

## High Precision Thin Film Leaded Resistors



### DESCRIPTION

A homogenous film of metal alloy is deposited on a high grade ceramic body. After a helical groove has been cut in the resistive layer, tinned connecting wires of electrolytic copper are welded to the end-caps. The resistors are coated with lacquer which provides electrical, mechanical, and climatic protection.

### FEATURES

- High precision resistors (TCR up to  $\pm 5$  ppm/K, 0.01 % tol.)
- High stability (0.05 %)
- Low temperature coefficient (up to  $\pm 5$  ppm/K)
- Lead (Pb)-free solder contacts
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Compliant to RoHS directive 2002/95/EC



**RoHS**  
COMPLIANT

### APPLICATIONS

- Test and measurement
- Telecom

### TECHNICAL SPECIFICATIONS

| DESCRIPTION  | MPR24  |  |
|--|--|--|
| CECC Size, DIN Size  | B, 0207  |  |
| Resistance Range   | 10 $\Omega$ to 1 M $\Omega$                                    |  |
| Resistance Tolerance   | $\pm 0.05$ %; $\pm 0.02$ %; $\pm 0.01$ %                       | $\pm 0.5$ %; $\pm 0.25$ %; $\pm 0.1$ % |
| Temperature Coefficient  | $\pm 25$ ppm/K; $\pm 15$ ppm/K; $\pm 10$ ppm/K; $\pm 05$ ppm/K |  |
| Climatic Category (LCT/UCT/Days)                                     | 55/125/56  | 55/155/56                              |
| Rated Dissipation, $P_{70}$  | 0.125 W  | 0.25 W                                 |
| Operating Voltage, $U_{max}$ . AC/DC                                 | 250 V  |  |
| Film Temperature   | 125 $^{\circ}$ C   | 155 $^{\circ}$ C                       |
| Max. Resistance Change for Resistance Range, $\Delta R$ max., After: |  |  |
| Load (1000 h, $P_{70}$ )   | $\pm (0.05$ % $R + 0.01$ $\Omega)$                             |  |
| Long Term Damp Heat Test (56 Days)                                   | $\pm (0.05$ % $R + 0.01$ $\Omega)$                             |  |
| Soldering (10 s, 260 $^{\circ}$ C)                                   | $\pm (0.01$ % $R + 0.01$ $\Omega)$                             |  |
| Permissible Voltage Against Ambient :                                |  |  |
| 1 Minute; $U_{ins}$  | 500 V  |  |
| Continuous   | 75 V   |  |
| Failure Rate   | $\leq 0.1 \times 10^{-9}$ /h                                   |  |

**PART NUMBER AND PRODUCT DESCRIPTION**

**PART NUMBER: MPR24000E1001DC100**

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | P | R | 2 | 4 | 0 | 0 | 0 | E | 1 | 0 | 0 | 1 | D | C | 1 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

|                              |                               |   |   |  |  |   |
|------------------------------|-------------------------------|---|---|--|--|---|
| <b>MODEL/SIZE</b><br>MPR2400 | <b>VARIANT</b><br>0 = Neutral | <b>TCR</b><br>Z = ± 5 ppm/K<br>Y = ± 10 ppm/K<br>X = ± 15 ppm/K<br>E = ± 25 ppm/K | <b>VALUE</b><br>3 digit value<br>1 digit multiplier<br>MULTIPLIER<br>9 = *10 <sup>-1</sup> 2 = *10 <sup>2</sup><br>0 = *10 <sup>0</sup> 3 = *10 <sup>3</sup><br>1 = *10 <sup>1</sup> 4 = *10 <sup>4</sup> | <b>TOLERANCE</b><br>T = ± 0.01 %<br>H = ± 0.02 %<br>A = ± 0.05 %<br>B = ± 0.1 %<br>C = ± 0.25 %<br>D = ± 0.5 % | <b>PACKAGING (1)</b><br>RP<br>CU<br>C1 | <b>SPECIAL</b><br>Up to 2 digits<br>00 = Standard |
|------------------------------|-------------------------------|---|---|--|--|---|

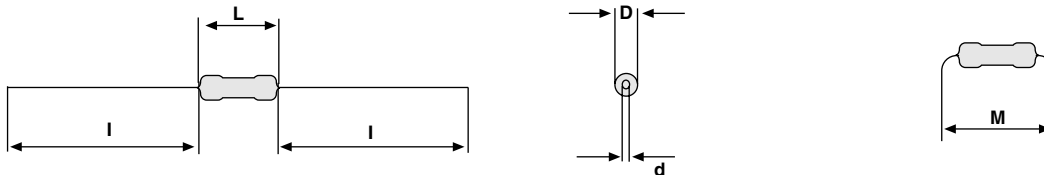
**PRODUCT DESCRIPTION: MPR24 - 25 0.5 % C1 1K0**

|                                     |   |   |  |   |
|-------------------------------------|---|---|--|---|
| <b>MPR24</b><br>MODEL/SIZE<br>MPR24 | <b>25</b><br>TCR<br>± 5 ppm/K<br>± 10 ppm/K<br>± 15 ppm/K<br>± 25 ppm/K | <b>0.5 %</b><br>TOLERANCE<br>± 0.01 %<br>± 0.02 %<br>± 0.05 %<br>± 0.1 %<br>± 0.25 %<br>± 0.5 % | <b>C1</b><br>PACKAGING (1)<br>RP<br>CU<br>C1 | <b>1K0</b><br>RESISTANCE VALUE<br>1K0 = 1 kΩ<br>50R5 = 50.5 Ω |
|-------------------------------------|---|---|--|---|

**Notes**

(1) Please refer to table PACKAGING for complete information

- The PART NUMBER is shown to facilitate the introduction of a unified part numbering system for ordering products

**DIMENSIONS**


| <b>DIMENSIONS</b> - Leaded resistor types, mass and relevant physical dimensions |                        |                        |                        |                        |                        |           |
|--|------------------------|------------------------|------------------------|------------------------|------------------------|-----------|
| TYPE   | D <sub>max.</sub> (mm) | L <sub>max.</sub> (mm) | d <sub>nom.</sub> (mm) | I <sub>min.</sub> (mm) | M <sub>min.</sub> (mm) | MASS (mg) |
| MPR 24   | 2.5                    | 6.3                    | 0.6                    | 28.0                   | 7.5                    | 220       |

**SCRIPT MARKING (2)**

| <b>TEMPERATURE COEFFICIENT AND TOLERANCE</b> - Printed resistance value and letter coding |          |             |             |             |
|---|----------|-------------|-------------|-------------|
| RESISTANCE VALUE  | TOL. (%) | LETTER CODE | TCR (ppm/K) | LETTER CODE |
| Clear text code for value   | ± 0.5    | D           | ± 25        | E           |
|   | ± 0.25   | C           | ± 15        | F           |
|   | ± 0.1    | B           | ± 10        | B           |
|   | ± 0.05   | A           | ± 05        | A           |
|   | ± 0.02   | P           | -           | -           |
|   | ± 0.01   | T           | -           | -           |

**Note**

(2) Resistors of TCR ± 25 ppm/K in combination with tolerances ± 0.5 %, ± 0.25 % and ± 0.1 % are only available with color coding in accordance with IEC 60062.

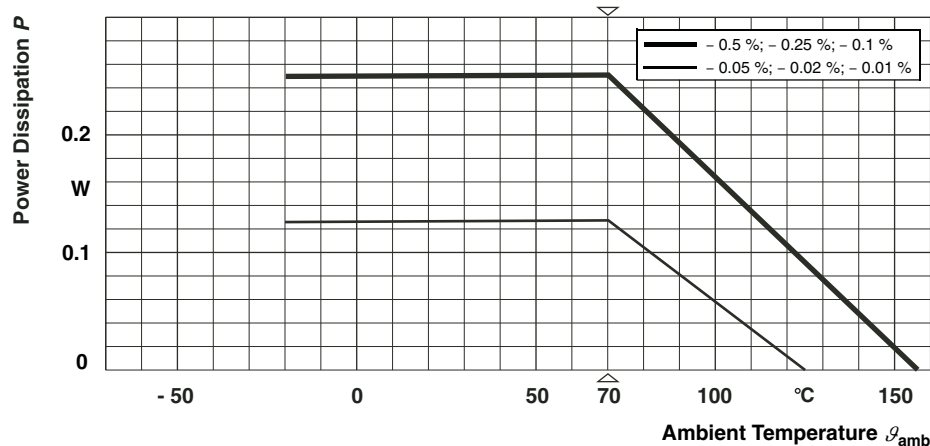
| TEMPERATURE COEFFICIENT AND RESISTANCE RANGE |           |                      |
|--|-----------|----------------------|
| DESCRIPTION                                  |           | RESISTANCE VALUE (2) |
| TCR (1)                                      | TOLERANCE | MPR24                |
| ± 25 ppm/K                                   | ± 0.5 %   | 10 Ω to 1 MΩ         |
|  | ± 0.25 %  | 10 Ω to 1 MΩ         |
|  | ± 0.1 %   | 10 Ω to 1 MΩ         |
|  | ± 0.05 %  | 24 Ω to 100 kΩ       |
|  | ± 0.02 %  | 24 Ω to 100 kΩ       |
| ± 15 ppm/K                                   | ± 0.5 %   | 10 Ω to 1 MΩ         |
|  | ± 0.25 %  | 10 Ω to 1 MΩ         |
|  | ± 0.1 %   | 10 Ω to 1 MΩ         |
|  | ± 0.05 %  | 24 Ω to 100 kΩ       |
|  | ± 0.02 %  | 24 Ω to 100 kΩ       |
| ± 10 ppm/K                                   | ± 0.5 %   | 10 Ω to 1 MΩ         |
|  | ± 0.25 %  | 10 Ω to 1 MΩ         |
|  | ± 0.1 %   | 10 Ω to 1 MΩ         |
|  | ± 0.05 %  | 24 Ω to 100 kΩ       |
|  | ± 0.02 %  | 24 Ω to 100 kΩ       |
| ± 5 ppm/K                                    | ± 0.5 %   | 10 Ω to 1 MΩ         |
|  | ± 0.25 %  | 10 Ω to 1 MΩ         |
|  | ± 0.1 %   | 10 Ω to 1 MΩ         |
|  | ± 0.05 %  | 24 Ω to 100 kΩ       |
|  | ± 0.02 %  | 24 Ω to 100 kΩ       |
|  | ± 0.01 %  | 24 Ω to 100 kΩ       |

**Notes**

- (1) The temperature coefficient is specified over the temperature range + 20 °C to + 70 °C
- (2) Resistance values to be selected from E192 series, for other values please contact the factory

| PACKAGING |             |      |             |          |
|-----------|-------------|------|-------------|----------|
| MODEL     | REEL        |      | BOX         |          |
|           | PIECES/REEL | CODE | PIECES/BOX  | CODE     |
| MPR24     | 5000        | RP   | 100<br>1000 | CU<br>C1 |

**FUNCTIONAL PERFORMANCE**



Derating (Depending on Resistance Tolerances)

**TESTS AND REQUIREMENTS**

Essentially all tests are carried out in accordance with the following specifications:

EN 60115-1, Generic specification (includes tests)

EN 140100, Sectional specification (includes schedule for qualification approval)

CECC 40101-806, Detail specification (includes schedule for conformance inspection)

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

The tests are carried out in accordance with IEC 60068-2-xx test method 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 1060 mbar).

For testing the components are mounted on a test board in accordance with IEC 60115-1, 4.31 unless otherwise specified.

In the Test Procedures and Requirements table only the tests and requirements are listed with reference to the relevant clauses of IEC 60115-1 and IEC 60068-2-xx test methods. A short description of the test procedure is also given.

| TEST PROCEDURES AND REQUIREMENTS |                            |                             |  |   |
|----------------------------------|----------------------------|-----------------------------|--|---|
| IEC 60115-1 CLAUSE               | IEC 60068-2-xx TEST METHOD | TEST                        | PROCEDURE  | REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )  |
|                                  |                            |                             | Stability for product types:   | 24 $\Omega$ to 100 k $\Omega$ 4.99 $\Omega$ to < 24 $\Omega$ ;<br>> 100 k $\Omega$ to 1 M $\Omega$                                |
| 4.5                              | -                          | Resistance ( $\Delta R/R$ ) | -  | $\pm 0.5\%$ ; $\pm 0.25\%$ ; $\pm 0.1\%$ ;<br>$\pm 0.05\%$ ; $\pm 0.02\%$ ; $\pm 0.01\%$ $\pm 0.5\%$ ; $\pm 0.25\%$ ; $\pm 0.1\%$ |
| 4.8                              | -                          | Temperature coefficient     | At 20/70/20 °C   | $\pm 25$ ppm/K; $\pm 15$ ppm/K; $\pm 10$ ppm/K; $\pm 05$ ppm/K  |
|                                  |                            |                             | At 20/LCT/20 °C and 20/UCT/20 °C   | $\pm 25$ ppm/K  |
| 4.25.1                           | -                          | Endurance at 70 °C          | $U = \sqrt{P_{70} \times R}$ or<br>$U = U_{max.}$ ;<br>1.5 h ON;<br>0.5 h OFF<br><br>70 °C; 2000 h | $\pm (0.05\% R + 0.01 \Omega)$  |
| 4.24                             | 78 (Cab)                   | Damp heat, steady state     | (40 $\pm$ 2) °C; 56 days;<br>(93 $\pm$ 3) % RH   | $\pm (0.05\% R + 0.01 \Omega)$  |
| 4.23                             |                            | Climatic sequence:          |  |   |
| 4.23.2                           | 2 (Ba)                     | Dry heat                    | 125 °C; 16 h   |   |
| 4.23.3                           | 30 (Db)                    | Damp heat, cyclic           | 55 °C; 24 h;<br>90 % to 100 % RH;<br>1 cycle   |   |
| 4.23.4                           | 1 (Aa)                     | Cold                        | - 55 °C; 2 h   |   |
| 4.23.5                           | 13 (M)                     | Low air pressure            | 8.5 kPa; 2 h;<br>15 °C to 35 °C  |   |

| TEST PROCEDURES AND REQUIREMENTS |   |  |   |  |
|----------------------------------|---|--|---|--|
| IEC 60115-1 CLAUSE               | IEC 60068-2-xx TEST METHOD                  | TEST                                       | PROCEDURE   | REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )   |
|                                  |   |  | Stability for product types:  | 24 $\Omega$ to 100 k $\Omega$ 4.99 $\Omega$ to < 24 $\Omega$ ;<br>> 100 k $\Omega$ to 1 M $\Omega$ |
| 4.23.6                           | 30 (Db)                                     | Damp heat, cyclic                          | 55 °C; 5 days;<br>95 % to 100 % RH;<br>5 cycles   | $\pm (0.05 \% R + 0.01 \Omega)$<br>no visible damage   |
| 4.13                             | -   | Short time overload                        | Room temperature;<br>$U = 2.5 \times \sqrt{P_{70} \times R}$ or<br>$U = 2 \times U_{max.}$ ;<br>5 s | $\pm (0.01 \% R + 0.01 \Omega)$<br>no visible damage   |
| 4.19                             | 14 (Na)                                     | Rapid change of temperature                | 30 min at LCT= - 55 ° C and<br>30 min at UCT = 155 ° C<br>5 cycles<br>200 cycles                    | $\pm (0.01 \% R + 0.01 \Omega)$<br>$\pm (0.25 \% R + 0.05 \Omega)$                                 |
| 4.29                             | 45 (XA)                                     | Component solvent resistance               | Isopropyl alcohol<br>+ 23 °C;<br>toothbrush method  | marking legible;<br>no visible damage  |
| 4.18.2                           | 20 (Tb)                                     | Resistance to soldering heat               | Unmounted components;<br>(260 $\pm$ 3) °C;<br>(10 $\pm$ 1) s  | $\pm (0.01 \% R + 0.01 \Omega)$<br>no visible damage   |
| 4.17                             | 20 (Ta)                                     | Solderability                              | + 235 °C; 2 s<br>solder bath method;<br>SnPb40  | Good tinning<br>( $\geq$ 95 % covered, no visible damage)  |
|                                  |   |  | + 245 °C; 3 s<br>solder bath method;<br>SnAg3Cu0.5  |  |
| 4.22                             | 6 (B4)                                      | Vibration                                  | 6 h;<br>10 Hz to 2000 Hz<br>1.5 mm or 196 m/s <sup>2</sup>  | $\pm (0.01 \% R + 0.01 \Omega)$ ;<br>no visible damage   |
| 4.16                             | 21 (Ua <sub>1</sub> )<br>21 (Ub)<br>21 (Uc) | Robustness of terminations                 | Tensile,<br>bending and torsion   | $\pm (0.01 \% R + 0.01 \Omega)$ ;<br>no visible damage   |
| 4.7                              | -   | Voltage proof                              | $U_{RMS} = U_{ins}$ ;<br>60 s   | No flashover or breakdown  |
| 4.12                             | -   | Noise                                      | IEC 60195:<br>$R \leq 100 \text{ k}\Omega$<br>$R > 100 \text{ k}\Omega$                             | max. 0.25 $\mu\text{V/V}$<br>max. 0.5 $\mu\text{V/V}$  |
| 4.40                             | -   | Electrostatic discharge (human body model) | IEC 61340-3-1;<br>3 pos. + 3 neg.<br>4 kV   | $\pm (0.5 \% + 0.05 \Omega)$   |



**12NC INFORMATION FOR HISTORICAL CODING REFERENCE**

- The resistors have a 12-digit numeric code starting with 2322 14.
- The subsequent 3 digits indicate the resistor type, specification and packaging; see the 12NC table.
- The remaining 3 digits indicate the resistance value. The number is available upon request and is fixed by the supplier.

**12NC Example**

The 12NC of an MPR24 resistor with tolerance of  $\pm 0.02\%$  and TCR  $\pm 05$  ppm/K, taped on bandolier in box of 100 units starts with 2322 141 77...; the last 3 digits are available upon request and are fixed by the supplier.

| 12NC - Resistor type and packaging |                |              |                  |                  |                   |
|------------------------------------|----------------|--------------|------------------|------------------|-------------------|
| DESCRIPTION                        |                |              | 2322 14. ....    |                  |                   |
|                                    |                |              | BANDOLIER IN BOX | BANDOLIER IN BOX | BANDOLIER ON REEL |
| TYPE                               | TCR            | TOL.         | 100 units        | 1000 units       | 5000 units        |
| MPR24                              | $\pm 25$ ppm/K | $\pm 0.5\%$  | 1 00...          | 1 10...          | 3 10...           |
|                                    |                | $\pm 0.25\%$ | 1 20...          | 1 30...          | 3 30...           |
|                                    |                | $\pm 0.1\%$  | 1 40...          | 1 50...          | 3 50...           |
|                                    |                | $\pm 0.05\%$ | 1 64...          | 3 64...          | -                 |
|                                    |                | $\pm 0.02\%$ | 1 74...          | 3 74...          | -                 |
|                                    |                | $\pm 0.01\%$ | 1 84...          | 3 84...          | -                 |
|                                    | $\pm 15$ ppm/K | $\pm 0.5\%$  | 1 05...          | 1 15...          | 3 15...           |
|                                    |                | $\pm 0.25\%$ | 1 25...          | 1 35...          | 3 35...           |
|                                    |                | $\pm 0.1\%$  | 1 45...          | 1 55...          | 3 55...           |
|                                    |                | $\pm 0.05\%$ | 1 65...          | 3 65...          | -                 |
|                                    |                | $\pm 0.02\%$ | 1 75...          | 3 75...          | -                 |
|                                    |                | $\pm 0.01\%$ | 1 85...          | 3 85...          | -                 |
|                                    | $\pm 10$ ppm/K | $\pm 0.5\%$  | 1 06...          | 1 16...          | 3 16...           |
|                                    |                | $\pm 0.25\%$ | 1 26...          | 1 36...          | 3 36...           |
|                                    |                | $\pm 0.1\%$  | 1 46...          | 1 56...          | 3 56...           |
|                                    |                | $\pm 0.05\%$ | 1 66...          | 3 66...          | -                 |
|                                    |                | $\pm 0.02\%$ | 1 76...          | 3 76...          | -                 |
|                                    |                | $\pm 0.01\%$ | 1 86...          | 3 86...          | -                 |
|                                    | $\pm 5$ ppm/K  | $\pm 0.5\%$  | 1 07...          | 1 17...          | 3 17...           |
|                                    |                | $\pm 0.25\%$ | 1 27...          | 1 37...          | 3 37...           |
|                                    |                | $\pm 0.1\%$  | 1 47...          | 1 57...          | 3 57...           |
|                                    |                | $\pm 0.05\%$ | 1 67...          | 3 67...          | -                 |
|                                    |                | $\pm 0.02\%$ | 1 77...          | 3 77...          | -                 |
|                                    |                | $\pm 0.01\%$ | 1 87...          | 3 87...          | -                 |



## **Disclaimer**

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Hyperlinks included in this datasheet may direct users to third-party websites. These links are provided as a convenience and for informational purposes only. Inclusion of these hyperlinks does not constitute an endorsement or an approval by Vishay of any of the products, services or opinions of the corporation, organization or individual associated with the third-party website. Vishay disclaims any and all liability and bears no responsibility for the accuracy, legality or content of the third-party website or for that of subsequent links.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.