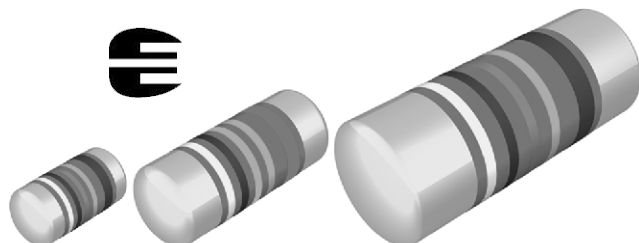


## Precision MELF Resistors



MMU 0102, MMA 0204 and MMB 0207 precision thin film melf resistors combine the proven reliability of the professional products with an advanced level of precision and stability. Therefore they are perfectly suited for applications in the fields of test and measuring equipment along with industrial and medical electronics.

## FEATURES

- Approved according to EN 140401-803
- Advanced thin film technology
- Superior stability: Class 0.05
- Wide precision range: 10  $\Omega$  to 1 M $\Omega$
- Force fitted steel caps, tin plated on nickel barrier
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



## APPLICATIONS

- Test and measuring equipment
- Industrial and medical electronics

## METRIC SIZE

|       |          |          |          |
|-------|----------|----------|----------|
| DIN:  | 0102     | 0204     | 0207     |
| CECC: | RC 2211M | RC 3715M | RC 6123M |

## TECHNICAL SPECIFICATIONS

| DESCRIPTION                                                                                      | MMU 0102                    |           | MMA 0204                    |           | MMB 0207                    |           |
|--------------------------------------------------------------------------------------------------|-----------------------------|-----------|-----------------------------|-----------|-----------------------------|-----------|
| Metric CECC size                                                                                 | RC 2211 M                   |           | RC 3715 M                   |           | RC 6123 M                   |           |
| Resistance range                                                                                 | 22 Ω to 332 kΩ              |           | 10 Ω to 511 kΩ              |           | 15 Ω to 1 MΩ                |           |
| Resistance tolerance                                                                             | ± 0.5 %; ± 0.25 %; ± 0.1 %  |           |                             |           | ± 0.25 %; ± 0.1 %           |           |
| Temperature coefficient                                                                          | ± 25 ppm/K; ± 15 ppm/K      |           |                             |           |                             |           |
| Operation mode                                                                                   | precision                   | standard  | precision                   | standard  | precision                   | standard  |
| Climatic category<br>(LCT/UCT/days)                                                              | 10/85/56                    | 55/125/56 | 10/85/56                    | 55/125/56 | 10/85/56                    | 55/125/56 |
| Rated dissipation, $P_{70}^{1)}$                                                                 | 0.06 W                      | 0.2 W     | 0.07 W                      | 0.25 W    | 0.11 W                      | 0.4 W     |
| Operating voltage, $U_{\max}$ AC/DC                                                              | 150 V                       |           | 200 V                       |           | 300 V                       |           |
| Film temperature                                                                                 | 85 °C                       | 125 °C    | 85 °C                       | 125 °C    | 85 °C                       | 125 °C    |
| Max. resistance change at $P_{70}$<br>for resistance range,<br>$ \Delta R/R $ max., after:       | 22 Ω to 332 kΩ              |           | 10 Ω to 511 kΩ              |           | 15 Ω to 1 MΩ                |           |
| 1000 h                                                                                           | ≤ 0.05 %                    | ≤ 0.1 %   | ≤ 0.05 %                    | ≤ 0.1 %   | ≤ 0.05 %                    | ≤ 0.1 %   |
| 8000 h                                                                                           | ≤ 0.1 %                     | ≤ 0.2 %   | ≤ 0.1 %                     | ≤ 0.2 %   | ≤ 0.1 %                     | ≤ 0.2 %   |
| 225 000 h                                                                                        | ≤ 0.3 %                     | ≤ 0.6 %   | ≤ 0.3 %                     | ≤ 0.6 %   | ≤ 0.3 %                     | ≤ 0.6 %   |
| Permissible voltage against<br>ambient (insulation):<br>1 minute, $U_{\text{ins}}$<br>continuous | 200 V<br>75 V               |           | 300 V<br>75 V               |           | 500 V<br>75 V               |           |
| Failure rate                                                                                     | ≤ 2.0 × 10 <sup>-9</sup> /h |           | ≤ 0.7 × 10 <sup>-9</sup> /h |           | ≤ 0.7 × 10 <sup>-9</sup> /h |           |

**Note:** 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.

<sup>1)</sup> The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heatflow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.



### 12NC INFORMATION

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

### Last Digit of 12NC Indicating Resistance Decade

| RESISTANCE DECADE                | LAST DIGIT |
|----------------------------------|------------|
| 10 $\Omega$ to 99.9 $\Omega$     | 9          |
| 100 $\Omega$ to 999 $\Omega$     | 1          |
| 1 k $\Omega$ to 9.99 k $\Omega$  | 2          |
| 10 k $\Omega$ to 99.9 k $\Omega$ | 3          |
| 100 k $\Omega$ to 999 k $\Omega$ | 4          |
| 1 M $\Omega$ to 9.99 M $\Omega$  | 5          |

### 12NC Example

The 12NC of a MMA 0204 resistor, value 47 k $\Omega$  and TC 25 with  $\pm 0.1$  % tolerance, supplied in blister tape of 3000 units per reel is: 2312 156 74703.

| 12NC - resistor type and packaging |                |              |                           |                  |                    |                  |
|------------------------------------|----------------|--------------|---------------------------|------------------|--------------------|------------------|
| DESCRIPTION                        |                |              | ORDERING CODE 2312 ... .. |                  |                    |                  |
|                                    |                |              | BLISTER TAPE ON REEL      |                  |                    | BULK CASE        |
| TYPE                               | TCR            | TOL.         | B1<br>1000 units          | BL<br>3000 units | B0<br>10 000 units | M8<br>8000 units |
| MMU 0102                           | $\pm 25$ ppm/K | $\pm 0.25$ % | 171 6....                 | <b>166 6....</b> | 176 6....          | 061 6....        |
|                                    |                | $\pm 0.1$ %  | 171 7....                 | <b>166 7....</b> | 176 7....          | 061 7....        |
|                                    | $\pm 15$ ppm/K | $\pm 0.5$ %  | 172 5....                 | 167 5....        | 177 5....          | 062 5....        |
|                                    |                | $\pm 0.25$ % | 172 6....                 | 167 6....        | 177 6....          | 062 6....        |
|                                    |                | $\pm 0.1$ %  | 172 7....                 | <b>167 7....</b> | 177 7....          | 062 7....        |
|                                    |                |              |                           |                  |                    |                  |
| TYPE                               | TCR            | TOL.         | B1<br>1000 units          | BL<br>3000 units | B0<br>10 000 units | M3<br>3000 units |
| MMA 0204                           | $\pm 25$ ppm/K | $\pm 0.25$ % | 141 6....                 | <b>156 6....</b> | 146 6....          | 041 6....        |
|                                    |                | $\pm 0.1$ %  | 141 7....                 | <b>156 7....</b> | 146 7....          | 041 7....        |
|                                    | $\pm 15$ ppm/K | $\pm 0.5$ %  | 142 5....                 | 157 5....        | 147 5....          | 042 5....        |
|                                    |                | $\pm 0.25$ % | 142 6....                 | 157 6....        | 147 6....          | 042 6....        |
|                                    |                | $\pm 0.1$ %  | 142 7....                 | <b>157 7....</b> | 147 7....          | 042 7....        |
|                                    |                |              |                           |                  |                    |                  |
| TYPE                               | TCR            | TOL.         | B1<br>1000 units          | B2<br>2000 units | B7<br>7000 units   |                  |
| MMB 0207                           | $\pm 25$ ppm/K | $\pm 0.25$ % | 181 6....                 | <b>196 6....</b> | 186 6....          |                  |
|                                    |                | $\pm 0.1$ %  | 181 7....                 | <b>196 7....</b> | 186 7....          |                  |
|                                    | $\pm 15$ ppm/K | $\pm 0.1$ %  | 182 7....                 | <b>197 7....</b> | 187 7....          |                  |

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

**PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>**PART NUMBER<sup>2)</sup>: MMA02040D5620BBL00

|                               |   |                           |   |   |                                          |   |   |                                                                                                                                                                                     |   |   |   |                                                        |   |                                        |   |                                 |   |
|-------------------------------|---|---------------------------|---|---|------------------------------------------|---|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------------------------------------------------------|---|----------------------------------------|---|---------------------------------|---|
| M                             | M | A                         | 0 | 2 | 0                                        | 4 | 0 | D                                                                                                                                                                                   | 5 | 6 | 2 | 0                                                      | B | B                                      | L | 0                               | 0 |
| MODEL/SIZE                    |   | SPECIAL CHARACTER         |   |   | TC                                       |   |   | VALUE                                                                                                                                                                               |   |   |   | TOLERANCE                                              |   | PACKAGING <sup>3)</sup>                |   | SPECIAL                         |   |
| MMU0102<br>MMA0204<br>MMB0207 |   | 0 = neutral, acc. CECC E0 |   |   | E = $\pm 15$ ppm/K<br>D = $\pm 25$ ppm/K |   |   | 3 digit value<br>1 digit multiplier<br><b>Multiplier</b><br>9 = $\cdot 10^{-1}$<br>0 = $\cdot 10^0$<br>1 = $\cdot 10^1$<br>2 = $\cdot 10^2$<br>3 = $\cdot 10^3$<br>4 = $\cdot 10^4$ |   |   |   | B = $\pm 0.1$ %<br>C = $\pm 0.25$ %<br>D = $\pm 0.5$ % |   | B1<br>B3<br>B0<br>B2<br>B7<br>M3<br>M8 |   | up to 2 digits<br>00 = standard |   |

PRODUCT DESCRIPTION: MMA 0204-25 0.1 % BL 562R

|                   |                      |                                  |                                            |                                        |                                               |
|-------------------|----------------------|----------------------------------|--------------------------------------------|----------------------------------------|-----------------------------------------------|
| MMA               | 0204                 | -25                              | 0.1 %                                      | BL                                     | 562R                                          |
| MODEL             | SIZE                 | TCR                              | TOLERANCE                                  | PACKAGING <sup>3)</sup>                | RESISTANCE VALUE                              |
| MMU<br>MMA<br>MMB | 0102<br>0204<br>0207 | $\pm 15$ ppm/K<br>$\pm 25$ ppm/K | $\pm 0.1$ %<br>$\pm 0.25$ %<br>$\pm 0.5$ % | B1<br>BL<br>B0<br>B2<br>B7<br>M3<br>M8 | 562R = 562 $\Omega$<br>4K64 = 4.64 k $\Omega$ |

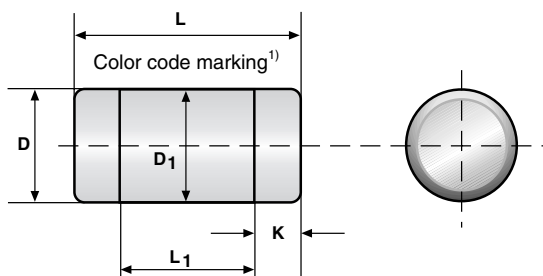
**Notes**

- Products can be ordered using either the PRODUCT DESCRIPTION or the 12NC.
- The PART NUMBER is shown to facilitate the introduction of the unified part numbering system. Currently, this PART NUMBER is applicable in the Americas and in Asia/Pacific only.
- Please refer to table PACKAGING, see below.

**PACKAGING**

| MODEL    | BLISTER TAPE ON REEL<br>ACC. IEC 60286-3 |             |         | BULK CASE<br>ACC. IEC 60286-6 |      |
|----------|------------------------------------------|-------------|---------|-------------------------------|------|
|          | DIAMETER                                 | PIECES/REEL | CODE    | PIECES/BULK CASE              | CODE |
| MMU 0102 | 180 mm/7"                                | 1000        | B1      | 8000                          | M8   |
|          | 180 mm/7"                                | 3000        | B3 = BL |                               |      |
|          | 330 mm/13"                               | 10 000      | B0      |                               |      |
| MMA 0204 | 180 mm/7"                                | 1000        | B1      | 3000                          | M3   |
|          | 180 mm/7"                                | 3000        | B3 = BL |                               |      |
|          | 330 mm/13"                               | 10 000      | B0      |                               |      |
| MMB 0207 | 180 mm/7"                                | 1000        | B1      | -                             | -    |
|          | 180 mm/7"                                | 2000        | B2      |                               |      |
|          | 330 mm/13"                               | 7000        | B7      |                               |      |

### DIMENSIONS



| DIMENSIONS - MELF resistor types, mass and relevant physical dimensions |               |               |                            |                        |             |              |
|-------------------------------------------------------------------------|---------------|---------------|----------------------------|------------------------|-------------|--------------|
| TYPE                                                                    | L<br>(mm)     | D<br>(mm)     | L <sub>1</sub> min<br>(mm) | D <sub>1</sub><br>(mm) | K<br>(mm)   | MASS<br>(mg) |
| MMU 0102                                                                | 2.2 + 0/- 0.1 | 1.1 + 0/- 0.1 | 1.2                        | D + 0/- 0.1            | 0.4 ± 0.05  | 7            |
| MMA 0204                                                                | 3.6 + 0/- 0.2 | 1.4 + 0/- 0.1 | 1.8                        | D + 0/- 0.15           | 0.8 ± 0.1   | 19           |
| MMB 0207                                                                | 5.8 + 0/- 0.2 | 2.2 + 0/- 0.2 | 2.8                        | D + 0/- 0.2            | 1.25 ± 0.15 | 79           |

<sup>1)</sup> Color code marking is applied according to IEC 60062\* in five bands. 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 approx. 50 % wider than the other bands. An interrupted band between the 4rd and 5th full band identifies the temperature coefficient.

| TEMPERATURE COEFFICIENT AND RESISTANCE RANGE |           |                                |                       |                     |
|----------------------------------------------|-----------|--------------------------------|-----------------------|---------------------|
| DESCRIPTION                                  |           | RESISTANCE VALUE <sup>1)</sup> |                       |                     |
| TCR                                          | TOLERANCE | MMU 0102                       | MMA 0204              | MMB 0207            |
| ± 25 ppm/K                                   | ± 0.25 %  | <b>47 Ω to 332 kΩ</b>          | <b>22 Ω to 511 kΩ</b> | <b>15 Ω to 1 MΩ</b> |
|                                              | ± 0.1 %   | <b>100 Ω to 221 kΩ</b>         | <b>43 Ω to 511 kΩ</b> | <b>33 Ω to 1 MΩ</b> |
| ± 15 ppm/K                                   | ± 0.5 %   | 22 Ω to 100 kΩ                 | 10 Ω to 332 kΩ        | -                   |
|                                              | ± 0.25 %  | 47 Ω to 100 kΩ                 | 22 Ω to 332 kΩ        | -                   |
|                                              | ± 0.1 %   | <b>100 Ω to 100 kΩ</b>         | <b>43 Ω to 332 kΩ</b> | <b>33 Ω to 1 MΩ</b> |

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

<sup>1)</sup> Resistance values to be selected from E24 and E192 series, for other values please contact the factory.



## 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 (85 %  $\text{Al}_2\text{O}_3$ , for MICRO-MELF: 96 %  $\text{Al}_2\text{O}_3$ ) 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. A further conditioning is applied in order to stabilise the trimming result. 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. Five color code rings designate the resistance value and tolerance in accordance with **IEC 60062\***.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are laid directly into the blister tape in accordance with **IEC 60 286-3\*** or bulk case in accordance with **IEC 60286-6\***.

## 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\***. Excellent solderability is proven, even after extended storage in excess of 10 years. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL**<sup>1)</sup> and the **CEFIC-EECA-EICTA**<sup>2)</sup> list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) and Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

<sup>1)</sup> Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)

<sup>2)</sup> CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issues -> environment policy -> chemicals -> chemicals for electronics

## APPROVALS

The resistors are tested in accordance with **EN 140401-803** (superseding **CECC 40401-803**) which refers to **EN 60115-1**, **EN 140400** and the variety of environmental test procedures of the **IEC 60068\*** series. Approval of conformity is indicated by the **CECC** logo on the package label.

Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **IEC QC 001002-3, clause 2**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240001** based on **IEC QC 001002-3, clause 6** is granted for the Vishay BEYSCHLAG manufacturing process.

## SPECIALS

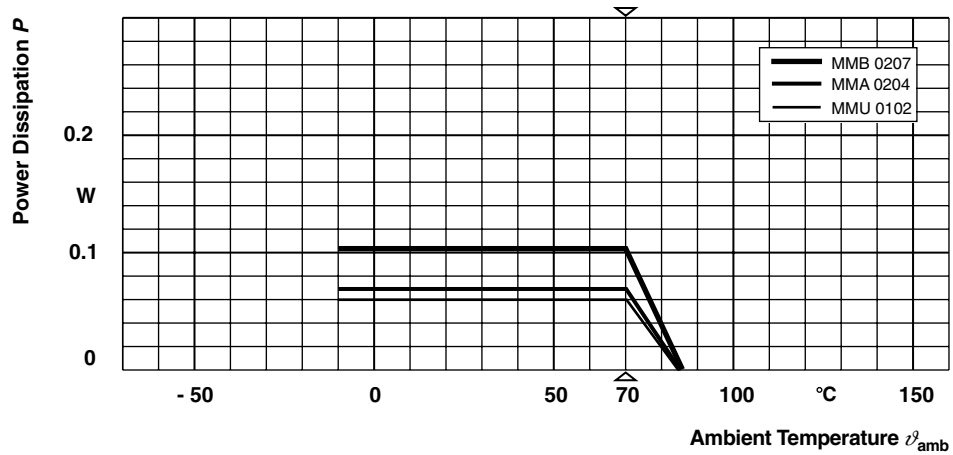
On request, resistors are available with established reliability in accordance with **EN 140401-803 Version E**. Please refer to the special data sheet for information on failure rate level, available resistance ranges and ordering codes.

### Note:

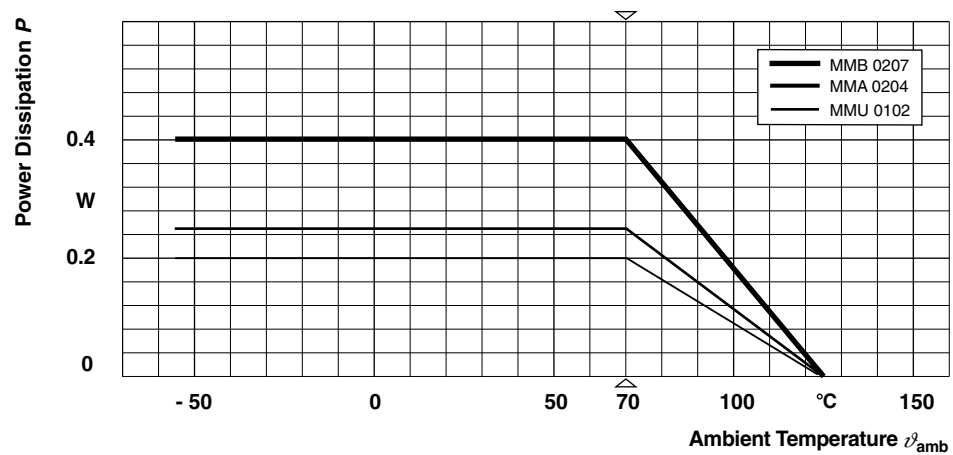
\* The quoted IEC standards are also released as EN standards with the same number and identical contents.



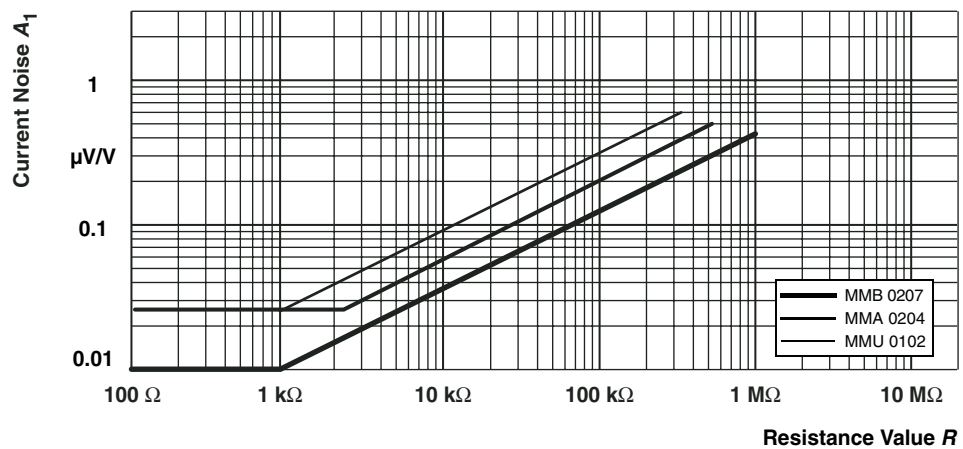
### FUNCTIONAL PERFORMANCE



### Derating - Precision Operation



### Derating - Standard Operation



In accordance with IEC 60195

### Current Noise - $A_1$

## TESTS AND REQUIREMENTS

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

EN 60115-1, generic specification

EN 140400, sectional specification

EN 140401-803, detail specification

The components are approved in accordance with the IECQ-CECC-system, where applicable. 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\* and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3\*. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

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 1 060 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 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. The stated requirements for long-term tests are typically fulfilled with a statistical safety of at least  $\bar{x} + 5 s$ .

### TEST PROCEDURES AND REQUIREMENTS

| EN<br>60115-1<br>CLAUSE | IEC<br>60068-2*<br>TEST<br>METHOD | TEST                                               | PROCEDURE                                                                                                          | REQUIREMENTS<br>PERMISSIBLE CHANGE ( $\Delta R$ )                             |                                       |                                       |
|-------------------------|-----------------------------------|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------|---------------------------------------|
|                         |                                   |                                                    |                                                                                                                    | STABILITY<br>CLASS 0.05<br>OR BETTER                                          | STABILITY<br>CLASS 0.1<br>OR BETTER   | STABILITY<br>CLASS 0.25<br>OR BETTER  |
|                         |                                   |                                                    | stability for product types:                                                                                       |                                                                               |                                       |                                       |
|                         |                                   |                                                    | MMU 0102                                                                                                           | 100 $\Omega$ to 100 k $\Omega$                                                | 43 $\Omega$ to 147 k $\Omega$         | 22 $\Omega$ to 332 k $\Omega$         |
|                         |                                   |                                                    | MMA 0204                                                                                                           | 100 $\Omega$ to 100 k $\Omega$                                                | 43 $\Omega$ to 221 k $\Omega$         | 10 $\Omega$ to 511 k $\Omega$         |
|                         |                                   |                                                    | MMB 0207                                                                                                           | 100 $\Omega$ to 270 k $\Omega$                                                | 43 $\Omega$ to 510 k $\Omega$         | 15 $\Omega$ to 1 M $\Omega$           |
| 4.5                     | -                                 | resistance                                         | -                                                                                                                  | $\pm 0.5 \% R$ ; $\pm 0.25 \% R$ ; $\pm 0.1 \% R$                             |                                       |                                       |
| 4.8.4.2                 | -                                 | temperature coefficient                            | at 20 / - 55 / 20 °C and<br>20 / 125 / 20 °C                                                                       | $\pm 25$ ppm/K, $\pm 15$ ppm/K                                                |                                       |                                       |
| 4.25.1                  | -                                 | endurance at<br>70 °C: precision<br>operation mode | $U = \sqrt{P_{70} \times R}$<br>$\leq U_{\max}$ ;<br>1.5 h on; 0.5 h off;<br>70 °C; 1000 h<br>70 °C; 8000 h        | $\pm (0.05 \% R + 5 \text{ m}\Omega)$<br>$\pm (0.1 \% R + 5 \text{ m}\Omega)$ |                                       |                                       |
|                         |                                   | endurance at<br>70 °C: standard<br>operation mode  | $U = \sqrt{P_{70} \times R}$<br>$\leq U_{\max}$ ;<br>1.5 h on; 0.5 h off;<br>70 °C; 1000 h<br>70 °C; 8000 h        | $\pm (0.1 \% R + 5 \text{ m}\Omega)$<br>$\pm (0.2 \% R + 5 \text{ m}\Omega)$  |                                       |                                       |
| 4.25.3                  | -                                 | endurance at<br>upper category                     | 85 °C; 1000 h                                                                                                      | $\pm (0.02 \% R + 5 \text{ m}\Omega)$                                         | $\pm (0.05 \% R + 5 \text{ m}\Omega)$ | $\pm (0.1 \% R + 5 \text{ m}\Omega)$  |
|                         |                                   |                                                    | 125 °C; 1000 h                                                                                                     | $\pm (0.05 \% R + 5 \text{ m}\Omega)$                                         | $\pm (0.1 \% R + 5 \text{ m}\Omega)$  | $\pm (0.15 \% R + 5 \text{ m}\Omega)$ |
| 4.24                    | 78 (Cab)                          | damp heat,<br>steady state                         | (40 $\pm$ 2) °C; 56 days;<br>(93 $\pm$ 3) % RH                                                                     | $\pm (0.05 \% R + 5 \text{ m}\Omega)$                                         | $\pm (0.1 \% R + 5 \text{ m}\Omega)$  |                                       |
| 4.39                    | 67 (Cy)                           | damp heat,<br>steady state,<br>accelerated         | (85 $\pm$ 2) °C; (85 $\pm$ 5) % RH;<br>$U = 0.1 \times \sqrt{P_{70} \times R}$<br>$\leq 100 \text{ V}$ ;<br>1000 h | $\pm (0.15 \% R + 5 \text{ m}\Omega)$                                         | $\pm (0.25 \% R + 5 \text{ m}\Omega)$ |                                       |

**TEST PROCEDURES AND REQUIREMENTS**

| EN<br>60115-1<br>CLAUSE | IEC<br>60068-2*<br>TEST<br>METHOD | TEST                                                                 | PROCEDURE                                                                                                                   | REQUIREMENTS<br>PERMISSIBLE CHANGE ( $\Delta R$ ) |                                              |                                               |
|-------------------------|-----------------------------------|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|----------------------------------------------|-----------------------------------------------|
|                         |                                   |                                                                      | stability for product types:                                                                                                | <b>STABILITY<br/>CLASS 0.05<br/>OR BETTER</b>     | <b>STABILITY<br/>CLASS 0.1<br/>OR BETTER</b> | <b>STABILITY<br/>CLASS 0.25<br/>OR BETTER</b> |
|                         |                                   |                                                                      | <b>MMU 0102</b>                                                                                                             | 100 $\Omega$ to 100 k $\Omega$                    | 43 $\Omega$ to 147 k $\Omega$                | 22 $\Omega$ to 332 k $\Omega$                 |
|                         |                                   |                                                                      | <b>MMA 0204</b>                                                                                                             | 100 $\Omega$ to 100 k $\Omega$                    | 43 $\Omega$ to 221 k $\Omega$                | 10 $\Omega$ to 511 k $\Omega$                 |
|                         |                                   |                                                                      | <b>MMB 0207</b>                                                                                                             | 100 $\Omega$ to 270 k $\Omega$                    | 43 $\Omega$ to 510 k $\Omega$                | 15 $\Omega$ to 1 M $\Omega$                   |
| 4.23                    |                                   | climatic                                                             |                                                                                                                             |                                                   |                                              |                                               |
| 4.23.2                  | 2 (Ba)                            | dry heat                                                             | UCT; 16 h                                                                                                                   |                                                   |                                              |                                               |
| 4.23.3                  | 30 (Db)                           | damp heat,<br>cyclic                                                 | 55 °C; 24 h; $\geq 90$ % RH;<br>1 cycle                                                                                     |                                                   |                                              |                                               |
| 4.23.4                  | 1 (Aa)                            | cold                                                                 | LCT; 2 h                                                                                                                    |                                                   |                                              |                                               |
| 4.23.5                  | 13 (M)                            | low air pressure                                                     | 8.5 kPa; 2 h; (25 $\pm$ 10) °C                                                                                              |                                                   |                                              |                                               |
| 4.23.6                  | 30 (Db)                           | damp heat,<br>cyclic                                                 | 55 °C; 24 h; $\geq 90$ % RH;<br>5 cycles                                                                                    |                                                   |                                              |                                               |
| 4.23.7                  | -                                 | d.c. load                                                            | $U = \sqrt{P_{70} \times R} \leq U_{\max}$ ; 1 min.<br>LCT = - 10 °C; UCT = 85 °C                                           | $\pm (0.05 \% R + 5 \text{ m}\Omega)$             | $\pm (0.1 \% R + 5 \text{ m}\Omega)$         | -                                             |
|                         |                                   |                                                                      | LCT = - 55 °C; UCT = 125 °C                                                                                                 | -                                                 | -                                            | $\pm (0.1 \% R + 5 \text{ m}\Omega)$          |
| -                       | 1 (Aa)                            | cold                                                                 | - 55 °C; 2 h                                                                                                                | $\pm (0.02 \% R + 5 \text{ m}\Omega)$             |                                              |                                               |
| 4.19                    | 14 (Na)                           | rapid change of<br>temperature                                       | 30 minutes at LCT;<br>30 minutes at UCT;<br>LCT = - 10 °C; UCT = 85 °C                                                      |                                                   |                                              |                                               |
|                         |                                   |                                                                      | 5 cycles                                                                                                                    | $\pm (0.01 \% R + 5 \text{ m}\Omega)$             | $\pm (0.02 \% R + 5 \text{ m}\Omega)$        | -                                             |
|                         |                                   |                                                                      | 1000 cycles                                                                                                                 | $\pm (0.1 \% R + 5 \text{ m}\Omega)$              | $\pm (0.1 \% R + 5 \text{ m}\Omega)$         | -                                             |
|                         |                                   |                                                                      | LCT = - 55 °C; UCT = 125 °C                                                                                                 |                                                   |                                              |                                               |
|                         |                                   |                                                                      | 5 cycles                                                                                                                    | -                                                 | -                                            | $\pm (0.025 \% R + 5 \text{ m}\Omega)$        |
|                         |                                   |                                                                      | 1000 cycles                                                                                                                 | -                                                 | -                                            | $\pm (0.2 \% R + 5 \text{ m}\Omega)$          |
| 4.13                    | -                                 | short time over-<br>load; precision<br>operation mode                | $U = 2.5 \times \sqrt{P_{70} \times R}$<br>$\leq 2 \times U_{\max}$ ; 5 s                                                   | $\pm (0.01 \% R + 5 \text{ m}\Omega)$             | $\pm (0.02 \% R + 5 \text{ m}\Omega)$        | $\pm (0.03 \% R + 5 \text{ m}\Omega)$         |
|                         |                                   | short time over-<br>load; standard<br>operation mode                 |                                                                                                                             | $\pm (0.05 \% R + 5 \text{ m}\Omega)$             |                                              |                                               |
| 4.27                    | -                                 | single pulse high<br>voltage overload;<br>standard<br>operation mode | severity no. 4:<br>$U = 10 \times \sqrt{P_{70} \times R}$<br>$\leq 2 \times U_{\max}$ ;<br>10 pulses 10 $\mu$ s/700 $\mu$ s | $\pm (0.25 \% R + 5 \text{ m}\Omega)^{1)}$        |                                              |                                               |
| 4.37                    | -                                 | periodic electric<br>overload;<br>standard<br>operation mode         | $U = \sqrt{15 \times P_{70} \times R}$<br>$\leq 2 \times U_{\max}$ ;<br>0.1 s on; 2.5 s off;<br>1000 cycles                 | $\pm (0.5 \% R + 5 \text{ m}\Omega)^{1)}$         |                                              |                                               |
| 4.22                    | 6 (Fc)                            | vibration                                                            | endurance by sweeping;<br>10 to 2000 Hz; no<br>resonance; amplitude<br>$\leq 1.5$ mm or $\leq 200$ m/s <sup>2</sup> ; 6 h   | $\pm (0.01 \% R + 5 \text{ m}\Omega)$             | $\pm (0.02 \% R + 5 \text{ m}\Omega)$        | $\pm (0.03 \% R + 5 \text{ m}\Omega)$         |

| TEST PROCEDURES AND REQUIREMENTS |                                   |                                                     |                                                                                                                            |                                                                                                    |                                              |                                               |
|----------------------------------|-----------------------------------|-----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------|
| EN<br>60115-1<br>CLAUSE          | IEC<br>60068-2*<br>TEST<br>METHOD | TEST                                                | PROCEDURE                                                                                                                  | REQUIREMENTS<br>PERMISSIBLE CHANGE ( $\Delta R$ )                                                  |                                              |                                               |
|                                  |                                   |                                                     | stability for product types:                                                                                               | <b>STABILITY<br/>CLASS 0.05<br/>OR BETTER</b>                                                      | <b>STABILITY<br/>CLASS 0.1<br/>OR BETTER</b> | <b>STABILITY<br/>CLASS 0.25<br/>OR BETTER</b> |
|                                  |                                   |                                                     | <b>MMU 0102</b>                                                                                                            | 100 $\Omega$ to 100 k $\Omega$                                                                     | 43 $\Omega$ to 147 k $\Omega$                | 22 $\Omega$ to 332 k $\Omega$                 |
|                                  |                                   |                                                     | <b>MMA 0204</b>                                                                                                            | 100 $\Omega$ to 100 k $\Omega$                                                                     | 43 $\Omega$ to 221 k $\Omega$                | 10 $\Omega$ to 511 k $\Omega$                 |
|                                  |                                   |                                                     | <b>MMB 0207</b>                                                                                                            | 100 $\Omega$ to 270 k $\Omega$                                                                     | 43 $\Omega$ to 510 k $\Omega$                | 15 $\Omega$ to 1 M $\Omega$                   |
| 4.40                             | -                                 | electrostatic<br>discharge<br>(Human Body<br>Model) | IEC 61340-3-1*;<br>3 pos. + 3 neg. discharges<br>MMU 0102: 1.5 kV<br>MMA 0204: 2 kV<br>MMB 0207: 4 kV                      | $\pm (0.5 \% R + 50 \text{ m}\Omega)^{1)}$                                                         |                                              |                                               |
| 4.17.2                           | 58 (Td)                           | solderability                                       | solder bath method;<br>SnPb40; non-activated flux;<br>(215 $\pm$ 3) $^{\circ}\text{C}$ ; (3 $\pm$ 0.3) s                   | good tinning ( $\geq 95 \%$ covered); no visible damage                                            |                                              |                                               |
|                                  |                                   |                                                     | solder bath method;<br>SnAg3Cu0,5 or SnAg3,5;<br>non-activated flux;<br>(235 $\pm$ 3) $^{\circ}\text{C}$ ; (2 $\pm$ 0.2) s | good tinning ( $\geq 95 \%$ covered); no visible damage                                            |                                              |                                               |
| 4.18.2                           | 58 (TD)                           | resistance to<br>soldering heat                     | solder bath method;<br>(260 $\pm$ 5) $^{\circ}\text{C}$ ; (10 $\pm$ 1) s                                                   | note 2                                                                                             |                                              | $\pm (0.05 \% R + 10 \text{ m}\Omega)$        |
|                                  |                                   |                                                     | reflow method 2<br>(IR/forced gas convection);<br>(260 $\pm$ 5) $^{\circ}\text{C}$ ; (10 $\pm$ 1) s                        | $\pm (0.01 \% R + 5 \text{ m}\Omega)$                                                              | $\pm (0.025 \% R + 5 \text{ m}\Omega)$       |                                               |
| 4.29                             | 45 (XA)                           | component<br>solvent<br>resistance                  | isopropyl alcohol; 50 $^{\circ}\text{C}$ ;<br>method 2                                                                     | no visible damage                                                                                  |                                              |                                               |
| 4.30                             | 45 (XA)                           | solvent<br>resistance of<br>marking                 | isopropyl alcohol; 50 $^{\circ}\text{C}$ ;<br>method 1, toothbrush                                                         | marking legible; no visible damage                                                                 |                                              |                                               |
| 4.32                             | 21 (Ue <sub>3</sub> )             | shear (adhesion)                                    | 45 N                                                                                                                       | no visible damage                                                                                  |                                              |                                               |
| 4.33                             | 21 (Ue <sub>1</sub> )             | substrate<br>bending                                | depth 2 mm, 3 times                                                                                                        | no visible damage, no open circuit in bent position<br>$\pm (0.02 \% R + 10 \text{ m}\Omega)^{3)}$ |                                              | $\pm (0.05 \% R + 10 \text{ m}\Omega)^{3)}$   |
| 4.7                              | -                                 | voltage proof                                       | $U_{\text{rms}} = U_{\text{ins}}$ ; 60 s                                                                                   | no flashover or breakdown                                                                          |                                              |                                               |
| 4.35                             | -                                 | flammability                                        | IEC 60 695-11-5*, needle<br>flame test; 10 s                                                                               | no burning after 30 s                                                                              |                                              |                                               |

## Notes

- The pulse load stability of professional MELF resistors applies for precision resistors also. However, severe pulse loads are likely to jeopardize precision stability requirements.
- Wave soldering is not recommended.
- Special requirements apply to MICRO-MELF, MMU 0102:
  - $R < 100 \Omega$ :  $\pm (0.15 \% R + 10 \text{ m}\Omega)$
  - $100 \Omega \leq R \leq 10 \text{ k}\Omega$ :  $\pm 0.1 \% R$
  - $R > 10 \text{ k}\Omega$ :  $\pm 0.05 \% R$

\* The quoted IEC standards are also released as EN standards with the same number and identical contents.



## REVISION HISTORY

Compared to the prior revision of this datasheet, 26-Feb-04, the following changes have been applied:

- Introduction of a standardized part numbering system
- Additional emphasis on the clean balance of materials and on the compliance with various EU directives.
- Revision of the current noise diagram based on new test results
- Introduction of a test and requirements for electrostatic discharge (ESD)
- No other change of technical contents
- No product change



### Disclaimer

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