Surface Mounted Power Resistor Thick Film Technology

FEATURES
- AEC-Q200 qualified
- 25 W at 25 °C case temperature
- Surface mounted resistor - TO-252 (DPAK) style package
- Wide resistance range: 0.016 Ω to 700 kΩ
- Non inductive
- Resistor isolated from metal tab
- Solder reflow secure at 270 °C / 10 s, MSL = 1
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

ADDITIONAL RESOURCES

STANDARD ELECTRICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>MODEL</th>
<th>SIZE</th>
<th>RESISTANCE RANGE Ω</th>
<th>RATED POWER P25 °C W</th>
<th>LIMITING ELEMENT VOLTAGE UL V</th>
<th>TOLERANCE ± %</th>
<th>TEMPERATURE COEFFICIENT ± ppm/°C</th>
<th>CRITICAL RESISTANCE Ω</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTO25</td>
<td>TO-252 (DPAK)</td>
<td>0.016 to 700K</td>
<td>25</td>
<td>500</td>
<td>1, 2, 5, 10</td>
<td>150</td>
<td>10K</td>
</tr>
</tbody>
</table>

MECHANICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Mechanical Protection</th>
<th>Molded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistive Element</td>
<td>Thick film</td>
</tr>
<tr>
<td>Substrate</td>
<td>Alumina</td>
</tr>
<tr>
<td>Connections</td>
<td>Tinned copper, Ni under layer</td>
</tr>
<tr>
<td>Weight</td>
<td>2 g max.</td>
</tr>
</tbody>
</table>

ENVIRONMENTAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>-55 °C to +150 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climatic Category</td>
<td>55 / 150 / 56</td>
</tr>
</tbody>
</table>

Dielectric Strength 1500 Vrms - 1 min - 15 mA max. (between terminals and board)

Inductance ≤ 0.1 μH

Notes
- For the assembly, we recommend the lead (Pb)-free thermal profile as per J-STD-020C
- Power dissipation is 3.2 W at an ambient temperature of 25 °C when mounted on a double sided copper board using FR4 HTG, 70 μm of copper, 39 mm x 30 mm x 1.6 mm, with thermal vias
- For other information about dissipation, see the Application Note 52027: “Thermal Management on SMD Thick Film Resistors (D2TO20, D2TO35, DTO25)”
DIMENSIONS

**Standard Package**

TO-252 style (DPAK)

### SPECIAL FEATURES

<table>
<thead>
<tr>
<th>Resistance Values</th>
<th>≥ 0.016</th>
<th>≥ 0.1</th>
<th>≥ 0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement Temperature Coefficient (TCR)</td>
<td>900 ppm/°C</td>
<td>350 ppm/°C</td>
<td>150 ppm/°C</td>
</tr>
</tbody>
</table>

**PERFORMANCE**

<table>
<thead>
<tr>
<th>TESTS</th>
<th>CONDITIONS</th>
<th>REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Momentary Overload</td>
<td>IEC 60115-1 §4.13 1,6 Pr 5 s US &lt; 1.5 UL</td>
<td>± (0.25 % + 0.005 Ω)</td>
</tr>
<tr>
<td>Load Life</td>
<td>IEC 60115-1 1000 h, 90/30 Pd at +25 °C</td>
<td>± (1 % + 0.005 Ω)</td>
</tr>
<tr>
<td>High Temperature Exposure</td>
<td>AEC-Q200 rev. D conditions: MIL-STD-202 method 108 1000 h, +175 °C, unpowered</td>
<td>± (1 % + 0.005 Ω)</td>
</tr>
<tr>
<td>Temperature Cycling</td>
<td>AEC-Q200 rev. D conditions: pre-conditioning 3 reflows according JESD020D JESD22 method JA-104 1000 cycles, (-55 °C to +125 °C) dwell time 15 min</td>
<td>± (0.5 % + 0.005 Ω)</td>
</tr>
<tr>
<td>Biased Humidity</td>
<td>AEC-Q200 rev. D conditions: MIL-STD-202 method 103 1000 h, 85°C, 85 % RH</td>
<td>± (0.5 % + 0.005 Ω)</td>
</tr>
<tr>
<td>Operational Life</td>
<td>AEC-Q200 rev. D conditions: pre-conditioning 3 reflows according JESD020D MIL-STD-202 method 108 1000 h, 90/30, powered, +125 °C</td>
<td>± (1 % + 0.005 Ω)</td>
</tr>
<tr>
<td>ESD Human Body Model</td>
<td>AEC-Q200 rev. D conditions: AEC-Q200-002 25 kV AD</td>
<td>± (0.5 % + 0.005 Ω)</td>
</tr>
<tr>
<td>Vibration</td>
<td>AEC-Q200 rev. D conditions: MIL-STD-202 method 204 20 g’s for 20 min, 12 cycles test from 10 Hz to 2000 Hz</td>
<td>± (0.5 % + 0.005 Ω)</td>
</tr>
<tr>
<td>Mechanical Shock</td>
<td>AEC-Q200 rev. D conditions: MIL-STD-202 method 213 100 g’s, 6 ms, 3.75 m/s 3 shocks/direction</td>
<td>± (0.5 % + 0.005 Ω)</td>
</tr>
<tr>
<td>Board Flex</td>
<td>AEC-Q200 rev. D conditions: AEC-Q200-005 bending 2 mm, 60 s</td>
<td>± (0.25 % + 0.01 Ω)</td>
</tr>
<tr>
<td>Terminal Strength</td>
<td>AEC-Q200 rev. D conditions: AEC-Q200-006 1.8 kgf, 60 s</td>
<td>± (0.25 % + 0.01 Ω)</td>
</tr>
</tbody>
</table>

**ASSEMBLY SPECIFICATIONS**

For the assembly on board, we recommend the lead (Pb)-free thermal profile as per J-STD-020C

<table>
<thead>
<tr>
<th>TESTS</th>
<th>CONDITIONS</th>
<th>REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance to Soldering Heat</td>
<td>AEC-Q200 REV D MIL-STD-202 method 210 Solder Bath method: 270 °C / 10 s</td>
<td>± (0.5 % + 0.005 Ω)</td>
</tr>
<tr>
<td>Moisture Sensitivity Level (MSL)</td>
<td>IPC / JEDEC® J-STD-020C 85 °C / 85 % RH / 168 h</td>
<td>Level: 1 + pass requirements of TCR Overload and Dielectric Strength after MSL</td>
</tr>
</tbody>
</table>
POWER RATING

The temperature of the case should be maintained within the limits specified.

![Graph showing thermal rating vs case temperature]

CHOICE OF THE BOARD

The user must choose the board according to the working conditions of the component (power, room temperature). Maximum working temperature must not exceed 150 °C. The dissipated power is simply calculated by the following ratio:

\[
P = \frac{\Delta T}{R_{TH (j - c)} + R_{TH (c - h)} + R_{TH (h - a)}} \tag{1}
\]

- \(P\): Expressed in W
- \(\Delta T\): Difference between maximum working temperature and room temperature
- \(R_{TH (j - c)}\): Thermal resistance value measured between resistive layer and outer side of the resistor. It is the thermal resistance of the component: 5 °C/W.
- \(R_{TH (c - h)}\): Thermal resistance value measured between outer side of the resistor and upper side of the board. This is the thermal resistance of the solder layer.
- \(R_{TH (h - a)}\): Thermal resistance of the board.

Example:

\[
R_{TH (c - h)} + R_{TH (h - a)} \text{ for DTO25 power rating 3 W at ambient temperature +25 °C.}
\]

Thermal resistance \(R_{TH (j - c)}\): 5 °C/W

Considering equation (1), we have:

\[
\Delta T = 150 °C - 25 °C = 125 °C
\]

\[
R_{TH (j - c)} + R_{TH (c - h)} + R_{TH (h - a)} = \Delta T/P = 125/3 = 41.7 °C/W
\]

\[
R_{TH (c - h)} + R_{TH (h - a)} = 41.7 °C/W - 5 °C/W = 36.7 °C/W
\]

ACCIDENTAL OVERLOAD

In any case the applied voltage must be lower than the maximum overload voltage of \(U_s = 750\) V. The values indicated on the graph below are applicable to resistors onto a board.
**ENERGY CURVE** at 25 °C

![Energy Curve Graph]

**POWER CURVE** at 25 °C

![Power Curve Graph]

Single Pulse:
These informations are for a single pulse on a cold resistor at 25 °C (not already used for a dissipation) and for pulses of 100 ms maximum duration.
The formula used to calculate $\mathcal{E}$ is:

$$
\mathcal{E} = P \times t = \frac{U^2}{R} \times t
$$

with:
- $\mathcal{E}$ (J): Pulse energy
- $P$ (W): Pulse power
- $t$ (s): Pulse duration
- $U$ (V): Pulse voltage
- $R$ (Ω): Resistor

The energy calculated must be less than that allowed by the graph.

Repetitive or Superimposed Pulses:
The following formula is used to calculate the "equivalent" energy of a repetitive pulse or the "equivalent energy" of a pulse on a resistor that is already dissipating power.

$$
E_c = E \times \left(1 + \frac{P_a}{P_t}\right)
$$

with:
- $E_c$ (J): Equivalent pulse energy
- $E$ (J): Known pulse energy
- $P_t$: Resistor power rating
- $P_a$: Mean power being dissipated

The energy calculated must be less than that allowed by the graph and the average power dissipated ($P_a$) must not exceed the continuous power of resistor.
**IMPEDEANCE CURVE** 10 Ω to 1 kΩ from 100 kHz to 300 MHz

![Impedance Curve Graph]

**PACKAGING**
- Tube: max. 50 units per tube
- Reel: max. 500 units per reel

**MARKING**
Model, style, resistance value (in Ω), tolerance (in %), manufacturing date, Vishay Sfernice trademark.
## ORDERING INFORMATION

<table>
<thead>
<tr>
<th>DTO</th>
<th>025</th>
<th>C</th>
<th>100 kΩ</th>
<th>± 1 %</th>
<th>XXX</th>
<th>e3</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODEL</td>
<td>STYLE</td>
<td>CONNECTIONS</td>
<td>RESISTANCE VALUE</td>
<td>TOLERANCE</td>
<td>CUSTOM DESIGN</td>
<td>LEAD (Pb)-FREE</td>
</tr>
</tbody>
</table>

- F = ± 1 %
- G = ± 2 %
- J = ± 5 %
- K = ± 10 %

Optional on request: shape, etc

## SAP PART NUMBERING GUIDELINES

<table>
<thead>
<tr>
<th>D</th>
<th>T</th>
<th>O</th>
<th>0</th>
<th>2</th>
<th>5</th>
<th>C</th>
<th>1</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>2</th>
<th>F</th>
<th>R</th>
<th>E</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLOBAL MODEL</td>
<td>SIZE</td>
<td>LEADS</td>
<td>OHMIC VALUE</td>
<td>TOLERANCE</td>
<td>PACKAGING</td>
<td>LEAD (Pb)-FREE / PACKAGING</td>
<td></td>
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</tbody>
</table>

- C = surface mount
- 48R70 = 48.7 Ω
- 48701 = 48.700 Ω
- 10002 = 0.01 Ω
- R0100 = 0.01 Ω
- R6800 = 0.68 Ω
- 27000 = 2700 Ω = 2.7 kΩ

- F = 1 %
- G = 2 %
- J = 5 %
- K = 10 %

- R = reel
- T = tube

- E3 = standard packaging reel 500 or tube 50 and lead (Pb)-free (pure tin)
- 15 = 1000 pcs. reel and lead (Pb)-free (pure tin)
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