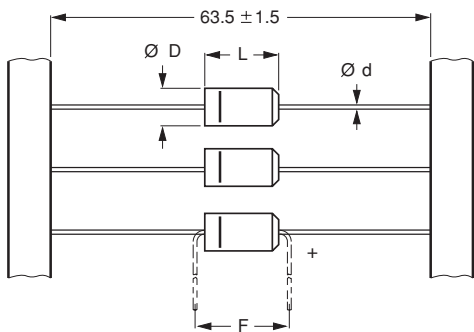
- Rated capacitance (in  $\mu\text{F}$ ).
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for  $\pm 20\%$ ).
- Rated voltage (in V).
- Upper category temperature (105 °C).
- Date code, in accordance with IEC 60062.
- Code for factory of origin.
- Name of manufacturer.
- Band to indicate the negative terminal.
- '+' sign to identify the positive terminal (not for case sizes  $L < 18$  mm).
- Series number (138).

### QUICK REFERENCE DATA

| DESCRIPTION  | VALUE  |  |
|--|--|--|
| Nominal case sizes ( $\varnothing D \times L$ in mm) | 6.3 × 12.7<br>to 10 × 25                     | 10 × 30<br>to 21 × 38                        |
| Rated capacitance range, $C_R$                       | 1.0 to 15000 $\mu\text{F}$                   |  |
| Tolerance on $C_R$                                   | $\pm 20\%$                                   |  |
| Rated voltage range, $U_R$                           | 6.3 to 100 V                                 |  |
| Category temperature range                           | -40 to +105 °C                               |  |
| Endurance test at 105 °C                             | 1000 hours                                   | 5 000 hours                                  |
| Useful life at 105 °C                                | 2000 hours                                   | 10000 hours                                  |
| Useful life at 40 °C, $I_R$ applied                  | $1.3 \times I_R$<br>applied:<br>200000 hours | $1.8 \times I_R$<br>applied:<br>500000 hours |
| Shelf life at 0 V, 105 °C                            | 500 hours                                    | 500 hours                                    |
| Based on sectional specification                     | IEC 60384-4/EN130 300                        |  |
| Climatic category IEC 60068                          | 40/105/56                                    |  |

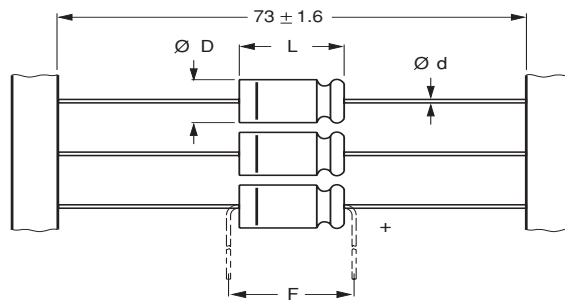
| SELECTION CHART FOR C <sub>R</sub> , U <sub>R</sub> AND RELEVANT NOMINAL CASE SIZES (∅D x L in mm) |                    |            |            |            |            |            |            |                          |
|--|--------------------|------------|------------|------------|------------|------------|------------|--------------------------|
| C <sub>R</sub><br>(μF)   | U <sub>R</sub> (V) |            |            |            |            |            |            |                          |
|  | 6.3                | 10         | 16         | 25         | 40         | 50         | 63         | 100                      |
| 1.0  | -                  | -          | -          | -          | -          | -          | -          | 6.3 x 12.7               |
| 2.2  | -                  | -          | -          | -          | -          | -          | -          | 6.3 x 12.7               |
| 4.7  | -                  | -          | -          | -          | -          | -          | -          | 6.3 x 12.7<br>7.7 x 12.7 |
| 10   | -                  | -          | -          | 6.3 x 12.7 | -          | 6.3 x 12.7 | 7.7 x 12.7 | 6.5 x 18                 |
| 22   | -                  | -          | 6.3 x 12.7 | 6.3 x 12.7 | -          | 7.7 x 12.7 | 6.5 x 18   | 8 x 18                   |
| 33   | -                  | -          | -          | 6.3 x 12.7 | 7.7 x 12.7 | -          | -          | -                        |
| 47   | -                  | -          | 6.3 x 12.7 | 7.7 x 12.7 | 6.5 x 18   | -          | 8 x 18     | 10 x 25                  |
| 68   | -                  | -          | -          | -          | -          | -          | -          | 10 x 30                  |
| 100  | 6.3 x 12.7         | -          | 7.7 x 12.7 | 6.5 x 18   | 8 x 18     | 10 x 18    | 10 x 25    | 12.5 x 30                |
| 150  | -                  | 7.7 x 12.7 | -          | -          | -          | -          | 10 x 30    | 15 x 30                  |
| 220  | 7.7 x 12.7         | 6.5 x 18   | 8 x 18     | 10 x 18    | 10 x 25    | -          | 12.5 x 30  | 15 x 30                  |
| 330  | -                  | -          | -          | -          | 10 x 30    | -          | 12.5 x 30  | 18 x 30                  |
| 470  | 6.5 x 18           | 8 x 18     | 10 x 18    | 10 x 25    | 12.5 x 30  | -          | 15 x 30    | 18 x 38                  |
| 680  | -                  | -          | -          | 10 x 30    | 12.5 x 30  | -          | 18 x 30    | 21 x 38                  |
| 1000   | 10 x 18            | 10 x 25    | 10 x 30    | 12.5 x 30  | 15 x 30    | -          | 18 x 38    | -                        |
| 1500   | -                  | 10 x 30    | 12.5 x 30  | 15 x 30    | 18 x 30    | -          | 21 x 38    | -                        |
| 2200   | 10 x 25            | 12.5 x 30  | 15 x 30    | 18 x 30    | 18 x 38    | -          | -          | -                        |
| 3300   | -                  | 15 x 30    | 18 x 30    | 18 x 38    | 21 x 38    | -          | -          | -                        |
| 4700   | -                  | 18 x 30    | 18 x 30    | 18 x 38    | -          | -          | -          | -                        |
| 6800   | -                  | 18 x 38    | 18 x 38    | 21 x 38    | -          | -          | -          | -                        |
| 10000  | -                  | 18 x 38    | 21 x 38    | -          | -          | -          | -          | -                        |
| 15000  | -                  | 21 x 38    | -          | -          | -          | -          | -          | -                        |

**DIMENSIONS in millimeters AND AVAILABLE FORMS**



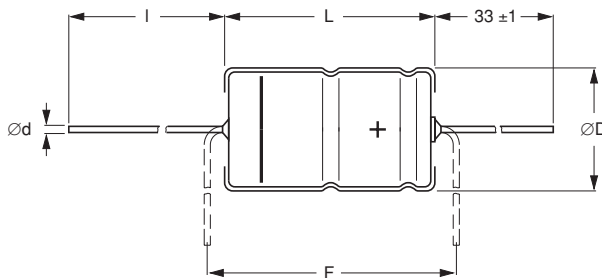
**Form BR:** Taped on reel.  
**Form BA:** Taped in box (ammopack).  
Case ∅D x L = 6.3 x 12.7 and 7.7 x 12.7 mm.

Fig.2 Forms BA and BR.



**Form BR:** Taped on reel,  
case ∅D x L = 6.5 x 18 to 15 x 30 mm.  
**Form BA:** Taped in box (ammopack),  
case ∅D x L = 6.5 x 18 to 10 x 25 mm.

Fig.3 Forms BA and BR.



**Form AA:** Axial in box.  
Case ∅D x L = 10 x 30 to 21 x 38 mm.

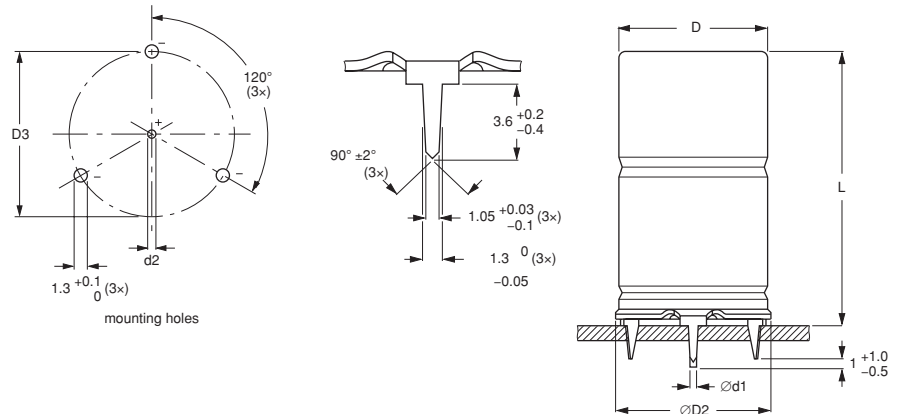
Fig.4 Form AA.

Table 1

| <b>AXIAL; DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b> |           |                            |       |                       |           |           |          |                      |         |         |
|---|-----------|----------------------------|-------|-----------------------|-----------|-----------|----------|----------------------|---------|---------|
| NOMINAL CASE SIZE<br>$\varnothing D \times L$<br>(mm)                         | 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 |
| 6.3 × 12.7  | (2)       | 0.6                        | –     | 6.5                   | 12.9      | 17.5      | ≈1.1     | –                    | 1000    | 1000    |
| 7.7 × 12.7  | (3)       | 0.6                        | –     | 7.9                   | 12.9      | 17.5      | ≈1.3     | –                    | 500     | 500     |
| 6.5 × 18  | 4         | 0.8                        | –     | 6.9                   | 18.5      | 25        | ≈1.3     | –                    | 1000    | 1000    |
| 8 × 18  | 5         | 0.8                        | –     | 8.5                   | 18.5      | 25        | ≈1.7     | –                    | 500     | 500     |
| 10 × 18   | 6         | 0.8                        | –     | 10.5                  | 18.5      | 25        | ≈2.5     | –                    | 500     | 500     |
| 10 × 25   | 7         | 0.8                        | –     | 10.5                  | 25.0      | 30        | ≈3.3     | –                    | 500     | 500     |
| 10 × 30   | 00        | 0.8                        | 55 ±1 | 10.5                  | 30.5      | 35        | ≈4.8     | 340                  | –       | 500     |
| 12.5 × 30   | 01        | 0.8                        | 55 ±1 | 13.0                  | 30.5      | 35        | ≈7.4     | 260                  | –       | 400     |
| 15 × 30   | 02        | 0.8                        | 55 ±1 | 15.5                  | 30.5      | 35        | ≈11.7    | 300                  | –       | 250     |
| 18 × 30   | 03        | 0.8                        | 55 ±1 | 18.5                  | 30.5      | 35        | ≈12.9    | 200                  | –       | –       |
| 18 × 38   | 04        | 0.8                        | 34 ±1 | 18.5                  | 39.0      | 44        | ≈19.0    | 125                  | –       | –       |
| 21 × 38   | 05        | 0.8                        | 34 ±1 | 21.5                  | 39.0      | 44        | ≈24.0    | 100                  | –       | –       |

**Note**

- Detailed tape dimensions see section 'PACKAGING'.

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


**Form MR:** case  $\varnothing D \times L = 15 \times 30$  to  $21 \times 38$  mm.  
 Case not insulated (insulation on request)  
 Especially for applications with severe shocks and vibrations.

Table 2

| <b>MOUNTING RING; DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b> |           |                        |                  |                       |                        |           |           |          |                      |
|---|-----------|------------------------|------------------|-----------------------|------------------------|-----------|-----------|----------|----------------------|
| 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 × 30   | 02        | 0.8                    | 1.0 +0.4         | 15.5                  | 17.5                   | 16.5 ±0.2 | 33        | ≈11.7    | 200                  |
| 18 × 30   | 03        | 0.8                    | 1.0 +0.4         | 18.5                  | 19.5                   | 18.5 ±0.2 | 33        | ≈12.9    | 240                  |
| 18 × 38   | 04        | 0.8                    | 1.0 +0.4         | 18.5                  | 19.5                   | 18.5 ±0.2 | 42        | ≈19.0    | 100                  |
| 21 × 38   | 05        | 0.8                    | 1.0 +0.4         | 21.5                  | 22.5                   | 21.5 ±0.2 | 42        | ≈24.0    | 100                  |



| ELECTRICAL DATA |   |
|-----------------|---|
| SYMBOL          | DESCRIPTION   |
| $C_R$           | rated capacitance at 100 Hz, tolerance $\pm 20\%$   |
| $I_R$           | rated RMS ripple current at 100 Hz, 105 °C  |
| $I_{L5}$        | max. leakage current after 5 minutes at $U_R$   |
| $\tan \delta$   | max. dissipation factor at 100 Hz   |
| ESR             | equivalent series resistance at 100 Hz<br>(calculated from $\tan \delta_{\max}$ and $C_R$ ) |
| Z               | max. impedance at 10 kHz or 100 kHz   |

**ORDERING EXAMPLE**

Electrolytic capacitor 138 series

470  $\mu\text{F}/10\text{ V}$ ;  $\pm 20\%$ Nominal case size:  $\varnothing 8 \times 18\text{ mm}$ ; Form BA

Catalog number: 2222 138 34471.

**Note**

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

Table 3

| ELECTRICAL DATA AND ORDERING INFORMATION |                                      |   |                                   |  |                        |                               |                             |                              |                               |                                |                               |                                |   |
|--|--------------------------------------|---|-----------------------------------|--|------------------------|-------------------------------|-----------------------------|------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|---|
| $U_R$<br>(V)                             | $C_R$<br>100 Hz<br>( $\mu\text{F}$ ) | NOMINAL<br>CASE<br>SIZE<br>$\varnothing D \times L$<br>(mm) | $I_R$<br>100 Hz<br>105 °C<br>(mA) | $I_{L5}$<br>5 min<br>( $\mu\text{A}$ ) | Tan $\delta$<br>100 Hz | ESR<br>100 Hz<br>( $\Omega$ ) | Z<br>10 kHz<br>( $\Omega$ ) | Z<br>100 kHz<br>( $\Omega$ ) | CATALOG NUMBER 2222 138 ..... |                                |                               |                                |   |
|  |                                      |   |                                   |  |                        |                               |                             |                              | IN BOX<br>FORM<br>AA          | TAPED<br>ON REEL<br>FORM<br>BR | TAPED<br>IN BOX<br>FORM<br>BA | MOUNTING<br>RING<br>FORM<br>MR |   |
| 6.3                                      | 100                                  | 6.3 × 12.7  | 99                                | 5.3                                    | 0.24                   | 3.8                           | 3.0                         | 1.8                          | -                             | 23101                          | 33101                         | -                              | - |
|  | 220                                  | 7.7 × 12.7  | 160                               | 6.8                                    | 0.24                   | 1.7                           | 1.4                         | 0.95                         | -                             | 23221                          | 33221                         | -                              | - |
|  | 470                                  | 6.5 × 18  | 250                               | 9.9                                    | 0.24                   | 0.81                          | 0.64                        | 0.5                          | -                             | 23471                          | 33471                         | -                              | - |
|  | 1000                                 | 10 × 18   | 430                               | 17                                     | 0.24                   | 0.38                          | 0.30                        | 0.24                         | -                             | 23102                          | 33102                         | -                              | - |
|  | 2200                                 | 10 × 25   | 640                               | 32                                     | 0.29                   | 0.21                          | 0.18                        | 0.15                         | -                             | 23222                          | 33222                         | -                              | - |
| 10                                       | 150                                  | 7.7 × 12.7  | 140                               | 7.0                                    | 0.2                    | 2.1                           | 1.3                         | 0.95                         | -                             | 24151                          | 34151                         | -                              | - |
|  | 220                                  | 6.5 × 18  | 190                               | 8.4                                    | 0.2                    | 1.4                           | 0.91                        | 0.5                          | -                             | 24221                          | 34221                         | -                              | - |
|  | 470                                  | 8 × 18  | 300                               | 13                                     | 0.2                    | 0.68                          | 0.43                        | 0.35                         | -                             | 24471                          | 34471                         | -                              | - |
|  | 1000                                 | 10 × 25   | 520                               | 24                                     | 0.2                    | 0.32                          | 0.20                        | 0.16                         | -                             | 24102                          | 34102                         | -                              | - |
|  | 1500                                 | 10 × 30   | 670                               | 34                                     | 0.26                   | 0.27                          | 0.20                        | 0.18                         | 14152                         | 24152                          | -                             | -                              |   |
|  | 2200                                 | 12.5 × 30   | 890                               | 48                                     | 0.27                   | 0.19                          | 0.14                        | 0.13                         | 14222                         | 24222                          | -                             | -                              |   |
|  | 3300                                 | 15 × 30   | 1140                              | 70                                     | 0.28                   | 0.135                         | 0.1                         | 0.1                          | 14332                         | 24332                          | -                             | 44332                          |   |
|  | 4700                                 | 18 × 30   | 1450                              | 98                                     | 0.31                   | 0.105                         | 0.083                       | 0.088                        | 14472                         | -                              | -                             | 44472                          |   |
|  | 6800                                 | 18 × 38   | 1880                              | 140                                    | 0.32                   | 0.075                         | 0.056                       | 0.069                        | 14682                         | -                              | -                             | 44682                          |   |
|  | 10000                                | 18 × 38   | 1980                              | 200                                    | 0.37                   | 0.059                         | 0.048                       | 0.065                        | 14103                         | -                              | -                             | 44103                          |   |
| 15000                                    | 21 × 38                              | 2200  | 300                               | 0.51                                   | 0.054                  | 0.044                         | 0.063                       | 14153                        | -                             | -                              | 44153                         |                                |   |
| 16                                       | 22                                   | 6.3 × 12.7  | 58                                | 4.7                                    | 0.12                   | 8.7                           | 7.3                         | 2.7                          | -                             | 25229                          | 35229                         | -                              | - |
|  | 47                                   | 6.3 × 12.7  | 83                                | 5.5                                    | 0.16                   | 5.4                           | 3.4                         | 1.9                          | -                             | 25479                          | 35479                         | -                              | - |
|  | 100                                  | 7.7 × 12.7  | 130                               | 7.2                                    | 0.16                   | 2.5                           | 1.6                         | 1.0                          | -                             | 25101                          | 35101                         | -                              | - |
|  | 220                                  | 8 × 18  | 230                               | 11                                     | 0.16                   | 1.2                           | 0.73                        | 0.35                         | -                             | 25221                          | 35221                         | -                              | - |
|  | 470                                  | 10 × 18   | 360                               | 19                                     | 0.16                   | 0.54                          | 0.34                        | 0.25                         | -                             | 25471                          | 35471                         | -                              | - |
|  | 1000                                 | 10 × 30   | 630                               | 36                                     | 0.19                   | 0.29                          | 0.20                        | 0.18                         | 15102                         | 25102                          | -                             | -                              |   |
|  | 1500                                 | 12.5 × 30   | 860                               | 52                                     | 0.19                   | 0.20                          | 0.14                        | 0.13                         | 15152                         | 25152                          | -                             | -                              |   |
|  | 2200                                 | 15 × 30   | 1090                              | 74                                     | 0.21                   | 0.15                          | 0.105                       | 0.103                        | 15222                         | 25222                          | -                             | 45222                          |   |
|  | 3300                                 | 18 × 30   | 1420                              | 110                                    | 0.23                   | 0.11                          | 0.083                       | 0.088                        | 15332                         | -                              | -                             | 45332                          |   |
|  | 4700                                 | 18 × 30   | 1480                              | 150                                    | 0.28                   | 0.093                         | 0.073                       | 0.082                        | 15472                         | -                              | -                             | 45472                          |   |
| 6800                                     | 18 × 38                              | 1930  | 220                               | 0.28                                   | 0.062                  | 0.048                         | 0.065                       | 15682                        | -                             | -                              | 45682                         |                                |   |
| 10000                                    | 21 × 38                              | 2100  | 320                               | 0.35                                   | 0.055                  | 0.044                         | 0.063                       | 15103                        | -                             | -                              | 45103                         |                                |   |
| 25                                       | 10                                   | 6.3 × 12.7  | 46                                | 4.5                                    | 0.09                   | 14                            | 12                          | 2.8                          | -                             | 26109                          | 36109                         | -                              | - |
|  | 22                                   | 6.3 × 12.7  | 61                                | 5.1                                    | 0.14                   | 10                            | 5.5                         | 2.5                          | -                             | 26229                          | 36229                         | -                              | - |
|  | 33                                   | 6.3 × 12.7  | 74                                | 5.7                                    | 0.14                   | 6.8                           | 3.6                         | 1.9                          | -                             | 26339                          | 36339                         | -                              | - |
|  | 47                                   | 7.7 × 12.7  | 96                                | 6.4                                    | 0.14                   | 4.7                           | 2.6                         | 1.0                          | -                             | 26479                          | 36479                         | -                              | - |



Aluminum Capacitors  
Axial, Miniature, Long-Life

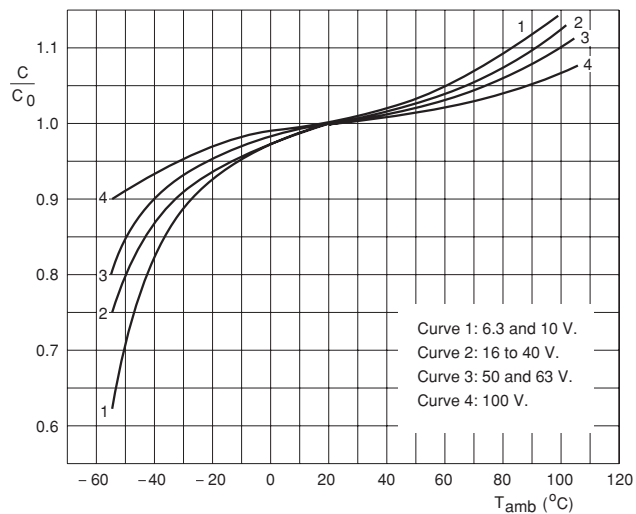
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| ELECTRICAL DATA AND ORDERING INFORMATION |                                  |   |  |                                  |                 |                      |                    |                     |                               |                                |                               |                                |
|--|----------------------------------|---|--|----------------------------------|-----------------|----------------------|--------------------|---------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|
| U <sub>R</sub><br>(V)                    | C <sub>R</sub><br>100 Hz<br>(μF) | NOMINAL<br>CASE<br>SIZE<br>ØD × L<br>(mm) | I <sub>R</sub><br>100 Hz<br>105 °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) | CATALOG NUMBER 2222 138 ..... |                                |                               |                                |
|  |                                  |   |  |                                  |                 |                      |                    |                     | IN BOX<br>FORM<br>AA          | TAPED<br>ON REEL<br>FORM<br>BR | TAPED<br>IN BOX<br>FORM<br>BA | MOUNTING<br>RING<br>FORM<br>MR |
| 25                                       | 100                              | 6.5 × 18                                  | 160  | 9.0                              | 0.13            | 2.1                  | 1.2                | 0.55                | -                             | 26101                          | 36101                         | -                              |
|  | 220                              | 10 × 18                                   | 270  | 15                               | 0.13            | 0.94                 | 0.55               | 0.27                | -                             | 26221                          | 36221                         | -                              |
|  | 470                              | 10 × 25                                   | 440  | 28                               | 0.13            | 0.44                 | 0.26               | 0.17                | -                             | 26471                          | 36471                         | -                              |
|  | 680                              | 10 × 30                                   | 580  | 38                               | 0.14            | 0.32                 | 0.20               | 0.18                | 16681                         | 26681                          | -                             | -                              |
|  | 1000                             | 12.5 × 30                                 | 790  | 54                               | 0.14            | 0.22                 | 0.14               | 0.13                | 16102                         | 26102                          | -                             | -                              |
|  | 1500                             | 15 × 30                                   | 1020                                       | 79                               | 0.15            | 0.16                 | 0.105              | 0.105               | 16152                         | 26152                          | -                             | 46152                          |
|  | 2200                             | 18 × 30                                   | 1320                                       | 110                              | 0.16            | 0.12                 | 0.083              | 0.088               | 16222                         | -                              | -                             | 46222                          |
|  | 3300                             | 18 × 38                                   | 1720                                       | 170                              | 0.17            | 0.08                 | 0.055              | 0.069               | 16332                         | -                              | -                             | 46332                          |
|  | 4700                             | 18 × 38                                   | 1840                                       | 240                              | 0.20            | 0.067                | 0.049              | 0.065               | 16472                         | -                              | -                             | 46472                          |
| 6800                                     | 21 × 38                          | 2100                                      | 340  | 0.26                             | 0.059           | 0.045                | 0.064              | 16682               | -                             | -                              | 46682                         |                                |
| 40                                       | 33                               | 7.7 × 12.7                                | 91   | 6.6                              | 0.11            | 5.3                  | 2.7                | 1.0                 | -                             | 27339                          | 37339                         | -                              |
|  | 47                               | 6.5 × 18                                  | 120  | 7.8                              | 0.10            | 3.4                  | 1.9                | 0.65                | -                             | 27479                          | 37479                         | -                              |
|  | 100                              | 8 × 18                                    | 180  | 12                               | 0.10            | 1.6                  | 0.9                | 0.40                | -                             | 27101                          | 37101                         | -                              |
|  | 220                              | 10 × 25                                   | 350  | 22                               | 0.10            | 0.72                 | 0.41               | 0.20                | -                             | 27221                          | 37221                         | -                              |
|  | 330                              | 10 × 30                                   | 490  | 30                               | 0.10            | 0.45                 | 0.25               | 0.21                | 17331                         | 27331                          | -                             | -                              |
|  | 470                              | 12.5 × 30                                 | 650  | 42                               | 0.10            | 0.33                 | 0.18               | 0.16                | 17471                         | 27471                          | -                             | -                              |
|  | 680                              | 12.5 × 30                                 | 750  | 58                               | 0.11            | 0.25                 | 0.145              | 0.13                | 17681                         | 27681                          | -                             | -                              |
|  | 1000                             | 15 × 30                                   | 970  | 84                               | 0.11            | 0.17                 | 0.105              | 0.097               | 17102                         | 27102                          | -                             | 47102                          |
|  | 1500                             | 18 × 30                                   | 1250                                       | 120                              | 0.12            | 0.13                 | 0.085              | 0.087               | 17152                         | -                              | -                             | 47152                          |
|  | 2200                             | 18 × 38                                   | 1640                                       | 180                              | 0.13            | 0.09                 | 0.055              | 0.070               | 17222                         | -                              | -                             | 47222                          |
|  | 3300                             | 21 × 38                                   | 1810                                       | 270                              | 0.15            | 0.075                | 0.052              | 0.069               | 17332                         | -                              | -                             | 47332                          |
| 50                                       | 10                               | 6.3 × 12.7                                | 51   | 5.0                              | 0.09            | 14                   | 7                  | 2.7                 | -                             | 21109                          | 31109                         | -                              |
|  | 22                               | 7.7 × 12.7                                | 82   | 6.2                              | 0.09            | 6.5                  | 3.2                | 1.1                 | -                             | 21229                          | 31229                         | -                              |
|  | 100                              | 10 × 18                                   | 230  | 14                               | 0.08            | 1.3                  | 0.7                | 0.30                | -                             | 21101                          | 31101                         | -                              |
| 63                                       | 4.7                              | 6.3 × 12.7                                | 35   | 4.6                              | 0.09            | 30                   | 17                 | 5                   | -                             | 28478                          | 38478                         | -                              |
|  | 10                               | 7.7 × 12.7                                | 59   | 5.3                              | 0.08            | 13                   | 8                  | 1.8                 | -                             | 28109                          | 38109                         | -                              |
|  | 22                               | 6.5 × 18                                  | 100  | 6.8                              | 0.07            | 5.1                  | 3.6                | 0.85                | -                             | 28229                          | 38229                         | -                              |
|  | 47                               | 8 × 18                                    | 150  | 9.9                              | 0.07            | 2.4                  | 1.7                | 0.50                | -                             | 28479                          | 38479                         | -                              |
|  | 100                              | 10 × 25                                   | 280  | 17                               | 0.07            | 1.1                  | 0.8                | 0.27                | -                             | 28101                          | 38101                         | -                              |
|  | 150                              | 10 × 30                                   | 410  | 23                               | 0.11            | 0.73                 | 0.41               | 0.31                | 18151                         | 28151                          | -                             | -                              |
|  | 220                              | 12.5 × 30                                 | 560  | 32                               | 0.11            | 0.50                 | 0.28               | 0.22                | 18221                         | 28221                          | -                             | -                              |
|  | 330                              | 12.5 × 30                                 | 660  | 46                               | 0.12            | 0.37                 | 0.22               | 0.18                | 18331                         | 28331                          | -                             | -                              |
|  | 470                              | 15 × 30                                   | 860  | 63                               | 0.12            | 0.26                 | 0.15               | 0.14                | 18471                         | 28471                          | -                             | 48471                          |
|  | 680                              | 18 × 30                                   | 1130                                       | 90                               | 0.12            | 0.19                 | 0.12               | 0.11                | 18681                         | -                              | -                             | 48681                          |
|  | 1000                             | 18 × 38                                   | 1460                                       | 130                              | 0.12            | 0.13                 | 0.08               | 0.09                | 18102                         | -                              | -                             | 48102                          |
| 1500                                     | 21 × 38                          | 1680                                      | 190  | 0.13                             | 0.10            | 0.07                 | 0.08               | 18152               | -                             | -                              | 48152                         |                                |
| 100                                      | 1.0                              | 6.3 × 12.7                                | 16   | 4.2                              | 0.09            | 140                  | 55                 | 10                  | -                             | 29108                          | 39108                         | -                              |
|  | 2.2                              | 6.3 × 12.7                                | 24   | 4.4                              | 0.09            | 65                   | 25                 | 8                   | -                             | 29228                          | 39228                         | -                              |
|  | 4.7                              | 7.7 × 12.7                                | 40   | 4.9                              | 0.08            | 27                   | 17                 | 5                   | -                             | 29478                          | 39478                         | -                              |
|  | 10                               | 6.5 × 18                                  | 67   | 6.0                              | 0.07            | 11                   | 8                  | 2.4                 | -                             | 29109                          | 39109                         | -                              |
|  | 22                               | 8 × 18                                    | 100  | 8.4                              | 0.07            | 5.1                  | 3.6                | 1.4                 | -                             | 29229                          | 39229                         | -                              |
|  | 47                               | 10 × 25                                   | 190  | 13                               | 0.07            | 2.4                  | 1.7                | 0.67                | -                             | 29479                          | 39479                         | -                              |
|  | 68                               | 10 × 30                                   | 300  | 18                               | 0.07            | 1.7                  | 1.1                | 0.97                | 19689                         | 29689                          | -                             | -                              |
|  | 100                              | 12.5 × 30                                 | 410  | 24                               | 0.07            | 1.1                  | 0.77               | 0.67                | 19101                         | 29101                          | -                             | -                              |
|  | 150                              | 15 × 30                                   | 550  | 34                               | 0.07            | 0.78                 | 0.52               | 0.46                | 19151                         | 29151                          | -                             | 49151                          |
|  | 220                              | 15 × 30                                   | 650  | 48                               | 0.07            | 0.54                 | 0.37               | 0.33                | 19221                         | 29221                          | -                             | 49221                          |
|  | 330                              | 18 × 30                                   | 880  | 70                               | 0.08            | 0.38                 | 0.27               | 0.24                | 19331                         | -                              | -                             | 49331                          |
|  | 470                              | 18 × 38                                   | 1130                                       | 98                               | 0.08            | 0.27                 | 0.19               | 0.17                | 19471                         | -                              | -                             | 49471                          |
|  | 680                              | 21 × 38                                   | 1330                                       | 140                              | 0.09            | 0.21                 | 0.14               | 0.14                | 19681                         | -                              | -                             | 49681                          |



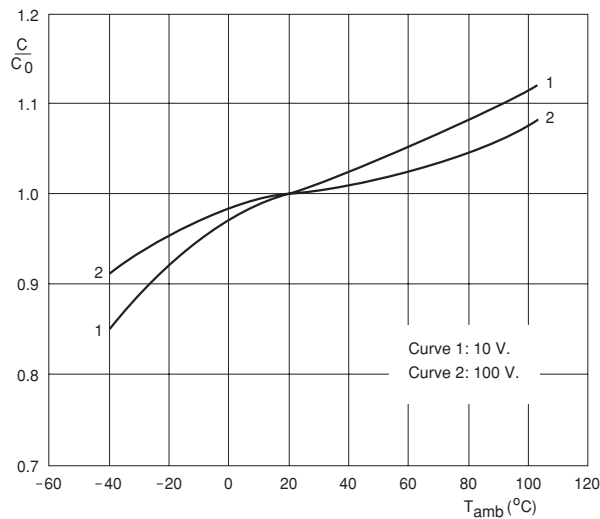
| ADDITIONAL ELECTRICAL DATA         |   |   |               |            |
|------------------------------------|---|---|---------------|------------|
| PARAMETER                          | CONDITIONS  | VALUE   |               |            |
|                                    |   | AXIAL   | MOUNTING RING |            |
| <b>Voltage</b>                     |   |   |               |            |
| Surge voltage                      |   | $U_s \leq 1.15 \times U_R$  |               |            |
| Reverse voltage                    |   | $U_{rev} \leq 1 \text{ V}$  |               |            |
| <b>Current</b>                     |   |   |               |            |
| Leakage current                    | after 1 minute at $U_R$ :<br>case $\varnothing D \times L = 6.3 \times 12.7$ and $7.7 \times 12.7$ mm<br>case $\varnothing D \times L = 6.5 \times 18$ to $21 \times 38$ mm | $I_{L1} \leq 0.02 C_R \times U_R + 3 \mu\text{A}$<br>$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$ |               |            |
|                                    | after 5 minutes at $U_R$  | $I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$  |               |            |
| <b>Inductance</b>                  |   |   |               |            |
| Equivalent series inductance (ESL) | case $\varnothing D \times L$ mm:   |   |               |            |
|                                    |   | 6.3 × 12.7  | typ. 20 nH    | –          |
|                                    |   | 7.7 × 12.7  | typ. 30 nH    | –          |
|                                    |   | 6.5 × 18  | typ. 15 nH    | –          |
|                                    |   | 8 × 18  | typ. 35 nH    | –          |
|                                    |   | 10 × 18   | typ. 69 nH    | –          |
|                                    |   | 10 × 25   | typ. 38 nH    | –          |
|                                    |   | 10 × 30   | typ. 38 nH    | –          |
|                                    |   | 12.5 × 30   | typ. 46 nH    | –          |
|                                    |   | 15 × 30   | typ. 48 nH    | typ. 39 nH |
|                                    | 18 × 30   | typ. 50 nH  | typ. 39 nH    |            |
|                                    | 18 × 38   | typ. 54 nH  | typ. 39 nH    |            |
|                                    | 21 × 38   | typ. 59 nH  | typ. 39 nH    |            |

**CAPACITANCE (C)**



Case  $\varnothing D \times L = 6.3 \times 12.7$  to  $10 \times 25$  mm.  
 $C_0$  = capacitance at 20 °C, 100 Hz.

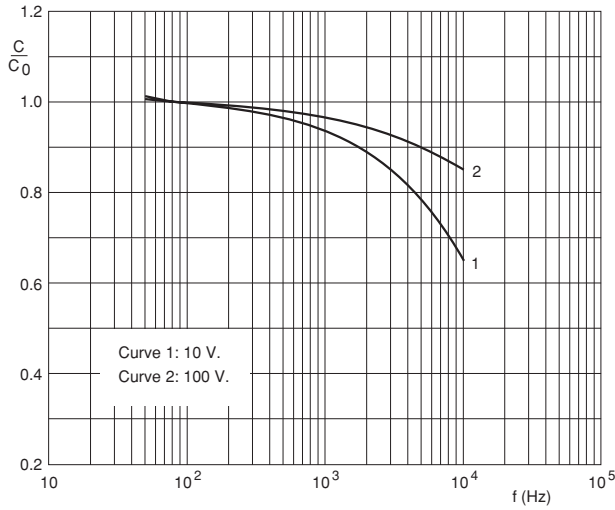
Fig.6 Typical multiplier of capacitance as a function of ambient temperature.



Case  $\varnothing D \times L = 10 \times 30$  to  $21 \times 38$  mm.  
 $C_0$  = capacitance at 20 °C, 100 Hz.

Fig.7 Multiplier of capacitance as a function of ambient temperature.

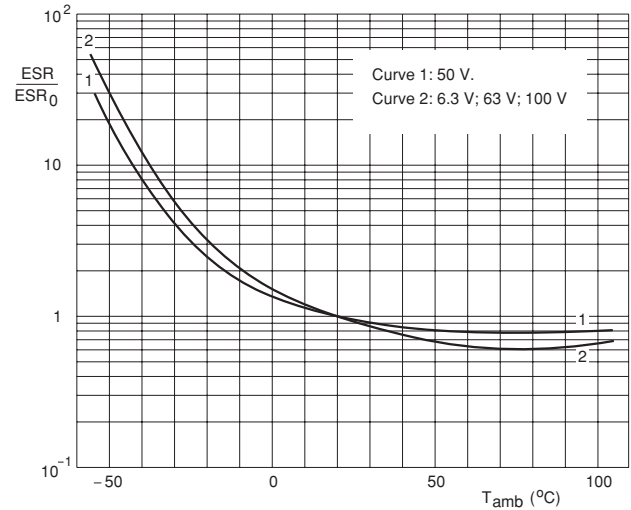
**CAPACITANCE (C)**



$C_0$  = capacitance at 20 °C, 100 Hz.

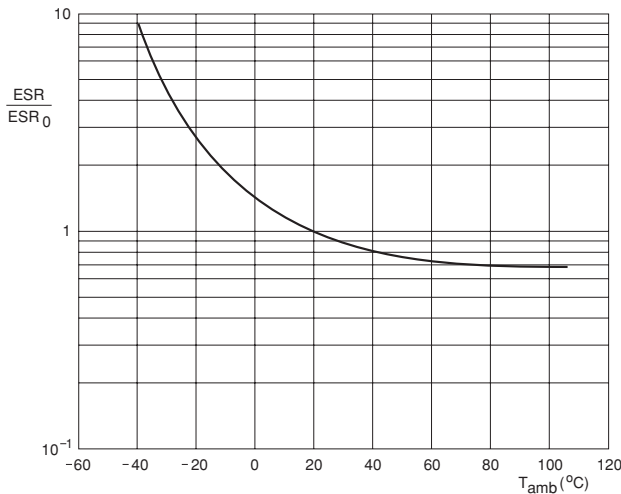
Fig.8 Typical multiplier of capacitance as a function of frequency.

**EQUIVALENT SERIES RESISTANCE (ESR)**



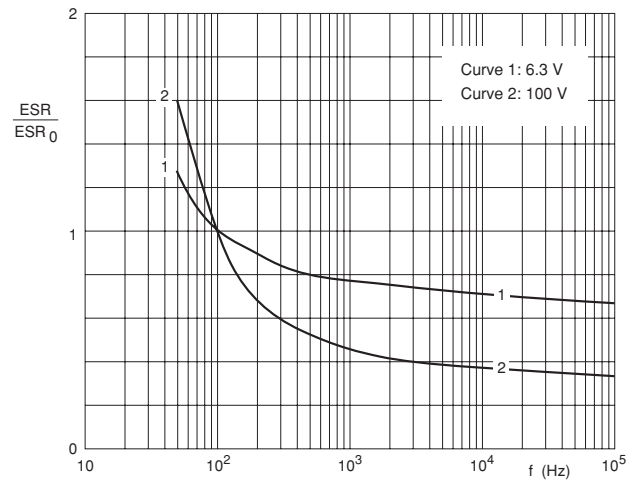
Case  $\varnothing D \times L = 6.3 \times 12.7$  to  $10 \times 25$  mm.  
 $ESR_0$  = typical ESR at 20 °C, 100 Hz.

Fig.9 Typical multiplier of ESR as a function of ambient temperature.



Case  $\varnothing D \times L = 10 \times 30$  to  $21 \times 38$  mm.  
 $ESR_0$  = typical ESR at 20 °C, 100 Hz.

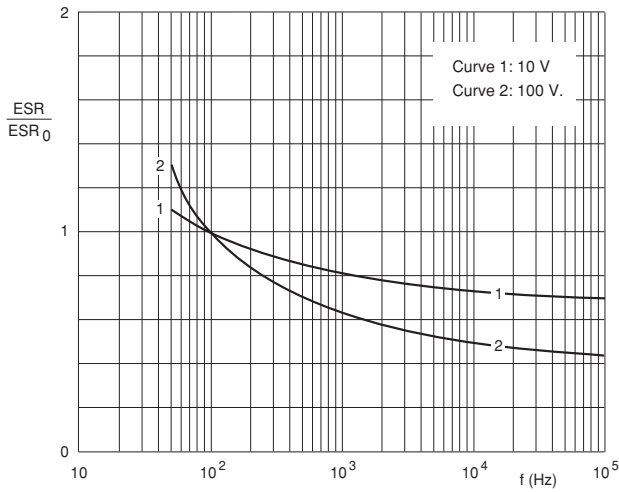
Fig.10 Typical multiplier of ESR as a function of ambient temperature.



Case  $\varnothing D \times L = 6.3 \times 12.7$  to  $10 \times 25$  mm.  
 $ESR_0$  = typical ESR at 20 °C, 100 Hz.

Fig.11 Typical multiplier of ESR as a function of frequency.

**EQUIVALENT SERIES RESISTANCE (ESR)**



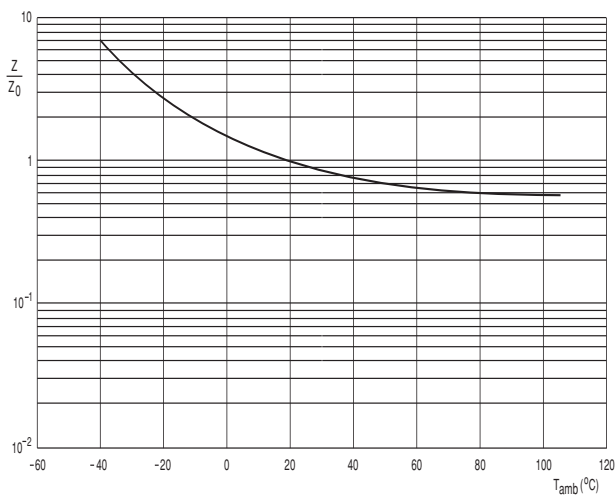
Case  $\varnothing D \times L = 10 \times 30$  to  $21 \times 38$  mm.  
ESR<sub>0</sub> = typical ESR at 20 °C, 100 Hz.

Fig.12 Typical multiplier of ESR as a function of frequency.

**IMPEDANCE (Z)**

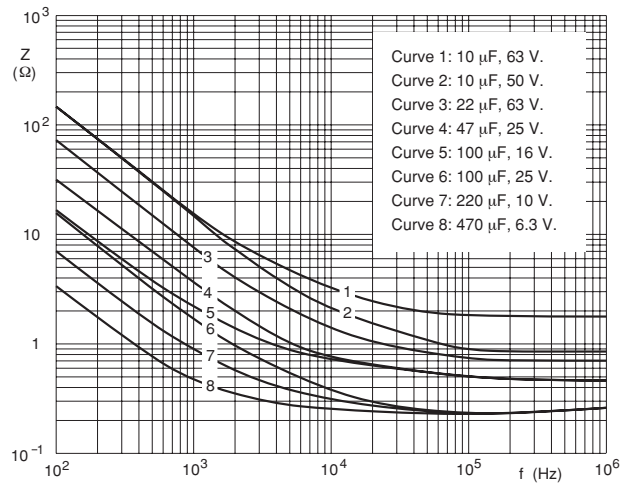
Table 4

| <b>IMPEDANCE x CAPACITANCE VALUES</b> (case $\varnothing D \times L = 6.3 \times 12.7$ to $10 \times 25$ mm) |  |       |       |       |       |      |       |       |
|--|--|-------|-------|-------|-------|------|-------|-------|
| $T_{amb}$  | $Z \times C_R (\Omega \times \mu F)$ at 10 kHz |       |       |       |       |      |       |       |
|  | 6.3 V  | 10 V  | 16 V  | 25 V  | 40 V  | 50 V | 63 V  | 100 V |
| +20 °C   | ≤300   | ≤200  | ≤160  | ≤120  | ≤90   | ≤70  | ≤80   | ≤80   |
| -25 °C   | ≤2000  | ≤1200 | ≤750  | ≤560  | ≤450  | ≤300 | ≤550  | ≤550  |
| -40 °C   | ≤5500  | ≤3200 | ≤2000 | ≤1500 | ≤1200 | ≤900 | ≤1500 | ≤1500 |



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

Fig.13 Typical impedance as a function of ambient temperature at 10 kHz.

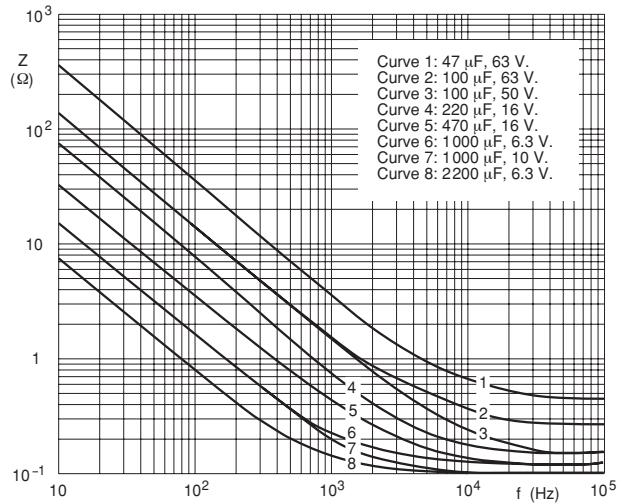


Case  $\varnothing D \times L = 6.3 \times 12.7$  to  $6.5 \times 18$  mm.  $T_{amb} = 20$  °C.

Fig.14 Typical impedance as a function of frequency.

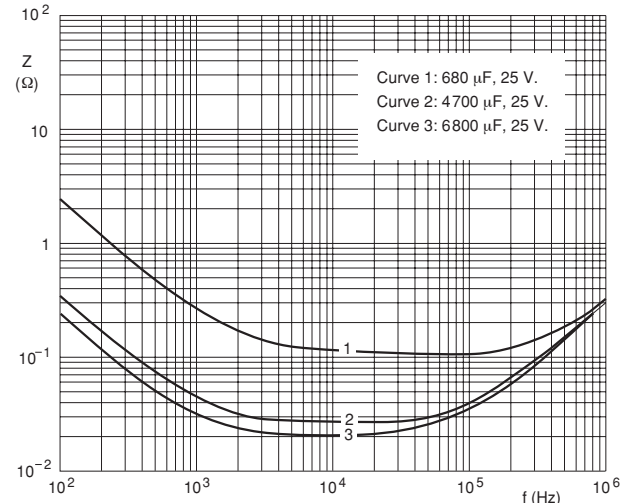


**IMPEDANCE (Z)**



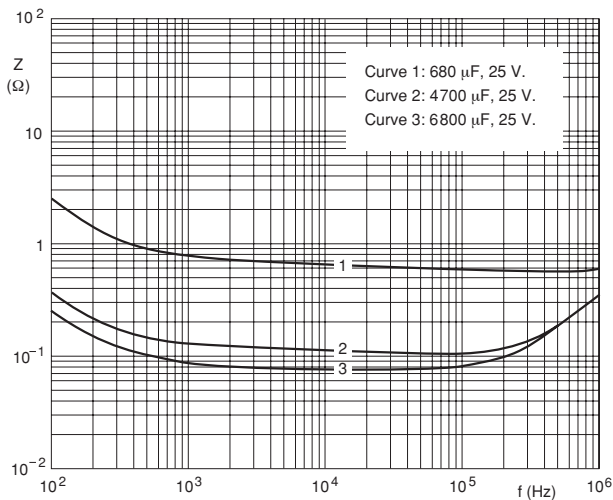
Case  $\text{ØD} \times \text{L} = 8 \times 18$  to  $10 \times 25$  mm.  $T_{\text{amb}} = 20$  °C.

Fig.15 Typical impedance as a function of frequency.



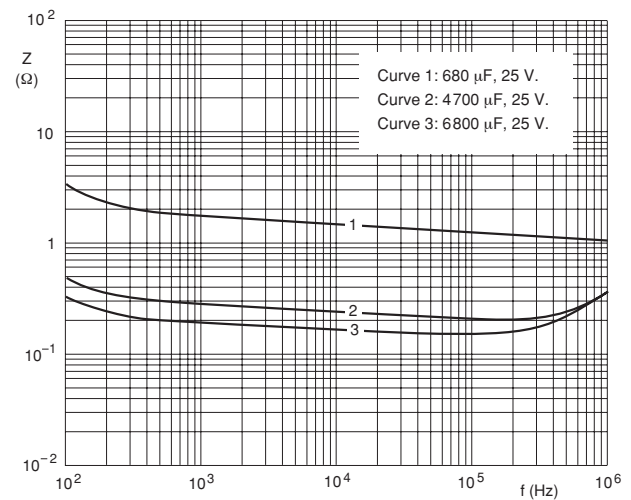
Case  $\text{ØD} \times \text{L} = 10 \times 30$  to  $21 \times 38$  mm.  $T_{\text{amb}} = 20$  °C.

Fig.16 Typical impedance as a function of frequency.



Case  $\text{ØD} \times \text{L} = 10 \times 30$  to  $21 \times 38$  mm.  $T_{\text{amb}} = -25$  °C.

Fig.17 Typical impedance as a function of frequency.



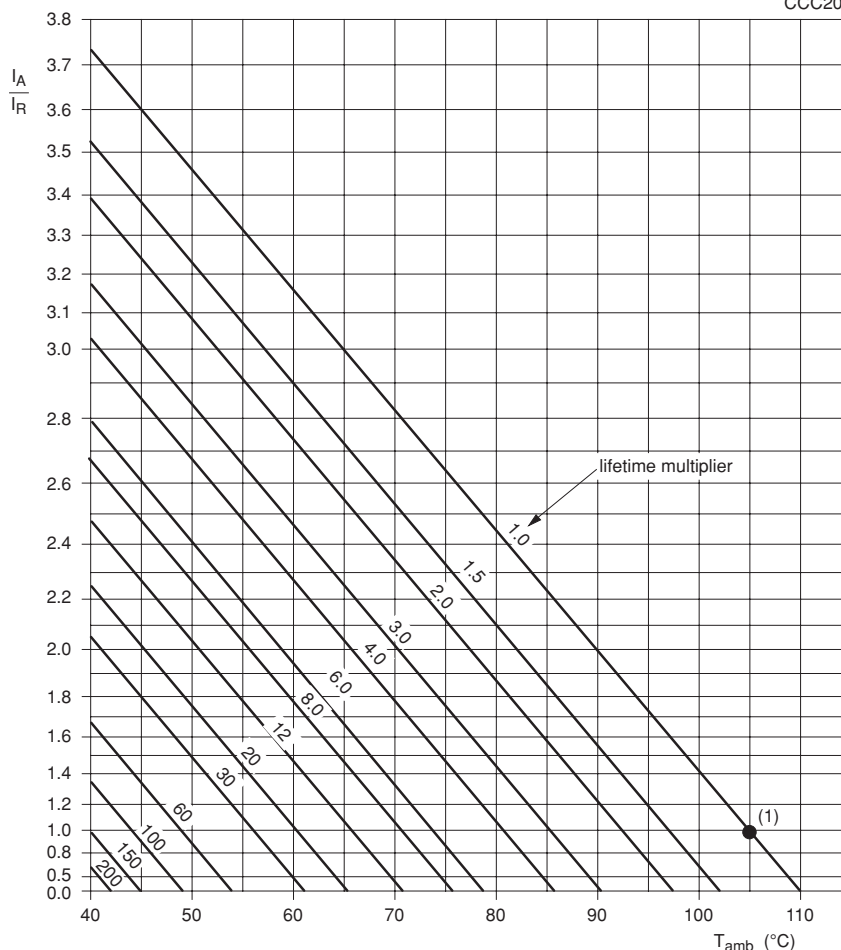
Case  $\text{ØD} \times \text{L} = 10 \times 30$  to  $21 \times 38$  mm.  $T_{\text{amb}} = -40$  °C.

Fig.18 Typical impedance as a function of frequency.



**RIPPLE CURRENT AND USEFUL LIFE**

CCC206



$I_A$  = actual ripple current at 100 Hz.  
 $I_R$  = rated ripple current at 100 Hz, 105 °C.

(1) Useful life at 105 °C and  $I_R$  applied:  
case  $\varnothing D \times L = 6.3 \times 12.7$  to  $10 \times 25$  mm: 2000 hours  
case  $\varnothing D \times L = 10 \times 30$  to  $21 \times 38$  mm: 10000 hours.

Fig.19 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> |                       |                      |                       |
|---|-----------------------|----------------------|-----------------------|
| FREQUENCY<br>(Hz)   | $I_R$ MULTIPLIER      |                      |                       |
|   | $U_R = 6.3$ to $10$ V | $U_R = 16$ to $25$ V | $U_R = 40$ to $100$ V |
| 50  | 0.95                  | 0.90                 | 0.85                  |
| 100   | 1.00                  | 1.00                 | 1.00                  |
| 300   | 1.07                  | 1.12                 | 1.20                  |
| 1000  | 1.12                  | 1.20                 | 1.30                  |
| 3000  | 1.15                  | 1.25                 | 1.35                  |
| $\geq 10000$  | 1.20                  | 1.30                 | 1.40                  |



Table 6

| <b>TEST PROCEDURES AND REQUIREMENTS</b>        |   |  |   |
|--|---|--|---|
| <b>TEST</b>                                    |   | <b>PROCEDURE<br/>(quick reference)</b>   | <b>REQUIREMENTS</b>   |
| <b>NAME OF TEST</b>                            | <b>REFERENCE</b>                            |  |   |
| Endurance                                      | IEC 60384-4/<br>EN130300<br>subclause 4.13  | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ applied;<br>case $\varnothing D \times L$ :<br>6.3 × 12.7 to 10 × 25 mm:<br>1000 hours;<br>10 × 30 to 21 × 38 mm:<br>5000 hours            | $U_R \leq 6.3\text{ V}$ ; $\Delta C/C$ : +15/-30%<br>$U_R > 6.3\text{ V}$ ; $\Delta C/C$ : $\pm 15\%$<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               | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied;<br>case $\varnothing D \times L$ :<br>6.3 × 12.7 to 10 × 25 mm:<br>2000 hours;<br>10 × 30 to 21 × 38 mm:<br>10000 hours | $U_R \leq 6.3\text{ V}$ ; $\Delta C/C$ : +45/-50%<br>$U_R > 6.3\text{ V}$ ; $\Delta C/C$ : $\pm 45\%$<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<br>high temperature) | IEC 60384-4/<br>EN130300,<br>subclause 4.17 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; no voltage applied;<br>500 hours<br><br>after test: $U_R$ to be applied for 30 minutes,<br>24 to 48 hours before measurement                     | $\Delta C/C$ , $\tan \delta$ , $Z$ :<br>for requirements<br>see 'Endurance test' above<br>$I_{L5} \leq 2 \times \text{spec. limit}$   |