Ultra High Precision, Z-Foil Audio Resistor Minimizes Noise and Distortion in the Signal Path with TCR of ± 0.05 ppm/°C, Tolerance to ± 0.005 % and High Linearity or Low Voltage Coefficient of Resistance (VCR) of 0.1 ppm/V

INTRODUCTION

Many manufacturers and users of precision electronic equipment suffer needlessly from unexplained instabilities and drifts due to noise effects. They resign themselves to making constant adjustments and troubleshooting. But in fact these can be avoided. Instability is often traceable to a few supposedly “fixed” resistors which are not really fixed at all. If these resistors would only retain their original values, there would be no need for costly controls and other compensating circuitry. That’s why the only resistor for applications such as these is Vishay Bulk Metal® Foil. In high-end audio equipment, careful selection of resistors is one of the best ways to avoid or minimize noise and distortion in the signal path. Noise is an unwanted wide spectrum signal that may be superimposed on any useful signal, including DC. Resistors, like other passive components, are noise sources to various degrees, depending upon resistance value, temperature, applied voltage, and resistor type. Many experiments have been done to show why some resistors are “noisier” than others. But the only test that audio experts and audiophiles have agreed on is comparing the level of fidelity that results when different resistor technologies are used in actual audio systems.

High-end analog audio applications require low intrinsic noise, high linearity of amplification, and minimal dynamic distortion. The typical audio amplifier consists of a voltage preamplifier (preamp) and power amplifier (final driver). The voltage preamplifier deals with low-level signals. That is why its intrinsic noise level is critical. Resistors are among the principal noise sources in the amplifiers. The main requirements for the audio power amplifier are high linearity of amplification and minimal dynamic distortion. Vishay Foil resistors are characterized by very low intrinsic non-linearity of the resistive element, which is made from cold-rolled bulk metal.

The VAR, composed of Vishay’s Bulk Metal® Z-foil technology, with improved sound quality, provides a combination of low noise and low inductance/capacitance, making it unrivalled for applications requiring low noise and distortion-free properties.

FEATURES

Pb-free Available

RoHS* COMPLIANT

- **Temperature coefficient of resistance (TCR):** ± 0.05 ppm/°C typical (0 °C to + 60 °C,+ 25 °C ref.) ± 0.2 ppm/°C typical (0 °C to + 125 °C, + 25 °C ref.)
- Rated power: to 0.4 W at + 70 °C
- Resistance tolerance: to ± 0.01 % (0.005% is available)
- Load life stability: to ± 0.005 % at 70 °C, 2000 h at rated power
- Resistance range: 10 Ω to 100 kΩ
- "Naked Z-foil resistor" design without molding or encapsulation adds an additional dimension for reducing signal distortion and increasing clarity in signal processing.
- 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)
- Electrostatic discharge (ESD) at least to 25 000 V
- Non-inductive, non-capacitive design
- Rise time: 1 ns, effectively no ringing
- Current noise: 0.010 µV (RMS)/Volt of Applied Voltage (< - 40 dB)
- Thermal EMF: 0.05 µV/°C
- Voltage coefficient: < 0.1 ppm/V
- Thermal stabilization time < 1 s (nominal value achieved within 10 ppm of steady state value)
- Inductance: < 0.08 µH typical
- The Z-Foil chip in the VAR has been especially treated to increase load life stability.
- Terminal Finish: lead (Pb)-free or tin/lead alloy(1)
- Prototype quantities available in just 5 working days or sooner. For more information, please contact foil@vishaypg.com

For better performances please contact us.

While the regular foil resistors are already widely acknowledged as the leading resistors for audio applications, the special “naked Z-foil resistor” design without mold or encapsulation, adds an additional dimension for reducing signal distortion and increasing clarity in signal processing. Our application engineering department is available to advise and to make recommendations. For non-standard technical requirements and special applications, please contact us.

Bulk Metal Foil resistors owe their low current noise and high linearity to the type of material they’re made of: a several microns thick cold-rolled metal foil. Every real-world resistor possesses certain nonlinearity of its electrical resistance (nonlinearity of volt-ampere characteristic). The degree of nonlinearity depends on two factors:

- Micro factors: internal microstructure of resistive material.
- Macro factors (laser trimming cuts cleanness, micro cracking in resistive element resulting from laser trimming, quality of contacts between resistive element and terminals, etc.).

As for the microstructure, the most linear materials are pure metals and metal alloys in bulk, such as the foil in Bulk Metal® Foil resistors. When the same materials are deposited in the form of very Thin (nanometer range) Films, they are less linear. Even less linear are composite materials like resistive cermets in Thick-Film resistors or carbon compositions in carbon composition resistors.

The macro factors that cause nonlinearity in other types of resistors aren’t relevant to foil resistors. Indeed, laser trimming of foil resistors consists of cutting shorting jumpers and does not damage current carrying portions of resistive element. Terminals in foil resistors are an integral part of the foil resistive element. This insures high-quality contact between resistive element and terminals

Several types of noise are found in resistors:

Thermal noise is caused by thermal movement of electrons in resistive material and gets worse as resistance and temperature increase. Thermal noise can be reduced by reducing resistance, temperature, or signal bandwidth.

Shot or fluctuation noise is caused by the discrete nature of charge carriers and fluctuation of their number in the unit of volume. Shot noise can be reduced by reducing bandwidth or increasing current. The spectral density of voltage in both thermal and shot noises is uniformly distributed in entire range of frequencies (“white” noise). The level of these types of noise does not depend on resistor type (resistive element material).

Current (excess, flicker) noise has 1/f type spectral density of voltage (“pink” noise). Its level essentially depends on resistor material. Current noise can be reduced by a) avoiding use of the low frequency band, b) reducing current, c) increasing the volume of resistive material, i.e. by using resistors with higher rated power than is needed for proper power dissipation, or d) using less noisy resistive materials.

Carbon composition resistors are the noisiest such device type followed by Thick Film and Thin Film resistors. The least noisy are bulk metals and metal alloys (foil, wire). At that, negligible capacitance/inductance of foil resistors (when compared to wirewound resistors) significantly reduces probability of self-excitation or "ringing" of amplification circuit.This is why Bulk Metal® foil resistors are such a good choice for low-noise applications.

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

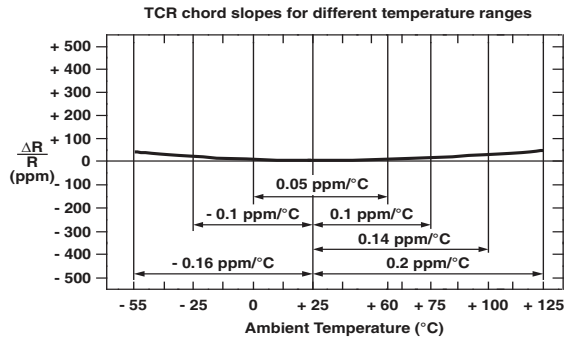


TABLE 1 - RESISTANCE VERSUS TCR (- 55 °C to + 125 °C, + 25 °C Ref.)(2)

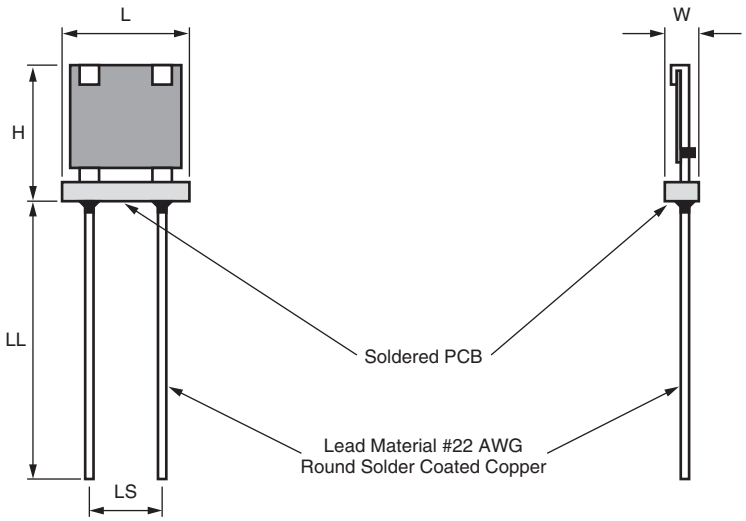
RESISTANCE VALUE (Ω)	TYPICAL TCR AND MAXIMUM SPREAD (ppm/°C)	TIGHTEST TOLERANCE (%)
100 to < 100K	± 0.2 ± 1.8	0.01
50 to < 100	± 0.2 ± 2.8	0.01
10 to < 50	± 0.2 ± 3.8	0.02

Note:

(1) Pb containing terminations are not RoHS compliant, exemptions may apply

(2) For non-standard requests, please contact application engineering at foil@vishaypg.com

FIGURE 2 - STANDARD DIMENSIONS



This product is fragile and may be damaged if mishandled.

VPG assumes no responsibility for damage caused by improper handling.

TABLE 2 - SPECIFICATIONS

RESISTANCE RANGE (Ω)	MAXIMUM WORKING VOLTAGE	AMBIENT POWER RATING		DIMENSIONS	
		at + 70 °C	at + 125 °C	INCHES	mm
10 to 100K	200	0.4 W	0.2 W	W: 0.080 max. L: 0.250 max. H: 0.310 max. LL: 1.000 ± 0.125 LS: 0.150 ± 0.005	W: 2.03 max. L: 6.35 max. H: 7.87 max. LL: 25.4 ± 3.18 LS: 3.81 ± 0.13

FIGURE 3 - POWER DERATING CURVE

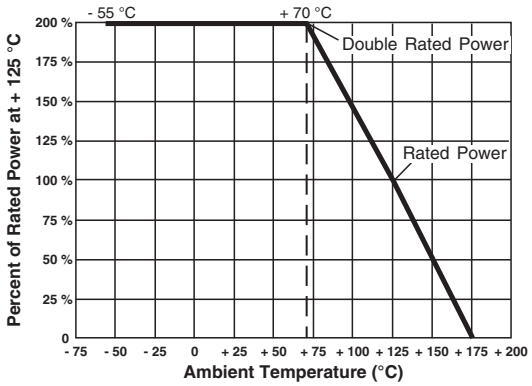
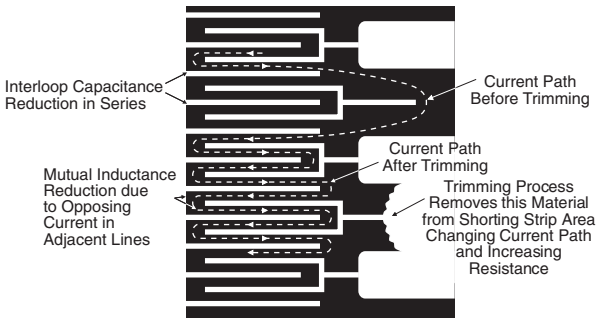


FIGURE 4 - TRIMMING TO VALUES
(Conceptual Illustration)

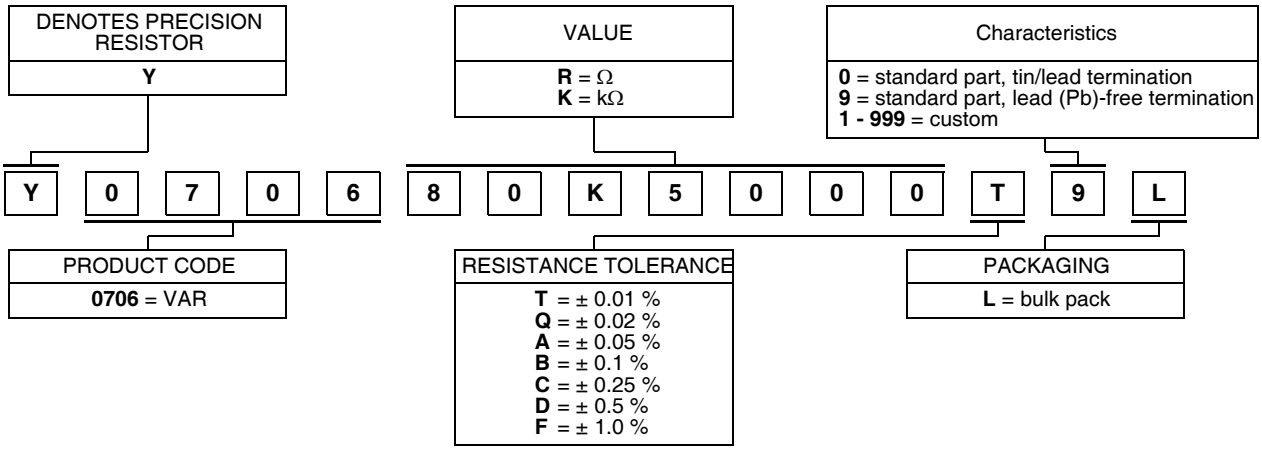


Note: Foil shown in black, etched spaces in white

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.

TABLE 3 - GLOBAL PART NUMBER INFORMATION(1)

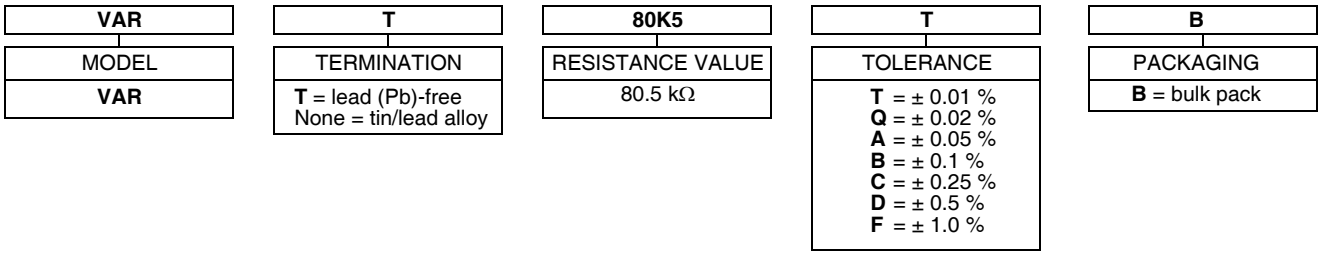
NEW GLOBAL PART NUMBER: Y070680K5000T9L (preferred part number format)



FOR EXAMPLE: ABOVE GLOBAL ORDER Y0706 80K5000 T 9 L:

TYPE: VAR
VALUE: 80.5 kΩ
ABSOLUTE TOLERANCE: ± 0.01 %
TERMINATION: lead (Pb)-free
PACKAGING: bulk pack

HISTORICAL PART NUMBER: VAR T 80K5 T B (will continue to be used)



Note

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

Disclaimer

ALL PRODUCTS, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE.

Vishay Precision Group, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, “Vishay Precision Group”), disclaim any and all liability for any errors, inaccuracies or incompleteness contained herein or in any other disclosure relating to any product.

The product specifications do not expand or otherwise modify Vishay Precision Group’s terms and conditions of purchase, including but not limited to, the warranty expressed therein.

Vishay Precision Group makes no warranty, representation or guarantee other than as set forth in the terms and conditions of purchase. **To the maximum extent permitted by applicable law, Vishay Precision Group disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.**

Information provided in datasheets and/or specifications may vary from actual results in different applications and performance may vary over time. Statements regarding the suitability of products for certain types of applications are based on Vishay Precision Group’s knowledge of typical requirements that are often placed on Vishay Precision Group products. It is the customer’s responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application.

No license, express, implied, or otherwise, to any intellectual property rights is granted by this document, or by any conduct of Vishay Precision Group.

The products shown herein are not designed for use in life-saving or life-sustaining applications unless otherwise expressly indicated. Customers using or selling Vishay Precision Group products not expressly indicated for use in such applications do so entirely at their own risk and agree to fully indemnify Vishay Precision Group for any damages arising or resulting from such use or sale. Please contact authorized Vishay Precision Group personnel to obtain written terms and conditions regarding products designed for such applications.

Product names and markings noted herein may be trademarks of their respective owners.