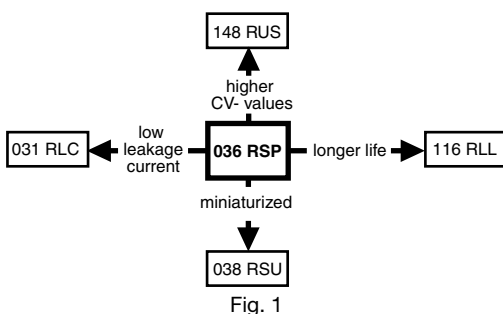
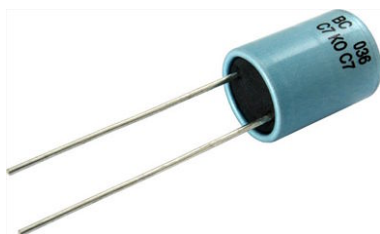


## Aluminum Electrolytic Capacitors Radial Semi-Professional



### QUICK REFERENCE DATA

| DESCRIPTION                                        | VALUE                     |
|----------------------------------------------------|---------------------------|
| Nominal case sizes (Ø D x L in mm)                 | 5 x 11 and 8.2 x 11       |
| Rated capacitance range, C <sub>R</sub>            | 2.2 µF to 470 µF          |
| Tolerance on C <sub>R</sub>                        | ± 20 %; ± 10 % on request |
| Rated voltage range, U <sub>R</sub>                | 6.3 V to 100 V            |
| Category temperature range                         | -55 °C to +85 °C          |
| Endurance test at 85 °C                            | 2000 h                    |
| Useful life at 105 °C                              | 750 h                     |
| Useful life at 85 °C                               | 3000 h                    |
| Useful life at 40 °C, 1.4 x I <sub>R</sub> applied | 80 000 h                  |
| Shelf life at 0 V, 85 °C                           | 500 h                     |
| Based on sectional specification                   | IEC 60384-4 / EN130300    |
| Climatic category IEC 60068                        | 55 / 085 / 56             |

### FEATURES

- Useful life: 3000 h at +85 °C, 750 h at +105 °C
- Reduced leakage current
- Miniaturized, high CV-product per unit volume
- Natural pitch 2.5 mm and 5 mm
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, all-insulated (light blue)
- Charge and discharge proof
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS  
COMPLIANT**

### APPLICATIONS

- Automotive, telecommunication, industrial, EDP, and audio-video
- Coupling, decoupling, smoothing, filtering, buffering, timing
- Portable and mobile equipment (small size, low mass)

### MARKING

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

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Minus-sign on top to identify the negative terminal
- Series number (036)

### SELECTION CHART FOR C<sub>R</sub>, U<sub>R</sub>, AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

| C <sub>R</sub><br>(µF) | U <sub>R</sub> (V) |          |          |          |          |          |          |          |          |
|------------------------|--------------------|----------|----------|----------|----------|----------|----------|----------|----------|
|                        | 6.3                | 10       | 16       | 25       | 35       | 40       | 50       | 63       | 100      |
| 2.2                    | -                  | -        | -        | -        | -        | -        | -        | 5 x 11   | -        |
| 3.3                    | -                  | -        | -        | -        | -        | -        | -        | 5 x 11   | -        |
| 4.7                    | -                  | -        | -        | -        | -        | -        | -        | 5 x 11   | -        |
| 6.8                    | -                  | -        | -        | -        | -        | -        | -        | 5 x 11   | -        |
| 10                     | -                  | -        | -        | -        | -        | -        | 5 x 11   | 5 x 11   | 8.2 x 11 |
|                        | -                  | -        | -        | -        | -        | -        | -        | 8.2 x 11 | -        |
| 15                     | -                  | -        | -        | -        | -        | 5 x 11   | -        | 5 x 11   | -        |
| 22                     | -                  | -        | -        | -        | 5 x 11   | -        | -        | 5 x 11   | 8.2 x 11 |
|                        | -                  | -        | -        | -        | -        | -        | -        | 8.2 x 11 | -        |
| 33                     | -                  | -        | 5 x 11   | -        | -        | -        | 5 x 11   | 8.2 x 11 | -        |
| 47                     | -                  | 5 x 11   | -        | -        | 5 x 11   | -        | 8.2 x 11 | 8.2 x 11 | -        |
| 68                     | -                  | -        | -        | 5 x 11   | -        | 8.2 x 11 | -        | 8.2 x 11 | -        |
| 100                    | 5 x 11             | -        | 5 x 11   | 8.2 x 11 | -        | -        | 8.2 x 11 | -        | -        |
| 150                    | -                  | 5 x 11   | 8.2 x 11 | -        | 8.2 x 11 | -        | -        | -        | -        |
| 220                    | -                  | 8.2 x 11 | 8.2 x 11 | 8.2 x 11 | -        | -        | -        | -        | -        |
| 330                    | 8.2 x 11           | -        | 8.2 x 11 | -        | -        | -        | -        | -        | -        |
| 470                    | -                  | 8.2 x 11 | -        | -        | -        | -        | -        | -        | -        |

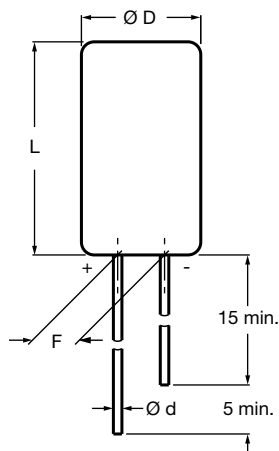
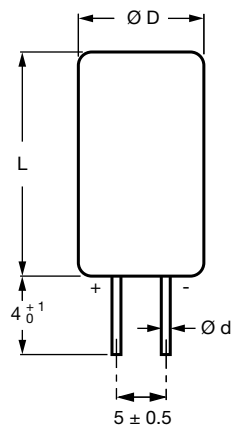
**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**

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

Case  $\varnothing D \times L = 8.2 \text{ mm} \times 11 \text{ mm}$  only

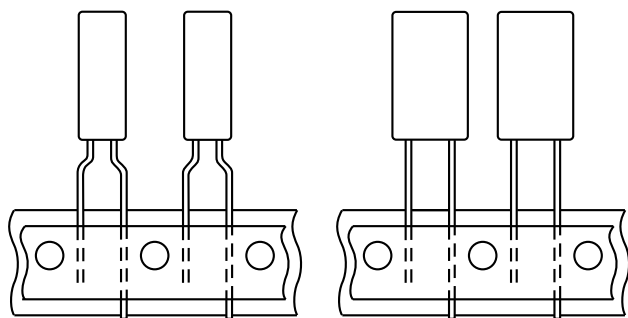
Fig. 3 - **Form CB:** Cut leads

Pitch  $F = 5 \text{ mm}$   
Case  $\varnothing D \times L = 5 \text{ mm} \times 11 \text{ mm}$  and  $8.2 \text{ mm} \times 11 \text{ mm}$ 

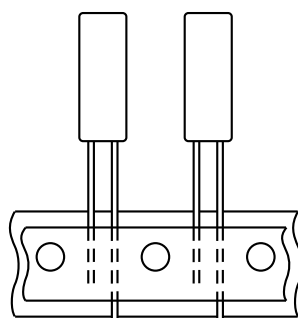
Fig. 4 - **Form TFA:** Taped in box (ammopack)

Pitch  $F = 2.5 \text{ mm}$   
Case  $\varnothing D \times L = 5 \text{ mm} \times 11 \text{ mm}$  only

Fig. 5 - **Form TNA:** Taped in box (ammopack)

**Table 1**

| <b>DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b> |              |                 |                               |                   |               |               |                      |                  |
|------------------------------------------------------------------------|--------------|-----------------|-------------------------------|-------------------|---------------|---------------|----------------------|------------------|
| NOMINAL<br>CASE SIZE<br>$\varnothing D \times L$                       | CASE<br>CODE | $\varnothing d$ | $\varnothing D_{\text{max.}}$ | $L_{\text{max.}}$ | F             | MASS<br>(g)   | PACKAGING QUANTITIES |                  |
|                                                                        |              |                 |                               |                   |               |               | FORM<br>CA, CB       | FORM<br>TFA, TNA |
| 5 x 11                                                                 | 11           | 0.5             | 5.5                           | 12                | $2.5 \pm 0.5$ | $\approx 0.4$ | 1000                 | 2000             |
| 8.2 x 11                                                               | 13           | 0.6             | 8.7                           | 12                | $5.0 \pm 0.5$ | $\approx 1.1$ | 1000                 | 1000             |

**Note**

- For tape dimensions, please see [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 Hz, 85 °C         |
| $I_{L1}$        | Max. leakage current after 1 min at $U_R$         |
| $\tan \delta$   | Max. dissipation factor at 100 Hz                 |
| $Z$             | Max. impedance at 10 kHz and 20 °C                |

**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 <sub>R</sub><br>(V)                    | C <sub>R</sub><br>100 Hz<br>(μF) | NOMINAL<br>CASE<br>SIZE<br>Ø D x L<br>(mm) | I <sub>R</sub><br>100 Hz<br>85 °C<br>(mA) | I <sub>L2</sub><br>2 min<br>(μA) | tan δ<br>100 Hz | Z<br>10 kHz<br>(Ω) | ORDERING CODE MAL2036..... |           |            |           |                |           |             |           |
|                                          |                                  |                                            |                                           |                                  |                 |                    | BULK PACKAGING             |           |            |           | TAPED AMMOPACK |           |             |           |
|                                          |                                  |                                            |                                           |                                  |                 |                    | LONG LEADS                 |           | CUT LEADS  |           |                |           |             |           |
|                                          |                                  |                                            |                                           |                                  |                 |                    | FORM<br>CA                 | F<br>(mm) | FORM<br>CB | F<br>(mm) | FORM<br>TFA    | F<br>(mm) | FORM<br>TNA | F<br>(mm) |
| 6.3                                      | 100                              | 5 x 11                                     | 130                                       | 7                                | 0.20            | 1.7                | 53101E3                    | 2.5       | -          | -         | 33101E3        | 5.0       | 73101E3     | 2.5       |
|                                          | 330                              | 8.2 x 11                                   | 300                                       | 16                               | 0.20            | 0.52               | 53331E3                    | 5.0       | 63331E3    | 5.0       | 33331E3        | 5.0       | -           | -         |
| 10                                       | 47                               | 5 x 11                                     | 95                                        | 6                                | 0.16            | 2.8                | 54479E3                    | 2.5       | -          | -         | 34479E3        | 5.0       | 74479E3     | 2.5       |
|                                          | 150                              | 5 x 11                                     | 150                                       | 12                               | 0.20            | 1.3                | 54151E3                    | 2.5       | -          | -         | 34151E3        | 5.0       | 74151E3     | 2.5       |
|                                          | 220                              | 8.2 x 11                                   | 260                                       | 17                               | 0.16            | 0.59               | 54221E3                    | 5.0       | 64221E3    | 5.0       | 34221E3        | 5.0       | -           | -         |
|                                          | 470                              | 8.2 x 11                                   | 400                                       | 31                               | 0.20            | 0.43               | 54471E3                    | 5.0       | 64471E3    | 5.0       | 34471E3        | 5.0       | -           | -         |
| 16                                       | 33                               | 5 x 11                                     | 90                                        | 7                                | 0.14            | 2.7                | 55339E3                    | 2.5       | -          | -         | 35339E3        | 5.0       | 75339E3     | 2.5       |
|                                          | 100                              | 5 x 11                                     | 160                                       | 13                               | 0.16            | 1.6                | 55101E3                    | 2.5       | -          | -         | 35101E3        | 5.0       | 75101E3     | 2.5       |
|                                          | 150                              | 8.2 x 11                                   | 230                                       | 18                               | 0.14            | 0.6                | 55151E3                    | 5.0       | 65151E3    | 5.0       | 35151E3        | 5.0       | -           | -         |
|                                          | 220                              | 8.2 x 11                                   | 280                                       | 24                               | 0.16            | 0.55               | 55221E3                    | 5.0       | 65221E3    | 5.0       | 35221E3        | 5.0       | -           | -         |
|                                          | 330                              | 8.2 x 11                                   | 390                                       | 35                               | 0.16            | 0.48               | 55331E3                    | 5.0       | 65331E3    | 5.0       | 35331E3        | 5.0       | -           | -         |
| 25                                       | 68                               | 5 x 11                                     | 140                                       | 13                               | 0.14            | 1.8                | 56689E3                    | 2.5       | -          | -         | 36689E3        | 5.0       | 76689E3     | 2.5       |
|                                          | 100                              | 8.2 x 11                                   | 210                                       | 18                               | 0.12            | 0.7                | 56101E3                    | 5.0       | 66101E3    | 5.0       | 36101E3        | 5.0       | -           | -         |
|                                          | 220                              | 8.2 x 11                                   | 310                                       | 36                               | 0.14            | 0.55               | 56221E3                    | 5.0       | 66221E3    | 5.0       | 36221E3        | 5.0       | -           | -         |
| 35                                       | 22                               | 5 x 11                                     | 87                                        | 8                                | 0.10            | 2.7                | 90001E3                    | 2.5       | -          | -         | 90027E3        | 5.0       | 90389E3     | 2.5       |
|                                          | 47                               | 5 x 11                                     | 130                                       | 13                               | 0.12            | 1.9                | 90094E3                    | 2.5       | -          | -         | 90098E3        | 5.0       | 90391E3     | 2.5       |
|                                          | 150                              | 8.2 x 11                                   | 270                                       | 35                               | 0.12            | 0.6                | 90099E3                    | 5.0       | 90101E3    | 5.0       | 90103E3        | 5.0       | -           | -         |
| 40                                       | 15                               | 5 x 11                                     | 72                                        | 7                                | 0.10            | 3.7                | 57159E3                    | 2.5       | -          | -         | 37159E3        | 5.0       | 77159E3     | 2.5       |
|                                          | 68                               | 8.2 x 11                                   | 180                                       | 20                               | 0.10            | 0.81               | 57689E3                    | 5.0       | 67689E3    | 5.0       | 37689E3        | 5.0       | -           | -         |
| 50                                       | 10                               | 5 x 11                                     | 60                                        | 6                                | 0.08            | 4.5                | 90004E3                    | 2.5       | -          | -         | 90028E3        | 5.0       | 90392E3     | 2.5       |
|                                          | 33                               | 5 x 11                                     | 110                                       | 13                               | 0.10            | 2.1                | 90104E3                    | 2.5       | -          | -         | 90108E3        | 5.0       | 90393E3     | 2.5       |
|                                          | 47                               | 8.2 x 11                                   | 160                                       | 18                               | 0.08            | 0.96               | 90011E3                    | 5.0       | 90012E3    | 5.0       | 90031E3        | 5.0       | -           | -         |
|                                          | 100                              | 8.2 x 11                                   | 250                                       | 33                               | 0.10            | 0.7                | 90109E3                    | 5.0       | 90111E3    | 5.0       | 90113E3        | 5.0       | -           | -         |
| 63                                       | 2.2                              | 5 x 11                                     | 25                                        | 4                                | 0.06            | 18                 | 58228E3                    | 2.5       | -          | -         | 38228E3        | 5.0       | 78228E3     | 2.5       |
|                                          | 3.3                              | 5 x 11                                     | 38                                        | 5                                | 0.06            | 12                 | 58338E3                    | 2.5       | -          | -         | 38338E3        | 5.0       | 78338E3     | 2.5       |
|                                          | 4.7                              | 5 x 11                                     | 45                                        | 5                                | 0.06            | 8.5                | 58478E3                    | 2.5       | -          | -         | 38478E3        | 5.0       | 78478E3     | 2.5       |
|                                          | 6.8                              | 5 x 11                                     | 55                                        | 6                                | 0.06            | 5.9                | 58688E3                    | 2.5       | -          | -         | 38688E3        | 5.0       | 78688E3     | 2.5       |
|                                          | 10                               | 5 x 11                                     | 70                                        | 7                                | 0.06            | 4.0                | 58109E3                    | 2.5       | -          | -         | 38109E3        | 5.0       | 78109E3     | 2.5       |
|                                          | 10                               | 8.2 x 11                                   | 120                                       | 7                                | 0.04            | 2.8                | 90036E3                    | 5.0       | 90041E3    | 5.0       | 90181E3        | 5.0       | -           | -         |
|                                          | 15                               | 5 x 11                                     | 80                                        | 9                                | 0.07            | 3.1                | 58159E3                    | 2.5       | -          | -         | 38159E3        | 5.0       | 78159E3     | 2.5       |
|                                          | 22                               | 5 x 11                                     | 100                                       | 11                               | 0.08            | 2.7                | 58229E3                    | 2.5       | -          | -         | 38229E3        | 5.0       | 78229E3     | 2.5       |
|                                          | 22                               | 8.2 x 11                                   | 150                                       | 11                               | 0.05            | 1.4                | 90117E3                    | 5.0       | 90118E3    | 5.0       | 90139E3        | 5.0       | -           | -         |
|                                          | 33                               | 8.2 x 11                                   | 160                                       | 16                               | 0.06            | 1.2                | 58339E3                    | 5.0       | 68339E3    | 5.0       | 38339E3        | 5.0       | -           | -         |
|                                          | 47                               | 8.2 x 11                                   | 190                                       | 21                               | 0.07            | 1.0                | 58479E3                    | 5.0       | 68479E3    | 5.0       | 38479E3        | 5.0       | -           | -         |
|                                          | 68                               | 8.2 x 11                                   | 210                                       | 29                               | 0.08            | 0.88               | 58689E3                    | 5.0       | 68689E3    | 5.0       | 38689E3        | 5.0       | -           | -         |
| 100                                      | 10                               | 8.2 x 11                                   | 80                                        | 9                                | 0.06            | 3.5                | 59109E3                    | 5.0       | 69109E3    | 5.0       | 39109E3        | 5.0       | -           | -         |
|                                          | 22                               | 8.2 x 11                                   | 110                                       | 16                               | 0.06            | 1.8                | 59229E3                    | 5.0       | 69229E3    | 5.0       | 39229E3        | 5.0       | -           | -         |

**ORDERING EXAMPLE**

Electrolytic capacitor 036 series

100  $\mu\text{F}$  / 16 V;  $\pm 20\%$ Nominal case size:  $\varnothing 5 \times 11\text{ mm}$ ; Form TFA

Ordering code: MAL203635101E3

Former 12NC: 2222 036 35101

| ADDITIONAL ELECTRICAL DATA         |                                                             |                                              |
|------------------------------------|-------------------------------------------------------------|----------------------------------------------|
| PARAMETER                          | CONDITIONS                                                  | VALUE                                        |
| <b>Voltage</b>                     |                                                             |                                              |
| Surge voltage                      |                                                             | $U_s \leq 1.15 U_R$                          |
| Reverse voltage                    |                                                             | $U_{rev} \leq 1 V$                           |
| <b>Current</b>                     |                                                             |                                              |
| Leakage current                    | After 1 min<br>$U_R = 6.3 V$ to $100 V$                     | $I_{L1} \leq 0.006 C_R \times U_R + 3 \mu A$ |
|                                    | After 5 min<br>$U_R = 6.3 V$ to $100 V$                     | $I_{L5} \leq 0.001 C_R \times U_R + 3 \mu A$ |
| <b>Inductance</b>                  |                                                             |                                              |
| Equivalent series inductance (ESL) | Case $\varnothing D \times L = 5 mm \times 11 mm$           | Typ. 13 nH                                   |
|                                    | Case $\varnothing D \times L = 8.2 mm \times 11 mm$         | Typ. 16 nH                                   |
| <b>Resistance</b>                  |                                                             |                                              |
| Equivalent series resistance (ESR) | Calculated from $\tan \delta_{max}$ and $C_R$ (see Table 2) | $ESR = \tan \delta / 2 \pi f C_R$            |

### CAPACITANCE (C)

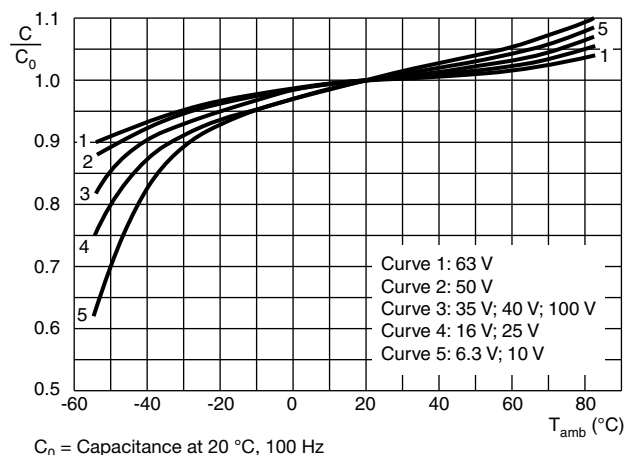


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

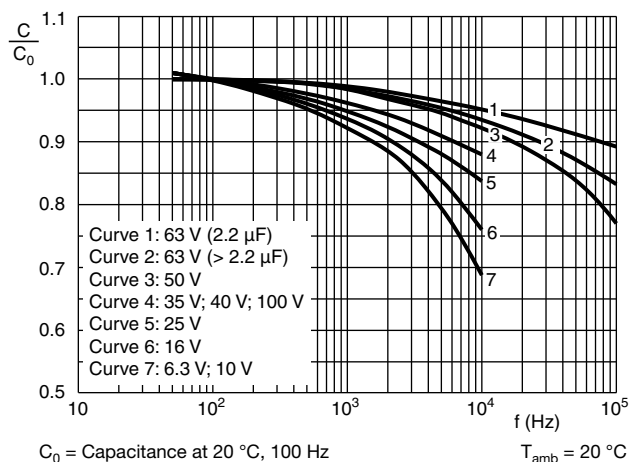


Fig. 7 - Typical multiplier of capacitance as a function of ambient temperature

### IMPEDANCE (Z)

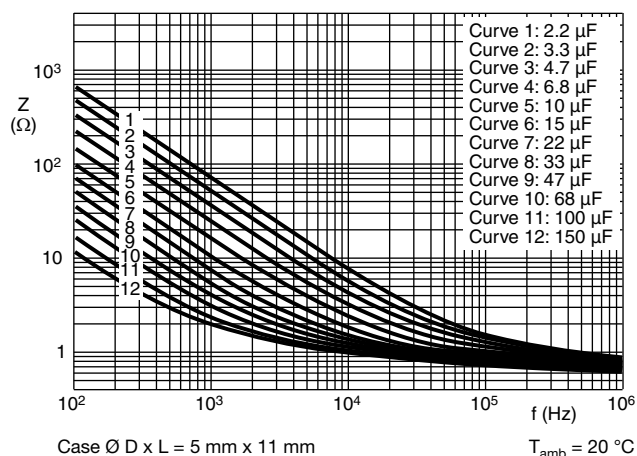


Fig. 8 - Typical impedance as a function of frequency

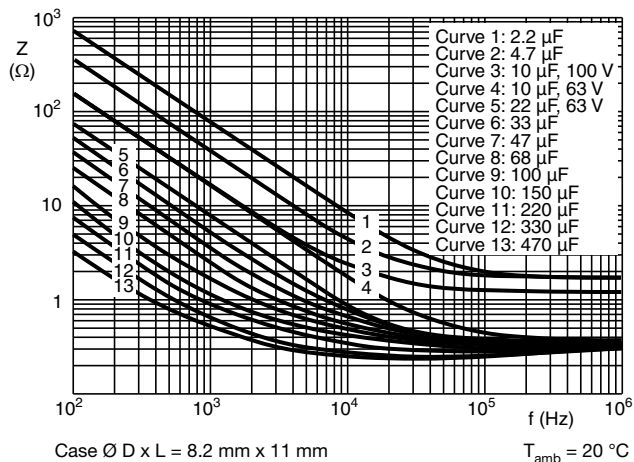


Fig. 9 - Typical impedance as a function of frequency

## RIPPLE CURRENT AND USEFUL LIFE

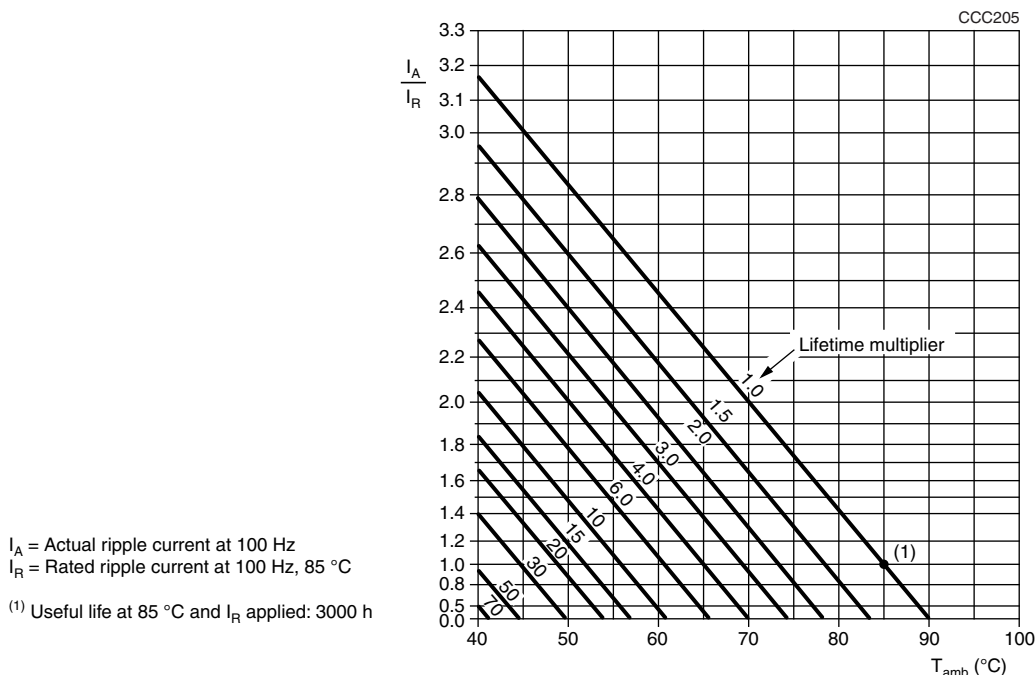


Fig. 10 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |                                        |                                       |                                        |
|-------------------------------------------------------------------|----------------------------------------|---------------------------------------|----------------------------------------|
| FREQUENCY<br>(Hz)                                                 | $I_R$ MULTIPLIER                       |                                       |                                        |
|                                                                   | $U_R = 6.3 \text{ V TO } 10 \text{ V}$ | $U_R = 16 \text{ V TO } 35 \text{ V}$ | $U_R = 40 \text{ V TO } 100 \text{ V}$ |
| 50                                                                | 0.90                                   | 0.85                                  | 0.80                                   |
| 100                                                               | 1.00                                   | 1.00                                  | 1.00                                   |
| 300                                                               | 1.12                                   | 1.20                                  | 1.25                                   |
| 1000                                                              | 1.20                                   | 1.30                                  | 1.40                                   |
| 3000                                                              | 1.25                                   | 1.35                                  | 1.50                                   |
| $\geq 10\,000$                                                    | 1.30                                   | 1.40                                  | 1.60                                   |

Table 4

| TEST PROCEDURES AND REQUIREMENTS               |                                             |                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TEST                                           |                                             | PROCEDURE<br>(quick reference)                                                                                                                         | REQUIREMENTS                                                                                                                                                                                                                                                                                                                       |
| NAME OF TEST                                   | REFERENCE                                   |                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                    |
| Endurance                                      | IEC 60384-4 /<br>EN130300<br>subclause 4.13 | $T_{amb} = 85 \text{ }^\circ\text{C}$ ;<br>$U_R$ applied;<br>2000 h                                                                                    | $U_R \leq 6.3 \text{ V}$ ; $\Delta C/C$ : +15 % / -30 %<br>$U_R > 6.3 \text{ V}$ ; $\Delta C/C$ : $\pm 15 \text{ } \%$<br>$\tan \delta \leq 1.3 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$                                                                             |
| Useful life                                    | CECC 30301<br>subclause 1.8.1               | $T_{amb} = 85 \text{ }^\circ\text{C}$ ;<br>$U_R$ and $I_R$ applied;<br>3000 h                                                                          | $U_R \leq 6.3 \text{ V}$ ; $\Delta C/C$ : +45 % / -50 %<br>$U_R > 6.3 \text{ V}$ ; $\Delta C/C$ : $\pm 45 \text{ } \%$<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: $\leq 1 \text{ } \%$ |
| Shelf life<br>(storage at high<br>temperature) | IEC 60384-4 /<br>EN130300<br>subclause 4.17 | $T_{amb} = 85 \text{ }^\circ\text{C}$ ; no voltage applied;<br>500 h<br>After test: $U_R$ to be applied for 30 min,<br>24 h to 48 h before measurement | $\Delta C/C$ , $\tan \delta$ , $Z$ :<br>for requirements see<br>"Endurance test" above<br>$I_{L5} \leq \text{spec. limit}$                                                                                                                                                                                                         |

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.



## Disclaimer

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