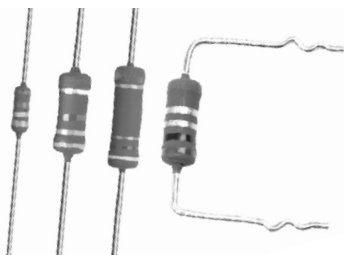


## Power Metal Film Leaded Resistors



### DESCRIPTION

A homogeneous 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 or copper-clad iron are welded to the end-caps. The resistors are coated with a red, non-flammable lacquer which provides electrical, mechanical and climatic protection. This coating is not resistant to aggressive fluxes and cleaning solvents. The encapsulation is resistant to all cleaning solvents in accordance with IEC 60068-2-45.

### FEATURES

- High power in small packages (1 W/0207 size to 3 W/0617 size)
- Different lead materials for different applications
- Defined interruption behaviour
- Technology: Metal film
- AEC-Q200 qualified (PR01 and PR02)
- Lead (Pb)-free solder contacts
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

### APPLICATIONS

- All general purpose power applications

| TECHNICAL SPECIFICATIONS                                           |          |                                                         |                 |                   |                 |                   |
|--------------------------------------------------------------------|----------|---------------------------------------------------------|-----------------|-------------------|-----------------|-------------------|
| DESCRIPTION                                                        | UNIT     | PR01                                                    | PR02<br>Cu-lead | PR02<br>FeCu-lead | PR03<br>Cu-lead | PR03<br>FeCu-lead |
| Resistance range <sup>(2)</sup>                                    | $\Omega$ | 0.22 to 1M                                              | 0.33 to 1M      | 1 to 1M           | 0.68 to 1M      | 1 to 1M           |
| Resistance tolerance                                               | %        | $\pm 1; \pm 5$                                          | $\pm 1; \pm 5$  | $\pm 1; \pm 5$    | $\pm 1; \pm 5$  | $\pm 1; \pm 5$    |
| Resistance series                                                  |          | $\pm 1$ (E24, E96); $\pm 5$ (E24 series) <sup>(1)</sup> |                 |                   |                 |                   |
| Rated dissipation, $P_{70}$<br>$1 \Omega \leq R$<br>$R < 1 \Omega$ | W        | 1<br>0.6                                                | 2<br>1.2        | 1.3<br>-          | 3<br>1.6        | 2.5<br>-          |
| Thermal resistance ( $R_{th}$ )                                    | K/W      | 135                                                     | 75              | 115               | 60              | 75                |
| Temperature coefficient                                            | ppm/K    | $\leq \pm 250$                                          | $\leq \pm 250$  | $\leq \pm 250$    | $\leq \pm 250$  | $\leq \pm 250$    |
| Maximum permissible voltage<br>( $U_{max}$ , AC/DC)                | V        | 350                                                     | 500             | 500               | 750             | 750               |
| Basic specifications                                               |          | IEC 60115-1                                             |                 |                   |                 |                   |
| Climatic category (IEC 60068-1)                                    |          | 55/155/56                                               |                 |                   |                 |                   |
| Stability after:                                                   |          |                                                         |                 |                   |                 |                   |
| Load (1000 h, $P_{70}$ )                                           |          | $\Delta R$ max.: $\pm (5 \% R + 0.1 \Omega)$            |                 |                   |                 |                   |
| Long term damp heat test (56 days)                                 |          | $\Delta R$ max.: $\pm (3 \% R + 0.1 \Omega)$            |                 |                   |                 |                   |
| Soldering (10 s, 260 °C)                                           |          | $\Delta R$ max.: $\pm (1 \% R + 0.05 \Omega)$           |                 |                   |                 |                   |

### Notes

- $R$  value is measured with probe distance of 24 mm  $\pm$  1 mm using 4-terminal method.

<sup>(1)</sup> 1 % tolerance is available for  $R_n$ -range from 1  $R$  upwards.

<sup>(2)</sup> Ohmic values (other than resistance range) are available on request.

**PART NUMBER AND PRODUCT DESCRIPTION**

Part Number: PR02000201001JA100

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | R | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 1 | J | A | 1 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| MODEL/SIZE                 | VARIANT                                     | WIRE TYPES                                               | TCR/MATERIAL | VALUE                                                                                                                                                                                                                                                                                 | TOLERANCE              | PACKAGING <sup>(1)</sup>                                             | SPECIAL                                                       |
|----------------------------|---------------------------------------------|----------------------------------------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|----------------------------------------------------------------------|---------------------------------------------------------------|
| PR0100<br>PR0200<br>PR0300 | 0 = Neutral<br>Z = Value overflow (Special) | 1 = Cu 0.6<br>2 = Cu 0.8<br>3 = FeCu 0.6<br>4 = FeCu 0.8 | 0 = Standard | <b>3 digit value</b><br><b>1 digit multiplier</b><br><b>MULTIPLIER</b><br>7 = *10 <sup>-3</sup> 2 = *10 <sup>2</sup><br>8 = *10 <sup>-2</sup> 3 = *10 <sup>3</sup><br>9 = *10 <sup>-1</sup> 4 = *10 <sup>4</sup><br>0 = *10 <sup>0</sup> 5 = *10 <sup>5</sup><br>1 = *10 <sup>1</sup> | F = ± 1 %<br>J = ± 5 % | N4    R2<br>N3    L1<br>A5    DC<br>A1    K1<br>AC    B1<br>R5    PC | The 2 digits are used for all special parts.<br>00 = Standard |

Product Description: PR02 5 % A1 1K0

| PR02                 | 5 %            | A1                                                                   | 1K0                          |
|----------------------|----------------|----------------------------------------------------------------------|------------------------------|
| MODEL/SIZE           | TOLERANCE      | PACKAGING <sup>(1)</sup>                                             | RESISTANCE VALUE             |
| PR01<br>PR02<br>PR03 | ± 1 %<br>± 5 % | N4    L1<br>N3    DC<br>A5    K1<br>A1    B1<br>AC    PC<br>R5    R2 | 1K0 = 1 kΩ<br>4K75 = 4.75 kΩ |

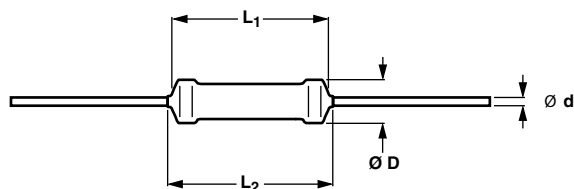
**Notes**

- The PART NUMBER is shown to facilitate the introduction of a unified part numbering system for ordering products.
- Please refer to table PACKAGING for details.

**PACKAGING**

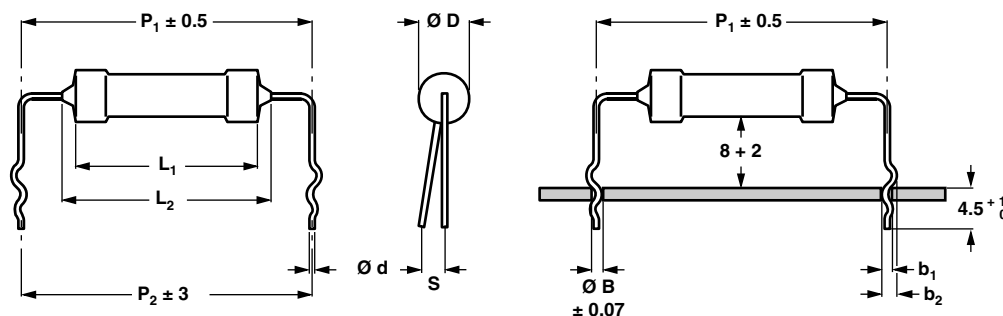
| MODEL | TAPING                                            | AMMO PACK                      |      | REEL                           |      | BULK, DOUBLE KINK                                    |        |      |
|-------|---------------------------------------------------|--------------------------------|------|--------------------------------|------|------------------------------------------------------|--------|------|
|       |                                                   | PIECES                         | CODE | PIECES                         | CODE | PITCH                                                | PIECES | CODE |
| PR01  | Axial, 52 mm<br>Wire Cu 0.6 mm<br>and FeCu 0.6 mm | 5000                           | A5   | 5000                           | R5   |                                                      |        |      |
|       |                                                   | 1000                           | A1   |                                |      |                                                      |        |      |
|       | Radial<br>Wire Cu 0.6 mm                          | 4000                           | N4   |                                |      | 17.8 mm<br>Wire Cu 0.6 mm<br>or FeCu 0.6 mm          | 1000   | L1   |
|       |                                                   |                                |      |                                |      | 12.5 mm<br>Wire FeCu 0.6 mm                          | 1000   | K1   |
| PR02  | Axial, 52 mm<br>Wire Cu 0.8 mm<br>and FeCu 0.6 mm | 1000                           | A1   | 5000<br>only with<br>Cu 0.8 mm | R5   |                                                      |        |      |
|       |                                                   | 3000<br>only with<br>Cu 0.8 mm | N3   | 2000<br>only with<br>Cu 0.8 mm | R2   | 17.8 mm<br>Wire Cu 0.8 mm<br>and FeCu 0.6 mm         | 1000   | L1   |
|       | Radial<br>Wire Cu 0.8 mm<br>and FeCu 0.6 mm       |                                |      |                                |      | 15.0 mm<br>only with FeCu 0.8 mm<br>Wire FeCu 0.6 mm | 1000   | B1   |
|       |                                                   |                                |      |                                |      |                                                      |        |      |
| PR03  | Axial, 63 mm<br>Wire Cu 0.8 mm<br>and FeCu 0.6 mm | 500                            | AC   |                                |      |                                                      |        |      |
|       |                                                   |                                |      |                                |      | 25.4 mm<br>Wire Cu 0.8 mm<br>and FeCu 0.6 mm         | 500    | DC   |
|       | Radial<br>Wire Cu 0.8 mm<br>and FeCu 0.6 mm       |                                |      |                                |      | 20 mm<br>Wire FeCu 0.8 mm                            | 500    | PC   |
|       |                                                   |                                |      |                                |      |                                                      |        |      |

## DIMENSIONS



Type with straight leads

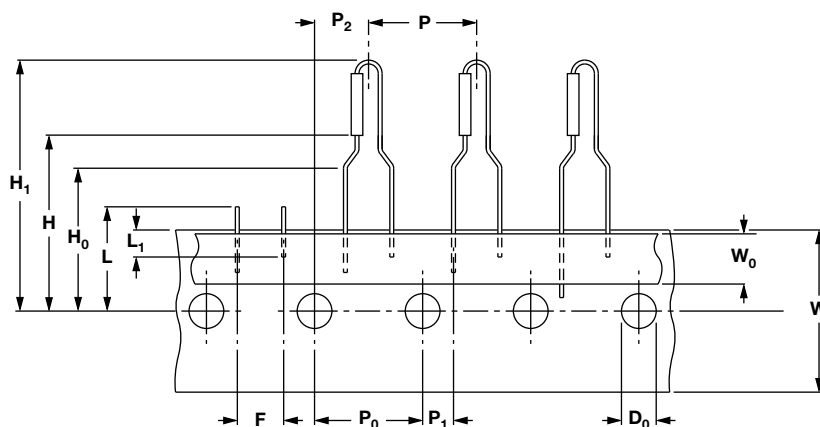
| DIMENSIONS - Straight lead type and relevant physical dimensions; see straight leads outline |                             |                             |                             |             |             |
|----------------------------------------------------------------------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------|-------------|
| TYPE                                                                                         | Ø D <sub>MAX.</sub><br>(mm) | L <sub>1</sub> MAX.<br>(mm) | L <sub>2</sub> MAX.<br>(mm) | Ø d<br>(mm) |             |
|                                                                                              |                             |                             |                             | Cu          | FeCu        |
| PR01                                                                                         | 2.5                         | 6.5                         | 8.0                         | 0.58 ± 0.05 | -           |
| PR02                                                                                         | 3.9                         | 10.0                        | 12.0                        | 0.78 ± 0.05 | 0.58 ± 0.05 |
| PR03                                                                                         | 5.2                         | 16.7                        | 19.5                        | 0.78 ± 0.05 | 0.58 ± 0.05 |



Type with double kink

Dimensions in millimeters

| DIMENSIONS - Double kink lead type and relevant physical dimensions; see double kinked outline |                              |             |             |                        |                        |                             |                        |                        |                           |             |
|------------------------------------------------------------------------------------------------|------------------------------|-------------|-------------|------------------------|------------------------|-----------------------------|------------------------|------------------------|---------------------------|-------------|
| TYPE                                                                                           | LEAD STYLE                   | Ø d<br>(mm) |             | b <sub>1</sub><br>(mm) | b <sub>2</sub><br>(mm) | Ø D <sub>MAX.</sub><br>(mm) | P <sub>1</sub><br>(mm) | P <sub>2</sub><br>(mm) | S <sub>MAX.</sub><br>(mm) | Ø B<br>(mm) |
|                                                                                                |                              | Cu          | FeCu        |                        |                        |                             |                        |                        |                           |             |
| PR01                                                                                           | Double kink<br>17.8 mm pitch | 0.58 ± 0.05 | 0.58 ± 0.05 | 1.10<br>+ 0.25/- 0.20  | 1.45<br>+ 0.25/- 0.20  | 2.5                         | 17.8                   | 17.8                   | 2                         | 0.8         |
|                                                                                                | Double kink<br>12.5 mm pitch | -           | 0.58 ± 0.05 | 1.10<br>+ 0.25/- 0.20  | 1.45<br>+ 0.25/- 0.20  |                             | 12.5                   | 12.5                   | 2                         | 0.8         |
| PR02                                                                                           | Double kink<br>17.8 mm pitch | 0.78 ± 0.05 | 0.58 ± 0.05 | 1.10<br>+ 0.25/- 0.20  | 1.45<br>+ 0.25/- 0.20  | 3.9                         | 17.8                   | 17.8                   | 2                         | 0.8         |
|                                                                                                | Double kink<br>12.5 mm pitch | -           | 0.78 ± 0.05 | 1.30<br>+ 0.25/- 0.20  | 1.65<br>+ 0.25/- 0.20  |                             | 15.0                   | 15.0                   | 2                         | 1.0         |
| PR03                                                                                           | Double kink<br>17.8 mm pitch | 0.78 ± 0.05 | 0.58 ± 0.05 | 1.10<br>+ 0.25/- 0.20  | 1.65<br>+ 0.25/- 0.20  | 5.2                         | 25.4                   | 25.4                   | 2                         | 1.0         |
|                                                                                                | Double kink<br>12.5 mm pitch | -           | 0.78 ± 0.05 | 1.30<br>+ 0.25/- 0.20  | 2.15<br>+ 0.25/- 0.20  |                             | 22.0                   | 20.0                   | 2                         | 1.0         |

**PRODUCTS WITH RADIAL LEADS (PR01, PR02)**


| DIMENSIONS - Radial taping |                                                 |       |           |      |
|----------------------------|-------------------------------------------------|-------|-----------|------|
| SYMBOL                     | PARAMETER                                       | VALUE | TOLERANCE | UNIT |
| P                          | Pitch of components                             | 12.7  | $\pm 1.0$ | mm   |
| P <sub>0</sub>             | Feed-hole pitch                                 | 12.7  | $\pm 0.2$ | mm   |
| P <sub>1</sub>             | Feed-hole centre to lead at topside at the tape | 3.85  | $\pm 0.5$ | mm   |
| P <sub>2</sub>             | Feed-hole center to body center                 | 6.35  | $\pm 1.0$ | mm   |
| F                          | Lead-to-lead distance                           | 4.8   | + 0.7/- 0 | mm   |
| W                          | Tape width                                      | 18.0  | $\pm 0.5$ | mm   |
| W <sub>0</sub>             | Minimum hold down tape width                    | 5.5   | -         | mm   |
| H1                         | Component height PR01                           | 29    | Max.      | mm   |
|                            | Component height PR02                           | 29    | $\pm 3.0$ |      |
| H <sub>0</sub>             | Lead wire clinch height                         | 16.5  | $\pm 0.5$ | mm   |
| H                          | Height of component from tape center            | 19.5  | $\pm 1$   | mm   |
| D <sub>0</sub>             | Feed-hole diameter                              | 4.0   | $\pm 0.2$ | mm   |
| L                          | Maximum length of snapped lead                  | 11.0  | -         | mm   |
| L <sub>1</sub>             | Minimum lead wire (tape portion) shortest lead  | 2.5   | -         | mm   |

**Note**

- Please refer Packaging document ([www.vishay.com/doc?28721](http://www.vishay.com/doc?28721)) for more detail.

| MASS PER UNIT    |           |
|------------------|-----------|
| TYPE             | MASS (mg) |
| PR01 Cu 0.6 mm   | 212       |
| PR01 FeCu 0.6 mm | 207       |
| PR02 Cu 0.8 mm   | 504       |
| PR02 FeCu 0.6 mm | 455       |
| PR02 FeCu 0.8 mm | 496       |
| PR03 Cu 0.8 mm   | 1192      |
| PR03 FeCu 0.6 mm | 1079      |
| PR03 FeCu 0.8 mm | 1185      |

## MARKING

The nominal resistance and tolerance are marked on the resistor using four or five colored bands in accordance with IEC 60062, marking codes for resistors and capacitors.

## OUTLINES

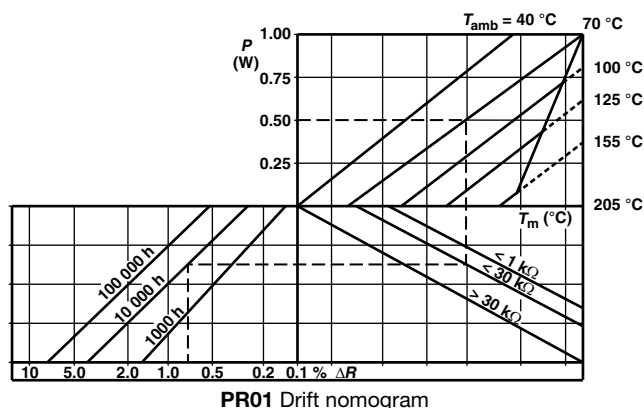
The length of the body ( $L_1$ ) is measured by inserting the leads into holes of two identical gauge plates and moving these plates parallel to each other until the resistor body is clamped without deformation (IEC 60294).

## FUNCTIONAL DESCRIPTION

### PRODUCT CHARACTERIZATION

Standard values of nominal resistance are taken from the E96/E24 series for resistors with a tolerance of  $\pm 1\%$  or  $\pm 5\%$ . The values of the E96/E24 series are in accordance with IEC 60063.

## FUNCTIONAL PERFORMANCE



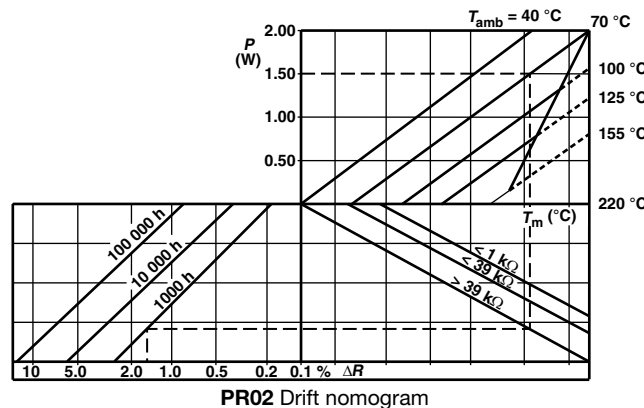
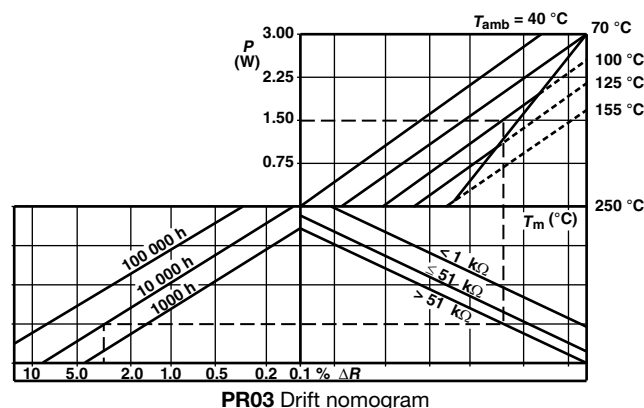
## MOUNTING

The resistors are suitable for processing on automatic insertion equipment and cutting and bending machines.

| MOUNTING PITCH |                         |                     |                  |
|----------------|-------------------------|---------------------|------------------|
| TYPE           | LEAD STYLE              | PITCH               |                  |
|                |                         | mm                  | e                |
| PR01           | Straight leads          | 12.5 <sup>(1)</sup> | 5 <sup>(1)</sup> |
|                | Radial taped            | 4.8                 | 2                |
|                | Double kink large pitch | 17.8                | 7                |
|                | Double kink small pitch | 12.5                | 5                |
| PR02           | Straight leads          | 15.0 <sup>(1)</sup> | 6 <sup>(1)</sup> |
|                | Radial taped            | 4.8                 | 2                |
|                | Double kink large pitch | 17.8                | 7                |
|                | Double kink small pitch | 15.0                | 6                |
| PR03           | Straight leads          | 23.0 <sup>(1)</sup> | 9 <sup>(1)</sup> |
|                | Double kink large pitch | 25.4                | 10               |
|                | Double kink small pitch | 20.0                | 8                |

### Note

<sup>(1)</sup> Recommended minimum value.

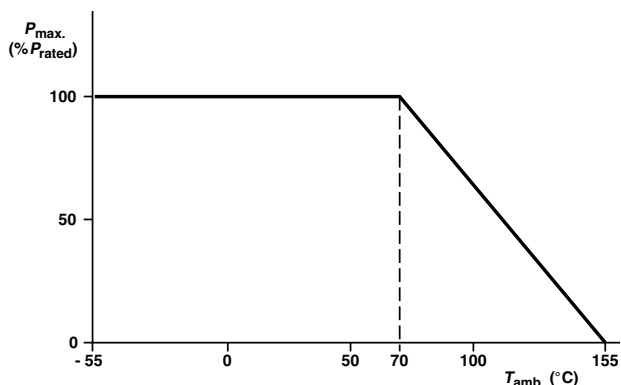


### Note

- The maximum permissible hot-spot temperature is 205 °C for PR01, 220 °C for PR02 and 250 °C for PR03.

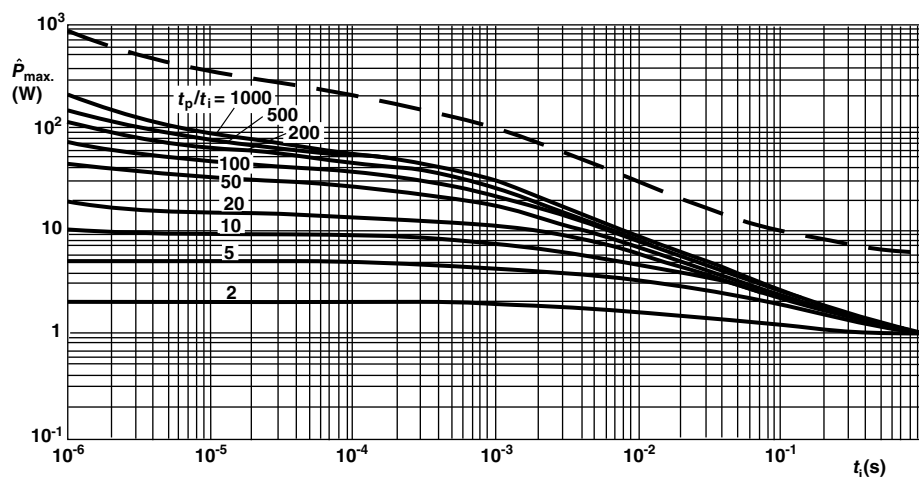
## DERATING

The power that the resistor can dissipate depends on the operating temperature.

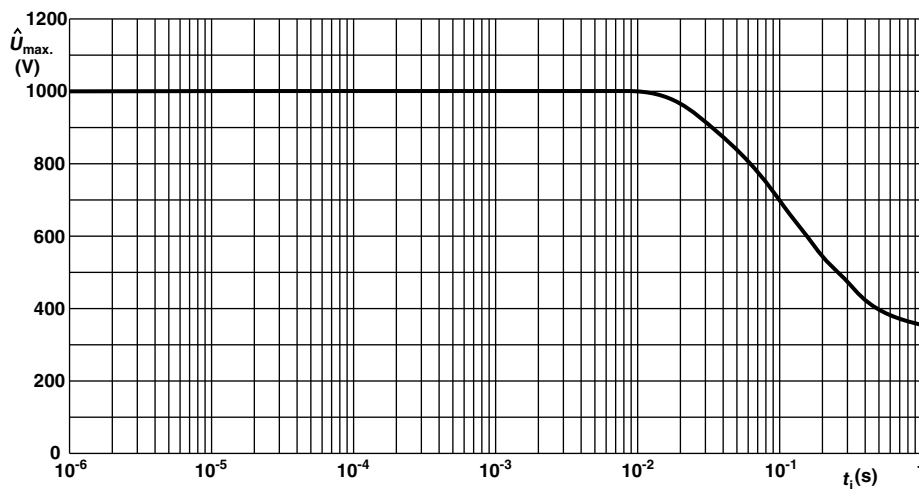


Maximum dissipation ( $P_{max.}$ ) in percentage of rated power as a function of the ambient temperature ( $T_{amb}$ )

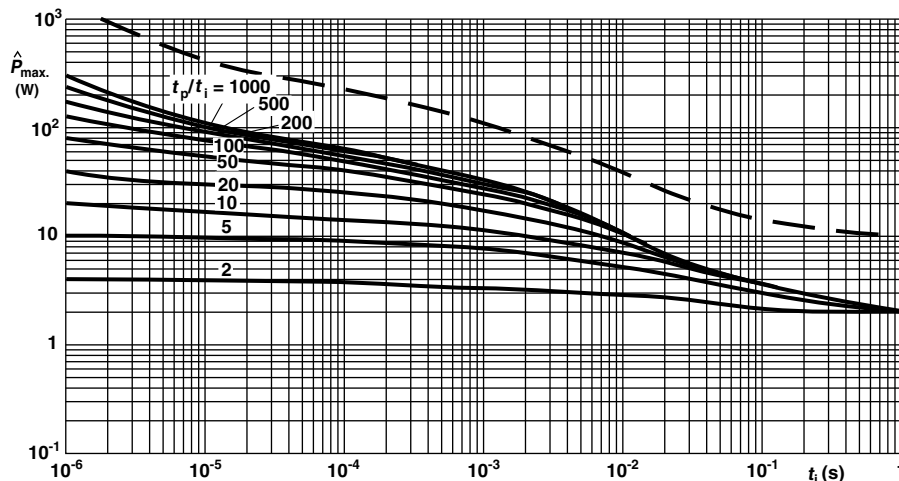
## PULSE LOADING CAPABILITIES



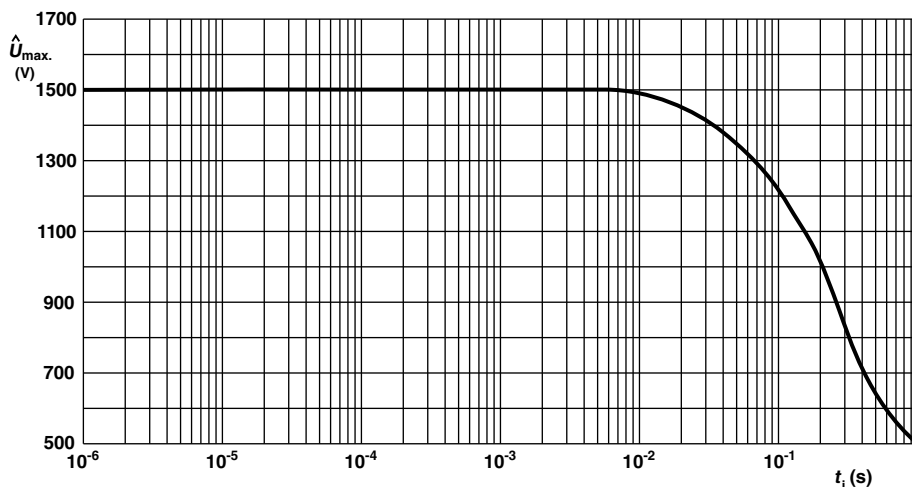
**PR01** Pulse on a regular basis; maximum permissible peak pulse power ( $\hat{P}_{max.}$ ) as a function of pulse duration ( $t_i$ )



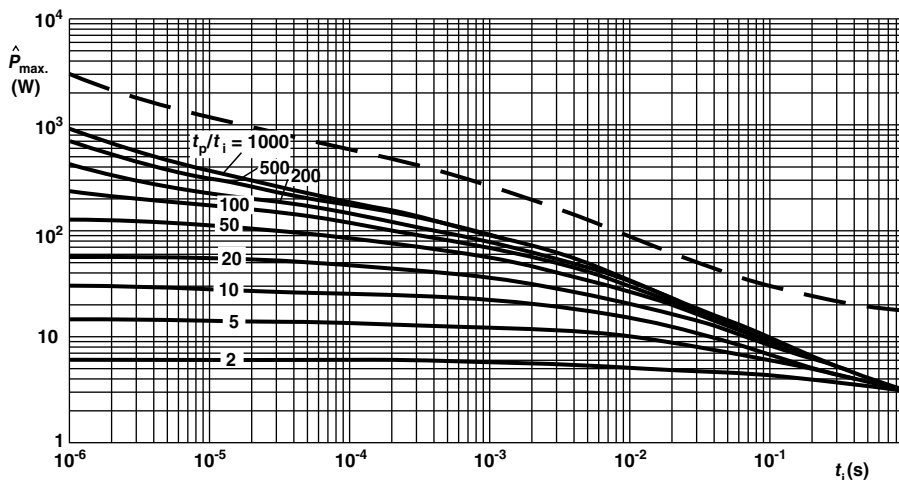
**PR01** Pulse on a regular basis; maximum permissible peak pulse voltage ( $\hat{U}_{max.}$ ) as a function of pulse duration ( $t_i$ )

**PULSE LOADING CAPABILITIES**


**PR02** Pulse on a regular basis; maximum permissible peak pulse power ( $\hat{P}_{max}$ ) as a function of pulse duration ( $t_i$ )

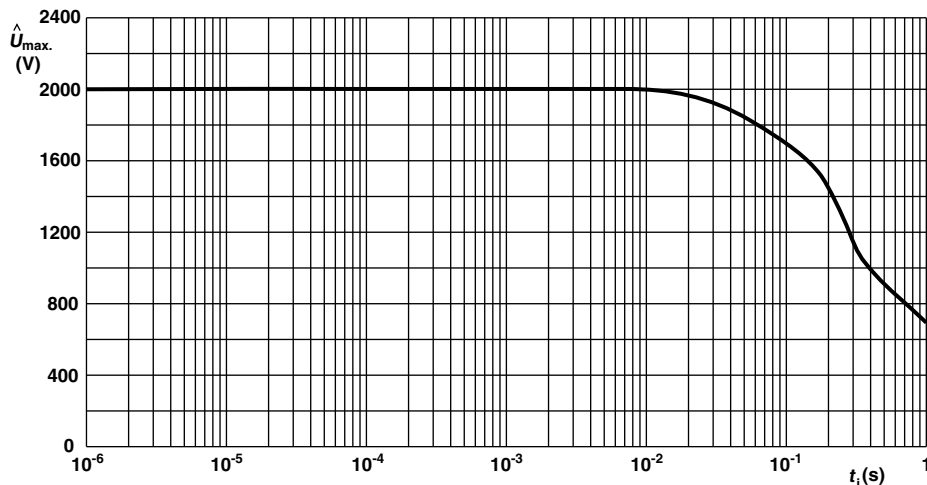


**PR02** Pulse on a regular basis; maximum permissible peak pulse voltage ( $\hat{U}_{max}$ ) as a function of pulse duration ( $t_i$ )



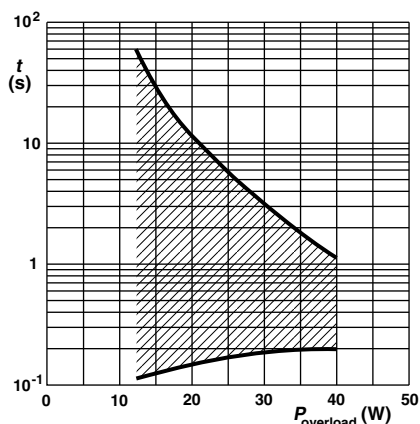
**PR03** Pulse on a regular basis; maximum permissible peak pulse power ( $\hat{P}_{max}$ ) as a function of pulse duration ( $t_i$ )

## PULSE LOADING CAPABILITIES



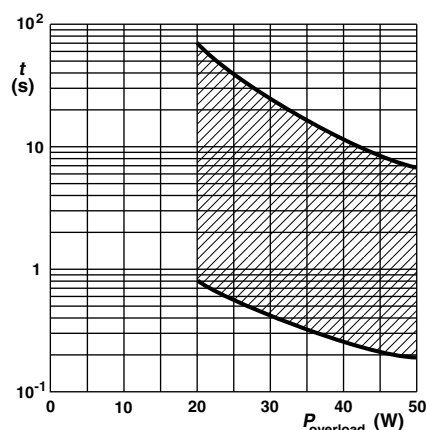
**PR03** Pulse on a regular basis; maximum permissible peak pulse voltage ( $\hat{U}_{max}$ ) as a function of pulse duration ( $t_i$ )

## INTERRUPTION CHARACTERISTICS



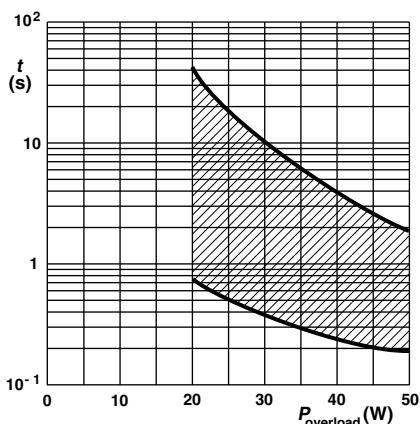
**PR01** Time to interruption as a function of overload power for range:  $0 R 22 \leq R_v < 1 R$

This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



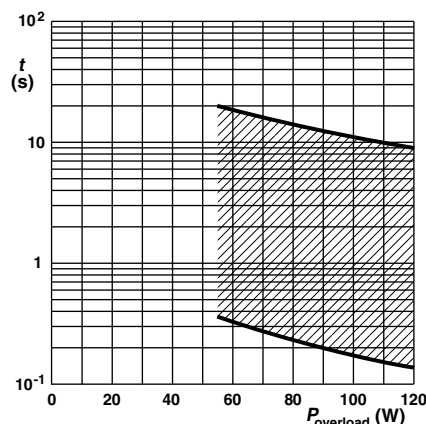
**PR01** Time to interruption as a function of overload power for range:  $16 R \leq R_n \leq 560 R$

This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



**PR01** Time to interruption as a function of overload power for range:  $1 R \leq R_n \leq 15 R$

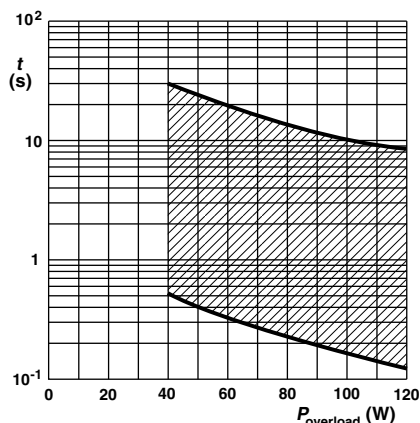
This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



**PR02** Time to interruption as a function of overload power for range:  $0.33 R \leq R_n \leq 5 R$

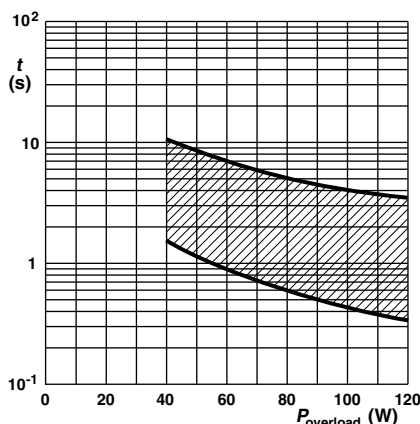
This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



**INTERRUPTION CHARACTERISTICS**


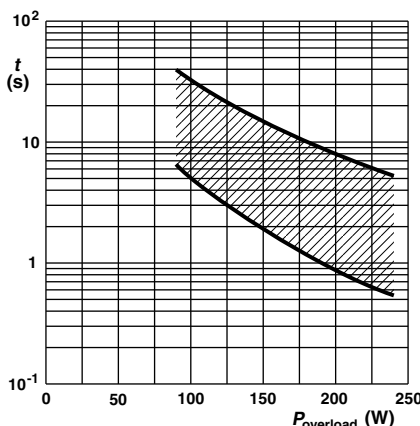
**PR02** Time to interruption as a function of overload power for range:  $5 R \leq R_n \leq 68 R$

This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



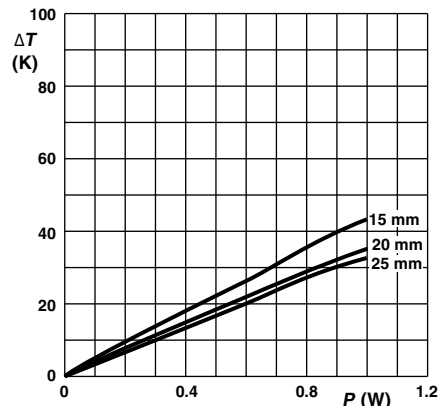
**PR02** Time to interruption as a function of overload power for range:  $68 R \leq R_n \leq 560 R$

This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



**PR03** Time to interruption as a function of overload power for range:  $0.68 R \leq R_n \leq 560 R$

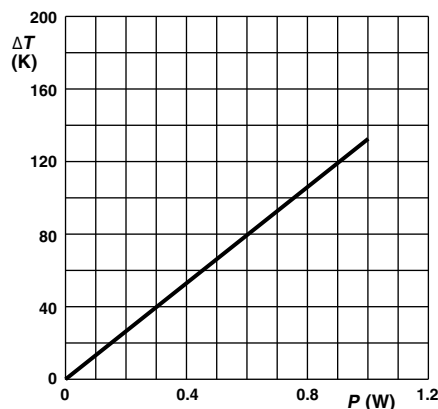
This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.

**APPLICATION INFORMATION**


Ø 0.6 mm Cu-leads

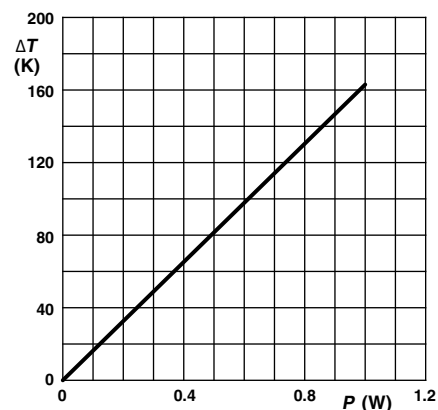
Minimum distance from resistor body to PCB = 1 mm

**PR01** Temperature rise ( $\Delta T$ ) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



Ø 0.6 mm Cu-leads

**PR01** Hot-spot temperature rise ( $\Delta T$ ) as a function of dissipated power.

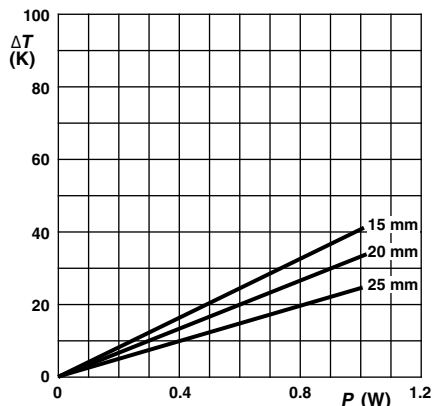


Ø 0.6 mm FeCu-leads

**PR01** Hot-spot temperature rise ( $\Delta T$ ) as a function of dissipated power.



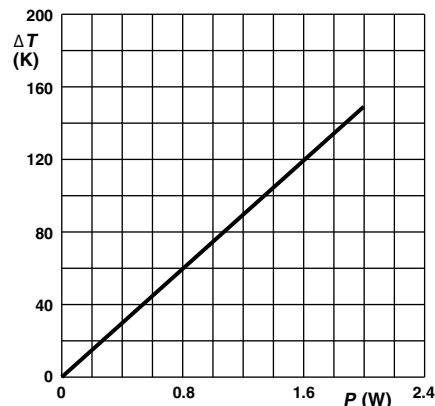
## APPLICATION INFORMATION



Ø 0.6 mm FeCu-leads

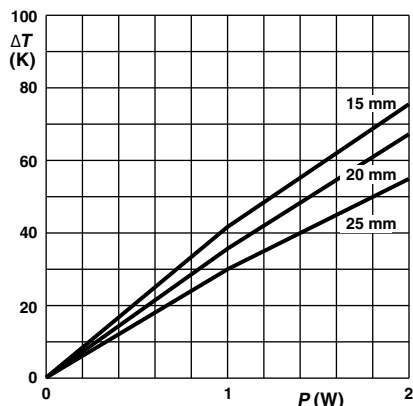
Minimum distance from resistor body to PCB = 1 mm

**PR01** Temperature rise ( $\Delta T$ ) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



Ø 0.8 mm Cu-leads

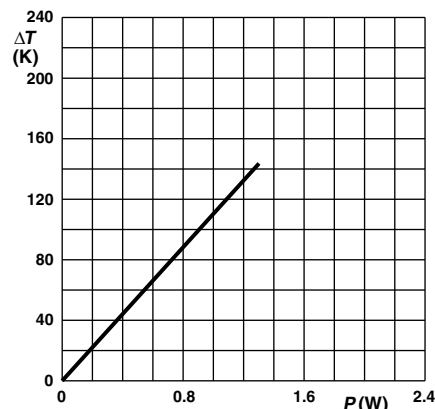
**PR02** Hot-spot temperature rise ( $\Delta T$ ) as a function of dissipated power.



Ø 0.8 mm Cu-leads

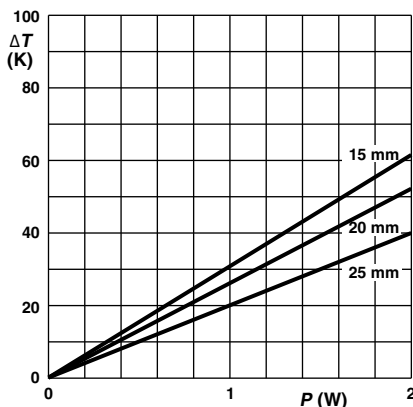
Minimum distance from resistor body to PCB = 1 mm

**PR02** Temperature rise ( $\Delta T$ ) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



Ø 0.6 mm FeCu-leads

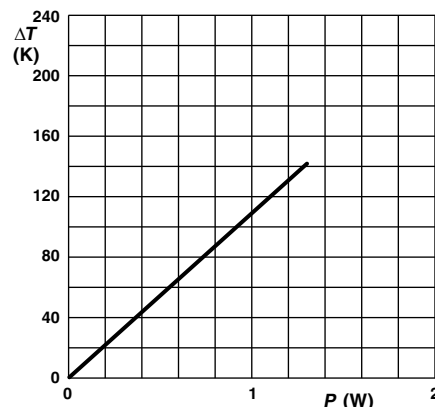
**PR02** Hot-spot temperature rise ( $\Delta T$ ) as a function of dissipated power.



Ø 0.6 mm FeCu-leads

Minimum distance from resistor body to PCB = 1 mm

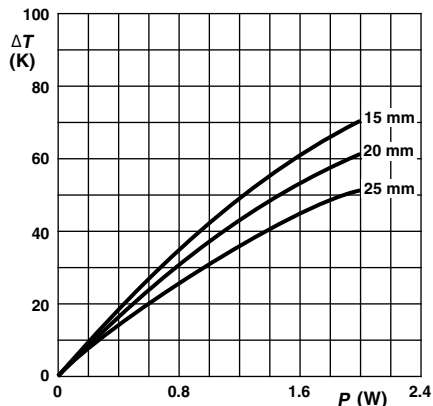
**PR02** Temperature rise ( $\Delta T$ ) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



Ø 0.8 mm FeCu-leads

**PR02** Hot-spot temperature rise ( $\Delta T$ ) as a function of dissipated power.

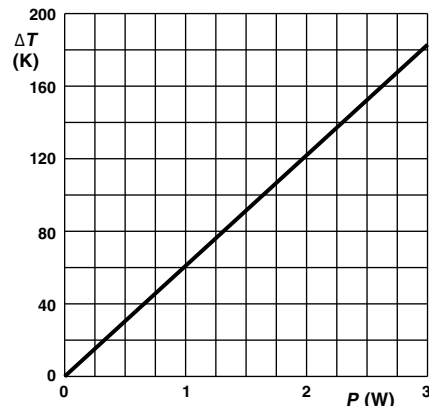
# APPLICATION INFORMATION



Ø 0.8 mm FeCu-leads

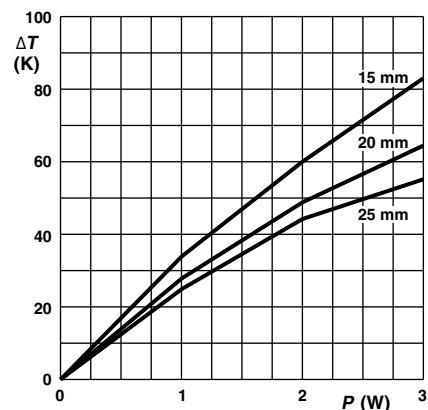
Minimum distance from resistor body to PCB = 1 mm

**PR02** Temperature rise ( $\Delta T$ ) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



Ø 0.8 mm Cu-leads

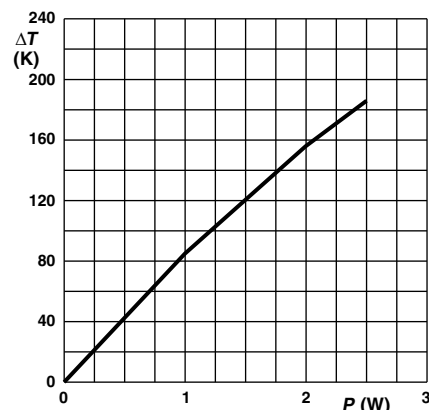
**PR03** Hot-spot temperature rise ( $\Delta T$ ) as a function of dissipated power.



Ø 0.8 mm Cu-leads

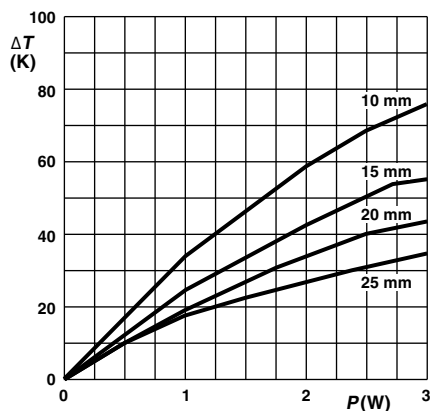
Minimum distance from resistor body to PCB = 1 mm

**PR03** Temperature rise ( $\Delta T$ ) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



Ø 0.6 mm FeCu-leads

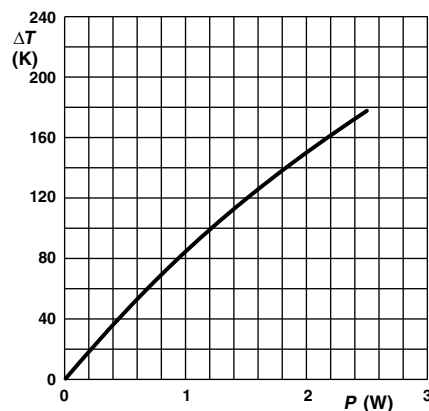
**PR03** Hot-spot temperature rise ( $\Delta T$ ) as a function of dissipated power.



Ø 0.6 mm FeCu-leads

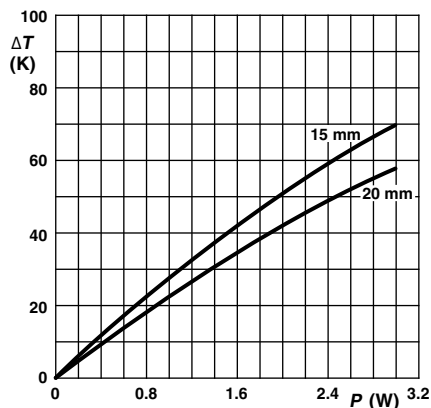
Minimum distance from resistor body to PCB = 1 mm

**PR03** Temperature rise ( $\Delta T$ ) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



Ø 0.8 mm FeCu-leads

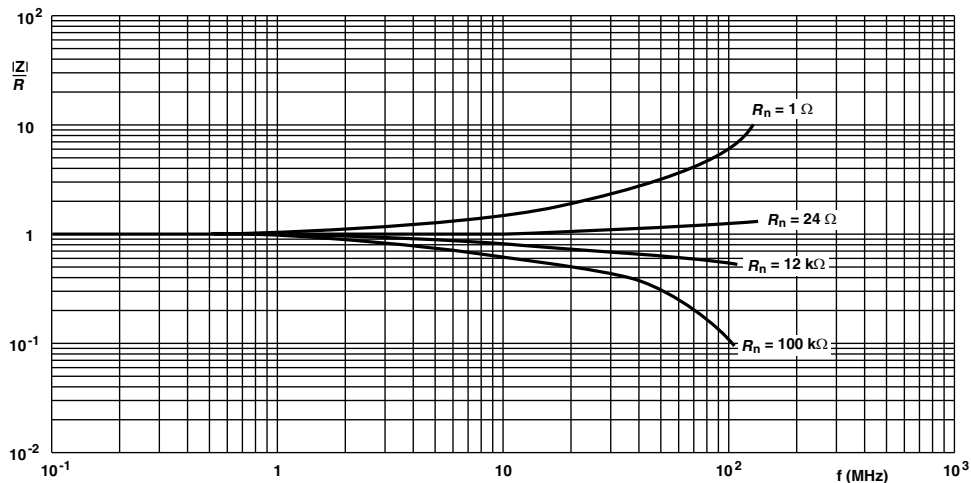
**PR03** Hot-spot temperature rise ( $\Delta T$ ) as a function of dissipated power.

**APPLICATION INFORMATION**


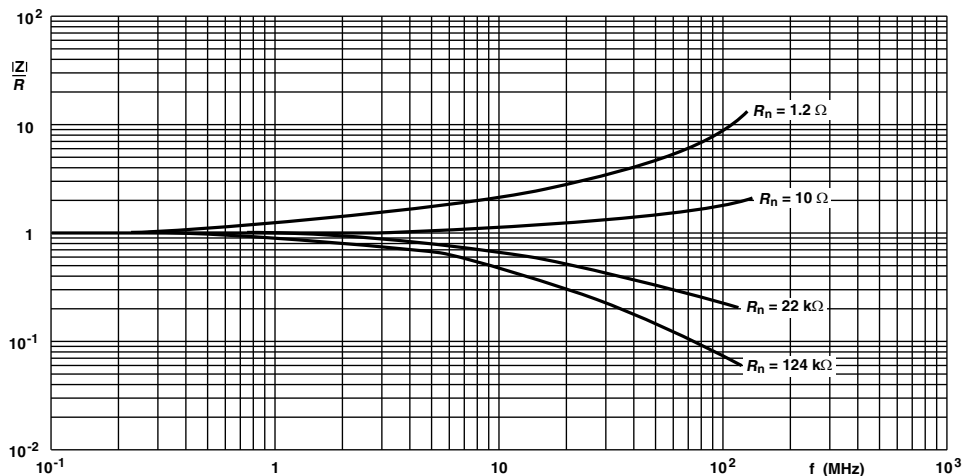
Ø 0.8 mm FeCu-leads

Minimum distance from resistor body to PCB = 1 mm

**PR03** Temperature rise ( $\Delta T$ ) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.

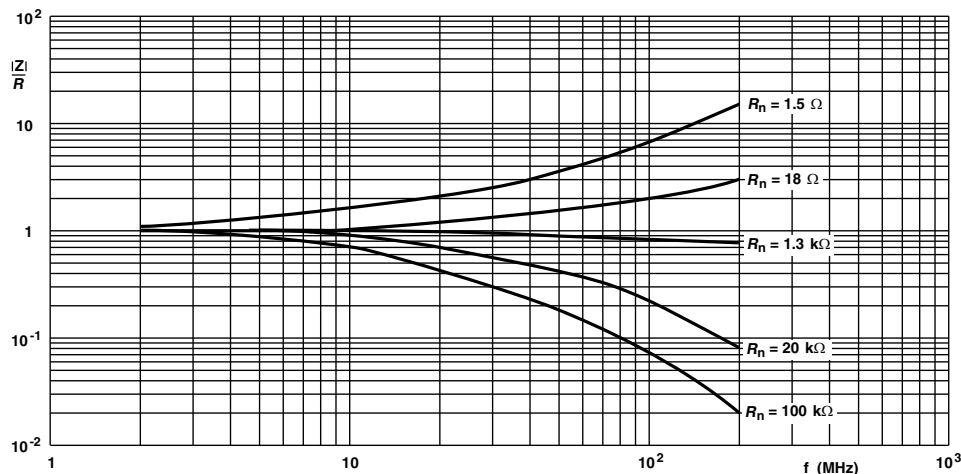


**PR01** Impedance as a function of applied frequency



**PR02** Impedance as a function of applied frequency

## APPLICATION INFORMATION



PR03 Impedance as a function of applied frequency

## TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC 60115-1 specification, category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days).

The tests are carried out in accordance with IEC 60068-2-xx Test Method under standard atmospheric conditions according to IEC 60068-1, 5.3.

In the Test Procedures and Requirements table, 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. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

| TEST PROCEDURES AND REQUIREMENTS |                          |                                                              |                                                                                                                                                                                                                                                                                                                                                                          |                                                        |
|----------------------------------|--------------------------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| IEC 60115-1 CLAUSE               | IEC 60068-2- TEST METHOD | TEST                                                         | PROCEDURE                                                                                                                                                                                                                                                                                                                                                                | REQUIREMENTS                                           |
| 4.4.1                            |                          | Visual examination                                           |                                                                                                                                                                                                                                                                                                                                                                          | No holes; clean surface; no damage                     |
| 4.4.2                            |                          | Dimensions (outline)                                         | Gauge (mm)                                                                                                                                                                                                                                                                                                                                                               | See Straight and Kinked Dimensions tables              |
| 4.5                              |                          | Resistance (refer note on first page for measuring distance) | Applied voltage (+ 0 %/- 10 %):<br>$R < 10 \Omega$ : 0.1 V<br>$10 \Omega \leq R < 100 \Omega$ : 0.3 V<br>$100 \Omega \leq R < 1 \text{ k}\Omega$ : 1 V<br>$1 \text{ k}\Omega \leq R < 10 \text{ k}\Omega$ : 3 V<br>$10 \text{ k}\Omega \leq R < 100 \text{ k}\Omega$ : 10 V<br>$100 \text{ k}\Omega \leq R < 1 \text{ M}\Omega$ : 25 V<br>$R = 1 \text{ M}\Omega$ : 50 V | $R - R_{\text{nom}}$ : max. $\pm 5 \%$                 |
| 4.18                             | 20 (Tb)                  | Resistance to soldering heat                                 | Thermal shock: 10 s; 260 °C; 3 mm from body                                                                                                                                                                                                                                                                                                                              | $\Delta R_{\text{max}}$ : $\pm (1 \% R + 0.05 \Omega)$ |
| 4.29                             | 45 (Xa)                  | Component solvent resistance                                 | Isopropyl alcohol or H <sub>2</sub> O followed by brushing                                                                                                                                                                                                                                                                                                               | No visual damage                                       |
| 4.17                             | 20 (Ta)                  | Solderability                                                | 2 s; 235 °C; Solder bath method; SnPb40<br>3 s; 245 °C; Solder bath method; SnAg3Cu0.5                                                                                                                                                                                                                                                                                   | Good tinning ( $\geq 95 \%$ covered); no damage        |
|                                  |                          | Solderability (after ageing)                                 | 8 h steam or 16 h 155 °C; leads immersed 6 mm:<br>for 2 s at 235 °C; solder bath (SnPb40)<br>for 3 s at 245 °C; solder bath (SnAg3Cu0.5)                                                                                                                                                                                                                                 | Good tinning ( $\geq 95 \%$ covered); no damage        |

**TEST PROCEDURES AND REQUIREMENTS**

| IEC 60115-1<br>CLAUSE | IEC 60068-2-<br>TEST<br>METHOD | TEST                                          | PROCEDURE                                                                                                  | REQUIREMENTS                                                                                                                                                                                               |
|-----------------------|--------------------------------|-----------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.7                   |                                | Voltage proof on insulation                   | Maximum voltage $U_{RMS} = 500$ V during 1 min; metal block method                                         | No breakdown or flashover                                                                                                                                                                                  |
| 4.16                  |                                | Robustness of terminations:                   |                                                                                                            |                                                                                                                                                                                                            |
| 4.16.2                | 21 (Ua1)                       | Tensile all samples                           | Load 10 N; 10 s                                                                                            | Number of failures:<br>$< 1 \times 10^{-6}$                                                                                                                                                                |
| 4.16.3                | 21 (Ub)                        | Bending half number of samples                | Load 5 N; 4 x 90°                                                                                          | Number of failures:<br>$< 1 \times 10^{-6}$                                                                                                                                                                |
| 4.16.4                | 21 (Uc)                        | Torsion other half of samples                 | 3 x 360° in opposite directions                                                                            | No damage<br>$\Delta R_{max.}: \pm (0.5 \% R + 0.05 \Omega)$                                                                                                                                               |
| 4.20                  | 29 (Eb)                        | Bump                                          | 3 x 1500 bumps in three directions; 40 g                                                                   | No damage<br>$\Delta R_{max.}: \pm (0.5 \% R + 0.05 \Omega)$                                                                                                                                               |
| 4.22                  | 6 (Fc)                         | Vibration                                     | Frequency 10 Hz to 500 Hz; displacement 1.5 mm or acceleration 10 g; three directions; total 6 h (3 x 2 h) | No damage<br>$\Delta R_{max.}: \pm (0.5 \% R + 0.05 \Omega)$                                                                                                                                               |
| 4.19                  | 14 (Na)                        | Rapid change of temperature                   | 30 min at LCT and 30 min at UCT; 5 cycles                                                                  | No visual damage<br><b>PR01:</b> $\Delta R_{max.}: \pm (1 \% R + 0.05 \Omega)$<br><b>PR02:</b> $\Delta R_{max.}: \pm (1 \% R + 0.05 \Omega)$<br><b>PR03:</b> $\Delta R_{max.}: \pm (2 \% R + 0.05 \Omega)$ |
| 4.23                  |                                | Climatic sequence:                            |                                                                                                            |                                                                                                                                                                                                            |
| 4.23.2                | 2 (Ba)                         | Dry heat                                      | 16 h; 155 °C                                                                                               |                                                                                                                                                                                                            |
| 4.23.3                | 30 (Db)                        | Damp heat (accelerated) 1 <sup>st</sup> cycle | 24 h; 55 °C; 90 % to 100 % RH                                                                              |                                                                                                                                                                                                            |
| 4.23.4                | 1 (Aa)                         | Cold                                          | 2 h; - 55 °C                                                                                               |                                                                                                                                                                                                            |
| 4.23.5                | 13 (M)                         | Low air pressure                              | 2 h; 8.5 kPa; 15 °C to 35 °C                                                                               |                                                                                                                                                                                                            |
| 4.23.6                | 30 (Db)                        | Damp heat (accelerated) remaining cycles      | 5 days; 55 °C; 95 % to 100 % RH                                                                            | $R_{ins \text{ min.}}: 10^3 \text{ M}\Omega$<br>$\Delta R_{max.}: \pm (1.5 \% R + 0.1 \Omega)$                                                                                                             |
| 4.24                  | 78 (Cab)                       | Damp heat (steady state)                      | 56 days; 40 °C; 90 % to 95 % RH; loaded with 0.01 $P_{70}$ (Steps: 0 V to 100 V)                           | $R_{ins \text{ min.}}: 1000 \text{ M}\Omega$<br>$\Delta R_{max.}: \pm (3 \% R + 0.1 \Omega)$                                                                                                               |
| 4.25.1                |                                | Endurance (at 70 °C)                          | 1000 h; loaded with $P_{70}$ or $U_{max.}$ ; 1.5 h ON and 0.5 h OFF                                        | $\Delta R_{max.}: \pm (5 \% R + 0.1 \Omega)$                                                                                                                                                               |
| 4.8                   |                                | Temperature coefficient                       | Between - 55 °C and + 155 °C                                                                               | $\leq \pm 250 \text{ ppm/K}$                                                                                                                                                                               |
| 4.6.1.1               |                                | Insulation resistance                         | Maximum voltage (DC) after 1 min; metal block method                                                       | $R_{ins \text{ min.}}: 10^4 \text{ M}\Omega$                                                                                                                                                               |

**12NC INFORMATION FOR HISTORICAL CODING REFERENCE**

The resistors have a 12-digit numeric code starting with 23

For 5 % tolerance:

- The next 7 digits indicate the resistor type and packing
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value
  - The last digit indicates the resistance decade

For 1 % tolerance:

- The next 6 digits indicate the resistor type and packing
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value
  - The last digit indicates the resistance decade

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

| RESISTANCE DECADE              | LAST DIGIT |
|--------------------------------|------------|
| 0.22 $\Omega$ to 0.91 $\Omega$ | 7          |
| 1 $\Omega$ to 9.76 $\Omega$    | 8          |
| 10 $\Omega$ to 97.6 $\Omega$   | 9          |
| 100 $\Omega$ to 976 $\Omega$   | 1          |
| 1 $\Omega$ to 9.76 k $\Omega$  | 2          |
| 10 $\Omega$ to 97.6 k $\Omega$ | 3          |
| 100 $\Omega$ to 976 k $\Omega$ | 4          |
| 1 M $\Omega$                   | 5          |

**12NC Example**

The 12NC for resistor type PR02 with Cu leads and a value of 750  $\Omega$  with 5 % tolerance, supplied on a bandolier of 1000 units in ammopack, is: 2306 198 53751.

| <b>12NC - Resistor Type and Packaging <sup>(1)</sup></b> |                          |             |                         |              |                     |                     |                     |                     |                       |
|----------------------------------------------------------|--------------------------|-------------|-------------------------|--------------|---------------------|---------------------|---------------------|---------------------|-----------------------|
| TYPE                                                     | LEAD $\varnothing$<br>mm | TOL.<br>(%) | 23.. ... .. (BANDOLIER) |              |                     |                     |                     |                     |                       |
|                                                          |                          |             | AMMOPACK                |              |                     |                     |                     | REEL                |                       |
|                                                          |                          |             | RADIAL TAPED            |              | STRAIGHT LEADS      |                     |                     |                     | RADIAL TAPED          |
|                                                          |                          |             |                         |              | 52 mm               | 52 mm               | 63 mm               | 52 mm               |                       |
|                                                          |                          |             | 4000 UNITS              | 3000 UNITS   | 5000 UNITS          | 1000 UNITS          | 500 UNITS           | 5000 UNITS          | 2000 UNITS            |
| PR01                                                     | Cu 0.6                   | 1           | -                       | -            | <b>22 196 1...</b>  | 06 191 2...         | -                   | 06 191 5...         | -                     |
|                                                          |                          | 5           | 06 197 03...            | -            | <b>22 193 14...</b> | 06 197 53...        | -                   | <b>06 197 23...</b> | -                     |
| PR02                                                     | Cu 0.8                   | 1           | -                       | 22 197 2...  | -                   | <b>22 197 1...</b>  | -                   | 06 192 5...         | <b>2322 197 5...</b>  |
|                                                          |                          | 5           | -                       | 06 198 03... | -                   | <b>06 198 53...</b> | -                   | <b>06 198 23...</b> | <b>2322 198 04...</b> |
|                                                          | FeCu 0.6                 | 5           | -                       | -            | -                   | 22 194 54...        | -                   | -                   | -                     |
| PR03                                                     | Cu 0.8                   | 5           | -                       | -            | -                   | -                   | <b>22 195 14...</b> | -                   | -                     |
|                                                          |                          | 1           | -                       | -            | -                   | -                   | <b>06 199 6...</b>  | -                   | -                     |
|                                                          | FeCu 0.6                 | 5           | -                       | -            | -                   | -                   | <b>22 195 54...</b> | -                   | -                     |

**Notes**

- Preferred types in bold.

<sup>(1)</sup> Other packaging versions are available on request.

| <b>12NC - Resistor Type and Packaging</b> |                          |             |                            |                 |                                    |                                    |
|-------------------------------------------|--------------------------|-------------|----------------------------|-----------------|------------------------------------|------------------------------------|
| TYPE                                      | LEAD $\varnothing$<br>mm | TOL.<br>(%) | 23.. ... .. (LOOSE IN BOX) |                 |                                    |                                    |
|                                           |                          |             | DOUBLE KINK                |                 |                                    |                                    |
|                                           |                          |             | PITCH = 17.8 mm            | PITCH = 25.4 mm | PITCH <sup>(2)(3)(4)</sup>         |                                    |
|                                           |                          |             | 1000 UNITS                 | 500 UNITS       | 1000 UNITS                         | 500 UNITS                          |
| PR01                                      | Cu 0.6                   | 5           | 22 193 03...               | -               | -                                  | -                                  |
|                                           | FeCu 0.6                 | 5           | 22 193 43...               | -               | <b>22 193 53...</b> <sup>(2)</sup> | -                                  |
| PR02                                      | Cu 0.8                   | 5           | 22 194 23...               | -               | -                                  | -                                  |
|                                           | FeCu 0.6                 | 5           | 22 194 83...               | -               | -                                  | -                                  |
|                                           | FeCu 0.8                 | 5           | -                          | -               | <b>22 194 63...</b> <sup>(3)</sup> | -                                  |
| PR03                                      | Cu 0.8                   | 5           | -                          | 22 195 23...    | -                                  | -                                  |
|                                           | FeCu 0.6                 | 5           | -                          | 22 195 83...    | -                                  | -                                  |
|                                           | FeCu 0.8                 | 5           | -                          | -               | -                                  | <b>22 195 63...</b> <sup>(4)</sup> |

**Notes**

- Preferred types in bold.

<sup>(2)</sup> PR01 pitch 12.5 mm.

<sup>(3)</sup> PR02 pitch 15.0 mm.

<sup>(4)</sup> PR03 pitch 20.0 mm, with reversed kinking direction as opposed to the drawing for the type with double kink figure.



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