

Ultra High Precision Z-Foil Surface Mount Power Resistor in TO-220 Configuration with TCR of $\pm 0.05 \text{ ppm}/^\circ\text{C}$, PCR of $4 \text{ ppm}/\text{W}$ and Load Life Stability of $\pm 0.005 \%$ (50 ppm)



Any value at any tolerance available within resistance range

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).

Model VPR221SZ is a 4 lead kelvin connected surface mount device which provides high rated power, excellent load life stability, low Temperature Coefficient (TCR) and low Power Coefficient (PCR) - all in one resistor. $\pm 0.05 \text{ ppm}/^\circ\text{C}$ Absolute TCR removes error due to temperature gradients.

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

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

TABLE 1 - TCR AND TOLERANCE

RESISTANCE RANGE (Ω)	TIGHTEST RESISTANCE TOLERANCE	TYPICAL TCR AND MAX. SPREAD ¹⁾
0.5 to < 1	$\pm 0.05 \%$	$\pm 0.2 \text{ ppm}/^\circ\text{C} \pm 2.8 \text{ ppm}/^\circ\text{C}$
1 to < 10	$\pm 0.02 \%$	$\pm 0.2 \text{ ppm}/^\circ\text{C} \pm 2.3 \text{ ppm}/^\circ\text{C}$
10 to 500	$\pm 0.01 \%$	$\pm 0.2 \text{ ppm}/^\circ\text{C} \pm 1.8 \text{ ppm}/^\circ\text{C}$

Notes

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

FEATURES

- Temperature Coefficient of Resistance (TCR):
 $\pm 0.05 \text{ ppm}/^\circ\text{C}$ typical (0 °C to + 60 °C)
 $\pm 0.2 \text{ ppm}/^\circ\text{C}$ typical (- 55 °C to + 125 °C, + 25 °C Ref.) (see table 1)
- Tolerance: to $\pm 0.01 \%$
- Power Coefficient "ΔR due to self heating":
 $4 \text{ ppm}/\text{W}$ typical
- Rated Power: 8 W chassis mounted (MIL-PRF-39009)
- Load Life Stability: to $\pm 0.005 \%$ at 25 °C for 2000 hours, at 1.5 W
- Resistance Range: 0.5 Ω to 500 Ω
- Electrostatic Discharge (ESD) above 25 000 Volts
- Short Time Overload $\leq 0.001 \%$ (10 ppm)
- Non Inductive, Non Capacitive Design
- Rise Time: 1 ns without ringing
- Current Noise < - 40 dB
- Thermal EMF: 0.05 $\mu\text{V}/^\circ\text{C}$ 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)
- Prototype samples available from 48 hours. For more information, please contact foil@vishay.com
- For better performances please contact us



RoHS*
COMPLIANT

APPLICATIONS

- Automatic Test Equipment (ATE)
- High Precision Instrumentation
- Electron Beam application
- Current Sensing applications
- Pulse applications
- Military
- Power amplifier
- Power supplies

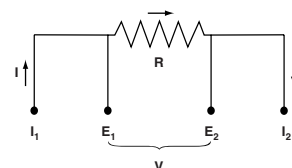
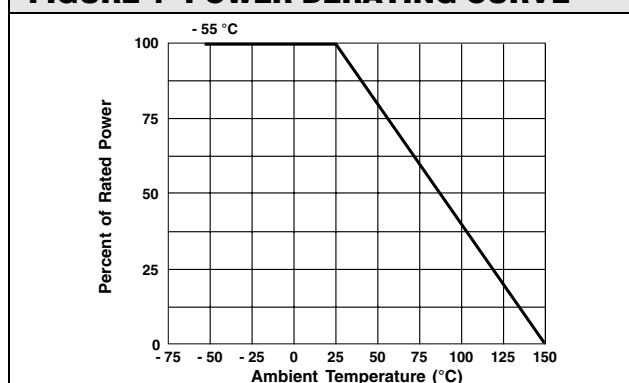


FIGURE 1- POWER DERATING CURVE



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

Ultra High Precision Z-Foil Surface Mount Power Resistor Vishay Foil Resistors
in TO-220 Configuration with TCR of $\pm 0.05 \text{ ppm}/^\circ\text{C}$, PCR
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FIGURE 2 - TRIMMING TO VALUES

(Conceptual Illustration)

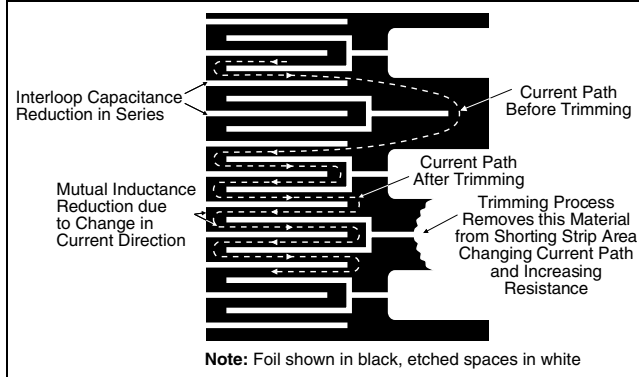


FIGURE 3 - TYPICAL TCR CURVE Z-FOIL

(for more details see table 1)

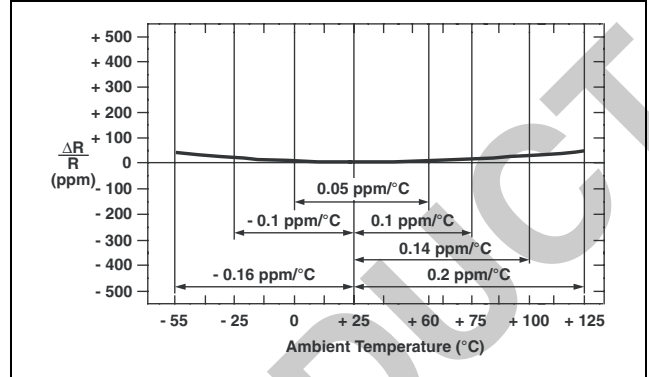


FIGURE 4 - VPR221SZ FORMING

DIMENSIONS in inches (millimeters)

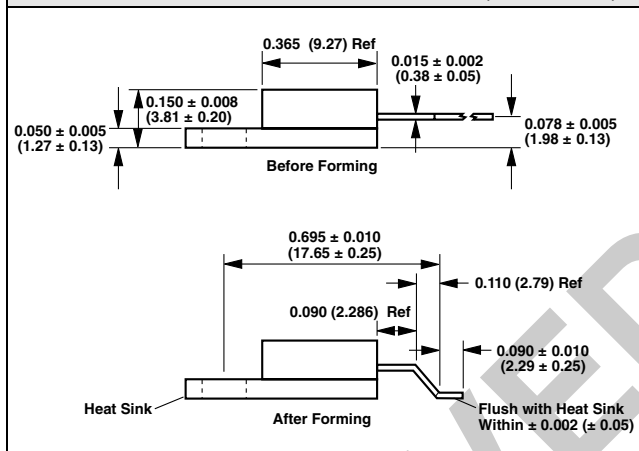


FIGURE 5 - VPR221SZ DIMENSIONS in

inches (millimeters)

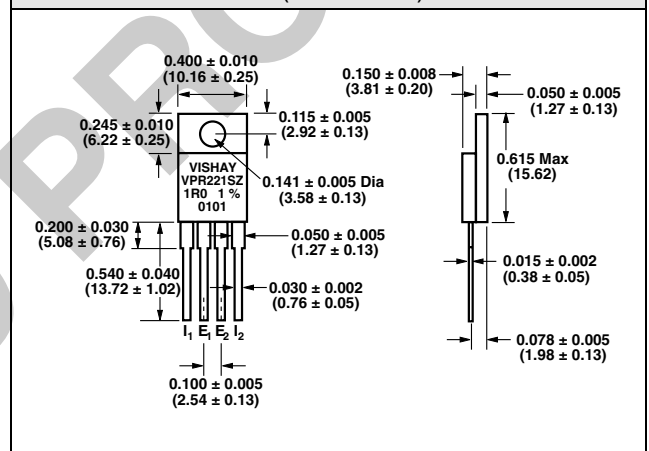
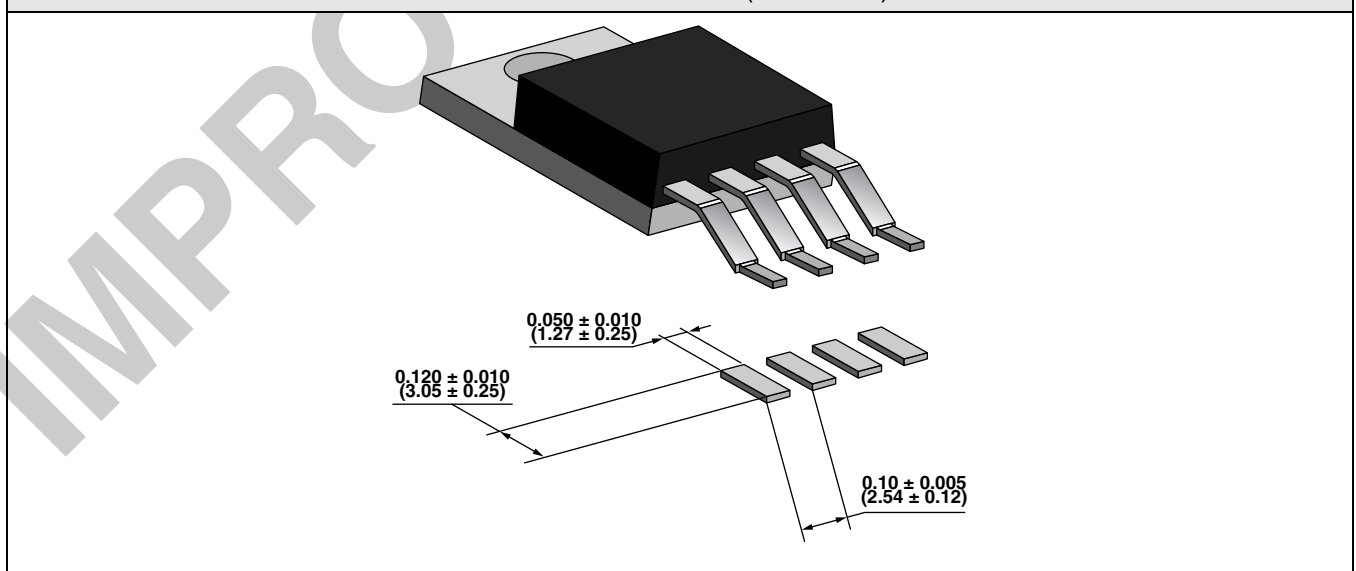


FIGURE 6 - LAND PATTERN DIMENSIONS in inches (millimeters)



VPR221SZ (Z-Foil)



Vishay Foil Resistors Ultra High Precision Z-Foil Surface Mount Power Resistor in TO-220 Configuration with TCR of $\pm 0.05 \text{ ppm/}^\circ\text{C}$, PCR of 4 ppm/W and Load Life Stability of $\pm 0.005 \%$ (50 ppm)

TABLE 2 - SPECIFICATIONS

Power Rating at + 25 °C	8 W or 3 A ¹⁾ on heat sink ²⁾ 1.5 watts in free air Further derating not necessary.
Current Noise	< 0.010 μV (rms)/V of applied voltage (- 40 dB)
High Frequency Operation Rise Time Inductance ³⁾ (L) Capacitance (C)	0.2 ns at 1 W 0.1 μH maximum: 0.03 μH typical 1.0 pF maximum: 0.5 pF typical
Voltage Coefficient ⁴⁾	< 0.1 ppm/V
Operating Temperature Range	- 55 °C to + 150 °C
Maximum Working Voltage	300 V, Not to exceed power rating
Thermal EMF ⁵⁾	0.15 $\mu\text{V/}^\circ\text{C}$ maximum (lead effect)
Weight	1.2 g maximum

Notes

1. Whichever is lower.
2. Heat sink chassis dimensions are requirements per MIL-R-39009/1B:

DIMENSIONS	inches	mm
L	6.00	152.4
W	4.00	101.6
H	2.00	50.8
T	0.04	1.0

3. Inductance (L) mainly due to the leads.
4. The resolution limit of existing test requirement (within the measurement capability of the equipment, "essentially zero").
5. $\mu\text{V/}^\circ\text{C}$ relates to EMF due to lead temperature difference.

TABLE 3 - PERFORMANCE SPECIFICATIONS¹⁾ MIL-PRF 39009

TEST OR CONDITION	MIL-PRF 39009	TYPICAL ΔR	MAXIMUM ΔR
Low temperature storage 24 hours at - 55 °C	$\pm 0.3 \% + 0.01 \Omega$	$\pm 0.001 \%$ (10 ppm)	$\pm 0.002 \%$ (20 ppm)
Dielectric withstanding voltage 300 V AC at Atm	$\pm 0.2 \% + 0.01 \Omega$	$\pm 0.001 \%$ (10 ppm)	$\pm 0.002 \%$ (20 ppm)
Dielectric withstanding voltage 200 V AC at Brm	$\pm 0.2 \% + 0.01 \Omega$	$\pm 0.001 \%$ (10 ppm)	$\pm 0.002 \%$ (20 ppm)
Insulation resistance	$> 10^4 \text{ M}\Omega$		$> 10^4 \text{ M}\Omega$
Low temperature operation	$\pm 0.3 \% + 0.01 \Omega$	$\pm 0.002 \%$ (20 ppm)	$\pm 0.008 \%$ (80 ppm)
Short time overload 5 x rated power for 5 seconds (in air)	$\pm 0.3 \% + 0.01 \Omega$	$\pm 0.001 \%$ (10 ppm)	$\pm 0.002 \%$ (20 ppm)
Moisture resistance + 65 °C to - 10 °C, 90 to 98 Rh, 10 days	$\pm 0.5 \% + 0.01 \Omega$	$\pm 0.005 \%$ (50 ppm)	$\pm 0.015 \%$ (150 ppm)
Terminal Strength	$\pm 0.2 \% + 0.01 \Omega$	$\pm 0.001 \%$ (10 ppm)	$\pm 0.002 \%$ (20 ppm)
Load life 8 W at + 25 °C, 2000 hours with heat sink	$\pm 1.0 \% + 0.01 \Omega$	$\pm 0.005 \%$ (50 ppm)	$\pm 0.015 \%$ (150 ppm)
Load life 1.5 W at + 25 °C for 2000 hours in free air	$\pm 1.0 \% + 0.01 \Omega$	$\pm 0.005 \%$ (50 ppm)	$\pm 0.015 \%$ (150 ppm)
High temperature exposure + 150 °C	$\pm 1.0 \% + 0.05 \Omega$	$\pm 0.005 \%$ (50 ppm)	$\pm 0.01 \%$ (100 ppm)

Note

1. Measurement error $\pm 0.001 \%$



TABLE 4 - GLOBAL PART NUMBER INFORMATION

The diagram shows a resistor with five color bands: Yellow, Black, Brown, Black, and Orange. Callouts provide the following information:

- Denotes Precision:** A box labeled 'Y' points to the first band (Yellow).
- Value:** A box labeled 'R = Ω ' points to the entire resistor.
- AER*:** A box explaining the AER code: '0 = Standard', '9 = Lead (Pb)-free', and '1 - 999 = Custom'. It points to the last band (Orange).
- Product Code:** A box labeled '2123 = VPR221SZ' points to the first four bands (Yellow, Black, Brown, Black).
- Resistance Tolerance:** A box listing tolerance values: T = $\pm 0.01\%$, Q = $\pm 0.02\%$, A = $\pm 0.05\%$, B = $\pm 0.1\%$, C = $\pm 0.25\%$, D = $\pm 0.5\%$, F = $\pm 1.0\%$. It points to the fifth band (Orange).
- Packaging:** A box labeled 'L = Bulk' points to the last band (Orange).

VPR221SZ	T	420R22	TCR0.2	T	B
MODEL	TERMINATION	OHMIC VALUE	TCR CHARACTERISTIC	ABSOLUTE TOLERANCE	PACKAGING
	T = Lead (Pb)-free none = Tin/Lead	420.22 Ω	TCR0.2	T = $\pm 0.01\%$ Q = $\pm 0.02\%$ A = $\pm 0.05\%$ B = $\pm 0.1\%$ C = $\pm 0.25\%$ D = $\pm 0.5\%$ F = $\pm 1.0\%$	B = Bulk

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



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