

## Aluminum Electrolytic Capacitors Radial Very Low Impedance

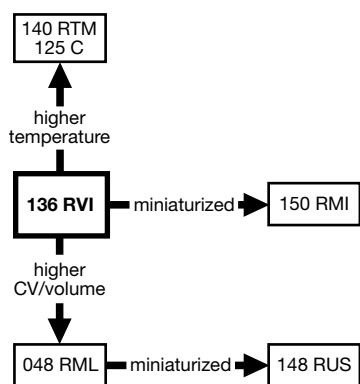


Fig. 1


**RoHS  
COMPLIANT**

### FEATURES

- Very low impedance and low ESR
- Very long useful life:  
4000 h to 10 000 h at 105 °C, very high reliability
- Excellent ripple current capability
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue sleeve
- Charge and discharge proof
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

### APPLICATIONS

- Power supplies (SMPS, DC/DC converters) for general industrial, EDP, audio-video, and telecommunications
- Smoothing, filtering, buffering

### MARKING

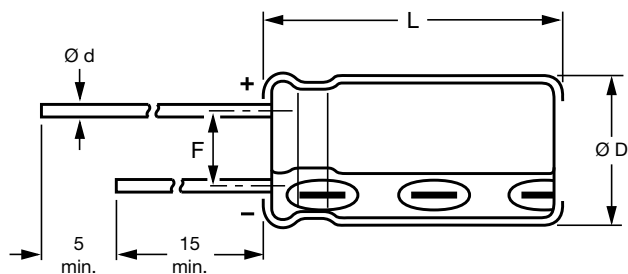
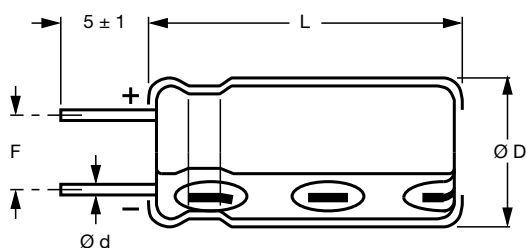
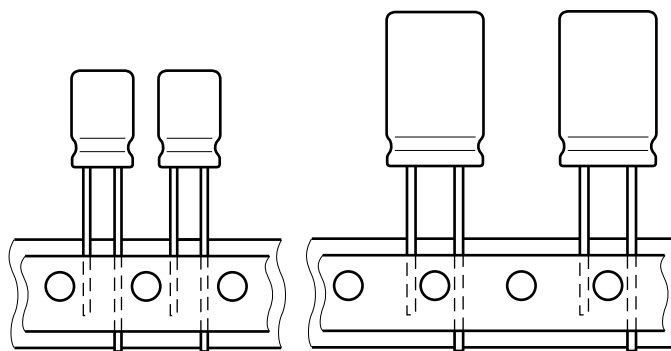
The capacitors are marked (where possible) with the following information:

- Rated capacitance value (in  $\mu\text{F}$ )
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for  $\pm 20\%$ )
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (136)

| QUICK REFERENCE DATA                                 |                                                    |
|------------------------------------------------------|----------------------------------------------------|
| DESCRIPTION                                          | VALUE                                              |
| Nominal case sizes ( $\varnothing D \times L$ in mm) | 10 x 12 to 18 x 35                                 |
| Rated capacitance range, $C_R$                       | 22 $\mu\text{F}$ to 10 000 $\mu\text{F}$           |
| Tolerance on $C_R$                                   | $\pm 20\%$                                         |
| Rated voltage range, $C_R$                           | 10 V to 100 V                                      |
| Category temperature range                           | -55 °C to +105 °C                                  |
| Endurance test at 105 °C                             | 3000 h to 5000 h<br>(dependent on case size)       |
| Useful life at 105 °C                                | 4000 h to 10 000 h<br>(dependent on case size)     |
| Useful life at 40 °C,<br>1.8 x $I_R$ applied         | 200 000 h to 500 000 h<br>(dependent on case size) |
| Shelf life at 0 V, 105 °C                            | 1000 h                                             |
| Based on sectional specification                     | IEC 60384-4 / EN130300                             |
| Climatic category IEC 60068                          | 55 / 105 / 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) |           |           |           |           |           |           |
|----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|                      | 10        | 16        | 25        | 35        | 50        | 63        | 100       |
| 22                   | -         | -         | -         | -         | -         | -         | 10 x 12   |
| 33                   | -         | -         | -         | -         | -         | -         | 10 x 12   |
| 47                   | -         | -         | -         | -         | -         | 10 x 12   | 10 x 16   |
| 56                   | -         | -         | -         | -         | -         | 10 x 12   | -         |
| 68                   | -         | -         | -         | -         | -         | 10 x 16   | 10 x 20   |
| 82                   | -         | -         | -         | -         | 10 x 12   | -         | -         |
| 100                  | -         | -         | -         | -         | 10 x 12   | 10 x 16   | 12.5 x 20 |
| 120                  | -         | -         | -         | 10 x 12   | 10 x 16   | 10 x 20   | -         |
|                      | -         | -         | -         | -         | -         | 12.5 x 16 | -         |
| 150                  | -         | -         | -         | 10 x 12   | 10 x 20   | 10 x 25   | 16 x 20   |
| 180                  | -         | -         | 10 x 12   | -         | 10 x 20   | 10 x 30   | -         |
|                      | -         | -         | -         | -         | 12.5 x 16 | -         | -         |
| 220                  | -         | -         | 10 x 12   | 10 x 16   | 10 x 25   | 12.5 x 20 | 16 x 25   |
| 270                  | -         | 10 x 12   | -         | -         | -         | 12.5 x 25 | -         |
| 330                  | -         | 10 x 12   | 10 x 16   | 10 x 20   | 10 x 30   | 16 x 20   | 16 x 31   |
|                      | -         | -         | -         | 12.5 x 16 | 12.5 x 20 | -         | -         |
| 390                  | 10 x 12   | -         | -         | 10 x 25   | -         | 12.5 x 31 | -         |
| 470                  | 10 x 12   | 10 x 16   | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 16 x 25   | 16 x 35   |
|                      | -         | -         | 12.5 x 16 | -         | -         | -         | 18 x 31   |
| 560                  | -         | -         | 10 x 25   | 10 x 30   | 12.5 x 31 | -         | -         |
|                      | -         | -         | -         | 12.5 x 20 | -         | -         | -         |
| 680                  | 10 x 16   | 10 x 20   | -         | 12.5 x 25 | 16 x 20   | 16 x 31   | 18 x 35   |
|                      | -         | 12.5 x 16 | -         | -         | -         | 18 x 25   | -         |
| 820                  | -         | 10 x 25   | 10 x 30   | -         | 16 x 25   | 16 x 35   | -         |
|                      | -         | -         | 12.5 x 20 | -         | -         | -         | -         |
| 1000                 | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 12.5 x 31 | 16 x 31   | 18 x 31   | -         |
|                      | 12.5 x 16 | -         | -         | 16 x 20   | 18 x 20   | -         | -         |
| 1200                 | 10 x 25   | 10 x 30   | -         | 16 x 25   | 16 x 35   | -         | -         |
|                      | -         | 12.5 x 20 | -         | -         | -         | -         | -         |
| 1500                 | 10 x 30   | 12.5 x 25 | 12.5 x 31 | 16 x 25   | 18 x 31   | 18 x 35   | -         |
|                      | 12.5 x 20 | -         | 16 x 20   | -         | -         | -         | -         |
| 1800                 | 12.5 x 20 | -         | 16 x 25   | 16 x 31   | -         | -         | -         |
| 2200                 | 12.5 x 25 | 12.5 x 31 | 16 x 31   | 16 x 35   | 18 x 35   | -         | -         |
|                      | -         | 16 x 20   | 18 x 20   | 18 x 31   | -         | -         | -         |
| 2700                 | 12.5 x 31 | 16 x 25   | 16 x 31   | -         | -         | -         | -         |
| 3300                 | 16 x 20   | 16 x 25   | 16 x 35   | 18 x 35   | -         | -         | -         |
|                      | -         | -         | 18 x 31   | -         | -         | -         | -         |
| 3900                 | 16 x 25   | 16 x 31   | -         | -         | -         | -         | -         |
| 4700                 | 16 x 31   | 16 x 35   | 18 x 35   | -         | -         | -         | -         |
|                      | -         | 18 x 31   | -         | -         | -         | -         | -         |
| 5600                 | 16 x 31   | -         | -         | -         | -         | -         | -         |
|                      | 18 x 25   | -         | -         | -         | -         | -         | -         |
| 6800                 | 16 x 35   | 18 x 35   | -         | -         | -         | -         | -         |
|                      | 18 x 31   | -         | -         | -         | -         | -         | -         |
| 10 000               | 18 x 35   | -         | -         | -         | -         | -         | -         |

**DIMENSIONS in millimeters AND AVAILABLE FORMS**

Fig. 2 - **Form CA:** Long leads

Fig. 3 - **Form CB:** Cut leads

Fig. 4 - **Form TFA:** Taped in box (ammopack)

**Table 1**

| <b>DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES</b> |              |     |                     |                   |           |             |                      |            |             |
|-----------------------------------------------------------------|--------------|-----|---------------------|-------------------|-----------|-------------|----------------------|------------|-------------|
| NOMINAL<br>CASE SIZE<br>Ø D x L                                 | CASE<br>CODE | Ø d | Ø D <sub>max.</sub> | L <sub>max.</sub> | F         | MASS<br>(g) | PACKAGING QUANTITIES |            |             |
|                                                                 |              |     |                     |                   |           |             | FORM<br>CA           | FORM<br>CB | FORM<br>TFA |
| 10 x 12                                                         | 14           | 0.6 | 10.5                | 13.5              | 5.0 ± 0.5 | ≈ 1.6       | 1000                 | 500        | 800         |
| 10 x 16                                                         | 15           | 0.6 | 10.5                | 17.5              | 5.0 ± 0.5 | ≈ 1.9       | 500                  | 500        | 800         |
| 10 x 20                                                         | 16           | 0.6 | 10.5                | 22.0              | 5.0 ± 0.5 | ≈ 2.2       | 500                  | 500        | 800         |
| 10 x 25                                                         | 16L          | 0.6 | 10.5                | 27.0              | 5.0 ± 0.5 | ≈ 3.0       | 1000                 | 1500       | 800         |
| 10 x 30                                                         | 16LL         | 0.6 | 10.5                | 32.0              | 5.0 ± 0.5 | ≈ 3.5       | 1000                 | 750        | -           |
| 12.5 x 16                                                       | 17a          | 0.6 | 13.0                | 17.5              | 5.0 ± 0.5 | ≈ 2.7       | 1000                 | 1500       | 500         |
| 12.5 x 20                                                       | 17           | 0.6 | 13.0                | 22.0              | 5.0 ± 0.5 | ≈ 4.0       | 500                  | 500        | 500         |
| 12.5 x 25                                                       | 18           | 0.6 | 13.0                | 27.0              | 5.0 ± 0.5 | ≈ 5.0       | 250                  | 250        | 500         |
| 12.5 x 31                                                       | 18L          | 0.6 | 13.0                | 33.5              | 5.0 ± 0.5 | ≈ 5.5       | 1000                 | 750        | -           |
| 16 x 20                                                         | 19a          | 0.8 | 16.5                | 22.0              | 7.5 ± 0.5 | ≈ 6.0       | 250                  | 250        | 250         |
| 16 x 25                                                         | 19           | 0.8 | 16.5                | 27.0              | 7.5 ± 0.5 | ≈ 8.0       | 250                  | 250        | 250         |
| 16 x 31                                                         | 20           | 0.8 | 16.5                | 33.5              | 7.5 ± 0.5 | ≈ 9.0       | 100                  | 100        | 250         |
| 16 x 35                                                         | 21           | 0.8 | 16.5                | 37.5              | 7.5 ± 0.5 | ≈ 11.0      | 100                  | 100        | -           |
| 18 x 20                                                         | 1820         | 0.8 | 18.5                | 22.0              | 7.5 ± 0.5 | ≈ 8.0       | 100                  | 100        | -           |
| 18 x 25                                                         | 1825         | 0.8 | 18.5                | 27.0              | 7.5 ± 0.5 | ≈ 10.0      | 100                  | 100        | -           |
| 18 x 31                                                         | 1831         | 0.8 | 18.5                | 33.5              | 7.5 ± 0.5 | ≈ 12.5      | 100                  | 100        | -           |
| 18 x 35                                                         | 22           | 0.8 | 18.5                | 37.5              | 7.5 ± 0.5 | ≈ 14.5      | 100                  | 100        | -           |

**Note**

- For detailed tape dimensions refer to packaging information: [www.vishay.com/doc?28360](http://www.vishay.com/doc?28360)



| ELECTRICAL DATA |                                                   |
|-----------------|---------------------------------------------------|
| SYMBOL          | DESCRIPTION                                       |
| $C_R$           | Rated capacitance at 100 Hz, tolerance $\pm 20\%$ |
| $I_R$           | Rated RMS ripple current at 100 kHz, 105 °C       |
| $I_{L2}$        | Max. leakage current after 2 min at $U_R$         |
| $\tan \delta$   | Max. dissipation factor at 100 Hz                 |
| $Z$             | Max. impedance at 100 kHz                         |

**Note**

- Unless otherwise specified, all electrical values in Table 2 apply at  $T_{amb} = 20\text{ °C}$ ,  $P = 86\text{ kPa}$  to  $106\text{ kPa}$ ,  $RH = 45\%$  to  $75\%$

**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) | $I_R$<br>100 kHz<br>105 °C<br>(mA) | $I_{L2}$<br>2 min<br>( $\mu\text{A}$ ) | $\tan \delta$<br>100 Hz | $Z$<br>100 kHz<br>+20 °C<br>(m $\Omega$ ) | $Z$<br>100 kHz<br>-10 °C<br>(m $\Omega$ ) | FREQ.<br>CODE <sup>(1)</sup> | ORDERING CODE<br>MAL2136..... |         |          |
|                                          |                                      |                                                          |                                    |                                        |                         |                                           |                                           |                              | BULK PACKAGING                |         | TAPED    |
|                                          |                                      |                                                          |                                    |                                        |                         |                                           |                                           |                              | FORM CA                       | FORM CB | FORM TFA |
| 10                                       | 390                                  | 10 x 12                                                  | 630                                | 39                                     | 0.19                    | 120                                       | 240                                       | MF1                          | 54391E3                       | 64391E3 | 34391E3  |
|                                          | 470                                  | 10 x 12                                                  | 630                                | 47                                     | 0.19                    | 120                                       | 240                                       | MF1                          | 54471E3                       | 64471E3 | 34471E3  |
|                                          | 680                                  | 10 x 16                                                  | 830                                | 68                                     | 0.19                    | 84                                        | 170                                       | MF1                          | 54681E3                       | 64681E3 | 34681E3  |
|                                          | 1000                                 | 10 x 20                                                  | 1000                               | 100                                    | 0.19                    | 62                                        | 130                                       | MF1                          | 54102E3                       | 64102E3 | 34102E3  |
|                                          | 1000                                 | 12.5 x 16                                                | 940                                | 100                                    | 0.19                    | 76                                        | 160                                       | MF1                          | 94105E3                       | 94106E3 | 94103E3  |
|                                          | 1200                                 | 10 x 25                                                  | 1300                               | 120                                    | 0.19                    | 52                                        | 110                                       | MF1                          | 54122E3                       | 64122E3 | 34122E3  |
|                                          | 1500                                 | 10 x 30                                                  | 1400                               | 150                                    | 0.19                    | 44                                        | 88                                        | MF1                          | 94155E3                       | 94156E3 | -        |
|                                          | 1500                                 | 12.5 x 20                                                | 1300                               | 150                                    | 0.19                    | 46                                        | 92                                        | MF1                          | 54152E3                       | 64152E3 | 34152E3  |
|                                          | 1800                                 | 12.5 x 20                                                | 1340                               | 180                                    | 0.19                    | 46                                        | 92                                        | MF1                          | 54182E3                       | 64182E3 | 34182E3  |
|                                          | 2200                                 | 12.5 x 25                                                | 1700                               | 220                                    | 0.21                    | 34                                        | 68                                        | MF1                          | 54222E3                       | 64222E3 | 34222E3  |
|                                          | 2700                                 | 12.5 x 31                                                | 2000                               | 270                                    | 0.21                    | 30                                        | 60                                        | MF1                          | 54272E3                       | 64272E3 | -        |
|                                          | 3300                                 | 16 x 20                                                  | 1600                               | 330                                    | 0.23                    | 38                                        | 76                                        | MF2                          | 54332E3                       | 64332E3 | 34332E3  |
|                                          | 3900                                 | 16 x 25                                                  | 2100                               | 390                                    | 0.23                    | 28                                        | 56                                        | MF2                          | 54392E3                       | 64392E3 | 34392E3  |
|                                          | 4700                                 | 16 x 31                                                  | 2400                               | 470                                    | 0.25                    | 25                                        | 50                                        | MF2                          | 54472E3                       | 64472E3 | 34472E3  |
|                                          | 5600                                 | 16 x 31                                                  | 2400                               | 560                                    | 0.27                    | 25                                        | 50                                        | MF2                          | 54562E3                       | 64562E3 | 34562E3  |
|                                          | 5600                                 | 18 x 25                                                  | 2270                               | 560                                    | 0.27                    | 25                                        | 50                                        | MF2                          | 94565E3                       | 94566E3 | -        |
|                                          | 6800                                 | 16 x 35                                                  | 2600                               | 680                                    | 0.29                    | 22                                        | 44                                        | MF2                          | 54682E3                       | 64682E3 | -        |
|                                          | 6800                                 | 18 x 31                                                  | 2760                               | 680                                    | 0.29                    | 23                                        | 46                                        | MF2                          | 94685E3                       | 94686E3 | -        |
|                                          | 10 000                               | 18 x 35                                                  | 3180                               | 1000                                   | 0.31                    | 21                                        | 42                                        | MF2                          | 54103E3                       | 64103E3 | -        |
| 16                                       | 270                                  | 10 x 12                                                  | 630                                | 43                                     | 0.16                    | 120                                       | 240                                       | MF3                          | 55271E3                       | 65271E3 | 35271E3  |
|                                          | 330                                  | 10 x 12                                                  | 630                                | 53                                     | 0.16                    | 120                                       | 240                                       | MF3                          | 55331E3                       | 65331E3 | 35331E3  |
|                                          | 470                                  | 10 x 16                                                  | 830                                | 75                                     | 0.16                    | 84                                        | 170                                       | MF3                          | 55471E3                       | 65471E3 | 35471E3  |
|                                          | 680                                  | 10 x 20                                                  | 1000                               | 110                                    | 0.16                    | 62                                        | 130                                       | MF3                          | 55681E3                       | 65681E3 | 35681E3  |
|                                          | 680                                  | 12.5 x 16                                                | 940                                | 110                                    | 0.16                    | 76                                        | 160                                       | MF3                          | 95685E3                       | 95686E3 | 95683E3  |
|                                          | 820                                  | 10 x 25                                                  | 1300                               | 130                                    | 0.16                    | 52                                        | 110                                       | MF3                          | 55821E3                       | 65821E3 | 35821E3  |
|                                          | 1000                                 | 12.5 x 20                                                | 1300                               | 160                                    | 0.16                    | 48                                        | 96                                        | MF3                          | 55102E3                       | 65102E3 | 35102E3  |
|                                          | 1200                                 | 10 x 30                                                  | 1400                               | 190                                    | 0.16                    | 44                                        | 88                                        | MF3                          | 95125E3                       | 95126E3 | -        |
|                                          | 1200                                 | 12.5 x 20                                                | 1300                               | 190                                    | 0.16                    | 46                                        | 92                                        | MF3                          | 55122E3                       | 65122E3 | 35122E3  |
|                                          | 1500                                 | 12.5 x 25                                                | 1700                               | 240                                    | 0.16                    | 34                                        | 68                                        | MF3                          | 55152E3                       | 65152E3 | 35152E3  |
|                                          | 2200                                 | 12.5 x 31                                                | 2000                               | 350                                    | 0.18                    | 30                                        | 60                                        | MF3                          | 95225E3                       | 95226E3 | -        |
|                                          | 2200                                 | 16 x 20                                                  | 1600                               | 350                                    | 0.18                    | 38                                        | 76                                        | MF4                          | 55222E3                       | 65222E3 | 35222E3  |
|                                          | 2700                                 | 16 x 25                                                  | 2100                               | 430                                    | 0.18                    | 28                                        | 56                                        | MF4                          | 55272E3                       | 65272E3 | 35272E3  |
|                                          | 3300                                 | 16 x 25                                                  | 2100                               | 530                                    | 0.20                    | 28                                        | 56                                        | MF4                          | 55332E3                       | 65332E3 | 35332E3  |
|                                          | 3900                                 | 16 x 31                                                  | 2400                               | 620                                    | 0.20                    | 25                                        | 50                                        | MF4                          | 55392E3                       | 65392E3 | 35392E3  |
|                                          | 4700                                 | 16 x 35                                                  | 2600                               | 750                                    | 0.22                    | 22                                        | 44                                        | MF4                          | 55472E3                       | 65472E3 | -        |
|                                          | 4700                                 | 18 x 31                                                  | 2560                               | 750                                    | 0.22                    | 23                                        | 46                                        | MF4                          | 95475E3                       | 95476E3 | -        |
|                                          | 6800                                 | 18 x 35                                                  | 3000                               | 1090                                   | 0.24                    | 21                                        | 42                                        | MF4                          | 55682E3                       | 65682E3 | -        |

**ORDERING EXAMPLE**

Electrolytic capacitor 136 series

1000  $\mu\text{F}$  / 25 V;  $\pm 20\%$ Nominal case size:  $\varnothing 12.5\text{ mm} \times 25\text{ mm}$ ; form TFA

Ordering code: MAL2 136 36102 E3

Former 12NC: 2222 136 36102

**ELECTRICAL DATA AND ORDERING INFORMATION**

| U <sub>R</sub><br>(V) | C <sub>R</sub><br>100 Hz<br>(μF) | NOMINAL<br>CASE SIZE<br>Ø D x L<br>(mm) | I <sub>R</sub><br>100 kHz<br>105 °C<br>(mA) | I <sub>L2</sub><br>2 min<br>(μA) | tan δ<br>100 Hz | Z<br>100 kHz<br>+20 °C<br>(mΩ) | Z<br>100 kHz<br>-10 °C<br>(mΩ) | FREQ.<br>CODE <sup>(1)</sup> | ORDERING CODE<br>MAL2136..... |         |          |
|-----------------------|----------------------------------|-----------------------------------------|---------------------------------------------|----------------------------------|-----------------|--------------------------------|--------------------------------|------------------------------|-------------------------------|---------|----------|
|                       |                                  |                                         |                                             |                                  |                 |                                |                                |                              | BULK PACKAGING                |         | TAPED    |
|                       |                                  |                                         |                                             |                                  |                 |                                |                                |                              | FORM CA                       | FORM CB | FORM TFA |
| 25                    | 180                              | 10 x 12                                 | 630                                         | 45                               | 0.14            | 120                            | 240                            | MF3                          | 56181E3                       | 66181E3 | 36181E3  |
|                       | 220                              | 10 x 12                                 | 630                                         | 55                               | 0.14            | 120                            | 240                            | MF3                          | 56221E3                       | 66221E3 | 36221E3  |
|                       | 330                              | 10 x 16                                 | 830                                         | 83                               | 0.14            | 84                             | 170                            | MF3                          | 56331E3                       | 66331E3 | 36331E3  |
|                       | 470                              | 10 x 20                                 | 1000                                        | 120                              | 0.14            | 62                             | 130                            | MF3                          | 56471E3                       | 66471E3 | 36471E3  |
|                       | 470                              | 12.5 x 16                               | 940                                         | 120                              | 0.14            | 76                             | 160                            | MF3                          | 96475E3                       | 96476E3 | 96473E3  |
|                       | 560                              | 10 x 25                                 | 1300                                        | 140                              | 0.14            | 52                             | 110                            | MF3                          | 56561E3                       | 66561E3 | 36561E3  |
|                       | 820                              | 10 x 30                                 | 1400                                        | 210                              | 0.14            | 44                             | 88                             | MF3                          | 96825E3                       | 96826E3 | -        |
|                       | 820                              | 12.5 x 20                               | 1300                                        | 210                              | 0.14            | 46                             | 92                             | MF3                          | 56821E3                       | 66821E3 | 36821E3  |
|                       | 1000                             | 12.5 x 25                               | 1700                                        | 250                              | 0.14            | 34                             | 68                             | MF3                          | 56102E3                       | 66102E3 | 36102E3  |
|                       | 1500                             | 12.5 x 31                               | 2000                                        | 380                              | 0.14            | 30                             | 60                             | MF3                          | 96155E3                       | 96156E3 | -        |
|                       | 1500                             | 16 x 20                                 | 1700                                        | 380                              | 0.14            | 38                             | 76                             | MF4                          | 56152E3                       | 66152E3 | 36152E3  |
|                       | 1800                             | 16 x 25                                 | 2100                                        | 450                              | 0.14            | 28                             | 56                             | MF4                          | 56182E3                       | 66182E3 | 36182E3  |
|                       | 2200                             | 16 x 31                                 | 2400                                        | 550                              | 0.16            | 25                             | 50                             | MF4                          | 56222E3                       | 66222E3 | 36222E3  |
|                       | 2200                             | 18 x 20                                 | 1680                                        | 550                              | 0.16            | 28                             | 56                             | MF4                          | 96225E3                       | 96226E3 | -        |
|                       | 2700                             | 16 x 31                                 | 2400                                        | 680                              | 0.16            | 25                             | 50                             | MF4                          | 56272E3                       | 66272E3 | 36272E3  |
|                       | 3300                             | 16 x 35                                 | 2600                                        | 830                              | 0.18            | 22                             | 44                             | MF4                          | 56332E3                       | 66332E3 | -        |
|                       | 3300                             | 18 x 31                                 | 2490                                        | 830                              | 0.18            | 27                             | 54                             | MF4                          | 96335E3                       | 96336E3 | -        |
|                       | 4700                             | 18 x 35                                 | 3000                                        | 1180                             | 0.20            | 21                             | 42                             | MF4                          | 56472E3                       | 66472E3 | -        |
| 35                    | 120                              | 10 x 12                                 | 630                                         | 42                               | 0.12            | 120                            | 240                            | MF5                          | 50121E3                       | 60121E3 | 30121E3  |
|                       | 150                              | 10 x 12                                 | 630                                         | 53                               | 0.12            | 120                            | 240                            | MF5                          | 50151E3                       | 60151E3 | 30151E3  |
|                       | 220                              | 10 x 16                                 | 830                                         | 77                               | 0.12            | 84                             | 170                            | MF5                          | 50221E3                       | 60221E3 | 30221E3  |
|                       | 330                              | 10 x 20                                 | 1000                                        | 120                              | 0.12            | 62                             | 130                            | MF5                          | 50331E3                       | 60331E3 | 30331E3  |
|                       | 330                              | 12.5 x 16                               | 940                                         | 120                              | 0.12            | 76                             | 160                            | MF5                          | 90335E3                       | 90336E3 | 90333E3  |
|                       | 390                              | 10 x 25                                 | 1300                                        | 140                              | 0.12            | 52                             | 110                            | MF5                          | 50391E3                       | 60391E3 | 30391E3  |
|                       | 470                              | 12.5 x 20                               | 1300                                        | 170                              | 0.12            | 48                             | 96                             | MF5                          | 50471E3                       | 60471E3 | 30471E3  |
|                       | 560                              | 10 x 30                                 | 1400                                        | 200                              | 0.12            | 44                             | 88                             | MF5                          | 90565E3                       | 90566E3 | -        |
|                       | 560                              | 12.5 x 20                               | 1300                                        | 200                              | 0.12            | 46                             | 92                             | MF5                          | 50561E3                       | 60561E3 | 30561E3  |
|                       | 680                              | 12.5 x 25                               | 1700                                        | 240                              | 0.12            | 34                             | 68                             | MF5                          | 50681E3                       | 60681E3 | 30681E3  |
|                       | 1000                             | 12.5 x 31                               | 2000                                        | 350                              | 0.12            | 30                             | 60                             | MF5                          | 90105E3                       | 90106E3 | -        |
|                       | 1000                             | 16 x 20                                 | 1700                                        | 350                              | 0.12            | 38                             | 76                             | MF6                          | 50102E3                       | 60102E3 | 30102E3  |
|                       | 1200                             | 16 x 25                                 | 2100                                        | 420                              | 0.12            | 28                             | 56                             | MF6                          | 50122E3                       | 60122E3 | 30122E3  |
|                       | 1500                             | 16 x 25                                 | 2100                                        | 530                              | 0.12            | 28                             | 56                             | MF6                          | 50152E3                       | 60152E3 | 30152E3  |
|                       | 1800                             | 16 x 31                                 | 2400                                        | 630                              | 0.12            | 25                             | 50                             | MF6                          | 50182E3                       | 60182E3 | 30182E3  |
|                       | 2200                             | 16 x 35                                 | 2600                                        | 770                              | 0.14            | 22                             | 44                             | MF6                          | 50222E3                       | 60222E3 | -        |
|                       | 2200                             | 18 x 31                                 | 2320                                        | 770                              | 0.14            | 27                             | 54                             | MF6                          | 90225E3                       | 90226E3 | -        |
|                       | 3300                             | 18 x 35                                 | 2890                                        | 1160                             | 0.16            | 21                             | 42                             | MF6                          | 50332E3                       | 60332E3 | -        |
| 50                    | 82                               | 10 x 12                                 | 480                                         | 41                               | 0.10            | 200                            | 400                            | MF5                          | 51829E3                       | 61829E3 | 31829E3  |
|                       | 100                              | 10 x 12                                 | 480                                         | 50                               | 0.10            | 200                            | 400                            | MF5                          | 51101E3                       | 61101E3 | 31101E3  |
|                       | 120                              | 10 x 16                                 | 760                                         | 60                               | 0.10            | 100                            | 200                            | MF5                          | 51121E3                       | 61121E3 | 31121E3  |
|                       | 150                              | 10 x 20                                 | 850                                         | 75                               | 0.10            | 90                             | 180                            | MF5                          | 51151E3                       | 61151E3 | 31151E3  |
|                       | 180                              | 10 x 20                                 | 950                                         | 90                               | 0.10            | 75                             | 150                            | MF5                          | 51181E3                       | 61181E3 | 31181E3  |
|                       | 180                              | 12.5 x 16                               | 780                                         | 90                               | 0.10            | 59                             | 120                            | MF5                          | 91185E3                       | 91186E3 | 91183E3  |
|                       | 220                              | 10 x 25                                 | 1200                                        | 110                              | 0.10            | 63                             | 130                            | MF5                          | 51221E3                       | 61221E3 | 31221E3  |
|                       | 330                              | 10 x 30                                 | 1300                                        | 170                              | 0.10            | 54                             | 110                            | MF5                          | 91335E3                       | 91336E3 | -        |
|                       | 330                              | 12.5 x 20                               | 1200                                        | 170                              | 0.10            | 59                             | 120                            | MF5                          | 51331E3                       | 61331E3 | 31331E3  |
|                       | 470                              | 12.5 x 25                               | 1500                                        | 240                              | 0.10            | 44                             | 88                             | MF5                          | 51471E3                       | 61471E3 | 31471E3  |
|                       | 560                              | 12.5 x 31                               | 1700                                        | 280                              | 0.10            | 39                             | 78                             | MF5                          | 51561E3                       | 61561E3 | -        |
|                       | 680                              | 16 x 20                                 | 1400                                        | 340                              | 0.10            | 50                             | 100                            | MF6                          | 51681E3                       | 61681E3 | 31681E3  |
|                       | 820                              | 16 x 25                                 | 1900                                        | 410                              | 0.10            | 34                             | 68                             | MF6                          | 51821E3                       | 61821E3 | 31821E3  |
|                       | 1000                             | 16 x 31                                 | 2200                                        | 500                              | 0.10            | 30                             | 60                             | MF6                          | 51102E3                       | 61102E3 | 31102E3  |
|                       | 1000                             | 18 x 20                                 | 1510                                        | 500                              | 0.10            | 41                             | 82                             | MF6                          | 91105E3                       | 91106E3 | -        |
|                       | 1200                             | 16 x 35                                 | 2300                                        | 600                              | 0.10            | 27                             | 54                             | MF6                          | 51122E3                       | 61122E3 | -        |
|                       | 1500                             | 18 x 31                                 | 2200                                        | 750                              | 0.10            | 31                             | 62                             | MF6                          | 51152E3                       | 61152E3 | -        |
|                       | 2200                             | 18 x 35                                 | 2650                                        | 1100                             | 0.12            | 27                             | 54                             | MF6                          | 51222E3                       | 61222E3 | -        |

**ELECTRICAL DATA AND ORDERING INFORMATION**

| U <sub>R</sub><br>(V) | C <sub>R</sub><br>100 Hz<br>(μF) | NOMINAL<br>CASE SIZE<br>Ø D x L<br>(mm) | I <sub>R</sub><br>100 kHz<br>105 °C<br>(mA) | I <sub>L2</sub><br>2 min<br>(μA) | tan δ<br>100 Hz | Z<br>100 kHz<br>+20 °C<br>(mΩ) | Z<br>100 kHz<br>-10 °C<br>(mΩ) | FREQ.<br>CODE <sup>(1)</sup> | ORDERING CODE<br>MAL2136..... |         |          |
|-----------------------|----------------------------------|-----------------------------------------|---------------------------------------------|----------------------------------|-----------------|--------------------------------|--------------------------------|------------------------------|-------------------------------|---------|----------|
|                       |                                  |                                         |                                             |                                  |                 |                                |                                |                              | BULK PACKAGING                |         | TAPED    |
|                       |                                  |                                         |                                             |                                  |                 |                                |                                |                              | FORM CA                       | FORM CB | FORM TFA |
| 63                    | 47                               | 10 x 12                                 | 380                                         | 30                               | 0.10            | 300                            | 750                            | MF7                          | 58479E3                       | 68479E3 | 38479E3  |
|                       | 56                               | 10 x 12                                 | 420                                         | 35                               | 0.10            | 270                            | 680                            | MF7                          | 58569E3                       | 68569E3 | 38569E3  |
|                       | 68                               | 10 x 16                                 | 520                                         | 43                               | 0.10            | 210                            | 530                            | MF7                          | 58689E3                       | 68689E3 | 38689E3  |
|                       | 100                              | 10 x 16                                 | 580                                         | 63                               | 0.10            | 190                            | 480                            | MF7                          | 58101E3                       | 68101E3 | 38101E3  |
|                       | 120                              | 10 x 20                                 | 650                                         | 76                               | 0.10            | 160                            | 400                            | MF7                          | 58121E3                       | 68121E3 | 38121E3  |
|                       | 120                              | 12.5 x 16                               | 610                                         | 76                               | 0.10            | 180                            | 450                            | MF7                          | 98125E3                       | 98126E3 | 98123E3  |
|                       | 150                              | 10 x 25                                 | 780                                         | 95                               | 0.10            | 130                            | 330                            | MF7                          | 58151E3                       | 68151E3 | 38151E3  |
|                       | 180                              | 10 x 30                                 | 960                                         | 110                              | 0.10            | 100                            | 250                            | MF7                          | 58181E3                       | 68181E3 | -        |
|                       | 220                              | 12.5 x 20                               | 870                                         | 140                              | 0.10            | 110                            | 280                            | MF7                          | 58221E3                       | 68221E3 | 38221E3  |
|                       | 270                              | 12.5 x 25                               | 1200                                        | 170                              | 0.10            | 74                             | 190                            | MF7                          | 58271E3                       | 68271E3 | 38271E3  |
|                       | 330                              | 16 x 20                                 | 1100                                        | 210                              | 0.10            | 85                             | 220                            | MF8                          | 58331E3                       | 68331E3 | 38331E3  |
|                       | 390                              | 12.5 x 31                               | 1300                                        | 250                              | 0.10            | 68                             | 170                            | MF7                          | 58391E3                       | 68391E3 | -        |
|                       | 470                              | 16 x 25                                 | 1500                                        | 300                              | 0.10            | 55                             | 140                            | MF8                          | 58471E3                       | 68471E3 | 38471E3  |
|                       | 680                              | 16 x 31                                 | 1700                                        | 430                              | 0.10            | 46                             | 120                            | MF8                          | 58681E3                       | 68681E3 | 38681E3  |
|                       | 680                              | 18 x 25                                 | 1470                                        | 430                              | 0.10            | 54                             | 108                            | MF8                          | 98685E3                       | 98686E3 | -        |
|                       | 820                              | 16 x 35                                 | 1900                                        | 520                              | 0.10            | 40                             | 100                            | MF8                          | 58821E3                       | 68821E3 | -        |
|                       | 1000                             | 18 x 31                                 | 1950                                        | 630                              | 0.10            | 39                             | 78                             | MF8                          | 58102E3                       | 68102E3 | -        |
|                       | 1500                             | 18 x 35                                 | 2350                                        | 950                              | 0.10            | 33                             | 66                             | MF8                          | 58152E3                       | 68152E3 | -        |
| 100                   | 22                               | 10 x 12                                 | 300                                         | 22                               | 0.07            | 450                            | 2300                           | MF7                          | 59229E3                       | 69229E3 | 39229E3  |
|                       | 33                               | 10 x 12                                 | 320                                         | 33                               | 0.07            | 390                            | 2000                           | MF7                          | 59339E3                       | 69339E3 | 39339E3  |
|                       | 47                               | 10 x 16                                 | 450                                         | 47                               | 0.07            | 320                            | 1600                           | MF7                          | 59479E3                       | 69479E3 | 39479E3  |
|                       | 68                               | 10 x 20                                 | 520                                         | 68                               | 0.07            | 240                            | 1200                           | MF7                          | 59689E3                       | 69689E3 | 39689E3  |
|                       | 100                              | 12.5 x 20                               | 800                                         | 100                              | 0.07            | 150                            | 750                            | MF7                          | 59101E3                       | 69101E3 | 39101E3  |
|                       | 150                              | 16 x 20                                 | 1000                                        | 150                              | 0.07            | 110                            | 550                            | MF8                          | 59151E3                       | 69151E3 | 39151E3  |
|                       | 220                              | 16 x 25                                 | 1300                                        | 220                              | 0.07            | 81                             | 400                            | MF8                          | 59221E3                       | 69221E3 | 39221E3  |
|                       | 330                              | 16 x 31                                 | 1600                                        | 330                              | 0.07            | 58                             | 290                            | MF8                          | 59331E3                       | 69331E3 | 39331E3  |
|                       | 470                              | 16 x 35                                 | 1800                                        | 470                              | 0.07            | 45                             | 230                            | MF8                          | 59471E3                       | 69471E3 | -        |
|                       | 470                              | 18 x 31                                 | 1800                                        | 470                              | 0.07            | 45                             | 230                            | MF8                          | 99475E3                       | 99476E3 | -        |
|                       | 680                              | 18 x 35                                 | 2000                                        | 680                              | 0.07            | 39                             | 200                            | MF8                          | 59681E3                       | 69681E3 | -        |

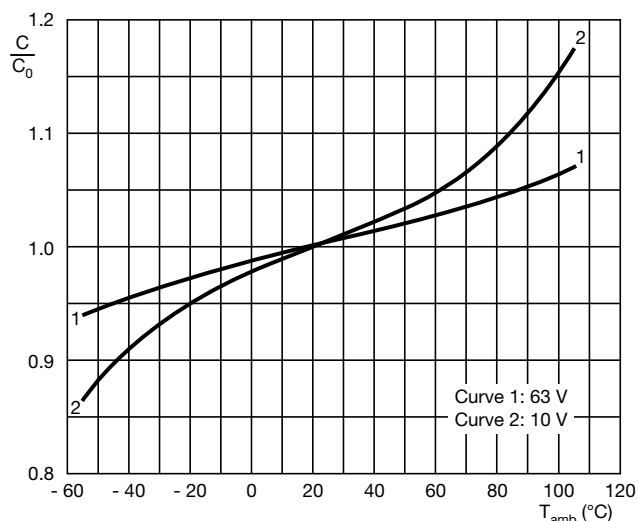
**Note**

<sup>(1)</sup> Determines the applicable row in the table "Multiplier of Ripple Current (I<sub>R</sub>) as a Function of Frequency"

**ADDITIONAL ELECTRICAL DATA**

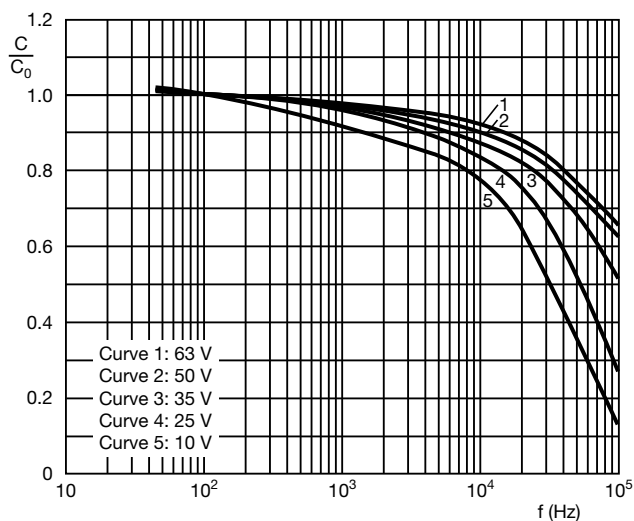
| PARAMETER                          | CONDITIONS                                                             | VALUE                             |
|------------------------------------|------------------------------------------------------------------------|-----------------------------------|
| <b>Voltage</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 2 min at U <sub>R</sub>                                          | $I_{L2} \leq 0.01 C_R \times U_R$ |
| <b>Inductance</b>                  |                                                                        |                                   |
| Equivalent series inductance (ESL) | Case Ø D = 10 mm                                                       | Typ. 16 nH                        |
|                                    | Case Ø D ≥ 12.5 mm                                                     | Typ. 18 nH                        |
| <b>Resistance</b>                  |                                                                        |                                   |
| Equivalent series resistance (ESR) | Calculated from tan δ <sub>max.</sub> and C <sub>R</sub> (see Table 2) | $ESR = \tan \delta / 2 \pi f C_R$ |

## CAPACITANCE (C)



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

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

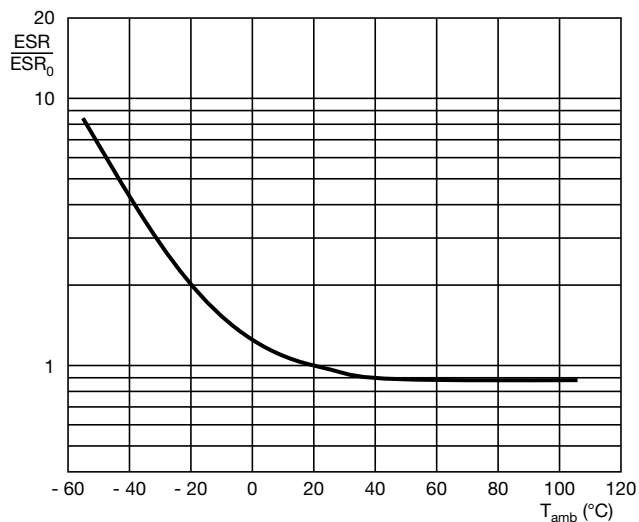


$C_0$  = Typical capacitance at 20 °C, 100 Hz

$T_{amb} = 20\text{ °C}$

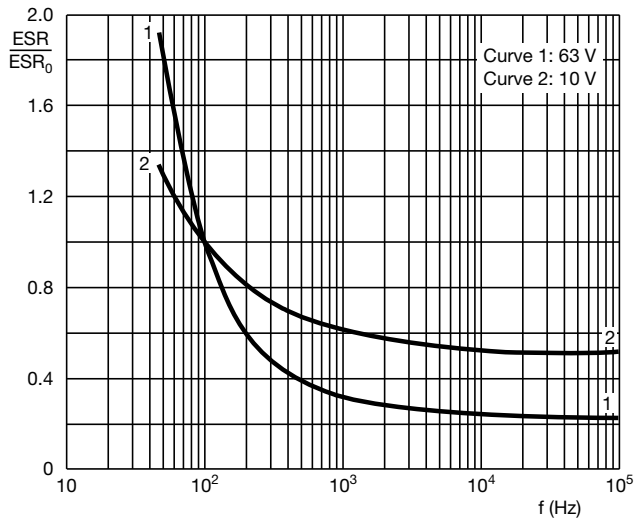
Fig. 6 - Typical multiplier of capacitance as a function of frequency

## EQUIVALENT SERIES RESISTANCE (ESR)



$ESR_0$  = Typical ESR at 20 °C, 100 Hz

Fig. 7 - Typical multiplier of ESR as a function of ambient temperature



$ESR_0$  = Typical ESR at 20 °C, 100 Hz

$T_{amb} = 20\text{ °C}$

Fig. 8 - Typical multiplier of ESR as a function of frequency

## IMPEDANCE (Z)

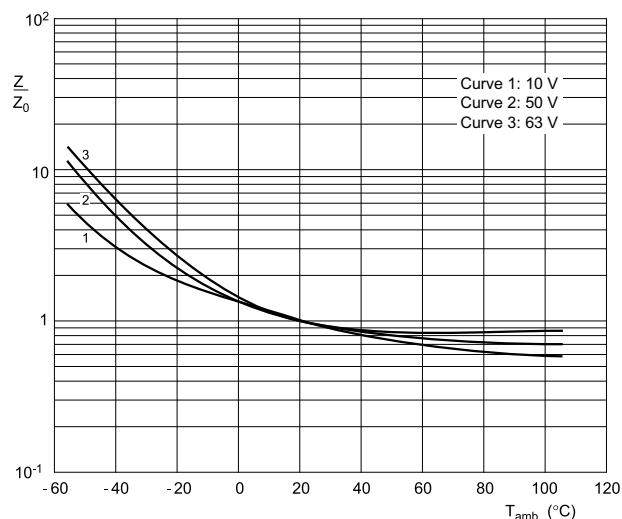


Fig. 9 - Typical multiplier of impedance as a function of ambient temperature

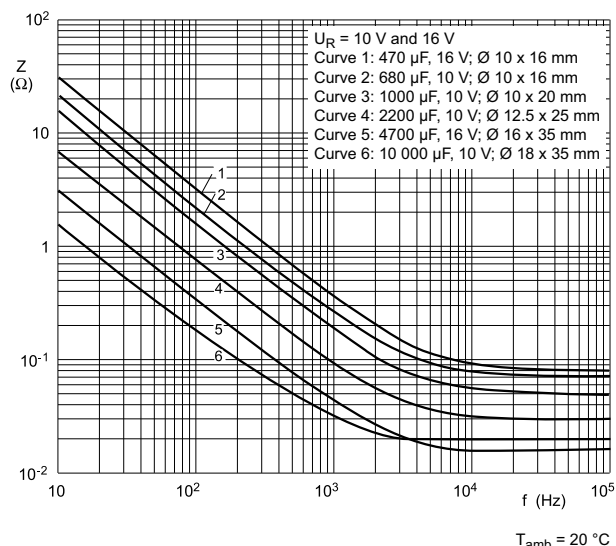


Fig. 10 - Typical impedance as a function of frequency

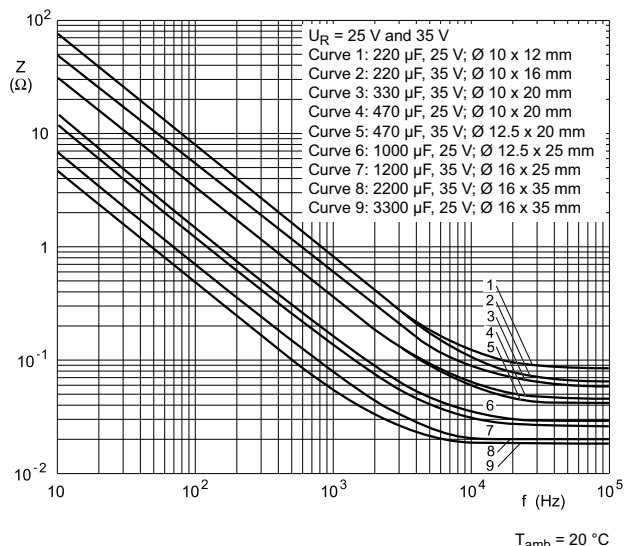


Fig. 11 - Typical impedance as a function of frequency

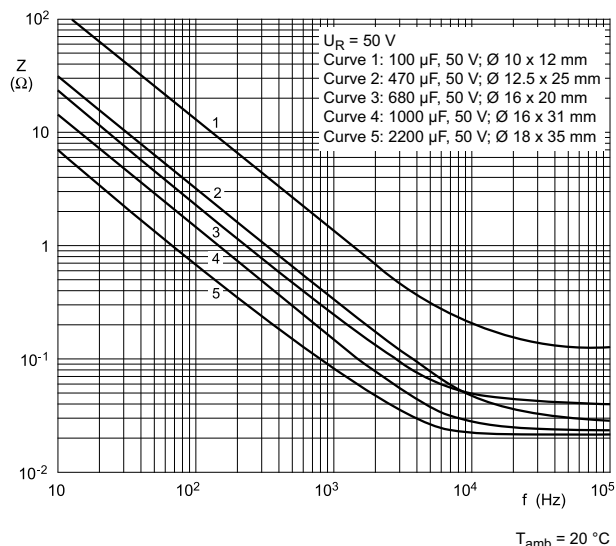


Fig. 12 - Typical impedance as a function of frequency

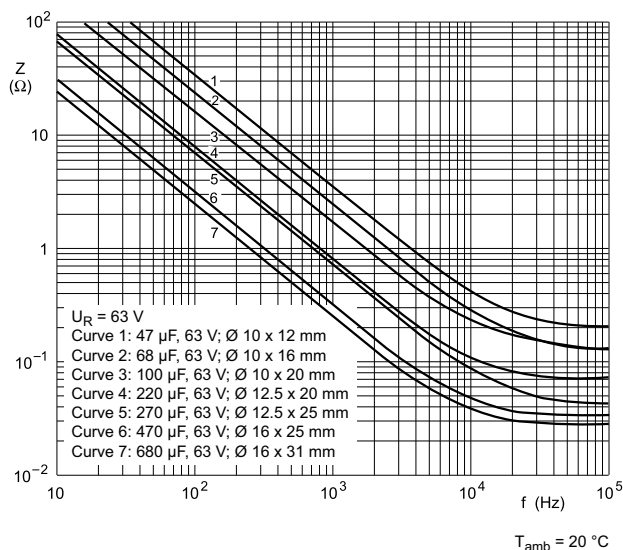


Fig. 13 - Typical impedance as a function of frequency

## RIPPLE CURRENT AND USEFUL LIFE

Table 3

| ENDURANCE TEST DURATION AND USEFUL LIFE |           |                                    |                                 |
|-----------------------------------------|-----------|------------------------------------|---------------------------------|
| NOMINAL CASE SIZE<br>Ø D x L<br>(mm)    | CASE CODE | ENDURANCE TEST<br>AT 105 °C<br>(h) | USEFUL LIFE<br>AT 105 °C<br>(h) |
| 10 x 12                                 | 14        | 3000                               | 4000                            |
| 10 x 16                                 | 15        | 3000                               | 6000                            |
| 10 x 20                                 | 16        | 3000                               | 6000                            |
| 10 x 25                                 | 16L       | 5000                               | 7000                            |
| 10 x 30                                 | 16LL      | 5000                               | 7000                            |
| 12.5 x 16                               | 17a       | 3000                               | 5000                            |
| 12.5 x 20                               | 17        | 3000                               | 7000                            |
| 12.5 x 25                               | 18        | 5000                               | 8000                            |
| 12.5 x 31                               | 18L       | 5000                               | 8000                            |
| 16 x 20                                 | 19a       | 3000                               | 7000                            |
| 16 x 25                                 | 19        | 5000                               | 10 000                          |
| 16 x 31                                 | 20        | 5000                               | 10 000                          |
| 16 x 35                                 | 21        | 5000                               | 10 000                          |
| 18 x 20                                 | 1820      | 3000                               | 7000                            |
| 18 x 25                                 | 1825      | 5000                               | 10 000                          |
| 18 x 31                                 | 1831      | 5000                               | 10 000                          |
| 18 x 35                                 | 22        | 5000                               | 10 000                          |

### Note

- Multiplier of useful life code: CCC206

$I_A$  = Actual ripple current at 100 Hz  
 $I_R$  = Rated ripple current at 100 Hz, 105 °C  
<sup>(1)</sup> Useful life at 105 °C and  $I_R$  applied;  
 see Table 3

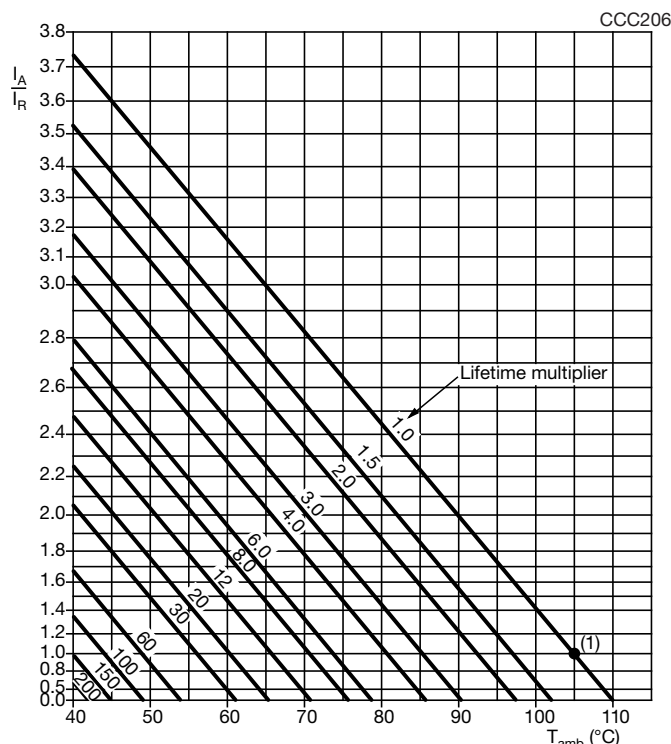


Fig. 14 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |                  |      |      |      |        |        |         |
|-------------------------------------------------------------------|------------------|------|------|------|--------|--------|---------|
| FREQ.<br>CODE                                                     | FREQUENCY (Hz)   |      |      |      |        |        |         |
|                                                                   | 100              | 300  | 1000 | 3000 | 10 000 | 30 000 | 100 000 |
|                                                                   | $I_R$ MULTIPLIER |      |      |      |        |        |         |
| MF1                                                               | 0.70             | 0.80 | 0.88 | 0.92 | 0.96   | 0.99   | 1.00    |
| MF2                                                               | 0.83             | 0.90 | 0.95 | 0.98 | 0.99   | 1.00   | 1.00    |
| MF3                                                               | 0.63             | 0.72 | 0.80 | 0.88 | 0.92   | 0.98   | 1.00    |
| MF4                                                               | 0.69             | 0.79 | 0.87 | 0.92 | 0.96   | 0.99   | 1.00    |
| MF5                                                               | 0.50             | 0.61 | 0.72 | 0.81 | 0.88   | 0.94   | 1.00    |
| MF6                                                               | 0.60             | 0.71 | 0.80 | 0.88 | 0.93   | 0.96   | 1.00    |
| MF7                                                               | 0.35             | 0.51 | 0.66 | 0.76 | 0.85   | 0.92   | 1.00    |
| MF8                                                               | 0.50             | 0.64 | 0.74 | 0.83 | 0.90   | 0.95   | 1.00    |

Table 5

| TEST PROCEDURES AND REQUIREMENTS               |                                          |                                                                                                                                             |                                                                                                                                                                                  |
|------------------------------------------------|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TEST                                           | REFERENCE                                | PROCEDURE<br>(quick reference)                                                                                                              | REQUIREMENTS                                                                                                                                                                     |
| NAME OF TEST                                   |                                          |                                                                                                                                             |                                                                                                                                                                                  |
| Endurance                                      | IEC 60384-4 / EN130300<br>subclause 4.13 | $T_{amb} = 105\text{ °C}$ ; $U_R$ applied;<br>for test duration see Table 3                                                                 | $\Delta C/C: \pm 20\%$<br>$\tan \delta \leq 2 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$                                                                     |
| Useful life                                    | CECC 30301<br>subclause 1.8.1            | $T_{amb} = 105\text{ °C}$ ; $U_R$ and $I_R$ applied;<br>for test duration see Table 3                                                       | $\Delta C/C: \pm 30\%$<br>$\tan \delta \leq 3 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1\%$ |
| Shelf life<br>(storage at high<br>temperature) | IEC 60384-4 / EN130300<br>subclause 4.17 | $T_{amb} = 105\text{ °C}$ ; no voltage applied;<br>1000 h<br>after test: $U_R$ to be applied for 30 min,<br>24 h to 48 h before measurement | $\Delta C/C: \pm 20\%$<br>$\tan \delta \leq 2 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$                                                                     |

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.



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