DuPont QS87 Series Resistors
SERIES Q-Q SIL

Technical Data Sheet

Product Description
The DuPont QS87 series resistors were designed for thick film hybrid applications and typically use high silver content termination materials. There is no blend break with this system which can provide values ranging between 1 Ohm to 100 MegOhms per square. The DuPont QS87 series members provide very good laser trim stability.

Processing
Substrates
Properties are based on tests on 96% alumina substrates. Substrates of other chemical compositions or from various manufacturers may result in variations in performance characteristics.

Terminations
Reported properties are based on tests with QS170 silver/platinum conductor composition, prefired at 850°C. Excellent results have also been obtained using DuPont QS175 silver, prefired at 850°C.

Printing
Specified properties are based on resistors printed to 25±2 μm dried print thickness. This is readily achieved using 200-mesh stainless steel screens with 15±3 μm emulsion thicknesses.

Drying
Print should be allowed to level for 5-10 minutes at room temperature and then dry for 10-15 minutes at 150°C.

Firing
Resistivity and TCR specifications are based on the recommended short firing profile with a 10 minute peak at 850°C.

Composition Properties

<table>
<thead>
<tr>
<th>Test</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity (Pa.s) Brookfield HBT, UC&amp;S 10 rpm, 25°C</td>
<td>145-210</td>
</tr>
<tr>
<td>Thinner</td>
<td>DuPont 4036 or DuPont 8250 or DuPont 4553</td>
</tr>
<tr>
<td>Coverage (cm²/g)</td>
<td>80 - 110</td>
</tr>
</tbody>
</table>

This table shows anticipated typical physical properties for DuPont QS87 series based on specific controlled experiments in our labs and are not intended to represent the product specifications, details of which are available upon request.

Encapsulation
In general, glass encapsulation is not required. However, for applications in need of mechanical protection or protection from extreme environments such as high temperature nitrogen or forming gas, encapsulant QQ550 fired at 500°C is recommended.

Storage and Shelf Life
Containers should be stored, tightly sealed, in a clean, stable environment at room temperature (~25°C). Shelf life of material in unopened containers is six months from date of shipment. Some settling of solids may occur and compositions should be thoroughly mixed prior to use.

Safety and Handling
For Safety and Handling information pertaining to this product, read the Material Safety Data Sheet (MSDS).
### Composition Properties

<table>
<thead>
<tr>
<th></th>
<th>QS869</th>
<th>QS870</th>
<th>QS871</th>
<th>QS872</th>
<th>QS873</th>
<th>QS874</th>
<th>QS875</th>
<th>QS876</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistivity(^1)^ (Ω/sq):</td>
<td>1.5</td>
<td>3</td>
<td>10</td>
<td>100</td>
<td>1K</td>
<td>10K</td>
<td>100K</td>
<td>1M</td>
</tr>
<tr>
<td>Shipping Specification: (%)</td>
<td>± 20</td>
<td>± 10</td>
<td>± 10</td>
<td>± 10</td>
<td>± 10</td>
<td>± 10</td>
<td>± 10</td>
<td>± 20</td>
</tr>
<tr>
<td>Coefficient of Variation: (CV%)</td>
<td>≤ 5</td>
<td>≤ 5</td>
<td>≤ 5</td>
<td>≤ 5</td>
<td>≤ 5</td>
<td>≤ 5</td>
<td>≤ 5</td>
<td>≤ 5</td>
</tr>
<tr>
<td>Temperature Coefficient Of Resistance(^3) ppm/°C</td>
<td>0 ± 200</td>
<td>0 ± 100</td>
<td>0 ± 100</td>
<td>0 ± 100</td>
<td>0 ± 100</td>
<td>0 ± 100</td>
<td>0 ± 100</td>
<td>0 ± 150</td>
</tr>
<tr>
<td>Short Term Overload Voltage(^4) (STOL) V/mm</td>
<td>3.5</td>
<td>5</td>
<td>9</td>
<td>30</td>
<td>75</td>
<td>200</td>
<td>355</td>
<td>392</td>
</tr>
<tr>
<td>Standard Working Voltage(^5):</td>
<td>1.4</td>
<td>2</td>
<td>4</td>
<td>12</td>
<td>30</td>
<td>80</td>
<td>142</td>
<td>157</td>
</tr>
<tr>
<td>(STOL) V/mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Rated Power Dissipation(^6): (MRPD) mW/mm(^2)</td>
<td>727</td>
<td>890</td>
<td>865</td>
<td>900</td>
<td>560</td>
<td>500</td>
<td>170</td>
<td>18</td>
</tr>
<tr>
<td>Electrostatic Discharge(^7): (ESD) %ΔR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,000 Volts</td>
<td>-0.1</td>
<td>-0.1</td>
<td>0.1</td>
<td>-0.1</td>
<td>-0.4</td>
<td>-0.8</td>
<td>-0.6</td>
<td></td>
</tr>
<tr>
<td>5,000 Volts</td>
<td>-0.1</td>
<td>0.7</td>
<td>-0.1</td>
<td>-0.6</td>
<td>-0.5</td>
<td>-0.2</td>
<td>-0.9</td>
<td></td>
</tr>
<tr>
<td>Quan Tech Noise(^8) dB</td>
<td>-23</td>
<td>-22</td>
<td>-19</td>
<td>-15</td>
<td>-5</td>
<td>-8</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

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(2) Resistor geometry
R, TCR, CV: 1.5 x 1.5 mm laser trimmed to 1.5x fired value
STOL, ESD, Noise: 1 x 1 mm laser trimmed to 1.5x fired value

(3) TCR
Cold TCR measured from -55°C to + 25°C.
Hot TCR measured from +25°C to + 125°C.

(4) STOL
Short term overload voltage required (5 second duration) to induce a permanent resistance change of <0.25%.

(5) Standard Working Voltage 0.4 x STOL
(6) Maximum Rated Power Dissipation (Standard Working Voltage)\(^2\) Resistance

(7) Electrostatic Discharge measures the %ΔR after 1 pulse at specified voltage.

(8) Quan Tech Noise
Uncapsulated resistors. Equipment limitations precluded testing of 1 MΩ/sq resistor.

This table shows anticipated typical physical properties for DuPont QS87 series based on specific controlled experiments in our labs and are not intended to represent the product specifications, details of which are available upon request.
1000 Hour Laser Trim Stability
This data is based on test of 1 mm x 1 mm unencapsulated resistors
terminated with DuPont QS170 silver/platinum conductor fired in the
recommended short firing profile.

Environmental Stability DuPont QS87 Resistors on DuPont QS170

![Graphs showing change in resistance over different conditions](image-url)
Length Effect

- QS 870
  - Relative Resistivity vs. Resistor Length (mm)
  - TCR (ppm/°C)
  - HTCR
  - CTCR

- QS 872
  - Relative Resistivity vs. Resistor Length (mm)
  - TCR (ppm/°C)
  - HTCR
  - CTCR

- QS 871
  - Relative Resistivity vs. Resistor Length (mm)
  - TCR (ppm/°C)
  - HTCR
  - CTCR

- QS 873
  - Relative Resistivity vs. Resistor Length (mm)
  - TCR (ppm/°C)
  - HTCR
  - CTCR

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Length Effect (cont.)
This data is based on 1 mm (40 mil) wide resistors terminated with DuPont QS170 conductor. Both conductor and resistors are fired in the recommended short firing profile with a peak temperature of 850°C.
Blend Behavior
The Blend Behavior data is based on test of 1.5 mm x 1.5 mm resistors terminated with DuPont QS170 silver/platinum conductor fired in the recommended short firing profile. HTCR: +25°C to +125°C. CTCR: -55°C to 25°C.
Blend Behavior (cont.)

- Graph 1: TCR (ppm/°C) vs. QS 872/QS 873 with curves for HTCR and CTCR.
- Graph 2: Plot showing resistivity (Ω·m) against QS 872/873% with two curves labeled HTCR and CTCR.
- Graph 3: TCR (ppm/°C) vs. QS 875/QS 876 with curves for HTCR and CTCR.
- Graph 4: Resistivity (Ω·m) against QS 875/876% with two curves for HTCR and CTCR.

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The dried thickness effect data is based on tests of 1.5 mm x 1.5 mm resistors terminated with DuPont QS170 silver/platinum conductor fired in the recommended short firing profile.
Peak Temperature Effect

The data is based on tests of 1.5 mm x 1.5 mm resistors terminated with DuPont QS170 silver/platinum conductor fired in the recommended short firing profile. Peak temperature is held for 10 minutes and varied from 825°C to 875°C.
The data is based on tests of 1.5 mm x 1.5 mm resistors terminated with DuPont QS170 silver/platinum conductor fired in the recommended short firing profile to a peak temperature of 850°C.
Refire Effect

Resistivity

Temperature Coefficient of Resistance

The data is based on tests of 1.5 mm x 1.5 mm resistors terminated with DuPont QS170 silver/platinun conductor fired in the recommended short firing profile. Time at peak temperature is varied from 5 to 15 minutes.
Recommended Short Firing Profile

For more information on DuPont QS87 or other DuPont Microcircuit Materials products, please contact your local representative:

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