

# Surface Mounted Power Resistor Thick Film Technology

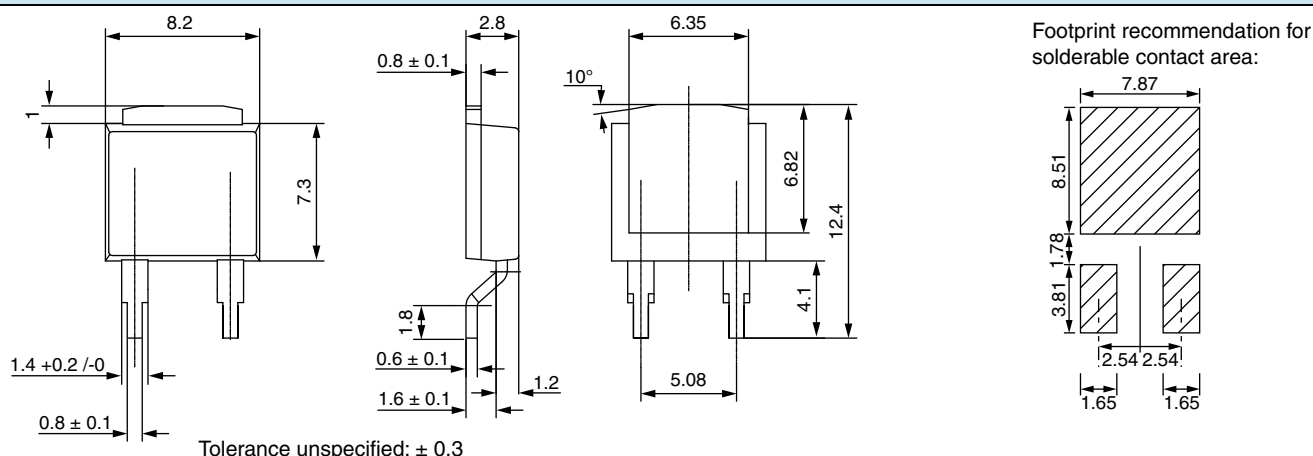


## FEATURES

- 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](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

## DIMENSIONS in millimeters



## 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)".

## STANDARD ELECTRICAL SPECIFICATIONS

| MODEL | SIZE          | RESISTANCE RANGE<br>Ω | RATED POWER<br>P <sub>25 °C</sub><br>W | LIMITING ELEMENT VOLTAGE U <sub>L</sub><br>V | TOLERANCE<br>± % | TEMPERATURE COEFFICIENT<br>± ppm/°C | CRITICAL RESISTANCE<br>Ω |
|-------|---------------|-----------------------|----------------------------------------|----------------------------------------------|------------------|-------------------------------------|--------------------------|
| DTO25 | TO-252 (DPAK) | 0.016 to 700K         | 25                                     | 200                                          | 1, 2, 5, 10      | 150                                 | 1.6K                     |

## MECHANICAL SPECIFICATIONS

|                       |                               |
|-----------------------|-------------------------------|
| Mechanical Protection | Molded                        |
| Resistive Element     | Thick film                    |
| Substrate             | Alumina                       |
| Connections           | Tinned copper, Ni under layer |
| Weight                | 2 g max.                      |

## ENVIRONMENTAL SPECIFICATIONS

|                   |                                                         |
|-------------------|---------------------------------------------------------|
| Temperature Range | -55 °C to +150 °C                                       |
| Climatic Category | 55 / 150 / 56                                           |
| Flammability      | IEC 60695-11-5<br>2 applications 30 s separated by 60 s |

## ELECTRICAL SPECIFICATIONS

|                                     |                                                                                                                     |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Tolerances                          | From 0.016 Ω to 0.047 Ω:<br>± 5 % and ± 10 %<br>> 0.047 Ω to 0.1 Ω:<br>± 2 % to ± 10 %<br>≥ 0.11 Ω: ± 1 % to ± 10 % |
| Power Rating and Thermal Resistance | 25 W at +25 °C case temperature R <sub>TH</sub> (j - c): 5 °C/W                                                     |
| Temperature Coefficient             | See Special Feature table<br>± 150 ppm/°C                                                                           |
| Dielectric Strength                 | 1500 V <sub>RMS</sub> - 1 min - 15 mA max.<br>(between terminals and board)                                         |
| Insulation Resistance               | ≥ 10 <sup>4</sup> MΩ                                                                                                |
| Inductance                          | ≤ 0.1 μH                                                                                                            |

## DIMENSIONS

|                  |                     |
|------------------|---------------------|
| Standard Package | TO-252 style (DPAK) |
|------------------|---------------------|

**SPECIAL FEATURES**

|                                                                                   |                                        |                                        |                                        |
|-----------------------------------------------------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|
| <b>Resistance Values</b>                                                          | $\geq 0.016$                           | $\geq 0.1$                             | $\geq 0.5$                             |
| <b>Requirement Temperature Coefficient (TCR)<br/>(-55 °C +150 °C) IEC 60115-1</b> | $\pm 900 \text{ ppm/}^{\circ}\text{C}$ | $\pm 350 \text{ ppm/}^{\circ}\text{C}$ | $\pm 150 \text{ ppm/}^{\circ}\text{C}$ |

**PERFORMANCE**

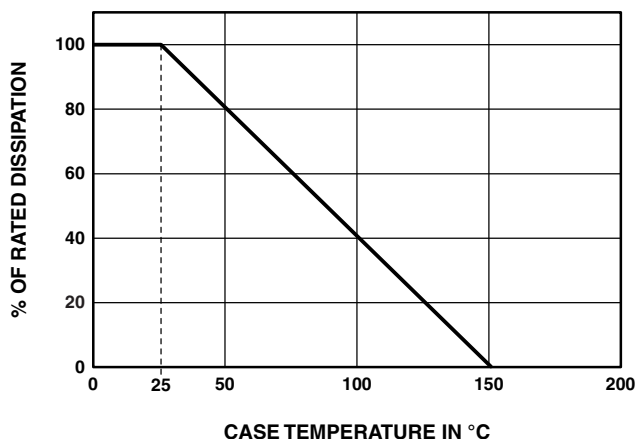
| TESTS                            | CONDITIONS                                                                                                                                                      | REQUIREMENTS                   |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Momentary Overload</b>        | IEC 60115-1 §4.13<br>1.6 Pr 5 s<br>US < 1.5 UL                                                                                                                  | $\pm (0.25 \% + 0.005 \Omega)$ |
| <b>Load Life</b>                 | IEC 60115-1<br>1000 h, 90/30 Pr at +25 °C                                                                                                                       | $\pm (1 \% + 0.005 \Omega)$    |
| <b>High Temperature Exposure</b> | AEC-Q200 REV D conditions:<br>MIL-STD-202 method 108<br>1000 h, +175 °C, unpowered                                                                              | $\pm (1 \% + 0.005 \Omega)$    |
| <b>Temperature Cycling</b>       | AEC-Q200 REV D conditions:<br>pre-conditioning 3 reflows according<br>JESD020D<br>JESD22 method JA-104<br>1000 cycles, (-55 °C to +125 °C)<br>dwell time 15 min | $\pm (0.5 \% + 0.005 \Omega)$  |
| <b>Biased Humidity</b>           | AEC-Q200 REV D conditions:<br>MIL-STD-202 method 103<br>1000 h, 85°C, 85 % RH                                                                                   | $\pm (0.5 \% + 0.005 \Omega)$  |
| <b>Operational Life</b>          | AEC-Q200 REV D conditions:<br>pre-conditioning 3 reflows according<br>JESD020D<br>MIL-STD-202 method 108<br>1000 h, 90/30, powered, +125 °C                     | $\pm (1 \% + 0.005 \Omega)$    |
| <b>ESD Human Body Model</b>      | AEC-Q200 REV D conditions:<br>AEC-Q200-002<br>25 kV <sub>AD</sub>                                                                                               | $\pm (0.5 \% + 0.005 \Omega)$  |
| <b>Vibration</b>                 | AEC-Q200 REV D conditions:<br>MIL-STD-202 method 204<br>20 g's for 20 min, 12 cycles<br>test from 10 Hz to 2000 Hz                                              | $\pm (0.5 \% + 0.005 \Omega)$  |
| <b>Mechanical Shock</b>          | AEC-Q200 REV D conditions:<br>MIL-STD-202 method 213<br>100 g's, 6 ms, 3.75 m/s<br>3 shocks/direction                                                           | $\pm (0.5 \% + 0.005 \Omega)$  |
| <b>Board Flex</b>                | AEC-Q200 REV D conditions:<br>AEC-Q200-005<br>bending 2 mm, 60 s                                                                                                | $\pm (0.25 \% + 0.01 \Omega)$  |
| <b>Terminal Strength</b>         | AEC-Q200 REV D conditions:<br>AEC-Q200-006<br>1.8 kgf, 60 s                                                                                                     | $\pm (0.25 \% + 0.01 \Omega)$  |

**ASSEMBLY SPECIFICATIONS**

| For the assembly on board, we recommend the lead (Pb)-free thermal profile as per J-STD-020C |                                                                               |                                                                                      |
|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| TESTS                                                                                        | CONDITIONS                                                                    | REQUIREMENTS                                                                         |
| <b>Resistance to Soldering Heat</b>                                                          | AEC-Q200 REV D<br>MIL-STD-202 method 210<br>Solder Bath method: 270 °C / 10 s | $\pm (0.5 \% + 0.005 \Omega)$                                                        |
| <b>Moisture Sensitivity Level (MSL)</b>                                                      | IPC / JEDEC® J-STD-020C<br>85 °C / 85 % RH / 168 h                            | Level: 1<br>+ pass requirements of TCR<br>Overload and Dielectric Strength after MSL |

## POWER RATING

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



## 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:

$$P = \frac{\Delta T}{R_{TH(j-c)} + R_{TH(c-h)} + R_{TH(h-a)}} \quad (1)$$

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:

$R_{TH(c-h)} + R_{TH(h-a)}$  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:

$$\Delta T = 150\text{ °C} - 25\text{ °C} = 125\text{ °C}$$

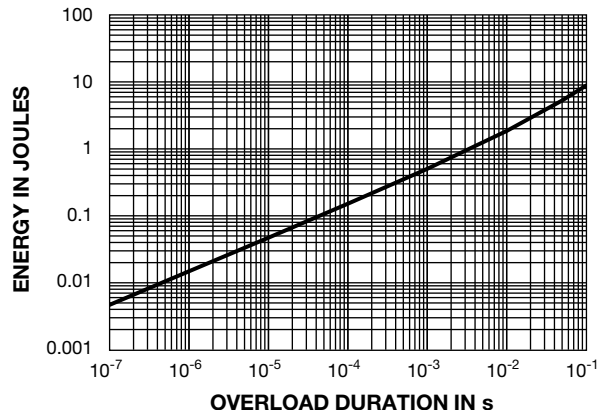
$$R_{TH(j-c)} + R_{TH(c-h)} + R_{TH(h-a)} = \Delta T / P = 125 / 3 = 41.7\text{ °C/W}$$

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

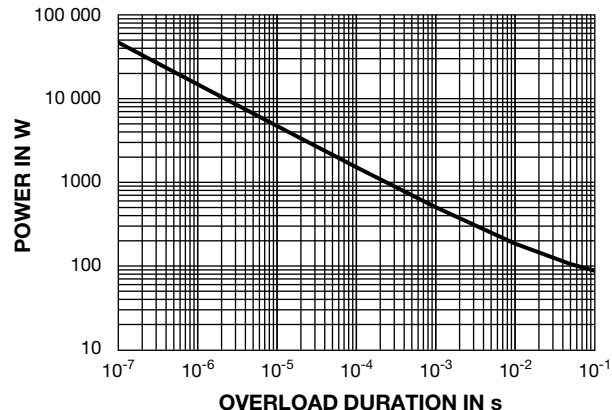
## ACCIDENTAL OVERLOAD

In any case the applied voltage must be lower than the maximum overload voltage of  $U_s = 300\text{ V}$ . The values indicated on the graph below are applicable to resistors onto a board.

### ENERGY CURVE at 25 °C



### POWER CURVE at 25 °C



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  $E$  is:

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

with:

$E$  (J): Pulse energy

$P$  (W): Pulse power

$t$  (s): Pulse duration

$U$  (V): Pulse voltage

$R$  ( $\Omega$ ): 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.

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

with:

 $E_G$  (J): Equivalent pulse energy

$E$  (J): Known pulse energy

$P_r$ : Resistor power rating

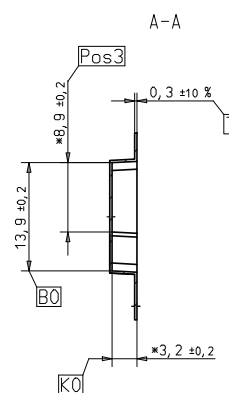
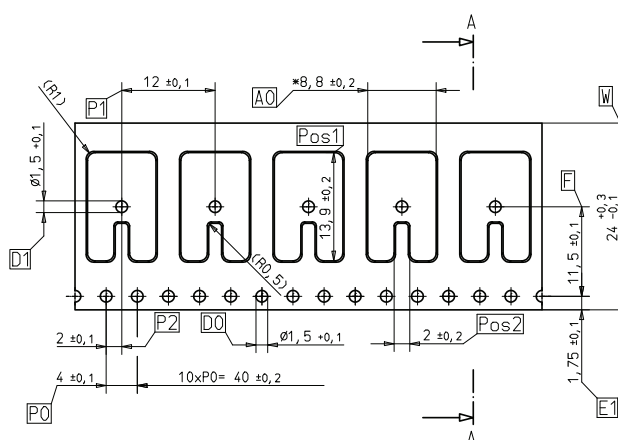
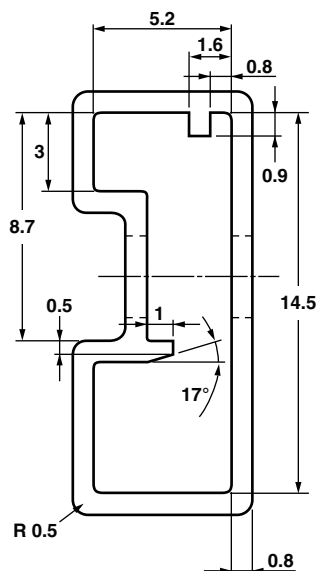
$P_a$ : Mean power being dissipated

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.

## PACKAGING

- Tube: max. 50 units per tube

- Reel: max. 500 units per reel



## MARKING

Model, style, resistance value (in  $\Omega$ ), tolerance (in %), manufacturing date, Vishay Sfernice trademark.



### ORDERING INFORMATION

|            |            |             |                                 |                                                                   |                                    |                |
|------------|------------|-------------|---------------------------------|-------------------------------------------------------------------|------------------------------------|----------------|
| <b>DTO</b> | <b>025</b> | <b>C</b>    | <b>100 k<math>\Omega</math></b> | <b><math>\pm 1\%</math></b>                                       | <b>XXX</b>                         | <b>e3</b>      |
| MODEL      | STYLE      | CONNECTIONS | RESISTANCE<br>VALUE             | TOLERANCE                                                         | CUSTOM DESIGN                      | LEAD (Pb)-FREE |
|            |            |             |                                 | F = $\pm 1\%$<br>G = $\pm 2\%$<br>J = $\pm 5\%$<br>K = $\pm 10\%$ | Optional on request:<br>shape, etc |                |

### SAP PART NUMBERING GUIDELINES

|                 |            |                          |                                                                                                                                                                                                                                                                                                                                                                 |          |          |          |                                                                       |                                                               |          |                      |          |          |          |          |          |
|-----------------|------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------|----------|-----------------------------------------------------------------------|---------------------------------------------------------------|----------|----------------------|----------|----------|----------|----------|----------|
| <b>D</b>        | <b>T</b>   | <b>O</b>                 | <b>0</b>                                                                                                                                                                                                                                                                                                                                                        | <b>2</b> | <b>5</b> | <b>C</b> | <b>1</b>                                                              | <b>0</b>                                                      | <b>0</b> | <b>0</b>             | <b>2</b> | <b>F</b> | <b>R</b> | <b>E</b> | <b>3</b> |
| GLOBAL<br>MODEL | SIZE       | LEADS                    | OHMIC VALUE                                                                                                                                                                                                                                                                                                                                                     |          |          |          | TOLERANCE                                                             | PACKAGING                                                     |          | LEAD (Pb)-FREE       |          |          |          |          |          |
| <b>DTO</b>      | <b>025</b> | <b>C</b> = surface mount | The first four digits are significant figures and the last digit specifies the number of zeros to follow. R designates decimal point.<br><br><b>48R70</b> = 48.7 $\Omega$<br><b>48701</b> = 48 700 $\Omega$<br><b>10002</b> = 100 000 $\Omega$<br><b>R0100</b> = 0.01 $\Omega$<br><b>R6800</b> = 0.68 $\Omega$<br><b>27000</b> = 2700 $\Omega$ = 2.7 k $\Omega$ |          |          |          | <b>F</b> = 1 %<br><b>G</b> = 2 %<br><b>J</b> = 5 %<br><b>K</b> = 10 % | <b>R</b> = reel<br>500 pieces<br><b>T</b> = tube<br>50 pieces |          | <b>E3</b> = pure tin |          |          |          |          |          |



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