Ultra High Precision Bulk Metal® Z-Foil Chip Resistors for Use in Hybrid Circuits with TCR of 0.05 ppm/°C, Tolerance to 0.005 %, and Load Life Stability of ± 0.01 % for 10 000 h

FIGURE 1 - TRIMMING CHIP RESISTORS

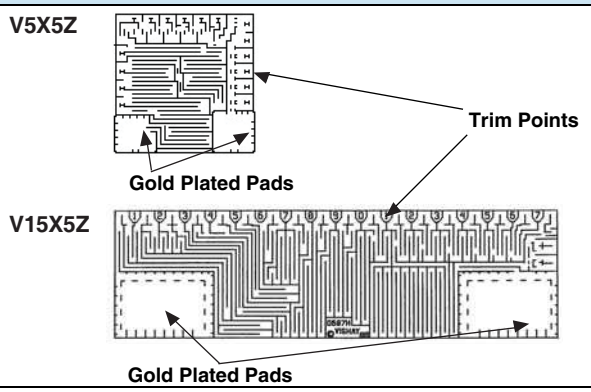
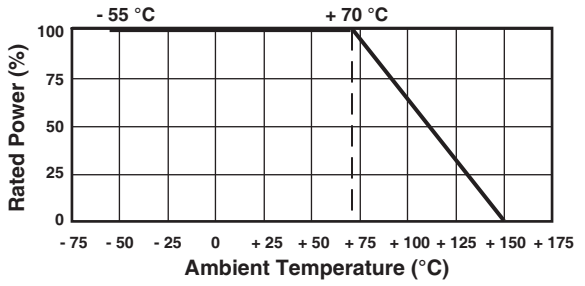


FIGURE 2 - POWER DERATING CURVE

Discrete chips suitable for working temperatures of up to + 200 °C are available on request.



FEATURES

- Temperature coefficient of resistance (TCR): 0.05 ppm/°C typical (0 °C to + 60 °C) 0.2 ppm/°C typical (- 55 °C to + 125 °C, + 25 °C ref.) TCR tracking: to 0.5 ppm/°C (1)(2)
- TCR characteristic is accomplished automatically without selection and regardless of the date of manufacture - even if years apart
- Hybrid chips with Z-Foil are also available for high temperature applications, please contact us for more details
- Resistance tolerance: Absolute: to ± 0.01 % (user trimmable to ± 0.005 %) Match: to 0.01 %
- Power rating: 50 mW to 150 mW at + 70 °C
- Load life stability: ± 0.01 % at + 70 °C, 10 000 h at rated power
- Resistance range: 50 Ω to 30 kΩ (see table 2)
- 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)
- Short time overload: ≤ 0.02 %
- Electrostatic discharge (ESD) up 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)
- Current noise: 0.010 μV_{RMS}/V of applied voltage (< - 40 dB)
- Non-inductive: < 0.08 µH
- Pattern design minimizing hot spots

Pb-free

RoHS COMPLIANT

The typical pattern and trimming illustrations show that the V5X5Z resistor has 16 trimming points, and the V15X5Z has 20. These trimming points are arranged around the chip periphery and are clearly indicated. 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 V5X5Z, + 30 % for the V15X5Z (not all trim points need be used; the ΔR necessary to adjust the pre-value to the desired final value dictates which trim points need to be used).

Monitoring of circuit output while “actively” trimming readily permits adjustment of the chip to ± 0.005 %.

Actual trimming charts are supplied on request for all images.

Vishay precision chip resistors offer an order of magnitude of improvement over other chip resistors in hybrid applications. With a maximum Temperature Coefficient of Resistance (TCR) of ± 2 ppm/°C, selected TCR tracking to 0.5 ppm/°C and factory supplied resistance tolerances to ± 0.01 %, they provide the user with accuracy and stability not available in other chip resistor products. If desired they can be user trimmed to any value within ± 0.005 %, where the value remains stable after trimming. Load life stability is 0.05 % ΔR maximum under full rated power for 2000 h at + 70 °C.

The Vishay precision trimming system allows for adjustment to precise resistance values without concern over mechanical override and control problems encountered in laser or air abrade trimming of solid geometry resistance patterns. This ability to trim resistor chips to tolerance levels never before available to hybrid manufacturers, now gives a project manager the ability to increase the value-added level of their hybrid services. More of the profit thus available can be retained within the facility. Now, instead of buying precision resistors in separate packages or modules (which require additional PC board real estate) and integrating them into a system, the project manager can utilize Vishay precision resistor chips or matched sets to manufacture the entire hybrid circuit in-house. Eliminates the need to “pin-out” for precision resistor requirements because the precision resistors are inside - part of the hybrid microcircuit design.

Vishay precision chip resistors are available either factory-trimmed to exact resistance values (option T) or ready for user trimming (option U); user trimming can be done either before or after bonding - using standard epoxies - onto the hybrid circuit substrate using standard laser, air abrade, or manual adjustment techniques. However care should be taken that no carbonization occurs when laser trimming.

TABLE 1 - TOLERANCE AND TCR VS. RESISTANCE VALUE(1)

VALUE (Ω)	STANDARD TOLERANCE (%)	TYPICAL TCR AND MAX SPREAD - 55 °C to + 125 °C, + 25 °C Ref. (ppm/°C)(2)
500 to 30K	± 0.01	± 0.2 ± 1.8
100 to < 500	± 0.02	
50 to < 100	± 0.02	± 0.2 ± 2.8

Note

(1) For tighter performances or high temperature applications, please contact application engineering.

(2) The TCR results show 4 terminal measurements. To view TCR results for 2 terminal measurements and for different gold wire lengths, refer to the nomogram on page 6.

FIGURE 3 - Z-FOIL TYPICAL RESISTANCE/ TEMPERATURE CURVE

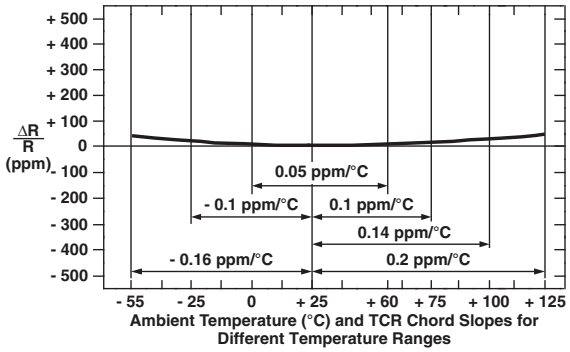


FIGURE 4 - DIMENSIONS in inches (millimeters)

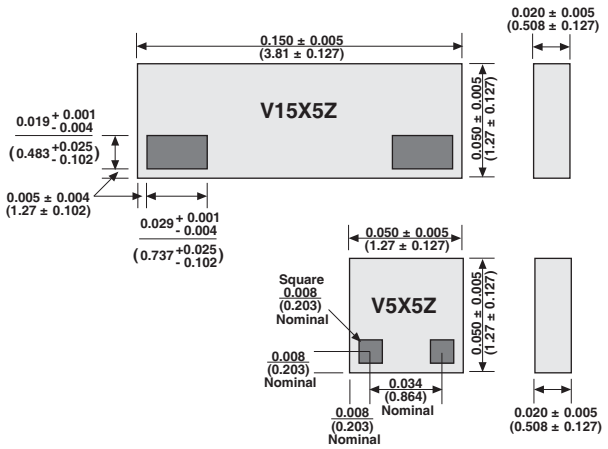


TABLE 2 - PRECISION CHIP RESISTOR SPECIFICATIONS	
Resistance range	50 Ω to 5 kΩ (model V5X5Z) 50 Ω to 30 kΩ (model V15X5Z)
TCR (- 55 °C to + 125 °C, + 25 °C Ref. (ppm/°C)	See Table 1
Trimming range (Approximate adjustment capability)	0 to 1.2 x nominal prevalue (V5X5Z)* 0 to 1.3 x nominal prevalue (V15X5Z) **Note** * The V5X5Z chips are being gradually redesigned for a higher trimming factor - 1.3 or more instead of 1.2. For information about the availability of a specific resistance value, contact the factory.
Resistance tolerance	Option T (trimmed to value at Vishay)* ± 0.01 %; ± 0.02 %; ± 0.05 %; ± 0.1 %; ± 0.25 %; ± 0.5 %; ± 1 %; ± 5 % Option U (for user trimming to any value within ± 0.005 %) G.F. = Good for values **Note** * See table 1 for resistance/tolerance limits
Power rating (at + 70 °C ambient temperature), (see figure 4)	V5X5Z: 0.05 W (15 V maximum) V15X5Z: 0.1 W (50 V maximum)
High frequency operation Rise time Inductance Capacitance	 1 ns without ringing 0.1 µH maximum; 0.08 µH typical 1.0 pF maximum; 0.5 pF typical
Current noise	< 0.010 μV_{RMS}/V of applied voltage (< - 40 dB)
Voltage coefficient	< 0.1 ppm/V
Working voltage	15 V (model V5X5Z) 50 V (model V15X5Z)
Termination pads	Gold: 50 µ" to 100 µ" thick

TABLE 3 - ENVIRONMENTAL PERFORMANCE COMPARISON		
	TYPICAL VISHAY	**MAXIMUM**
Test group I Thermal shock	 ± 0.02 %	 ± 0.04 %
Test group II Low temperature operation Short time overload High temperature exposure Resistance to bonding exposure	 ± 0.005 % ± 0.02 % ± 0.02 % ± 0.02 %	 ± 0.01 % ± 0.04 % ± 0.05 % ± 0.05 %
Test group III Moisture resistance	 ± 0.03 %	 ± 0.1 %
Test group IV (Load Life Stability) 2000 h at + 70 °C 10 000 h at + 70 °C	 ± 0.005 % ± 0.01 %	 ± 0.015 % ± 0.05 %

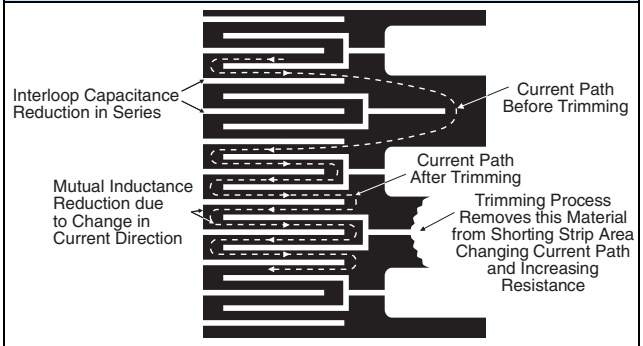
Notes

(1) TCR tracking is a measure of the similarity of resistance value change in two or more resistors which are undergoing the same temperature changes. Tracking could be expressed as the difference in the temperature coefficients of the resistors, expressed in ppm/°C as $(\Delta R_1/R_1 - \Delta R_2/R_2) \times 10^{-6}/\Delta T$ °C.

(2) Selected TCR tracking is available for specially ordered lots of resistors. The selected TCR tracking can be 3, 2, 1 and as close as 0.5 ppm/°C throughout the full temperature range. Should close TCR tracking be required for differing resistance values, contact the factory.

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 spot” and improves the long term stability of the hybrid chips.

FIGURE 5 - TRIMMING TO VALUES
(conceptual illustration)



Note: Foil shown in black, etched spaces in white

TABLE 4 - GLOBAL PART NUMBER INFORMATION (trimmed option) (1)(2)

NEW GLOBAL PART NUMBER: Y4033249R000Q0W (preferred part number format)

DENOTES PRECISION	VALUE	CHARACTERISTICS
Y	**R** = Ω **K** = kΩ	**0** = standard **1 to 999** = custom

Y	4	0	3	3	2	4	9	R	0	0	0	Q	0	W

PRODUCT CODE	RESISTANCE TOLERANCE	PACKAGING
Trimmed (2): **4033** = V5X5ZT **4034** = V15X5ZT	**T** = ± 0.01 % **Q** = ± 0.02 % **A** = ± 0.05 % **B** = ± 0.1 % **C** = ± 0.25 % **D** = ± 0.5 % **F** = ± 1.0 % **J** = ± 5.0 %	**W** = waffle pack

FOR EXAMPLE: ABOVE GLOBAL ORDER Y4033 249R000 Q 0 W:

TYPE: V5X5Z trimmed
VALUE: 249.0 Ω
ABSOLUTE TOLERANCE: ± 0.02 %
PACKAGING: waffle pack

HISTORICAL PART NUMBER: V5X5ZT 249R00 Q W (will continue to be used)

V5X5ZT	249R00	Q	W
MODEL	OHMIC VALUE	RESISTANCE TOLERANCE	PACKAGING
V5X5ZT **V15X5ZT**	**249R00** = 249.0 Ω	**T** = ± 0.01 % **Q** = ± 0.02 % **A** = ± 0.05 % **B** = ± 0.1 % **C** = ± 0.25 % **D** = ± 0.5 % **F** = ± 1.0 % **J** = ± 5.0 %	**W** = waffle pack

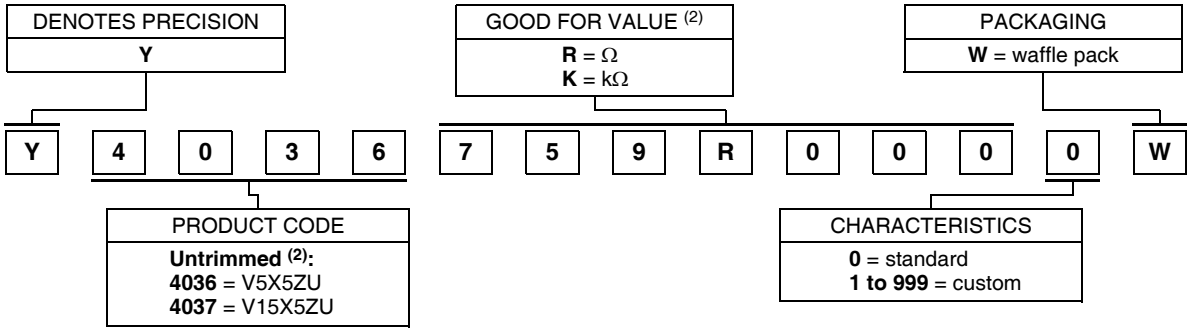
Notes

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

(2) VISHAY to supply chips trimmed to the purchaser’s exact resistance and tolerance specifications, ready for insertion into a hybrid microcircuit with no further processing other than bonding and termination. Specify exact resistance value(s) and tolerance(s).

TABLE 5 - GLOBAL PART NUMBER INFORMATION (untrimmed option) (1)(2)

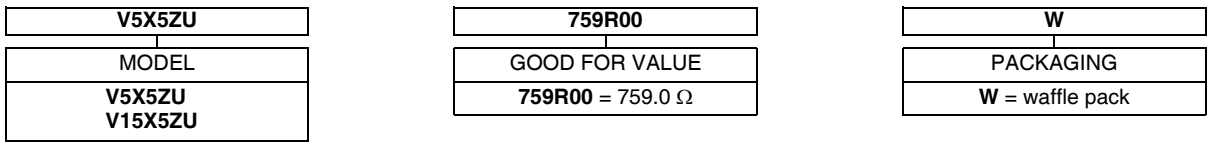
NEW GLOBAL PART NUMBER: Y4036759R0000W (preferred part number format)



FOR EXAMPLE: ABOVE GLOBAL ORDER Y4036 759R000 0 W:

TYPE: V5X5Z untrimmed
GOOD FOR VALUE: 759.0 Ω
PACKAGING: waffle pack

HISTORICAL PART NUMBER: V5X5ZU 759R00 W (will continue to be used)



Notes

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

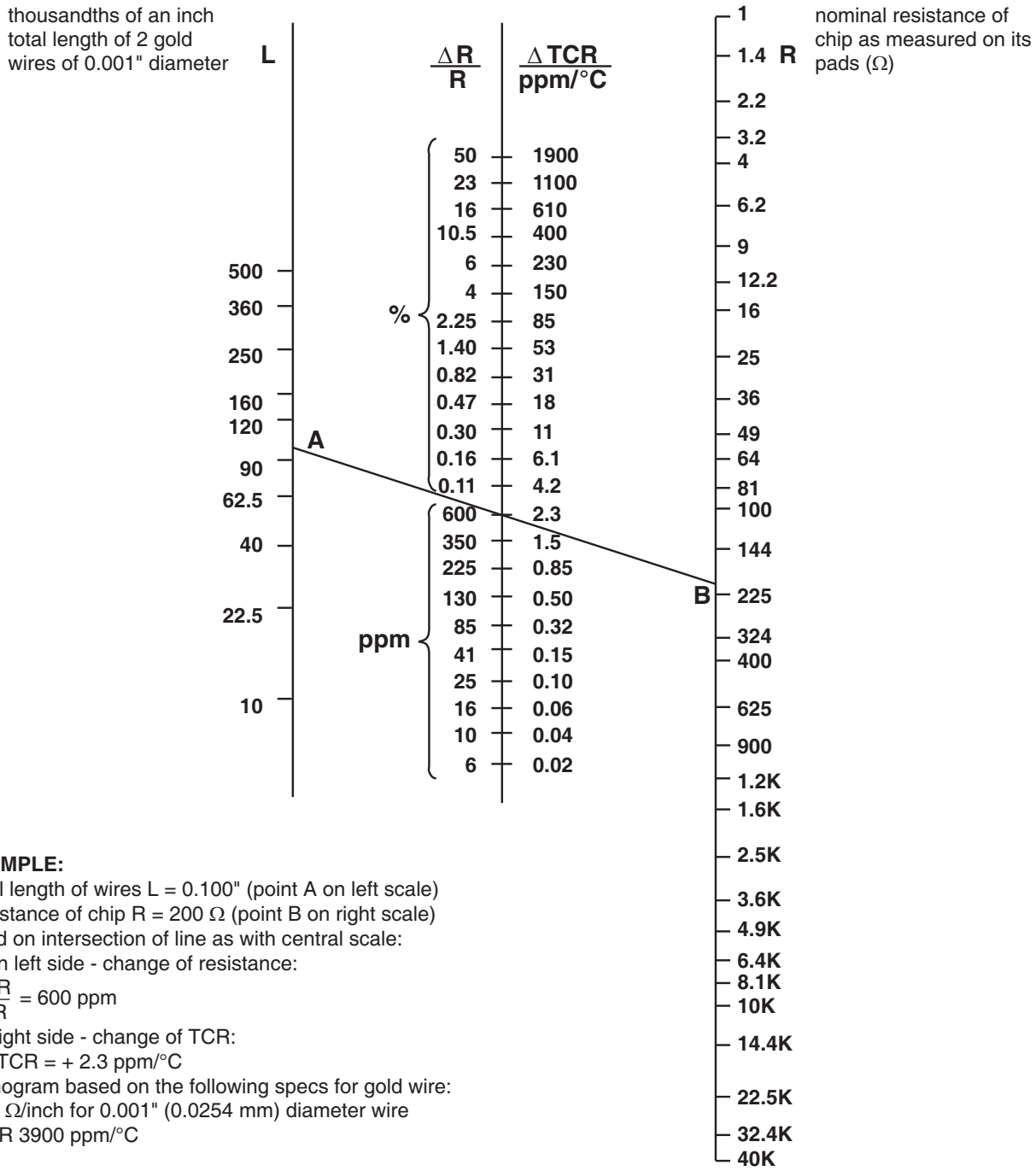
(2) To order user trimmable chips specify the final resistance value desired.

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 nomogram below shows the effect on both parameters with varying lengths of 0.001" (0.0254 mm) diameter 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:

$\frac{\Delta R}{R}$ = 600 ppm

On right side - change of TCR:
ΔTCR = + 2.3 ppm/°C
Nomogram based on the following specs for gold wire:
• 1.2 Ω/inch for 0.001" (0.0254 mm) diameter wire
• TCR 3900 ppm/°C

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