

## Bulk Metal® Foil Technology

### Hermetically Sealed Power and Current Sensing Resistor with TCR of 2 ppm/°C and Power up to 10 Watts



#### Any value available within resistance range

Vishay Bulk Metal® Foil power resistors offer the best approach to low value power and current sensing when a combination of accuracy, tight TCR, low thermal EMF, low voltage coefficient, Kelvin connection, and long term stability (under power) are required.

Vishay Models VHP-3 and VHP-4 offer all welded construction and screw mounting directly to a metal heat sink for maximum heat transfer. Hermetic sealing and nitrogen back fill provide the maximum protection against environmental stresses, thereby ensuring long term stability. A special feature of this construction is Kovar eyelet's and OFHC solder plated copper leads providing the lowest thermal EMFs in the industry.

Vishay Model VPR247 has many of the advantages of the VHP-4 but with significantly reduced size and weight. It also has gold plated copper leads.

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

#### FEATURES

- Temperature coefficient of resistance TCR:  $\pm 2 \text{ ppm/}^\circ\text{C}$  typical ( $- 55 \text{ }^\circ\text{C}$  to  $+ 125 \text{ }^\circ\text{C}$ ,  $+ 25 \text{ }^\circ\text{C}$  ref.) (see tables 1 and 2)
- Tolerance: to  $\pm 0.01 \%$  (see tables 1 and 2)
- Power rating (heat-sinked): 10 W
- Load life stability:  $\pm 0.01 \%$  at  $25 \text{ }^\circ\text{C}$ , 2000 h at rated power
- Resistance range:  $0.05 \Omega$  to  $80 \text{ k}\Omega$
- Electrostatic discharge (ESD) above 25 000 V
- Non inductive, non capacitive design
- Rise time: 1.0 ns without ringing
- Current noise:  $< - 40 \text{ dB}$
- Thermal EMF:  $0.05 \mu\text{V/}^\circ\text{C}$  typical
- Voltage coefficient:  $< 0.1 \text{ ppm/V}$
- Non inductive:  $0.08 \mu\text{H}$
- Non hot spot design
- Terminal finishes available:  
VHP-3 and VHP-4: lead (Pb)-free  
tin/lead alloy  
VPR247: gold plated
- Any value available within resistance range (e.g. 1K234)
- Prototype samples available from 48 h. For more information, please contact [foil@vishaypg.com](mailto:foil@vishaypg.com)
- For better performances, please contact Application Engineering



Available  
**RoHS\***  
COMPLIANT

**TABLE 1 - VHP-3<sup>1)</sup> SPECIFICATIONS**

RESISTANCE RANGE ( $\Omega$ )	TIGHTEST TOLERANCE	TYPICAL TCR <sup>3), 4)</sup>	MAXIMUM TCR <sup>3)</sup>
50 to 80K	$\pm 0.01 \%$	$\pm 2 \text{ ppm/}^\circ\text{C}$	$\pm 5 \text{ ppm/}^\circ\text{C}$
25 to $< 50$	$\pm 0.02 \%$		$\pm 7 \text{ ppm/}^\circ\text{C}$
10 to $< 25$	$\pm 0.05 \%$		$\pm 10 \text{ ppm/}^\circ\text{C}$
5 to $< 10$	$\pm 0.1 \%$		$\pm 13 \text{ ppm/}^\circ\text{C}$
2 to $< 5$	$\pm 0.25 \%$		$\pm 20 \text{ ppm/}^\circ\text{C}$
1 to $< 2$	$\pm 0.5 \%$		$\pm 25 \text{ ppm/}^\circ\text{C}$
0.5 to $< 1$	$\pm 1.0 \%$		$\pm 50 \text{ ppm/}^\circ\text{C}$
0.25 to $< 0.5$	$\pm 2.0 \%$		
0.1 to $< 0.25$	$\pm 5.0 \%$		

**TABLE 2 - VHP-4 AND VPR247 SPECIFICATIONS<sup>1), 2)</sup>**

RESISTANCE RANGE ( $\Omega$ )	TIGHTEST TOLERANCE	TYPICAL TCR <sup>3), 4)</sup>	MAXIMUM TCR <sup>3)</sup>
10 to 500	$\pm 0.01 \%$	$\pm 2 \text{ ppm/}^\circ\text{C}$	$\pm 5 \text{ ppm/}^\circ\text{C}$
5 to $< 10$	$\pm 0.02 \%$		$\pm 6 \text{ ppm/}^\circ\text{C}$
2 to $< 5$	$\pm 0.05 \%$		$\pm 8 \text{ ppm/}^\circ\text{C}$
1 to $< 2$	$\pm 0.1 \%$		$\pm 10 \text{ ppm/}^\circ\text{C}$
0.5 to $< 1$	$\pm 0.25 \%$		$\pm 15 \text{ ppm/}^\circ\text{C}$
0.25 to $< 0.5$	$\pm 0.5 \%$		$\pm 20 \text{ ppm/}^\circ\text{C}$
0.1 to $< 0.25$	$\pm 1.0 \%$		$\pm 25 \text{ ppm/}^\circ\text{C}$
0.05 to $< 0.1$	$\pm 2.0 \%$		$\pm 30 \text{ ppm/}^\circ\text{C}$

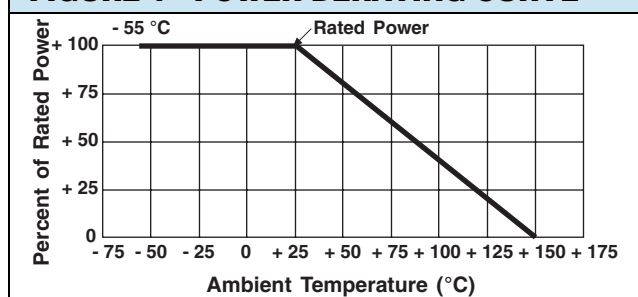
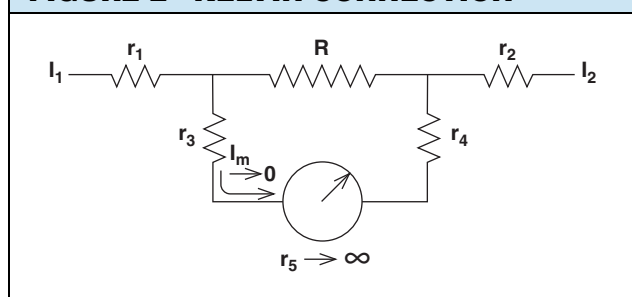
#### Notes

1. Weight of VHP-3 and VHP-4 = 15 g maximum  
VPR247 = 7 g maximum
2. Available up to  $500 \Omega$
3.  $- 55 \text{ }^\circ\text{C}$  to  $+ 125 \text{ }^\circ\text{C}$ ,  $+ 25 \text{ }^\circ\text{C}$  ref.
4. See figure 5

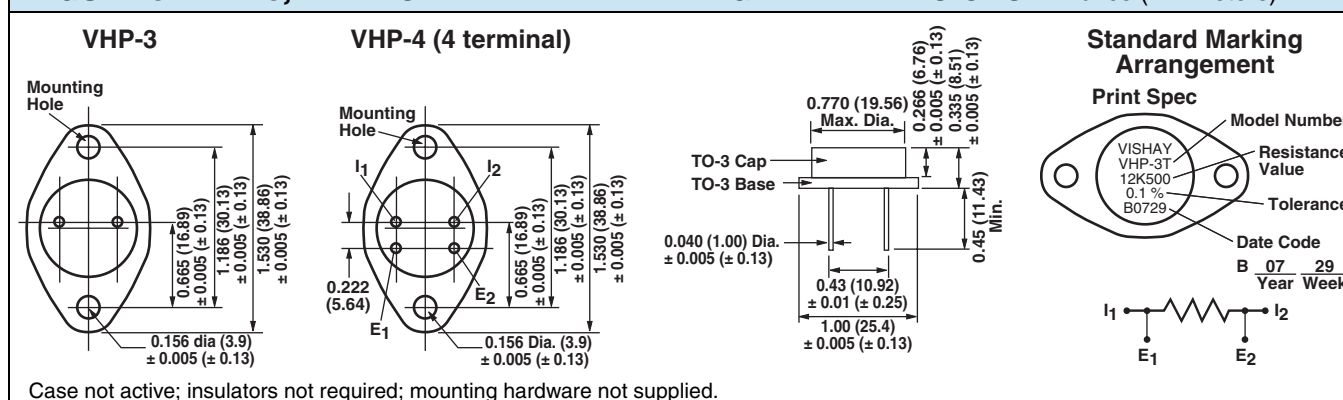
\* Pb containing terminations are not RoHS compliant, exemptions may apply

**TABLE 3 - GENERAL SPECIFICATIONS**

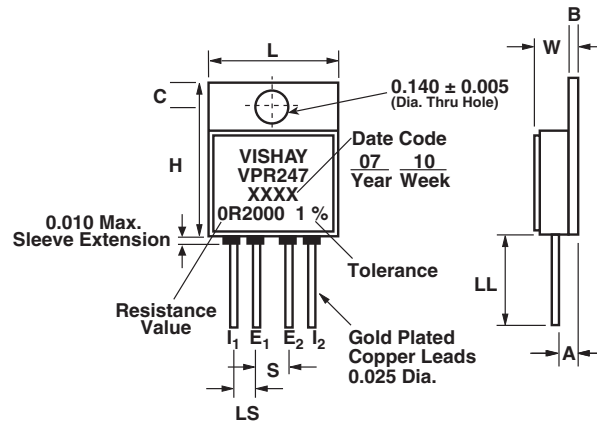
<b>Stability</b>  Load life 2000 h  Shelf life	$\pm 0.05\%$ maximum $\Delta R$ , 3 W in still air at $+25\text{ }^{\circ}\text{C}$ $\pm 0.05\%$ maximum $\Delta R$ under full rated power (10 W at $+25\text{ }^{\circ}\text{C}$ on heat sink) $\pm 0.0005\%$ (5 ppm) maximum $\Delta R$ /year
<b>Power Rating</b>  At $+25\text{ }^{\circ}\text{C}$ (see Fig. 1)	10 W or 3 A - heat sink <sup>2)</sup> 3 W or 3 A - free air
<b>Current Noise</b>	$< 0.010\text{ }\mu\text{V}$ (RMS)/V of applied voltage (- 40 dB)
<b>High Frequency Operation</b>  Rise time Inductance (L) <sup>3)</sup> Capacitance (C)	1.0 ns at 1 k $\Omega$ without ringing 0.1 $\mu\text{H}$ maximum; 0.08 $\mu\text{H}$ typical 1.0 pF maximum; 0.5 pF typical
<b>Voltage Coefficient</b>	$< 0.1\text{ ppm/V}$
<b>Operating Temperature Range</b>	$-55\text{ }^{\circ}\text{C}$ to $+150\text{ }^{\circ}\text{C}$
<b>Hermeticity</b>	$10^{-7}$ Atmospheric cc/s maximum
<b>Maximum Working Voltage<sup>7)</sup></b>	600 V
<b>Thermal EMF<sup>8)</sup></b>	0.1 $\mu\text{V}/^{\circ}\text{C}$ maximum (lead effect) 2.5 $\mu\text{V}/\text{W}$ maximum (power effect)

**FIGURE 1 - POWER DERATING CURVE****FIGURE 2 - KELVIN CONNECTION**

Kelvin (4-terminal) connections are used for these low ohmic value products to measure a precise voltage drop across the resistive element. In these applications the contact resistance, lead resistance, and their TCR effect may be greater than that of the element itself and could cause significant errors if the standard 2-terminal connection is used. Figure 2 shows a high impedance measurement system where  $r_5$  approaches infinity and  $I_m$  approaches zero resulting in negligible IR drop through  $r_3$  and  $r_4$  which negates their lead resistance and TCR effect. With the voltage sense leads  $E_1$  and  $E_2$  inside of  $r_1$  and  $r_2$  the resistance and TCR effect of the current leads,  $I_1$  and  $I_2$  are negated and only the resistance and TCR of the element  $R$  are sensed. This method of measurement is essential for precise current sensing.

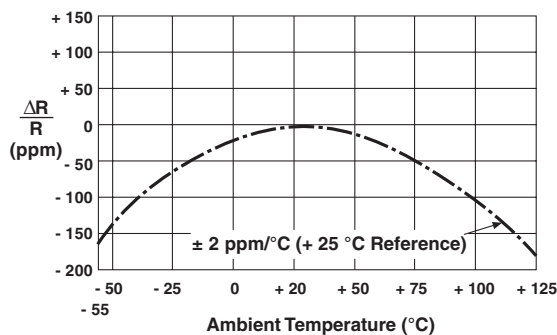
**FIGURE 3 - VHP-3, VHP-4 STANDARD IMPRINTING AND DIMENSIONS** in inches (millimeters)

**FIGURE 4 - VPR247 STANDARD IMPRINTING AND DIMENSIONS**



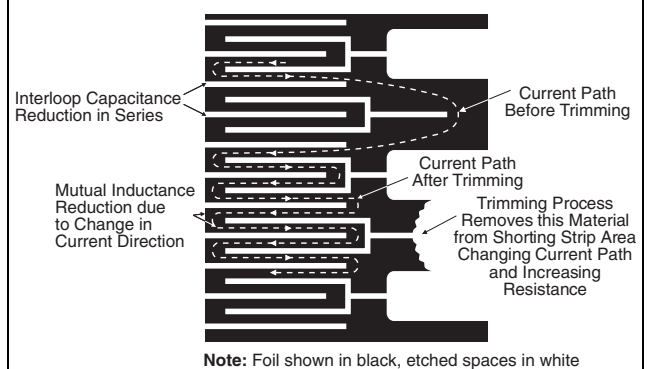
DIMENSION	INCHES	MM
L	$0.690 \pm 0.005$	$17.53 \pm 0.13$
H	$0.820 \pm 0.005$	$20.83 \pm 0.13$
W	$0.215 \pm 0.005$	$5.46 \pm 0.13$
LL	0.500 minimum	12.70 minimum
LS	$0.100 \pm 0.005$	$2.54 \pm 0.13$
S	$0.200 \pm 0.005$	$5.08 \pm 0.13$
A	$0.120 \pm 0.005$	$3.05 \pm 0.13$
B	$0.040 \pm 0.005$	$1.02 \pm 0.13$
C	$0.120 \pm 0.005$	$3.05 \pm 0.13$

**FIGURE 5 - TYPICAL TCR CURVE**



(For more details, see tables 1 and 2)

**FIGURE 6 - TRIMMING TO VALUES**



**TABLE 4 - ENVIRONMENTAL PERFORMANCE**

	METHOD PARAGRAPH <sup>6)</sup>	MIL-PRF-39009 $\Delta R$ LIMITS	VHP-3, VHP-4 AND VPR247 TYPICAL $\Delta R$ TEST DATA <sup>9)</sup>
<b>Test Group I</b>			
Conditioning	4.8.2	$\pm 0.2 \% + 0.01 \Omega$	$\pm 0.03 \%$
<b>Test Group II</b>			
Resistance temperature Characteristic (- 55 °C to + 125 °C)	4.8.4	$< 1 \Omega$ $\pm 100 \text{ ppm}/^\circ\text{C}$ ; $1 \Omega$ to $19.6 \Omega$ : $\pm 50 \text{ ppm}/^\circ\text{C}$ ; $\geq 20 \Omega$ : $\pm 30 \text{ ppm}/^\circ\text{C}$	See tables 1 and 2, page 1
Low temperature storage DWV	4.8.16	$\pm 0.3 \% + 0.01 \Omega$	$\pm 0.005 \%$
(300 V at atmospheric pressure)	4.8.5	$\pm 0.2 \% + 0.01 \Omega$	$\pm 0.005 \%$
Insulation resistance	4.8.6	$10^4 \text{ M}\Omega$	$> 10^4 \text{ M}\Omega$
Low temperature operation	4.8.7	$\pm 0.3 \% + 0.01 \Omega$	$\pm 0.01 \%$
Short time overload <sup>8)</sup> (5 s at 15 W)	4.8.8	$\pm 0.3 \% + 0.01 \Omega$	$\pm 0.03 \%$
Moisture resistance	4.8.9	$\pm 0.5 \% + 0.01 \Omega$	$\pm 0.02 \%$
Terminal strength	4.8.10	$\pm 0.2 \% + 0.01 \Omega$	$\pm 0.005 \%$
<b>Test Group III</b>			
Shock - specified pulse (Post-test DWV at 300 V)	4.8.11	$\pm 0.2 \% + 0.01 \Omega$	$\pm 0.005 \%$
Vibration - high frequency (Post-test DWV at 300 V)	4.8.12	$\pm 0.2 \% + 0.01 \Omega$	$\pm 0.005 \%$
<b>Test Group IV</b>			
Life test 10 W at 25 °C for 2000 h	4.8.13	$\pm 1.0 \% + 0.01 \Omega$	$\pm 0.01 \%$
80 % power at + 70 °C for 2000 h	-	-	$\pm 0.04 \%$
<b>Test Group V</b>			
High temperature exposure 2000 h at + 150 °C	4.8.14	$\pm 1.0 \% + 0.05 \Omega$	$\pm 0.05 \%$

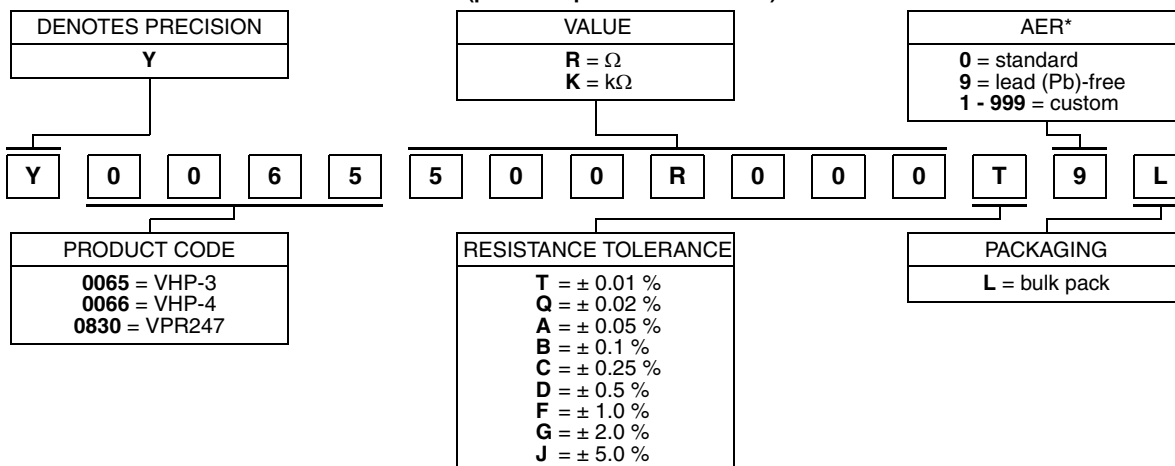
**Notes**

1. Whichever is lower.
2. Heat sink chassis dimensions and requirements per MIL-PRF-39009/1:

	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) due mainly to the leads.
4. The resolution limit of existing test equipment (within the measurement capability of the equipment, or "essentially zero").
5. Not to exceed power rating of resistor.
6. Vishay test data as compared to MIL-PRF-39009 is shown for illustration purposes, Vishay test conditions that deviate from the Mil test method are noted within parentheses.
7. Maximum ambient temperature rating is + 150 °C.
8. Maximum overload rating is 15 W (5 x rated power in free air; 1.5 x rated power on heatsink), with applied voltage not to exceed 750 V.
9.  $\Delta R$ 's are as shown plus 0.001  $\Omega$  to allow for measurement errors at low resistance values.

**TABLE 5 - GLOBAL PART NUMBER INFORMATION**

**NEW GLOBAL PART NUMBER: Y0065500R000T9L (preferred part number format)**



FOR EXAMPLE: ABOVE GLOBAL ORDER Y0065 500R000 T 9 L:

TYPE: VHP-3

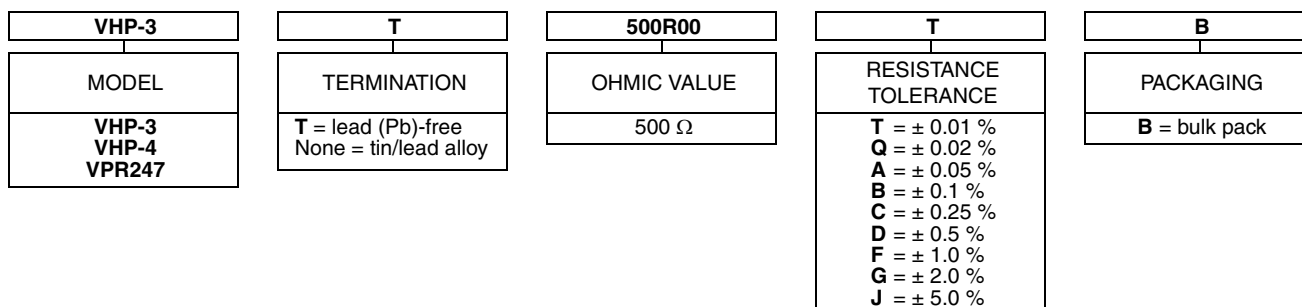
VALUE: 500.0  $\Omega$

ABSOLUTE TOLERANCE:  $\pm 0.01\%$

TERMINATION: lead (Pb)-free

PACKAGING: bulk pack

**HISTORICAL PART NUMBER: VHP-3T 500R00 T B (will continue to be used)**



**Note**

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

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