High-ohmic/high-voltage resistors VR68

FEATURES

- These resistors meet the safety requirements of:
  "UL1676" (range 510 kΩ to 11 MΩ)
  "EN60065"
  "BS60065" (U.K.)
  "NFC 92-130" (France)
  "VDE 0860" (Germany)
- High pulse loading capability
- Small size.

APPLICATIONS

- Where high resistance, high stability and high reliability at high voltage are required
- Safety component in combination with high voltage
- Picture tubes
- High voltage bleeders
- Cascade switches.

DESCRIPTION

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 68-2-45".

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance range</td>
<td>100 kΩ to 68 MΩ; note 1</td>
</tr>
<tr>
<td>Resistance tolerance and series</td>
<td>±1%; E24/E96 series; ±5%; E24 series</td>
</tr>
<tr>
<td>Maximum dissipation at T&lt;sub&gt;amb&lt;/sub&gt; = 70 °C</td>
<td>1 W</td>
</tr>
<tr>
<td>Thermal resistance, R&lt;sub&gt;th&lt;/sub&gt;</td>
<td>70 K/W</td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>≤ ±200 × 10⁻⁶/K</td>
</tr>
<tr>
<td>Maximum permissible voltage:</td>
<td></td>
</tr>
<tr>
<td>DC</td>
<td>10000 V</td>
</tr>
<tr>
<td>RMS</td>
<td>7000 V</td>
</tr>
<tr>
<td>Dielectric withstanding voltage</td>
<td>700 V</td>
</tr>
<tr>
<td>of the insulation for 1 minute</td>
<td></td>
</tr>
<tr>
<td>Basic specifications</td>
<td>IEC 115-1B</td>
</tr>
<tr>
<td>Safety requirements</td>
<td>UL1676 (510 kΩ to 11 MΩ); EN60065; BS60065; VDE 0860; NFC 92-130</td>
</tr>
<tr>
<td>Climatic category (IEC 68)</td>
<td>55/155/56</td>
</tr>
<tr>
<td>Stability after:</td>
<td></td>
</tr>
<tr>
<td>load (1000 hours)</td>
<td>ΔR/R max.: ±1.5% +0.1 Ω; typ. 1%</td>
</tr>
<tr>
<td>accelerated damp heat test (6 days)</td>
<td>ΔR/R max.: ±1.5% +0.1 Ω; typ. 1%</td>
</tr>
<tr>
<td>long term damp heat test (56 days)</td>
<td>ΔR/R max.: ±1.5% +0.1 Ω; typ. 0.5%</td>
</tr>
<tr>
<td>Noise</td>
<td>max. 2.5 µV/V; typ. 0.5</td>
</tr>
</tbody>
</table>

Note

1. Values up to 220 MΩ are available upon request.
ORDERING INFORMATION

Table 1  Ordering code indicating resistor type and packaging

<table>
<thead>
<tr>
<th>TYPE</th>
<th>TAPE WIDTH (mm)</th>
<th>TOL. (%)</th>
<th>ORDERING CODE 2322 ... .....</th>
<th>BANDOLIER IN AMMOPACK</th>
<th>BANDOLIER ON REEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR68</td>
<td>66.7</td>
<td>±1</td>
<td>244 8...</td>
<td>500 units</td>
<td>1000 units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±5</td>
<td>244 13...</td>
<td>2000 units</td>
<td>5000 units</td>
</tr>
</tbody>
</table>

Ordering code (12NC)
- The resistors have a 12-digit ordering code staring with 2322
- The subsequent:
  - 4 digits for 1% tolerance products (E24 and E96 series)
  - or 5 digits for 5% (E24 series) indicate the resistor type and packaging; see Table 1.
- 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 in accordance with Table 2.

Table 2  Last digit of 12NC

<table>
<thead>
<tr>
<th>RESISTANCE DECADE</th>
<th>LAST DIGIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 to 976 kΩ</td>
<td>4</td>
</tr>
<tr>
<td>1 to 9.76 MΩ</td>
<td>5</td>
</tr>
<tr>
<td>≥10 MΩ</td>
<td>6</td>
</tr>
</tbody>
</table>

ORDERING EXAMPLE
The ordering code for a VR68, resistor value 7.5 MΩ, 5% tolerance, supplied on a bandolier of 500 units in ammopack, is: 2322 244 13755.
FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96/E24/E12 series for resistors with a tolerance of ±1% or 5%. The values of the E96/E24 series are in accordance with “IEC publication 63”.

Limiting values

<table>
<thead>
<tr>
<th>TYPE</th>
<th>LIMITING VOLTAGE(1) (V)</th>
<th>LIMITING POWER (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DC</td>
<td>RMS</td>
</tr>
<tr>
<td>VR68</td>
<td>10000</td>
<td>7000</td>
</tr>
</tbody>
</table>

Note

1. The maximum voltage that may be continuously applied to the resistor element, see “IEC publication 115-1”.

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

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig. 1.

PULSE LOADING CAPABILITY

Fig. 1  Maximum dissipation (\(P_{\text{max}}\)) in percentage of rated power as a function of the ambient temperature (\(T_{\text{amb}}\)).

Fig. 2  Maximum allowed peak pulse voltage in accordance with “IEC 65 chapter 14.1”; 50 discharges from a 1 nF capacitor charged to \(V_{\text{max}}\); 12 discharges/minute (drift \(\Delta R/R \leq 1\%\)).
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Application information

**Fig. 3** Hot-spot temperature rise ($\Delta T$) as a function of dissipated power.

**Fig. 4** Temperature rise ($\Delta T$) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.

**MECHANICAL DATA**

**Mass per 100 units**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>MASS (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR68</td>
<td>148</td>
</tr>
</tbody>
</table>

**Marking**

The nominal resistance and tolerance are marked on the resistor using four or five coloured bands in accordance with IEC publication 62 "Colour codes for fixed resistors".

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 294").

**Table 3** Resistor type and relevant physical dimensions; see Fig. 5

<table>
<thead>
<tr>
<th>TYPE</th>
<th>$\varnothing$D MAX. (mm)</th>
<th>$L_1$ MAX. (mm)</th>
<th>$L_2$ MAX. (mm)</th>
<th>$\varnothing$d (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR68</td>
<td>6.8</td>
<td>18.0</td>
<td>19.0</td>
<td>0.8</td>
</tr>
</tbody>
</table>
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TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 115-1"; 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 68, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 68-1", subclause 5.3.

Unless otherwise specified the following values apply:

- Temperature: 15 °C to 35 °C
- Relative humidity: 45% to 75%
- Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 115-1 and 68"; 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.

Table 4  Test procedures and requirements

<table>
<thead>
<tr>
<th>IEC 115-1 CLAUSE</th>
<th>IEC 68 TEST METHOD</th>
<th>TEST</th>
<th>PROCEDURE</th>
<th>REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.16</td>
<td>U</td>
<td>robustness of terminations:</td>
<td>Ø0.8 mm; load 10 N; 10 s</td>
<td>number of failures &lt;10 x 10^{-6}</td>
</tr>
<tr>
<td>4.16.2</td>
<td>Ua</td>
<td>tensile all samples</td>
<td>Ø0.8 mm; load 5 N; 4 x 90°</td>
<td>number of failures &lt;10 x 10^{-6}</td>
</tr>
<tr>
<td>4.16.3</td>
<td>Ub</td>
<td>bending half number of samples</td>
<td></td>
<td>no damage</td>
</tr>
<tr>
<td>4.16.4</td>
<td>Uc</td>
<td>torsion other half of samples</td>
<td>3 x 360° in opposite directions</td>
<td>ΔR/R max.: ±0.5% +0.05 Ω</td>
</tr>
<tr>
<td>4.17</td>
<td>Ta</td>
<td>solderability</td>
<td>2 s; 235 °C; flux 600</td>
<td>good tinning; no damage</td>
</tr>
<tr>
<td>4.18</td>
<td>Tb</td>
<td>resistance to soldering heat</td>
<td>thermal shock: 3 s; 350 °C; 6 mm from body</td>
<td>ΔR/R max.: ±0.5% +0.05 Ω</td>
</tr>
<tr>
<td>4.19</td>
<td>Na</td>
<td>rapid change of temperature</td>
<td>30 minutes at -55 °C and 30 minutes at +155 °C; 5 cycles</td>
<td>ΔR/R max.: ±0.5% +0.05 Ω</td>
</tr>
<tr>
<td>4.20</td>
<td>Eb</td>
<td>bump</td>
<td>3 x 1500 bumps in 3 directions; 40 g</td>
<td>no damage</td>
</tr>
<tr>
<td>4.22</td>
<td>Fc</td>
<td>vibration</td>
<td>frequency 10 to 500 Hz; displacement 1.5 mm or acceleration 10 g; 3 directions; total 6 hours (3 x 2 hours)</td>
<td>no damage</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>IEC 115-1 CLAUSE</th>
<th>IEC 68 TEST METHOD</th>
<th>TEST</th>
<th>PROCEDURE</th>
<th>REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.23</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.23.2</td>
<td>Ba</td>
<td>climatic sequence:</td>
<td>16 hours; 155 °C</td>
<td></td>
</tr>
<tr>
<td>4.23.3</td>
<td>Db</td>
<td>dry heat</td>
<td>24 hours; 55 °C; 90 to 100% RH</td>
<td></td>
</tr>
<tr>
<td>4.23.4</td>
<td>Aa</td>
<td>damp heat (accelerated)</td>
<td>2 hours; −55 °C</td>
<td></td>
</tr>
<tr>
<td>4.23.5</td>
<td>M</td>
<td>cold</td>
<td>2 hours; 8.5 kPa; 15 to 35 °C</td>
<td>R_{\text{ins}} \text{min.}: 10^3 \Omega</td>
</tr>
<tr>
<td>4.23.6</td>
<td>Db</td>
<td>remaining cycles:</td>
<td>5 days; 55 °C; 95 to 100% RH</td>
<td>$\Delta R/R_{\text{max.}}: \pm 1.5% +0.1 \Omega$</td>
</tr>
<tr>
<td>4.24.2</td>
<td>Ca</td>
<td>damp heat (steady state)</td>
<td>56 days; 40 °C; 90 to 95% RH; dissipation 0.01 $P_n$; limiting voltage 100 V (DC)</td>
<td>$\Delta R/R_{\text{max.}}: \pm 1.5% +0.1 \Omega$</td>
</tr>
<tr>
<td>4.25.1</td>
<td></td>
<td>endurance</td>
<td>1000 hours at 70 °C; $P_n$ or $V_{\text{max}}$</td>
<td>$\Delta R/R_{\text{max.}}: \pm 1.5% +0.1 \Omega$</td>
</tr>
<tr>
<td>4.8.4</td>
<td></td>
<td>temperature coefficient</td>
<td>between −55 °C and +155 °C (TC $\times 10^{-6}$/K)</td>
<td>$\leq \pm 200$</td>
</tr>
<tr>
<td>4.7</td>
<td></td>
<td>voltage proof on insulation</td>
<td>700 V (RMS) during 1 minute; V-block method</td>
<td>no breakdown</td>
</tr>
<tr>
<td>4.12</td>
<td></td>
<td>noise</td>
<td>IEC publication 195</td>
<td>max. 2.5 $\mu$V/V</td>
</tr>
<tr>
<td>4.6.1.1</td>
<td></td>
<td>insulation resistance</td>
<td>500 V (DC or RMS) during 1 minute; V-block method</td>
<td>$R_{\text{ins}} \text{min.}: 10^4 \Omega$</td>
</tr>
<tr>
<td>4.13</td>
<td></td>
<td>short time overload</td>
<td>room temperature; dissipation 6.25 $\times P_n$ (voltage not more than 2 $\times$ limiting voltage; 10000 V max.); 10 cycles; 5 s on and 45 s off</td>
<td>$\Delta R/R_{\text{max.}}: \pm 0.5% +0.05 \Omega$</td>
</tr>
</tbody>
</table>