



**THE DATASHEET OF
MAL219612105E3**



Energy Storage Double Layer Capacitors



FEATURES

- Polarized capacitor with high charge density, alternative product to rechargeable backup batteries
- Dielectric: electric double layer
- Radial leads, cylindrical case, insulated with a blue sleeve
- Available in both vertical and low-profile versions
- Unlimited charge and discharge cycle numbers
- No charge-discharge control circuitry and no series resistor necessary
- Maintenance-free, no periodic replacement or service necessary
- Ecologically beneficial (no Cd, no Li)
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


**RoHS
COMPLIANT**

APPLICATIONS

- Energy storage, for backup of semiconductor memories (CMOS) in all fields of electronics
- Telecommunication, audio-video, EDP
- General industrial, clock and timer systems

MARKING

The capacitors are marked with the following information:

- Rated capacitance (in F)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Name of manufacturer
- Negative terminal identification
- Upper category temperature (at 85 °C types only)

| QUICK REFERENCE DATA (Low Leakage Series) | | | |
|--|--------------------------------------|--------------------------|-------------------------|
| DESCRIPTION | VALUE | | |
| | STANDARD FORM A | HIGH TEMPERATURE FORM A | STANDARD FORM B |
| Nominal case sizes (Ø D x L in mm) | 13.5 x 7 and 20.5 x 8 | 13.5 x 7 and 20.5 x 10.5 | 11.5 x 13 and 19 x 20.5 |
| Rated capacitance range, C _R | 0.22 F to 1.5 F | 0.22 F to 1 F | 0.22 F to 1.5 F |
| Tolerance on C _R at 20 °C | -20 % to +80 % | | |
| Rated voltage, U _R | 5.5 V | 5.5 V | 5.5 V |
| Maximum surge voltage, U _S | 6.0 V | 6.0 V | 6.0 V |
| Category temperature range | -25 °C to +70 °C | -40 °C to +85 °C | -25 °C to +70 °C |
| Useful life at U _R : | | | |
| at 85 °C | - | 1000 h | - |
| at 70 °C | 1000 h | 2800 h | 1000 h |
| at 40 °C | 8000 h | 23 000 h | 8000 h |
| at 25 °C | 23 000 h | 64 000 h | 23 000 h |
| Shelf life at 0 V | 1000 h at upper category temperature | | |
| Climatic category IEC 60068 | 25 / 070 / 21 | 25 / 085 / 21 | 25 / 070 / 21 |



| QUICK REFERENCE DATA (Standard Series) | | | |
|---|--------------------------------------|-------------------------|----------------------|
| DESCRIPTION | VALUE | | |
| | STANDARD FORM A | HIGH TEMPERATURE FORM A | VERTICAL FORM B |
| Nominal case sizes (Ø D x L in mm) | 13 x 7 and 21 x 7.5 | 13 x 9 and 21 x 9 | 11.5 x 13 (vertical) |
| Rated capacitance range, C _R | 0.047 F to 1.0 F | 0.047 F to 0.68 F | 0.047 F to 0.33 F |
| Tolerance on C _R at 20 °C | -20 % to +80 % | | |
| Rated voltage, U _R | 5.5 V | 5.5 V | 5.5 V |
| Maximum surge voltage, U _S | 6.3 V | 6.3 V | 6.3 V |
| Category temperature range | -25 °C to +70 °C | -25 °C to +85 °C | -25 °C to +70 °C |
| Useful life at U _R : | | | |
| at 85 °C | - | 1000 h | - |
| at 70 °C | 1000 h | 2800 h | 1000 h |
| at 40 °C | 8000 h | 23 000 h | 8000 h |
| at 25 °C | 23 000 h | 64 000 h | 23 000 h |
| Shelf life at 0 V | 1000 h at upper category temperature | | |
| Climatic category IEC 60068 | 25 / 070 / 21 | 25 / 085 / 21 | 25 / 070 / 21 |

| SELECTION CHART FOR C_R, U_R, AND FORM AT UPPER CATEGORY TEMPERATURE (UCT) | | | | | |
|---|------|------------------------|-------------|--------------------|-------------|
| C _R (F) | FORM | U _R = 5.5 V | | | |
| | | STANDARD SERIES | | LOW LEAKAGE SERIES | |
| | | UCT = 85 °C | UCT = 70 °C | UCT = 85 °C | UCT = 70 °C |
| 0.047 | A | 13 x 9 | 13 x 7 | - | - |
| | B | - | 11.5 x 13 | - | - |
| 0.1 | A | 13 x 9 | 13 x 7 | - | - |
| | B | - | 11.5 x 13 | - | - |
| 0.22 | A | - | 13 x 7 | 13.5 x 9 | 13.5 x 7 |
| | B | - | 11.5 x 13 | - | 11.5 x 13 |
| 0.33 | A | - | 13 x 7 | 13.5 x 9 | 13.5 x 7 |
| | B | - | 11.5 x 13 | - | 11.5 x 13 |
| 0.47 | A | 21 x 9 | 21 x 7.5 | 20.5 x 10.5 | 13.5 x 7 |
| | B | - | - | - | 11.5 x 13 |
| 0.68 | A | 21 x 9 | - | 20.5 x 10.5 | - |
| | B | - | - | - | - |
| 1.0 | A | - | 21 x 7.5 | 20.5 x 10.5 | 20.5 x 8 |
| | B | - | - | - | 19 x 20.5 |
| 1.5 | A | - | - | - | 20.5 x 8 |
| | B | - | - | - | 19 x 20.5 |

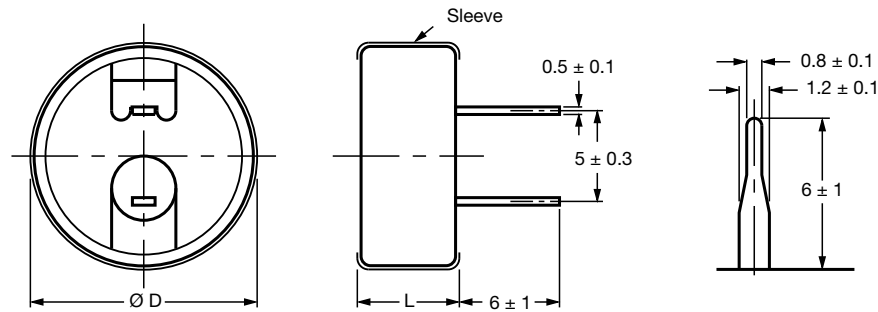
DIMENSIONS in millimeters **AND AVAILABLE FORMS**


Fig. 1 - Form A: Low profile

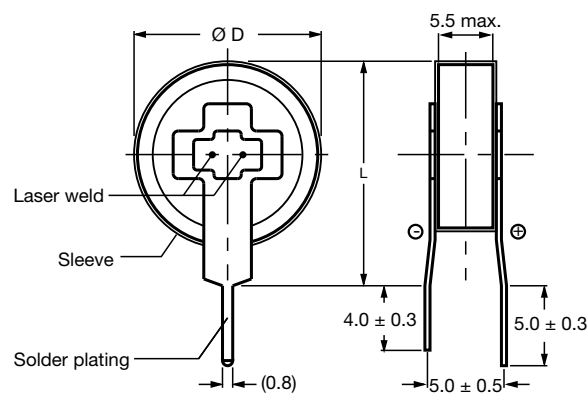


Fig. 2 - Form B: Vertical

| DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES (Low Leakage Series) | | | | | | |
|---|--------------|------|---------------------|-------------------|-------------|-------------------------|
| NOMINAL CASE SIZE Ø D x L (mm) | CASE CODE | FORM | Ø D _{max.} | L _{max.} | MASS (g) | PACKAGING QUANTITIES |
| 11.5 x 13 | 6 | B | 12 | 14 | ≈ 1.6 | 2000 |
| 19 x 20.5 | 7 | B | 19.5 | 21.5 | ≈ 4.0 | 800 |
| 13.5 x 7 | 8 | A | 14 | 7.5 | ≈ 3.5 | 1000 |
| 13.5 x 9 | 8a | A | 14 | 9.5 | ≈ 4.1 | 800 |
| 20.5 x 8 | 9 | A | 21 | 8.5 | ≈ 9.0 | 1000 |
| 20.5 x 10.5 | 10 | A | 21 | 11 | ≈ 10.0 | 600 |

| DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES (Standard Series) | | | | | | |
|--|--------------|------|---------------------|-------------------|-------------|-------------------------|
| NOMINAL CASE SIZE Ø D x L (mm) | CASE CODE | FORM | Ø D _{max.} | L _{max.} | MASS (g) | PACKAGING QUANTITIES |
| 11.5 x 13 | 1 | B | 11.8 | 13.5 | ≈ 1.5 | 1000 |
| 13 x 7 | 2 | A | 13.5 | 7.5 | ≈ 2.8 | 1000 |
| 13 x 9 | 3 | A | 13.5 | 9.5 | ≈ 3.4 | 1000 |
| 21 x 7.5 | 4 | A | 21.5 | 8.0 | ≈ 7.1 | 500 |
| 21 x 9 | 5 | A | 21.5 | 9.5 | ≈ 8.8 | 500 |

Note

- Packaging: bulk in box



| ELECTRICAL DATA | |
|-----------------|---|
| SYMBOL | DESCRIPTION |
| C_R | Rated capacitance, tolerance -20 % / +80 %, measured by constant current discharge method |
| UCT | Upper category temperature |
| I_L | Max. leakage current after 30 min at U_R |
| R_1 | Max. internal resistance at 1 kHz |

Note

- Unless otherwise specified, all electrical values in Table 1 apply at $T_{amb} = 20\text{ °C}$, $P = 86\text{ kPa}$ to 106 kPa and $RH = 45\text{ %}$ to 75 %

ORDERING EXAMPLE

Double layer capacitor 196 series

1.0 F / 5.5 V

Nominal case size: $\varnothing 20.5\text{ mm} \times 8\text{ mm}$; form A

Ordering code: MAL219642105E3

Table 1

| ELECTRICAL DATA AND ORDERING INFORMATION (Low Leakage Series) ⁽¹⁾ | | | | | | | | |
|--|--------------|--|-----------|------|-------------|--------------------------------|--------------------------------|----------------|
| U_R (V) | C_R (F) | NOMINAL CASE SIZE $\varnothing D \times L$ (mm) | CASE CODE | FORM | UCT (°C) | I_L 30 min (μA) | R_1 1 kHz (Ω) | ORDERING CODE |
| STANDARD SERIES | | | | | | | | |
| 5.5 | 0.22 | 13.5 x 7 | 8 | A | 70 | 3 | 75 | MAL219642224E3 |
| | 0.33 | 13.5 x 7 | 8 | A | 70 | 5 | 50 | MAL219642334E3 |
| | 0.47 | 13.5 x 7 | 8 | A | 70 | 5 | 50 | MAL219642474E3 |
| | 1.0 | 20.5 x 8 | 9 | A | 70 | 8 | 30 | MAL219642105E3 |
| | 1.5 | 20.5 x 8 | 9 | A | 70 | 8 | 30 | MAL219642155E3 |
| STANDARD SERIES, VERTICAL | | | | | | | | |
| 5.5 | 0.22 | 11.5 x 13 | 6 | B | 70 | 3 | 75 | MAL219652224E3 |
| | 0.33 | 11.5 x 13 | 6 | B | 70 | 5 | 50 | MAL219652334E3 |
| | 0.47 | 11.5 x 13 | 6 | B | 70 | 5 | 50 | MAL219652474E3 |
| | 1.0 | 19 x 20.5 | 7 | B | 70 | 8 | 30 | MAL219652105E3 |
| | 1.5 | 19 x 20.5 | 7 | B | 70 | 8 | 30 | MAL219652155E3 |
| HIGH TEMPERATURE SERIES | | | | | | | | |
| 5.5 | 0.22 | 13.5 x 9 | 8a | A | 85 | 3 | 75 | MAL219662224E3 |
| | 0.33 | 13.5 x 9 | 8a | A | 85 | 5 | 50 | MAL219662334E3 |
| | 0.47 | 20.5 x 10.5 | 10 | A | 85 | 10 | 50 | MAL219662474E3 |
| | 0.68 | 20.5 x 10.5 | 10 | A | 85 | 8 | 30 | MAL219662684E3 |
| | 1.0 | 20.5 x 10.5 | 10 | A | 85 | 10 | 30 | MAL219662105E3 |

Note

- ⁽¹⁾ Preferred for ordering

Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION (Standard Series) ⁽¹⁾ | | | | | | | | |
|---|--------------|---|-----------|------|-------------|--------------------------------|--------------------------------|----------------|
| U_R (V) | C_R (F) | NOMINAL CASE SIZE $\varnothing D \times L$ (mm) | CASE CODE | FORM | UCT (°C) | I_L 30 min (μA) | R_1 1 kHz (Ω) | ORDERING CODE |
| STANDARD SERIES | | | | | | | | |
| 5.5 | 0.047 | 13 x 7 | 2 | A | 70 | 69 | 120 | MAL219612473E3 |
| | 0.10 | 13 x 7 | 2 | A | 70 | 100 | 75 | MAL219612104E3 |
| | 0.22 | 13 x 7 | 2 | A | 70 | 135 | 75 | MAL219612224E3 |
| | 0.33 | 13 x 7 | 2 | A | 70 | 182 | 75 | MAL219612334E3 |
| | 0.47 | 21 x 7.5 | 4 | A | 70 | 216 | 30 | MAL219612474E3 |
| | 1.0 | 21 x 7.5 | 4 | A | 70 | 315 | 30 | MAL219612105E3 |
| HIGH TEMPERATURE SERIES | | | | | | | | |
| 5.5 | 0.047 | 13 x 9 | 3 | A | 85 | 69 | 300 | MAL219622473E3 |
| | 0.10 | 13 x 9 | 3 | A | 85 | 100 | 200 | MAL219622104E3 |
| | 0.47 | 21 x 9 | 5 | A | 85 | 216 | 50 | MAL219622474E3 |
| | 0.68 | 21 x 9 | 5 | A | 85 | 260 | 50 | MAL219622684E3 |
| VERTICAL, MINIATURIZED SERIES | | | | | | | | |
| 5.5 | 0.047 | 11.5 x 13 | 1 | B | 70 | 69 | 120 | MAL219632473E3 |
| | 0.10 | 11.5 x 13 | 1 | B | 70 | 100 | 75 | MAL219632104E3 |
| | 0.22 | 11.5 x 13 | 1 | B | 70 | 135 | 75 | MAL219632224E3 |
| | 0.33 | 11.5 x 13 | 1 | B | 70 | 182 | 75 | MAL219632334E3 |

Note

- ⁽¹⁾ Not recommended for new design

MEASURING OF CHARACTERISTICS

CAPACITANCE (C)

Capacitance shall be measured by constant current discharge method.

| DISCHARGE CURRENT AS A FUNCTION OF RATED CAPACITANCE | | | | | | | | | |
|--|-------|-----|------|------|------|------|-----|-----|------|
| PARAMETER | VALUE | | | | | | | | UNIT |
| Rated capacitance, C _R | 0.047 | 0.1 | 0.22 | 0.33 | 0.47 | 0.68 | 1.0 | 1.5 | F |
| Discharge current, I _D | 0.1 | | | 1.0 | | | | | mA |

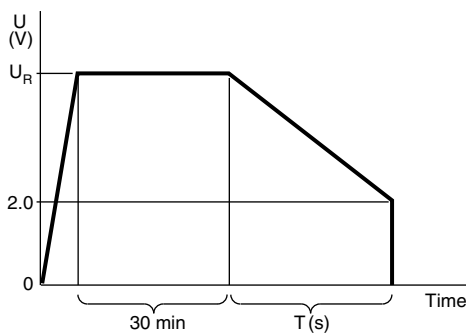


Fig. 3 - Voltage diagram for capacitance measurement

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

$$C(F) = \frac{I_D(mA) \times 10^{-3} \times T(s)}{U_R(V) - 2}$$

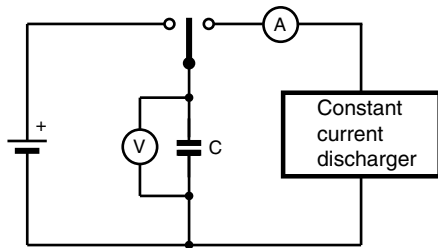


Fig. 4 - Test circuit for capacitance measurement

INTERNAL RESISTANCE (R_I) AT 1 kHz

$$R_I(\Omega) = \frac{V_C(V)}{10^{-3}}$$

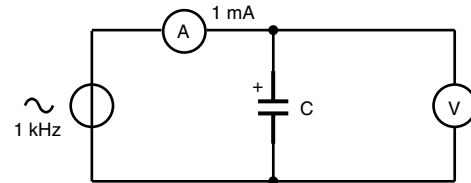


Fig. 5 - Test circuit for R_I measurement

LEAKAGE CURRENT (I_L)

Leakage current shall be measured after 30 min application of rated voltage U_R:

$$I_L(\mu A) = \frac{V(V)}{10^{-4}}$$

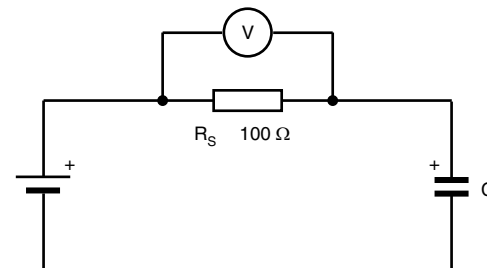


Fig. 6 - Test circuit for leakage current

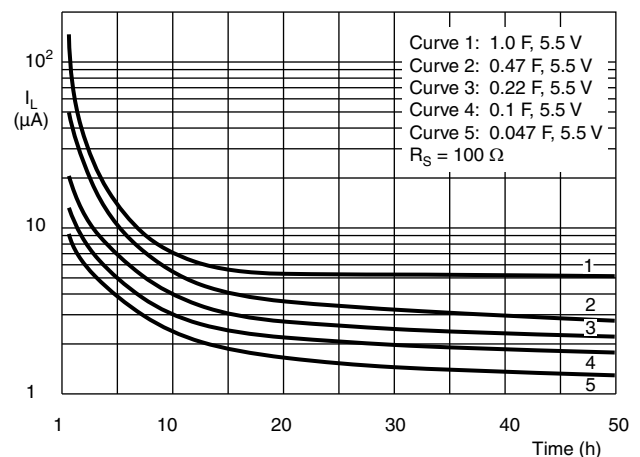


Fig. 7 - Typical leakage current as a function of time

DISCHARGE CHARACTERISTICS

Backup time of 196 DLC series capacitors depends on minimum memory holding voltage and discharge current (corresponding with the current consumption of the load). For minimum backup times of standard and vertical miniaturized series see Figures 8 and 9 (charging time ≥ 24 h).

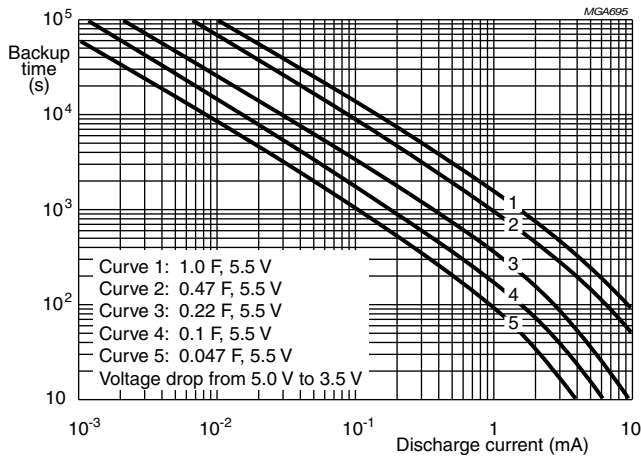


Fig. 8 - Typical backup time as a function of discharge current

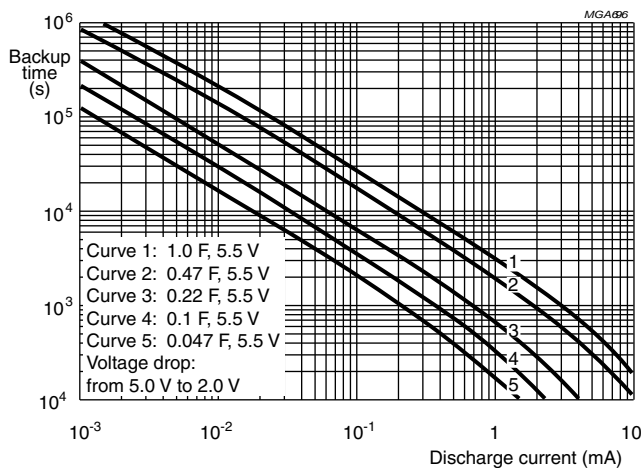


Fig. 9 - Typical backup time as a function of discharge current

Figure 10 shows the backup time when a 196 DLC capacitor is discharged by a constant resistance (charging time ≥ 24 h).

The horizontal axis shows the initial value of discharge current if 5 V is connected to the capacitor via a fixed series resistor.

Example: 1 μ A corresponds to 5 M Ω and 0.1 μ A corresponds to 50 M Ω

The vertical axis shows that period of time during which the voltage drops from 5 V to 2 V.

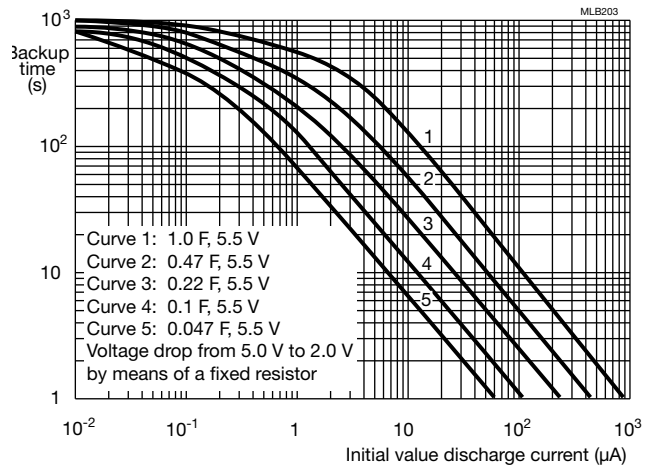


Fig. 10 - Typical backup time as a function of initial discharge current

Table 3

| TEST PROCEDURES AND REQUIREMENTS for standard and vertical miniaturized series (5.5 V; 70 °C) | | | |
|--|---|---|---|
| NAME OF TEST | IEC 60384-4 / EN130300 SUBCLAUSE | PROCEDURE (quick reference) | REQUIREMENTS |
| Robustness of terminations | 4.4 | Tensile strength; application of loading force for 10 s: 20 N (standard series) 5 N (vertical miniaturized series) | No breaks |
| Resistance to soldering heat | 4.5 | Solder bath; 260 °C; 5 s | $\Delta C/C: \pm 10 \%$ R_I and $I_L \leq \text{spec. limit}$ |
| Solderability | 4.6 | Solder bath; 235 °C; 2 s | $\geq 75 \%$ tinning |
| Vibration | 4.8 | 10 Hz to 55 Hz; 1.5 mm; 3 directions; 2 h per direction | $\Delta C/C: \pm 10 \%$ R_I and $I_L \leq \text{spec. limit}$ |
| Damp heat, steady state | 4.12 | 500 h at 55 °C; RH 90 % to 95 %; no voltage applied | $\Delta C/C: \pm 30 \%$ $R_I \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$ |
| Endurance | 4.13 | $T_{\text{amb}} = 70 \text{ °C}$; 5.5 V applied; 1000 h | $\Delta C/C: \pm 30 \%$ $R_I \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$ |
| Useful life | - | $T_{\text{amb}} = 70 \text{ °C}$; 5.5 V applied; 1000 h | $\Delta C/C: \pm 30 \%$ $R_I \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$ |
| Storage at upper category temperature | 4.17 | $T_{\text{amb}} = 70 \text{ °C}$; no voltage applied; 1000 h | $\Delta C/C: \pm 30 \%$ $R_I \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$ |
| Self discharge | - | 24 h storage at room temperature after application of 5 V for 1 h | Remaining voltage: $\geq 4 \text{ V}$ |
| Characteristics at high and low temperature | 4.19 | Step 1: reference measurement at +20 °C of C, R_I and I_L Step 2: measurement at -25 °C Step 3: measurement at +20 °C Step 4: measurement at +70 °C Step 5: measurement at +20 °C | $\Delta C/C: \pm 30 \%$ of +20 °C value $R_I \leq 5 \times \text{the } +20 \text{ °C value}$ $I_L \leq 4 \times \text{the } +20 \text{ °C value}$ |

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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