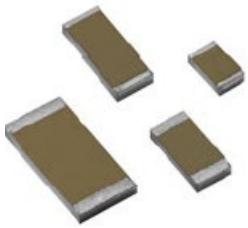
Ultra High-Precision Foil Wraparound Surface Mount Chip Resistor

for High Temperature Applications up to +200°C, Humidity Proof (85°C/85% RH) to 0.005%, Stability Under Load of 0.02%

FEATURES

- **Humidity test: 85°C/85% RH, 1000 hrs to ΔR 0.005%, typical**
- Temperature coefficient of resistance (TCR): 2.5 ppm/°C typical (–55°C to +175°C, +25°C ref.)
- Resistance range: 5 Ω to 125 kΩ (for higher and lower values, please contact us)
- Resistance tolerance: to ±0.01%
- Power coefficient "ΔR due to self heating": 5 ppm at rated power
- Power rating: to 750 mW at +70°C
  to 150 mW at +175°C
- **Load life stability: ±0.005% typical at 70°C (2000 h, rated power)**
- **Stability under load: 0.02% at +175 °C (2000 h, derated power)**
- Bulk Metal Foil resistors are not restricted to standard values; we can supply specific "as required" values at no extra cost or delivery (e.g., 1K2345 vs. 1K)
- Thermal stabilization time <1 s (nominal value achieved within 10 ppm of steady state value)
- **Electrostatic discharge (ESD) at least to 25 kV**
- Short time overload: 0.005%
- 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
- Terminal finish available: lead (Pb)-free only
- Matched sets are available on request
- For higher temperature application up to +240°C and for better performances, contact foil@vpgsensors.com



Top View

Pb-free Available

RoHS COMPLIANT

INTRODUCTION

The FRST is based on the new generation Z1 Foil Technology of Bulk Metal® Foil resistor elements from VPG, which makes these resistors virtually insensitive to destabilizing factors. Their element, based on the new Z1 Foil Technology is a solid alloy that displays the desirable bulk properties of its parent material; thus, it is inherently stable (less than 0.02% ΔR after 2,000 hrs, derated power at +175°C), noise-free and withstands ESD to 25 kV or more. The alloy is matched to the substrate and forms a single entity with balanced temperature characteristics for an unusually low and predictable TCR over a wide range from –55C° to more than 175°C. Resistance patterns are photo-etched to permit trimming of resistance values to very tight tolerances.

The FRST series has a full wraparound termination, and was especially designed for applications up to +200°C.

The FRST is available in any value within the specified resistance range. The VFR application engineering department is available to advise and make recommendations. For non-standard technical requirements and special applications, please contact us using the e-mail address in the footer below.

Figure 1—Power Derating Curve

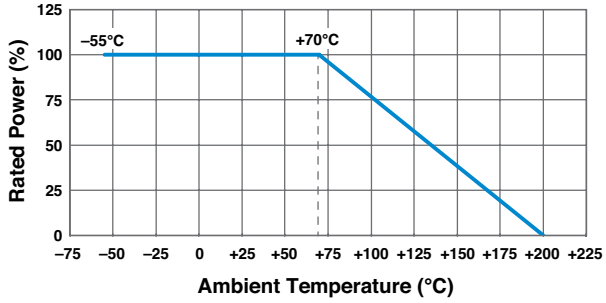


Table 1—Tolerance and TCR vs. Resistance Value[1] (–55°C to +175°C, +25°C Ref.)

Resistance Value (Ω)	Tolerance (%)	Typical TCR (ppm/°C)
250 to 125k	±0.01%	±2.5
100 to <250	±0.02%	
50 to <100	±0.05%	
25 to <50	±0.1%	
10 to <25	±0.25%	
5 to <10[2]	±0.5%	

Notes

(1) For tighter performances and non-standard values lower than 5 Ω and above 125 kΩ, please contact VFR application engineering using the e-mail address in the footer below.

(2) TCR of these low value range : ±10 ppm/°C max

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 for more than 200°C, resistance to moisture and a number of other characteristics that will be described below, the Z1 Foil Technology products 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 such as 85°C/85% RH 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.

The Z1 Foil Technology resistors 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. 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. Compared to Bulk Metal Foil, thick and thin film resistor elements are produced with a non-controllable material. Heat or mechanical stresses on the resistive elements cause the particles forming the film to expand. However, after these stresses are alleviated, the articles in the film matrix do not return to the exact original position. That degenerates their overall stability.

VPG's ultra high precision Bulk Metal Foil technology includes many types of resistors with a variety of standard configurations that can withstand unconventional environmental conditions above and below the earth's surface using special post manufacturing operations specially developed for this purpose. The stability of a resistor depends primarily on its history of exposures to high 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 of resistance, 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 that need to operate in an environment with temperatures above +175°C, these effects must be taken into account to achieve high stability with changes in load (Joule Effect) and ambient temperature.

The Z1 Foil Technology provides an order of magnitude reduction in the Bulk Metal Foil element's sensitivity to temperature changes—both external and internal—with emphasis on long-term stability in high temperature environments.

In order to take full advantage of the low TCR and long-term stability improvement, it is necessary to take into account the differences in the resistor's response to each of the above-mentioned effects. As described below, new products have been developed to successfully deal with these factors. For high temperature applications where stability and total error budget is the main concern, the new generation of Vishay Foil resistors offers the best resilience against time at elevated temperature.

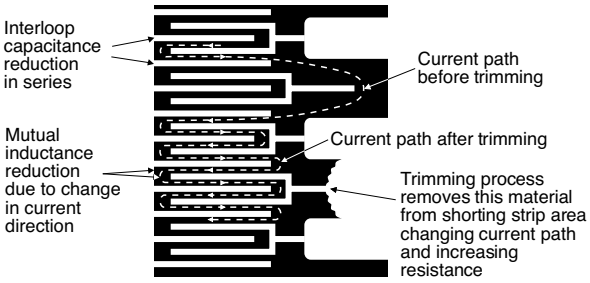
The Z1 Foil Technology allows us to produce customer-oriented products designed to satisfy unique and specific technical requirements. In addition to the special chip stabilization under extreme environment conditions in the production line, we offer additional specially oriented post manufacturing operations (PMO) for high temperature applications that require an even higher degree of reliability and stability.

Electrostatic discharge (ESD) is another potential problem that can cause unpredictable failure in high temperature applications that increase the sensitivity of the resistors to ESD.

ESD damage to electronic devices can occur at any point in the device's life cycle, from manufacturing to field service. A resistor that is exposed to an ESD event may fail immediately or may experience a latent defect. With latent defects, premature failure can occur after the resistor is already functioning in the finished product after an unpredictable length of service. Bulk Metal Foil resistors are capable of withstanding electrostatic discharges at least to 25 kV without degradation.

The VFR Application Engineering department is always available to assist with any special requirements you might have. If you are not sure which resistor best suits your needs, please do not hesitate to contact them for more information: foil@vpgsensors.com

Figure 2—Trimming to Values
(conceptual illustration)



Foil shown in black, etched spaces in white

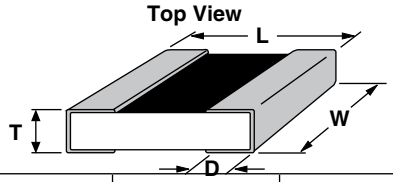
Note
To acquire a precision resistance value, the Bulk Metal® Foil chip is trimmed by selectively removing built-in "shorting bars." To increase the resistance in known increments, marked areas are cut, producing progressively smaller increases in resistance. This method reduces the effect of "hot spots"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

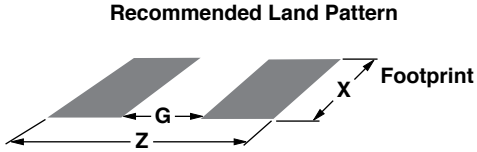
Table 2—Specifications

Chip Size	Rated Power at +70°C (mW)	Derated Power at +175°C (mW)	Max. Working Voltage ($\leq\sqrt{P \times R}$)	Resistance Range (Ω)	Max. Weight (mg)
0603*	100	20	22 V	100 to 4k*	4
0805	200	40	40 V	5 to 8k	6
1206	300	60	87 V	5 to 25k	11
1506	300	60	95 V	5 to 30k	12
2010	500	100	187 V	5 to 70k	27
2512	750	150	220 V	5 to 125k	40

Note
* For 0603 values between 4k and 5k, please contact us.

Table 3—Dimensions in Inches (Millimeters)





Chip Size	L ±0.005 (0.13)	W ±0.005 (0.13)	Thickness Maximum	D ±0.005 (0.13)	Z [1]	G [1]	X [1]
0603	0.063 (1.60)	0.032 (0.81)	0.025 (0.64)	0.011 (0.28)	0.102 (2.59)	0.031 (0.78)	0.031(0.78)
0805	0.080 (2.03)	0.050 (1.27)		0.015 (0.38)	0.122 (3.10)	0.028 (0.71)	0.050 (1.27)
1206	0.126 (3.20)	0.062 (1.57)		0.020 (0.51)	0.175 (4.45)	0.059 (1.50)	0.071 (1.80)
1506	0.150 (3.81)	0.062 (1.57)		0.020 (0.51)	0.199 (5.05)	0.083 (2.11)	0.071 (1.80)
2010	0.198 (5.03)	0.097 (2.46)		0.025 (0.64)	0.247 (6.27)	0.115 (2.92)	0.103 (2.62)
2512	0.249 (6.32)	0.127 (3.23)		0.032 (0.81)	0.291 (7.39)	0.150 (3.81)	0.127 (3.23)

Notes
[1] Land Pattern Dimensions are per IPC-7351A.

Table 4—Performances (Based on MIL-PRF-55342)

Test	Conditions	Typical Limit % (ppm)	Max Limit %[1] (ppm)
Short Time Overload	6.25 x P_{nom}	±0.005% (50)	±0.01% (100)
High Temperature Exposure	+200°C, 1,000 h	±0.02% (200)	±0.05% (500) [2]
Resistance to Soldering Heat	Per MIL-PRF-55342 (p.4.8.8.1)	±0.005% (50)	±0.01% (100)
Moisture Resistance	Per MIL-PRF-55342 (p. 4.8.9)	±0.005% (50)	±0.01% (100)
Humidity Test	85°C/85% RH, 1000 h	±0.005% (50)	±0.01% (100) [3]
Stability Under Load, 175°C, 2,000 h	Derated power (see Table 2)	±0.02% (200)	±0.03% (300)
Load-Life Test, 70°C, 2,000 h	@ rated power (see Table 2)	±0.005% (50)	±0.01% (100)
Thermal Shock	5 x (–65°C to +175°C)	±0.005% (50)	±0.01% (100)

Notes
[1] As shown +0.01 Ω to allow for measurement errors at low values.
[2] Applicable to all FRST series except for 0603 size. The limit for 0603 is ± 0.1% (1,000 ppm).
[3] Applicable to all FRST series except for 0603 size. The limit for 0603 is ± 0.03% (300 ppm).

Figure 3—Recommended Mounting

1. IR and vapor phase reflow are recommended.
2. Avoid the use of cleaning agents that attack epoxy resins, which form part of the resistor construction.
3. Vacuum pick up is recommended for handling.
4. If the use of a soldering iron becomes necessary, precautionary measures should be taken to avoid any possible damage/overheating of the resistor.

* Recommendation: The solder fillet profile should be such as to avoid running over the top metallization.

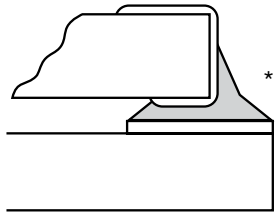


Figure 4—Global Part Number Information[1]

NEW GLOBAL PART NUMBER: Y401612K7560T9R (preferred part number format)

DENOTES PRECISION	VALUE	CHARACTERISTICS
Y	**R** = Ω **K** = kΩ	**9** = lead (Pb)-free **1 to 999** = custom

Y	4	0	1	6	1	2	K	7	5	6	0	T	9	R

PRODUCT CODE	RESISTANCE TOLERANCE	PACKAGING
4013 = FRST0603 **4014** = FRST0805 **4015** = FRST1206 **4016** = FRST1506 **4017** = FRST2010 **4018** = FRST2512	**T** = ± 0.01 % **Q** = ± 0.02 % **A** = ± 0.05 % **B** = ± 0.10 % **C** = ± 0.25 % **D** = ± 0.5 % **F** = ± 1.0 %	**R** = tape and reel **W** = waffle pack

FOR EXAMPLE: ABOVE GLOBAL ORDER Y4016 12K7560 T 9 R:

TYPE: FRST1506
VALUES: 12.7560 kΩ
ABSOLUTE TOLERANCE: 0.01 %
TERMINATION: lead (Pb)-free
PACKAGING: tape and reel

Note

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

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