

# Ultra High Precision Bulk Metal® Z-Foil Surface Mount Power Resistor in TO-220 Configuration with TCR of $\pm 0.05$ ppm/°C, PCR of $4$ ppm/W and Load Life Stability of $\pm 0.005$ % (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).

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.  $\pm 0.05$  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.

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 ( $\Omega$ )	TIGHTEST RESISTANCE TOLERANCE	TYPICAL TCR AND MAX. SPREAD <sup>(1)</sup>
0.5 to < 1	$\pm 0.05$ %	$\pm 0.2$ ppm/°C $\pm 2.8$ ppm/°C
1 to < 10	$\pm 0.02$ %	$\pm 0.2$ ppm/°C $\pm 2.3$ ppm/°C
10 to 500	$\pm 0.01$ %	$\pm 0.2$ ppm/°C $\pm 1.8$ ppm/°C

### Notes

<sup>(1)</sup> 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

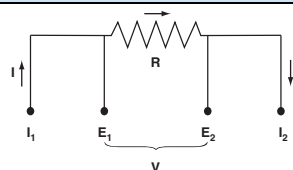
## FEATURES

- Temperature coefficient of resistance (TCR):  $\pm 0.05$  ppm/°C typical (0 °C to + 60 °C)  
 $\pm 0.2$  ppm/°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 ppm/W typical
- Rated power: 8 W chassis mounted (MIL-PRF-39009)
- Load life stability: to  $\pm 0.005$  % at 25 °C for 2000 h, at 1.5 W
- Resistance range: 0.5  $\Omega$  to 500  $\Omega$
- Foil resistors are not restricted to standard values; specific "as requested" values can be supplied at no extra cost or delivery (e.g. 100R2345 vs. 100R)
- Electrostatic discharge (ESD) up to 25 000 V
- Short time overload  $\leq 0.001$  % (10 ppm)
- Non-inductive, non-capacitive design
- Rise time: 1 ns effectively no ringing
- Current noise: 0.010  $\mu$ V<sub>RMS</sub>/V of applied voltage (< - 40 dB)
- Thermal EMF: 0.05  $\mu$ V/°C typical
- Voltage coefficient < 0.1 ppm/V
- Non-inductive: < 0.08  $\mu$ H
- Non hot spot design
- Thermal stabilization time < 1 s (nominal value achieved within 10 ppm of steady state value)
- Terminal finish: lead (Pb)-free or tin/lead alloy
- Compliant to RoHS directive 2002/95/EC
- Prototype quantities available in just 5 working days or sooner. For more information, please contact [foil@vishaypg.com](mailto:foil@vishaypg.com)
- For better performances please contact us

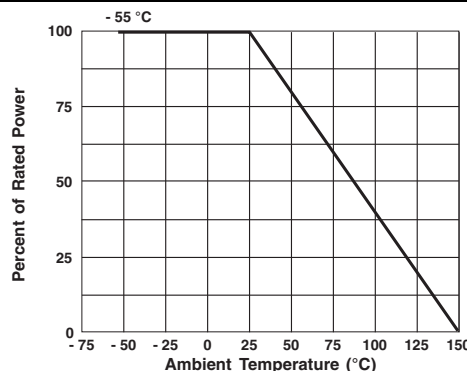


RoHS\*  
COMPLIANT

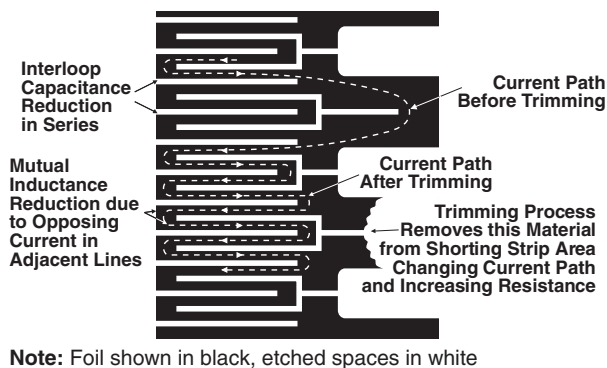
**FIGURE 1 - SCHEMATICS**



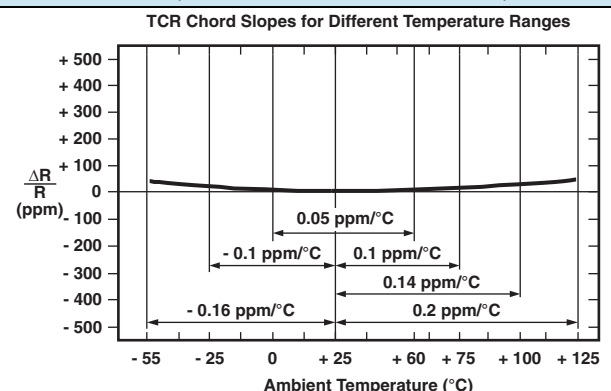
**FIGURE 2 - POWER DERATING CURVE**



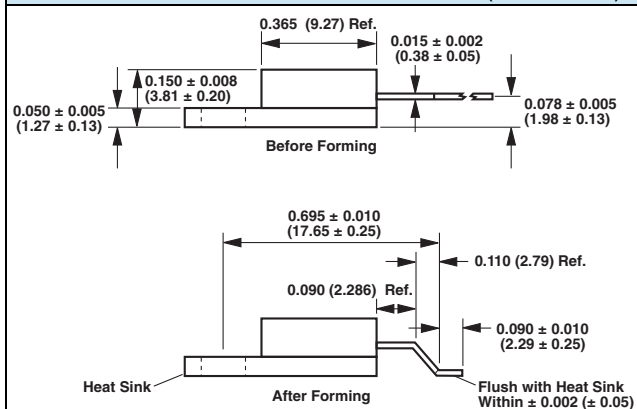
**FIGURE 3 - TRIMMING TO VALUES**  
(conceptual illustration)



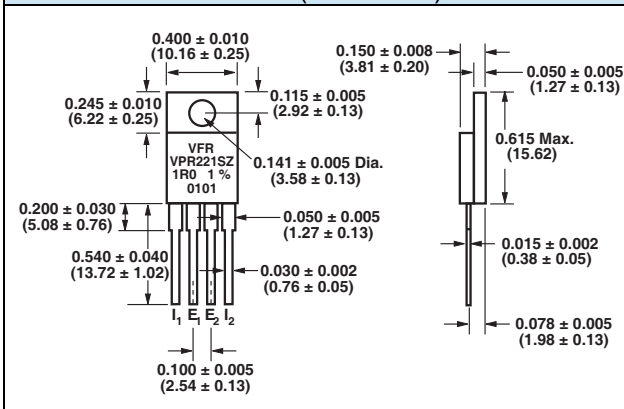
**FIGURE 4 - TYPICAL RESISTANCE/TEMPERATURE CURVE**  
(for more details see table 1)



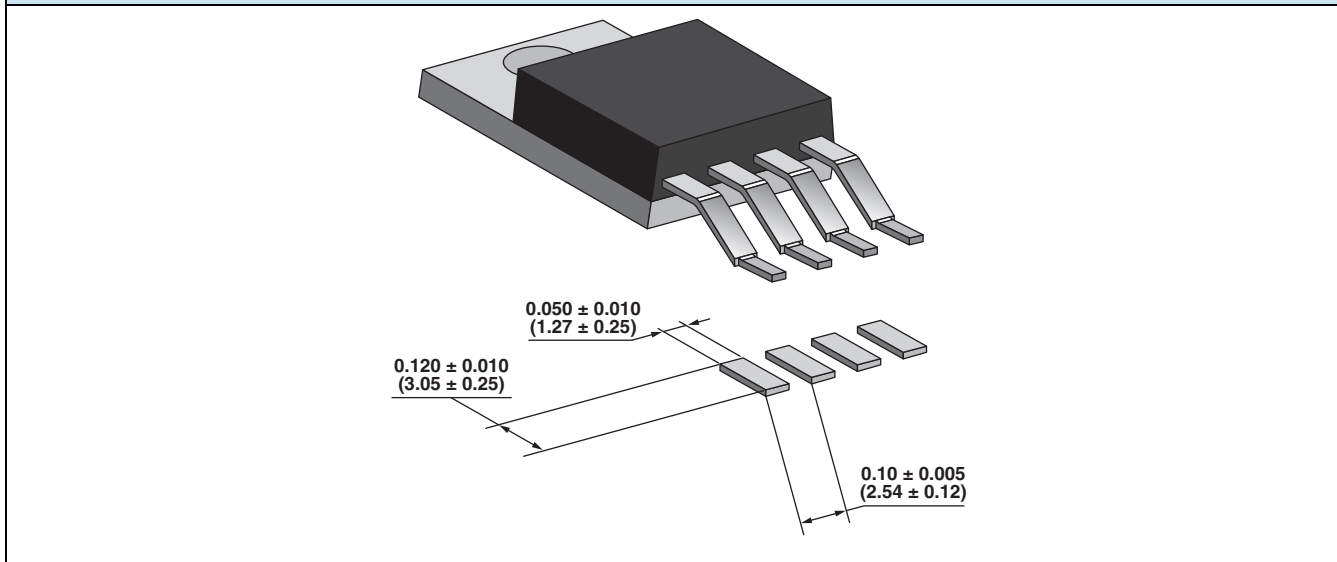
**FIGURE 5 - VPR221SZ FORMING DIMENSIONS** in inches (millimeters)



**FIGURE 6 - VPR221SZ DIMENSIONS**  
in inches (millimeters)



**FIGURE 7 - LAND PATTERN DIMENSIONS** in inches (millimeters)



**TABLE 2 - SPECIFICATIONS**

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

**Notes**

(1) Whichever is lower

(2) Heat sink chassis dimensions are requirements per MIL-R-39009/1B:

DIMENSIONS	inches	mm
<b>L</b>	6.00	152.4
<b>W</b>	4.00	101.6
<b>H</b>	2.00	50.8
<b>T</b>	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”)

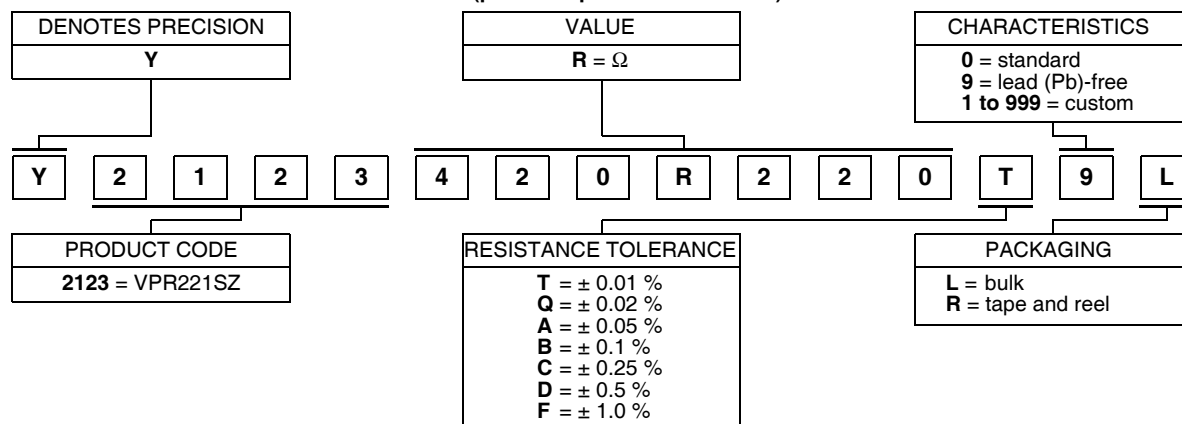
(5)  $\mu\text{V}/^\circ\text{C}$  relates to EMF due to lead temperature difference

**TABLE 3 - PERFORMANCE SPECIFICATIONS <sup>(1)</sup> MIL-PRF 39009**

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

**Note**

(1) Measurement error  $\pm 0.001 \%$

**TABLE 4 - GLOBAL PART NUMBER INFORMATION (1)****NEW GLOBAL PART NUMBER: Y2123420R220T9L (preferred part number format)**

FOR EXAMPLE: ABOVE GLOBAL ORDER Y2123 420R220 T 9 L:

TYPE: VPR221SZ

VALUE: 420.22  $\Omega$ ABSOLUTE TOLERANCE:  $\pm 0.01\%$ 

TERMINATION: lead (Pb)-free

PACKAGING: bulk

**HISTORICAL PART NUMBER: VPR221SZ T 420R22 TCR0.2 T B (will continue to be used)**

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 $\Omega$	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 T = tape and reel

**Note**

(1) For non-standard requests, please contact application engineering

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