

# 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 (1)   |
| 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

(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

## 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

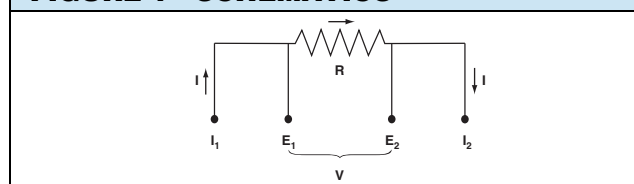
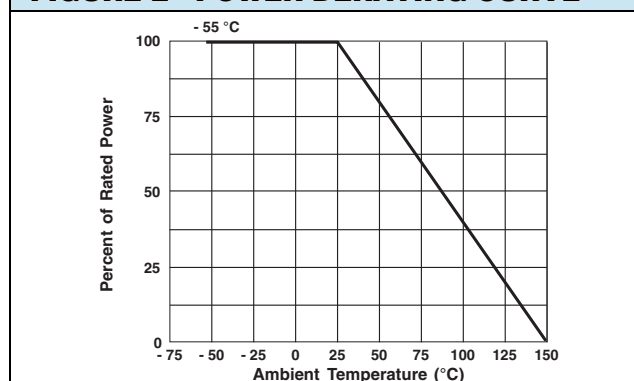
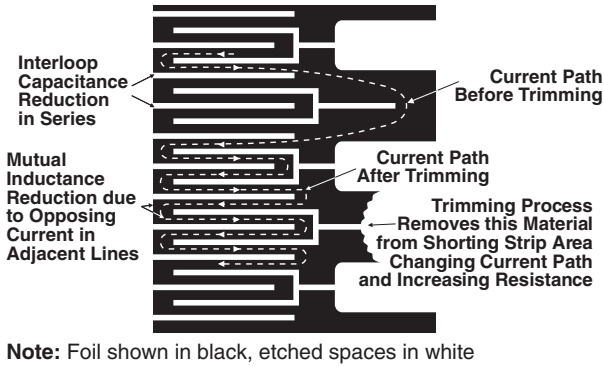


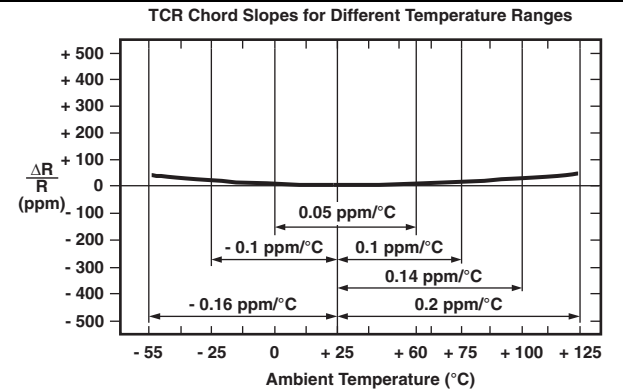
FIGURE 2 - POWER DERATING CURVE



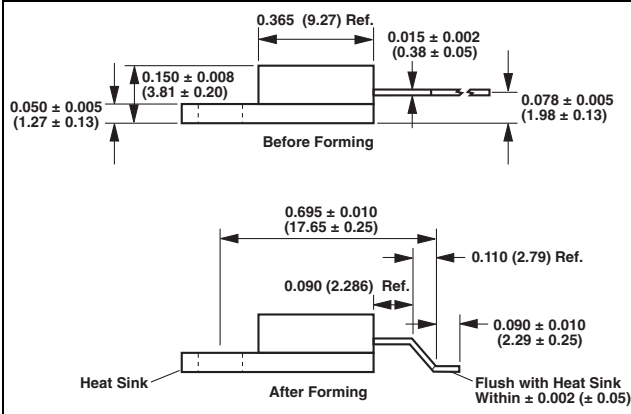
**FIGURE 3 - TRIMMING TO VALUES**  
(conceptual illustration)



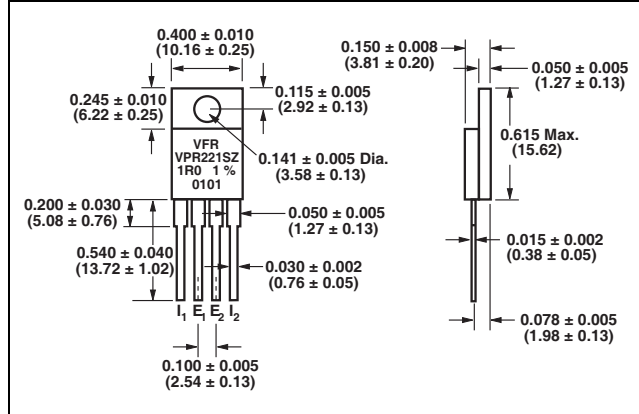
**FIGURE 4 - TYPICAL RESISTANCE/TEMPERATURE CURVE**  
(for more details see table 1)



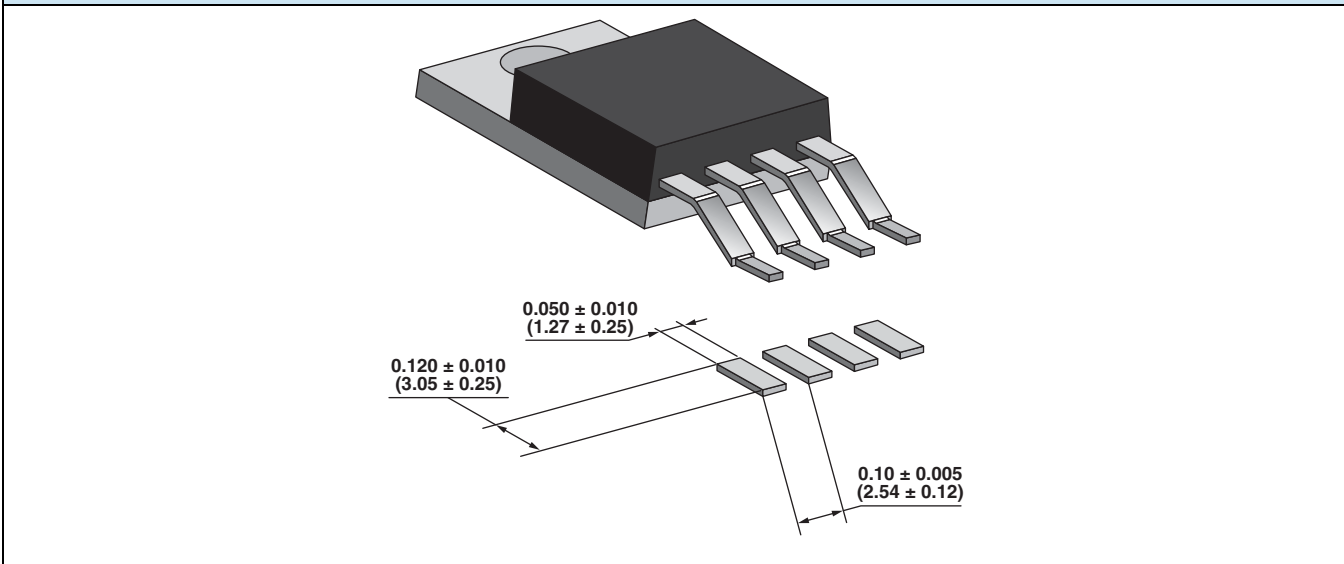
**FIGURE 5 - VPR221SZ FORMING DIMENSIONS** in inches (millimeters)



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



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



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

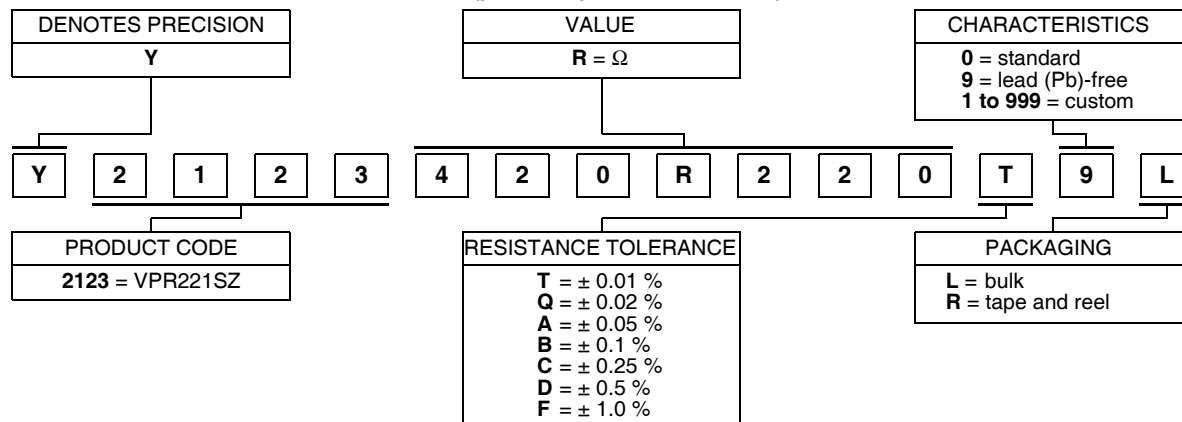
| TABLE 3 - PERFORMANCE SPECIFICATIONS <sup>(1)</sup> MIL-PRF 39009 |                            |                        |                          |
|---|----------------------------|------------------------|--------------------------|
| TEST OR CONDITION   | MIL-PRF 39009              | TYPICAL $\Delta R$     | MAXIMUM $\Delta R$       |
| Low temperature storage 24 h at - 55 °C                           | $\pm 0.3\% + 0.01\ \Omega$ | $\pm 0.001\%$ (10 ppm) | $\pm 0.002\%$ (20 ppm)   |
| Dielectric withstanding voltage 300 $V_{\text{AC}}$ at Atm        | $\pm 0.2\% + 0.01\ \Omega$ | $\pm 0.001\%$ (10 ppm) | $\pm 0.002\%$ (20 ppm)   |
| Dielectric withstanding voltage 200 $V_{\text{AC}}$ 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 s (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 RH 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 h 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 h 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 (1)**

**NEW GLOBAL PART NUMBER: Y2123420R220T9L (preferred part number format)**



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

TYPE: VPR221SZ

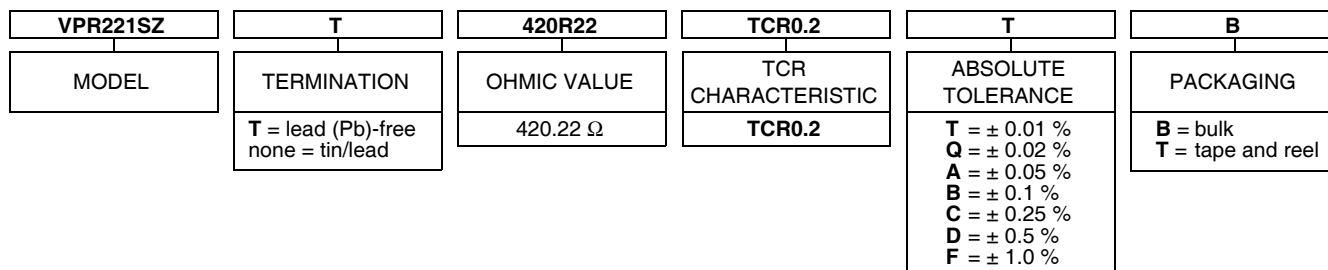
VALUE: 420.22 Ω

ABSOLUTE TOLERANCE: ± 0.01 %

TERMINATION: lead (Pb)-free

PACKAGING: bulk

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



**Note**

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



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### Наши контакты:

**Телефон:** +7 812 627 14 35

**Электронная почта:** [sales@st-electron.ru](mailto:sales@st-electron.ru)

**Адрес:** 198099, Санкт-Петербург,  
Промышленная ул, дом № 19, литера Н,  
помещение 100-Н Офис 331