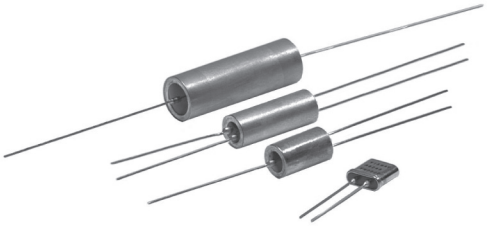
New Generation of Secondary Standards Hermetically Sealed High Precision Bulk Metal® Foil Technology Resistors with TCR of ± 2 ppm/°C, Tolerance of ± 0.001 % and Load Life Stability of ± 0.005 % (Metrology, Laboratory, Instrumentation, Industrial)



INTRODUCTION

The H series resistors are oil-filled, hermetically sealed ultra precision resistors and are used as secondary standards for metrology applications.

The hermetic sealing eliminates the ingress of moisture and oxygen, while the oil acts as a thermal conductor, thus eliminating the long-term degradation elements of unsealed resistors, while at the same time allowing the device to accept short periods of overload without degradation.

Vishay's Bulk Metal® Foil outperforms all other resistor technologies available today for applications that require precision and stability. When combined with the hermetic sealing and oil filling, the H series resistors become **the most precise and stable resistors available**.

With accuracies of 0.001 %, a resistance range from 5 Ω to 1.84 MΩ, and long term shelf life of less than 2 ppm, these devices are virtually secondary standards that can be carried in sets for daily or periodic calibration of factory measurement equipment.

The H series is available with laboratory and metrology level precision and long-term stability with additional in-house oriented processes such as: chip stabilization, special TCR plotting, additional treatments for ultra stability and special post manufacturing operations (PMO). (Please refer to the last page)

FEATURES

Pb-free Available

RoHS* COMPLIANT

- Temperature coefficient of resistance (TCR): ± 2 ppm/°C typical (- 55 °C to + 125 °C, + 25 °C ref.). For ultra high performances (instrumentation and metrology) please refer to the last page
- Resistance range: 5 Ω to 1.84 MΩ (higher or lower values of resistance available)
- Vishay Foil resistors are not restricted to standard values; specific "as required" values can be supplied at no extra cost or delivery (e.g. 1K2345 vs. 1K)
- Power rating: 0.3 W to 2.5 W at + 25 °C (depending on model - see table 2)
- Tolerance: to ± 0.001 % (10 ppm)
- Load life stability to ± 0.002 % (20 ppm) at 25 °C, 2000 h at rated power
- **Load life stability can be considerably improved through in-house stabilization**
- **Shelf life stability: ± 2 ppm for at least 6 years (unaffected by humidity)**
- Electrostatic discharge (ESD) up to 25 000 V
- Rise time: 1 ns effectively no ringing
- Thermal stabilization time < 1 s (nominal value achieved within 10 ppm of steady state value)
- Current noise: 0.010 μV_{RMS}/V of applied voltage (< - 40 dB)
- Thermal EMF: 0.05 µV/°C typical
- Voltage coefficient: < 0.1 ppm/V
- Non-inductive: < 0.08 µH
- Non-inductive, non-capacitive design
- Non hot spot design
- Terminal finish available: lead (Pb)-free or tin/lead alloy
- Impervious to harmful environments - oil-filled
- 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
- For better performances (values, TCR, tolerance, stability), please see the HZ series

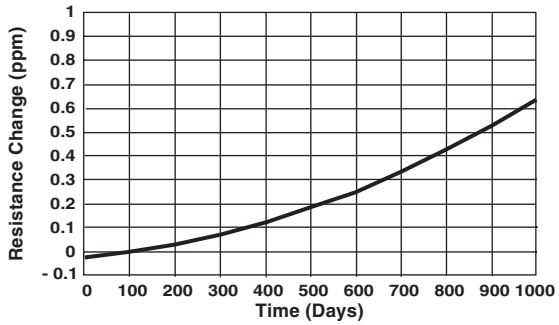
TABLE 1 - TCR VS. RESISTANCE VALUE

RESISTANCE VALUE (Ω)	TYPICAL TCR AND MAX. SPREAD (- 55 °C to + 125 °C, + 25 °C ref.) (ppm/°C)
100 to < 1M84	± 2 ± 2.5
50 to < 100	± 2 ± 3.5
5 to < 50	± 2 ± 4.5

Note

- For maximum TCR < 1 ppm/°C, see VHP100 and contact application engineering

FIGURE 1 - SHELF LIFE - VHA518-11 12K9 VS. QHE



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

FIGURE 2 - POWER DERATING CURVE

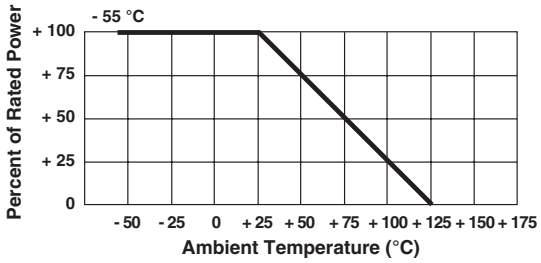
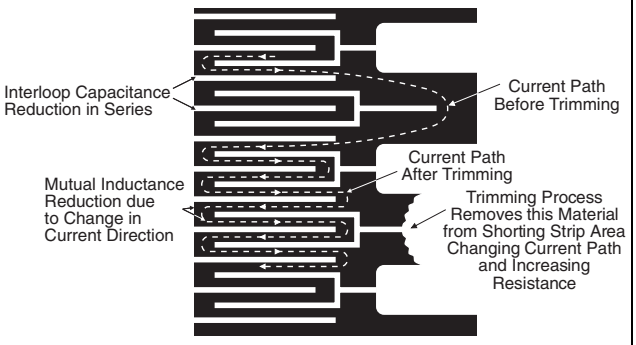


FIGURE 3 - TRIMMING TO VALUES
(Conceptual Illustration)



Note: Foil shown in black, etched spaces in white

FIGURE 4 - TYPICAL RESISTANCE/ TEMPERATURE CURVE

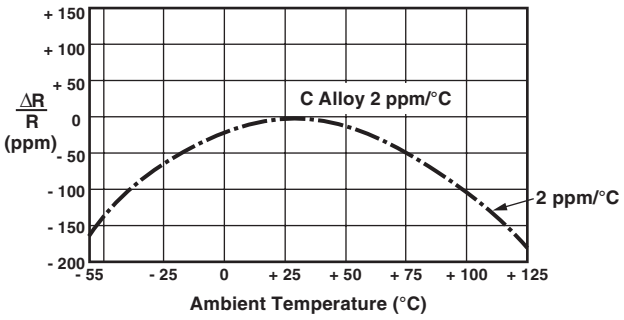


TABLE 2 - MODEL SELECTION

MODEL NUMBER	RESISTANCE RANGE (Ω)	STANDARD RESISTANCE TOLERANCE PER RANGE		MAXIMUM WORKING VOLTAGE (2)	POWER RATING at + 25 °C	AVERAGE WEIGHT (g)	CONSTRUCTION BRIEF	DIMENSIONS (3)	
		RANGE (Ω)	TIGHTEST (%)					INCHES	mm
VHP202	5 to 100K > 100K to 150K	1K to □ (1) 500 to < 1K 50 to < 500 30 to < 50 20 to < 30 10 to < 20 5 to < 10	± 0.001 ± 0.0025 ± 0.005 ± 0.01 ± 0.02 ± 0.05 ± 0.1	300	0.3 W 0.2 W	1.4	Oil-filled, tinned copper leads, nickel shell, kovar and glass header	W: 0.162 ± 0.020 L: 0.415 ± 0.020 H: 0.430 ± 0.020** LL: 1.000 ± 0.125 LS: 0.150 ± 0.010 (4) ST: 0.095 max.	4.11 ± 0.51 10.54 ± 0.51 10.92 ± 0.51 25.4 ± 3.18 3.81 ± 0.25 2.41 max.
VHA412	5 to 100K > 100K to 150K			250	0.3 W 0.2 W	4.6	Oil-filled, tinned copper leads, tinned brass shell, kovar and glass end bells	L: 0.625 ± 0.031 D: 0.375 ± 0.031 LL: 1.000 min.	15.88 ± 0.79 9.53 ± 0.79 25.4 min.
VHA414	5 to 200K > 200K to 335K			350	0.5 W 0.3 W	7.3		L: 1.000 ± 0.031 D: 0.375 ± 0.031 LL: 1.000 min.	25.4 ± 0.79 9.53 ± 0.79 25.4 min.
VHA512*	5 to 300K > 300K to 500K			350	0.75 W 0.4 W	6.3		L: 0.625 ± 0.031 D: 0.500 ± 0.031 LL: 1.000 min.	15.88 ± 0.79 12.7 ± 0.79 25.4 min.
VHA516-4* VHA516-5* VHA516-6*	5 to 400K > 400K to 668K 5 to 500K > 500K to 835K 5 to 600K > 600K to 1M			500	1.0 W 0.5 W 1.25 W 0.6 W 1.5 W 0.7 W	9.2		L: 1.000 ± 0.031 D: 0.500 ± 0.031 LL: 1.000 min.	25.4 ± 0.79 12.7 ± 0.79 25.4 min.
VHA518-7* VHA518-8* VHA518-9* VHA518-10* VHA518-11*	5 to 700K > 700K to 1M17 5 to 800K > 800K to 1M34 5 to 900K > 900K to 1M5 5 to 1.0M > 1.0M to 1M67 5 to 1.0M > 1.0M to 1M84			600	1.75 W 0.8 W 2.0 W 0.9 W 2.25 W 1.0 W 2.5 W 1.1 W 2.5 W 1.2 W	13.5		L: 1.500 ± 0.031 D: 0.500 ± 0.031 LL: 1.000 min.	38.1 ± 0.79 12.7 ± 0.79 25.4 min.

Notes
* Available in a 4-lead terminal
** 0.375 H available
See next page for numbered footnotes

FIGURE 5 - STANDARD IMPRINTING AND DIMENSIONS

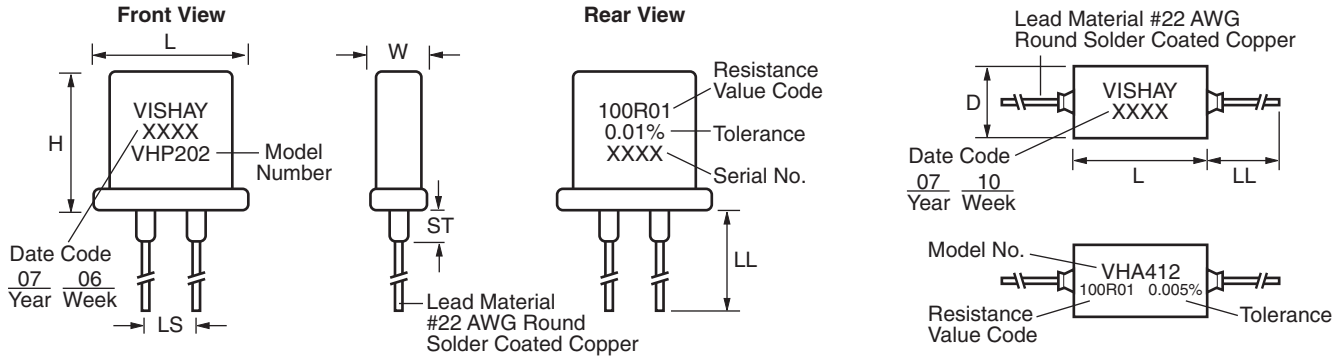


TABLE 3 - "H" SERIES SPECIFICATIONS

Stability [8]	
Load life at 2000 h	± 0.002 % (20 ppm) at 25 °C at rated power
Shelf life	± 2 ppm (0.0002 %) for at least 6 years
Current Noise	< - 40 dB
High Frequency Operation	
Rise time	1.0 ns without ringing
Inductance (L) [5]	0.1 µH maximum; 0.08 µH typical
Capacitance (C)	1.0 pF maximum; 0.5 pF typical
Voltage Coefficient	< 0.1 ppm/V [6]
Thermal EMF [7]	0.1 µV/°C maximum; 0.05 µV/°C typical; 1 µV/W maximum
Hermeticity	10^{-7} atmospheric cc/s maximum

Notes

[1] Upper end of resistance range varies with model selected (i.e. VHP202; the range is to 150 kΩ; VHA518-10, the range is to 1M67 Ω) per table 2

[2] Not to exceed power rating of resistor

[3] Insulating sleeve - a special case insulating plastic sleeve is available on VHA models. See table 4 for instructions on how to specify

[4] 0.200" (5.08 mm) lead spacing available - specify VH202J

[5] Inductance (L) due mainly to the leads

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

[7] µV/°C relates to EMF due to lead temperature difference and µV/W due to power applied to the resistor

[8] Load life ΔR maximum. Can be reduced through in-house oriented processes

POST MANUFACTURING OPERATIONS OR PMO FOR IMPROVED END OF LIFE

Many analog applications can include requirements for performance under conditions of stress beyond the normal and over extended periods of time. This calls for more than just selecting a standard device and applying it to a circuit. The standard device may turn out to be all that is needed but an analysis of the projected service conditions should be made and it may well dictate a routine of stabilization known as post manufacturing operations or PMO. The PMO operations that will be discussed are only applicable to Bulk Metal Foil resistors. They stabilize Bulk Metal Foil resistors while they are harmful to other types. Short time overload, accelerated load life, and temperature cycling are the three PMO exercises that do the most to remove the anomalies down the road. Vishay Bulk Metal Foil resistors are inherently stable as manufactured. These PMO exercises are only of value on Bulk Metal Foil resistors and they improve the performance by amounts that are small but significant when compared to the very tight tolerances. Users are encouraged to contact Vishay Foil applications engineering for assistance in choosing the PMO operations that are right for their application.

TABLE 4 - GLOBAL PART NUMBER INFORMATION (1)

NEW GLOBAL PART NUMBER: Y0019120K500V9L (preferred part number format)

DENOTES PRECISION	VALUE	CHARACTERISTICS
Y	**R** = Ω **K** = kΩ **M** = MΩ	**0** = standard **1** = tin/lead with plastic sleeve **9** = lead (Pb)-free **19** = lead (Pb)-free with plastic sleeves **2 to 999** = custom

Y	0	0	1	9	1	2	0	K	5	0	0	V	9	L

PRODUCT CODE	RESISTANCE TOLERANCE	PACKAGING
0024 = VHP202 and VH202C **0019** = VHA412 **0025** = VHA414 **0023** = VHA512 **1725** = VHA512 (4-terminals) **0104** = VHA516-4 **1726** = VHA516-4 (4-terminals) **0105** = VHA516-5 **1727** = VHA516-5 (4-terminals) **0106** = VHA516-6 **1728** = VHA516-6 (4-terminals) **0107** = VHA518-7 **1729** = VHA518-7 (4-terminals) **0108** = VHA518-8 **1730** = VHA518-8 (4-terminals) **0109** = VHA518-9 **1731** = VHA518-9 (4-terminals) **0110** = VHA518-10 **1732** = VHA518-10 (4-terminals) **0111** = VHA518-11 **1733** = VHA518-11 (4-terminals)	**S** = ± 0.001 % **U** = ± 0.002 % **X** = ± 0.0025 % **V** = ± 0.005 % **T** = ± 0.01 % **Q** = ± 0.02 % **A** = ± 0.05 % **B** = ± 0.1 % **C** = ± 0.25 % **D** = ± 0.5 % **F** = ± 1.0 %	**L** = bulk pack

FOR EXAMPLE: ABOVE GLOBAL ORDER Y0019 120K500 V 9 L:

TYPE: VHA412
VALUE: 120.5 kΩ
ABSOLUTE TOLERANCE: ± 0.005 %
TERMINATION: lead (Pb)-free
PACKAGING: bulk pack

HISTORICAL PART NUMBER: VHA412T 120K50 V B (will continue to be used)

VHA412	T		120K50	V	B
MODEL	TERMINATION	PLASTIC SLEEVE	OHMIC VALUE	TOLERANCE	PACKAGING
VHP202 and VH202C **VHA412** **VHA414** **VHA512** (2) **VHA516-4** (2) **VHA516-5** (2) **VHA516-6** (2) **VHA518-7** (2) **VHA518-8** (2) **VHA518-9** (2) **VHA518-10** (2) **VHA518-11** (2)	**T** = lead (Pb)-free **None** = tin/lead	**P** = plastic sleeve **None** = standard	**120K50** = 120.5 kΩ	**S** = ± 0.001 % **U** = ± 0.002 % **X** = ± 0.0025 % **V** = ± 0.005 % **T** = ± 0.01 % **Q** = ± 0.02 % **A** = ± 0.05 % **B** = ± 0.1 % **C** = ± 0.25 % **D** = ± 0.5 % **F** = ± 1.0 %	**B** = bulk pack

Notes

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

(2) 4-terminal construction of these types are available, please quote:

2-Terminal	VHA512	VHA516-4	VHA516-5	VHA516-6	VHA518-7	VHA518-8	VHA518-9	VHA518-10	VHA518-11
4-Terminal	302073	302074-4	302074-5	302074-6	302075-7	302075-8	302075-9	302075-10	302075-11

ULTRA HIGH PRECISION HERMETICALLY SEALED RESISTORS

INTRODUCTION

The response of Vishay's hermetically sealed resistors under variable conditions and stresses can be made better by additional in-house oriented processes (PMO). Processes such as short time overload, accelerated load life and temperature cycling produce enhanced levels of accuracy, stability and speed, offering immediate answers to many resistor applications currently believed unsolvable, and opens entirely new areas of design where the use of resistors had not been considered.

APPLICATIONS INCLUDE

- Resistance standards
- Feedback devices for operational amplifiers
- Precision voltage dividers
- Meter multipliers
- Precision bridge resistors
- Decade voltage dividers

See table 5 for the improvement to expect in hermetically sealed parts when calling for Vishay in-house oriented processes (PMO).

TABLE 5 - EXAMPLES OF NON-STANDARD REQUIREMENTS

TYPE	VALUE	TOLERANCE		TCR		REMARKS
		ABSOLUTE	MATCH	ABSOLUTE	TRACKING	
VHA518-11 Set of 10 Resistors (+ 20 °C to + 30 °C)	1 Ω	0.1 %	0.005 %	0.5 ppm/°C	0.5 ppm/°C	with PMO
VHA518-7 4-Terminal (+ 20 °C to + 30 °C)	10 Ω	0.05 %	-	0.5 ppm/°C	-	with PMO
	100 Ω	0.01 %	-	0.5 ppm/°C	-	
	120 Ω	0.005 %	-	0.4 ppm/°C	-	
	1K	0.005 %	-	0.3 ppm/°C	-	
	10K	0.001 %	-	0.3 ppm/°C	-	
	100K	0.001 %	-	0.3 ppm/°C	-	
VHA518-7 4-Terminal Matched Pairs (+ 20 °C to + 30 °C)	10 Ω	0.05 %	0.02 %	0.5 ppm/°C	0.5 ppm/°C	with PMO
	100 Ω	0.01 %	0.01 %	0.5 ppm/°C	0.5 ppm/°C	
	1K	0.005 %	0.002 %	0.3 ppm/°C	0.3 ppm/°C	
	10K	0.001 %	0.002 %	0.3 ppm/°C	0.3 ppm/°C	
	100K	0.001 %	0.002 %	0.3 ppm/°C	0.3 ppm/°C	
VHA518 Set of 10 Resistors (+ 18 °C to + 28 °C, + 23 °C ref.)	999Ω475	0.05 %	0.005 %	0.5 ppm/°C	0.5 ppm/°C	with PMO

ORDERING INFORMATION

Resistors are built to your requirements. Send your schematic and electrical requirements to the applications engineering department at foil@vishaypg.com. A unique part number will be assigned which defines all aspects of your resistor.

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