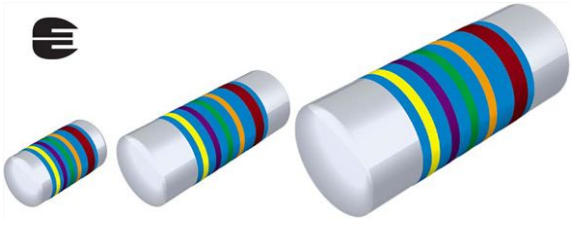
# Professional Thin Film MELF Resistors



MMU 0102, MMA 0204 and MMB 0207 professional thin film MELF resistors are the perfect choice for most fields of modern professional electronics where reliability and stability is of major concern. The typical applications in the fields of automotive, telecommunication and medical equipment reflect the outstanding level of proven reliability.

## FEATURES

- Approved according to EN 140401-803
- AEC-Q200 qualified
- Advanced metal film technology
- Excellent overall stability: Exceeds class 0.25
- Sulfur resistance verified according to ASTM B 809
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE

Pb-free

RoHS COMPLIANT

HALOGEN FREE

GREEN (5-2008)

## APPLICATIONS

- Automotive
- Telecommunication
- Industrial
- Medical equipment

| TECHNICAL SPECIFICATIONS | | | |
|---|---|---|---|
| **DESCRIPTION** | **MMU 0102** | **MMA 0204** | **MMB 0207** |
| DIN size | 0102 | 0204 | 0207 |
| Metric CECC size | RC 2211M | RC 3715M | RC 6123M |
| Resistance range | 0.22 Ω to 2.21 MΩ; 0 Ω | 0.22 Ω to 10 MΩ; 0 Ω | 0.1 Ω to 15 MΩ; 0 Ω |
| Resistance tolerance | ± 5 %; ± 2 %; ± 1 %; ± 0.5 % | ± 5 %; ± 1 %; ± 0.5 % | ± 5 %; ± 2 %; ± 1 %; ± 0.5 % |
| Temperature coefficient | ± 50 ppm/K; ± 25 ppm/K | | ± 100 ppm/K; ± 50 ppm/K; ± 25 ppm/K |
| Rated dissipation, $P_{70}$ (1) | 0.3 W | 0.4 W | 1.0 W |
| Operating voltage, $U_{max.}$ AC/DC | 150 V | 200 V | 350 V |
| Operating temperature range | - 55 °C to 155 °C | - 55 °C to 155 °C | - 55 °C to 155 °C |
| Permissible voltage against ambient (insulation): | | | |
| 1 min, $U_{ins}$ | 200 V | 300 V | 500 V |
| Continuous | 75 V | 75 V | 75 V |
| Failure rate: $FIT_{observed}$ | ≤ 0.1 x $10^{-9}$/h | | |

**Note**

(1) Please refer to APPLICATION INFORMATION below.

## APPLICATION INFORMATION

The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded. Furthermore, a high level of ambient temperature or of power dissipation may raise the temperature of the solder joint, hence special solder alloys or board materials may be required to maintain the reliability of the assembly.

These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime. At the maximum permissible film temperature of 155 °C the useful lifetime is specified for 8000 h. The designer may estimate the performance of the particular resistor application or set certain load and temperature limits in order to maintain a desired stability.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| MAXIMUM RESISTANCE CHANGE AT RATED DISSIPATION | | | |
|---|---|---|---|
| **OPERATION MODE** | | **STANDARD** | **POWER** |
| Rated dissipation, $P_{70}$ | MMU 0102 | 0.2 W | 0.3 W |
| | MMA 0204 | 0.25 W | 0.4 W |
| | MMB 0207 | 0.4 W | 1.0 W [(1)] |
| Operating temperature range | | - 55 °C to 125 °C | - 55 °C to 155 °C |
| Permissible film temperature, $\vartheta_F$ max. | | 125 °C | 155 °C |
| Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ after: | MMU 0102 | 0.22 Ω to 221 kΩ | 0.22 Ω to 221 kΩ |
| | MMA 0204 | 0.22 Ω to 332 kΩ | 0.22 Ω to 332 kΩ |
| | MMB 0207 | 0.22 Ω to 1 MΩ | 0.22 Ω to 1 MΩ |
| | 1000 h | ≤ 0.15 % | ≤ 0.25 % |
| | 8000 h | ≤ 0.3 % | ≤ 0.5 % |
| | 225 000 h | ≤ 1.0 % | - |

**Note**

(1) Specified power rating requires dedicated heat sink pads.

| TEMPERATURE COEFFICIENT AND RESISTANCE RANGE | | | | |
|---|---|---|---|---|
| **TYPE/SIZE** | **TCR** | **TOLERANCE** | **RESISTANCE** | **E-SERIES** |
| MMU 0102 | ± 50 ppm/K | ± 5 % | 0.22 Ω to 0.91 Ω | E24 |
| | | ± 2 % | 1 Ω to 9.1 Ω | |
| | | ± 1 % | 10 Ω to 2.21 MΩ | E24; E96 |
| | | ± 0.5 % | 10 Ω to 221 kΩ | E24; E192 |
| | ± 25 ppm/K | ± 1 % | 10 Ω to 221 kΩ | E24; E96 |
| | | ± 0.5 % | 10 Ω to 221 kΩ | E24; E192 |
| | Jumper | - | ≤ 10 mΩ; $I_{max.}$ = 2 A | - |
| MMA 0204 | ± 50 ppm/K | ± 5 % | 0.22 Ω to 0.91 Ω | E24 |
| | | ± 1 % | 1 Ω to 10 MΩ | E24; E96 |
| | | ± 0.5 % | 10 Ω to 2.21 MΩ | E24; E192 |
| | ± 25 ppm/K | ± 1 % | 10 Ω to 511 kΩ | E24; E96 |
| | | ± 0.5 % | 10 Ω to 511 kΩ | E24; E192 |
| | Jumper | - | ≤ 10 mΩ; $I_{max.}$ = 3 A | - |
| MMB 0207 | ± 100 ppm/K | ± 5 % | 0.1 Ω to 0.2 Ω | E24 |
| | ± 50 ppm/K | ± 5 % | 0.22 Ω to 0.91 Ω | |
| | | ± 2 % | 0.2 Ω to 0.91 Ω | |
| | | ± 1 % | 1 Ω to 15 MΩ | E24; E96 |
| | ± 25 ppm/K | ± 0.5 % | 10 Ω to 1 MΩ | E24; E192 |
| | Jumper | - | ≤ 10 mΩ; $I_{max.}$ = 5 A | - |


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## PACKAGING

| TYPE/SIZE | CODE | QUANTITY | CARRIER TAPE | WIDTH | PITCH | REEL DIAMETER |
|---|---|---|---|---|---|---|
| MMU 0102 | B3 = BL | 3000 | Antistatic blister tape acc. IEC 60286-3 type II | 8 mm | 4 mm | 180 mm/7" |
| | B0 | 10 000 | | | | 330 mm/13" |
| | M8 | 8000 | Bulk case acc. IEC 60286-6 | - | - | - |
| MMA 0204 | B3 = BL | 3000 | Antistatic blister tape acc. IEC 60286-3 type II | 8 mm | 4 mm | 180 mm/7" |
| | B0 | 10 000 | | | | 330 mm/13" |
| | M3 | 3000 | Bulk case acc. IEC 60286-6 | - | - | - |
| MMB 0207 | B2 | 2000 | Antistatic blister tape acc. IEC 60286-3 type II | 12 mm | 4 mm | 180 mm/7" |
| | B7 | 7000 | | | | 330 mm/13" |

## PART NUMBER AND PRODUCT DESCRIPTION

**Part Number: MMB02070D5620DB200**
**Part Number: MMB02070Z0000ZB200**

| M | M | B | 0 | 2 | 0 | 7 | 0 | D | 5 | 6 | 2 | 0 | D | B | 2 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | M | B | 0 | 2 | 0 | 7 | 0 | Z | 0 | 0 | 0 | 0 | Z | B | 2 | 0 | 0 |

| TYPE/SIZE | VERSION | TCR | RESISTANCE | TOLERANCE | PACKAGING |
|---|---|---|---|---|---|
| **MMU 0102**<br>**MMA 0204**<br>**MMB 0207** | **0** =<br>EN 140401-803,<br>"Version A" | **D** = ± 25 ppm/K<br>**C** = ± 50 ppm/K<br>**B** = ± 100 ppm/K<br>**Z** = Jumper | **3 digit value**<br>**1 digit multiplier**<br><br>MULTIPLIER<br>**7** = $*10^{-3}$<br>**8** = $*10^{-2}$<br>**9** = $*10^{-1}$<br>**0** = $*10^{0}$<br>**1** = $*10^{1}$<br>**2** = $*10^{2}$<br>**3** = $*10^{3}$<br>**4** = $*10^{4}$<br>**5** = $*10^{5}$<br>**0000** = Jumper | **D** = ± 0.5 %<br>**F** = ± 1 %<br>**G** = ± 2 %<br>**J** = ± 5 %<br>**Z** = Jumper | **B3**<br>**B0**<br>**B2**<br>**B7**<br>**M3**<br>**M8** |

**Product Description: MMB 0207-25 0.5% B2 562R**
**Product Description: MMB 0207 B2 0R0**

| | | | | | |
|---|---|---|---|---|---|
| **MMB** | **0207** | **-25** | **0.5 %** | **B2** | **562R** |
| **MMA** | **0207** | **-** | **-** | **B2** | **0R0** |
| TYPE | SIZE | TCR | TOLERANCE | PACKAGING | RESISTANCE |
| **MMU**<br>**MMA**<br>**MMB** | **0102**<br>**0204**<br>**0207** | ± **25** ppm/K<br>± **50** ppm/K<br>± **100** ppm/K | ± **0.5** %<br>± **1** %<br>± **2** %<br>± **5** % | **BL**<br>**B0**<br>**B2**<br>**B7**<br>**M3**<br>**M8** | **562R** = 562 Ω<br>**0R0** = Jumper |

**Note**

- Products can be ordered using either the PART NUMBER or the PRODUCT DESCRIPTION.


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## DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a high grade ceramic body ($Al_2O_3$) and conditioned to achieve the desired temperature coefficient. Nickel plated steel termination caps are firmly pressed on the metallised rods. A special laser is used to achieve the target value by smoothly cutting a helical groove in the resistive layer without damaging the ceramics. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating. Four or five colour code rings designate the resistance value and tolerance in accordance with **IEC 60062** [(1)].
The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. This includes full screening for the elimination of products with a potential risk of early field failures (feasible for $R \geq 10\ \Omega$) according to EN 140401-803, 2.1.2.2. Only accepted products are laid directly into the blister tape in accordance with **IEC 60286-3, Type II** [(1)] or bulk case in accordance with **IEC 60286-6** [(1)].

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## ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1** [(1)]. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The suitability of conformal coatings, if applied, shall be qualified by appropriate means to ensure the long-term stability of the whole system.
The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes. Solderability is specified for 2 years after production or requalification, however, excellent solderability is proven after extended storage in excess of 10 years. The permitted storage time is 20 years. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **JIG 101** list of legal restrictions on hazardous substances.
This includes full compliance with the following directives:

- 2000/53/EC End of Life Vehicle Directive (ELV) and Annex II (ELV II)
- 2011/65/EU Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

## APPROVALS

The resistors are approved within the IECQ-CECC Quality Assessment System for Electronic Components to the detail specification **EN 140401-803** which refers to **EN 60115-1**, **EN 140400** and the variety of environmental test procedures of the **IEC 60068** [(1)] series.

Conformity is attested by the use of the **CECC** logo ( ) as the mark of conformity on the package label. Vishay Beyschlag has achieved "**Approval of Manufacturer**" in accordance with **IECQ 03-1**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240001** based on **IECQ 03-3-1**is granted for the Vishay Beyschlag manufacturing process.

The resistors are qualified according to AEC-Q200.

## RELATED PRODUCTS

For products with precision specification see the datasheet:

- "Precision Thin Film MELF Resistors" (www.vishay.com/doc?28714)
- "Ultra Precision Thin Film MELF Resistors" (www.vishay.com/doc?28715)

Resistors are available with established reliability in accordance with **EN 140401-803 Version E**. Please refer to datasheet "MELF Resistors with Established Reliability". (www.vishay.com/doc?28707)

**Note**

(1) The quoted IEC standards are also released as EN standards with the same number and identical contents.


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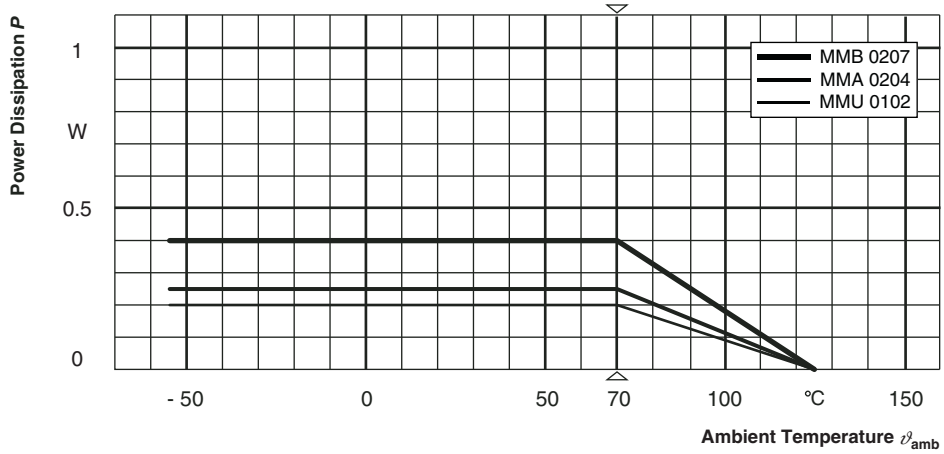
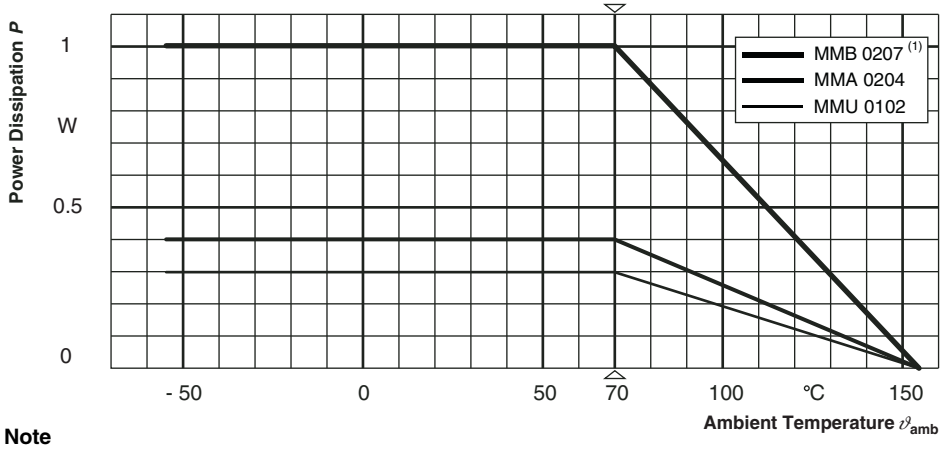
## FUNCTIONAL PERFORMANCE



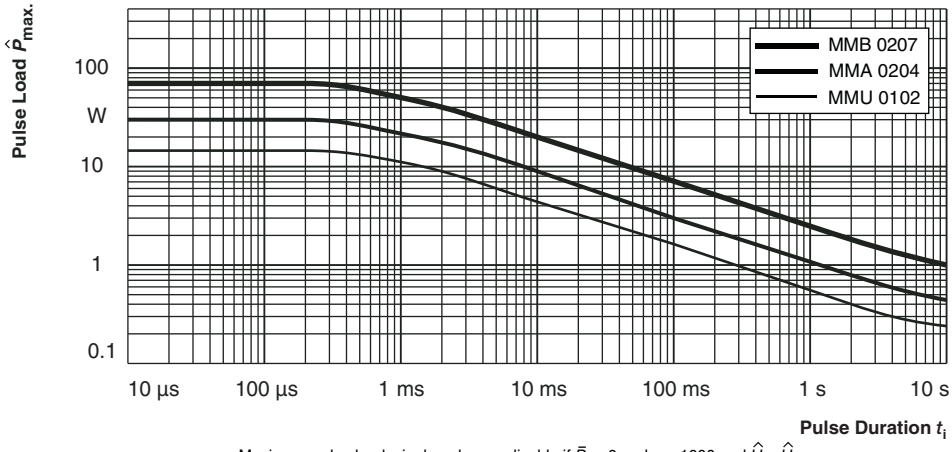

### Derating - Standard Operation Mode




**Note**

(1) Specified power rating requires dedicated heat sink pads

### Derating - Power Operation Mode




### Single Pulse

Maximum pulse load, single pulse; applicable if $\bar{P} \rightarrow 0$ and n ≤ 1000 and $\hat{U} \leq \hat{U}_{max.}$;
for permissible resistance change equivalent to 8000 h operation in power operation mode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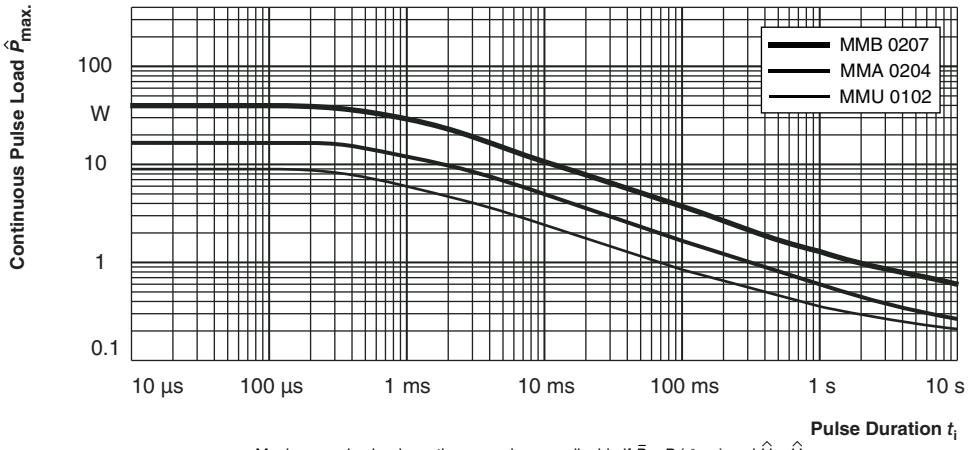
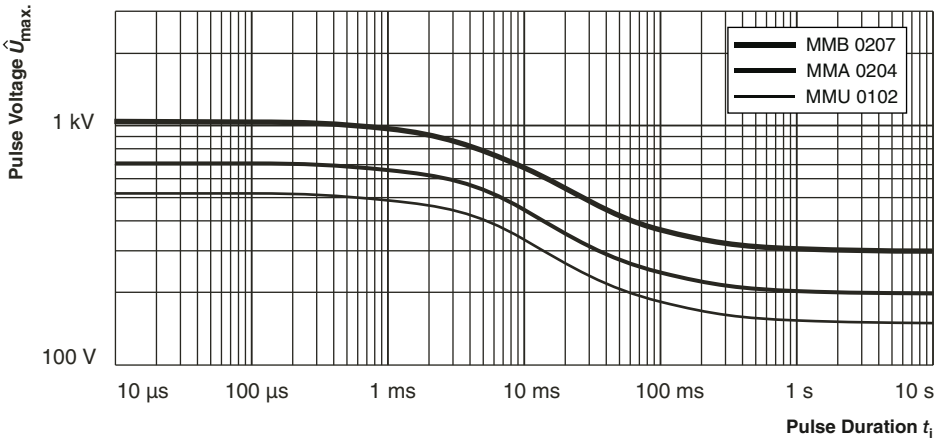


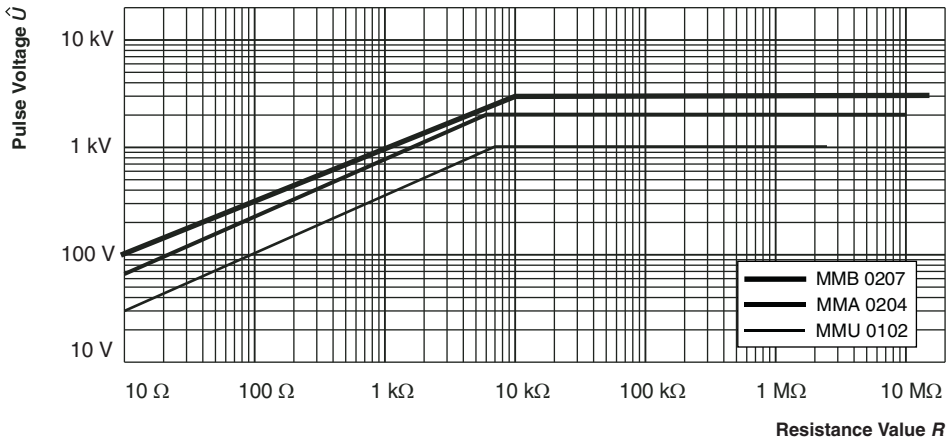

Maximum pulse load, continuous pulses; applicable if $\bar{P} \leq P(\vartheta_{amb})$ and $\hat{U} \leq \hat{U}_{max.}$;
for permissible resistance change equivalent to 8000 h operation in power operation mode

**Continuous Pulse**




Maximum pulse voltage, single and continuous pulses; applicable if $\hat{P} \leq \hat{P}_{max.}$;
for permissible resistance change equivalent to 8000 h operation in power operation mode

**Pulse Voltage**




Pulse load rating in accordance with IEC 60 115-1, 4.27; 1.2 µs/50 µs;
5 pulses at 12 s intervals; for permissible resistance change (0.5 % x $R$ + 0.05 Ω)

**1.2/50 Pulse**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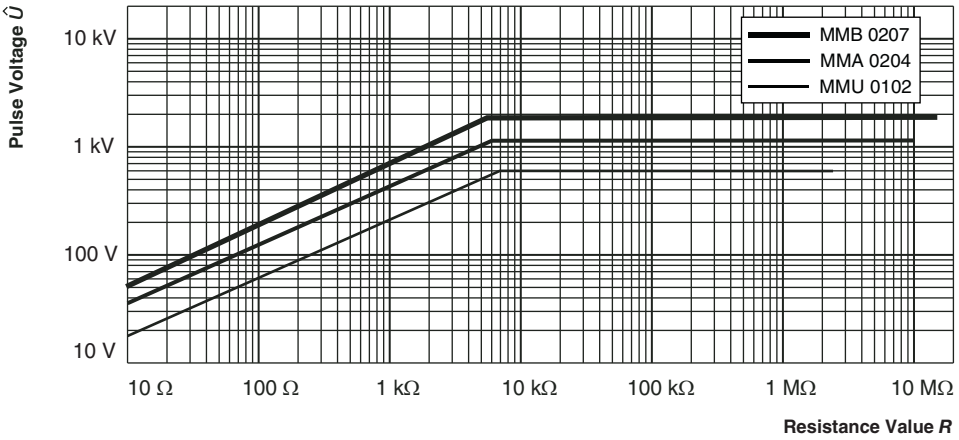
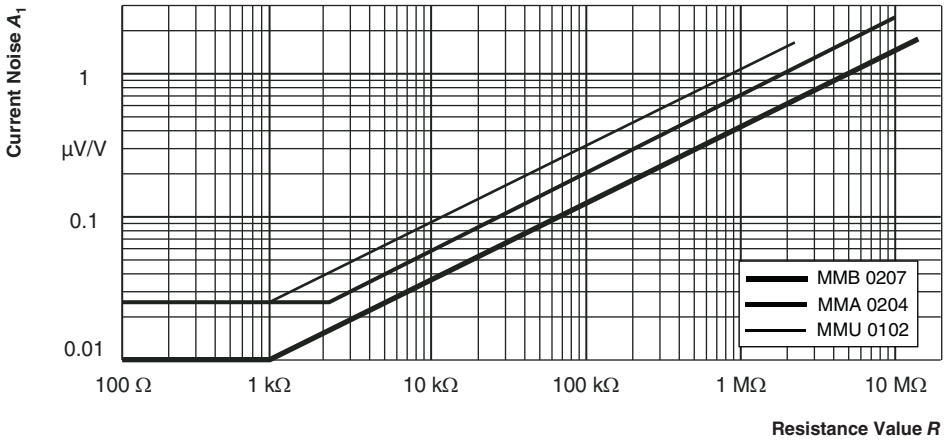


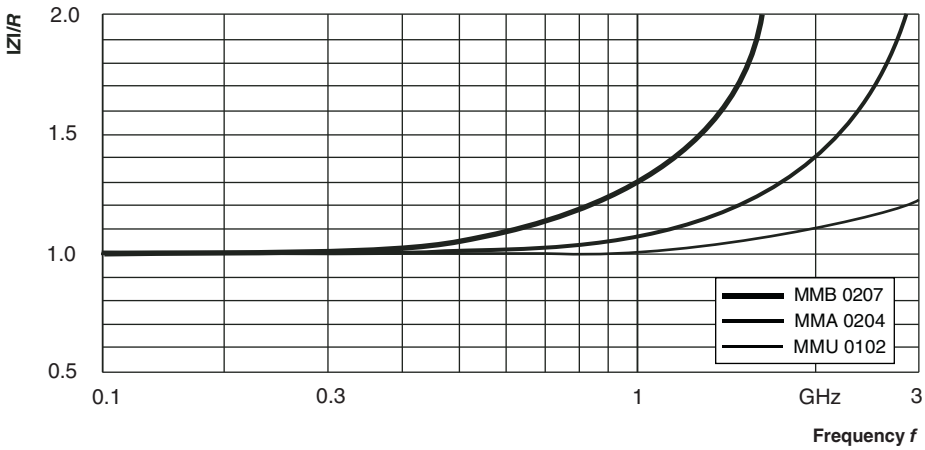

Pulse load rating in accordance with IEC 60115-1, 4.27; 10 µs/700 µs;
10 pulses at 1 minute intervals; for permissible resistance change (0.5 % x *R* + 0.05 Ω)

**10/700 Pulse**




Accordance with IEC 60195

**Current Noise - $A_1$**




|*Z*|/*R* for 49.9 Ω MELF resistors

**RF - Behaviour**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## TESTS AND REQUIREMENTS

All tests are carried out in accordance with the following specifications:

EN 60115-1, generic specification (includes tests)

EN 140400, sectional specification (includes schedule for qualification approval)

EN 140401-803, detail specification (includes schedule for conformance inspection)

The components are approved in accordance with the IECQ-CECC-system, where applicable. The following table contains only the most important tests. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS 703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60068 (1) and under standard atmospheric conditions in accordance with IEC 60068-1 (1), 5.3. A climatic category temperature is applied, defined by the lower category temperature (LCT), the upper category temperature (UCT), and the number of days of the damp heat steady state test. (56).

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on printed-circuit boards in accordance with EN 140400, 2.3.3, unless otherwise specified.

The requirements stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140401-803. However, some additional tests and a number of improvements against those minimum requirements have been included.

**TEST PROCEDURES AND REQUIREMENTS**

| EN 60115-1 CLAUSE | IEC 60068-2 (1) TEST METHOD | TEST | PROCEDURE | REQUIREMENTS PERMISSIBLE CHANGE ($\Delta R$) | | | |
|---|---|---|---|---|---|---|---|
| | | | Stability for product types: | STABILITY CLASS 0.25 OR BETTER | STABILITY CLASS 0.5 OR BETTER | STABILITY CLASS 1 OR BETTER | STABILITY CLASS 2 OR BETTER |
| | | | **MMU 0102** | 10 Ω to 221 kΩ | 1 Ω to < 10 Ω | < 1 Ω | > 221 kΩ |
| | | | **MMA 0204** | 10 Ω to 332 kΩ | 1 Ω to < 10 Ω | < 1 Ω | > 332 kΩ |
| | | | **MMB 0207** | 10 Ω to 1 MΩ | 1 Ω to < 10 Ω | < 1 Ω | > 1 MΩ |
| 4.5 | - | Resistance | - | ± 1 % $R$; ± 0.5 % $R$ | ± 2 % $R$; ± 1 % $R$ | ± 5 % $R$ | ± 1 % $R$ |
| 4.8.4.2 | - | Temperature coefficient | At (20/- 55/20) °C and (20/125/20) °C | ± 50 ppm/K, ± 25 ppm/K | | | |
| 4.25.1 | - | Endurance at 70 °C: Standard operation mode | $U = \sqrt{P_{70} \times R} \leq U_{max.}$; 1.5 h on; 0.5 h off; 70 °C; 1000 h | ± (0.15 % $R$ + 10 mΩ) | | | ± (0.5 % $R$ + 10 mΩ) |
| | | | 70 °C; 8000 h | ± (0.3 % $R$ + 10 mΩ) | | | ± (1 % $R$ + 10 mΩ) |
| | | Endurance at 70 °C: Power operation mode | $U = \sqrt{P_{70} \times R} \leq U_{max.}$; 1.5 h on; 0.5 h off; 70 °C; 1000 h | ± (0.25 % $R$ + 10 mΩ) | | | ± (0.5 % $R$ + 10 mΩ) |
| | | | 70 °C; 8000 h | ± (0.5 % $R$ + 10 mΩ) | | | ± (1 % $R$ + 10 mΩ) |
| 4.25.3 | – | Endurance at upper category temperature | 125 °C; 1000 h | ± (0.15 % $R$ + 5 mΩ) | ± (0.25 % $R$ + 5 mΩ) | ± (0.5 % $R$ + 5 mΩ) | ± (1 % $R$ + 5 mΩ) |
| | | | 155 °C; 1000 h | ± (0.3 % $R$ + 5 mΩ) | ± (0.5 % $R$ + 5 mΩ) | ± (0.1 % $R$ + 5 mΩ) | ± (2 % $R$ + 5 mΩ) |
| 4.24 | 78 (Cab) | Damp heat, steady state | (40 ± 2) °C; 56 days; (93 ± 3) % RH | ± (0.15 % $R$ + 10 mΩ) | ± (0.5 % $R$ + 10 mΩ) | ± (0.1 % $R$ + 10 mΩ) | ± (1 % $R$ + 10 mΩ) |
| 4.39 | 67 (Cy) | Damp heat, steady state, accelerated | (85 ± 2) °C; (85 ± 5) % RH; $U = 0.3 \times \sqrt{P_{70} \times R} \leq 100$ V and $U = 0.3 \times U_{max.}$; (the smaller value is valid) 1000 h | ± (0.25 % $R$ + 10 mΩ) | ± (0.5 % $R$ + 10 mΩ) | ± (1 % $R$ + 10 mΩ) | ± (2 % $R$ + 10 mΩ) |


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| TEST PROCEDURES AND REQUIREMENTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| EN 60115-1 CLAUSE | IEC 60068-2 (1) TEST METHOD | TEST | PROCEDURE | REQUIREMENTS PERMISSIBLE CHANGE (Δ*R*) | | | |
| | | | Stability for product types: | STABILITY CLASS 0.25 OR BETTER | STABILITY CLASS 0.5 OR BETTER | STABILITY CLASS 1 OR BETTER | STABILITY CLASS 2 OR BETTER |
| | | | **MMU 0102** | 10 Ω to 221 kΩ | 1 Ω to < 10 Ω | < 1 Ω | > 221 kΩ |
| | | | **MMA 0204** | 10 Ω to 332 kΩ | 1 Ω to < 10 Ω | < 1 Ω | > 332 kΩ |
| | | | **MMB 0207** | 10 Ω to 1 MΩ | 1 Ω to < 10 Ω | < 1 Ω | > 1 MΩ |
| 4.23 | | Climatic sequence: | | ± (0.15 % *R* + 10 mΩ) | ± (0.5 % *R* + 10 mΩ) | ± (1 % *R* + 10 mΩ) | ± (1 % *R* + 10 mΩ) |
| 4.23.2 | 2 (Bb) | Dry heat | UCT; 16 h | | | | |
| 4.23.3 | 30 (Db) | Damp heat, cyclic | 55 °C; 24 h; ≥ 90 % RH; 1 cycle | | | | |
| 4.23.4 | 1 (Ab) | Cold | LCT; 2 h | | | | |
| 4.23.5 | 13 (M) | Low air pressure | 8.5 kPa; 2 h; (25 ± 10) °C | | | | |
| 4.23.6 | 30 (Db) | Damp heat, cyclic | 55 °C; 24 h; ≥ 90 % RH; 5 cycles | | | | |
| 4.23.7 | - | DC load | $U = \sqrt{P_{70} \times R} \leq U_{max.}$; 1 min. LCT = - 55 °C; UCT = 155 °C | | | | |
| - | 1 (Ab) | Cold | - 55 °C; 2 h | ± (0.05 % *R* + 5 mΩ) | | | ± (0.1 % *R* + 5 mΩ) |
| 4.19 | 14 (Na) | Rapid change of temperature | 30 min at LCT; 30 min at UCT; LCT = - 55 °C; UCT = 125 °C | ± (0.05 % *R* + 10 mΩ) | | | |
| | | | 5 cycles | | | | ± (0.1 % *R* + 10 mΩ) |
| | | | 1000 cycles | ± (0.15 % *R* + 10 mΩ) | | | ± (0.25 % *R* + 10 mΩ) |
| | | | LCT = - 55 °C; UCT = 155 °C | ± (0.25 % *R* + 10 mΩ) | | | |
| | | | 1000 cycles | | | | ± (0.5 % *R* + 10 mΩ) |
| 4.13 | - | Short time overload: Standard operation mode | $U = 2.5 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max.}$; 5 s | ± (0.03 % *R* + 5 mΩ) | | | ± (0.15 % *R* + 5 mΩ) |
| | | Short time overload: Power operation mode | | ± (0.05 % *R* + 5 mΩ) | | | ± (0.15 % *R* + 5 mΩ) |
| 4.27 | - | Single pulse high voltage overload: Standard operation mode | Severity no. 4: $U = 10 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max.}$; 10 pulses 10 µs/700 µs | ± (0.25 % *R* + 5 mΩ) | | | |
| | | Single pulse high voltage overload: Power operation mode | | ± (0.5 % *R* + 5 mΩ) | | | |


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## TEST PROCEDURES AND REQUIREMENTS

| EN 60115-1 CLAUSE | IEC 60068-2 [1] TEST METHOD | TEST | PROCEDURE | REQUIREMENTS PERMISSIBLE CHANGE (Δ*R*) | | | |
|---|---|---|---|---|---|---|---|
| | | | Stability for product types: | **STABILITY CLASS 0.25 OR BETTER** | **STABILITY CLASS 0.5 OR BETTER** | **STABILITY CLASS 1 OR BETTER** | **STABILITY CLASS 2 OR BETTER** |
| | | | **MMU 0102** | 10 Ω to 221 kΩ | 1 Ω to < 10 Ω | < 1 Ω | > 221 kΩ |
| | | | **MMA 0204** | 10 Ω to 332 kΩ | 1 Ω to < 10 Ω | < 1 Ω | > 332 kΩ |
| | | | **MMB 0207** | 10 Ω to 1 MΩ | 1 Ω to < 10 Ω | < 1 Ω | > 1 MΩ |
| 4.37 | - | Periodic electric overload: Standard operation mode | $U = \sqrt{15 \times P_{70} \times R} \leq 2 \times U_{max.}$ 0.1 s on; 2.5 s off; 1000 cycles | ± (0.5 % *R* + 5 mΩ) | | | |
| | | Periodic electric overload: Power operation mode | | ± (1 % *R* + 5 mΩ) | | | |
| 4.22 | 6 (Fc) | Vibration | Endurance by sweeping; 10 Hz to 2000 Hz; no resonance; amplitude ≤ 1.5 mm or ≤ 200 m/s²; 7.5 h | ± (0.05 % *R* + 5 mΩ) | | | ± (0.1 % *R* + 5 mΩ) |
| 4.40 | - | Electrostatic discharge (Human Body Model) | IEC 61340-3-1 [1]; 3 pos. + 3 neg. discharges MMU 0102: 1.5 kV MMA 0204: 2 kV MMB 0207: 4 kV | ± (0.5 % *R* + 0.05 Ω) | | | |
| 4.17.2 | 58 (Td) | Solderability | Solder bath method; SnPb40; non-activated flux; (215 ± 3) °C; (3 ± 0.3) s | Good tinning (≥ 95 % covered); no visible damage | | | |
| | | | Solder bath method; SnAg3Cu0.5 or SnAg3.5; non-activated flux; (235 ± 3) °C; (2 ± 0.2) s | Good tinning (≥ 95 % covered); no visible damage | | | |
| 4.18.2 | 58 (Td) | Resistance to soldering heat | Solder bath method; (260 ± 5) °C; (10 ± 1) s | ± (0.05 % *R* + 10 mΩ) | ± (0.1 % *R* + 10 mΩ) | ± (0.25 % *R* + 10 mΩ) | ± (0.25 % *R* + 10 mΩ) |
| | | | Reflow method 2 (IR/forced gas convection); (260 ± 5) °C; (10 ± 1) s | ± (0.02 % *R* + 10 mΩ) | ± (0.05 % *R* + 10 mΩ) | ± (0.05 % *R* + 10 mΩ) | ± (0.1 % *R* + 10 mΩ) |
| 4.29 | 45 (XA) | Component solvent resistance | Isopropyl alcohol; 50 °C; method 2 | No visible damage | | | |
| 4.30 | 45 (XA) | Solvent resistance of marking | Isopropyl alcohol; 50 °C; method 1, toothbrush | Marking legible; no visible damage | | | |
| 4.32 | 21 ($Ue_3$) | Shear (adhesion) | 45 N | No visible damage | | | |
| 4.33 | 21 ($Ue_1$) | Substrate bending | Depth 2 mm, 3 times | No visible damage, no open circuit in bent position ± (0.05 % *R* + 5 mΩ) [2] | | | |
| 4.7 | - | Voltage proof | $U_{RMS} = U_{ins}$; 60 s | No flashover or breakdown | | | |
| 4.35 | - | Flammability | IEC 60695-11-5 [1], needle flame test; 10 s | No burning after 30 s | | | |

**Notes**

[1] The quoted IEC standards are also released as EN standards with the same number and identical contents.

[2] Special requirements apply to MICRO-MELF, MMU 0102:
- $R < 100\ \Omega$: ± (0.25 % *R* + 10 mΩ)
- $100\ \Omega \leq R \leq 221\ k\Omega$: ± 0.1 % *R*
- $221\ k\Omega < R$: ± 0.25 % *R*


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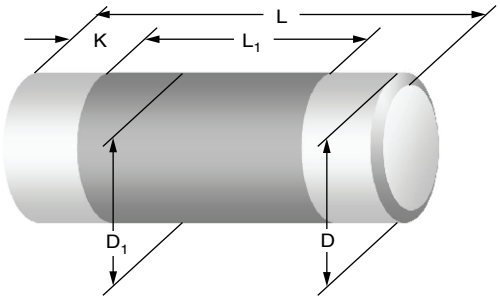
## DIMENSIONS

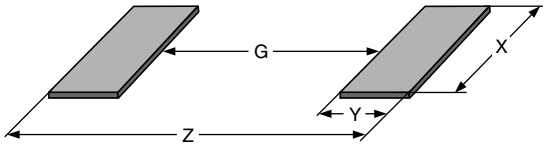



| DIMENSIONS AND MASS | | | | | | |
|---|---|---|---|---|---|---|
| TYPE/SIZE | L (mm) | D (mm) | $L_{1\ min.}$ (mm) | $D_1$ (mm) | K (mm) | MASS (mg) |
| MMU 0102 | 2.2 + 0/- 0.1 | 1.1 + 0/- 0.1 | 1.2 | D + 0/- 0.1 | 0.4 ± 0.05 | 8 |
| MMA 0204 | 3.6 + 0/- 0.2 | 1.4 + 0/- 0.1 | 1.8 | D + 0/- 0.15 | 0.8 ± 0.1 | 22 |
| MMB 0207 | 5.8 + 0/- 0.15 | 2.2 + 0/- 0.2 | 3.2 | D + 0/- 0.2 | 1.25 ± 0.1 | 80 |

**Note**

- Color code marking is applied according to IEC 60062 (1) in four bands (E24 series) or five bands (E96 or E192 series). Each color band appears as a single solid line, voids are permissible if at least $^2/_3$ of the band is visible from each radial angle of view. The last color band for tolerance is approximately 50 % wider than the other bands. An interrupted yellow band between the 4th and 5th full band indicates TC25.

## PATTERN STYLES FOR MELF RESISTORS




| RECOMMENDED SOLDER PAD DIMENSIONS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TYPE/SIZE | WAVE SOLDERING | | | | REFLOW SOLDERING | | | |
| | G (mm) | Y (mm) | X (mm) | Z (mm) | G (mm) | Y (mm) | X (mm) | Z (mm) |
| MMU 0102 | 0.7 | 1.2 | 1.5 | 3.1 | 1.1 | 0.8 | 1.3 | 2.7 |
| MMA 0204 | 1.5 | 1.5 | 1.8 | 4.5 | 1.7 | 1.2 | 1.6 | 4.1 |
| MMB 0207 | 2.8 | 2.1 | 2.6 | 7.0 | 3.2 | 1.7 | 2.4 | 6.6 |

**Notes**

- The rated dissipation applies only if the permitted film temperature is not exceeded. Furthermore, a high level of ambient temperature or of power dissipation may raise the temperature of the solder joint, hence special solder alloys or board materials may be required to maintain the reliability of the assembly. Specified power rating above 125 °C requires dedicated heat-sink pads, which to a great extend depend onboard materials and design. The given solder pad dimensions reflect the considerations for board design and assembly as outlined e.g. in standards IEC 61188-5-x (1), or in publication IPC-7351. They do not guarantee any supposed thermal properties, particularly as these are also strongly influenced by many other parameters.
  Still, the given solder pad dimensions will be found adequate for most general applications, e.g. those referring to “standard operation mode”. Please note however that applications for “power operation mode” require special considerations for the design of solder pads and adjacent conductor areas.

(1) The quoted IEC standards are also released as EN standards with the same number and identical contents.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## HISTORICAL 12NC INFORMATION

- The resistors had a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicated the resistor type, specification and packaging; see the 12NC table.
- The remaining 4 digits indicated the resistance value:
  - The first 3 digits indicated the resistance value.
  - The last digit indicated the resistance decade in accordance with the 12NC Indicating Resistance Decade table.

**Last Digit of 12NC Indicating Resistance Decade**

| RESISTANCE DECADE | LAST DIGIT |
|---|---|
| 0.1 Ω to 0.999 Ω | 7 |
| 1 Ω to 9.99 Ω | 8 |
| 10 Ω to 99.9 Ω | 9 |
| 100 Ω to 999.9 Ω | 1 |
| 1 kΩ to 9.99 kΩ | 2 |
| 10 kΩ to 99.9 kΩ | 3 |
| 100 kΩ to 999 kΩ | 4 |
| 1 MΩ to 9.99 MΩ | 5 |
| 10 MΩ to 99.9 MΩ | 6 |

**Historical 12NC**

The 12NC of a MMU 0102 resistor, value 47 kΩ. and TCR 50 with ± 1 % tolerance, supplied in blister tape of 3000 units per reel is: 2312 165 14703.

**HISTORICAL 12NC** - Resistor type and packaging

| DESCRIPTION | | | 2312 ... ..... | | |
|---|---|---|---|---|---|
| | | | BLISTER TAPE ON REEL | | BULK CASE |
| **TYPE** | **TCR** | **TOL.** | **BL 3000 UNITS** | **B0 10 000 UNITS** | **M8 8000 UNITS** |
| MMU 0102 | ± 50 ppm/K | ± 5 % | 165 3.... | 175 3.... | 060 3.... |
| | | ± 2 % | 165 2.... | 175 2.... | 060 2.... |
| | | ± 1 % | 165 1.... | 175 1.... | 060 1.... |
| | | ± 0.5 % | 165 5.... | 175 5.... | 060 5.... |
| | ± 25 ppm/K | ± 1 % | 166 1.... | 176 1.... | 061 1.... |
| | | ± 0.5 % | 166 5.... | 176 5.... | 061 5.... |
| | Jumper | | 165 90001 | 175 90001 | 060 90001 |
| **TYPE** | **TCR** | **TOL.** | **BL 3000 UNITS** | **B0 10 000 UNITS** | **M3 3000 UNITS** |
| MMA 0204 | ± 50 ppm/K | ± 5 % | 155 3.... | 145 3.... | 040 3.... |
| | | ± 1 % | 155 1.... | 145 1.... | 040 1.... |
| | | ± 0.5 % | 155 5.... | 145 5.... | 040 5.... |
| | ± 25 ppm/K | ± 1 % | 156 1.... | 146 1.... | 041 1.... |
| | | ± 0.5 % | 156 5.... | 146 5.... | 041 5.... |
| | Jumper | | 155 90001 | 145 90001 | 040 90001 |
| **TYPE** | **TCR** | **TOL.** | **B2 2000 UNITS** | **B7 7000 UNITS** | |
| MMB 0207 | ± 100 ppm/K | ± 5 % | 195 3.... | 185 3.... | |
| | ± 50 ppm/K | ± 5 % | 195 3.... | 185 3.... | |
| | | ± 2 % | 195 2.... | 185 2.... | |
| | | ± 1 % | 195 1.... | 185 1.... | |
| | ± 25 ppm/K | ± 0.5 % | 196 5.... | 186 5.... | |
| | Jumper | | 195 90001 | 185 90001 | |


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- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.

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