# High Ohmic/High Voltage Metal Glaze Leaded 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 IEC 60068-2-45.

## FEATURES

RoHS COMPLIANT

- Technology: Metal glaze
- $R_{max.}$ = 22 MΩ; $U_{max.}$ = 1600 $V_{DC}$
- High pulse loading capability (up to 7 kV)
- Small size (0207)
- Lead (Pb)-free solder contacts
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Compliant to RoHS Directive 2002/95/EC
- AEC-Q200 qualified

## APPLICATIONS

- Where high resistance, high stability and high reliability at high voltage are required
- High humidity environment
- White goods
- Power supplies

## TECHNICAL SPECIFICATIONS

| DESCRIPTION | UNIT | VR25 |
|---|---|---|
| Resistance Range (1) | Ω | 100K to 22M |
| Resistance Tolerance<br>100 kΩ to 15 MΩ<br>15 MΩ to 22 MΩ | % | <br>± 1; ± 5;<br>± 5; ± 10 |
| Resistance Series<br>100 kΩ to 15 MΩ<br>15 MΩ to 22 MΩ | | <br>E24/E96 series; E24 series<br>E24 series; E12 series |
| Rated Dissipation, $P_{70}$ | W | 0.25 |
| Thermal Resistance ($R_{th}$) | K/W | 140 |
| Temperature Coefficient | ppm/K | ≤ ± 200 |
| Maximum Permissible Voltage $U_{max.}$<br>DC<br>RMS | V | <br>1600<br>1150 |
| Dielectric Withstanding Voltage of the Insulation for 1 Min | V | 700 |
| Basic Specifications | | IEC 60115-1 |
| Climatic Category (IEC 60068-1) | | 55/155/56 |
| Max. Resistance Change for Resistance Range, $\Delta R$ max., after:<br>Load (1000 h, $P_{70}$)<br>Long Term Damp Heat Test (56 Days)<br>Soldering (10 s, 260 °C) | | <br>± (1.5 % $R$ + 0.1 Ω)<br>± (1.5 % $R$ + 0.1 Ω)<br>± (1.5 % $R$ + 0.1 Ω) |
| Noise | μV/V | max. 5 |

**Note**

(1) Ohmic values (other than resistance range) are available on request.



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## PART NUMBER

**PART NUMBER: VR25000001503JA100**

| V | R | 2 | 5 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 3 | J | A | 1 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| MODEL/SIZE | VARIANT | TCR/MATERIAL | VALUE | TOLERANCE | PACKAGING (1) | SPECIAL |
|---|---|---|---|---|---|---|
| **VR25000** | **0** = Neutral<br>**Z** = Value overflow (Special) | **0** = Standard | **3 digit value**<br>**1 digit multiplier**<br>MULTIPLIER<br>3 = *$10^3$<br>4 = *$10^4$<br>5 = *$10^5$ | **F** = ± 1 %<br>**J** = ± 5 %<br>**K** = ± 10 % | **A5**<br>**A2**<br>**A1**<br>**R5**<br>**N4** | The 2 digits are used for all special parts.<br>**00** = Standard |

**PRODUCT DESCRIPTION: VR25 5 % A1 150K**

| VR25 | 5 % | A1 | 150K |
|---|---|---|---|
| MODEL/SIZE | TOLERANCE | PACKAGING (1) | RESISTANCE VALUE |
| **VR25** | **± 1** %<br>**± 5** %<br>**± 10** % | **A5**<br>**A2**<br>**A1**<br>**R5**<br>**N4** | **150K** = 150 kΩ<br>**8M2** = 8.2 MΩ |

**Notes**

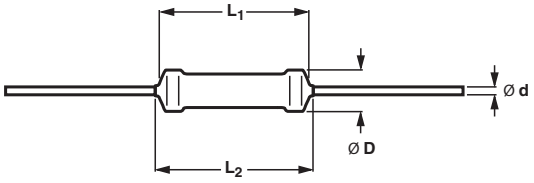
- The PART NUMBER is shown to facilitate the introduction of a unified part numbering system for ordering products

(1) Please refer to table PACKAGING

## PACKAGING

| MODEL | TAPING | AMMOPACK | | REEL | |
|---|---|---|---|---|---|
| | | PIECES | CODE | PIECES | CODE |
| VR25 | Axial, 26 mm | 2000 | A2 | - | - |
| | Axial, 52 mm | 5000 | A5 | 5000 | R5 |
| | | 1000 | A1 | - | - |
| | Radial | 4000 | N4 | - | - |

## DIMENSIONS




Outline

**DIMENSIONS** - Resistor type and relevant physical dimensions

| TYPE | Ø $D_{max.}$ | $L_{1\ max.}$ | $L_{2\ max.}$ | Ø d |
|---|---|---|---|---|
| VR25 | 2.5 | 6.5 | 7.5 | 0.58 ± 0.05 |



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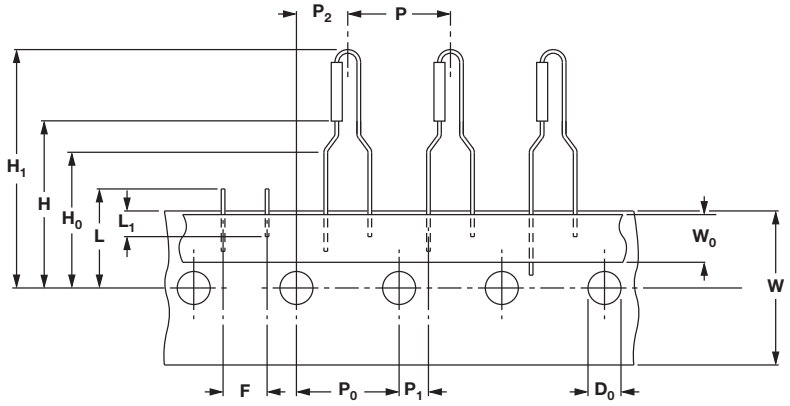
## PRODUCTS WITH RADIAL LEADS




| DIMENSIONS - RADIAL TAPING | | | | |
|---|---|---|---|---|
| SYMBOL | PARAMETER | VALUE | TOLERANCE | UNIT |
| P | Pitch of components | 12.7 | ± 1.0 | mm |
| $P_0$ | Feed-hole pitch | 12.7 | ± 0.2 | mm |
| $P_1$ | Feed-hole centre to lead at topside at the tape | 3.85 | ± 0.5 | mm |
| $P_2$ | Feed-hole center to body center | 6.35 | ± 1.0 | mm |
| F | Lead-to-lead distance | 4.8 | + 0.7/- 0 | mm |
| W | Tape width | 18.0 | ± 0.5 | mm |
| $W_0$ | Minimum hold down tape width | 5.5 | - | mm |
| H1 | Component height | 29 | Max. | mm |
| $H_0$ | Lead wire clinch height | 16.5 | ± 0.5 | mm |
| H | Height of component from tape center | 19.5 | ± 1 | mm |
| $D_0$ | Feed-hole diameter | 4.0 | ± 0.2 | mm |
| L | Maximum length of snipped lead | 11.0 | - | mm |
| $L_1$ | Minimum lead wire (tape portion) shortest lead | 2.5 | - | mm |

**Note**
- Please refer document number 28721 “Packaging” for more detail

| MASS PER UNIT | |
|---|---|
| TYPE | MASS (mg) |
| VR25, 52 mm | 212 |
| VR25, 26 mm | 148 |

## 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.

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 60294).

## FUNCTIONAL PERFORMANCE
## PRODUCT CHARACTERIZATION

Standard values of nominal resistance are taken from the E96/E24/E12 series for resistors with a tolerance of ± 1 %, 5 %, or 10 %. The values of the E96/E24/E12 series are in accordance with IEC 60063.

| LIMITING VALUES | | | |
|---|---|---|---|
| TYPE | LIMITING VOLTAGE (1) $U_{max.}$ | | LIMITING POWER $P_{70}$ (W) |
| | DC | RMS | |
| VR25 | 1600 | 1150 | 0.25 |

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

(1) The maximum voltage that may be continuously applied to the resistor element, see IEC 60115-1



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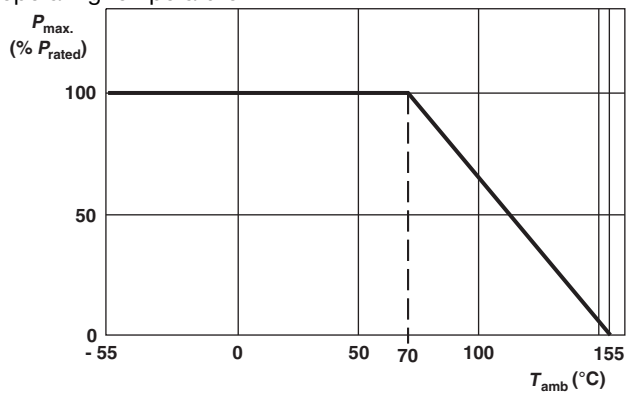
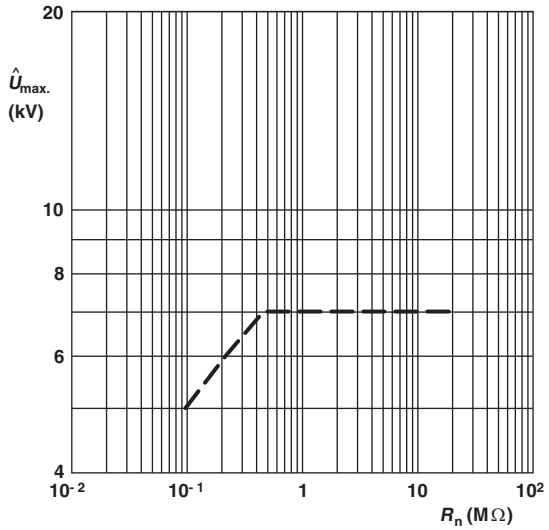
## DERATING

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



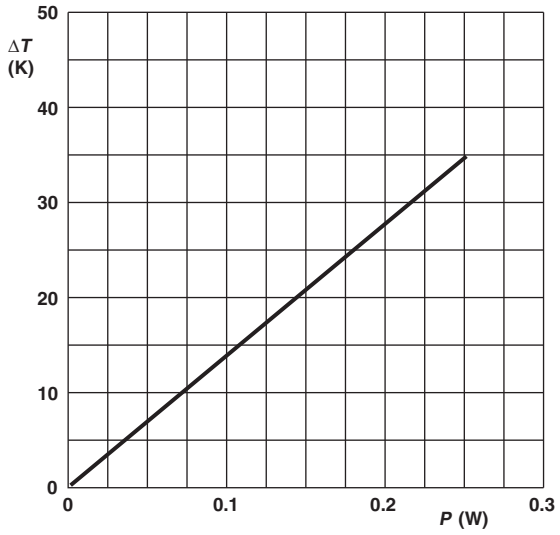

Maximum dissipation ($P_{max.}$) in percentage of rated power as a function of the ambient temperature ($T_{amb}$)

## PULSE LOADING CAPABILITY

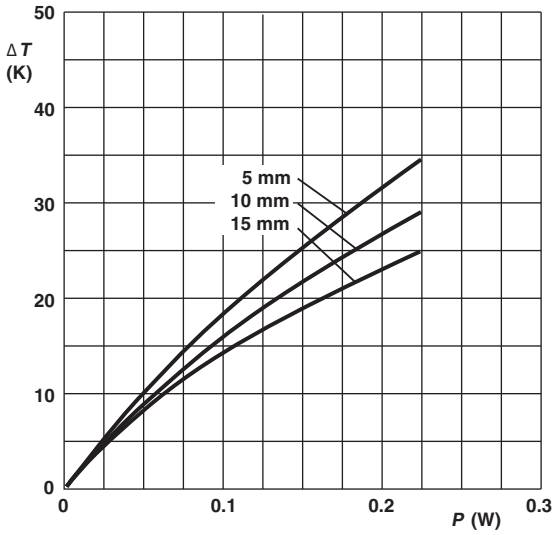



Maximum allowed peak pulse voltage in accordance with IEC 60065, 14.1.a; 50 discharges from a 1 nF capacitor charged to $\hat{U}_{max.}$; 12 discharges/min (drift $\Delta R/R \leq 2$ %)

## APPLICATION INFORMATION




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




Temperature rise ($\Delta T$) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting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## 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 the tests and requirements are listed with reference to the relevant clauses of IEC 60115-1 and IEC 60068-2-xx test methods. A short description of the test procedure is also given. 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 | | Robustness of terminations: | | |
| 4.16.2 | 21 (Ua1) | Tensile all samples | Ø 0.6 mm; load 10 N; 10 s | Number of failures < $10 \times 10^{-6}$ |
| 4.16.3 | 21 (Ub) | Bending half number of samples | Ø 0.6 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.: ± (0.5 % $R$ + 0.05 Ω) |
| 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 (≥ 95 % covered); no damage |
| | | Solderability (after aging) | 8 h steam or 16 h 155 °C; leads immersed 6 mm; for 2 s at 235 °C; solder bath (SnPb40) for 3 s at 245 °C; solder bath (SnAg3Cu0.5) method | Good tinning (≥ 95 % covered); no damage |
| 4.18 | 20 (Tb) | Resistance to soldering heat | Thermal shock: 10 s; 260 °C; 3 mm from body | $\Delta R$ max.: ± (0.5 % $R$ + 0.05 Ω) |
| 4.19 | 14 (Na) | Rapid change of temperature | 30 min at - 55 °C and 30 min at + 155 °C; 5 cycles | $\Delta R$ max.: ± (0.5 % $R$ + 0.05 Ω) |
| 4.20 | 29 (Eb) | Bump | 3 x 1500 bumps in 3 directions; 40 g | No damage<br>$\Delta R$ max.: ± (0.5 % $R$ + 0.05 Ω) |
| 4.22 | 6 (Fc) | Vibration | Frequency 10 Hz to 500 Hz; displacement 1.5 mm or acceleration 10 g; 3 directions; total 6 h (3 x 2 h) | No damage<br>$\Delta R$ max.: ± (0.5 % $R$ + 0.05 Ω) |
| 4.23 | | Climatic sequence: | | |
| 4.23.2 | 2 (Ba) | Dry heat | 16 h; 155 °C | |
| 4.23.3 | 30 (Db) | Damp heat (accelerated) 1st 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 | $R_{ins}$ min.: $10^3$ MΩ<br>$\Delta R$ max.: ± (1.5 % $R$ + 0.1 Ω) |
| 4.24 | 78 (Cab) | Damp heat (steady state) | 56 days; 40 °C; 90 % to 95 % RH; dissipation 0.01 $P_{70}$; limiting voltage $U$ = 100 $V_{DC}$ | $\Delta R$ max.: ± (1.5 % $R$ + 0.1 Ω) |
| 4.25.1 | | Endurance | 1000 h at 70 °C; $P_{70}$ or $U_{max.}$ | $\Delta R$ max.: ± (1.5 % $R$ + 0.1 Ω) |
| 4.8 | | Temperature coefficient | Between - 55 °C and + 155 °C | ≤ ± 200 ppm/K |
| 4.7 | | Voltage proof on insulation | $U_{RMS}$ = 700 V during 1 min; V-block method | No breakdown |
| 4.12 | | Noise | IEC 60195 | Max. 5 µV/V |
| 4.6.1.1 | | Insulation resistance | $U$ = 500 $V_{DC}$ during 1 min; V-block method | $R_{ins}$ min.: $10^4$ MΩ |
| 4.13 | | Short time overload | Room temperature; dissipation 6.25 x $P_{70}$ (voltage not more than 2 x limiting voltage); 10 cycles; 5 s ON and 45 s OFF | $\Delta R$ max.: ± (2.0 % $R$ + 0.05 Ω) |


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| TEST PROCEDURES AND REQUIREMENTS | | | | |
|---|---|---|---|---|
| IEC 60115-1 CLAUSE | IEC 60068-2- TEST METHOD | TEST | PROCEDURE | REQUIREMENTS |
| 4.26 | | Active flammability "cheese-cloth test" | Steps of: 5/10/16/25/40 x $P_{70}$ duration 5 min | No flaming of gauze cylinder |
| 4.35 | | Passive flammability "needle-flame test" | Application of test flame for 20 s | No ignition of product; no ignition of under-layer; burning time less than 30 s |

## 12NC INFORMATION FOR HISTORICAL CODING REFERENCE

- The resistors have a 12-digit numeric code starting with 2322 241
- The subsequent:
  first digit for 1 % tolerance products (E24 and E96 series) or 2 digits for 5 % (E24 series) and 10 % (E12 series) indicate the resistor type and packing.
- The remaining digits indicate the resistance value:
  - The first 3 digits for 1 % or 2 digits for 5 and 10 % 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 kΩ to 976 kΩ | 4 |
| 1 MΩ to 9.76 MΩ | 5 |
| ≥ 10 MΩ | 6 |

**12NC Example**

The 12NC for a VR25, resistor value 7.5 MΩ, 5 % tolerance, supplied on a bandolier of 1000 units in ammopack, is: 2322 241 13755.

**12NC** - Resistor type and packaging

| TYPE | TOL. (%) | 2322 241 ..... | | | | |
|---|---|---|---|---|---|---|
| | | BANDOLIER IN AMMOPACK | | | | BANDOLIER ON REEL |
| | | RADIAL TAPED | STRAIGHT LEADS | | | |
| | | 4000 UNITS | 52 mm | 26 mm | 52 mm | 52 mm |
| | | | 1000 UNITS | 2000 UNITS | 5000 UNITS | 5000 UNITS |
| VR25 | ± 1 | 0.... | 8.... | - | 7.... | 6.... |
| | ± 5 | 36... | 13... | 43... | 53... | 23... |
| | ± 10 | 38... | 12... | 42... | 52... | 22... |


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