

## POWER RESISTOR - PR02

### FEATURES

- Metal film technology
- High power in small package
- High stability, reliability and uniformity characteristics
- Different leads for different applications
- Various forming styles are available
- Defined interruption behavior (fusing time)
- Non-flammable
- Various packing and taping configurations
- Good performance for pulse applications



### MARKET SEGMENTS AND APPLICATIONS

| INDUSTRY SECTOR | APPLICATION SEGMENT | END-USER EQUIPMENT                                                                                                                     |
|-----------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Industrial      | Power               | Power supplies<br>Motor speed controls                                                                                                 |
| Telecom         | Data Communication  | Line protection resistor<br>Power supplies                                                                                             |
| Consumer        | Sound & Vision      | Amplifiers<br>Color monitor<br>Television<br>Video cassette recorder                                                                   |
|                 | Kitchen Appliances  | Blender                                                                                                                                |
|                 | Lighting            | Ballast equipment                                                                                                                      |
| Automotive      | Electronic Systems  | Dashboard electronics<br>Lighting equipment<br>Window/mirror steering<br>ABS system, Alarm system, Airbag<br>Electronic fuel injection |

### PR02

## TECHNOLOGY

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. The encapsulation is resistant to all cleaning solvents in accordance with MIL-STD-202, method 215 and IEC 60068-2-45.

## QUICK REFERENCE DATA

| DESCRIPTION                                           | PR02 $\pm 5\%$<br>(E24 series)    |                           | PR02 $\pm 1\%$<br>(E24/E96 series) |           |
|-------------------------------------------------------|-----------------------------------|---------------------------|------------------------------------|-----------|
|                                                       | Cu-lead                           | FeCu-lead                 | Cu-lead                            | FeCu-lead |
| Resistance range                                      | 0.33 $\Omega$ - 1 M $\Omega$      | 1 $\Omega$ - 1 M $\Omega$ | 1 $\Omega$ - 1 M $\Omega$          |           |
| Maximum dissipation at $T_{amb} = 70^{\circ}\text{C}$ | 2 W                               | 1.3 W                     | 2 W                                | 1.3 W     |
| Thermal resistance ( $R_{th}$ )                       | 75 K/W                            | 115 K/W                   | 75 K/W                             | 115 K/W   |
| Limiting voltage (DC or RMS)                          | 500 V                             |                           |                                    |           |
| Rated voltage <sup>(1)</sup>                          | $\sqrt{P_n \times R}$             |                           |                                    |           |
| Temperature coefficient                               | $\pm 250$ ppm/ $^{\circ}\text{C}$ |                           |                                    |           |
| Basic specification                                   | IEC 60115-1 and 60115-4           |                           |                                    |           |
| Climatic category (IEC 60068)                         | 55/155/56                         |                           |                                    |           |
| Stability $\Delta R/R_{max}$ after:                   |                                   |                           |                                    |           |
| Load                                                  | $\pm 5\% + 0.1 \Omega$            |                           | $\pm 1\% + 0.1 \Omega$             |           |
| Climatic tests                                        | $\pm 3\% + 0.1 \Omega$            |                           | $\pm 1\% + 0.1 \Omega$             |           |
| Resistance to soldering heat                          | $\pm 1\% + 0.05 \Omega$           |                           | $\pm 0.5\% + 0.05 \Omega$          |           |

(1) Maximum rated voltage is the limiting voltage

## PR02

## MECHANICAL DATA

## AXIAL STYLE

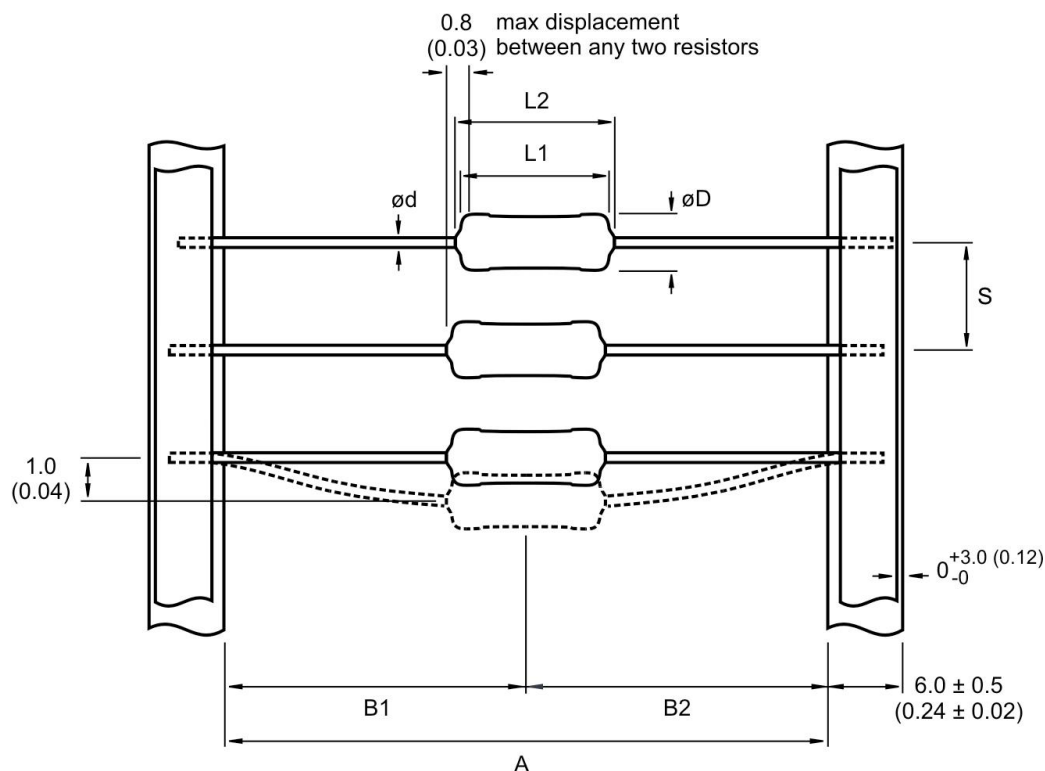


Fig. 1

Table 1. Mechanical Data.

| PRODUCT | A                                            | L1<br>max      | L2<br>max      | ØD<br>max     | B1-B2  max    | Ød                                                      | S                          | WEIGHT<br>gr/100 pcs |
|---------|----------------------------------------------|----------------|----------------|---------------|---------------|---------------------------------------------------------|----------------------------|----------------------|
| PR02    | 52.0 + 1.5 / - 0.0<br>(2.05 + 0.06 / - 0.00) | 10.0<br>(0.40) | 12.0<br>(0.48) | 3.9<br>(0.16) | 1.2<br>(0.05) | 0.80 ± 0.03 Cu <sup>(1)</sup><br>(0.031 ± 0.001 Cu)     | 5.0 ± 0.1<br>(0.20 ± 0.01) | 52.0                 |
|         |                                              |                |                |               |               | 0.60 ± 0.05 FeCu <sup>(2)</sup><br>(0.024 ± 0.002 FeCu) |                            | 46.0                 |

Dimensions unless specified in mm (inches)

(1) Preferred type

(2) 0.80 FeCu available for preformed types

## MOUNTING

The resistors are suitable for processing on automatic insertion equipment, cutting and bending machines. A radial taped version economizes space on the PCB. The double kink style offers great advantages for manual insertion improving the mounting stability for the customer. They have a real *snap in* function to fix the resistor in PCB without weakening the connecting leads.

## PR02

## ELECTRICAL CHARACTERISTICS

## DERATING

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

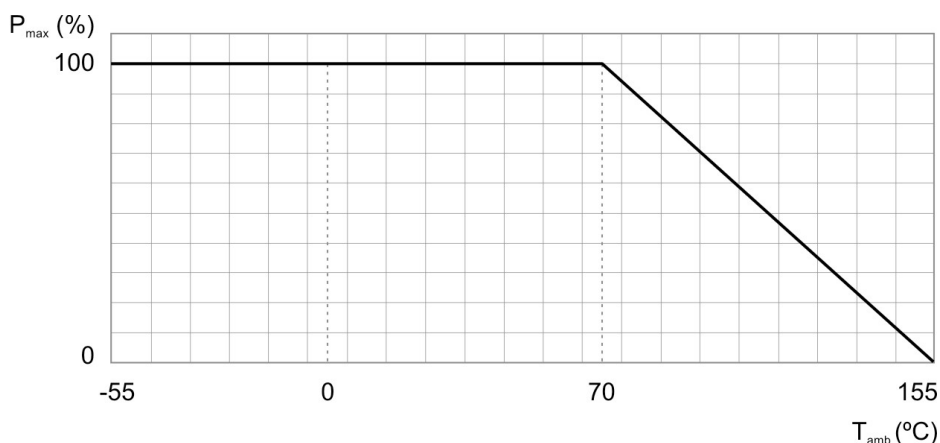


Fig. 2. Maximum dissipation ( $P_{max}$ ) in percentage of rated power as a function of ambient temperature ( $T_{amb}$ )

## APPLICATION INFORMATION

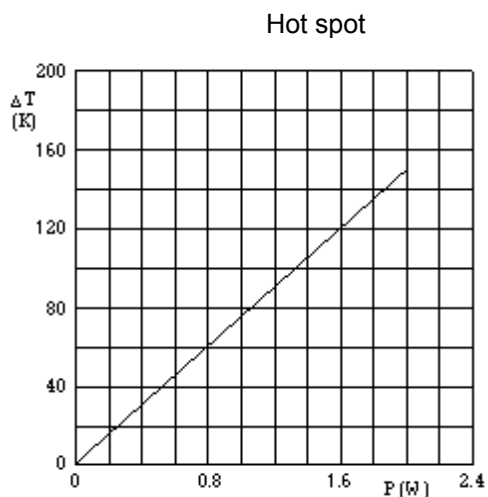


Fig. 3.  $\phi 0.80$  mm Cu - leads  
Hot spot temperature rise ( $\Delta T$ ) as a function of dissipated power.

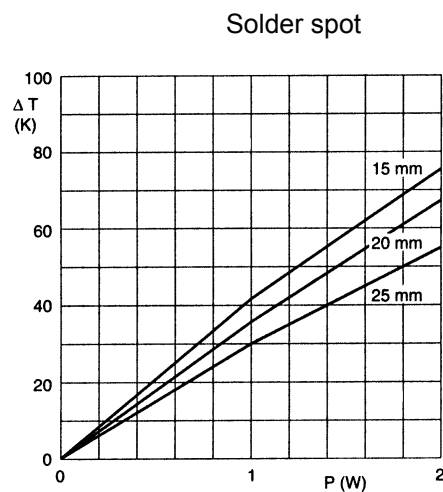


Fig. 4.  $\phi 0.80$  mm Cu - leads  
Minimum distance from resistor body to PCB = 1mm.  
Temperature rise ( $\Delta T$ ) at the lead end (solder spot) as a function of dissipated power at various leads lengths after mounting.

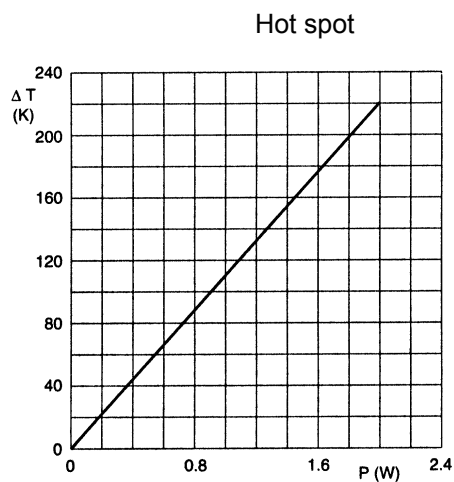


Fig. 5.  $\phi 0.60$  mm FeCu - leads  
Hot spot temperature rise ( $\Delta T$ ) as a function of dissipated power

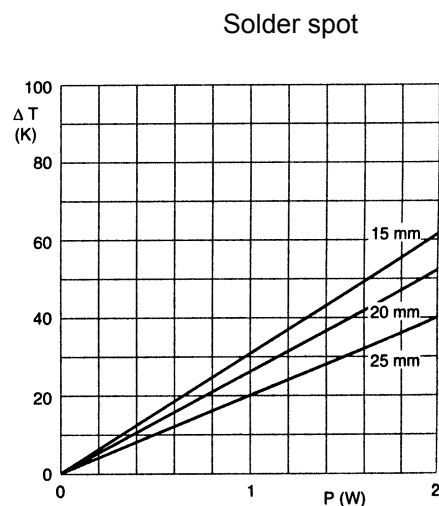


Fig. 6.  $\phi 0.60$  mm FeCu - leads  
Minimum distance from resistor body to PCB = 1 mm.  
Temperature rise ( $\Delta T$ ) at the lead end (solder spot) as a function of dissipated power at various leads lengths after mounting

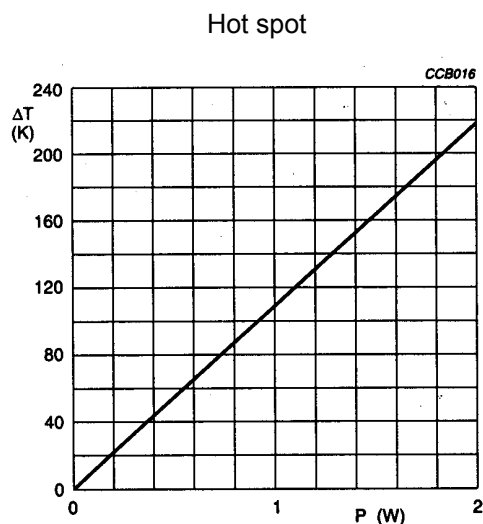


Fig. 7.  $\phi 0.80$  mm FeCu - leads  
Hot spot temperature rise ( $\Delta T$ ) as a function of dissipated power (preformed types only)

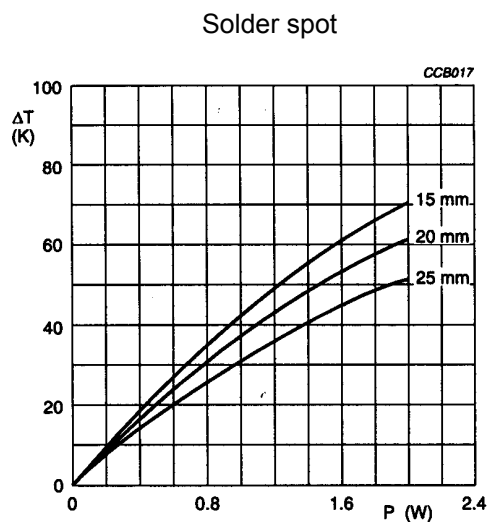


Fig. 8.  $\phi 0.80$  mm FeCu - leads  
Minimum distance from resistor body to PCB = 1 mm.  
Temperature rise ( $\Delta T$ ) at the lead end (solder spot) as a function of dissipated power at various leads lengths after mounting (preformed types only)

Note: The maximum permissible hot spot temperature is 220 °C

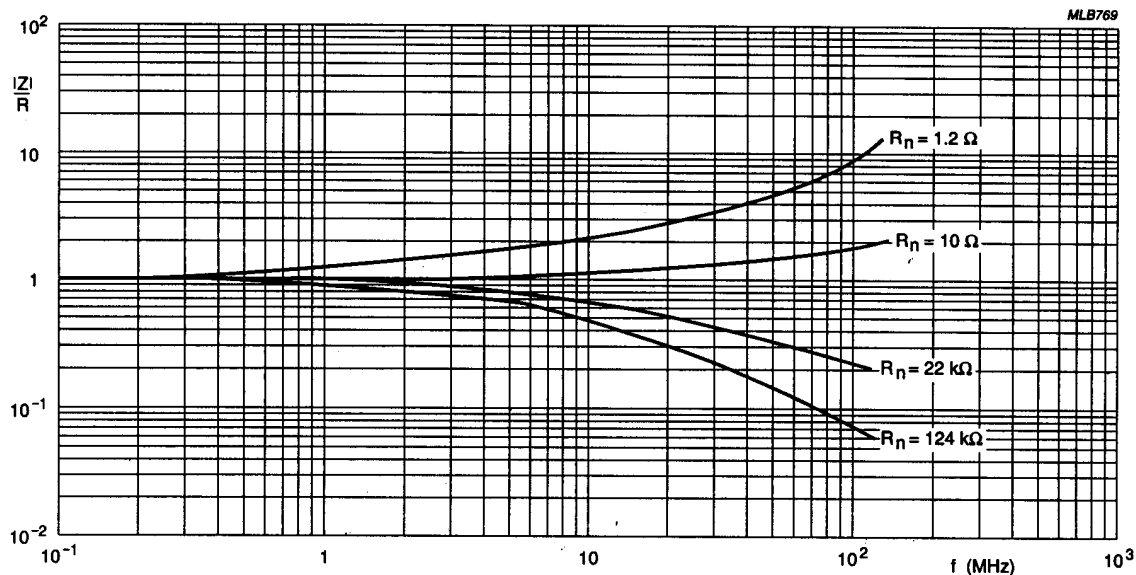


Fig. 9. Impedance as a function of applied frequency.

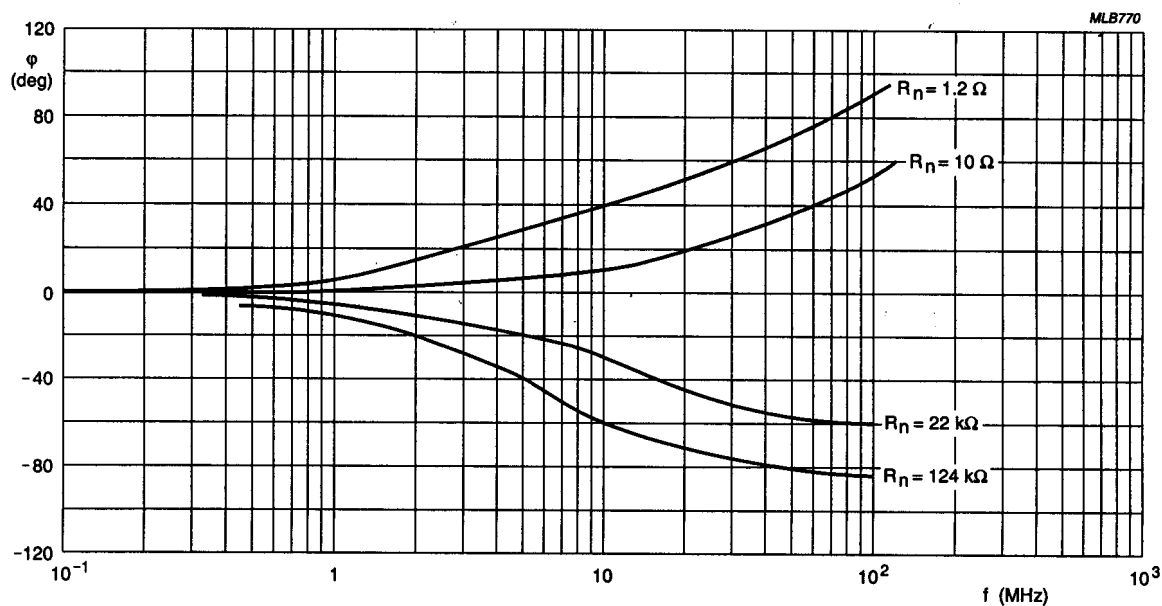


Fig. 10. Phase angle as a function applied frequency

## PULSE LOADING CAPABILITIES

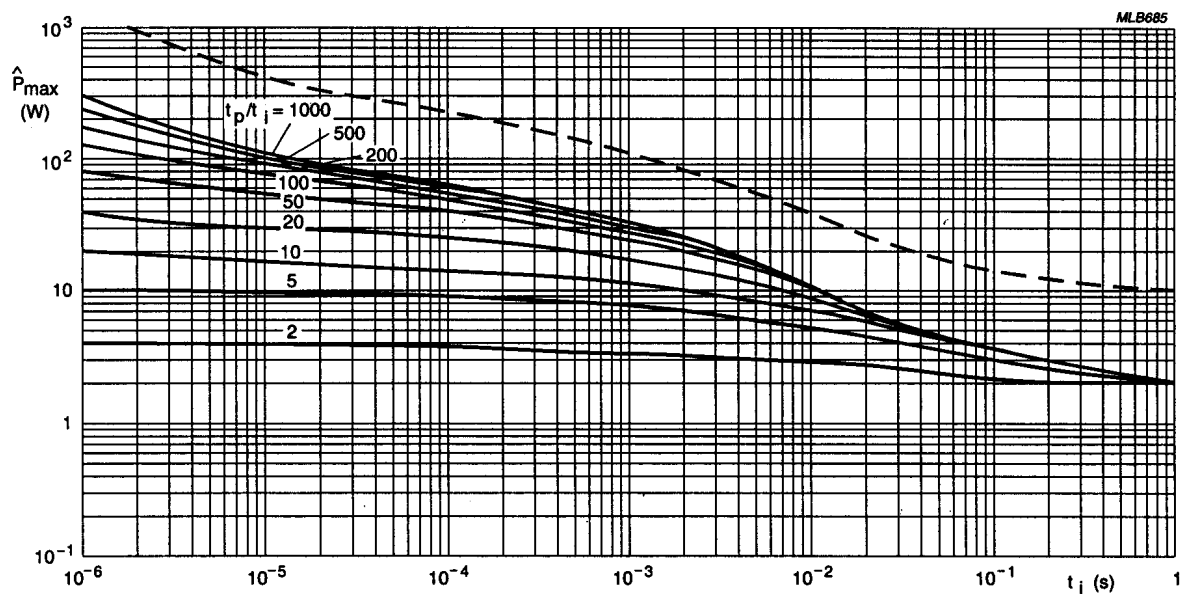


Fig. 11. Pulse on a regular basis, maximum permissible peak pulse power ( $\hat{P}_{max}$ ) as a function of pulse duration ( $t_i$ )

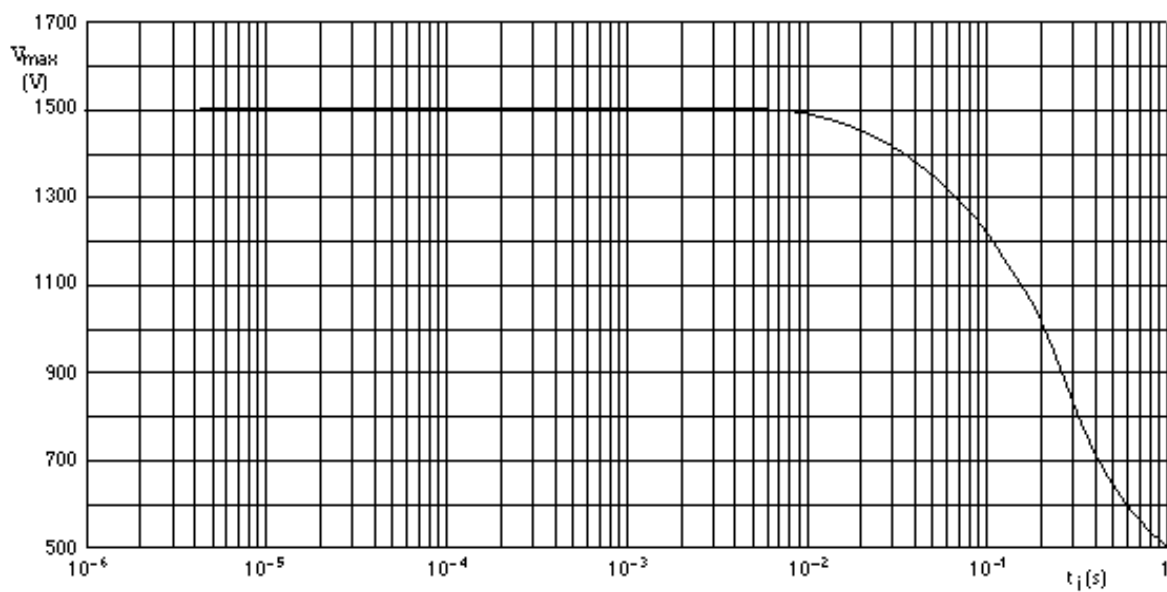


Fig. 12. Pulse on a regular basis, maximum permissible peak pulse voltage ( $\hat{V}_{max}$ ) as a function of pulse duration ( $t_i$ )

## INTERRUPTION CHARACTERISTICS

The graphs are based on measured data under constant voltage conditions; these data may deviate according to the application.

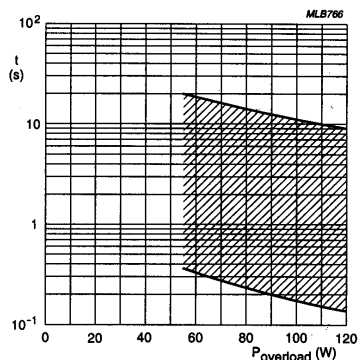


Fig. 13. Time to interruption as a function of overload power for range:  $0R33 \leq R_n < 5R$

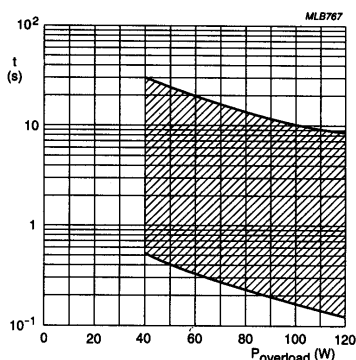


Fig. 14. Time to interruption as a function of overload power for range:  $5R \leq R_n < 68R$

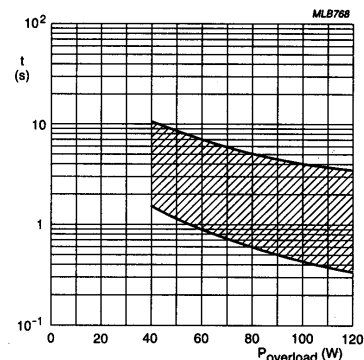


Fig. 15. Time to interruption as a function of overload power for range:  $68R \leq R_n < 560R$

## MARKING

The nominal resistance and tolerance are marked on the resistor using four or five colored bands in accordance with IEC publication 60062 "color code for fixed resistors". Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of  $\pm 5\%$  or  $\pm 1\%$ . The values of the E24/E96 series are in accordance with IEC publication 60063.

## ORDERING INFORMATION

Table 2. Ordering code.

| LEAD Ø               | TOLERANCE | TAPING         | QUANTITY<br>(pcs) | PACKAGING      | ORDERING<br>CODE |
|----------------------|-----------|----------------|-------------------|----------------|------------------|
| 0.80 Cu<br>(0.031)   | ±1%       | 52.0<br>(2.05) | 1000              | AMMOPACK       | 2322 197 1XXXX   |
|                      | ±5%       |                | 5000              | REEL           | 2306 192 5XXXX   |
|                      |           | REEL           |                   | 2306 198 23XXX |                  |
| 0.60 FeCu<br>(0.024) |           |                | 52.0<br>(2.05)    | 1000           | AMMOPACK         |
|                      | AMMOPACK  |                |                   |                | 2322 194 54XXX   |

Dimensions unless specified in mm (inches)

Check "**Formed leads**" specifications to see related part-numbers

The resistors have a 12 digit ordering code starting with 2306 or 2322.

The next 5 digits indicate the resistor type and packaging see table 2.

For 5% tolerance the last 3 digits indicate the resistance value;

- The first 2 digits indicate the resistance value;
- The last digit indicates the resistance decade in accordance with table 3.

For 1% tolerance the last 4 digits indicate the resistance value;

- The first 3 digits indicate the resistance value;
- The last digit indicates the resistance decade in accordance with table 3.

Table 3. Last digit of ordering code.

| RESISTANCE DECADE (5%) | RESISTANCE DECADE (1%) | LAST DIGIT |
|------------------------|------------------------|------------|
| 0.33 - 0.91 $\Omega$   | -                      | 7          |
| 1 - 9.1 $\Omega$       | 1 - 9.76 $\Omega$      | 8          |
| 10 - 91 $\Omega$       | 10 - 97.6 $\Omega$     | 9          |
| 100 - 910 $\Omega$     | 100 - 976 $\Omega$     | 1          |
| 1 - 9.1 k $\Omega$     | 1 - 9.76 k $\Omega$    | 2          |
| 10 - 91 k $\Omega$     | 10 - 97.6 k $\Omega$   | 3          |
| 100 - 910 k $\Omega$   | 100 - 976 k $\Omega$   | 4          |
| 1 M $\Omega$           | 1 M $\Omega$           | 5          |

Example:

PR02, 750  $\Omega$ ,  $\pm 5\%$ , 0.80 Cu leads, ammopack 1000 pcs is **2306 198 53751**

## NAFTA ORDERING INFORMATION

Table 4. NAFTA ordering code.

| LEAD Ø               | TOLERANCE | TAPING         | QUANTITY<br>(pcs) | PACKAGING | NAFTA<br>ORDERING CODE |
|----------------------|-----------|----------------|-------------------|-----------|------------------------|
| 0.80 Cu<br>(0.031)   | ±5%       | 52.0<br>(2.05) | 1000              | AMMOPACK  | 5083NWxxxxxJA8AFX      |
|                      |           |                | 5000              | REEL      | 5083NWxxxxxJ12AFX      |
| 0.60 FeCu<br>(0.024) |           |                | 1000              | AMMOPACK  | 5083NWxxxxxJA8AFXF06   |
| 0.80 Cu<br>(0.031)   | ±1%       |                | 1000              | AMMOPACK  | 5083NWxxxxxFA8AF5      |
|                      |           |                | 5000              | REEL      | 5083NWxxxxxF12AF5      |

Dimensions unless specified in mm (inches)

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The ohmic value in the NAFTA ordering code (see table 4) is represented by the “xxxxx” in the middle of the above ordering code. Table 5 gives some examples how to use these 5 digits.

Table 5. Ohmic value examples.

| VALUE          | 5 DIGITS |
|----------------|----------|
| 1 $\Omega$     | 1R000    |
| 10 $\Omega$    | 10R00    |
| 100 $\Omega$   | 100R0    |
| 1 k $\Omega$   | 1K000    |
| 10 k $\Omega$  | 10K00    |
| 100 k $\Omega$ | 100K0    |
| 1 M $\Omega$   | 1M000    |

## PACKAGING

### TAPE IN AMMOPACK

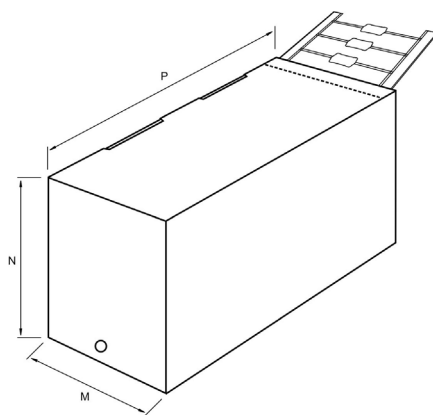


Table 6. Ammopack.

| PRODUCT | TAPING                                      | M           | N           | P             | QUANTITY (pcs) |
|---------|---------------------------------------------|-------------|-------------|---------------|----------------|
| PR02    | 52.0 + 1.5 / - 0.0<br>(2.05+ 0.06 / - 0.00) | 78<br>(3.1) | 60<br>(2.4) | 262<br>(10.4) | 1000           |

Dimensions unless specified in mm (inches)

### PR02

## TAPE ON REEL

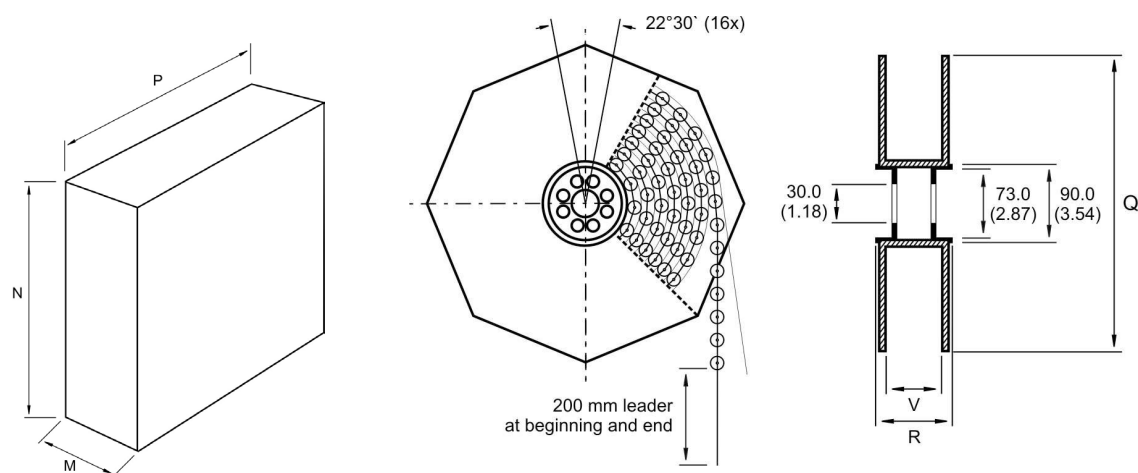


Table 7. Reel.

| PRODUCT | TAPING                                       | M           | N             | P             | Q             | V           | R           | QTY (pcs) |
|---------|----------------------------------------------|-------------|---------------|---------------|---------------|-------------|-------------|-----------|
| PR02    | 52.0 + 1.5 / - 0.0<br>(2.05 + 0.06 / - 0.00) | 92<br>(3.6) | 361<br>(14.3) | 361<br>(14.3) | 355<br>(14.0) | 75<br>(2.9) | 86<br>(3.4) | 5000      |

Dimensions unless specified in mm (inches)

## TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance to the schedule of IEC publications 60115 – 1, category 55/155/56 (rated temperature range - 55 °C to + 155 °C; damp heat, long term, 56 days and along the lines of IEC publications 60068-2); “Recommended basic climatic and mechanical robustness testing procedure for electronic components” and under standard atmosphere conditions according to IEC 60068-1 subclause 5.3, unless otherwise specified.

In some instances deviations from IEC applications were necessary for our method specified.

Table 8. Test and requirements.

| IEC 60115-1<br>CLAUSE | IEC 60068-2<br>TEST<br>METHOD | TEST                  | PROCEDURE                                     | REQUIREMENTS                        |         |
|-----------------------|-------------------------------|-----------------------|-----------------------------------------------|-------------------------------------|---------|
|                       |                               |                       |                                               | PR02 5%                             | PR02 1% |
| 4.6.1.1               | -                             | Insulation resistance | 500V (DC) during 1 minute;<br>V-block method. | $R_{ins \min} 10^4 \text{ M}\Omega$ |         |

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| IEC<br>60115-1<br>CLAUSE | IEC<br>60068-2<br>TEST<br>METHOD | TEST                                             | PROCEDURE                                                                                                      | REQUIREMENTS                                             |                                              |
|--------------------------|----------------------------------|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|----------------------------------------------|
|                          |                                  |                                                  |                                                                                                                | PR02 5%                                                  | PR02 1%                                      |
| 4.7                      | -                                | Voltage proof on insulation                      | 500V (RMS) during 1 minute;<br>V-block method.                                                                 | No breakdown or flashover                                |                                              |
| 4.8                      | -                                | Temperature coefficient                          | Between<br>- 55 °C and+ 155 °C                                                                                 | ±250 ppm/°C                                              |                                              |
| 4.16                     | 21(U)                            | Robustness of Terminations:                      |                                                                                                                | No damage<br>$\Delta R/R_{\max} \pm 0.5\% + 0.05 \Omega$ |                                              |
| 4.16.2                   | 21(Ua1)                          | Tensile all samples                              | Load 10 N; 10 s                                                                                                |                                                          |                                              |
| 4.16.3                   | 21(Ub)                           | Bending half number of samples                   | Load 5 N; 4 x 90°                                                                                              |                                                          |                                              |
| 4.16.4                   | 21(Uc)                           | Torsion other half of samples                    | 3 x 360° in opposite directions                                                                                |                                                          |                                              |
| 4.17                     | 20(Ta)                           | Solderability (after ageing)                     | 16 h 155 °C; immersed in flux 600, leads immersed 2 mm for 2 ±0.5 s in a solder bath at 235 ±5 °C              | Good tinning (≥95% covered);<br>no damage                |                                              |
| 4.18                     | 20(Tb)                           | Resistance to soldering heat                     | Thermal shock 3 s;<br>350 ±10 °C; 6 mm from body                                                               | $\Delta R/R_{\max}$<br>±1% + 0.05 $\Omega$               | $\Delta R/R_{\max}$<br>±0.5% + 0.05 $\Omega$ |
| 4.19                     | 14 (Na)                          | Rapid change of temperature                      | 30 minutes at – 55 °C and<br>30 minutes at + 155 °C;<br>5 cycles                                               | No visual damage                                         |                                              |
|                          |                                  |                                                  |                                                                                                                | $\Delta R/R_{\max}$<br>±1% + 0.05 $\Omega$               | $\Delta R/R_{\max}$<br>±0.5% + 0.05 $\Omega$ |
| 4.22                     | 6 (Fc)                           | Vibration                                        | Frequency 10 to 500 Hz,<br>displacement 1.5mm or<br>acceleration 10g, three directions;<br>total 6 h (3 x 2 h) | No damage<br>$\Delta R/R_{\max} \pm 0.5\% + 0.05 \Omega$ |                                              |
| 4.23                     |                                  | Climatic sequence:                               |                                                                                                                | $R_{\text{ins min}} 10^3 M\Omega$                        |                                              |
| 4.23.2                   | 2(Ba)                            | Dry heat                                         | 16 h; 155 °C                                                                                                   |                                                          |                                              |
| 4.23.3                   | 30(Db)                           | Damp heat (accelerated)<br>1 <sup>st</sup> cycle | 24 h; 25 °C to 55 °C;<br>90 to 100% RH                                                                         |                                                          |                                              |
| 4.23.4                   | 1(Aa)                            | Cold                                             | 2 h; - 55 °C                                                                                                   | $\Delta R/R_{\max}$<br>±3% + 0.05 $\Omega$               |                                              |
| 4.23.6                   | 30(Db)                           | Damp heat (accelerated)<br>remaining cycles      | 5 days; 25 °C to 55 °C;<br>90 to 100% R.H.                                                                     |                                                          |                                              |

## PR02

| IEC<br>60115-1<br>CLAUSE                        | IEC<br>60068-2<br>TEST<br>METHOD | TEST                            | PROCEDURE                                                                   | REQUIREMENTS                                   |                                                |
|-------------------------------------------------|----------------------------------|---------------------------------|-----------------------------------------------------------------------------|------------------------------------------------|------------------------------------------------|
|                                                 |                                  |                                 |                                                                             | PR02 5%                                        | PR02 1%                                        |
| 4.24                                            | 3(Ca)                            | Damp heat<br>(steady state)     | 56 days; 40 °C; 90 to 95% R.H.;<br>loaded with 0.01Pn                       | $R_{ins\ min} 10^3\ M\Omega$                   |                                                |
|                                                 |                                  |                                 |                                                                             | $\Delta R/R_{max}$<br>$\pm 3\% + 0.05\ \Omega$ | $\Delta R/R_{max}$<br>$\pm 1\% + 0.05\ \Omega$ |
| 4.25.1                                          | -                                | Endurance<br>(at 70 °C)         | 1000 h loaded with Pn or $V_{max}$ ,<br>1.5 h ON and 0.5 h OFF              | $\Delta R/R_{max}$<br>$\pm 5\% + 0.05\ \Omega$ | $\Delta R/R_{max}$<br>$\pm 1\% + 0.05\ \Omega$ |
| 4.29                                            | 45(Xa)                           | Component solvent<br>resistance | Isopropyl alcohol followed by<br>brushing in accordance with<br>MIL STD 202 | No visible damage                              |                                                |
| See 2 <sup>nd</sup> amendment<br>to IEC 60115-1 |                                  | Pulse Load                      |                                                                             | See figs. 11 and 12                            |                                                |