

Aluminum Electrolytic Capacitors Power Economic Printed Wiring

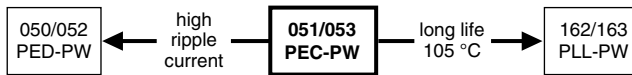


Fig. 1

| QUICK REFERENCE DATA | | |
|---|------------------------|------------------|
| DESCRIPTION | VALUE | |
| | 051 | 053 |
| Nominal case size (Ø D x L in mm) | 25 x 30 to 40 x 100 | |
| Rated capacitance range (E6 series), C _R | 680 µF to 150 000 µF | 68 µF to 2200 µF |
| Tolerance on C _R | ± 20 % | |
| Rated voltage range, U _R | 10 V to 100 V | 200 V to 400 V |
| Category temperature range | -40 °C to +85 °C | |
| Endurance test at 85 °C | 5000 h | |
| Useful life at 85 °C | 12 000 h | |
| Useful life at 40 °C, 1.4 x I _R applied | 200 000 h | |
| Shelf life at 0 V, 85 °C | 500 h | |
| Based on sectional specification | IEC 60384-4 / EN130300 | |
| Climatic category IEC 60068 | 40/085/56 | |

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types with reduced dimensions, cylindrical aluminum case, insulated with a blue sleeve
- Provided with keyed polarity
- Long useful life: 12 000 h at 85 °C
- High ripple current capability
- High resistance to shock and vibration
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


**RoHS
COMPLIANT**

APPLICATIONS

- General purpose, industrial, medical and audio/video systems
- Standard and switched mode power supplies
- Energy storage in pulse systems

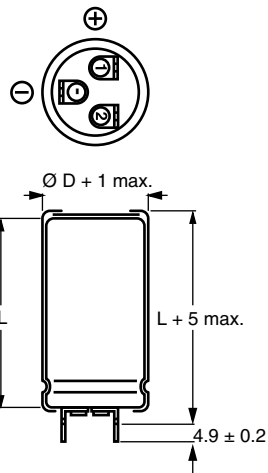
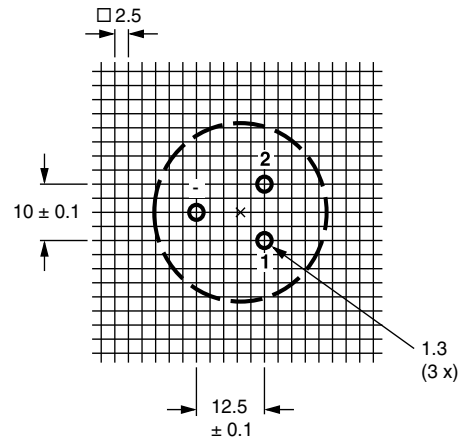
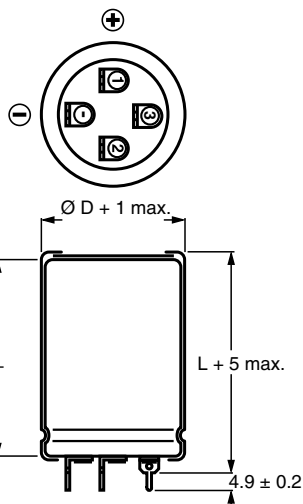
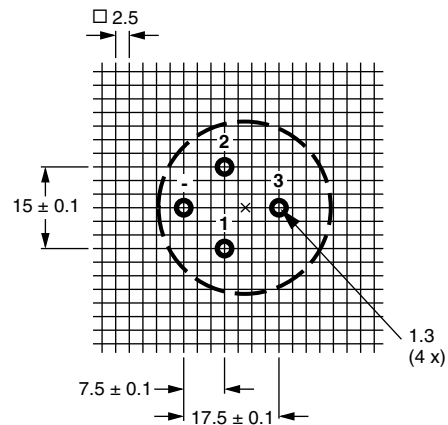
MARKING

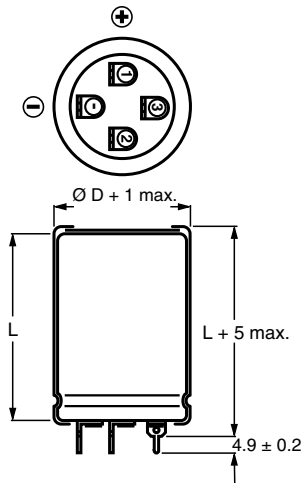
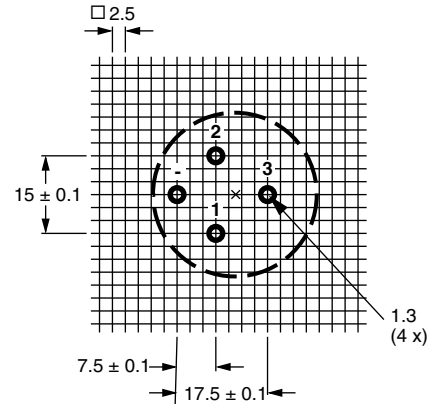
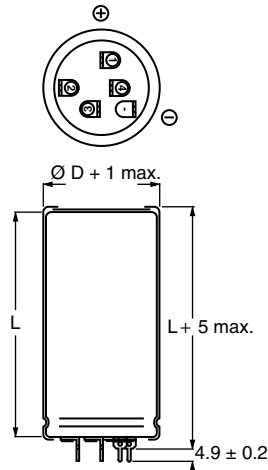
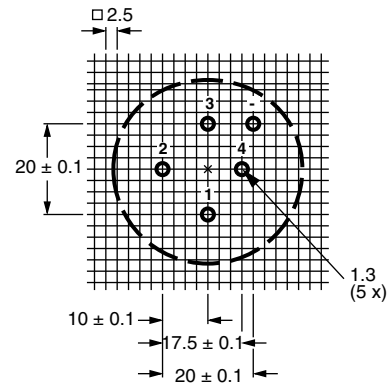
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code (YYMM)
- Name of manufacturer
- Code for factory of origin
- Polarity of the terminals and “-” sign to indicate the negative terminal, visible from the top and/or side of the capacitor
- Code number
- Climatic category in accordance with IEC 60068

| SELECTION CHART FOR C _R , U _R , AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm) | | | | | | | | | |
|---|--------------------|----|---------|---------|---------|---------|----------|----------|----------|
| C _R (µF) | U _R (V) | | | | | | | | |
| | 10 | 16 | 25 | 40 | 63 | 100 | 200 | 385 | 400 |
| 68 | - | - | - | - | - | - | - | 25 x 30 | 25 x 30 |
| 100 | - | - | - | - | - | - | - | 25 x 40 | 25 x 40 |
| 150 | - | - | - | - | - | - | 25 x 30 | 30 x 40 | 30 x 40 |
| 220 | - | - | - | - | - | - | 25 x 40 | 35 x 40 | 35 x 40 |
| 330 | - | - | - | - | - | - | 30 x 40 | 35 x 50 | 35 x 50 |
| | - | - | - | - | - | - | - | 40 x 40 | 40 x 40 |
| 470 | - | - | - | - | - | - | 35 x 40 | 40 x 50 | 40 x 50 |
| | - | - | - | - | - | 25 x 30 | 35 x 50 | 40 x 70 | 40 x 70 |
| 680 | - | - | - | - | - | - | 40 x 40 | - | - |
| | - | - | - | - | - | 25 x 40 | 40 x 50 | 40 x 100 | 40 x 100 |
| 1000 | - | - | - | - | - | 30 x 40 | 40 x 70 | - | - |
| 1500 | - | - | - | - | 25 x 30 | 35 x 40 | 40 x 100 | - | - |
| 2200 | - | - | - | - | - | 25 x 30 | 35 x 40 | 40 x 100 | - |
| 3300 | - | - | - | 25 x 30 | 25 x 40 | 35 x 50 | - | - | - |
| | - | - | - | - | - | 40 x 40 | - | - | - |
| 4700 | - | - | 25 x 30 | 25 x 40 | 30 x 40 | 40 x 50 | - | - | - |

| SELECTION CHART FOR C_R , U_R , AND RELEVANT NOMINAL CASE SIZES ($\varnothing D \times L$ in mm) | | | | | | | | | |
|---|-----------|----------|----------|----------|----------|----------|-----|-----|-----|
| C_R (μF) | U_R (V) | | | | | | | | |
| | 10 | 16 | 25 | 40 | 63 | 100 | 200 | 385 | 400 |
| 6800 | - | 25 x 30 | 25 x 40 | 30 x 40 | 35 x 40 | 40 x 70 | - | - | - |
| 10 000 | 25 x 30 | 25 x 40 | 30 x 40 | 35 x 40 | 35 x 50 | 40 x 100 | - | - | - |
| | - | - | - | - | 40 x 40 | - | - | - | - |
| 15 000 | 25 x 40 | 30 x 40 | 35 x 40 | 35 x 50 | 40 x 70 | - | - | - | - |
| | - | - | - | 40 x 40 | - | - | - | - | - |
| 22 000 | 30 x 40 | 35 x 40 | 35 x 50 | 40 x 50 | 40 x 100 | - | - | - | - |
| | - | - | 40 x 40 | - | - | - | - | - | - |
| 33 000 | 35 x 40 | 35 x 50 | 40 x 50 | 40 x 70 | - | - | - | - | - |
| | - | 40 x 40 | - | - | - | - | - | - | - |
| 47 000 | 35 x 50 | 40 x 50 | 40 x 70 | 40 x 100 | - | - | - | - | - |
| | 40 x 40 | - | - | - | - | - | - | - | - |
| 68 000 | 40 x 50 | 40 x 70 | 40 x 100 | - | - | - | - | - | |
| 100 000 | 40 x 70 | 40 x 100 | - | - | - | - | - | - | |
| 150 000 | 40 x 100 | - | - | - | - | - | - | - | |

DIMENSIONS in millimeters AND AVAILABLE FORMS

 Fig. 1 - Printed wiring pin version
(case $\varnothing D = 25$ mm)

 Fig. 2 - Mounting hole diagram viewed from component side
(case $\varnothing D = 25$ mm)

 Fig. 3 - Printed wiring pin version
(case $\varnothing D = 30$ mm)

 Fig. 4 - Mounting hole diagram viewed from component side
(case $\varnothing D = 30$ mm)


 Fig. 5 - Printed wiring pin version
(case Ø D = 35 mm)

 Fig. 6 - Mounting hole diagram viewed from component side
(case Ø D = 35 mm)

 Fig. 7 - Printed wiring pin version
(case Ø D = 40 mm)

 Fig. 8 - Mounting hole diagram viewed from component side
(case Ø D = 40 mm)

MOUNTING

When a number of capacitors are connected in a bank, they must not be closer together than 15 mm, when no derating of ripple current and / or temperature is applied.

Pin number 1 is the positive terminal. Pin “-” is the negative terminal.

Pin numbers 2, 3 and 4 (if present) should be free from the electrical circuit or connected to the minus terminal.

Table 1

| DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES | | | | | |
|--|---------------------------|-------------------------|---------------------|---|---|
| NOMINAL CASE SIZE Ø D x L | Ø D_{max.} | L_{max.} | MASS (g) | PACKAGING QUANTITIES (units per box) | CARDBOARD BOX DIMENSIONS L x W x H |
| 25 x 30 | 26 | 35 | ≈ 24 | 100 | 290 x 280 x 50 |
| 25 x 40 | 26 | 45 | ≈ 28 | 100 | 290 x 280 x 60 |
| 30 x 40 | 31 | 45 | ≈ 38 | 100 | 340 x 330 x 60 |
| 35 x 40 | 36 | 45 | ≈ 51 | 50 | 390 x 198 x 60 |
| 35 x 50 | 36 | 55 | ≈ 66 | 50 | 390 x 198 x 70 |
| 40 x 40 | 41 | 45 | ≈ 78 | 50 | 440 x 223 x 60 |
| 40 x 50 | 41 | 55 | ≈ 82 | 50 | 440 x 223 x 70 |
| 40 x 70 | 41 | 75 | ≈ 110 | 25 | 230 x 230 x 90 |
| 40 x 100 | 41 | 105 | ≈ 176 | 25 | 230 x 230 x 120 |



| ELECTRICAL DATA | |
|-----------------|---|
| SYMBOL | DESCRIPTION |
| C _R | Rated capacitance at 100 Hz |
| I _R | Rated RMS ripple current at 100 Hz, 85 °C or at 20 kHz, 70 °C |
| I _{L1} | Max. leakage current after 1 min at U _R |
| I _{L5} | Max. leakage current after 5 min at U _R |
| ESR | Max. equivalent series resistance at 100 Hz |
| Z | Max. impedance at 10 kHz |

ORDERING EXAMPLE

Electrolytic capacitor 051 series
 10 000 µF/25 V; ± 20 %
 Nominal case size: Ø 30 mm x 40 mm
 Ordering code: MAL2 051 56103 E3
 Former 12NC: 2222 051 56103

Note

- Unless otherwise specified, all electrical values in tables 2 and 3 apply at T_{amb} = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION 051 SERIES | | | | | | | | | |
|---|----------------------------------|---|--|--|----------------------------------|----------------------------------|-----------------------|---------------------|-------------------------------|
| U _R (V) | C _R 100 Hz (µF) | NOMINAL CASE SIZE Ø D x L (mm) | I _R 100 Hz 85 °C (A) | I _R 20 kHz 70 °C (A) | I _{L1} 1 min (mA) | I _{L5} 5 min (mA) | ESR 100 Hz (mΩ) | Z 10 kHz (mΩ) | ORDERING CODE MAL2051..... |
| 10 | 10 000 | 25 x 30 | 3.1 | 5.9 | 0.60 | 0.20 | 51 | 40 | 54103E3 |
| | 15 000 | 25 x 40 | 4.1 | 7.8 | 0.90 | 0.30 | 37 | 30 | 54153E3 |
| | 22 000 | 30 x 40 | 5.0 | 9.5 | 1.32 | 0.44 | 30 | 25 | 54223E3 |
| | 33 000 | 35 x 40 | 5.5 | 10.4 | 1.98 | 0.66 | 28 | 24 | 54333E3 |
| | 47 000 | 35 x 50 | 6.8 | 12.9 | 2.82 | 0.94 | 23 | 20 | 54473E3 |
| | 47 000 | 40 x 40 | 5.8 | 10.4 | 2.82 | 0.94 | 29 | 22 | 44473E3 |
| | 68 000 | 40 x 50 | 7.1 | 13.5 | 4.08 | 1.36 | 24 | 20 | 54683E3 |
| | 100 000 | 40 x 70 | 9.2 | 17.4 | 6.00 | 2.00 | 19 | 16 | 54104E3 |
| 150 000 | 40 x 100 | 12.0 | 22.7 | 9.00 | 3.00 | 16 | 14 | 54154E3 | |
| 16 | 6800 | 25 x 30 | 3.1 | 5.9 | 0.65 | 0.22 | 53 | 42 | 55682E3 |
| | 10 000 | 25 x 40 | 4.0 | 7.6 | 0.96 | 0.32 | 39 | 34 | 55103E3 |
| | 15 000 | 30 x 40 | 5.0 | 9.5 | 1.44 | 0.48 | 31 | 27 | 55153E3 |
| | 22 000 | 35 x 40 | 5.5 | 10.4 | 2.12 | 0.71 | 29 | 26 | 55223E3 |
| | 33 000 | 35 x 50 | 6.7 | 12.7 | 3.17 | 1.06 | 23 | 21 | 55333E3 |
| | 33 000 | 40 x 40 | 5.7 | 10.8 | 3.17 | 1.06 | 30 | 24 | 45333E3 |
| | 47 000 | 40 x 50 | 7.0 | 13.3 | 4.52 | 1.51 | 24 | 20 | 55473E3 |
| | 68 000 | 40 x 70 | 9.2 | 17.4 | 6.53 | 2.18 | 19 | 16 | 55683E3 |
| 100 000 | 40 x 100 | 12.0 | 22.7 | 9.60 | 3.20 | 16 | 14 | 55104E3 | |
| 25 | 4700 | 25 x 30 | 2.9 | 5.5 | 0.71 | 0.24 | 60 | 42 | 56472E3 |
| | 6800 | 25 x 40 | 3.9 | 7.4 | 1.02 | 0.34 | 42 | 34 | 56682E3 |
| | 10 000 | 30 x 40 | 4.8 | 9.1 | 1.50 | 0.50 | 34 | 27 | 56103E3 |
| | 15 000 | 35 x 40 | 5.3 | 10.0 | 2.25 | 0.75 | 30 | 26 | 56153E3 |
| | 22 000 | 35 x 50 | 6.5 | 12.3 | 3.30 | 1.10 | 24 | 21 | 56223E3 |
| | 22 000 | 40 x 40 | 5.7 | 10.8 | 3.30 | 1.10 | 31 | 24 | 46223E3 |
| | 33 000 | 40 x 50 | 7.0 | 13.3 | 4.95 | 1.65 | 25 | 20 | 56333E3 |
| | 47 000 | 40 x 70 | 9.2 | 17.4 | 7.05 | 2.35 | 19 | 16 | 56473E3 |
| 68 000 | 40 x 100 | 12.0 | 22.7 | 10.20 | 3.40 | 16 | 14 | 56683E3 | |
| 40 | 3300 | 25 x 30 | 2.9 | 5.5 | 0.80 | 0.27 | 87 | 63 | 57332E3 |
| | 4700 | 25 x 40 | 3.8 | 7.2 | 1.13 | 0.38 | 62 | 47 | 57472E3 |
| | 6800 | 30 x 40 | 4.7 | 8.9 | 1.64 | 0.55 | 49 | 38 | 57682E3 |
| | 10 000 | 35 x 40 | 5.2 | 9.8 | 2.40 | 0.80 | 48 | 37 | 57103E3 |
| | 15 000 | 35 x 50 | 6.3 | 11.9 | 3.60 | 1.20 | 37 | 28 | 57153E3 |
| | 15 000 | 40 x 40 | 5.6 | 10.6 | 3.60 | 1.20 | 50 | 35 | 47153E3 |
| | 22 000 | 40 x 50 | 5.8 | 11.0 | 5.28 | 1.76 | 39 | 28 | 57223E3 |
| | 33 000 | 40 x 70 | 7.8 | 14.8 | 7.92 | 2.64 | 28 | 21 | 57333E3 |
| 47 000 | 40 x 100 | 10.4 | 19.7 | 11.28 | 3.76 | 22 | 17 | 57473E3 | |



| ELECTRICAL DATA AND ORDERING INFORMATION 051 SERIES | | | | | | | | | |
|---|----------------------------------|---|--|--|----------------------------------|----------------------------------|-----------------------|---------------------|-------------------------------|
| U _R (V) | C _R 100 Hz (μF) | NOMINAL CASE SIZE Ø D x L (mm) | I _R 100 Hz 85 °C (A) | I _R 20 kHz 70 °C (A) | I _{L1} 1 min (mA) | I _{L5} 5 min (mA) | ESR 100 Hz (mΩ) | Z 10 kHz (mΩ) | ORDERING CODE MAL2051..... |
| 63 | 2200 | 25 x 30 | 2.5 | 4.7 | 0.84 | 0.28 | 83 | 62 | 58222E3 |
| | 3300 | 25 x 40 | 3.3 | 6.2 | 1.25 | 0.42 | 58 | 42 | 58332E3 |
| | 4700 | 30 x 40 | 4.1 | 7.8 | 1.78 | 0.60 | 49 | 38 | 58472E3 |
| | 6800 | 35 x 40 | 4.5 | 8.5 | 2.57 | 0.86 | 48 | 37 | 58682E3 |
| | 10 000 | 35 x 50 | 5.4 | 10.2 | 3.78 | 1.26 | 37 | 28 | 58103E3 |
| | 10 000 | 40 x 40 | 4.6 | 8.7 | 3.78 | 1.26 | 52 | 37 | 48103E3 |
| | 15 000 | 40 x 70 | 7.5 | 14.2 | 5.67 | 1.89 | 29 | 24 | 58153E3 |
| | 22 000 | 40 x 100 | 10.0 | 19.0 | 8.32 | 2.77 | 22 | 19 | 58223E3 |
| 100 | 680 | 25 x 30 | 1.74 | 3.30 | 0.41 | 0.14 | 190 | 130 | 59681E3 |
| | 1000 | 25 x 40 | 2.34 | 4.44 | 0.60 | 0.20 | 130 | 90 | 59102E3 |
| | 1500 | 30 x 40 | 2.95 | 5.59 | 0.90 | 0.30 | 95 | 67 | 59152E3 |
| | 2200 | 35 x 40 | 3.69 | 7.00 | 1.32 | 0.44 | 71 | 53 | 59222E3 |
| | 3300 | 35 x 50 | 4.37 | 8.29 | 1.98 | 0.66 | 55 | 41 | 59332E3 |
| | 3300 | 40 x 40 | 4.16 | 7.89 | 1.98 | 0.66 | 64 | 48 | 49332E3 |
| | 4700 | 40 x 50 | 5.21 | 9.88 | 2.82 | 0.94 | 49 | 38 | 59472E3 |
| | 6800 | 40 x 70 | 6.97 | 13.22 | 4.08 | 1.36 | 35 | 28 | 59682E3 |
| | 10 000 | 40 x 100 | 9.50 | 18.00 | 6.00 | 2.00 | 26 | 21 | 59103E3 |

Table 3

| ELECTRICAL DATA AND ORDERING INFORMATION 053 SERIES | | | | | | | | | |
|---|----------------------------------|---|--|--|----------------------------------|----------------------------------|-----------------------|---------------------|-------------------------------|
| U _R (V) | C _R 100 Hz (μF) | NOMINAL CASE SIZE Ø D x L (mm) | I _R 100 Hz 85 °C (A) | I _R 20 kHz 70 °C (A) | I _{L1} 1 min (mA) | I _{L5} 5 min (mA) | ESR 100 Hz (mΩ) | Z 10 kHz (mΩ) | ORDERING CODE MAL2053..... |
| 200 | 150 | 25 x 30 | 0.70 | 1.33 | 0.18 | 0.06 | 1000 | 770 | 52151E3 |
| | 220 | 25 x 40 | 0.94 | 1.78 | 0.26 | 0.09 | 680 | 525 | 52221E3 |
| | 330 | 30 x 40 | 1.27 | 2.41 | 0.40 | 0.14 | 460 | 360 | 52331E3 |
| | 470 | 35 x 40 | 1.66 | 3.15 | 0.57 | 0.19 | 320 | 250 | 52471E3 |
| | 680 | 35 x 50 | 2.19 | 4.15 | 0.82 | 0.28 | 220 | 170 | 52681E3 |
| | 680 | 40 x 40 | 2.17 | 4.11 | 0.82 | 0.28 | 220 | 170 | 42681E3 |
| | 1000 | 40 x 50 | 2.86 | 5.42 | 1.20 | 0.40 | 150 | 115 | 52102E3 |
| | 1500 | 40 x 70 | 3.81 | 7.22 | 1.80 | 0.60 | 110 | 85 | 52152E3 |
| 2200 | 40 x 100 | 5.20 | 9.86 | 2.64 | 0.88 | 80 | 60 | 52222E3 | |
| 385 | 68 | 25 x 30 | 0.47 | 0.89 | 0.16 | 0.06 | 2200 | 1480 | 58689E3 |
| | 100 | 25 x 40 | 0.64 | 1.21 | 0.23 | 0.08 | 1500 | 1020 | 58101E3 |
| | 150 | 30 x 40 | 0.90 | 1.71 | 0.35 | 0.12 | 1000 | 700 | 58151E3 |
| | 220 | 35 x 40 | 1.15 | 2.18 | 0.51 | 0.17 | 680 | 480 | 58221E3 |
| | 330 | 35 x 50 | 1.53 | 2.90 | 0.77 | 0.26 | 450 | 340 | 58331E3 |
| | 330 | 40 x 40 | 1.52 | 2.88 | 0.77 | 0.26 | 450 | 340 | 48331E3 |
| | 470 | 40 x 50 | 1.96 | 3.72 | 1.09 | 0.36 | 320 | 260 | 58471E3 |
| | 680 | 40 x 70 | 2.70 | 5.12 | 1.58 | 0.53 | 220 | 190 | 58681E3 |
| 1000 | 40 x 100 | 3.70 | 7.02 | 2.31 | 0.78 | 180 | 140 | 58102E3 | |
| 400 | 68 | 25 x 30 | 0.54 | 1.02 | 0.16 | 0.06 | 2100 | 1000 | 56689E3 |
| | 100 | 25 x 40 | 0.73 | 1.38 | 0.24 | 0.08 | 1400 | 780 | 56101E3 |
| | 150 | 30 x 40 | 0.98 | 1.86 | 0.36 | 0.12 | 950 | 520 | 56151E3 |
| | 220 | 35 x 40 | 1.28 | 2.43 | 0.52 | 0.17 | 650 | 400 | 56221E3 |
| | 330 | 35 x 50 | 1.67 | 3.17 | 0.79 | 0.26 | 480 | 280 | 56331E3 |
| | 330 | 40 x 40 | 1.67 | 3.17 | 0.79 | 0.26 | 480 | 280 | 46331E3 |
| | 470 | 40 x 50 | 2.12 | 4.02 | 1.12 | 0.37 | 340 | 220 | 56471E3 |
| | 680 | 40 x 70 | 2.90 | 5.50 | 1.63 | 0.54 | 235 | 155 | 56681E3 |
| 1000 | 40 x 100 | 4.05 | 7.68 | 2.40 | 0.80 | 160 | 110 | 56102E3 | |



| ADDITIONAL ELECTRICAL DATA | | |
|------------------------------------|--|--|
| PARAMETER | CONDITIONS | VALUE |
| Voltage | | |
| Surge voltage | ≤ 250 V versions | $U_s = 1.15 \times U_R$ |
| | ≥ 385 V versions | $U_s = 1.1 \times U_R$ |
| Reverse voltage | | $U_{rev} \leq 1 \text{ V}$ |
| Current | | |
| Leakage current | After 1 min at U_R | $I_{L1} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$ |
| | After 5 min at U_R | $I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$ |
| Inductance | | |
| Equivalent series inductance (ESL) | Case $\varnothing D = 25 \text{ mm}$ | Max. 25 nH |
| | Case $\varnothing D = 30 \text{ mm}$ and 35 mm | Max. 30 nH |
| | Case $\varnothing D = 40 \text{ mm}$ | Max. 35 nH |

CAPACITANCE (C)

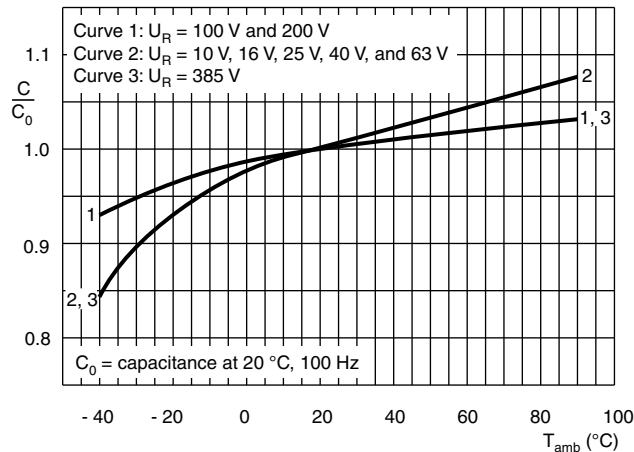


Fig. 9 - Typical multiplier of capacitance as a function of ambient temperature

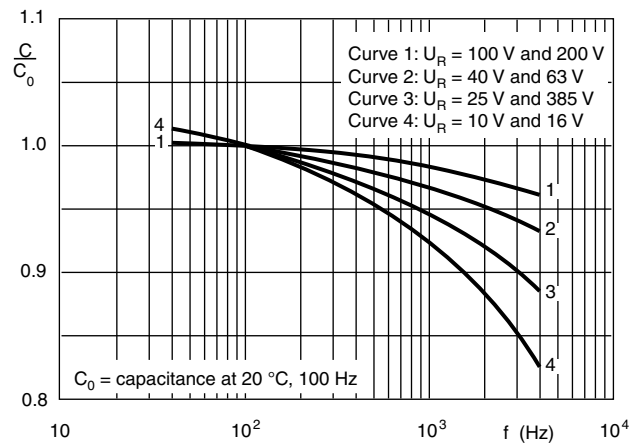


Fig. 10 - Typical multiplier of capacitance as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)

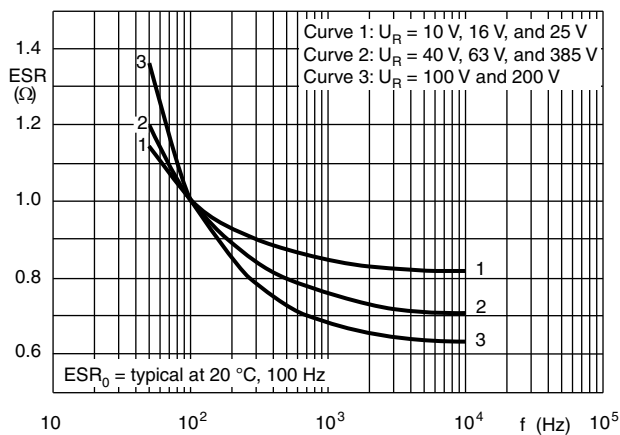


Fig. 11 - Typical multiplier of typical ESR as a function of frequency

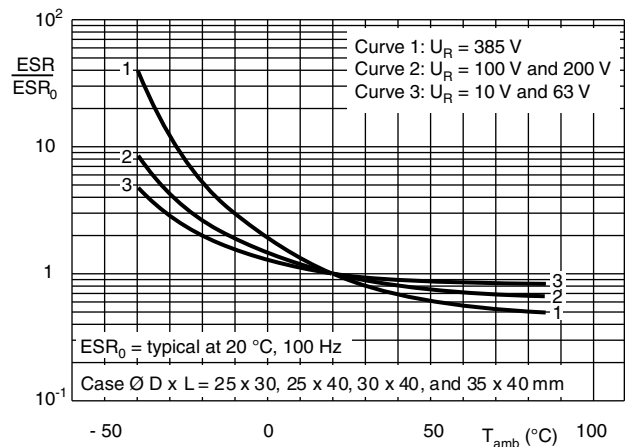


Fig. 12 - Typical multiplier of ESR as a function of ambient temperature

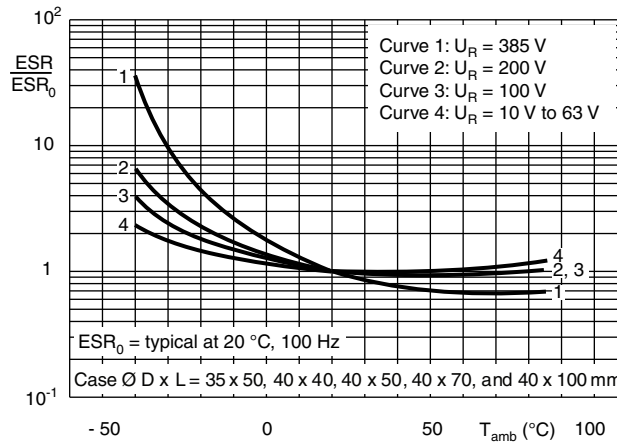


Fig. 13 - Typical multiplier of ESR as a function of ambient temperature

IMPEDANCE (Z)

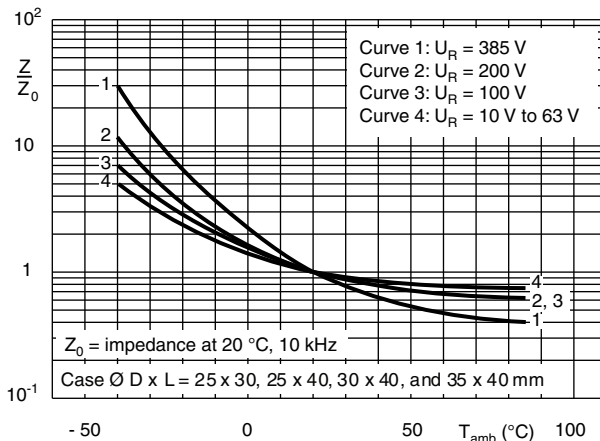


Fig. 14 - Typical multiplier of impedance as a function of ambient temperature

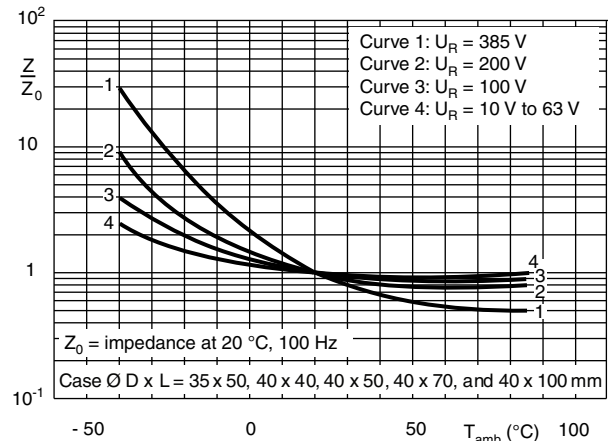


Fig. 15 - Typical multiplier of impedance as a function of ambient temperature

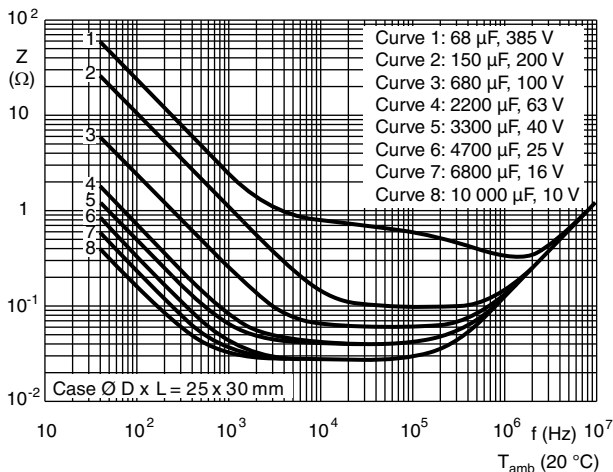


Fig. 16 - Typical impedance as a function of frequency

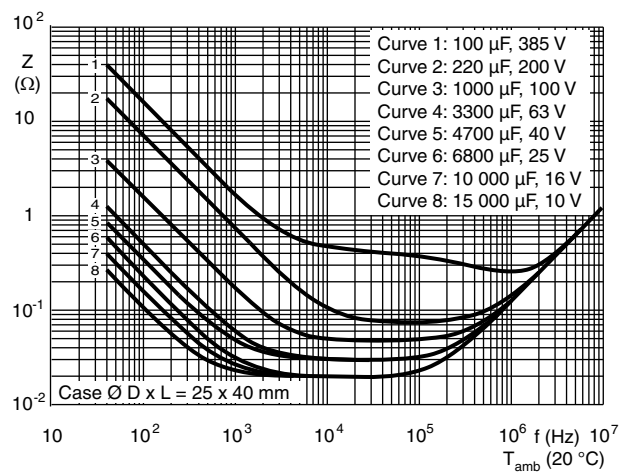


Fig. 17 - Typical impedance as a function of frequency

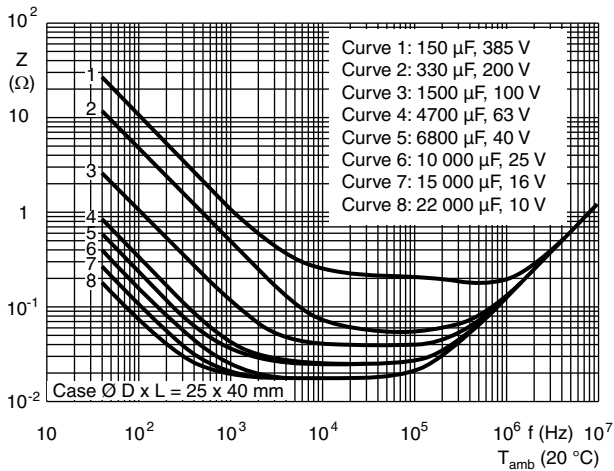


Fig. 18 - Typical impedance as a function of frequency

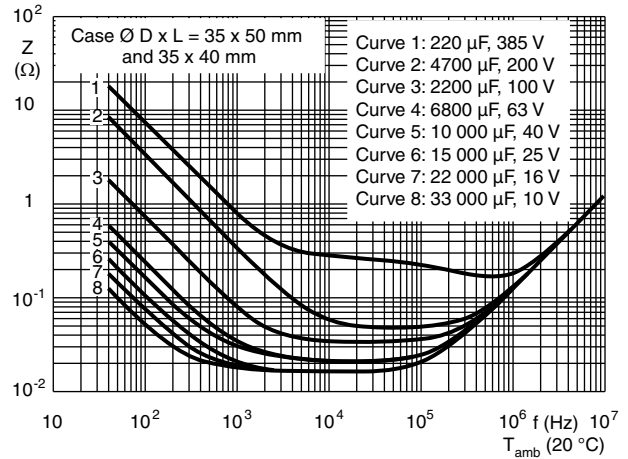


Fig. 19 - Typical impedance as a function of frequency

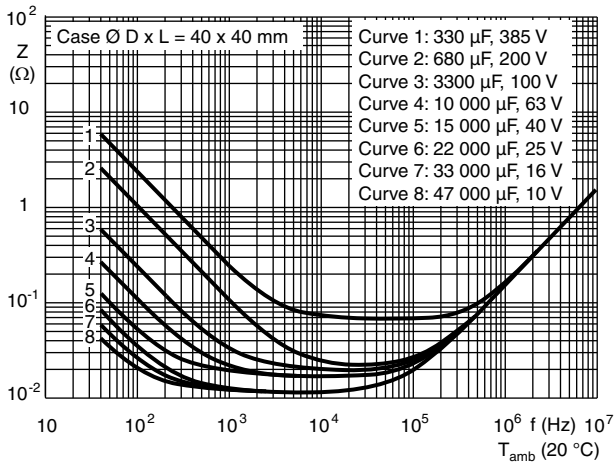


Fig. 20 - Typical impedance as a function of frequency

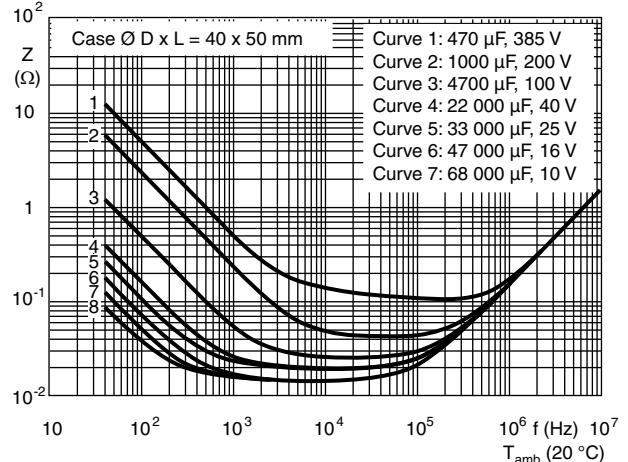


Fig. 21 - Typical impedance as a function of frequency

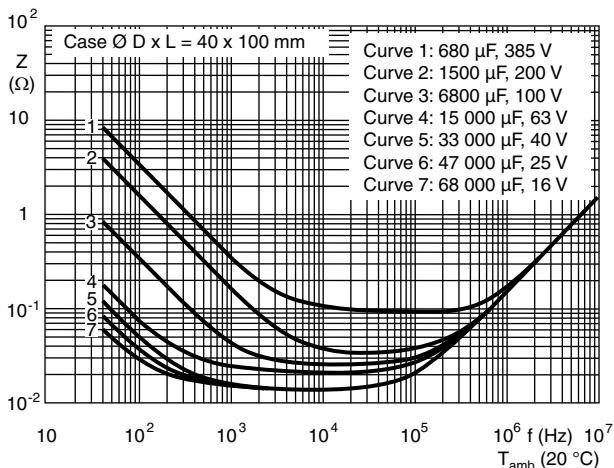


Fig. 22 - Typical impedance as a function of frequency

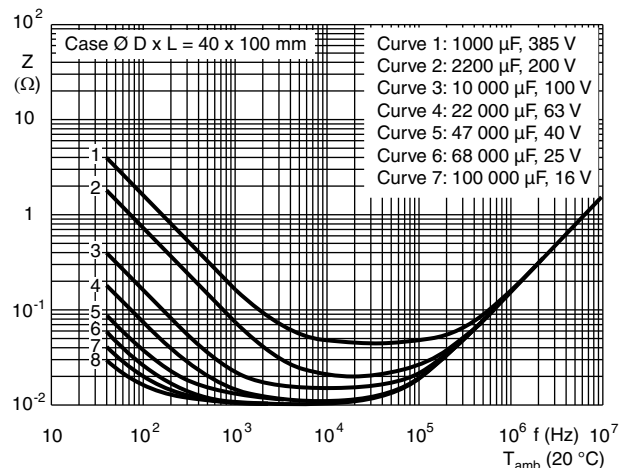
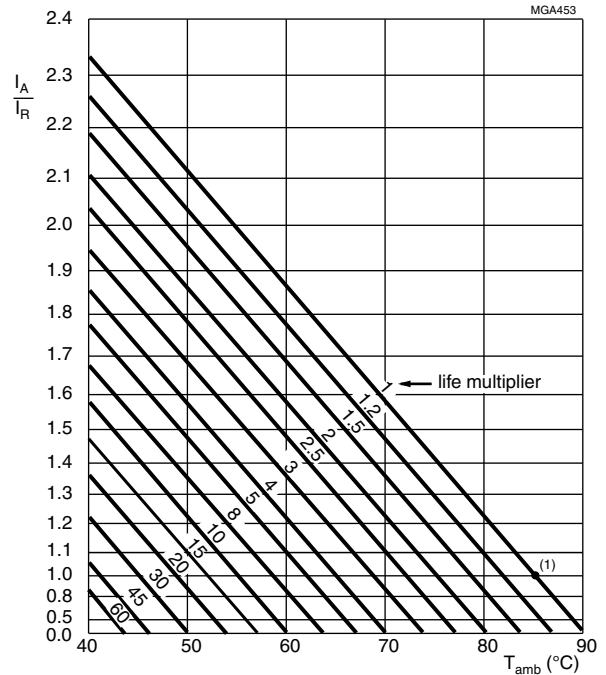


Fig. 23 - Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE



I_A = Actual ripple current at 100 Hz
 I_R = Rated ripple current at 100 Hz and 85 °C
 (1) Useful life at 85 °C and I_R applied: 12 000 h

Fig. 24 - 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 | |
|---|------------------|
| FREQUENCY (Hz) | I_R MULTIPLIER |
| 50 | 0.83 |
| 100 | 1.00 |
| 200 | 1.10 |
| 400 | 1.15 |
| 1000 | 1.19 |
| ≥ 2000 | 1.20 |

Table 5

| TEST PROCEDURES AND REQUIREMENTS | | | |
|---|---------------------------------------|--|---|
| TEST | | PROCEDURE (quick reference) | REQUIREMENTS |
| NAME OF TEST | REFERENCE | | |
| Endurance | IEC 60384-4 / EN130300 subclause 4.13 | $T_{amb} = 85\text{ °C}$; U_R applied; 5000 h | $U_R \leq 100\text{ V}$; $\Delta C/C: \pm 15\%$ $U_R > 100\text{ V}$; $\Delta C/C: \pm 10\%$ $ESR \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ |
| Useful life | CECC 30301 subclause 1.8.1 | $T_{amb} = 85\text{ °C}$; U_R and I_R applied; 12 000 h | $U_R \leq 100\text{ V}$; $\Delta C/C: \pm 45\%$ $U_R > 100\text{ V}$; $\Delta C/C: \pm 30\%$ $ESR \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $U_R \leq 100\text{ V}: \leq 1\%$; $U_R > 100\text{ V}: \leq 3\%$ |
| Shelf life (storage at high temperature) | IEC 60384-4 / EN130300 subclause 4.17 | $T_{amb} = 85\text{ °C}$; no voltage applied; 500 h after test: U_R to be applied for 30 min, 24 h to 48 h before measurement | $\Delta C/C: \pm 10\%$ $ESR \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$ |



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