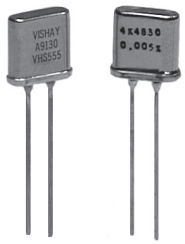
# Hermetically Sealed High Precision Bulk Metal® Foil Technology Aerospace Resistors with TCR of ± 1 ppm/°C, Tolerance to ± 0.005 % and Load Life Stability of ± 0.005 %



**Any value at any tolerance available within resistance range**

The "VH" series of resistors is the hermetic version of several molded "S" series devices. Hermetic sealing eliminates the ingress of both oxygen, which degrades resistors over long periods, and moisture which degrades resistors more quickly. These parts are made with glass to metal seal enclosures employing Kovar eyelets which allow the copper leads to pass through the enclosure to minimize the thermal EMF from the lead junctions. Rubber fill between the metal housing and resistance element acts both as a mechanical damper and thermal transfer path.

VHS102 and VH102K are the hermetically-sealed counterpart of the S102C and S102K high-performance molded resistors. VHS555 is the hermetically-sealed version of the S555, MIL style RNC90Y.

## FEATURES

Pb-free Available

RoHS* COMPLIANT

- Temperature coefficient of resistance (TCR):
  - 55 °C to + 125 °C, + 25 °C ref.:
    VH102K: ± 1 ppm/°C typical
    VHS102: ± 2 ppm/°C typical
    VHS555: ± 5 ppm/°C maximum
- Tolerance: to ± 0.005 %
- Resistance range: 1 Ω to 150 kΩ (higher or lower resistance values are available
- Load life stability: 0.005 % (70 °C for 2000 h at rated power)
- Electrostatic discharge (ESD) > 25 000 V
- Power rating: 0.6 W at + 70 °C; 0.3 W at + 125 °C
- Non inductive, non capacitive design
- Non hot spot design
- Rise time: 1.0 ns without ringing
- Current Noise: < - 40 dB
- Thermal EMF: 0.05 µV/°C typical
- Voltage coefficient: < 0.1 ppm/V
- Non inductive: < 0.08 µH
- Termal finishes available: lead (Pb)-free
  tin/lead alloy
- Impervious to harmful environments - oil filled
- For better performance, please see VH102Z datasheet

## TABLE 1 - MODEL SELECTION

| MODEL NUMBER | RESISTANCE RANGE (Ω) | STANDARD RESISTANCE TOLERANCE[1] % | | MAXIMUM WORKING VOLTAGE[2] | AMBIENT POWER RATING[3] ††† | | AVERAGE WEIGHT (g) | DIMENSIONS | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | TIGHTEST | LOOSEST | | at + 70 °C | at + 125 °C | | | INCHES | mm |
| VH102K† | 30.1 to 150K | ± 0.005 | ± 1.0 | 300 | 0.6 W | 0.3 W | 1.4 | W | 0.185 maximum | 4.70 maximum |
| | 20 to < 30.1 | ± 0.01 | ± 1.0 | | | | | L | 0.435 maximum | 11.05 maximum |
| | 10 to < 20 | ± 0.05 | ± 1.0 | | | | | H | 0.430 maximum†††† | 10.92 maximum |
| VHS102 | 5 to < 10 | ± 0.10 | ± 1.0 | | | | | LL | 1 ± 0.125 | 25.4 ± 3.18 |
| | 1 to < 5 | ± 0.25 | ± 1.0 | | | | | LS | 0.150 ± 0.010[4] | 3.81 ± 0.25 |
| VHS555†† | 30.1 to 150K | ± 0.005 | ± 1.0 | | | | | ST | 0.095 maximum | 2.41 maximum |
| | 16.2 to < 30.1 | ± 0.05 | ± 1.0 | | | | | | | |
| | 4.99 to < 16.2 | ± 0.10 | ± 1.0 | | | | | | | |
| | 1 to < 4.99 | ± 0.25 | ± 1.0 | | | | | | | |

**Notes**

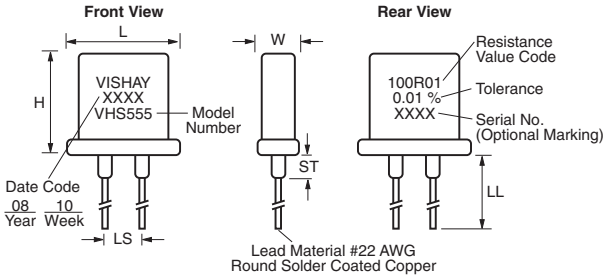
† Available from 1 Ω to 100 kΩ only

†† Contains RNC90Y inside (4.99 Ω to 121 kΩ)

††† Above 100 kΩ VHS102 power is derated to 0.4 W at + 70 °C and 0.2 W at + 125 °C

†††† 0.375 H available

## FIGURE 1 - STANDARD IMPRINTING AND DIMENSIONS




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

| TABLE 2 - TOLERANCE AND TCR VS. RESISTANCE VALUE | | |
|---|---|---|
| **RESISTOR** | **RESISTANCE VALUE (Ω)** | **TYPICAL TCR AND MAXIMUM SPREAD (- 55 °C to + 125 °C, + 25 °C ref.) (ppm/°C)** |
| VHS102 | 80 to 150K | ± 2 ± 2.5 |
| VH102K | 80 to 100K | ± 1 ± 2.5 |
| VHS102 | 50 to < 80 | ± 2 ± 3.5 |
| VH102K | | ± 1 ± 3.5 |
| VHS102 | 1 to < 50 | ± 2 ± 4.5 |
| VH102K | | ± 1 ± 4.5 |

| TABLE 3 - SPECIFICATIONS[5)] | | | | |
|---|---|---|---|---|
| **Selected[6)] TCR Tracking[8)]** | 0.5 ppm/°C | | | |
| **Stability[12)]** | | | | |
| | VH102K | VHS102 | VHS555 | |
| Load life at 2000 h | ± 0.025 % | ± 0.025 % | ± 0.015 % | at 0.3 W/+ 125 °C |
| | ± 0.005 % | ± 0.005 % | ± 0.0025 % | at 0.1 W/+ 60 °C |
| Load life at 10 000 h | ± 0.02 % | ± 0.02 % | ± 0.01 % | at 0.05 W/+ 125 °C |
| **Shelf Life Stability** | ± 5 ppm | (0.0005 %) | maximum ΔR after 1 year | |
| | ± 10 ppm | (0.001 %) | maximum ΔR after 3 years | |
| **Current Noise** | < 0.010 $\mu V_{RMS}$/V of applied voltage (- 40 dB) | | | |
| **High Frequency Operation** | | | | |
| Rise time | 1.0 ns | | | |
| Inductance (L)[9)] | 0.1 µH maximum; 0.08 µH typical | | | |
| Capacitance (C) | 1.0 pF maximum; 0.5 pF typical | | | |
| **Voltage Coefficient** | < 0.1 ppm/V[10)] | | | |
| **Thermal EMF[11)]** | 0.1 µV/°C maximum; 0.05 µV/°C typical 1 µV/W | | | |
| **Hermeticity** | $10^{-7}$ atmospheric cc/s maximum | | | |

**Notes:**

1) Standard resistance tolerance: ± 0.005 %; ± 0.01 %; ± 0.02 %; ± 0.05 %; ± 0.1 %; ± 0.25 %; ± 0.5 %; ± 1.0 %.

2) Not to exceed power rating of resistor.

3) See Figure 2 below.

4) 0.200" (5.08 mm) lead spacing available (except VHS555) - specify VH102J (S102C type), VH102L (S102K type).

5) Maximum is 1.0 % A.Q.L. standard for all specifications except TCR. (For TCR information see notes 6 to 10.) Typical is a designers reference which represents that 85 % of the units supplied, over a long period of time, will be at least the figure shown or better.

6) Vishay maximum TCR spread is defined as the 3 σ (sigma) limit of a normal Gaussian distribution (99.73 % of a production lot) which is within a band, centered on the nominal curve. This Vishay maximum TCR spread is no greater than ± 2.5 ppm/°C from nominal throughout the full temperature range. This definition of the Vishay maximum TCR spread from nominal applies to all resistance values. However, as the resistance value decreases below 80 Ω, the Vishay maximum TCR spread from nominal specification starts to increase. (See Figure 3 in datasheet "7 Technical Reasons to Specify Vishay Bulk Metal® Foil Resistive Components")

7) Selected TCR tracking is available for specially ordered lots of resistors. The selected TCR tracking can be 3, 2, 1 and as close as 0.5 ppm/°C throughout the full temperature range.

8) TCR tracking is a measure of the similarity of resistance value change in two or more resistors which are undergoing the same temperature changes. Tracking could be expressed as the difference in the temperature coefficients of the resistors, expressed in ppm/°C as $(\Delta R_1/R_1$ to $\Delta R_2/R_2) \times 10^{-6}/\Delta T°C$. When a number of resistors are referenced to a nominal TCR, the spread or envelope around the nominal would be the difference. If the spread is ± 1.5 ppm/°C about a nominal, the tracking, as defined above, will be 3 ppm/°C.

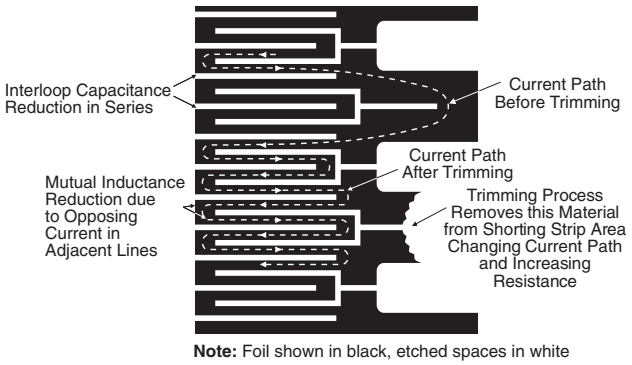
9) Inductance (L) due mainly to the leads.

10) The resolution limit of existing test equipment (within the measurement capability of the equipment, or "essentially zero")

11) µV/°C relates to EMF due to lead temperature difference and µV/W due to power applied to the resistor.

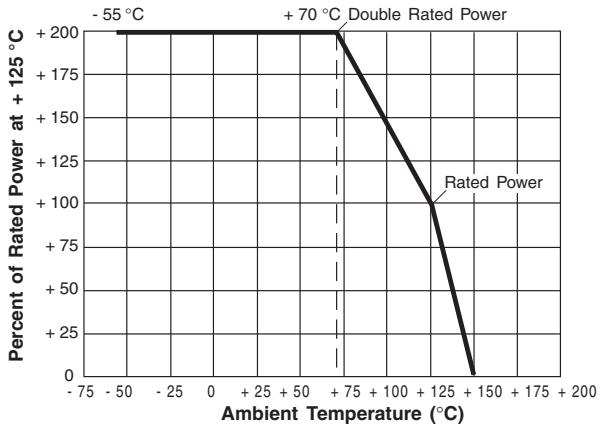
12) Load life ΔR maximum can be reduced through in-house oriented processes.

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




**Note:** Foil shown in black, etched spaces in white

## FIGURE 3 - POWER DERATING CURVE




## TABLE 4 - ENVIRONMENTAL PERFORMANCE COMPARISON

| | MIL-PRF-55182/9 CHARACTERISTIC Y MAXIMUM ΔR | VH102K TYPICAL[5] ΔR | VHS102 TYPICAL[5] ΔR | VHS555 TYPICAL[5] ΔR |
|---|---|---|---|---|
| **Test Group I** | | | | |
| Thermal shock | ± 0.05 % | ± 0.002 % | ± 0.002 % | ± 0.002 % |
| Overload | ± 0.05 % | ± 0.003 % | ± 0.003 % | ± 0.003 % |
| **Test Group II** | | | | |
| Resistance temperature characteristics | ± 5 ppm/°C | See Figures 7 and 8[1] | See Figures 1 and 2, and Figures 5 and 6[1] | |
| Temperature storage | ± 0.05 % | ± 0.005 % | ± 0.005 % | ± 0.0025 |
| Low temperature operation | ± 0.05 % | ± 0.005 % | ± 0.005 % | ± 0.005 % |
| Terminal strength | ± 0.02 % | ± 0.002 % | ± 0.002 % | ± 0.002 % |
| **Test Group III** | | | | |
| DWV | ± 0.02 % | ± 0.005 % | ± 0.005 % | ± 0.002 % |
| Insulation resistance | $10^4$ MΩ | 40 x $10^5$ MΩ | 40 x $10^5$ MΩ | 40 x $10^5$ MΩ |
| Resistance to solder heat | ± 0.02 % | ± 0.002 % | ± 0.002 % | ± 0.002 % |
| Moisture resistance | ± 0.05 % | ± 0.005 % | ± 0.005 % | ± 0.005 % |
| **Test Group IV** | | | | |
| Shock | ± 0.01 % | ± 0.002 % | ± 0.002 % | ± 0.002 % |
| Vibration | ± 0.02 % | ± 0.002 % | ± 0.002 % | ± 0.002 % |
| **Test Group V** | | | | |
| Life test at 0.3 W/+ 125 °C | | | | |
| 2000 h | ± 0.05 % | ± 0.03 % | ± 0.03 % | ± 0.01 % |
| 10 000 h | ± 0.5 % | ± 0.05% | ± 0.05 % | ± 0.02 % |
| **Test Group Va** | | | | |
| + 70 °C power rating | ± 0.05 % | ± 0.02 % | ± 0.02 % | ± 0.02 % |
| **Test Group VI** | | | | |
| High temperature exposure | ± 0.05 % | ± 0.05 % | ± 0.05 % | ± 0.04 % |
| **Test Group VII** | | | | |
| Voltage coefficient | 0.0005 %/V | < 0.00001 %/V | < 0.00001 %/V | < 0.00001 %/V |

**Notes:**

1. These figures can be found in data sheet "7 Technical Reasons to Specify Bulk Metal® Foil Resistive Components."

- See previous page for numbered footnotes.

## TABLE 5 - GLOBAL PART NUMBER INFORMATION

**NEW GLOBAL PART NUMBER: Y578780K5000V9L (preferred part number format)**

| DENOTES PRECISION | VALUE | AER* |
|---|---|---|
| **Y** | **R** = Ω<br>**K** = kΩ<br>**M** = MΩ | **0** = standard product, tin/lead terminations<br>**9** = standard product, lead (Pb)-free terminations<br>**Other** = custom |

| Y | 5 | 7 | 8 | 7 | 8 | 0 | K | 5 | 0 | 0 | 0 | V | 9 | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| PRODUCT CODE | RESISTANCE TOLERANCE | PACKAGING |
|---|---|---|
| **0077** = VHS102<br>**0788** = VH102J<br>**5787** = VH102K<br>**0787** = VH102L<br>**0087** = VHS555 | **V** = ± 0.005 %<br>**T** = ± 0.01 %<br>**Q** = ± 0.02 %<br>**A** = ± 0.05 %<br>**B** = ± 0.1 %<br>**C** = ± 0.25 %<br>**D** = ± 0.5 %<br>**F** = ± 1.0 % | **L** = bulk pack |

FOR EXAMPLE: ABOVE GLOBAL ORDER Y5787 80K5000 V 9 L:

TYPE: VH102K
VALUE: 80.5 kΩ
ABSOLUTE TOLERANCE: ± 0.005 %
TERMINATION: lead (Pb)-free
PACKAGING: bulk pack

**HISTORICAL PART NUMBER: VH102KT 8K500 V B (will continue to be used)**

| VH102K | T | 80K500 | V | B |
|---|---|---|---|---|
| MODEL | TERMINATION | OHMIC VALUE | RESISTANCE TOLERANCE | PACKAGING |
| **VHS102**<br>**VH102J**<br>**VH102K**<br>**VH102L**<br>**VHS555** | **T** = lead (Pb)-free<br>None = tin/lead alloy | **80K500** = 80.5 kΩ | **V** = ± 0.005 %<br>**T** = ± 0.01 %<br>**Q** = ± 0.02 %<br>**A** = ± 0.05 %<br>**B** = ± 0.1 %<br>**C** = ± 0.25 %<br>**D** = ± 0.5 %<br>**F** = ± 1.0 % | **B** = bulk pack |

**Note**

* Application engineering release: for non-standard requests, please contact application engineering.

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