VISHAY PRECISION GROUP

Bulk Metal® Foil Resistors

Precision Resistor Network Devices (PRND)

Where the World Goes
for Precision Measurement and Control

5 April 2011

Designing with Foil Resistors in Hermetic Packages

- When relative performance along with absolute performance is a resistance requirement, the preferred solution is a network of resistors
- The combining of resistors in a common package reduces the temperature variation by sharing the heat during non-uniform loading
- Hermetic sealing of VFR networks enhances their already inherently stable environmental performance
- The result is improved load life stability and better performance during high temperature and moisture exposure

Designing with Foil Resistors in Hermetic Packages

- 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 the same environmental conditions for the resistors
- VFR has implemented several stabilization patterns, considered proprietary, to enhance the stability for military/airborne/space applications
- The electrical specs in a hermetically sealed network hold their tight TC ratio under the combined influences of temperature, load, and time

Designing with Foil Resistors in Hermetic Packages

- The hermeticity, location of the chips within the package, and the “heat sink” effect of the ceramic package itself, help to preserve uniform conditions inside it
- The foil technology advantage in such a construction assures remarkable performance due to the following factors:
  - Fundamentally low TCR
  - Very small drift with load over time
  - Common behavior: all drifts move in the same direction with temperature, load, and time
  - VFR applies a proprietary stabilization process especially designed to minimize the shifts over extended time frames

Designing with Foil Resistors in Hermetic Packages

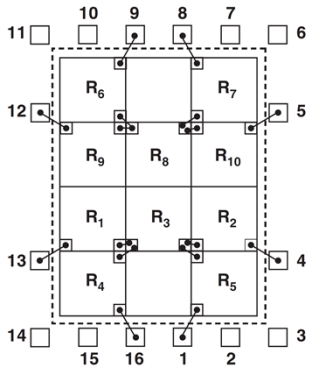
- The Table below shows the expected performance from resistor networks made in various ways including thick film, thin film and Bulk Metal Foil

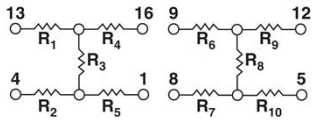
NETWORK TECHNOLOGY	THICK FILM	THIN FILM	HERMETIC FOIL
Absolute tolerance	1 %	0.10 %	0.005 %
Ratio tolerance available	1 %	0.10 %	0.005 %
Temperature coefficient	300 ppm/°C	25 ppm/°C	5 ppm/°C
TCR tracking	100 ppm/°C	10 ppm/°C	0.5 ppm/°C
Tracking change with load life	500 ppm	250 ppm	20 ppm
Δratio with moisture	1000 ppm	5000 ppm	10 ppm
Rise time	50 ns	10 ns	1 ns without ringing
Resistance to soldering heat	0.25 % - 3 %	0.10 %	0.01 %

PRND

- Precision Resistor Network Devices (PRNDs) are custom designed hermetically-sealed networks which can be configured to any circuit schematic and specifications the customer desires

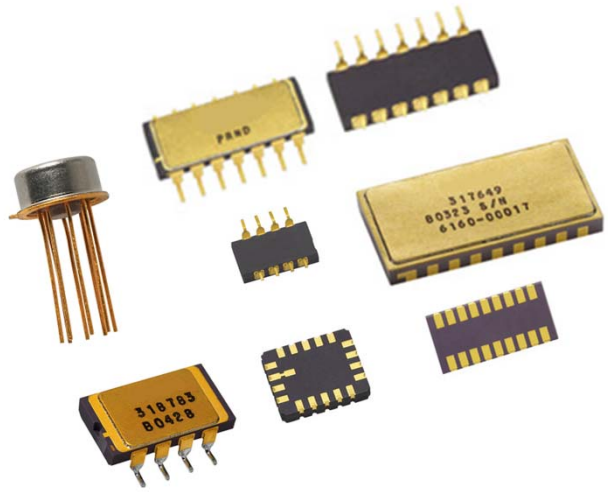
- Multiple VFR hybrid chip resistors are arranged within the devices and connected by gold-wire bonding





Vishay Foil Hermetic PRND

- Large inventory of packages and resistor chips
- Die attachment
- Wire bonding
- Value trimming
- Dry nitrogen back-fill
- Hermetic sealing



Packages

- The enclosure method employed by VFR for DIP, LCC and Flatpack packages utilizes a ceramic package and a gold plated Kovar lid tin/gold solder-sealed to the ceramic

- TO packages have a glass to metal seal header and a metal can or cover is welded to the header

Packages

- Glass-to-metal seal headers offer good thermal dissipation and sharing of temperatures between resistors
- Ceramic dual-in-line packages offer more pin availability and more chip capacity
- Ceramic flatpacks offer the lowest profile, but take more board space
- Ceramic leadless carriers are also available, but when tight tolerances or low values are considerations, fixturing and associated contact resistance must be taken into account

Standard Available Packages

DIP, PLUG-IN, LEADLESS CARRIER, AND FLATPACKS	
Ceramic package:	94 % alumina (AL_2O_3)
Lid:	Gold plated Kovar
Attachment:	Solder - tin/gold eutetic
Leads:	Alloy 42 (iron nickel) with 100 µ" gold plating, MIL-STD-1276, type G-21-A
TO packages:	
Metal cover:	Grade A nickel
Header:	Gold plated Kovar
HERMETICITY	
Gross leak:	No bubbles, MIL-STD-202, method 112, test condition D
Fine leak:	$< 5 \times 10^{-7}$ cc/s MIL-STD-202, method 112, test condition C, procedure 111A

Hybrid Chip Resistors

- The principal building blocks of the networks are VFR Bulk Metal foil resistor hybrid chips: V5X5, V15X5, and V15X10

  (also available with Z foil: V5X5Z and V15X5Z)

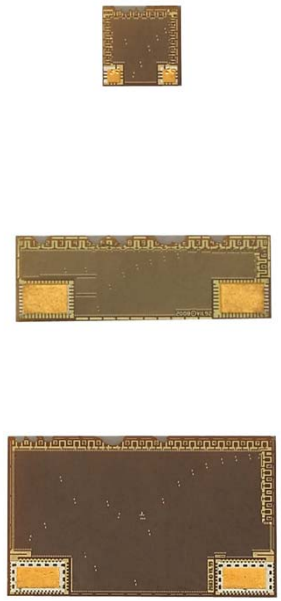
- Certain specialty chips are also available (or produced on demand) when warranted

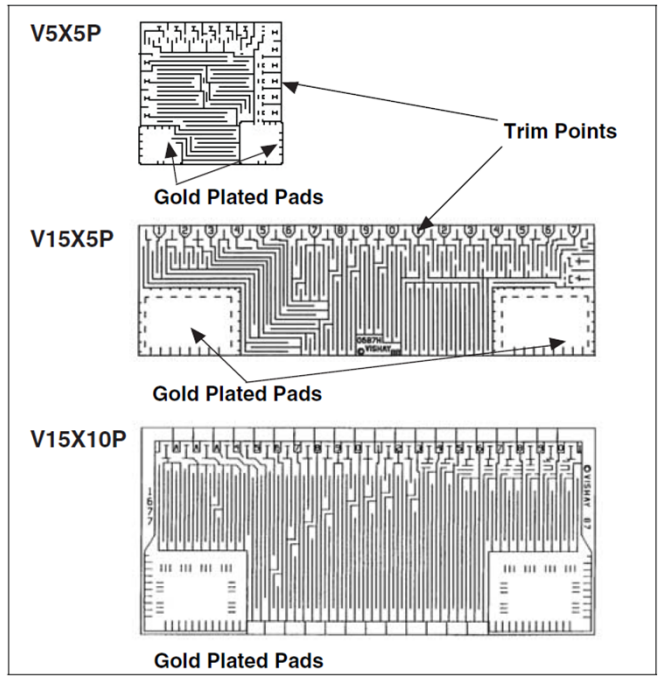
- The chips are Bulk Metal foil on a high alumina substrate and with a protective coating applied for handling purposes

- The pads are gold plated for gold ball bonding interconnects during assembly

Hybrid Chips

FORMAT OF CHIP RESISTORS USED IN HERMETIC NETWORKS





Packages and Their Potential Circuits

MODEL #	GENERIC PACKAGE	NUMBER OF PINS	CHIP V5x5 CAPACITY	CHIP V15x5 CAPACITY	PACKAGE POWER	EXAMPLES OF CIRCUITS
1401	TO18	3	2	1	0.15 W	Divider, center-tap grounded
1403	TO18	4	5	1	0.15 W	Divider, case grounded
1413	TO5	8	9	3	0.4 W	Divider, case isolated
1417	TO5	8	12	3	0.4 W	Three dividers
1419	TO5	10	12	3	0.4 W	Shift-down weighted ladder
1421	TO8	12	49	16	0.6 W	Four dividers
1422	TO8	16	49	15	0.6 W	7-bit ladder
1442 (1)	DIP	8	12	4	0.4 W	Four feed-through Rs
1445 (1)	DIP	14	30	10	1.2 W	Two decades of BCD ladder
1446 (1)	DIP	16	36	12	1.4 W	11-resistor string with taps
1457	DIP	18	80	25	1.8 W	7-bit R2R ladder
1460	DIP	20	221	73	2.4 W	12-bit R2R ladder
VSM85	LCC	16	12	4	0.4 W	Four dividers
VSM86	LCC	20	16	4	0.6 W	Five dividers
VSM87	LCC	24	16	5	0.6 W	Six dividers
VSM88	LCC	28	25	10	1.0 W	Seven dividers
VSM89	LCC	32	35	14	1.4 W	Eight dividers
1476	Flatpack	30	225	75	2.4 W	12-bit R2R ladder

Note

(1) Available in Gull-Wing Lead-Form package

Military & Space Qualification

Qualified Producers List (QPL)

- VFR models 1445Q and 1446Q networks are qualified to MIL-PRF-83401, Characteristic C, Schematic A
- Actual performance exceeds all the requirements of MIL-PRF-83401characteristics “C”
- Model 1445Q contains 7 resistors and 1446Q contains 8 resistors
  - Qualified resistance range is 100 Ω through 10 kΩ
  - Other values are available non-QPL
  - Power rating is 0.1 W per resistor

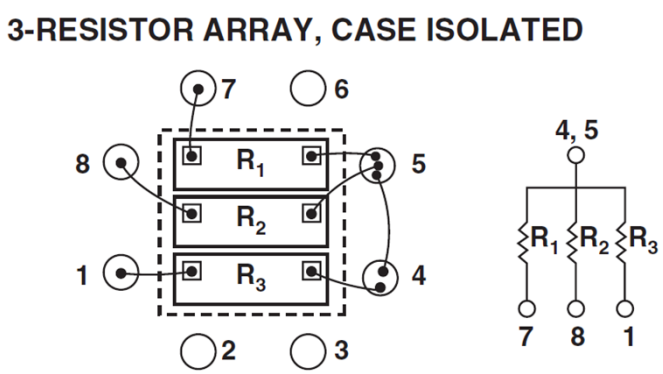
Model	Mil Spec No.	Termination Type	Resistance Range	Absolute Tolerance	No. of Resistors	Absolute TCR (Mil Range)
1445Q	MIL-PRF-83401	14 pin DIP	100 R - 10 K	0.1 %	7	100 R - 1 K 10 ppm/°C 1 K - 10 K 5 ppm/°C
1446Q		16 pin DIP			8	

PRND in Compliance with EEE-INST-002

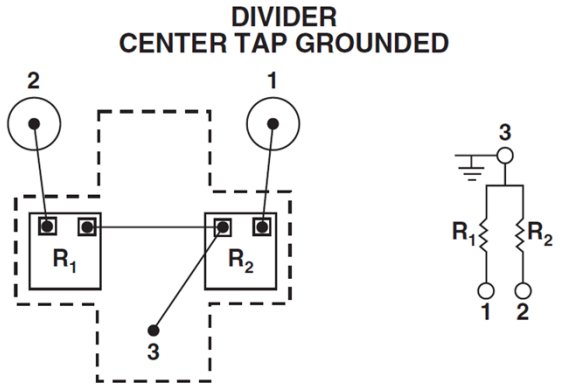
- Custom Hermetically Sealed Precision Resistor Network Device (PRND) featuring Screen/Test Flow in Compliance with EEE-INST-002: Tables 2A and 3A, Film/Foil, Level 1 and MIL-PRF-83401
  - Table 2A: 100% tests/inspections
  - Table 3A: Destructive tests per MIL-PRF-83401
- Available with various package types:
  - E.g. LCC, DIP, Gull Wing, Flatpack, and more
- Please contact foil@vishaypg.com for more information.

Custom PRNDs - Examples

3-resistor array in 1413 package:

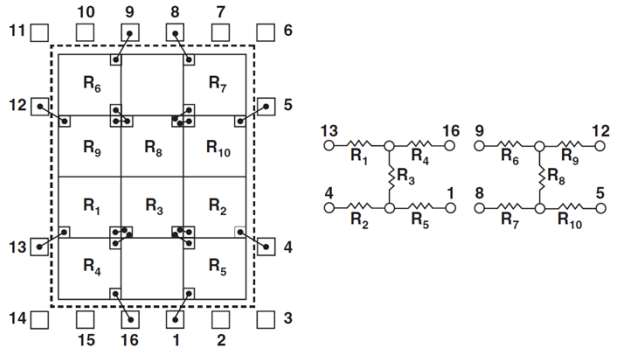


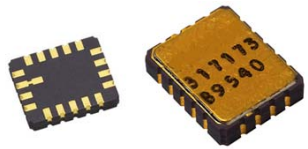
Divider in 1401 package:



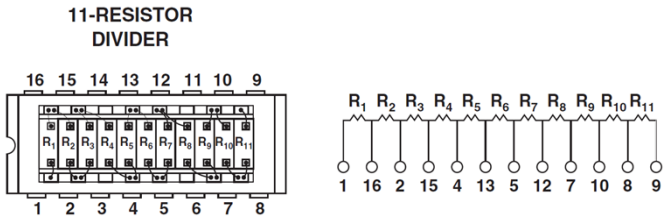
Custom PRNDs - Examples

4 voltage dividers in VSM86 package:





11-resistor divider in 1446 package:



PRND Key Benefits

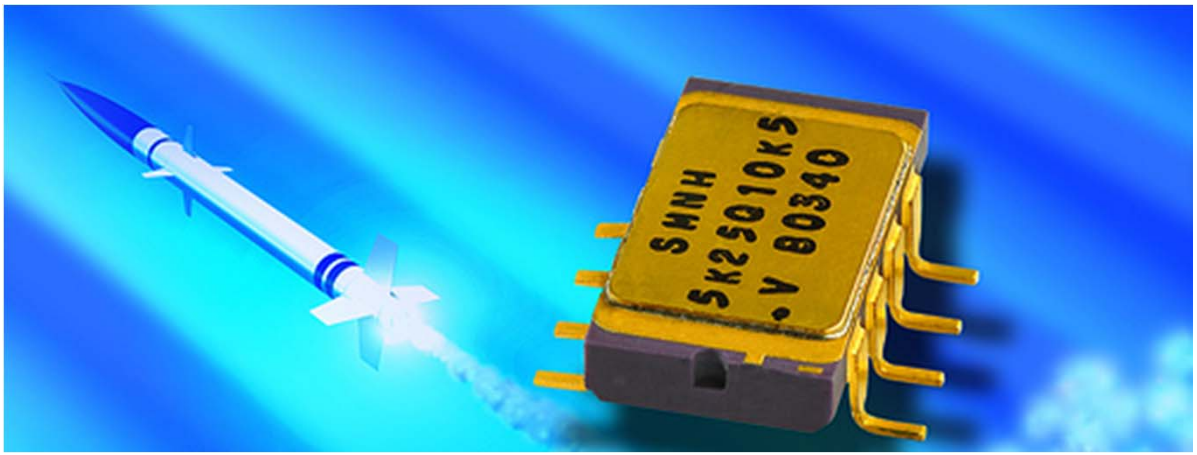
- Temperature coefficient of resistance (TCR):
  - To ±2 ppm/°C. (-55°C to +125 °C, + 25 °C Ref.)
  - Tracking to ±0.5 ppm/ °C . (-55 °C to +125 °C, +25 °C Ref.)
- Resistance range: 5 Ω to 80 kΩ (per chip)
- Resistance tolerance : Absolute to 0.005%, Match to 0.002%
- Load life stability: to ±0.015% (70 °C, 2000 h at rated power)
- Custom designed hermetically-sealed networks
- Multiple foil hybrid chips are arranged within a device and connected by gold-wire bonding
- Wide variety of packages (e.g. DIP, LCC, TO etc)

Inherent Characteristics of Foil Resistors

- VFR resistors are not restricted to standard values, specific “as-required” values (e.g., 100.1234 Ω vs 100 Ω) can be supplied at no extra cost or delivery time
- Electrostatic discharge (ESD): at least to 25 kV
- Rise time: 1 ns, effectively no ringing
- Thermal stabilization time <1 s

  (nominal value achieved within 10 ppm of steady state value)
- Non-inductive, non-capacitive design
- Voltage coefficient: 0.1 ppm/V
- Current noise: 0.010 µV RMS/V of applied voltage (<- 40dB)
- Thermal EMF: <0.1 µV/°C

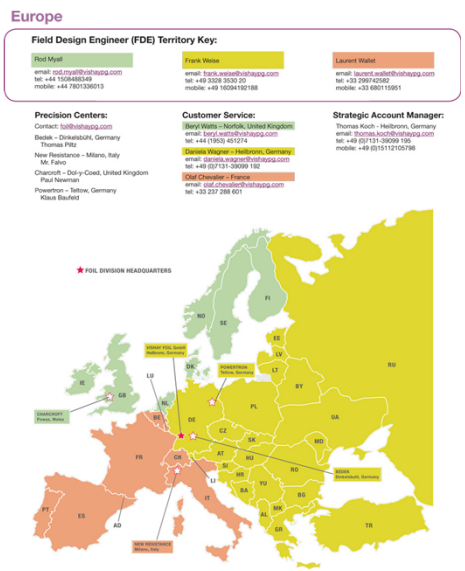
Foil PRND



For compete list of our foil PRND please refer to :

http://www.vishaypg.com/foil-resistors/hybrid-chips-prnd/

Europe



Central and South America

North America

Asia and Israel

For further information please contact our Application Engineering department at:

foil@vishaypg.com

www.vishayfoilresistors.com