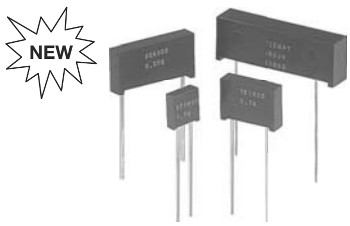
Ultra High Precision Z-Foil Resistor with TCR of ± 0.05 ppm/°C, Tolerance of ± 0.005 % (50 ppm), Load Life Stability of ± 0.005 %, ESD Immunity up to 25 kV and Thermal EMF of 0.05 µV/°C



INTRODUCTION

The Bulk Metal® Foil resistor is based on a special concept where a proprietary bulk metal cold rolled foil is cemented to a ceramic substrate. It is then photoetched into a resistive pattern. Furthermore, it is laser adjusted to any desired value and tolerance. Because the metals used are not drawn, wound or mistreated in any way during manufacturing process, the Bulk Metal Foil resistor maintains all its design, physical and electrical characteristics while winding of wire or sputtering does not. Z foil resistors achieve maximum stability and near-zero TCR. These performance characteristics are built-in for every unit, and do not rely on screening or other artificial means for uniform performances.

The stability of a resistor depends primarily on its history of exposures to 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 suddenly-applied power (defined by the power coefficient, 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, these effects must be taken into account to achieve high stability with changes in load (Joule Effect) and ambient temperature.

Vishay's new Z-Foil technology provides an order of magnitude reduction in the Bulk Metal Foil element's sensitivity to temperature changes - both external and internal. This technology provides an absolute TCR of ± 0.05 ppm/°C typical (instrument range: 0 °C to +60 °C), ± 0.2 ppm/°C typical (military range: - 55 °C to + 125 °C, + 25 °C ref), and a PCR of 5 ppm at rated power.

In order to take full advantage of this TCR improvement, it is necessary to take into account the differences in the resistor's response to each of the above-mentioned effects. The Z series has been developed to successfully deal with these factors.

TABLE 1 - TYPICAL TCR AND MAX. SPREAD
(- 55 °C to + 125 °C, + 25 °C ref.)

VALUE	STANDARD TOLERANCE	TYPICAL TCR AND MAX. SPREAD (ppm/°C)
100 Ω to 600 KΩ	± 0.005 %	± 0.2 ± 0.6
80 Ω to < 100 Ω	± 0.005 %	± 0.2 ± 0.8
50 Ω to < 80 Ω	± 0.01 %	± 0.2 ± 1.0
25 Ω to < 50 Ω	± 0.01 %	± 0.2 ± 1.3
10 Ω to < 25 Ω	± 0.02 %	± 0.2 ± 1.6

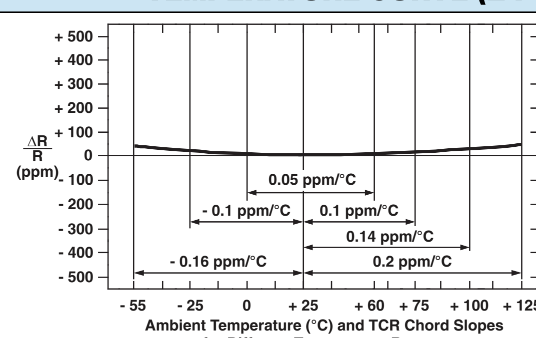
FEATURES

- **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.) (see table 1)
- Rated power: to 1 W at + 125 °C
- Resistance tolerance: to ± 0.005 % (50 ppm)
- Load life stability: to ± 0.005 % at 70 °C, 2000 h or to ±0.015% at 70°C,10000 h (see table 4)
- Resistance range: 10 Ω to 600 kΩ
- 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)
- Total accumulated change in resistance over life (EOL) < 0.05 % (or better with PMO)
- Electrostatic discharge 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
- Low inductance: < 0.08 µH typical
- Thermal stabilization time < 1 s (nominal value achieved within 10 ppm of steady state value)
- Pattern design minimizing hot spots
- Terminal finish: lead (Pb)-free or tin/lead alloy
- Matched sets are available per request (TCR tracking: to 0.5 ppm/°C)
- Prototype quantities available in just 5 working days or sooner. For more information, please contact foil@vishaypg.com
- **Load life ΔR maximum can be reduced significantly with our post manufacturing operations (PMO) see page 4 for details**

Pb-free Available

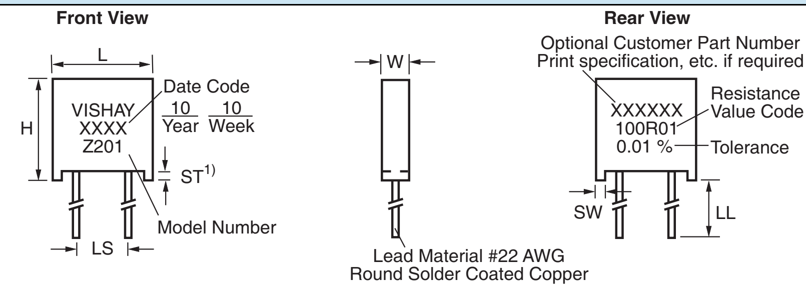
RoHS* COMPLIANT

FIGURE 1 - TYPICAL RESISTANCE/ TEMPERATURE CURVE (Z-FOIL)



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

FIGURE 2 - STANDARD IMPRINTING AND DIMENSIONS



Note

1. The standoffs shall be so located as to give a lead clearance of 0.010" minimum between the resistor body and the printed circuit board when the standoffs are seated on the printed circuit board. This is to allow for proper cleaning of flux and other contaminants from the unit after all soldering processes.

TABLE 2 - MODEL SELECTION

MODEL NUMBER	RESISTANCE RANGE (2) (Ω)	MAXIMUM WORKING VOLTAGE	AMBIENT POWER RATING at + 70 °C	AMBIENT POWER RATING at + 125 °C	AVERAGE WEIGHT (g)	DIMENSIONS INCHES	DIMENSIONS mm
Z201 (Z201L) (1)	10R to 100K	300	0.6 W	0.3 W	0.6	W: 0.105 ± 0.010 L: 0.300 ± 0.010 H: 0.326 ± 0.010 ST: 0.010 min. SW: 0.035 ± 0.010 LL: 1.000 ± 0.125 LS: 0.150 ± 0.005	2.67 ± 0.25 7.62 ± 0.25 8.28 ± 0.25 0.254 min. 1.02 ± 0.13 25.4 ± 3.18 3.81 ± 0.13
Z204	10R to 200K	350	1.0 W	0.5 W	1.4	W: 0.160 max. L: 0.575 max. H: 0.413 max. ST: 0.035 ± 0.005 SW: 0.050 ± 0.005 LL: 1.000 ± 0.125 LS: 0.400 ± 0.020	4.06 max. 14.61 max. 10.49 max. 0.889 ± 0.13 1.27 ± 0.13 25.4 ± 3.18 10.16 ± 0.51
Z205	10R to 300K	350	1.5 W	0.75 W	1.9	W: 0.160 max. L: 0.820 max. H: 0.413 max. ST: 0.035 ± 0.005 SW: 0.050 ± 0.005 LL: 1.000 ± 0.125 LS: 0.650 ± 0.020	4.06 max. 20.83 max. 10.49 max. 0.889 ± 0.13 1.27 ± 0.13 25.4 ± 3.18 16.51 ± 0.51
Z206	10R to 600K	500	2.0 W up to 400K 1.0 W over 400K	1.0 W up to 400K 0.5 W over 400K	4.0	W: 0.260 max. L: 1.200 max. H: 0.413 max. ST: 0.035 ± 0.005 SW: 0.050 ± 0.005 LL: 1.000 ± 0.125 LS: 0.900 ± 0.020	6.60 max. 30.48 max. 10.49 max. 0.889 ± 0.13 1.27 ± 0.13 25.4 ± 3.18 22.86 ± 0.51

Note

(1) 0.200" (5.08 mm) lead spacing available - specify Z201L for Z201.

(2) for non standard values please contact Application Engineering Department at foil@vishaypg.com

FIGURE 3 - POWER DERATING CURVE

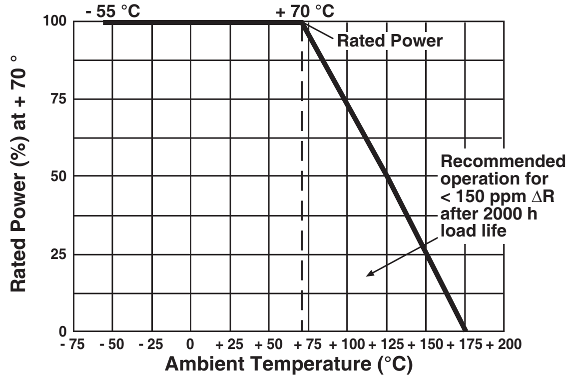
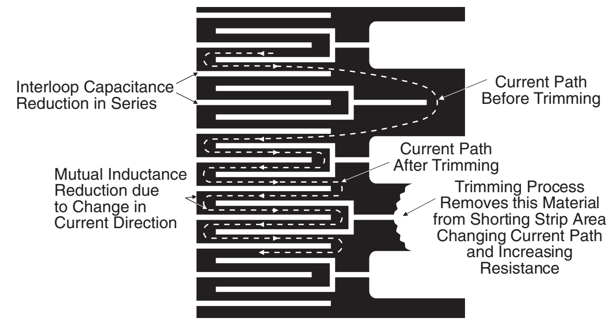


FIGURE 4 - TRIMMING TO VALUES
(conceptual illustration)



Note: Foil shown in black, etched spaces in white

TABLE 3 - ENVIRONMENTAL PERFORMANCE COMPARISON

	MIL-PRF-55182 CHAR J	Z SERIES TYPICAL ΔR	Z SERIES MAXIMUM ΔR
Test Group I			
Thermal shock, 5 x (- 65 °C to + 150 °C)	± 0.2 %	± 0.002 % (20 ppm)	± 0.01 % (100 ppm)
Short time overload, 6.25 x rated power	± 0.2 %	± 0.003 % (30 ppm)	± 0.01 % (100 ppm)
Test Group II			
Resistance temperature characteristics	± 25 ppm/°C	± 0.05 ppm/°C	see table 1
Low temperature storage (24 h at - 65 °C)	± 0.15 %	± 0.002 % (20 ppm)	± 0.01 % (100 ppm)
Low temperature operation (45 min, rated power at - 65 °C)	± 0.15 %	± 0.002 % (20 ppm)	± 0.01 % (100 ppm)
Terminal strength	± 0.2 %	± 0.002 % (20 ppm)	± 0.01 % (100 ppm)
Test Group III			
DWV	± 0.15 %	± 0.002 % (20 ppm)	± 0.01 % (100 ppm)
Resistance to solder heat	± 0.1 %	± 0.005 % (50 ppm)	± 0.01 % (100 ppm)
Moisture resistance	± 0.4 %	± 0.01 % (100 ppm)	± 0.05 % (500 ppm)
Test Group IV			
Shock	± 0.2 %	± 0.002 % (20 ppm)	± 0.01 % (100 ppm)
Vibration	± 0.2 %	± 0.002 % (20 ppm)	± 0.01 % (100 ppm)
Test Group V			
Life test at 0.3 W/+ 125 °C			
2000 h	± 0.5 %	± 0.005 % (50 ppm)	± 0.015 % (150 ppm)
10 000 h	± 2.0 %	± 0.015 % (150 ppm)	± 0.05 % (500 ppm)
Test Group Va			
Life test at 0.6 W (2 x rated power)/+ 70 °C, 2000 h	± 0.5 %	± 0.005 % (50 ppm)	± 0.015 % (150 ppm)
Test Group VI			
High temperature exposure (2000 h at + 175 °C)	± 2.0 %	± 0.05 % (500 ppm)	± 0.1 % (1000 ppm)
Test Group VII			
Voltage coefficient	5 ppm/V	< 0.1 ppm/V	< 0.1 ppm/V

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STANDARD OPERATIONS AND TEST CONDITIONS

A. Standard Test Operations:

By 100 % Inspection

- Short-time overload (6.25 x rated power for 5 s)
- Resistance - tolerance check
- Visual and mechanical

By Sample Inspection

- TCR
- Environmental tests per table 3 on a quarterly basis to establish performance by similarity

B. Standard Test Conditions:

- Lead test point: 0.5" (12.7 mm) from resistor body
- Temperature: + 23 °C ± 2 °C
- Relative humidity: per MIL-STD-202

POST MANUFACTURING OPERATIONS OR PMO

Many analog applications can include requirements for performance under conditions of stress beyond the normal and over extended periods of time. This calls for more than just selecting a standard device and applying it to a circuit. The standard device may turn out to be all that is needed but an analysis of the projected service conditions should be made and it may well dictate a routine of stabilization known as post manufacturing operations or PMO. The PMO operations that will be discussed are only applicable to Bulk Metal Foil resistors. They stabilize Bulk Metal Foil resistors while they are harmful to other types. Short time overload, accelerated load life, and temperature cycling are the three PMO exercises that do the most to remove the anomalies down the road. Vishay Bulk Metal Foil resistors are inherently stable as manufactured. These PMO exercises are only of value on Bulk Metal Foil resistors and they improve the performance by small but significant amounts. Users are encouraged to contact Vishay Foil applications engineering for assistance in choosing the PMO operations that are right for their application.

TABLE 4 - “Z” SERIES SPECIFICATIONS		
Stability (1)		
Load life at 2000 h	± 0.015 % (150 ppm)	Maximum ΔR at 0.3 W/+ 125 °C
	± 0.005 % (50 ppm)	Maximum ΔR at 0.1 W/+ 70 °C
Load life at 10 000 h	± 0.05 % (500 ppm)	Maximum ΔR at 0.3 W/+ 125 °C
	± 0.01 % (100 ppm)	Maximum ΔR at 0.1 W/+ 70 °C
Current Noise	0.010 μVRMS/V of applied voltage (< - 40 dB)	
High Frequency Operation		
Rise time	1.0 ns at 1 kΩ	
Inductance (L) (2)	0.1 μH maximum; 0.08 μH typical	
Capacitance (C)	1.0 pF maximum; 0.5 pF typical	
Voltage Coefficient	< 0.1 ppm/V (3)	
Thermal EMF (4)	0.05 μV/°C typical	
	1 μV/W	(Model Z201)

Notes

(1) Load life ΔR maximum can be reduced by 80 %, please contact applications engineering department.
(2) Inductance (L) due mainly to the leads.
(3) The resolution limit of existing test equipment (within the measurement capability of the equipment, or “essentially zero”.)
(4) μV/°C relates to EMF due to lead temperature difference and μV/watt due to power applied to the resistor.

TABLE 5 - GLOBAL PART NUMBER INFORMATION [1]

NEW GLOBAL PART NUMBER: Y145380K5000V9L (preferred part number format)

Y	1	4	5	3	8	0	K	5	0	0	0	V	9	L

DENOTES PRECISION
Y

VALUE
R = Ω
K = kΩ
M = MΩ

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

PRODUCT CODE
1453 = Z201
1454 = Z201L
1441 = Z204
1443 = Z205
1447 = Z206

RESISTANCE TOLERANCE
V = ± 0.005 %
T = ± 0.01 %
Q = ± 0.02 %
A = ± 0.05 %
B = ± 0.1 %
C = ± 0.25 %
D = ± 0.5 %
F = ± 1.0 %

PACKAGING
L = bulk pack

FOR EXAMPLE: ABOVE GLOBAL ORDER Y1453 80K5000 V 9 L:
TYPE: Z201
VALUE: 80.5 kΩ
ABSOLUTE TOLERANCE: ± 0.005 %
TERMINATION: lead (Pb)-free
PACKAGING: bulk pack

HISTORICAL PART NUMBER: Z201 T 250R00 V B (will continue to be used)

Z201	T	250R00	V	B
MODEL	TERMINATION	RESISTANCE VALUE	TOLERANCE	PACKAGING
Z201 **Z201L** **Z204** **Z205** **Z206**	**T** = lead (Pb)-free None = tin/lead alloy	**250R00** = 250.00 Ω **5K2310** = 5.231 kΩ **1M000** = 1 MΩ	**V** = ± 0.005 % **T** = ± 0.01 % **Q** = ± 0.02 % **A** = ± 0.05 % **B** = ± 0.1 % **C** = ± 0.25 % **D** = ± 0.5 % **F** = ± 1.0 %	**B** = bulk pack

Note

[1] For non-standard requests, please contact application engineering.

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