Ultra High-Precision Through-Hole Foil Resistor for High Temperature Applications up to +200°C

FEATURES

- Temperature coefficient of resistance (TCR):
  ±0.2 ppm/°C nominal (–55°C to +125°C, +25°C ref.)
  ±1 ppm/°C nominal (–55°C to +200°C, +25°C ref.)
- Resistance range: 10 Ω to 100 kΩ (for higher and lower values, please contact VFR's application engineering department)
- Resistance tolerance: to ±0.01 %
- Working power: 0.1 W at 200°C (see table 2)
- Load life stability: to ±0.1% after 1,000 hrs of rated power at 200°C
- "Silicon coated 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)
- Thermal stabilization time: <1 s (within 10 ppm of steady state value)
- Electrostatic discharge (ESD): at least to 25 kV
- Non-inductive, non-capacitive design
- Rise time: 1 ns effectively no ringing
- Current noise: <0.010 $\mu V_{rms}/V$ of applied voltage (<–40 dB)
- Voltage coefficient: <0.1 ppm/V
- Non-inductive: <0.08 µH
- Non-hot spot design

HIGH TEMPERATURE PRODUCTS

Resistors are the passive building blocks of an electrical circuit. They may be used for dropping the voltage, buffering the surge when the circuit is turned on, providing feedback in a monitoring loop, sensing current flow, etc. When the application requires stability over time and load, initial accuracy, minimal change with temperature of more than 175°C, resistance to moisture and a number of other characteristics that will be described below, only Vishay Foil Resistors have the attributes needed for such application. Over the past few months, there has been considerable growth in the demand for precise, stable and reliable resistors that can operate in harsh environments and especially at high temperatures to 200°C. Many analog circuits for industrial, military, aerospace, medical, down-hole, oil well, and automotive applications require passive

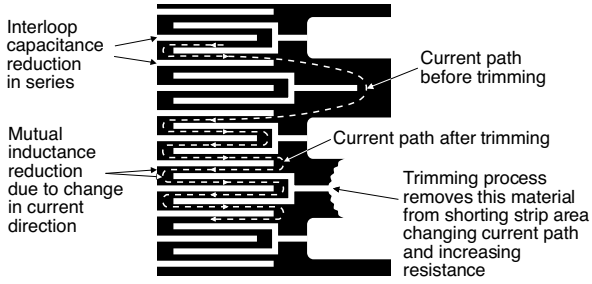
components such as resistors to have a minimal drift from their initial values when operating above +175°C and in humid environments. In these applications, the most important factor is the temperature dependence and the end of life tolerance (which is part of the stability) and to a lesser extent, the initial tolerance.

TABLE 1—TCR (NOMINAL AND MAX.) FROM –55°C TO +125°C, 175°C AND 200°C*

Resistance Value	Tolerance (%)	>125°C	>175°C	>200°C
10 Ω to 25 Ω	±0.02%	±1±3.8	±1±4.3	±1±4.8
25 Ω to 50 Ω	±0.01%	±1±3.3	±1±3.8	±1±4.3
50 Ω to 80 Ω	±0.01%	±1±2.8	±1±3.3	±1±3.8
80 Ω to 100 Ω	±0.01%	±1±2.3	±1±2.8	±1±3.3
100 Ω to 100 KΩ	±0.01%	±1±1.8	±1±2.3	±1±2.8

* Reference temperature: +25°C

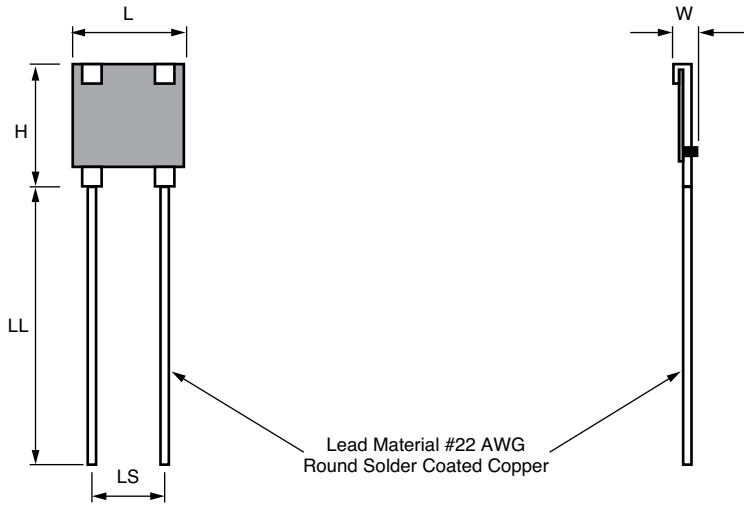
FIGURE 1—TRIMMING TO VALUES
(conceptual illustration)



Foil shown in black, etched spaces in white

Note
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 Vishay Foil resistors.

FIGURE 2—STANDARD DIMENSIONS in Inches (Millimeters)



This product requires careful handling.

Not suitable for automatic insertion equipment.

Dimension	inches	(mm)
W	0.080 max	(2.03 max)
L	0.250 max	(6.35 max)
H	0.310 max	(7.87 max)
LL	1.000 ±0.125	(25.4 ±3.18)
LS(1)	0.150 ±0.005	(3.81 ±0.13)

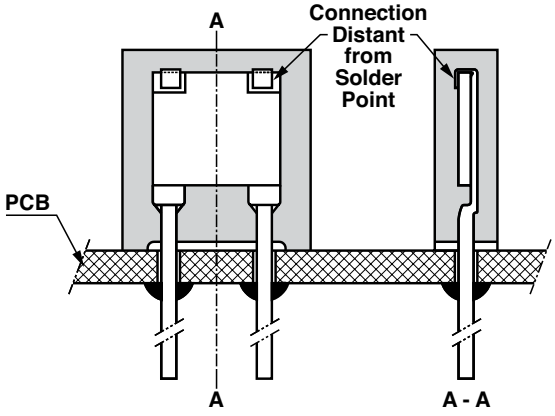
Note

(1) An additional lead space option is available: 0.200" (5.08 mm). For these specifications, please specify Z201HTJ (see Table 4) when placing an order.

TABLE 2—SPECIFICATIONS

Resistance Range (Ω)	Maximum Working Voltage	Rated Power at Ambient		
		at +70°C	at +125°C	at +200°C
10 to 100k	200	0.4 W	0.2 W	0.1 W

FIGURE 3—BETTER STABILITY WITH THROUGH-HOLE



LONG-TERM STABILITY

Some process controls in high temperature environment are not very critical but many, many are—particularly when a process is operating near a tipping point where it could get out of control quickly if not well monitored. Entire production batches have been lost or suffered reduced reliability when critical parameters were not kept within narrow limits. One thing that can cause this to happen is changes in the resistor over time. Reference points in the control process thus become less and less reliable. Repeatability of the process from batch to batch begins to drift. The process is changing while the monitors appear to be holding it within specified limits because the precision resistor is producing a different output voltage than it was in previous runs for the same sensor output. So the process appears to be under control when, in reality, it is experiencing an undetected drift.

Long-term stability is thus one of the considerations that drive the selection of which resistor technology to use in the application. As for surface-mount chip resistors, the leaded option is much better due to reduced stress on the resistor from the PCB.

THERMAL EMF

In a resistor, the resistance is composed of a resistance element of one material and two terminations of a different material. When the junction of the element and the termination is heated in a closed circuit, there is a DC voltage generated in the circuit (see Seebeck and Peltier Effects). If both termination junctions of the resistor are at exactly the same temperature, there is no net thermal EMF voltage generated in the circuit due to thermal EMF error voltages in the resistor. In fact, however, the terminals are very seldom at the same temperature because their temperatures are influenced by uneven power dissipation within the resistor, differential heating from other components on the board, and heat conducted along the board itself. Obviously, in a sense resistor that's supposed to accurately convert a current to a voltage, the presence of an extraneous thermal EMF voltage could constitute a significant error source in the system. That is why it's important that Bulk Metal® Foil resistors have a thermal EMF voltage of less than 0.1 μV/°C difference across the element to termination junction.

RELIABILITY

In addition to possible ESD damage, there are other reliability considerations. There is another, often overlooked reliability concern: moisture. All epoxy coatings and plastic encapsulants are hygroscopic; they absorb moisture from the air. Under the varying temperature, pressure, and humidity conditions of normal operations, moisture is drawn through the external coatings and elevates the humidity level of the inside of the resistor to a higher level than the unrestrained fluctuating conditions outside the resistor itself. If the resistor were to run at high power and generate a lot of heat, the moisture would be driven out of the resistor and there would be no humidity consequences. But the best conditions for long term load-life stability are the worst conditions for moisture damage in low DC power applications. When the moisture is drawn into the resistor it imports minute ions from the coating to the resistor element's surface where it adds to any residuals left during production. These materials form a mild etchant in the presence of the electric field established across the element by the DC voltage. This etchant removes and transports resistance material across the surface of the element, and deposits it on another portion of the resistance grid. This process can open a thin film or metal film resistor in just a few hours of operation or effect a more gradual increase in resistance over a longer period of time, opening after months rather than hours. The resistance grid of the Bulk Metal Foil resistor is hundreds of times thicker than an equivalent value thin film resistor so it would take hundreds of times more chemistry to do the same amount of damage as to the metal and thin film resistors.

TEMPERATURE COEFFICIENT OF RESISTANCE (TCR)

TCR is more important in some applications than in others. Where the sense resistor is in an office control station environment the temperature is fairly well controlled over a narrow range but when the sense resistor is close to the processes the sense resistor may be exposed to a much higher range of temperatures.

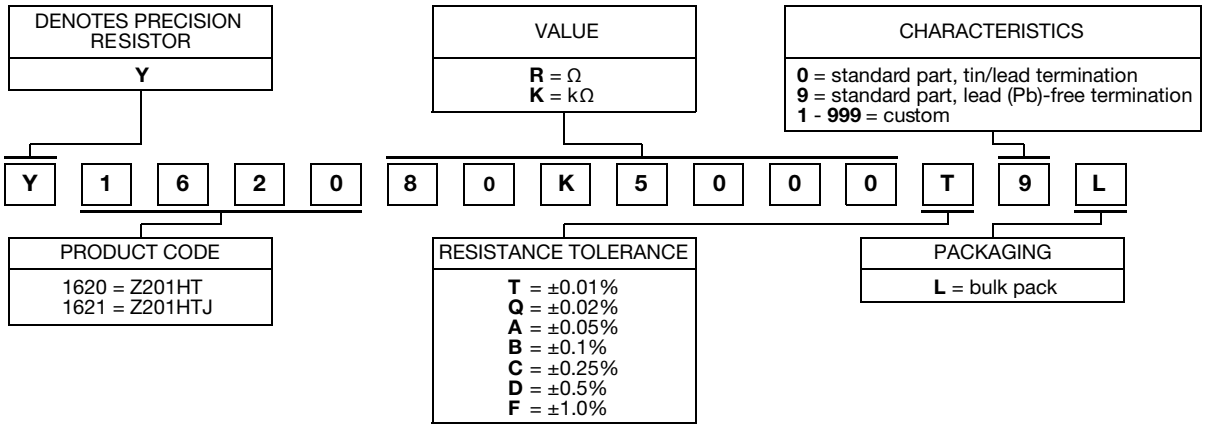
Using a metal or thin film resistor at ±10 ppm/°C would result in a 100 ppm (0.01%) error if the ambient changes by only 10°C. If the temperature of operation is not close to the midpoint of the temperature range used to quantify the TCR at ±10 ppm/°C, it would result in a much larger error over higher temperature ranges. A Bulk Metal Foil resistor would only change 0.0002% to 0.002% over that same 10°C span, depending upon which model is used (0.2 ppm/°C to 2 ppm/°C.) And for larger temperature spans, it would be even more important to use the Bulk Metal Foil resistor for its inherently low TCR.

HARMONIC DISTORTION

Harmonic distortion is an important consideration in the choice of precision resistors for sensitive applications. A significant signal voltage across the resistor may change the resistance value depending on the construction, material, and size. Under these conditions Bulk Metal Foil resistors behave more linearly than other resistor types.

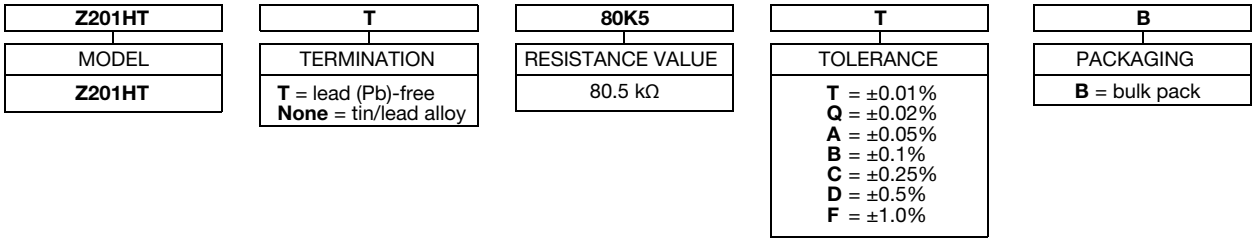
TABLE 3—GLOBAL PART NUMBER INFORMATION(1)

NEW GLOBAL PART NUMBER: Y162080K5000T9L (preferred part number format)



FOR EXAMPLE: ABOVE GLOBAL ORDER Y1620 80K5000 T 9 L:
TYPE: Z201HT
VALUE: 80.5 kΩ
ABSOLUTE TOLERANCE: ±0.01%
TERMINATION: lead (Pb)-free
PACKAGING: bulk pack

HISTORICAL PART NUMBER: Z201HT T 80K5 T B (will continue to be used)



Note
(1) For non-standard requests, please contact Application Engineering

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