

## Precision MELF Resistors



### FEATURES

- Approved to EN 140401-803
- AEC-Q200 qualified
- Advanced thin film technology
- Superior stability: Class 0.05
- Wide precision range: 10  $\Omega$  to 1 M $\Omega$
- Matte Sn termination on Ni barrier layer
- Compliant to RoHS Directive 2011/65/EU



**RoHS**  
COMPLIANT

### APPLICATIONS

- Test and measuring equipment
- Industrial and medical electronics

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.

### 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            |
| 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, $U_{\text{max}}$ , AC/DC                                        | 150 V                       |                     | 200 V              |                     | 300 V              |                     |
| Permissible film temperature, $\vartheta_F$ max.                                   | 85 °C                       | 125 °C              | 85 °C              | 125 °C              | 85 °C              | 125 °C              |
| Operating temperature range                                                        | - 10 °C to 85 °C            | - 55 °C to 125 °C   | - 10 °C to 85 °C   | - 55 °C to 125 °C   | - 10 °C to 85 °C   | - 55 °C to 125 °C   |
| Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ max., after: | 22 Ω to 332 kΩ              |                     | 10 Ω to 511 kΩ     |                     | 15 Ω to 1 MΩ       |                     |
|                                                                                    | 1000 h                      | ≤ 0.05 %<br>≤ 0.1 % | ≤ 0.1 %<br>≤ 0.2 % | ≤ 0.05 %<br>≤ 0.1 % | ≤ 0.1 %<br>≤ 0.2 % | ≤ 0.05 %<br>≤ 0.1 % |
|                                                                                    | 8000 h                      | ≤ 0.1 %             | ≤ 0.2 %            | ≤ 0.1 %             | ≤ 0.2 %            | ≤ 0.1 %             |
|                                                                                    | 225 000 h                   | ≤ 0.3 %             | ≤ 0.6 %            | ≤ 0.3 %             | ≤ 0.6 %            | ≤ 0.3 %             |
| Permissible voltage against ambient (insulation):                                  |                             |                     |                    |                     |                    |                     |
| 1 min, $U_{\text{ins}}$                                                            | 200 V                       |                     | 300 V              |                     | 500 V              |                     |
| Continuous                                                                         | 75 V                        |                     | 75 V               |                     | 75 V               |                     |
| Failure rate: FIT <sub>observed</sub>                                              | ≤ 0.1 x 10 <sup>-9</sup> /h |                     |                    |                     |                    |                     |

### Notes

- 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.

## DIMENSIONS



### DIMENSIONS AND MASS

| 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 | 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            | 1.15 ± 0.1 | 80           |

#### Note

- Color code marking is applied according to IEC 60062 <sup>(3)</sup> in five bands. Each color band appears as a single solid line, voids are permissible if at least  $\frac{2}{3}$  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 band between the 4<sup>th</sup> and 5<sup>th</sup> full band indicates the temperature coefficient (yellow = TC25, orange = TC15).

## PATTERN STYLES FOR MELF RESISTORS



### RECOMMENDED SOLDER PAD DIMENSIONS

| TYPE     | WAVE SOLDERING |           |           |           | REFLOW SOLDERING |           |           |           |
|----------|----------------|-----------|-----------|-----------|------------------|-----------|-----------|-----------|
|          | G<br>(mm)      | Y<br>(mm) | X<br>(mm) | Z<br>(mm) | G<br>(mm)        | Y<br>(mm) | X<br>(mm) | Z<br>(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       |

#### Note

- The given solder pad dimensions reflect the considerations for board design and assembly as outlined e.g. in standards IEC 61188-5-x, or in publication IPC-7351. They do not guarantee any supposed thermal properties, however, they will be found adequate for most general applications.



# MMU 0102, MMA 0204, MMB 0207 - Precision

Precision MELF Resistors

Vishay Beyschlag

## PART NUMBER AND PRODUCT DESCRIPTION

Part Number: MMA02040D5620BB300

M M A 0 2 0 4 0 D 5 6 2 0 B B 3 0 0

| TYPE/SIZE                     | VERSION                                        | TCR                                      | RESISTANCE                                                                                                                                                                          | TOLERANCE                                              | PACKAGING                              |
|-------------------------------|------------------------------------------------|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|----------------------------------------|
| MMU0102<br>MMA0204<br>MMB0207 | 0 = Standard,<br>EN 140401-803,<br>"Version A" | 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 |

Product Description: MMA 0204-25 0.1 % BL 562R

| MMA               | 0204                 | -25                              | 0.1 %                                      | BL                                     | 562R                |
|-------------------|----------------------|----------------------------------|--------------------------------------------|----------------------------------------|---------------------|
| TYPE              | SIZE                 | TCR                              | TOLERANCE                                  | PACKAGING                              | RESISTANCE          |
| 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 $\Omega$ |

### Notes

- Products can be ordered using either the PART NUMBER or the PRODUCT DESCRIPTION.
- Approval to EN 140401-803, "Version A", is not available for  $\pm 15$  ppm/K,  $\pm 0.5$  %.

## PACKAGING

| TYPE     | CODE    | QUANTITY | CARRIER TAPE                                        | WIDTH | PITCH | REEL DIAMETER |
|----------|---------|----------|-----------------------------------------------------|-------|-------|---------------|
| MMU 0102 | B1      | 1000     | Antistatic blister tape acc.<br>IEC 60286-3 type II | 8 mm  | 4 mm  | 180 mm/7"     |
|          | B3 = BL | 3000     |                                                     |       |       | 330 mm/13"    |
|          | B0      | 10 000   |                                                     |       |       |               |
|          | M8      | 8000     | Bulk case acc.<br>IEC 60286-6                       | -     | -     | -             |
| MMA 0204 | B1      | 1000     | Antistatic blister tape acc.<br>IEC 60286-3 type II | 8 mm  | 4 mm  | 180 mm/7"     |
|          | B3 = BL | 3000     |                                                     |       |       | 330 mm/13"    |
|          | B0      | 10 000   |                                                     |       |       |               |
|          | M3      | 3000     | Bulk case acc.<br>IEC 60286-6                       | -     | -     | -             |
| MMB 0207 | B1      | 1000     | Antistatic blister tape acc.<br>IEC 60286-3 type II | 12 mm | 4 mm  | 180 mm/7"     |
|          | B2      | 2000     |                                                     |       |       | 330 mm/13"    |
|          | B7      | 7000     |                                                     |       |       |               |

**TEMPERATURE COEFFICIENT AND RESISTANCE RANGE**

| DESCRIPTION |           | RESISTANCE             |                       |                     |
|-------------|-----------|------------------------|-----------------------|---------------------|
| 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> |

**Notes**

- Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.
- Resistance values to be selected from E24 and E192 series, for other values please contact the factory.
- Approval to EN 140401-803, "Version A", is not available for ± 15 ppm/K; ± 0.5 %.

**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 ( $\text{Al}_2\text{O}_3$ ) 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** <sup>(3)</sup>.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. This includes pulse load screening (for  $R \geq 10 \Omega$ ) and additional non-linearity screening (for  $R \geq 30 \Omega$ ) for the elimination of products with a potential risk of early life failures 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** <sup>(3)</sup> or bulk case in accordance with **IEC 60286-6** <sup>(3)</sup>.

**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** <sup>(3)</sup>. 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 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.

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.

**Notes**

<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/index.php?id=995](http://www.eicta.org/index.php?id=995) → issues → environment policy → chemicals → chemicals for electronics.

<sup>(3)</sup> The quoted IEC standards are also released as EN standards with the same number and identical contents.

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)
- 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** <sup>(3)</sup> 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 **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.

The resistors are qualified according to AEC-Q200.

**RELATED PRODUCTS**

For thin film products with a wider resistance, see the datasheet:

- "Professional MELF Resistors"  
([www.vishay.com/doc?28713](http://www.vishay.com/doc?28713))

For products with tighter precision specification, see the datasheet:

- "High Precision MELF resistors"  
([www.vishay.com/doc?28715](http://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](http://www.vishay.com/doc?28707)).



### 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 under standard atmospheric conditions in accordance with IEC 60068-1, 5.3 <sup>(4)</sup>. Climatic category LCT/UCT/56 (rated temperature range: Lower category temperature, upper category temperature; damp heat, steady state, test duration 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 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 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 60115-1<br>CLAUSE             | IEC 60068-2 <sup>(4)</sup><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 $\Omega$                   |
| 4.5                              | -                                            | Resistance                                         | -                                                                                                           | $\pm 0.5 \% R$ ; $\pm 0.25 \% R$ ; $\pm 0.1 \% R$                             |                                              |                                               |
| 4.8.4.2                          | -                                            | Temperature<br>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<br>temperature      | 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                                                              | $\pm (0.05 \% R + 5 \text{ m}\Omega)$                                         | $\pm (0.1 \% R + 5 \text{ m}\Omega)$         |                                               |



| TEST PROCEDURES AND REQUIREMENTS |                                      |                                                                      |                                                                                                                                                                           |                                                                               |                                                                               |                                                                                |
|----------------------------------|--------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| EN<br>60115-1<br>CLAUSE          | IEC<br>60068-2 (4)<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 $\Omega$                                                    |
| 4.39                             | 67 (Cy)                              | Damp heat,<br>steady state,<br>accelerated                           | (85 $\pm$ 2) $^{\circ}$ C; (85 $\pm$ 5) % RH;<br>$U = 0.3 \times \sqrt{P_{70}} \times R$<br>$\leq 100$ V;<br>1000 h                                                       | $\pm (0.15 \% R + 5 \text{ m}\Omega)$                                         | $\pm (0.25 \% R + 5 \text{ m}\Omega)$                                         |                                                                                |
| 4.23                             |                                      | Climatic<br>sequence:                                                |                                                                                                                                                                           |                                                                               |                                                                               |                                                                                |
| 4.23.2                           | 2 (Bb)                               | dry heat                                                             | UCT; 16 h                                                                                                                                                                 |                                                                               |                                                                               |                                                                                |
| 4.23.3                           | 30 (Db)                              | damp heat, cyclic                                                    | 55 $^{\circ}$ C; 24 h; $\geq 90$ % RH;<br>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 $\pm$ 10) $^{\circ}$ C                                                                                                                                  |                                                                               |                                                                               |                                                                                |
| 4.23.6                           | 30 (Db)                              | damp heat, cyclic                                                    | 55 $^{\circ}$ C; 24 h; $\geq 90$ % RH;<br>5 cycles                                                                                                                        |                                                                               |                                                                               |                                                                                |
| 4.23.7                           | -                                    | DC load                                                              | $U = \sqrt{P_{70}} \times R$<br>$\leq U_{\text{max}}$ ; 1 min.<br>LCT = - 10 $^{\circ}$ C;<br>UCT = 85 $^{\circ}$ C<br>LCT = - 55 $^{\circ}$ C;<br>UCT = 125 $^{\circ}$ C | $\pm (0.05 \% R + 5 \text{ m}\Omega)$                                         | $\pm (0.1 \% R + 5 \text{ m}\Omega)$                                          | -                                                                              |
| -                                | 1 (Ab)                               | Cold                                                                 | - 55 $^{\circ}$ C; 2 h                                                                                                                                                    | $\pm (0.02 \% R + 5 \text{ m}\Omega)$                                         |                                                                               |                                                                                |
| 4.19                             | 14 (Na)                              | Rapid change<br>of temperature                                       | 30 min at LCT;<br>30 min at UCT;<br>LCT = - 10 $^{\circ}$ C;<br>UCT = 85 $^{\circ}$ C<br>5 cycles<br>1000 cycles                                                          | $\pm (0.01 \% R + 5 \text{ m}\Omega)$<br>$\pm (0.1 \% R + 5 \text{ m}\Omega)$ | $\pm (0.02 \% R + 5 \text{ m}\Omega)$<br>$\pm (0.1 \% R + 5 \text{ m}\Omega)$ | -<br>-                                                                         |
|                                  |                                      |                                                                      | LCT = - 55 $^{\circ}$ C;<br>UCT = 125 $^{\circ}$ C<br>5 cycles<br>1000 cycles                                                                                             | -<br>-                                                                        | -<br>-                                                                        | $\pm (0.025 \% R + 5 \text{ m}\Omega)$<br>$\pm (0.2 \% R + 5 \text{ m}\Omega)$ |
| 4.13                             | -                                    | Short time<br>overload;<br>precision<br>operation mode               | $U = 2.5 \times \sqrt{P_{70}} \times R$<br>$\leq 2 \times U_{\text{max}}$ ; 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<br>over load;<br>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>$\leq 2 \times U_{\text{max}}$ ;<br>10 pulses 10 $\mu$ s/700 $\mu$ s                                         | $\pm (0.25 \% R + 5 \text{ m}\Omega)^{(1)}$                                   |                                                                               |                                                                                |

**TEST PROCEDURES AND REQUIREMENTS**

| EN<br>60115-1<br>CLAUSE | IEC<br>60068-2 <sup>(4)</sup><br>TEST<br>METHOD | TEST                                                   | PROCEDURE                                                                                                                           | REQUIREMENTS<br>PERMISSIBLE CHANGE ( $\Delta R$ )                                                   |                                        |                                              |
|-------------------------|-------------------------------------------------|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|----------------------------------------|----------------------------------------------|
|                         |                                                 |                                                        | Stability for product types:                                                                                                        | STABILITY<br>CLASS 0.05<br>OR BETTER                                                                | STABILITY<br>CLASS 0.1<br>OR BETTER    | STABILITY<br>CLASS 0.25<br>OR BETTER         |
|                         |                                                 |                                                        | 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 $\Omega$                  |
| 4.37                    | -                                               | Periodic electric overload;<br>standard 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 Hz to 2000 Hz;<br>no resonance; amplitude<br>$\leq 1.5 \text{ mm}$ or $\leq 200 \text{ m/s}^2$ ; 7.5 h | $\pm (0.01 \% R + 5 \text{ m}\Omega)$                                                               | $\pm (0.02 \% R + 5 \text{ m}\Omega)$  | $\pm (0.03 \% R + 5 \text{ m}\Omega)$        |
| 4.40                    | -                                               | Electrostatic discharge<br>(Human Body Model)          | IEC 61340-3-1 <sup>(4)</sup> ;<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 soldering heat                           | Solder bath method;<br>(260 $\pm$ 5) $^{\circ}\text{C}$ ; (10 $\pm$ 1) s                                                            | Note <sup>(2)</sup>                                                                                 |                                        | $\pm (0.05 \% R + 10 \text{ m}\Omega)$       |
|                         |                                                 |                                                        | 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 solvent resistance                           | Isopropyl alcohol; 50 $^{\circ}\text{C}$ ;<br>method 2                                                                              | No visible damage                                                                                   |                                        |                                              |
| 4.30                    | 45 (XA)                                         | Solvent resistance of 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 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 <sup>(4)</sup> ,<br>needle flame test; 10 s                                                                         | No burning after 30 s                                                                               |                                        |                                              |

**Notes**

(1) The pulse load stability of professional MELF resistors applies for precision resistors also. However, severe pulse loads are likely to jeopardize precision stability requirements.

(2) Wave soldering is not recommended.

(3) Special requirements apply to MICRO-MELF, MMU 0102:

-  $R < 100 \Omega$ :  $\pm (0.15 \% R + 10 \text{ m}\Omega)$ .

-  $100 \Omega \leq R \leq 10 \text{ k}\Omega$ :  $\pm 0.1 \% R$ .

-  $R > 10 \text{ k}\Omega$ :  $\pm 0.05 \% R$ .

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



# MMU 0102, MMA 0204, MMB 0207 - Precision

Precision MELF Resistors

Vishay Beyschlag

## 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 |
|----------------------------------|------------|
| 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          |

## Historical 12NC Example

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

## HISTORICAL 12NC - Resistor type and packaging

| DESCRIPTION |                |              | 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....            | 166 6....        | 176 6....          | 061 6....        |
|             |                | $\pm 0.1$ %  | 171 7....            | 166 7....        | 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....            | 167 7....        | 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....            | 156 6....        | 146 6....          | 041 6....        |
|             |                | $\pm 0.1$ %  | 141 7....            | 156 7....        | 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....            | 157 7....        | 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....            | 196 6....        | 186 6....          |                  |
|             |                | $\pm 0.1$ %  | 181 7....            | 196 7....        | 186 7....          |                  |
|             | $\pm 15$ ppm/K | $\pm 0.1$ %  | 182 7....            | 197 7....        | 187 7....          |                  |



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