

# Bulk Metal<sup>®</sup> Foil Resistors

## Hybrid Chips



Stress Measurements



Process Control



Hospital Patient Bed Weighing



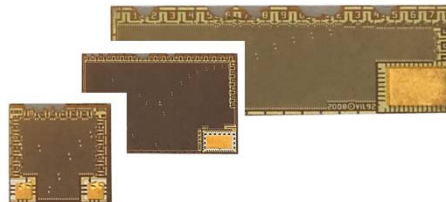
Precision Navigation Systems



Axle Overload Protection

# Hybrid Chips

- Hybrid chips with gold-plated pads are available for the customer to use gold-wire bonding between the components in their circuit
- The use of gold-wire bonding maintains the characteristics necessary for the chip to have a low thermal EMF, since using the same elements and materials reduces the potential difference which can cause an EMF
- The customer has wide flexibility in determining the implementation and selection of chips



## Hybrid Chips

- A number of chips are available varying in size, trimming specifications, and foil technology—this includes the latest release of **Z-Foil hybrid chips**
- With a maximum temperature coefficient of resistance (TCR) of  $\pm 0.2$  ppm/ $^{\circ}$ C, selected TCR tracking to 0.5 ppm/ $^{\circ}$ C and factory supplied resistance tolerances to  $\pm 0.01\%$ , they provide the user with accuracy and stability not available in other chip resistor products
- If desired they can be trimmed to  $\pm 0.005\%$ , where the value remains stable after trimming
- Load life stability is 0.05%  $\Delta R$  maximum under full rated power for 2000 h at + 70 $^{\circ}$ C
- Shelf life stability is 0.0005%  $\Delta R$  maximum per year (hermetically sealed)

## Hybrid Chips

- In analog circuits, the most important factor is the end of life tolerance, which is part of the stability and, to a lesser extent, the initial tolerance
- Foil hybrid Z-Foil chips 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

## Hybrid Chips

- 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
- Offering the utmost in ESD immunity, the V5X5, V15X5, and V15X10 withstand electrostatic discharges at least to 25 kV, for increased reliability, and offer a non-inductive ( $<0.08 \mu\text{H}$ ) and non-capacitive design
- Hybrid chips are also available for high-temperature applications above  $+220^{\circ}\text{C}$

# Trimming

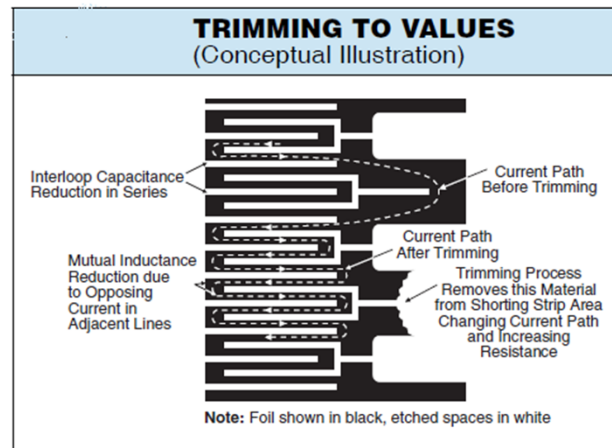
- The customer has the opportunity to order untrimmed chips, in which user trimming can be done either before or after bonding—using standard epoxies onto the hybrid circuit substrate using standard laser, air abraid, or manual adjustment techniques
- The precision trimming system allows for adjustment to precise resistance values without concern over mechanical override and control problems encountered in laser or air abraid trimming of solid geometry resistance patterns

# Trimming

- This ability to trim resistor chips to tolerance levels never before available to hybrid manufacturers, now gives a design engineer the ability to increase the value-added level of their hybrid services
- Instead of buying precision resistors in separate packages or modules (which require additional PC board real estate) and integrating them into a system, the design engineer can utilize precision resistor chips or matched sets to manufacture the entire hybrid circuit in-house
- This eliminates the need to “pin-out” for precision resistor requirements because the precision resistors are inside part of the hybrid microcircuit design

# Trimming

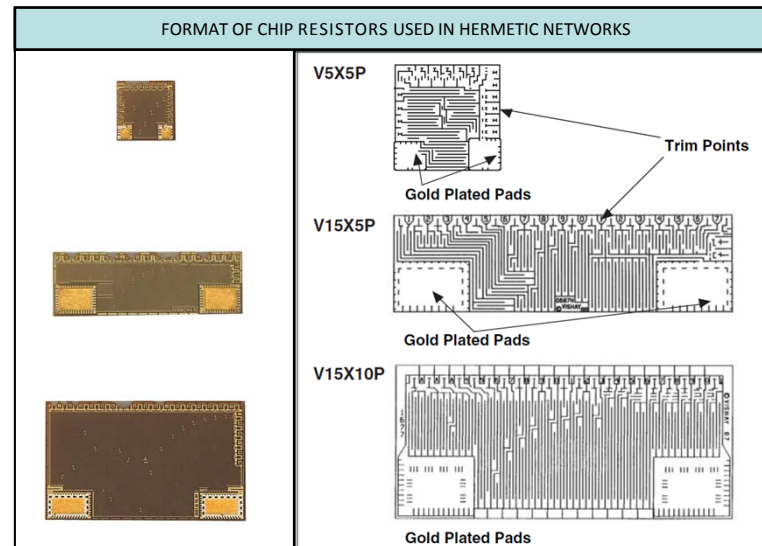
- To acquire a precision resistance value, the Bulk Metal Foil chip is trimmed by selectively removing built-in “shorting bars”
- To increase the resistance in known increments, marked areas are cut, producing progressively smaller increases in resistance
- This method reduces the effect of “hot spots” and improves the long term stability of the hybrid chips





# Trimming

- The typical pattern and trimming illustrations show that the V5X5 resistor has 16 trimming points, the V15X5 has 20 and the V15X10 has 21
- These trimming points are arranged around the chip periphery and are clearly indicated.



# Trimming

- Trimming to the desired resistance value and tolerance is accomplished by cutting the trim points, thereby producing specific incremental changes in the chip's resistance value relative to the original prevalue: up to + 20% for the V5X5, + 30% for the V15X5, and + 50% for the V15X10
- Not all trim points need to be used; the  $\Delta R$  necessary to adjust the pre-value to the desired final value dictates which trim points need to be used)

## Effects of Gold Wire

- The bonding of the gold wires to the chip has an effect on the overall resistance and on the temperature coefficient, according to the length of wire used
- The hybrid chips datasheets includes Nomogram which shows the effect on both parameters with varying lengths of 0.001" (0.0254 mm) diameter of gold wire.

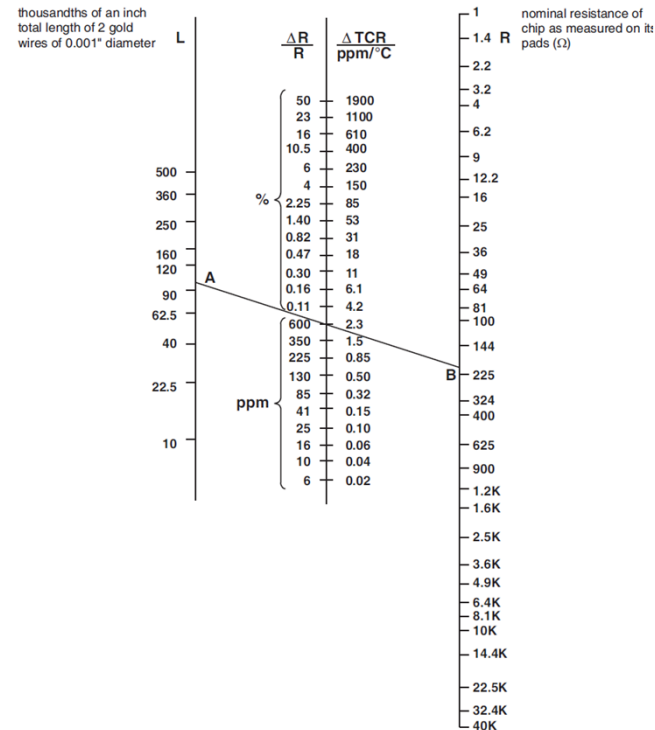
# Effects of Gold Wire

## NOMOGRAM

Change of resistance and TCR due to a length L of gold wire added at wire bonding.

### EXAMPLE:

- Total length of wires L = 0.100" (point A on left scale)
- Resistance of chip R = 200 Ω (point B on right scale)
- Read on intersection of line as with central scale:
- On left side - change of resistance:  $\Delta R/R = 600$  ppm
- On right side - change of TCR:
- $\Delta TCR = +2.3$  ppm
- Nomogram based on the following specs for gold wire:
  - Conductivity 72% of copper
  - 1.2 Ω/inch for 0.001" (0.0254 mm) diameter wire
  - TCR 3900 ppm/°C



# Hybrid Chips Key Benefits

- Temperature coefficient of resistance (TCR):
  - $\pm 0.05$  ppm/ $^{\circ}\text{C}$  typical ( $0^{\circ}\text{C}$  to  $+ 60^{\circ}\text{C}$ )
  - $\pm 0.2$  ppm/ $^{\circ}\text{C}$  typical ( $- 55^{\circ}\text{C}$  to  $+ 125^{\circ}\text{C}$ ,  $+ 25^{\circ}\text{C}$  ref.)
- TCR tracking: to 0.5 ppm/ $^{\circ}\text{C}$
- Custom hybrid chips available for high temperature applications  $>220^{\circ}\text{C}$
- Resistance tolerance: Absolute: to  $\pm 0.01\%$  (user trimmable to  $\pm 0.005\%$ )  
Match: to 0.01%
- Power rating: 50 mW to 150 mW at  $+ 70^{\circ}\text{C}$
- Load life stability:  $\pm 0.01\%$  at  $+ 70^{\circ}\text{C}$ , 10 000 h at rated power
- Resistance range: 5  $\Omega$  to 80 k $\Omega$
- Current noise: 0.010  $\mu\text{VRMS}/\text{V}$  of applied voltage ( $< - 40$  dB)

# Inherent Characteristics of Foil Resistors

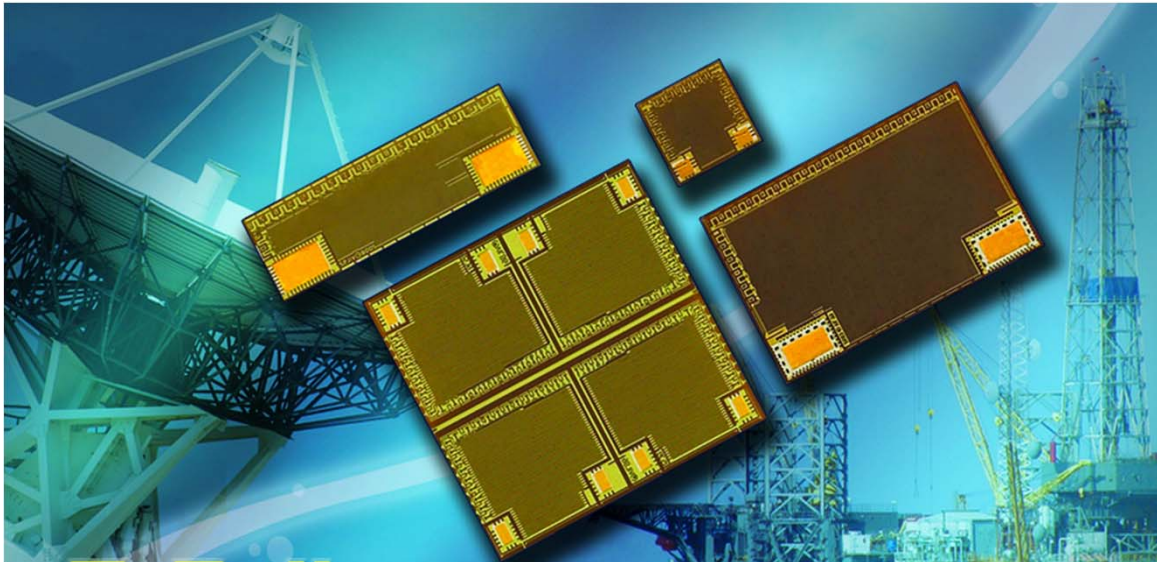
- VFR resistors are not restricted to standard values; specific “as required” values (e.g. 1K2345 vs. 1K) can be supplied at no extra cost or delivery
- Short time overload:  $\leq 0.02\%$
- Electrostatic discharge (ESD) at least to 25 000 V
- Non-inductive, non-capacitive design
- Rise time: 1 ns effectively no ringing
- Thermal stabilization time  $< 1$  s (nominal value achieved within 10 ppm of steady state value)
- Pattern design minimizing hot spots

# Special Applications

- The hybrid chips can be modified to serve in special applications such as:
  - High-temperature environments
  - Connected using aluminum wire bonding
  - Custom made configuration as networks in hermetic package (PRND)
- Applications Engineering assistance is also available to help with custom designs for multiple resistors on a single chip
- Our custom services have produced up to 16 resistors within 0.01% tolerance and TCR tracking of less than 0.1ppm/°C on a single quarter-inch square chip



## Foil Hybrid Chips



For complete list of our foil hybrid chip resistors please refer to :  
<http://www.vishaypg.com/foil-resistors/hybrid-chips-prnd/>



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