

Electrical Double Layer Energy Storage Capacitors Power and Energy Versions



Image is not to scale

FEATURES

- Polarized energy storage capacitor with high capacity and energy density
- Energy version with high stability available
- Rated voltage: 2.7 V
- Available in through-hole (radial) version
- Useful life: 1000 h at 85 °C
- Rapid charge and discharge
- Maintenance-free, no service necessary
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


**RoHS
COMPLIANT**

APPLICATIONS

- Power backup
- Burst power support
- Storage device for energy harvesting
- Micro UPS power source
- Energy recovery

MARKING

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

- Rated capacitance (in F)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Logo of manufacturer
- Negative terminal identification
- Series number (220)

PACKAGING

Supplied in ESD trays.

| QUICK REFERENCE DATA | |
|---|--|
| DESCRIPTION | VALUE |
| Nominal case sizes (Ø D x L in mm) | 16 x 20; 18 x 20; 16 x 31; 18 x 31 |
| Rated capacitance range, C _R | 15 F to 40 F |
| Rated voltage, U _R (65 °C / 85 °C) | 2.7 V / 2.3 V |
| Category temperature range | -40 °C to +85 °C |
| Endurance test at 85 °C | 1000 h |
| Useful life at 85 °C | 1000 h |
| Useful life at 20 °C | > 10 years |
| Shelf life at 20 °C | 2 years |
| Cycle life | > 500 000 cycles |

| SELECTION CHART FOR C _R , U _R , AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm) | |
|---|--|
| C _R (F) | U _R (V) = 2.7 V |
| 15 | 16 x 20 |
| 20 | 16 x 20; 18 x 20 |
| 25 | 18 x 20 |
| 30 | 16 x 31 |
| 35 | 16 x 31, 18 x 31 ⁽¹⁾ |
| 40 | 18 x 31 ⁽¹⁾ |

Note

⁽¹⁾ Preferred case size.

DIMENSIONS in millimeters AND AVAILABLE FORMS


Fig. 1 - Form CA: long leads

Table 1

| DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES | | | | | | | |
|---|-----------|-----|---------------------|-------------------|-----------|-------------|----------------------|
| NOMINAL CASE SIZE Ø D x L | CASE CODE | Ø d | Ø D _{max.} | L _{max.} | F | MASS (g) | PACKAGING QUANTITIES |
| | | | | | | | FORM CA IN TRAY |
| 16 x 20 | 19a | 0.8 | 16.5 | 22 | 7.5 ± 0.5 | ≈ 6.0 | 200 |
| 18 x 20 | 1820 | 0.8 | 18.5 | 22 | 7.5 ± 0.5 | ≈ 7.0 | 200 |
| 16 x 31 | 20 | 0.8 | 16.5 | 33.5 | 7.5 ± 0.5 | ≈ 9.0 | 200 |
| 18 x 31 | 1831 | 0.8 | 18.5 | 33.5 | 7.5 ± 0.5 | ≈ 10.0 | 200 |

| ELECTRICAL DATA | |
|-----------------|---|
| SYMBOL | DESCRIPTION |
| C _R | Rated capacitance, tolerance -20 % / +50 % |
| I _P | Max. peak current |
| I _L | Max. leakage current after 0.5 h / 72 h at U _R |

Note

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

ORDERING EXAMPLE

Capacitor series 220 EDLC

40 F / 2.7 V

Nominal case size: Ø 18 mm x 31 mm; Form CA

Ordering code: MAL222091001E3

Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION FOR ENERGY VERSION | | | | | | | | | | | | | | | |
|---|---------------------------------------|----------------------------------|---|---|---|--|---|-------|---|------|---|-------|---|-------|----------------------------------|
| U _R (V) | U _{CT} ⁽¹⁾ (V) | U _S (V) (< 1 s) | C _R ⁽²⁾ 100 Hz (µF) | NOMINAL CASE SIZE Ø D x L (mm) | MAX. ESR _{DC} ⁽²⁾ INITIAL (mΩ) | MAX. ESR _{AC} INITIAL, 1 kHz (mΩ) | I _P MAX. PEAK CURRENT (A) | | I _L MAX. LEAKAGE CURRENT AFTER | | STORED ENERGY E AT U _R (Wh) | | SPECIFIC ENERGY E _d AT U _R (Wh/kg) | | ORDERING CODE MAL2220..... |
| | | | | | | | 65 °C | 85 °C | 0.5 h | 72 h | 65 °C | 85 °C | 65 °C | 85 °C | |
| 2.7 | 2.3 | 2.85 | 15 000 000 | 16 x 20 | 40 | 30 | 25 | 20 | 6 | 75 | 0.015 | 0.011 | 2.5 | 1.8 | 90003E3 |
| 2.7 | 2.3 | 2.85 | 20 000 000 | 18 x 20 | 38 | 28 | 25 | 20 | 6 | 75 | 0.020 | 0.015 | 2.9 | 2.1 | 90004E3 |
| 2.7 | 2.3 | 2.85 | 30 000 000 | 16 x 31 | 36 | 26 | 25 | 20 | 15 | 150 | 0.030 | 0.022 | 3.4 | 2.5 | 90002E3 |
| 2.7 | 2.3 | 2.85 | 35 000 000 | 18 x 31 | 35 | 25 | 25 | 20 | 15 | 150 | 0.035 | 0.029 | 3.5 | 2.6 | 90001E3 |

Notes

- U_{CT} = rated voltage at upper category temperature
- Rated capacitance C_R and ESR_{DC}



Table 3

| ELECTRICAL DATA AND ORDERING INFORMATION FOR POWER VERSION | | | | | | | | | | | | | | | | |
|--|---------------------------------------|-------|----------------------------------|---|---|---|--|--|-------|---|-------|---|-------|---|---------|----------------------------------|
| U _R (V) | U _{CT} ⁽¹⁾ (V) | | U _S (V) (< 1 s) | C _R ⁽²⁾ 100 Hz (μF) | NOMINAL CASE SIZE Ø D x L (mm) | MAX. ESR _{DC} ⁽²⁾ INITIAL (mΩ) | MAX. ESR _{AC} INITIAL, 1 kHz (mΩ) | I _p MAX. PEAK CURRENT (A) | | I _L MAX. LEAKAGE CURRENT AFTER | | STORED ENERGY E AT U _R (Wh) | | SPECIFIC ENERGY Ed AT U _R (Wh/kg) | | ORDERING CODE MAL2220..... |
| | 65 °C | 85 °C | | | | | | 65 °C | 85 °C | 0.5 h | 72 h | 65 °C | 85 °C | 65 °C | 85 °C | |
| 2.7 | 2.3 | 2.85 | 20 000 000 | 16 x 20 | 24 | 18 | 25 | 20 | 8 | 75 | 0.020 | 0.015 | 3.4 | 2.3 | 91003E3 | |
| 2.7 | 2.3 | 2.85 | 25 000 000 | 18 x 20 | 20 | 15 | 25 | 20 | 8 | 75 | 0.025 | 0.018 | 3.6 | 2.6 | 91004E3 | |
| 2.7 | 2.3 | 2.85 | 35 000 000 | 16 x 31 | 20 | 14 | 30 | 25 | 15 | 200 | 0.035 | 0.026 | 3.8 | 2.9 | 91002E3 | |
| 2.7 | 2.3 | 2.85 | 40 000 000 | 18 x 31 | 18 | 12 | 35 | 30 | 20 | 200 | 0.041 | 0.029 | 4.1 | 3.0 | 91001E3 | |

Notes

- (1) U_{CT} = rated voltage at upper category temperature
- (2) Rated capacitance C_R and ESR_{DC}

| TEST PROCEDURES AND REQUIREMENTS (1) | | |
|---|--|--|
| NAME OF TEST | PROCEDURE (quick reference) | |
| Capacitance C _R and ESR _{DC} | Measured by DC discharging method as described in "Measuring of Characteristics". (2) | |
| Maximum peak current | Non-repetitive current for maximum 1 s at specified operating temperature. Maximum operating voltage (refer to derating table) must not be exceeded. Usually to be tested with constant current discharge from U _R to 0.5 x U _R . Maximum current should not be used in normal operation and is only provided as reference value. | |
| Leakage current I _L | Measured at U _R . Capacitor is charged to the rated voltage at 20 °C. Leakage current is the current at specified time that is required to keep the capacitor charged at the rated voltage. | |
| Endurance | After loading the capacitor the specified time at maximum category temperature T _{MAX} . and related permissible maximum operating voltage U _R : | |
| | Capacitance | Within ± 30 % of minimum initial specified value |
| | ESR | Less than 3 x initial specified value |
| | Leakage | Within specified value |
| Useful life | After loading the capacitor the specified time at maximum category temperature T _{MAX} . and related permissible maximum operating voltage U _R : | |
| | Capacitance | Within ± 30 % of minimum initial specified value |
| | ESR | Less than 3 x initial specified value |
| | Leakage | Within specified value |
| Storage at upper category temperature | After loading the capacitor the specified time at maximum storage temperature T _{MAX} . without charge and under 40 % RH: | |
| | Capacitance | Within ± 30 % of minimum initial specified value |
| | ESR | Less than 3 x initial specified value |
| | Leakage | Within specified value |
| Shelf life | Stored uncharged at 20 °C. Parameter within initial specification | |
| Cycle life | Cycles at 20 °C between rated voltage and half of rated voltage U _R with constant current 3 A and 1 s rest between charge and discharge: > 500 000 cycles | |
| | Capacitance | Within ± 30 % of minimum initial specified value |
| | ESR | Less than 3 x initial specified value |
| Stored energy E _s specific energy Ed and Ev | E [Wh] = ½ x C x (U _R) ² x 1/3600 Ed [Wh/kg] = ½ x C x (U _R) ² x 1/3600 x 1/mass Ev [Wh/L] = ½ x C x (U _R) ² x 1/3600 x 1/volume | |
| Soldering | Hand or wave soldering allowed. For details refer to soldering requirements for radial aluminum electrolytic capacitors in supplementary document. | |
| Cleaning | For printed circuit board cleaning apply non-aggressive cleaning agents only. For details refer to cleaning requirements for aluminum electrolytic capacitors in supplementary document. | |
| Environmental conditions | Do not expose capacitors to <ul style="list-style-type: none"> • temperatures outside specified range • high humidity atmospheres • corrosive atmospheres, e.g. halogenides, sulphurous or nitrous gases, acid or alkaline solutions, etc. • environments containing oil and grease | |

Notes

- General remark: temperatures to be measured at capacitor case
- (1) Conditions: electrical measurements at 20 °C, unless otherwise specified
- (2) Rated capacitance C_R and ESR_{DC}

MEASURING OF CHARACTERISTICS
CAPACITANCE (C)

Capacitance shall be measured by constant current discharge method.

- Constant current charge with 10 mA/F to U_R
- Constant voltage charge at U_R for 5 min
- Constant current discharge with 10 mA/F to 0.1 V



Fig. 2 - Voltage Diagram for Capacitance Measurement

Capacitance value C_R is given by discharge current I_D , time t and rated voltage U_R , according to the following equation:

$$C_R [F] = \frac{I_D [A] \times (t_2 [s] - t_1 [s])}{U_1 [V] - U_2 [V]}$$

| | |
|--------------|---|
| C_R | Rated capacitance, in F |
| U_R | Rated voltage, in V |
| U_1 | Starting voltage, $0.8 \times U_R$ in V |
| U_2 | Ending voltage, $0.4 \times U_R$ in V |
| ΔU_3 | Voltage drop at internal resistance, in V |
| t_1 | Time from start of discharge until voltage U_1 is reached, in s |
| t_2 | Time from start of discharge until voltage U_2 is reached, in s |
| I_D | Absolute value of discharge current, in A |

EQUIVALENT SERIES RESISTANCE (ESR_{DC})

- Constant current charge to U_R
- Constant voltage charge at U_R for 5 min
- Constant current discharge to 0.1 V

$$ESR_{DC} [\Omega] = \frac{\Delta U_3 [V]}{I_D [A]}$$

| | |
|--------------|---|
| ESR_{DC} | Equivalent series resistance, in Ω |
| ΔU_R | Voltage drop at internal resistance, in V |
| I_D | Absolute value of discharge current, in A |



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