Philips Components

**General purpose chip resistors**

sizes 1206, 0805, 0603 and 0402

RC01/11/21/31

5%; 2%

**FEATURES**

- Low assembly costs
- High component and equipment reliability
- Excellent performance at high frequency, especially the RC31
- Complete standard SMD family.

**APPLICATIONS**

- All general purpose applications.

**DESCRIPTION**

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coat and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RC01</strong></td>
<td><strong>RC11</strong></td>
</tr>
<tr>
<td>Size code</td>
<td>1206 (3216)</td>
</tr>
<tr>
<td>Resistance range</td>
<td>1 Ω to 10 MΩ</td>
</tr>
<tr>
<td>Resistance tolerance and E-series</td>
<td>±5%, ±2%; E24 series</td>
</tr>
<tr>
<td>Temperature coefficient:</td>
<td>&lt;250 ±250 × 10⁻⁶/K</td>
</tr>
<tr>
<td>1 Ω ≤ R &lt; 10 Ω</td>
<td>≤±200 × 10⁻⁶/K</td>
</tr>
<tr>
<td>10 Ω ≤ R &lt; 10 MΩ</td>
<td></td>
</tr>
<tr>
<td>Maximum dissipation at T_amb = 70 °C</td>
<td>0.25 W</td>
</tr>
<tr>
<td>Maximum permissible voltage</td>
<td>200 V (DC or RMS)</td>
</tr>
<tr>
<td>Climatic category (IEC 60068)</td>
<td>55/155/56</td>
</tr>
<tr>
<td>Basic specification</td>
<td>IEC 60115-8</td>
</tr>
</tbody>
</table>
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ORDERING INFORMATION

Table 1  Ordering code indicating resistor type and packaging

<table>
<thead>
<tr>
<th>TYPE</th>
<th>TOL. (%)</th>
<th>ORDERING CODE 2322 ... ......</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PAPER TAPE ON REEL(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5000 units</td>
</tr>
<tr>
<td>RC01</td>
<td>±5</td>
<td>711 61...</td>
</tr>
<tr>
<td></td>
<td>±2</td>
<td>711 41...</td>
</tr>
<tr>
<td>RC11</td>
<td>±5</td>
<td>730 61...</td>
</tr>
<tr>
<td></td>
<td>±2</td>
<td>730 31...</td>
</tr>
<tr>
<td>RC21</td>
<td>±5</td>
<td>702 60...</td>
</tr>
<tr>
<td></td>
<td>±2</td>
<td>702 65...</td>
</tr>
<tr>
<td>RC31</td>
<td>±5</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>±2</td>
<td>–</td>
</tr>
</tbody>
</table>

Jumper 0 Ω

<table>
<thead>
<tr>
<th>TYPE</th>
<th>ORDERING CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC01(1)</td>
<td>711 91032</td>
</tr>
<tr>
<td>RC11(1)</td>
<td>730 91002</td>
</tr>
<tr>
<td>RC21(2)</td>
<td>702 96001</td>
</tr>
<tr>
<td>RC31(2)</td>
<td>705 91001</td>
</tr>
</tbody>
</table>

Notes
1. The jumper has a maximum resistance $R_{\text{max}} = 50 \text{ m}\Omega$ and a rated current $I_R = 2 \text{ A}$.
2. The jumper has a maximum resistance $R_{\text{max}} = 50 \text{ m}\Omega$ and a rated current $I_R = 1 \text{ A}$.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322
- The subsequent 5 digits indicate the resistor type and packaging; see Table 1.
- The remaining 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 2.

Table 2  Last digit of 12NC

<table>
<thead>
<tr>
<th>RESISTANCE DECADE</th>
<th>LAST DIGIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 9.76 Ω</td>
<td>8</td>
</tr>
<tr>
<td>10 to 97.6 Ω</td>
<td>9</td>
</tr>
<tr>
<td>100 to 976 Ω</td>
<td>1</td>
</tr>
<tr>
<td>1 to 9.76 kΩ</td>
<td>2</td>
</tr>
<tr>
<td>10 to 97.6 kΩ</td>
<td>3</td>
</tr>
<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 of a RC11 resistor, value 4700 Ω with ±2% tolerance, supplied on paper tape of 5000 units per reel is: 2322 730 31472.
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FUNCTIONAL DESCRIPTION

Product characterization
Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of ±5% or ±2%. The values of the E24 series are in accordance with “IEC publication 60063”.

Limiting values

<table>
<thead>
<tr>
<th>TYPE</th>
<th>LIMITING VOLTAGE (V)</th>
<th>LIMITING POWER (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC01</td>
<td>200</td>
<td>0.25</td>
</tr>
<tr>
<td>RC11</td>
<td>150</td>
<td>0.125</td>
</tr>
<tr>
<td>RC21</td>
<td>50</td>
<td>0.063</td>
</tr>
<tr>
<td>RC31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note
1. This is the maximum voltage that may be continuously applied to the resistor element, see “IEC publication 60115-8”.

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

![Diagram showing maximum dissipation (P max) in percentage of rated power as a function of the ambient temperature (T amb).](image-url)
PULSE LOADING CAPABILITIES

Fig. 2 Maximum permissible peak pulse voltage without failing to ‘open circuit’ in accordance with DIN IEC 60040 (CO) 533 for type: RC01.

Fig. 3 Maximum permissible peak pulse voltage without failing to ‘open circuit’ in accordance with DIN IEC 60040 (CO) 533 for type: RC11.
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Fig. 4 Maximum permissible peak pulse voltage without failing to ‘open circuit’ in accordance with DIN IEC 60040 (CO) 533 for type: RC21.

Fig. 5 Maximum permissible peak pulse voltage without failing to ‘open circuit’ in accordance with DIN IEC 60040 (CO) 533 for type: RC31.
Fig. 6  Pulse on a regular basis for type: \textbf{RC01}; maximum permissible peak pulse power ($\hat{P}_{\text{max}}$) as a function of pulse duration for $R \leq 10$ kΩ, single pulse and repetitive pulse $t_p/t_i = 1000$. 

Fig. 7  Pulse on a regular basis for type: \textbf{RC01}; maximum permissible peak pulse voltage ($\hat{V}_{\text{max}}$) as a function of pulse duration.
Fig. 8  Pulse on a regular basis for type: RC11; maximum permissible peak pulse power $\hat{P}_{\text{max}}$ as a function of pulse duration for $R \leq 10 \, \text{k}\Omega$, single pulse and repetitive pulse $t_p/t_i = 1000$.

Fig. 9  Pulse on a regular basis for type: RC11; maximum permissible peak pulse voltage $\hat{V}_{\text{max}}$ as a function of pulse duration.
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Fig. 10 Pulse on a regular basis for type: RC21; maximum permissible peak pulse power ($\dot{P}_{\text{max}}$) as a function of pulse duration for $R \leq 10$ kΩ, single pulse and repetitive pulse $t_p/t_i = 1000$.

Fig. 11 Pulse on a regular basis for type: RC21; maximum permissible peak pulse voltage ($\dot{V}_{\text{max}}$) as a function of pulse duration.
Fig. 12 Pulse on a regular basis for type: RC31; maximum permissible peak pulse power ($\dot{P}_{\text{max}}$) as a function of pulse duration for $R \leq 10$ kΩ, single pulse and repetitive pulse $t_p/t_i = 1000$.

Fig. 13 Pulse on a regular basis for type: RC31; maximum permissible peak pulse voltage ($\dot{V}_{\text{max}}$) as a function of pulse duration.
MECHANICAL DATA

Mass per 100 units

<table>
<thead>
<tr>
<th>TYPE</th>
<th>MASS (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC01</td>
<td>1.0</td>
</tr>
<tr>
<td>RC11</td>
<td>0.55</td>
</tr>
<tr>
<td>RC21</td>
<td>0.25</td>
</tr>
<tr>
<td>RC31</td>
<td>0.052</td>
</tr>
</tbody>
</table>

Marking

Each resistor, except RC31, is marked with a three digit code (occasionally four digit) on the protective coating to designate the nominal resistance value.

3-DIGIT MARKING

For values up to 91 Ω the R is used as a decimal point. For values of 100 Ω or greater the first 2 digits are significant, the third indicates the number of zeros to follow.

Example

<table>
<thead>
<tr>
<th>MARKING</th>
<th>RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>12R</td>
<td>12 Ω</td>
</tr>
<tr>
<td>823</td>
<td>82 kΩ</td>
</tr>
</tbody>
</table>

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits are significant, the fourth indicates the number of zeros to follow.

Example

<table>
<thead>
<tr>
<th>MARKING</th>
<th>RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>12R0</td>
<td>12 Ω</td>
</tr>
<tr>
<td>8202</td>
<td>82 kΩ</td>
</tr>
</tbody>
</table>

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

Table 3 Chip resistor types and relevant physical dimensions; see Fig.14

<table>
<thead>
<tr>
<th>TYPE</th>
<th>L (mm)</th>
<th>W (mm)</th>
<th>T (mm)</th>
<th>t1 (mm)</th>
<th>t2 (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC01</td>
<td>3.20</td>
<td>±0.10/−0.20</td>
<td>1.60 ±0.15</td>
<td>0.55 ±0.10</td>
<td>0.45 ±0.25</td>
</tr>
<tr>
<td>RC11</td>
<td>2.00 ±0.15</td>
<td>1.25 ±0.15</td>
<td>0.55 ±0.10</td>
<td>0.40 ±0.20</td>
<td>0.40 ±0.20</td>
</tr>
<tr>
<td>RC21</td>
<td>1.60 ±0.10</td>
<td>0.80 ±0.15/−0.05</td>
<td>0.45 ±0.10</td>
<td>0.30 ±0.20</td>
<td>0.30 ±0.20</td>
</tr>
<tr>
<td>RC31</td>
<td>1.00 ±0.05</td>
<td>0.50 ±0.05</td>
<td>0.35 ±0.05</td>
<td>0.20 ±0.10</td>
<td>0.25 ±0.10</td>
</tr>
</tbody>
</table>

For dimensions see Table 3.

Fig.14 Outlines.
TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of “IEC publication 60115-8”, 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, “Recommended basic climatic and mechanical robustness testing procedure for electronic components” and under standard atmospheric conditions according to “IEC 60068-1”, 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 60115-8 and 60068”; 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 60115-8 CLAUSE</th>
<th>IEC 60068-2 TEST METHOD</th>
<th>TEST</th>
<th>PROCEDURE</th>
<th>REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>RC01</td>
<td>RC11</td>
</tr>
</tbody>
</table>

Tests in accordance with the schedule of IEC publication 60115-8

<p>| 4.4.1 | visual examination | no holes; clean surface; no visible damage |
| 4.4.2 | dimensions (see Fig.14) | gauge (mm) | see Table 3 |
| 4.5   | resistance | applied voltage (+0/-10%): R = Rnom max. ±2% or R = Rnom max. ±5% |
| 4.18  | 20 (Tb) resistance to soldering heat | unmounted chips; 10 ±1 s; 260 ±5 °C | no visible damage | no visible damage |
| 4.29  | 45 (Xa) component solvent resistance | isopropyl alcohol or H2O followed by brushing in accordance with “MIL 202 F” | no visible damage |</p>
<table>
<thead>
<tr>
<th>IEC 60115-8 CLAUSE</th>
<th>IEC 60068-2 TEST METHOD</th>
<th>TEST</th>
<th>PROCEDURE</th>
<th>REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.17</td>
<td>RC01 RC11 RC21 RC31</td>
<td>solderability</td>
<td>unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C</td>
<td>good tinning (≥95% covered); no visible damage</td>
</tr>
<tr>
<td>4.7</td>
<td>RC01 RC11 RC21 RC31</td>
<td>voltage proof on insulation</td>
<td>maximum voltage (RMS) during 1 minute metal block method</td>
<td>no breakdown or flashover</td>
</tr>
<tr>
<td>4.13</td>
<td>RC01 RC11 RC21 RC31</td>
<td>short time overload</td>
<td>room temperature; P = 6.25 × P_n; 5 s (V ≤ 2 × V_{max})</td>
<td>ΔR/R max.: ±(1% + 0.05 Ω) ΔR/R max.: ±(2% + 0.1 Ω)</td>
</tr>
<tr>
<td>4.33</td>
<td>RC01 RC11 RC21 RC31</td>
<td>bending</td>
<td>resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm for RC01 and 5 mm for RC11, RC21 and RC31</td>
<td>no visible damage; ΔR/R max.: ±(1% + 0.05 Ω)</td>
</tr>
<tr>
<td>4.19</td>
<td>RC01 RC11 RC21 RC31</td>
<td>rapid change of temperature</td>
<td>30 minutes at LCT and 30 minutes at UCT; 5 cycles</td>
<td>no visible damage; ΔR/R max.: ±(0.5% + 0.05 Ω) no visible damage; ΔR/R max.: ±(2% + 0.1 Ω)</td>
</tr>
<tr>
<td>4.24.2</td>
<td>RC01 RC11 RC21 RC31</td>
<td>damp heat (steady state)</td>
<td>56 days; 40 ±2 °C; 93 ±2/−3% RH; loaded with 0.01 P_n: R ≤ 1 MΩ R &gt; 1 MΩ</td>
<td>ΔR/R max.: ±(1.5% + 0.1 Ω) ΔR/R max.: ±(3% + 0.1 Ω) ΔR/R max.: ±(3% + 0.1 Ω) ΔR/R max.: ±(3% + 0.1 Ω)</td>
</tr>
<tr>
<td>4.25.1</td>
<td>RC01 RC11 RC21 RC31</td>
<td>endurance</td>
<td>1000 ±48/−0 hours; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off: R ≤ 1 MΩ R &gt; 1 MΩ</td>
<td>ΔR/R max.: ±(1.5% + 0.1 Ω) ΔR/R max.: ±(3% + 0.1 Ω) ΔR/R max.: ±(3% + 0.1 Ω) ΔR/R max.: ±(3% + 0.1 Ω)</td>
</tr>
<tr>
<td>4.23.2</td>
<td>RC01 RC11 RC21 RC31</td>
<td>endurance at upper category temperature</td>
<td>1000 ±48/−0 hours; no load: R ≤ 1 MΩ R &gt; 1 MΩ</td>
<td>ΔR/R max.: ±(1.5% + 0.1 Ω) ΔR/R max.: ±(3% + 0.1 Ω) ΔR/R max.: ±(3% + 0.1 Ω) ΔR/R max.: ±(3% + 0.1 Ω)</td>
</tr>
<tr>
<td>4.8.4.2</td>
<td>RC01 RC11 RC21 RC31</td>
<td>temperature coefficient</td>
<td>at 20/LCT/20 °C and 20/UCT/20 °C: R ≤ 10 Ω 10 Ω &lt; R</td>
<td>≤250 ±250 × 10^{-6}/K ≤200 ±200 × 10^{-6}/K</td>
</tr>
</tbody>
</table>
### General purpose chip resistors

**sizes 1206, 0805, 0603 and 0402**

**Other tests in accordance with IEC 60115 clauses and IEC 60068 test method**

<table>
<thead>
<tr>
<th>Clause</th>
<th>Procedure</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4.17</strong></td>
<td>20 (Ta) solderability (after ageing)</td>
<td>8 hours steam or 16 hours 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C</td>
</tr>
<tr>
<td><strong>4.6.1.1</strong></td>
<td>Insulation resistance</td>
<td>Voltage (DC) after 1 minute, metal block method: 100 V for RC01 and RC11, 50 V for RC21 and RC31</td>
</tr>
<tr>
<td><strong>4.12</strong></td>
<td>Noise</td>
<td>IEC publication 60195 (measured with Quantech - equipment):</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$R \leq 100$ Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$100 \text{ Ω} &lt; R \leq 1 \text{ kΩ}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1 \text{ kΩ} &lt; R \leq 10 \text{ kΩ}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$10 \text{ kΩ} &lt; R \leq 100 \text{ kΩ}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$100 \text{ kΩ} &lt; R \leq 1 \text{ MΩ}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1 \text{ MΩ} &lt; R \leq 10 \text{ MΩ}$</td>
</tr>
</tbody>
</table>

**Other applicable tests**

<table>
<thead>
<tr>
<th>Clause</th>
<th>Procedure</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(JIS) C 5202 7.5</strong></td>
<td>Resistance to damp heat (steady state)</td>
<td>1000 ±48/−0 hours; 40 ±2 °C; 93 ±2/−3% RH; loaded with $P_n$ or $V_{\text{max}}$; 1.5 hours on and 0.5 hours off:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$R \leq 1 \text{ MΩ}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$R &gt; 1 \text{ MΩ}$</td>
</tr>
<tr>
<td></td>
<td>Leaching</td>
<td>Unmounted chips: 60 ±1 s; 260 ±5 °C</td>
</tr>
<tr>
<td><strong>trio damp heat test</strong></td>
<td>1000 ±48/−0 hours; 85 ±2 °C; 85 ±5% RH; loaded with 0.01 $P_n$ or $V_{\text{max}}$</td>
<td>$R \leq 1 \text{ MΩ}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$R &gt; 1 \text{ MΩ}$</td>
</tr>
</tbody>
</table>