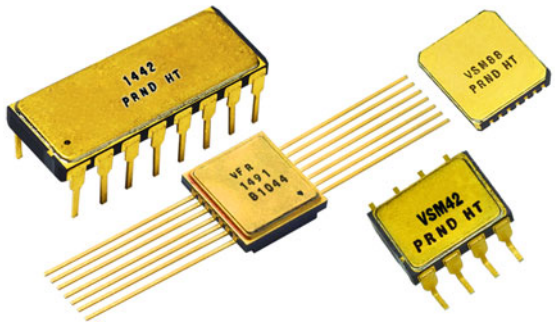
Custom Hermetically Sealed Precision Resistor Network Devices (PRND) For High Temperature Applications up to +230°C with Load Life Stability of 0.03% and Long Term Stability of 0.03%



INTRODUCTION

PRND (Precision Resistor Network Devices) are custom made, hermetically sealed networks which incorporate all the performance features of the Bulk Metal® Foil technology. The PRND can be configured to various circuit schematics and specifications the customer requests. Multiple Bulk Metal® Z1-Foil HTHG chip resistors are arranged within the devices and connected by gold-wire bonding. Hermetic sealing of Vishay Foil Resistors' networks enhances their already inherently stable environmental performance. The result is improved load life stability and better performance during high temperature and moisture exposure.

The combination of the ceramic package which has the advantage of electrical isolation on the underside and high heat dissipation capability ("heat-sink effect"), together with the hermeticity and the location of the chips within the package help preserve uniform conditions inside it.

The best long term tracking stability for thermally coupled resistors is guaranteed by the mounting of the resistors in the same hermetically sealed package. This assembly ensures uniform environmental conditions for the resistors. The electrical specs in a hermetically sealed network hold their tight TC ratio under the combined influences of temperature, load and time.

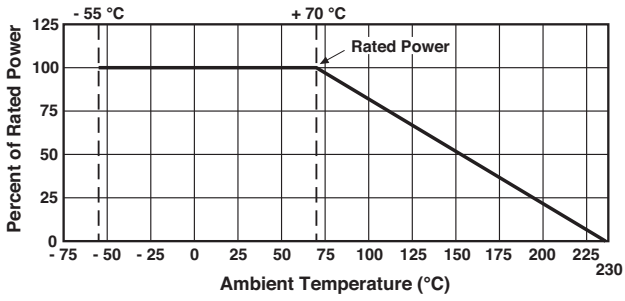
The Bulk Metal® Foil technology's advantage in such a construction assures remarkable performance due to the following factors: fundamentally low TCR, tight tolerance, very small drift with load over time, common behavior: all drifts move in the same direction with temperature, load and time, TCR and tolerance match and excellent tracking.

Vishay Foil Resistors' hermetic networks are based on fabrication from a standing inventory of packages and resistor chips. This permits quick delivery of prototypes since there are no masks to design or trial processing to be made. Further, it allows a large combination of values, tolerances and circuits. There are normally no engineering or setup charges, and no minimum quantities are required.

FEATURES

- **Temperature coefficient of resistance (TCR):**
  Absolute: ± 2.5 ppm/°C typical
  Tracking: 2.5 ppm/°C typical
  (- 55 °C to + 200 °C, + 25 °C ref.)
- Resistance range: 5 Ω to 125 kΩ (per chip)
- Resistance tolerance: Absolute: to ± 0.01%
  Match: to ±0.005%
- Hermetically sealed for maximum environmental protection
- Power rating(2): 0.4W to 1.4W per package, at +70 °C
  50 mW to 150 mW per resistor, at +70 °C
- **Load life stability:**
  ΔR: 0.03% typical (derated power at 200 °C, 2000 h)
  ΔRatio: 0.015% typical
- **Long-term High Temperature Exposure:**
  ΔR: 0.03% typical (1000h @ +230°C, Zero power)
  ΔRatio: 0.015% typical
- **Shelf life stability:**
  ΔR: ± 2 ppm typical after at least 6 years
  ΔRatio:± 2 ppm typical
- 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)
- Thermal stabilization time < 1 s (nominal value achieved within 10 ppm of steady state value)
- Rise time: 1 ns effectively no ringing
- Non-inductive, non-capacitive design
- Current noise: 0.010 μV_{RMS}/V of applied voltage (< - 40 dB)
- Voltage coefficient: 0.1 ppm/V
- Non inductive: 0.08 μH
- Non hot spot design
- Terminal finish: gold plated (lead (Pb)-free)

FIGURE 1 - POWER DERATING CURVE (2)



Notes

(1) For internal configuration and circuit schematic, please contact Application Engineering

(2) For power rating per each package, please refer to page 4

HIGH TEMPERATURE PRODUCTS

Resistors are the passive building blocks of an electrical circuit. They may be used for dropping the voltage, buffering the surge when the circuit is turned on, providing feedback in a monitoring loop, sensing current flow, etc. When the application requires stability over time and load, initial accuracy, minimal change with temperature for more than 200 °C, resistance to moisture and a number of other characteristics that will be described below, only the new generation of Vishay Foil Resistors have the attributes needed for such application. In recent years, there has been considerable growth in the demand for precise, stable and reliable resistors that can operate in harsh environments and especially at high temperatures to 220 °C. Many analog circuits for industrial, military, aerospace, medical, down-hole, oil well and automotive applications require passive components such as resistors to have a minimal drift from their initial values when operating above + 175 °C and in humid environments. In these applications, the most important factor is the temperature dependence and the end of life tolerance (which is part of the stability) and to a lesser extent, the initial tolerance.

The new Vishay Foil resistors provide stabilities well under the maximum allowable drift required by customers' specifications through thousands of hours of operation under harsh conditions, such as the extreme temperatures and radiation-rich environments of down-hole oil-well logging applications, in the frigid arctic, under the sea or in deep space. All Bulk Metal® Foil resistors receive stabilization processing, such as repetitive short term power overloads, to assure reliable service through the unpredictable stresses of extreme operation. Compared to Bulk Metal® Foil, thick and thin film resistor elements are produced with materials over which there is only limited control. Heat or mechanical stresses on the resistive elements cause the particles forming the film to expand. However, after these stresses are alleviated, the particles in the film matrix do not return to the exact original position. That degenerates their overall stability.

Vishay Foil Resistors' Ultra High Precision Bulk Metal® Foil technology includes many types of resistors with a variety of standard configurations that can withstand unconventional environmental conditions above and below the earth's surface using special post manufacturing operations specially developed for this purpose. The stability of a resistor depends primarily on its history of exposures to high temperature. Stability is affected by:

1. Changes in the ambient temperature and heat from adjacent components (defined by the Temperature Coefficient of Resistance, or TCR)
2. Destabilizing thermal shock of sudden change of applied power (defined by the Power Coefficient of Resistance, or PCR)
3. Long-term exposure to applied power (load-life stability)
4. Repetitive stresses from being switched on and off

In very high-precision resistors that need to operate in an environment with temperatures above + 175 °C, these effects must be taken into account to achieve high stability with changes in load (Joule Effect) and ambient temperature.

The Bulk Metal® Foil Resistors' new Z1-Foil technology provides an order of magnitude reduction in the Bulk Metal® Foil element's sensitivity to temperature changes — both external and internal – with emphasis on long term stability in high temperature environments.

In order to take full advantage of the low TCR and long term stability improvement, it is necessary to take into account the differences in the resistor's response to each of the above-mentioned effects. As described below, new products have been developed to successfully deal with these factors. For high temperature applications where stability and total error budget is the main concern, the new generation of Vishay Foil resistors offers the best resilience against time at elevated temperature.

The new Vishay Foil technology allows us to produce customer-oriented products designed to satisfy unique and specific technical requirements. In addition to the special chip stabilization under extreme environment conditions in the production line, we offer additional specially oriented post manufacturing operations (PMO) for high temperature applications that require an even higher degree of reliability and stability.

Electrostatic Discharge (ESD) is another potential problem that can cause unpredictable failure in high temperature applications that increase the sensitivity of the resistors to ESD.

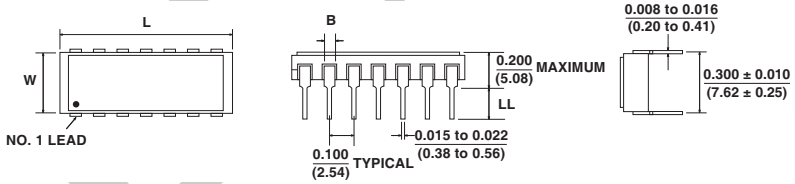
ESD damage to electronic devices can occur at any point in the device's life cycle, from manufacturing to field service. A resistor that is exposed to an ESD event may fail immediately or may experience a latent defect. With latent defects, premature failure can occur after the resistor is already functioning in the finished product after an unpredictable length of service. Bulk Metal® Foil resistors are capable of withstanding electrostatic discharges at least to 25 kV without degradation.

VFR's Application Engineering department is always available to assist with any special requirements you might have. If you are not sure which resistor best suits your needs, please do not hesitate to contact them for more information: Foil@vishaypg.com

TABLE 1 - PRND NETWORK PERFORMANCE (TESTS IN ACCORDANCE TO MIL-PRF-83401)(1)		
TEST OR CONDITION		**ΔR LIMITS OF BULK METAL® Z1-FOIL TECHNOLOGY (TYPICAL)**
Resistance Temp Characteristic (- 55 °C to + 200°C, +25 °C ref.)	ppm/°C	±2.5
Tracking To Reference Element (- 55 to + 125 °C)	ppm/°C	±2.5
Max Ambient Temp at Derated Power		+ 200 °C
Max Ambient Temp at Zero Power		+ 230 °C
Thermal Shock and Power Conditioning	ΔR ΔRatio	±0.003% ±0.01%
Low Temperature Operation (45 min at Rated power , -65°C)	ΔR ΔRatio	±0.01% ±0.01%
Short Time Overload (@ 6.25 x Rated power , 5 sec)	ΔR ΔRatio	±0.01% ±0.01%
Terminal Strength (Pull test & Bend test)	ΔR ΔRatio	±0.01% ±0.01%
Resistance to Soldering Heat (10 sec @ +260)	ΔR ΔRatio	±0.01% ±0.01%
Moisture Resistance (10 days)	ΔR ΔRatio	±0.01% ±0.01%
Shock (Specified Pulse) (100g, 6 msec)	ΔR ΔRatio	±0.01% ±0.01%
Vibration, High Frequency (10Hz - 2000Hz), 20G	ΔR ΔRatio	±0.01% ±0.01%
Load Life (+ 200 °C, Derated Power, 2000 hours)	ΔR ΔRatio	±0.03% ±0.015%
Long-term High Temperature Exposure 1000h @ +230°C, Zero power	ΔR ΔRatio	±0.03% ±0.015%
Low Temperature Storage	ΔR ΔRatio	±0.01% ±0.01%
Insulation Resistance		10,000 MΩ
Resistance Tolerance and, when applicable, Resistance Ratio Accuracy		±0.01% ±0.005%

PACKAGE SIZES AND CHARACTERISTICS(1)(2)

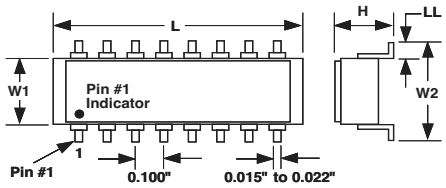
FIGURE 2 - DUAL-IN-LINE PACKAGE (DIP) CONFIGURATION(2)



MODEL	NO. OF PINS	MAXIMUM DIMENSIONS IN INCHES (MM)				MAXIMUM POWER RATING (WATTS) AT + 70 °C
		L	W	B	LL (Typical)	
1442	8	0.520 ± 0.020 (13.21 ± 0.51)	0.310 ± 0.010 (7.874± 0.025)	0.054 (1.37)	0.170 (4.318)	0.4
1445	14	0.770 ± 0.008 (19.558±0.203)	0.310± 0.08 (7.874± 2.032)	0.047 (1.194)	0.170 (4.318)	1.2
1446	16	0.800 ± 0.010 (20.32±0.254)	0.310 ± 0.010 (7.874± 0.025)	0.049 (1.245)	0.170 (4.318)	1.4

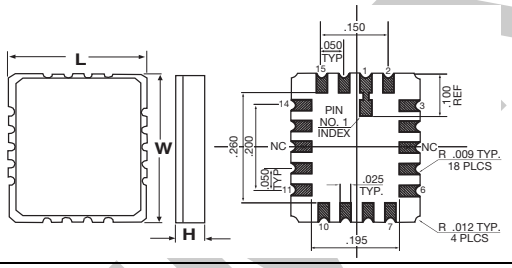
NOTES:
1. Measurement error allowed for ΔR limits: 0.01 Ω
2. For internal configuration and circuit schematic, please contact Application Engineering

FIGURE 3 - GULL WING CONFIGURATION(2)



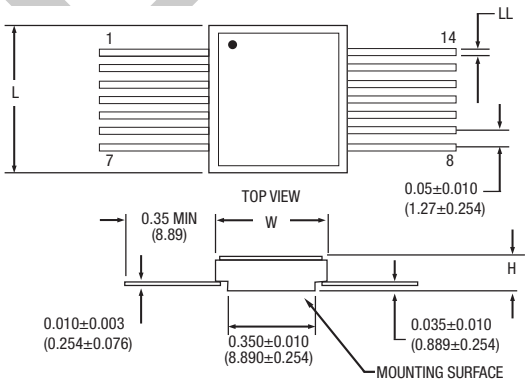
MODEL	NO. OF PINS	MAXIMUM DIMENSIONS IN INCHES (MM)					MAXIMUM POWER RATING (WATTS) AT + 70 °C
		L	W1	W2	H	LL	
VSM42	8	0.520 ± 0.020 (13.21 ± 0.51)	0.310 ± 0.010 (7.874± 0.025)	0.440 ± 0.030 (11.176 ± 0.762)	0.180 (4.572)	0.075 ± 0.015 (1.905 ± 0.381)	0.4
VSM45	14	0.770 ± 0.008 (19.558±0.203)	0.310± 0.08 (7.874± 2.032)	0.440 ± 0.030 (11.176 ± 0.762)	0.180 (4.572)	0.075 ± 0.015 (1.905 ± 0.381)	1.2
VSM46	16	0.800 ± 0.010 (20.32±0.254)	0.310 ± 0.010 (7.874± 0.025)	0.450 ± 0.020 (11.43± 0.508)	0.180 (4.572)	0.045 ± 0.010 (1.143 ± 0.254)	1.4

FIGURE 4 - LEADLESS CHIP CARRIER (LCC) CONFIGURATION(2)



MODEL	NO. OF PINS	MAXIMUM DIMENSIONS IN INCHES (MM)				MAXIMUM POWER RATING (WATTS) AT + 70 °C
		L	W	H	LL	
VSM85	16	0.295 (7.493)	0.360 (9.144)	0.090 (2.286)	N/A	0.4

FIGURE 5 - FLATPACK CONFIGURATION(2)



MODEL	NO. OF PINS	MAXIMUM DIMENSIONS IN INCHES (MM)				MAXIMUM POWER RATING (WATTS) AT + 70 °C
		L	W	H	LL	
1491	14	0.470±0.010 (11.938±0.254)	0.450±0.010 (11.43±0.254)	0.140 Max (3.556)	0.028±0.006 (0.711±0.154)	1.4

Notes

(1) Other hermetic package configurations also available.

(2) For internal configuration and circuit schematic, please contact Application Engineering.

TABLE 2 - MECHANICAL SPECIFICATIONS	
Resistive Element	High precision Bulk Metal® Foil chips
Body	Ceramic package: 94 % alumina (Al_2O_3)
Lid	Gold plated kovar
Terminals	Alloy 42 (iron nickel) with 100 µ" gold plating (MIL-STD-1276, type G-21-A)
Internal Connections	Gold wire bonding
Solderability	Per MIL-PRF-83401
Marking Resistance to Solvents	Permanency testing per MIL-PRF-83401

FIGURE 6 - SAMPLE CIRCUIT DESIGN AND CHIP LAYOUT (VSM42 MODEL)

NOTE:

Usable area is represented by the dotted lines - a rectangle 0.150 Inches x 0.200 Inches. Illustrations not to scale. Chips shown undersize for clarity. Drawing view is from the top looking down into the package.

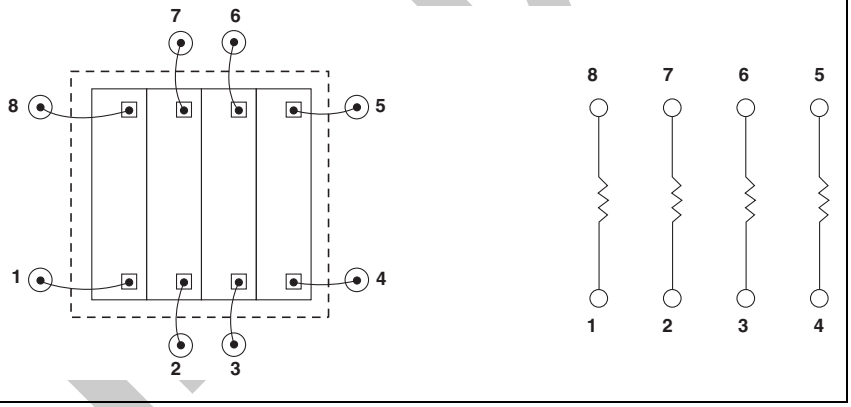
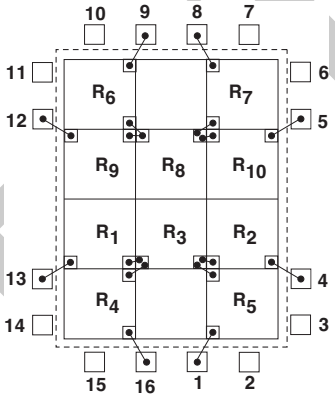
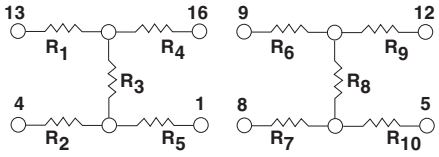


FIGURE 7 - SAMPLE CIRCUIT DESIGN AND CHIP LAYOUT (VSM85 MODEL)



NOTE:

Usable area is represented by the dotted lines - a rectangle 0.150" x 0.200". Illustrations not to scale. Chips shown undersize for clarity. Drawing view is from the top looking down into the package.



ORDERING INFORMATION

Hermetically Sealed Precision Resistor Network Device (PRND) are built to your requirements. Send your schematic and electrical requirements to the Applications Engineering Department (foil@vishaypg.com). A unique part number will be assigned which defines all aspects of your network.

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