Ultra High Precision Z-Foil Power Resistor in TO-220 Configuration with TCR of ± 0.05 ppm/°C, PCR of 4 ppm/W and Load Life Stability of ± 0.005 % (50 ppm)

INTRODUCTION

The Z-Foil Technology provides a significant reduction of the resistive component’s sensitivity to ambient temperature variations (TCR) and applied power changes (PCR).

VPR221Z provides high rated power, excellent load life stability, low Temperature Coefficient (TCR) and low Power Coefficient (PCR) - all in one resistor. ± 0.05 ppm/°C Absolute TCR removes error due to temperature gradients.

By taking advantage of the overall stability and reliability of Bulk Metal® Z-Foil resistors, designers can significantly reduce circuit errors and greatly improve overall circuit performances.

Model VPR221Z is a 4 lead kelvin connected device.

Our Application Engineering Department is available to advise and make recommendations. For non-standard technical requirements and special applications, please contact us.

FEATURES

- Temperature coefficient of resistance (TCR): ± 0.05 ppm/°C typical (0 °C to + 60 °C)
- ± 0.2 ppm/°C typical (- 55 °C to + 125 °C, + 25 °C ref.) (see table 1)
- Tolerance: ± 0.01 %
- Power coefficient “∂R due to self heating” 4 ppm/W typical
- Rated power: 8 W chassis mounted (MIL-PRF-39009)
- Load life stability: to ± 0.005 % at 25 °C for 2000 hours, at 1.5 W
- Resistance range: 0.5 Ω to 500 Ω
- Electrostatic discharge (ESD) above 25 000 V
- Short time overload ≤ 0.001 % (10 ppm)
- Non-inductive, non-capacitive design
- Rise time: 1 ns without ringing
- Current noise < - 40 dB
- Thermal EMF: 0.05 µV/°C typical
- Voltage coefficient < 0.1 ppm/V
- Non inductive: < 0.08 µH
- Non hot spot design
- Terminal finishes available: lead (Pb)-free tin/lead alloy
- Any value available within resistance range (e.g. 1K234)
- For better performances please contact us

APPLICATIONS

- Automatic test equipment (ATE)
- High precision instrumentation
- Electron beam application
- Current sensing applications
- Pulse applications
- Military
- Power amplifier
- Power supplies

TABLE 1 - TCR AND TOLERANCE

<table>
<thead>
<tr>
<th>RESISTANCE RANGE (Ω)</th>
<th>TIGHTEST RESISTANCE TOLERANCE</th>
<th>TYPICAL TCR AND MAX. SPREAD</th>
<th>TYPICAL TCR AND MAX. SPREAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 to &lt; 1</td>
<td>± 0.05 %</td>
<td>± 0.2 ppm/°C ± 2.8 ppm/°C</td>
<td></td>
</tr>
<tr>
<td>1 to &lt; 10</td>
<td>± 0.02 %</td>
<td>± 0.2 ppm/°C ± 2.3 ppm/°C</td>
<td></td>
</tr>
<tr>
<td>10 to 500</td>
<td>± 0.01 %</td>
<td>± 0.2 ppm/°C ± 1.8 ppm/°C</td>
<td></td>
</tr>
</tbody>
</table>

Notes

1. MIL-Range (- 55 °C to + 125 °C, + 25 °C Ref.)
   • Contact Applications Engineering for other available values

* Pb containing terminations are not RoHS compliant, exemptions may apply

For any questions, contact: foil@vishaypg.com
www.foilresistors.com

Revision: 25-Mar-10
VPR221Z (Z-Foil)

Vishay Foil Resistors

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2 Revision: 25-Mar-10

FIGURE 2 - TRIMMING TO VALUES
(Conceptual Illustration)

Interloop Capacitance Reduction in Series

Current Path Before Trimming

Mutual Inductance Reduction due to Change in Current Direction

Current Path After Trimming

Trimming Process

Removes this Material from Shorning Strip Area

Changing Current Path and Increasing Resistance

Note: Foil shown in black, etched spaces in white

FIGURE 3 - TYPICAL TCR CURVE Z-FOIL
(for more details see table 1)

Ambient Temperature (°C)

ΔR R (ppm)

0.05 ppm/°C

0.1 ppm/°C

0.14 ppm/°C

- 0.1 ppm/°C

0.1 ppm/°C

0.2 ppm/°C

- 0.16 ppm/°C

- 0.2 ppm/°C

A surface mount version of this product is available see data sheets for VPR220S, VPR221S

FIGURE 4 - VPR221Z DIMENSIONS in inches (millimeters)

TABLE 2 - SPECIFICATIONS

Power Rating at + 25 °C

8 W or 3 A(2) on heat sink(3)
1.5 W in free air
Further derating not necessary.

Current Noise

< 0.010 µV (rms)/V of applied voltage (~ 40 dB)

High Frequency Operation

Rise Time
0.2 ns at 1 W

Inductance(4) (L)
0.1 µH maximum: 0.03 µH typical(1)
1.0 pF maximum: 0.5 pF typical(1)

Voltage Coefficient(5)

< 0.1 ppm/V

Operating Temperature Range

- 55 °C to + 150 °C

Maximum Working Voltage

300 V, Not to exceed power rating

Thermal EMF(6)

0.15 µV/°C maximum (lead effect)

Weight

1.2 g maximum

Notes

1. Maximum is 1.0 % A.Q.L. standard for all specifications except TCR.
2. Whichever is lower.
3. Heat sink chassis dimensions are requirements per MIL-R-39099/1B:
4. Inductance (L) mainly due to the leads.
5. The resolution limit of existing test requirement (within the measurement capability of the equipment, “essentially zero”).
6. µV/°C relates to EMF due to lead temperature difference.
TABLE 3 - PERFORMANCE SPECIFICATIONS\(^1\) MIL-PRF 39009

<table>
<thead>
<tr>
<th>TEST OR CONDITION</th>
<th>MIL-PRF 39009</th>
<th>TYPICAL (\Delta R)</th>
<th>MAXIMUM (\Delta R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low temperature storage 24 hours at - 55 °C</td>
<td>± 0.3 % + 0.01 Ω</td>
<td>± 0.001 % (10 ppm)</td>
<td>± 0.002 % (20 ppm)</td>
</tr>
<tr>
<td>Dielectric withstanding voltage 300 V AC at Atm</td>
<td>± 0.2 % + 0.01 Ω</td>
<td>± 0.001 % (10 ppm)</td>
<td>± 0.002 % (20 ppm)</td>
</tr>
<tr>
<td>Dielectric withstanding voltage 200 V AC at Brm</td>
<td>± 0.2 % + 0.01 Ω</td>
<td>± 0.001 % (10 ppm)</td>
<td>± 0.002 % (20 ppm)</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>&gt; 10(^4) MΩ</td>
<td></td>
<td>&gt; 10(^4) MΩ</td>
</tr>
<tr>
<td>Low temperature operation</td>
<td>± 0.3 % + 0.01 Ω</td>
<td>± 0.002 % (20 ppm)</td>
<td>± 0.008 % (80 ppm)</td>
</tr>
<tr>
<td>Short time overload 5 x rated power for 5 seconds (in air)</td>
<td>± 0.3 % + 0.01 Ω</td>
<td>± 0.001 % (10 ppm)</td>
<td>± 0.002 % (20 ppm)</td>
</tr>
<tr>
<td>Moisture resistance + 65 °C to - 10 °C, 90 to 98 Rh, 10 days</td>
<td>± 0.5 % + 0.01 Ω</td>
<td>± 0.005 % (50 ppm)</td>
<td>± 0.015 % (150 ppm)</td>
</tr>
<tr>
<td>Terminal Strength</td>
<td>± 0.2 % + 0.01 Ω</td>
<td>± 0.001 % (10 ppm)</td>
<td>± 0.002 % (20 ppm)</td>
</tr>
<tr>
<td>Load life 8 W at + 25 °C, 2000 hours with heat sink</td>
<td>± 1.0 % + 0.01 Ω</td>
<td>± 0.005 % (50 ppm)</td>
<td>± 0.015 % (150 ppm)</td>
</tr>
<tr>
<td>Load life 1.5 W at + 25 °C for 2000 hours in free air</td>
<td>± 1.0 % + 0.01 Ω</td>
<td>± 0.005 % (50 ppm)</td>
<td>± 0.015 % (150 ppm)</td>
</tr>
<tr>
<td>High temperature exposure + 150 °C</td>
<td>± 1.0 % + 0.05 Ω</td>
<td>± 0.005 % (50 ppm)</td>
<td>± 0.01 % (100 ppm)</td>
</tr>
</tbody>
</table>

Note
1. Measurement error ± 0.001 Ω

TABLE 4 - GLOBAL PART NUMBER INFORMATION

NEW GLOBAL PART NUMBER: Y1690420R220T9L (preferred part number format)

<table>
<thead>
<tr>
<th>DENOTES PRECISION</th>
<th>VALUE</th>
<th>AER*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>R = Ω</td>
<td>0 = standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 = lead (Pb)-free</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 to 999 = custom</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRODUCT CODE</th>
<th>RESISTANCE TOLERANCE</th>
<th>PACKAGING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1690</td>
<td>T = ± 0.01 %</td>
<td>L = bulk pack</td>
</tr>
<tr>
<td></td>
<td>Q = ± 0.02 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A = ± 0.05 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B = ± 0.1 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C = ± 0.25 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D = ± 0.5 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F = ± 1.0 %</td>
<td></td>
</tr>
</tbody>
</table>

FOR EXAMPLE: ABOVE GLOBAL ORDER Y1690 420R220 T 9 L:
TYPE: VPR221Z
VALUE: 420.22 Ω
ABSOLUTE TOLERANCE: ± 0.01 %
TERMINATION: Lead (Pb)-free
PACKAGING: Bulk Pack

HISTORICAL PART NUMBER: VPR221Z T 420R22 TCR0.2 T B (will continue to be used)

<table>
<thead>
<tr>
<th>MODEL</th>
<th>TERMINATION</th>
<th>OHMIC VALUE</th>
<th>TCR CHARACTERISTIC</th>
<th>ABSOLUTE TOLERANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPR221Z</td>
<td>T</td>
<td>420R22</td>
<td>TCR0.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>420.22 Ω</td>
<td>TCR0.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T</td>
<td></td>
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</tr>
</tbody>
</table>

Note
* For non-standard requests, please contact Application Engineering.
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