

# 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

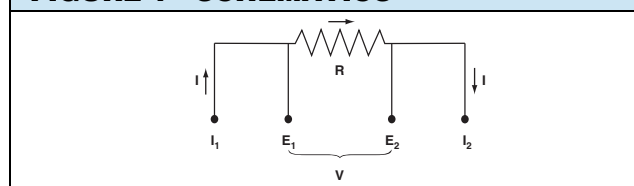
## FEATURES

- 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

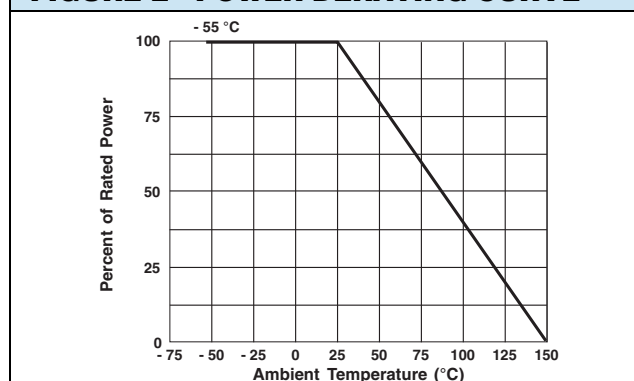


RoHS\*  
COMPLIANT

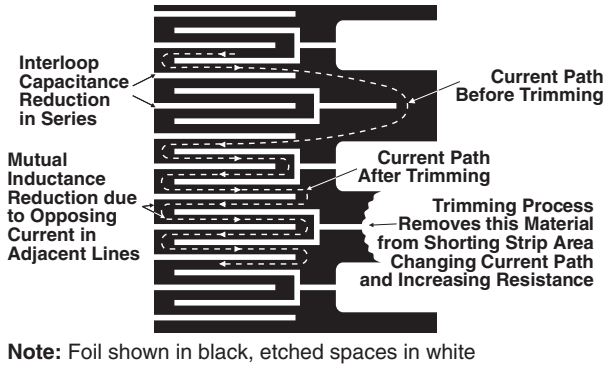
**FIGURE 1 - SCHEMATICS**



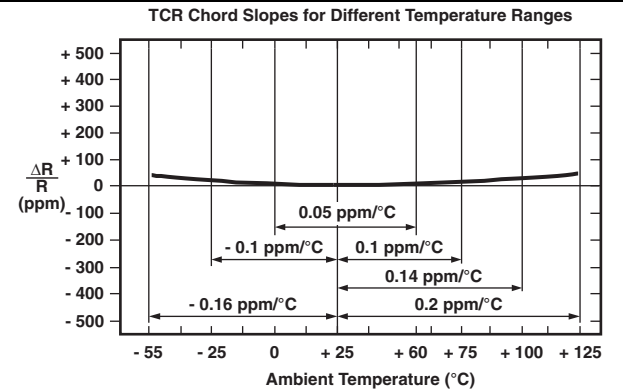
**FIGURE 2 - POWER DERATING CURVE**



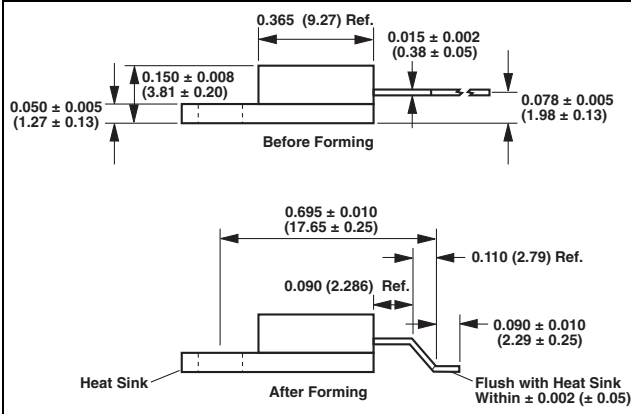
**FIGURE 3 - TRIMMING TO VALUES**  
(conceptual illustration)



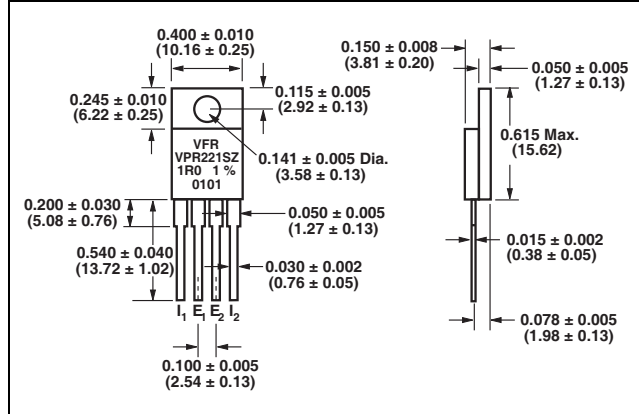
**FIGURE 4 - TYPICAL RESISTANCE/TEMPERATURE CURVE**  
(for more details see table 1)



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



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



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

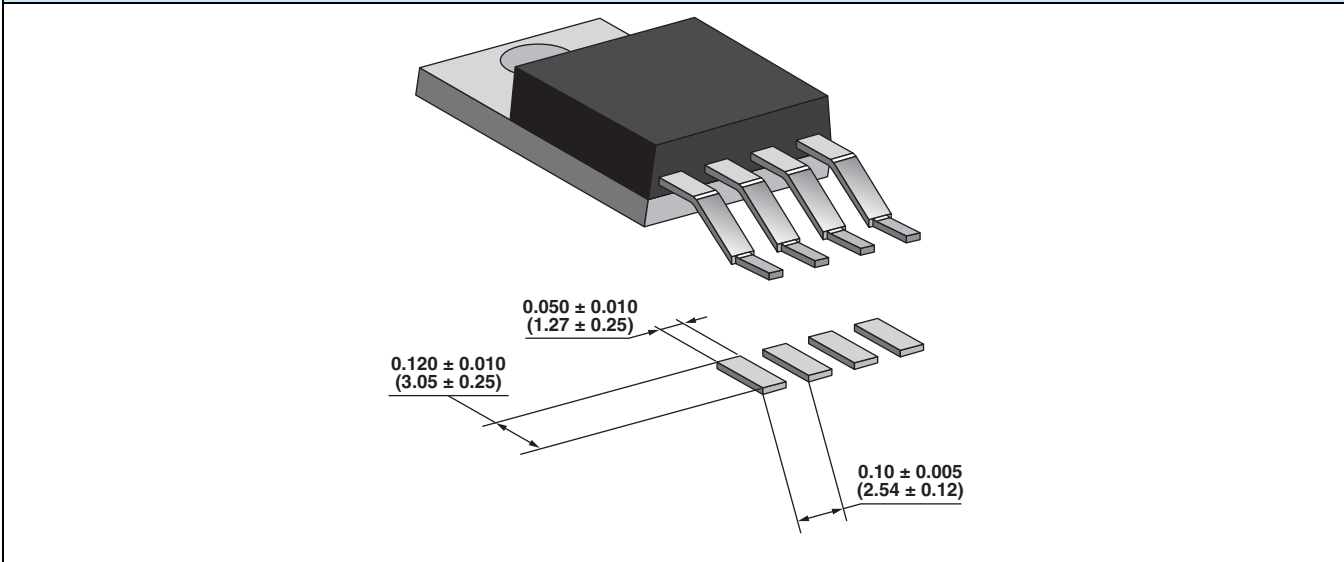


TABLE 2 - SPECIFICATIONS	
Power Rating at + 25 °C	8 W or 3 A <sup>(1)</sup> on heat sink <sup>(2)</sup> 1.5 W in free air <b>Further derating not necessary.</b>
Current Noise	< 0.010 $\mu\text{V}_{\text{RMS}}/\text{V}$ of applied voltage (- 40 dB)
High Frequency Operation Rise Time Inductance (L) <sup>(3)</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
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

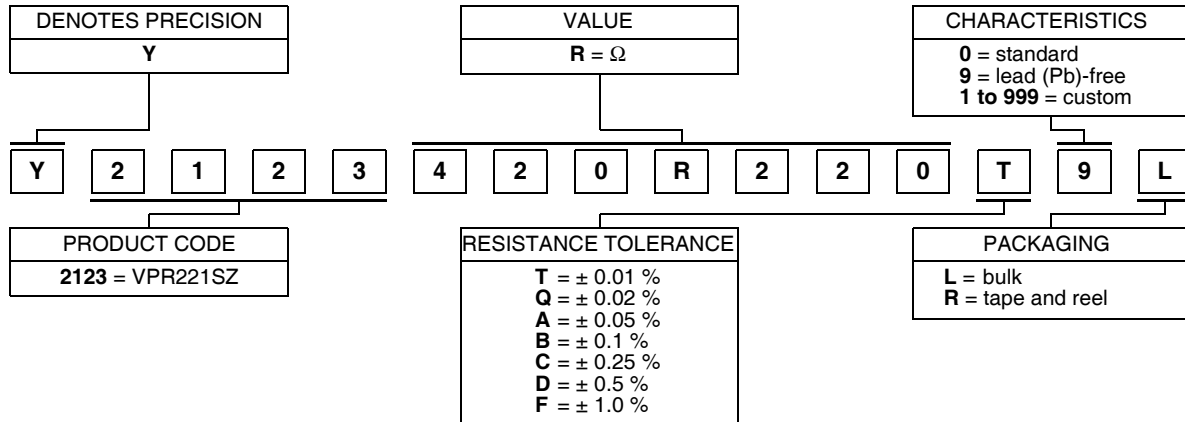
(4) The resolution limit of existing test requirement (within the measurement capability of the equipment, “essentially zero”)

(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	$\pm 0.3 \% + 0.01 \Omega$	$\pm 0.001 \% (10 \text{ ppm})$	$\pm 0.002 \% (20 \text{ ppm})$
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:

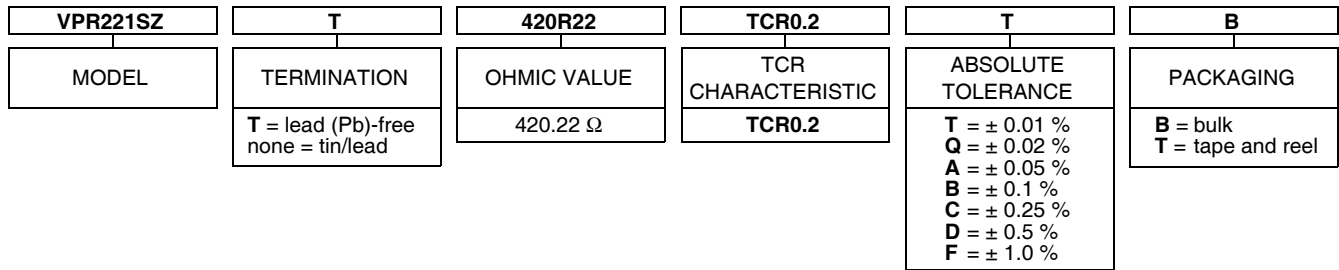
TYPE: VPR221SZ

VALUE: 420.22 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

## Disclaimer

ALL PRODUCTS, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE.

Vishay Precision Group, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "VPG"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained herein or in any other disclosure relating to any product.

The product specifications do not expand or otherwise modify VPG's terms and conditions of purchase, including but not limited to, the warranty expressed therein.

VPG makes no warranty, representation or guarantee other than as set forth in the terms and conditions of purchase. **To the maximum extent permitted by applicable law, VPG disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.**

Information provided in datasheets and/or specifications may vary from actual results in different applications and performance may vary over time. Statements regarding the suitability of products for certain types of applications are based on VPG's knowledge of typical requirements that are often placed on VPG products. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. You should ensure you have the current version of the relevant information by contacting VPG prior to performing installation or use of the product, such as on our website at [vpgsensors.com](http://vpgsensors.com).

No license, express, implied, or otherwise, to any intellectual property rights is granted by this document, or by any conduct of VPG.

The products shown herein are not designed for use in life-saving or life-sustaining applications unless otherwise expressly indicated. Customers using or selling VPG products not expressly indicated for use in such applications do so entirely at their own risk and agree to fully indemnify VPG for any damages arising or resulting from such use or sale. Please contact authorized VPG personnel to obtain written terms and conditions regarding products designed for such applications.

Product names and markings noted herein may be trademarks of their respective owners.

Copyright Vishay Precision Group, Inc., 2014. All rights reserved.