

# Ultra High Precision Z-Foil Power Resistor in TO-220 Configuration with TCR of $\pm 0.05 \text{ ppm/}^\circ\text{C}$ , PCR of $4 \text{ ppm/W}$ 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).

VPR221Z 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 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.

**TABLE 1 - TCR AND TOLERANCE**

RESISTANCE RANGE ( $\Omega$ )	TIGHTEST RESISTANCE TOLERANCE	TYPICAL TCR AND MAX. SPREAD <sup>1)</sup>
0.5 to < 1	$\pm 0.05 \%$	$\pm 0.2 \text{ ppm/}^\circ\text{C} \pm 2.8 \text{ ppm/}^\circ\text{C}$
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  $^\circ\text{C}$  to + 125  $^\circ\text{C}$ , + 25  $^\circ\text{C}$  Ref.)
- Contact Applications Engineering for other available values

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

## FEATURES

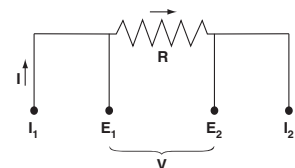
- Temperature coefficient of resistance (TCR):  
 $\pm 0.05 \text{ ppm/}^\circ\text{C}$  typical (0  $^\circ\text{C}$  to + 60  $^\circ\text{C}$ )  
 $\pm 0.2 \text{ ppm/}^\circ\text{C}$  typical (- 55  $^\circ\text{C}$  to + 125  $^\circ\text{C}$ , + 25  $^\circ\text{C}$  ref.) (see table 1)
- Tolerance: 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  $^\circ\text{C}$  for 2000 hours, at 1.5 W
- Resistance range: 0.5  $\Omega$  to 500  $\Omega$
- Electrostatic discharge (ESD) above 25 000 V
- 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  $\mu\text{H}$
- 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



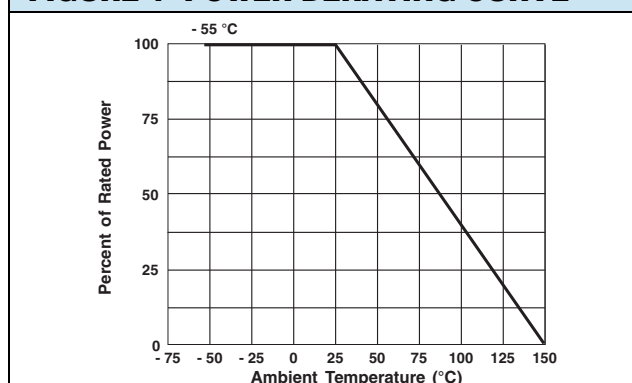
**RoHS\***  
COMPLIANT

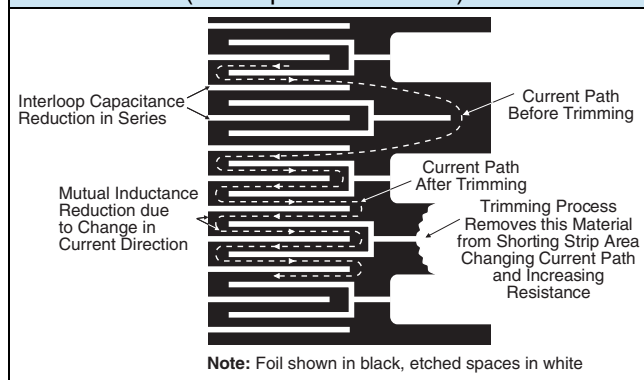
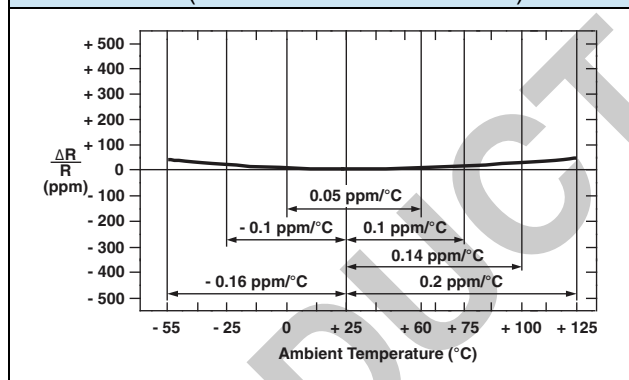
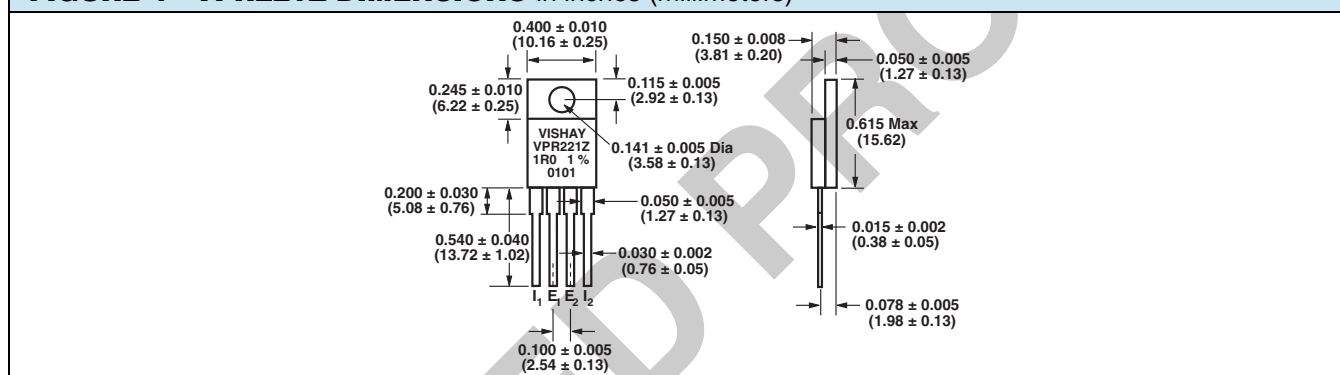
## APPLICATIONS

- 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**



**FIGURE 2 - TRIMMING TO VALUES**  
 (Conceptual Illustration)

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

**FIGURE 4 - VPR221Z DIMENSIONS** in inches (millimeters)


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

**TABLE 2 - SPECIFICATIONS**

<b>Power Rating at + 25 °C</b>	8 W or 3 A <sup>2)</sup> on heat sink <sup>3)</sup> 1.5 W in free air <b>Further derating not necessary.</b>
<b>Current Noise</b>	< 0.010 μV (rms)/V of applied voltage (- 40 dB)
<b>High Frequency Operation</b> Rise Time Inductance <sup>4)</sup> (L) Capacitance (C)	0.2 ns at 1 W 0.1 μH maximum: 0.03 μH typical <sup>1)</sup> 1.0 pF maximum: 0.5 pF typical <sup>1)</sup>
<b>Voltage Coefficient<sup>5)</sup></b>	< 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<sup>6)</sup></b>	0.15 μV/°C maximum (lead effect)
<b>Weight</b>	1.2 g maximum

**Notes**

- Maximum is 1.0 % A.Q.L. standard for all specifications except TCR.
- Whichever is lower.
- Heat sink chassis dimensions are requirements per MIL-R-39009/1B:

- Inductance (L) mainly due to the leads.
- The resolution limit of existing test requirement (within the measurement capability of the equipment, "essentially zero").
- μV/°C relates to EMF due to lead temperature difference.

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

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

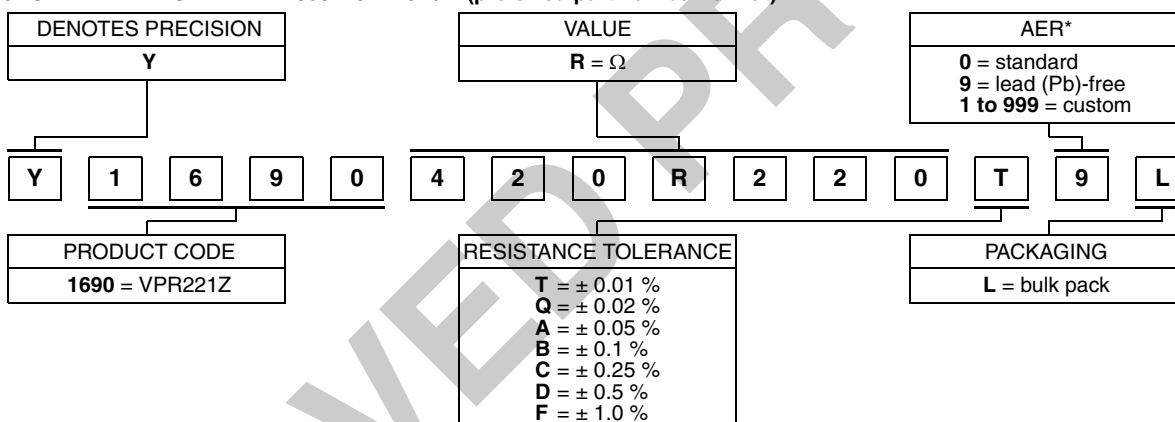
TEST OR CONDITION	MIL-PRF 39009	TYPICAL $\Delta R$	MAXIMUM $\Delta R$
Low temperature storage 24 hours at - 55 °C	$\pm 0.3 \% + 0.01 \Omega$	$\pm 0.001 \% (10 \text{ ppm})$	$\pm 0.002 \% (20 \text{ ppm})$
Dielectric withstanding voltage 300 V AC at Atm	$\pm 0.2 \% + 0.01 \Omega$	$\pm 0.001 \% (10 \text{ ppm})$	$\pm 0.002 \% (20 \text{ ppm})$
Dielectric withstanding voltage 200 V AC at Brm	$\pm 0.2 \% + 0.01 \Omega$	$\pm 0.001 \% (10 \text{ ppm})$	$\pm 0.002 \% (20 \text{ ppm})$
Insulation resistance	$> 10^4 M\Omega$		$> 10^4 M\Omega$
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 seconds (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 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 hours 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 hours 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  $\pm 0.001 \Omega$

**TABLE 4 - GLOBAL PART NUMBER INFORMATION**

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



FOR EXAMPLE: ABOVE GLOBAL ORDER Y1690 420R220 T 9 L:

TYPE: VPR221Z

VALUE: 420.22  $\Omega$

ABSOLUTE TOLERANCE:  $\pm 0.01 \%$

TERMINATION: Lead (Pb)-free

PACKAGING: Bulk Pack

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

VPR221Z	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 pack

**Note**

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

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