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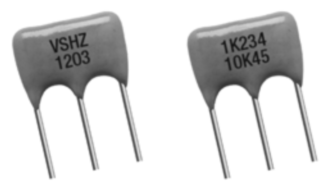
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

Ultra High Precision Z-Bulk Metal® Foil Technology Low Profile Conformally Coated Voltage Divider Resistor with TCR Tracking to 0.1 ppm/°C, Power Coefficient Tracking of 5 ppm at Rated Power, and Tolerance Match to 0.01 % (100 ppm)



APPLICATIONS

- Instrumentation amplifiers
- Bridge networks
- Differential amplifiers
- Military
- Space
- Medical
- Automatic test equipment
- Down-hole (high temperature)

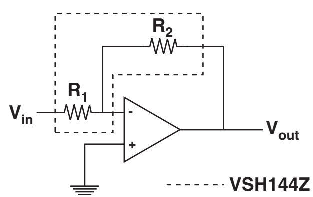


TABLE 1A - MODEL VSH144Z SPECIFICATIONS		
RESISTANCE VALUES	ABSOLUTE TOLERANCE	ABSOLUTE TCR (- 55 °C to + 125 °C, + 25 °C ref.) TYPICAL AND MAX. SPREAD
≥ 500 Ω to 20 kΩ	± 0.01 %	± 0.2 ppm/°C ± 2.5 ppm/°C
100 Ω to < 500 Ω	± 0.02 %	

TABLE 1B - MODEL VSH144Z SPECIFICATIONS		
RESISTANCE RATIO	TOLERANCE MATCH	TCR TRACKING MAX.
1:1	0.01 %	0.5 ppm/°C
> 1:1 to 4:1		0.75 ppm/°C
> 4:1 to 10:1	0.02 %	1.5 ppm/°C
> 10:1		2.0 ppm/°C

FEATURES

Pb-free Available
RoHS* COMPLIANT

- **Temperature coefficient of resistance (TCR): absolute: ± 0.05 ppm/°C typical (0 °C to + 60 °C) ± 0.2 ppm/°C typical (- 55 °C to + 125 °C, + 25 °C ref.) tracking: 0.1 ppm/°C typical**
- Tolerance: absolute and matching to 0.01 % (100 ppm)
- Power coefficient tracking "ΔR due to self heating": 5 ppm at rated power
- Power rating: 0.2 W at 70 °C, for the entire resistive element R_1 and R_2, divided proportionally between the two values
- Load life ratio stability: < 0.01 % (100 ppm) 0.2 W at 70 °C for 2000 h
- Maximum working voltage: 200 V
- Resistance range: 100R to 20K per resistive element
- Vishay Foil resistors are not restricted to standard values/ratios; specific "as requested" values/ratios can be supplied at no extra cost or delivery (e.g. 1K2345 vs. 1K)
- Electrostatic discharge (ESD) up to 25 000 V
- Non-inductive, non-capacitive design
- Rise time: 1 ns effectively no ringing
- 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 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@vpgsensors.com
- For better performances please contact us

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

INTRODUCTION

The VSH144Z voltage divider is based on the latest generation of Bulk Metal® Z-Foil technology which is the most recommended solution for ultra high precision, stability and reliable voltage division or anywhere else that requires two resistors to maintain a stable ratio under power and throughout all application variables.

Why are extremely low TCR resistors required?

This is a proper question when evaluating system cost. The answers are as numerous as the system in which they are installed but a few examples may provide insight:

1) Commercial broadcast equipment heats up through the day and requires constant manual adjustment through the day for proper signal adjustment.
2) Satellites in synchronous orbit rotate through temperature extremes.
3) A fighter jet resting on the 115° desert floor takes off and reaches altitude at - 60° in less than two minutes.
4) A system that requires fast response time in order to produce the required signal with minimum stabilization time.
   Resistors may be selected for TCR tracking but that is only useful when the resistors are operating at the same temperature. If the resistors are operating at different temperatures because of differential self-heating, or due to locally-different thermal influence from different adjacent components, or because they are operating in different regions of the equipment, the ratios change proportional to the differences in operating temperature times and the absolute TCR in addition to differences in TCR tracking ratios. Additionally, when resistors within a set have different absolute TCR's (individual TCR's - not relative or tracking TCR), the ratios change even more due to the differential self-heating as well as to differential ambient temperatures:
   Δ ratio = (TCR track x Δ temp 1) + (absolute TCR x Δ temp 2)
   where Δ temp 1 is the change of ambient temperature and Δ temp 2 is the temperature difference between two resistors due to differential self-heating.
   Differential self-heating can occur, for example, when the same current flows through resistors of different resistance values. The construction of the VSH144Z keeps both resistors at the same temperature regardless of resistance value or differential power.
   For best performance in such applications, low absolute TCRs are required.

What is TCR tracking and why it is important?

TCR tracking is a measure of the uniformity of the thermally-induced resistance changes in two or more resistors. Resistors "track" closely when their individual TCRs are close, and this is a measure of how closely these resistors will maintain their initial ratios over various temperature changes. Some resistors may increase in value with an increase in temperature (positive TCR) while others will decrease in value with an increase in temperature (negative TCR), or, they may not change in value at the same rate (differential TCR). Other temperature effects, such as self heating due to the application of power can add to the ambient temperature effects. An example of these effects can be seen where two resistors with different TCR characteristics are used around an operation amplifier. The amplification ratio will be affected by the differential TCR of the resistors and will be compounded by the differential self heating effects of the I^2R differences of the feedback VS the input resistor.

Good design practice requires fundamentally low TCR networks in this application since this would minimize both varying temperature and self heating effects.

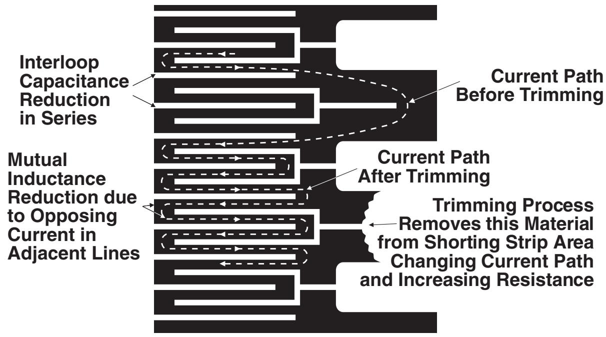
This could not be accomplished with high TCR resistors, even with good tracking.

What is the reason for such excellent stability?

The secret of Bulk Metal Z-Foil technology's benchmark stability lies in the fact that it retains the inherent metallurgical stability of the alloy from which it is made: the alloy is not melted and drawn as it is in the manufacture of wirewound resistors, nor is it evaporated and re-deposited or sputtered as it is in thin-film resistors. This underlying metallurgical stability is preserved throughout the manufacturing processes by preventing the introduction of additional stresses into the final component.

Our application engineering department is available to advise and make recommendations. For non-standard technical requirements and special applications. Please contact foil@vpgsensors.com.

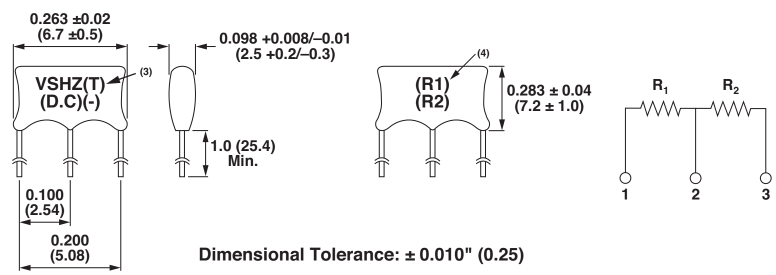
FIGURE 1 - TRIMMING TO VALUES (conceptual illustration)



Note: Foil shown in black, etched spaces in white

FIGURE 2 - STANDARD PRINTING AND DIMENSIONS in inches (millimeters)

Model VSH144Z and Schematic (2)



Dimensional Tolerance: ± 0.010" (0.25)

(1) Lead wires: #22 AWG solder coated copper, 0.75" minimum length
(2) Each divider pair consists of two resistors on one single chip
(3) For lead (Pb)-free: print "T" after VSHZ and "-" after (D.C.)
(4) If the resistance value contains more than 5 characters, the VCODE will be printed instead (see table 2).

FIGURE 3 - POWER DERATING CURVE

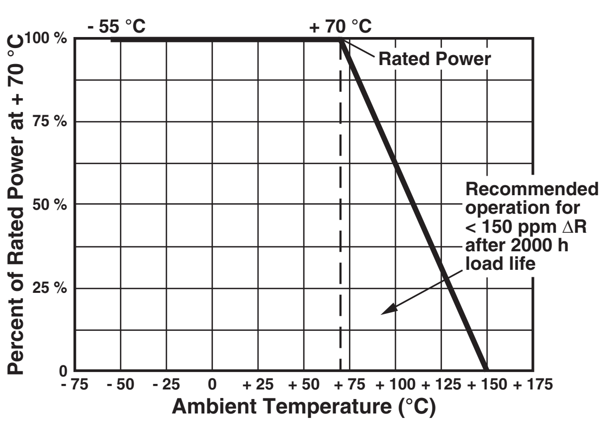
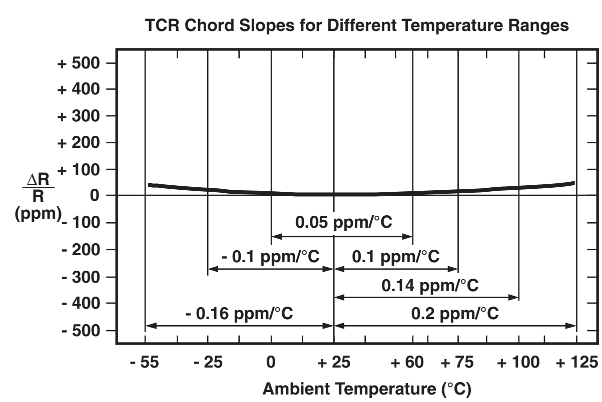


FIGURE 4 - TYPICAL RESISTANCE/ TEMPERATURE CURVE
(for more details see table 1A)



Note:
- Power is divided proportionally between the 2 values

TABLE 2 - EXAMPLES OF VCODES FOR POPULAR VALUES (other values available on request)					
VSH144Z RATIOS					
VCODES	R_1	R_2	VCODES	R_1	R_2
V0009	20K	20K	V0058	2K	20K
V0010	20K	10K	V0030	2K	18K
V0100	20K	2K	V0029	2K	4K
V0055	19K4	9K7	V0059	2K	2K
V0223	17K5	20K	V0103	2K	3K
V0097	15K	15K	V0154	1K5	3K
V0001	10K	10K	V0032	1K	16K
V0042	10K	8K323	V0121	1K	2K
V0006	10K	2K	V0004	1K	1K
V0166	10K	15K	V0379	1K	7K
V0226	9K	10K	V0374	800R	800R
V0003	9K	1K	V0022	511R	16K2
V0013	8K	16K	V0091	500R	500R
V0107	6K	20K	V0162	500R	15K
V0014	6K	7K	V0378	500R	4K5
V0160	6K	6K	V0061	300R	300R
V0159	5K5	7K7	V0088	100R	100R
V0005	5K	10K	V0380	100R	15K
V0002	5K	5K	V0375	100R	12K3
V0373	4K	12K	V0381	100R	50R
V0026	3K	19K2	V0377	50R	28K
V0156	3K	6K	V0376	35R	20K
V0158	2K7	10K	-	-	-

Note

• A combination of these values is also available in reverse order.

For any questions, contact
foil@vpgsensors.com

TABLE 3 - GLOBAL PART NUMBER INFORMATION (1)

NEW GLOBAL PART NUMBER: Y1680V0058QT9L (preferred part number format)

Y	1	6	8	0	V	0	0	5	8	Q	T	9	L

DENOTES PRECISION
- **Y**

PRODUCT CODE
- **1680** = VSH144Z

VCODE
- RESISTANCE VALUE CODE

RESISTANCE TOLERANCE
- **V** = ± 0.005 %
- **T** = ± 0.01 %
- **Q** = ± 0.02 %
- **A** = ± 0.05 %
- **B** = ± 0.1 %
- **D** = ± 0.5 %
- **F** = ± 1.0 %

TOLERANCE MATCH
- **V** = 0.005 %
- **T** = 0.01 %
- **Q** = 0.02 %
- **A** = 0.05 %
- **B** = 0.1 %
- **D** = 0.5 %
- **F** = 1.0 %

CHARACTERISTICS
- **0** = standard
- **9** = lead (Pb)-free
- **1 to 999** = custom

PACKAGING
- **L** = bulk pack

FOR EXAMPLE: ABOVE GLOBAL ORDER Y1680 V0058 Q T 9 L:

TYPE: VSH144Z
VALUES: 2K/20K
ABSOLUTE TOLERANCE: ± 0.02 %
TOLERANCE MATCH: 0.01 %
TERMINATION: lead (Pb)-free
PACKAGING: bulk pack

HISTORICAL PART NUMBER: VSH144ZT 2K/20K TCR0.2 Q T B (will continue to be used)

VSH144Z	T	2K/20K	TCR0.2	Q	T	B
MODEL	TERMINATION	OHMIC VALUE	TCR CHARACTERISTIC	ABSOLUTE TOLERANCE	TOLERANCE MATCH	PACKAGING
VSH144Z	**T** = lead (Pb)-free **None** = tin/lead alloy	R_1 = 2 kΩ R_2 = 20 kΩ		**V** = ± 0.005 % **T** = ± 0.01 % **Q** = ± 0.02 % **A** = ± 0.05 % **B** = ± 0.1 % **D** = ± 0.5 % **F** = ± 1.0 %	**V** = 0.005 % **T** = 0.01 % **Q** = 0.02 % **A** = 0.05 % **B** = 0.1 % **D** = 0.5 % **F** = 1.0 %	**B** = bulk pack

Note

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

For any questions, contact
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