

## High Ohmic (up to 33 M $\Omega$ )/ High Voltage (up to 3.5 kV) Resistors



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

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

### FEATURES

- Lead (Pb)-free solder contacts
- These resistors meet the safety requirements of:
  - "UL1676" (510 k $\Omega$  to 11 M $\Omega$ ); File No: E171160
  - "IEC 60065"
  - "EN60065"
  - "VDE 0860" (Germany)
  - "CQC" (China)
- High pulse loading capability (10 kV)
- Small size (0309)
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Compatible with "Restriction of the use of Hazardous Substances" (RoHS) directive 2002/95/EC (issue 2004)



### APPLICATIONS

- Where high resistance, high stability and high reliability at high voltage are required
- Safety component in combination with high voltage
- White goods
- High humidity environment
- Power supplies

| TECHNICAL SPECIFICATIONS                                      |                                                                   |
|---------------------------------------------------------------|-------------------------------------------------------------------|
| DESCRIPTION                                                   | VALUE                                                             |
| Resistance Range <sup>(1)</sup>                               | 100 k $\Omega$ to 33 M $\Omega$                                   |
| Resistance Tolerance and Series                               | $\pm 1\%$ : E24/E96 series;<br>$\pm 5\%$ : E24 series             |
| Maximum Dissipation at $T_{amb} = 70\text{ }^{\circ}\text{C}$ | 0.5 W                                                             |
| Thermal Resistance, $R_{th}$                                  | 120 K/W                                                           |
| Temperature Coefficient                                       | $\leq \pm 200 \times 10^{-6}/\text{K}$                            |
| Maximum Permissible Voltage:                                  |                                                                   |
| DC                                                            | 3500 V                                                            |
| RMS                                                           | 2500 V                                                            |
| Dielectric Withstanding Voltage of the Insulation for 1 Min   | 700 V                                                             |
| Basic Specifications                                          | IEC 60115-1B                                                      |
| Safety Requirements                                           | UL1676 (510 k $\Omega$ to 11 M $\Omega$ ); EN60065; VDE 0860; CQC |
| Climatic Category (IEC 60068)                                 | 55/155/56                                                         |
| Stability After:                                              |                                                                   |
| Load (1000 h)                                                 | $\Delta R \text{ max.: } \pm (1.5\% R + 0.1\text{ }\Omega)$       |
| Accelerated Damp Heat Test (6 Days)                           | $\Delta R \text{ max.: } \pm (1.5\% R + 0.1\text{ }\Omega)$       |
| Long Term Damp Heat Test (56 Days)                            | $\Delta R \text{ max.: } \pm (1.5\% R + 0.1\text{ }\Omega)$       |
| Noise                                                         | max. 2.5 $\mu\text{V/V}$                                          |

#### Note:

<sup>(1)</sup> Ohmic values (other than resistance range) are available upon request

## 12NC INFORMATION

- The resistors have a 12-digit numeric code starting with 2322 242.
- The subsequent:  
first digit for 1 % tolerance products (E24 and E96 series)  
or 2 digits for 5 % (E24 series) indicate the resistor type and packaging
- The remaining digits indicate the resistance value:
  - The first 3 digits for 1 % or 2 digits for 5 % tolerance products indicate the resistance value
  - The last digit indicates the resistance decade

### Last Digit of 12NC Indicating Resistance Decade

| RESISTANCE DECADE     | LAST DIGIT |
|-----------------------|------------|
| 100 to 976 k $\Omega$ | 4          |
| 1 to 9.76 M $\Omega$  | 5          |
| $\geq 10$ M $\Omega$  | 6          |

### 12NC Example

The 12NC for a VR37, resistor value 7.5 M $\Omega$ , 5 % tolerance, supplied on a bandolier of 1000 units in ammpack, is: 2322 242 13755.

## 12NC - resistor type and packaging

| TYPE | TAPE WIDTH (mm) | TOL. (%) | ORDERING CODE 2322 242 ..... |                   |
|------|-----------------|----------|------------------------------|-------------------|
|      |                 |          | BANDOLIER IN AMMOPACK        | BANDOLIER ON REEL |
|      |                 |          | 1000 units                   | 5000 units        |
| VR37 | 52              | $\pm 1$  | 8....                        | 6....             |
|      |                 | $\pm 5$  | 13...                        | 23...             |

## PART NUMBER

PART NUMBER: VR37000001503JA100

V R 3 7 0 0 0 0 0 1 5 0 3 J A 1 0 0

| MODEL/SIZE | SPECIAL CHARACTER                           | TCR/MATERIAL | VALUE                                                                                                                     | TOLERANCE                      | PACKAGING <sup>(1)</sup> | SPECIAL                                                       |
|------------|---------------------------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------|--------------------------|---------------------------------------------------------------|
| VR37000    | 0 = Neutral<br>Z = Value overflow (Special) | 0 = Standard | 3 digit value<br>1 digit multiplier<br>MULTIPLIER<br>3 = *10 <sup>3</sup><br>4 = *10 <sup>4</sup><br>5 = *10 <sup>5</sup> | F = $\pm 1$ %<br>J = $\pm 5$ % | A1<br>R5                 | The 2 digits are used for all special parts.<br>00 = Standard |

PRODUCT DESCRIPTION: VR37 5 % A1 150K

|            |                        |                          |                                               |
|------------|------------------------|--------------------------|-----------------------------------------------|
| VR37       | 5 %                    | A1                       | 150K                                          |
| MODEL/SIZE | TOLERANCE              | PACKAGING <sup>(1)</sup> | RESISTANCE VALUE                              |
| VR37       | $\pm 1$ %<br>$\pm 5$ % | A1<br>R5                 | 150K = 150 k $\Omega$<br>8M2 = 8.2 M $\Omega$ |

### Notes:

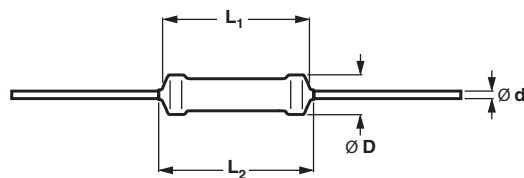
<sup>(1)</sup> Please refer to table PACKAGING

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

## PACKAGING

| CODE | PIECES | DESCRIPTION                               | MODEL/SIZE |
|------|--------|-------------------------------------------|------------|
| A1   | 1000   | Bandolier in ammpack straight leads 52 mm | VR37       |
| R5   | 5000   | Bandolier on reel straight leads 52 mm    |            |

## DIMENSIONS



Outline

| DIMENSIONS - resistor type and relevant physical dimensions |                               |                    |                    |                 |
|-------------------------------------------------------------|-------------------------------|--------------------|--------------------|-----------------|
| TYPE                                                        | $\varnothing D_{\text{max.}}$ | $L_1 \text{ max.}$ | $L_2 \text{ max.}$ | $\varnothing d$ |
| VR37                                                        | 4.0                           | 9.0                | 10.0               | $0.7 \pm 0.03$  |

| MASS PER 100 UNITS |          |
|--------------------|----------|
| TYPE               | MASS (g) |
| VR37               | 45.7     |

Yellow and grey are used instead of gold and silver because metal particles in the lacquer could affect high-voltage properties.

## 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 publication 60294").

## MARKING

The nominal resistance and tolerance are marked on the resistor using four or five colored bands in accordance with IEC publication 60062 "Color codes for fixed resistors".

## FUNCTIONAL PERFORMANCE

### PRODUCT CHARACTERIZATION

Standard values of nominal resistance are taken from the E96/E24/E12 series for resistors with a tolerance of  $\pm 1\%$  or  $5\%$ . The values of the E96/E24 series are in accordance with "IEC publication 60063".

| LIMITING VALUES |                                     |      |                    |
|-----------------|-------------------------------------|------|--------------------|
| TYPE            | LIMITING VOLTAGE <sup>(1)</sup> (V) |      | LIMITING POWER (W) |
|                 | DC                                  | RMS  |                    |
| VR37            | 3500                                | 2500 | 0.5                |

#### Notes:

<sup>(1)</sup> The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-1"

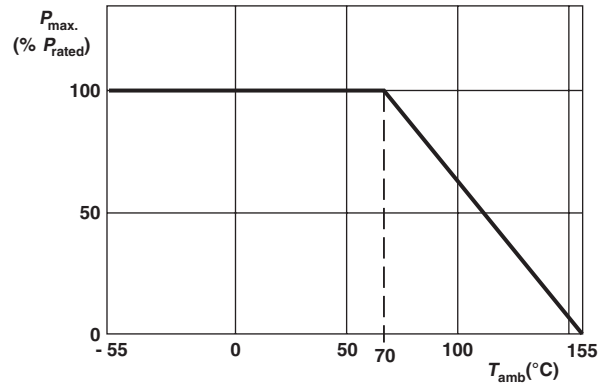
- The maximum permissible hot-spot temperature is 155 °C



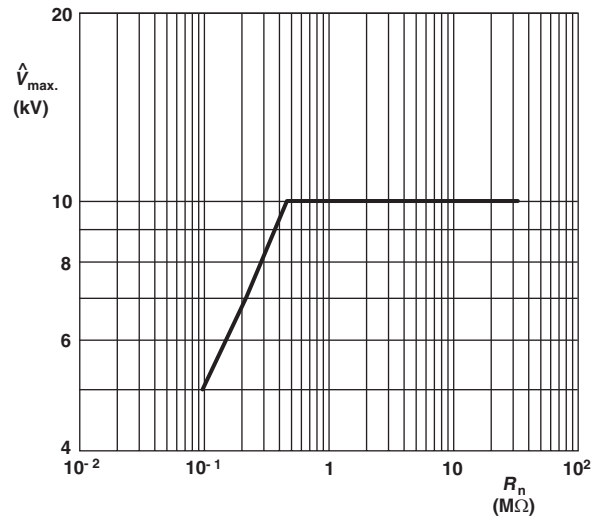
## High Ohmic (up to 33 M $\Omega$ )/ High Voltage (up to 3.5 kV) Resistors

Vishay BCcomponents

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

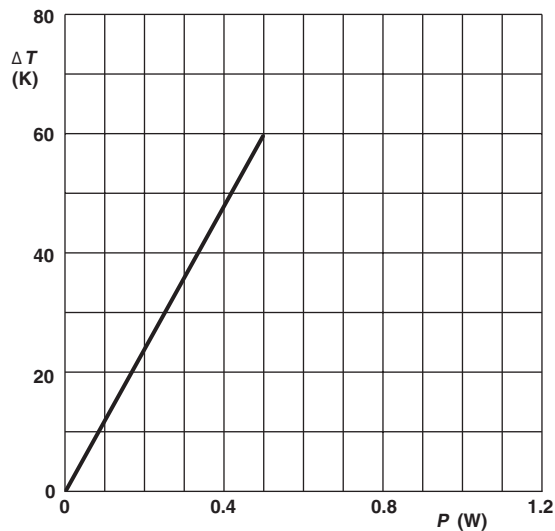


Maximum dissipation ( $P_{max}$ ) in percentage of rated power as a function of the ambient temperature ( $T_{amb}$ )



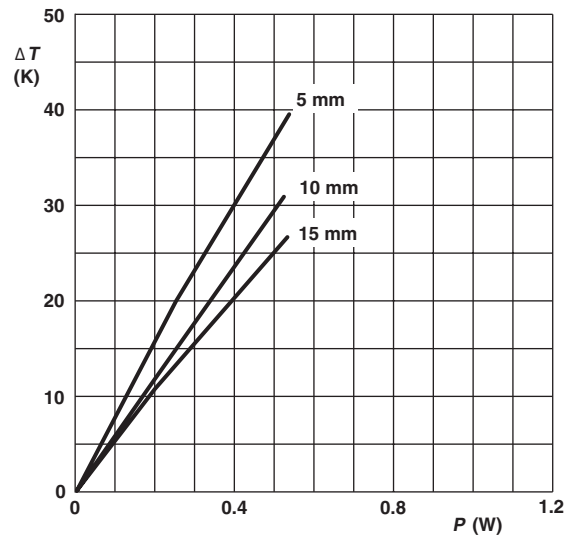
Maximum allowed peak pulse voltage in accordance with "IEC 60065 chapter 14.1"; 50 discharges from a 1 nF capacitor charged to  $\hat{V}_{max}$ ; 12 discharges/minute (drift  $\Delta R/R \leq 2\%$ )

### Derating



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

### Pulse Loading Capability



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

### Application Information

## TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-1", category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068-2, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and

under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

In the Test Procedures and Requirements table the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-1 and 60068-2"; 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                                                                                 |
| 4.16                             | 21 (U)                  | robustness of terminations:                   |                                                                                                           |                                                                                              |
| 4.16.2                           | 21 (Ua1)                | tensile all samples                           | $\varnothing$ 0.7 mm; load 10 N; 10 s                                                                     | number of failures < $10 \times 10^{-6}$                                                     |
| 4.16.3                           | 21 (Ub)                 | bending half number of samples                | $\varnothing$ 0.7 mm; load 5 N; 4 x 90°                                                                   | number of failures < $10 \times 10^{-6}$                                                     |
| 4.16.4                           | 21 (Uc)                 | torsion other half of samples                 | 3 x 360° in opposite directions                                                                           | no damage<br>$\Delta R$ max.: $\pm (0.5 \% R + 0.05 \Omega)$                                 |
| 4.17                             | 20 (Ta)                 | solderability                                 | 2 s; 235 °C                                                                                               | good tinning; no damage                                                                      |
| 4.18                             | 20 (Tb)                 | resistance to soldering heat                  | thermal shock: 3 s; 350 °C;<br>3 mm from body                                                             | $\Delta R$ max.: $\pm (0.5 \% R + 0.05 \Omega)$                                              |
| 4.19                             | 14 (Na)                 | rapid change of temperature                   | 30 min at - 55 °C and<br>30 min at + 155 °C; 5 cycles                                                     | $\Delta R$ max.: $\pm (0.5 \% R + 0.05 \Omega)$                                              |
| 4.20                             | 29 (Eb)                 | bump                                          | 3 x 1500 bumps in 3 directions; 40 g                                                                      | no damage<br>$\Delta R$ max.: $\pm (0.5 \% R + 0.05 \Omega)$                                 |
| 4.22                             | 6 (Fc)                  | vibration                                     | frequency 10 to 500 Hz; displacement<br>1.5 mm or acceleration 10 g; 3 directions;<br>total 6 h (3 x 2 h) | no damage<br>$\Delta R$ max.: $\pm (0.5 \% R + 0.05 \Omega)$                                 |
| 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 to 35 °C                                                                                 |                                                                                              |
| 4.23.6                           | 30 (Db)                 | damp heat (accelerated) remaining cycles      | 5 days; 55 °C; 95 to 100 % RH                                                                             | $R_{ins}$ min.: 10 <sup>3</sup> M $\Omega$<br>$\Delta R$ max.: $\pm (1.5 \% R + 0.1 \Omega)$ |

High Ohmic (up to 33 M $\Omega$ )/  
High Voltage (up to 3.5 kV) Resistors

Vishay BCcomponents

| TEST PROCEDURES AND REQUIREMENTS |                               |                             |                                                                                                                                           |                                                   |
|----------------------------------|-------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| IEC 60115-1<br>CLAUSE            | IEC 60068-2<br>TEST<br>METHOD | TEST                        | PROCEDURE                                                                                                                                 | REQUIREMENTS                                      |
| 4.24.2                           | 3 (Ca)                        | damp heat<br>(steady state) | 56 days; 40 °C; 90 to 95 % RH;<br>dissipation 0.01 P <sub>n</sub> ;<br>limiting voltage 100 V (DC)                                        | $\Delta R$ max.: $\pm (1.5 \% R + 0.1 \Omega)$    |
| 4.25.1                           |                               | endurance                   | 1000 h at 70 °C; P <sub>n</sub> or V <sub>max</sub> .                                                                                     | $\Delta R$ max.: $\pm (1.5 \% R + 0.1 \Omega)$    |
| 4.8.4                            |                               | temperature coefficient     | between - 55 °C and + 155 °C<br>(TC x 10 <sup>-6</sup> /K)                                                                                | $\leq \pm 200$                                    |
| 4.7                              |                               | voltage proof on insulation | 700 V <sub>RMS</sub> during 1 min;<br>V-block method                                                                                      | no breakdown                                      |
| 4.12                             |                               | noise                       | "IEC publication 60195"                                                                                                                   | max. 2.5 $\mu$ V/V                                |
| 4.6.1.1                          |                               | insulation resistance       | 500 V (DC) during 1 min;<br>V-block method                                                                                                | R <sub>ins</sub> min.: 10 <sup>4</sup> M $\Omega$ |
| 4.13                             |                               | short time overload         | room temperature;<br>dissipation 6.25 x P <sub>n</sub> (voltage not more<br>than 2 x limiting voltage); 10 cycles;<br>5 s ON and 45 s OFF | $\Delta R$ max.: $\pm (2.0 \% R + 0.05 \Omega)$   |



### Disclaimer

All product specifications and data are subject to change without notice.

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 herein or in any other disclosure relating to any product.

Vishay disclaims any and all liability arising out of the use or application of any product described herein or of any information provided herein to the maximum extent permitted by law. The product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein, which apply to these products.

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.

The products shown herein are not designed for use in medical, life-saving, or life-sustaining applications unless otherwise expressly indicated. Customers using or selling Vishay products not expressly indicated for use in such applications do so entirely at their own risk and agree to fully indemnify Vishay for any damages arising or resulting from such use or sale. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

Product names and markings noted herein may be trademarks of their respective owners.