

## Aluminum Electrolytic Capacitors Radial Semi-Professional

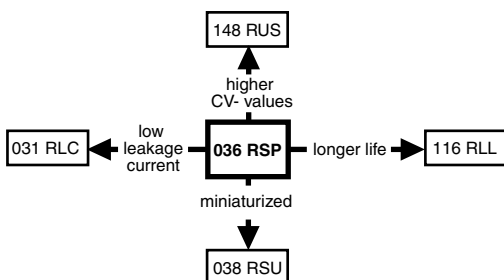
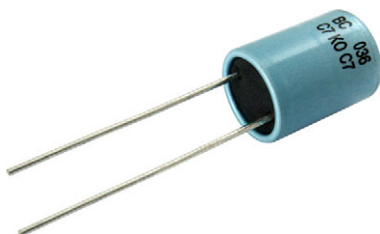


Fig. 1

### QUICK REFERENCE DATA

| DESCRIPTION                                        | VALUE                     |
|----------------------------------------------------|---------------------------|
| Nominal case sizes (Ø D x L in mm)                 | 8.2 x 11                  |
| Rated capacitance range, C <sub>R</sub>            | 10 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 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      |
| 10                     | -                  | -        | -        | -        | -        | -        | -        | -        | 8.2 x 11 |
| 22                     | -                  | -        | -        | -        | -        | -        | -        | 8.2 x 11 | -        |
| 33                     | -                  | -        | -        | -        | -        | -        | -        | 8.2 x 11 | 8.2 x 11 |
| 47                     | -                  | -        | -        | -        | -        | -        | 8.2 x 11 | 8.2 x 11 | -        |
| 68                     | -                  | -        | -        | -        | -        | 8.2 x 11 | -        | 8.2 x 11 | -        |
| 100                    | -                  | -        | -        | 8.2 x 11 | -        | -        | 8.2 x 11 | -        | -        |
| 150                    | -                  | -        | 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 | -        | -        | -        | -        | -        | -        | -        |

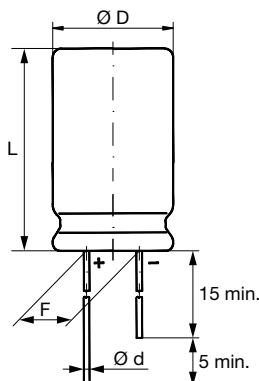
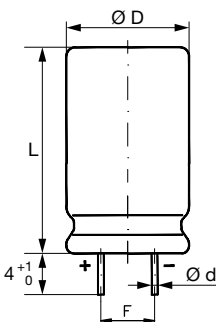
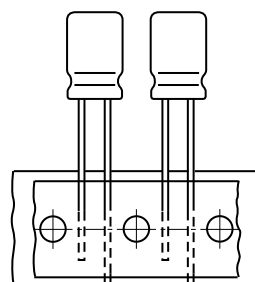
**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**

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

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

Case Ø D x L = 8.2 mm x 11 mm  
Pitch F = 5 mm

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

**Table 1**

| <b>DIMENSIONS</b> in millimeters, <b>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, CB       | FORM<br>TFA |
| 8.2 x 11                                                               | 13N          | 0.6 | 8.7                 | 12                | 5.0 ± 0.5 | ≈ 1.1       | 1000                 | 1000        |

**Note**

- For tape dimensions, please see [www.vishay.com/doc?28360](http://www.vishay.com/doc?28360).

| <b>ELECTRICAL DATA</b> |                                                    |
|------------------------|----------------------------------------------------|
| SYMBOL                 | DESCRIPTION                                        |
| C <sub>R</sub>         | Rated capacitance at 100 Hz, tolerance ± 20 %      |
| I <sub>R</sub>         | Rated RMS ripple current at 100 Hz, 85 °C          |
| I <sub>L1</sub>        | Max. leakage current after 1 min at U <sub>R</sub> |
| tan δ                  | 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<sub>amb</sub> = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

**ORDERING EXAMPLE**

Electrolytic capacitor 036 series

100 µF / 16 V; ± 20 %

Nominal case size: Ø 5 x 11 mm; Form TFA

Ordering code: MAL203635101E3

Former 12NC: 2222 036 35101

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>L1</sub><br>1 min<br>(μA) | tan δ<br>100 Hz | Z<br>10 kHz<br>(Ω) | ORDERING CODE MAL2036..... |           |            |           |                   |           |
|                                          |                                  |                                            |                                           |                                  |                 |                    | BULK PACKAGING             |           |            |           | TAPED<br>AMMOPACK |           |
|                                          |                                  |                                            |                                           |                                  |                 |                    | LONG LEADS                 |           | CUT LEADS  |           |                   |           |
|                                          |                                  |                                            |                                           |                                  |                 |                    | FORM<br>CA                 | F<br>(mm) | FORM<br>CB | F<br>(mm) | FORM<br>TFA       | F<br>(mm) |
| 6.3                                      | 330                              | 8.2 x 11                                   | 300                                       | 16                               | 0.20            | 0.52               | 53331E3                    | 5.0       | 63331E3    | 5.0       | 33331E3           | 5.0       |
| 10                                       | 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                                       | 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                                       | 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                                       | 150                              | 8.2 x 11                                   | 270                                       | 35                               | 0.12            | 0.6                | 90099E3                    | 5.0       | 90101E3    | 5.0       | 90103E3           | 5.0       |
| 40                                       | 68                               | 8.2 x 11                                   | 180                                       | 20                               | 0.10            | 0.81               | 57689E3                    | 5.0       | 67689E3    | 5.0       | 37689E3           | 5.0       |
| 50                                       | 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                                       | 10                               | 8.2 x 11                                   | 120                                       | 7                                | 0.04            | 2.8                | 90036E3                    | 5.0       | 90041E3    | 5.0       | 90181E3           | 5.0       |
|                                          | 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       |

| ADDITIONAL ELECTRICAL DATA         |                                                              |                                              |
|------------------------------------|--------------------------------------------------------------|----------------------------------------------|
| PARAMETER                          | CONDITIONS                                                   | VALUE                                        |
| <b>Voltage</b>                     |                                                              |                                              |
| Surge voltage                      |                                                              | $U_g \leq 1.15 U_R$                          |
| 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 x L = 8.2 mm x 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)

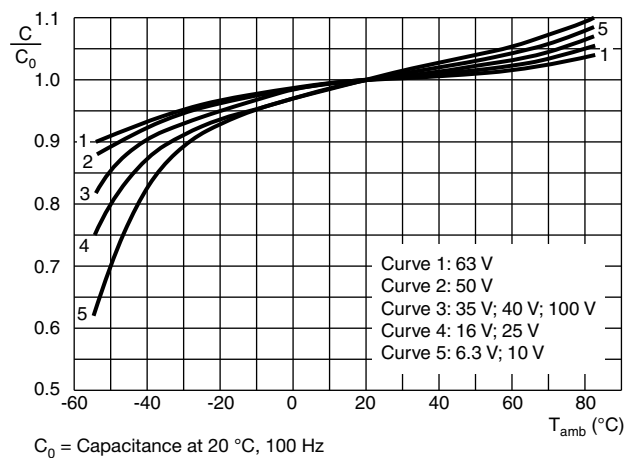


Fig. 5 - Typical multiplier of capacitance as a function of ambient temperature

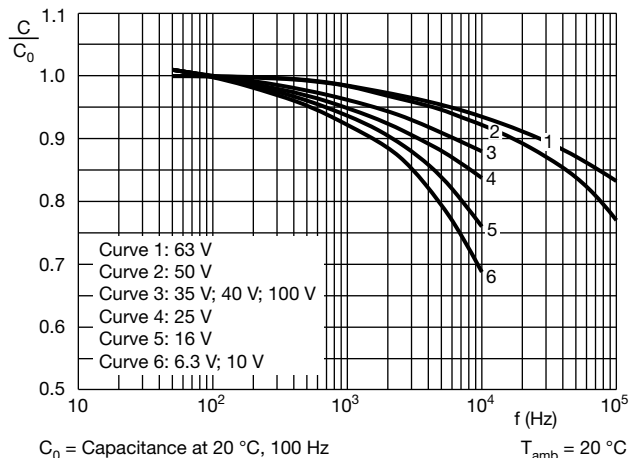


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

## IMPEDANCE (Z)

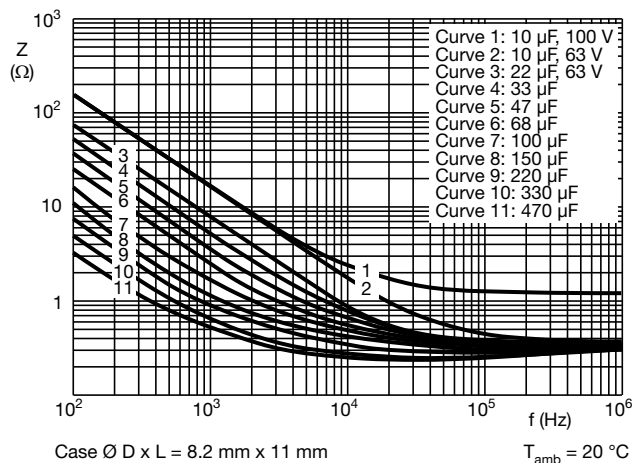


Fig. 7 - Typical impedance as a function of frequency

## RIPPLE CURRENT AND USEFUL LIFE

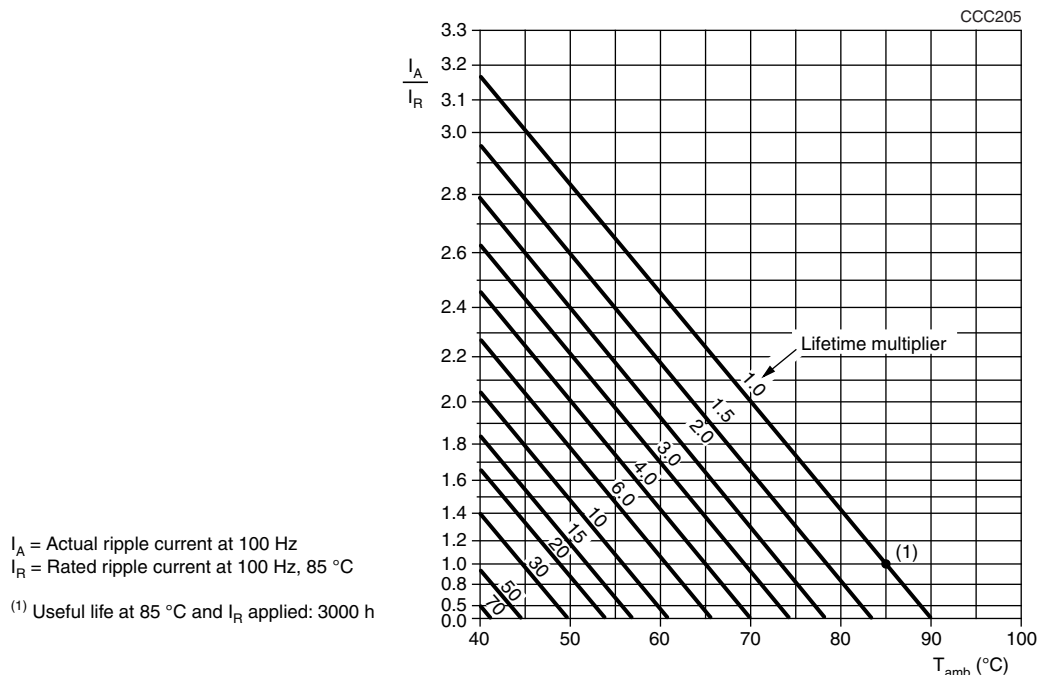


Fig. 8 - Multiplier of useful life as a function of ambient temperature and ripple current load

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 | $T_{amb} = 85 \text{ °C}$ ;<br>$U_R$ applied;<br>2000 h                                                                                    | $U_R \leq 6.3 \text{ V}$ ; $\Delta C/C$ : +15 % / -30 %<br>$U_R > 6.3 \text{ V}$ ; $\Delta C/C$ : $\pm 15 \%$<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               | $T_{amb} = 85 \text{ °C}$ ;<br>$U_R$ and $I_R$ applied;<br>3000 h                                                                          | $U_R \leq 6.3 \text{ V}$ ; $\Delta C/C$ : +45 % / -50 %<br>$U_R > 6.3 \text{ V}$ ; $\Delta C/C$ : $\pm 45 \%$<br>$\tan \delta \leq 3 \times \text{spec. limit}$<br>$Z \leq 3 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$<br>No short or open circuit<br>Total failure percentage: $\leq 1 \%$ |
| Shelf life<br>(storage at high<br>temperature) | IEC 60384-4 /<br>EN130300<br>subclause 4.17 | $T_{amb} = 85 \text{ °C}$ ; 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.



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