Ultra High Precision Z1 Foil Technology Flip Chip Resistor for Load Life Stability of 0.005% (50 ppm) with TCR of ± 0.2, 35% Space Saving vs. Wraparound Design, Power to 750mW

INTRODUCTION

The FRFC is based on the new generation Z1 Foil Technology of the Bulk Metal® Precision Foil resistor elements by Vishay Precision Group (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 (remarkably improved load life stability of 30 ppm), noise-free and withstands ESD to 25KV 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 - 55 °C to more than + 125 °C. Resistance patterns are photo-etched to permit trimming of resistance values to very tight tolerances.

The flip chip configuration provides a substantial PCB space saving of more than 35 % vs. a surface mount chip with wraparound terminations. The FRFC is available in any value within the specified resistance range.

The FRFC Series is an upgraded version of the VFCP Series (Z Foil) with an improved rated power of 750mW.

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

RESISTANCE VALUE (Ω)	TOLERANCE (%)	TYPICAL TCR AND MAX. SPREAD (- 55 °C to + 125 °C, + 25 °C Ref.)
250 to 125K	± 0.01	± 0.2 ± 1.6
100 to < 250	± 0.02	± 0.2 ± 1.6
50 to < 100	± 0.05	± 0.2 ± 1.8
25 to < 50	± 0.1	± 0.2 ± 2.8
10 to < 25	± 0.25	± 0.2 ± 2.8
5 to <10	± 0.5	±0.2 ±7.8

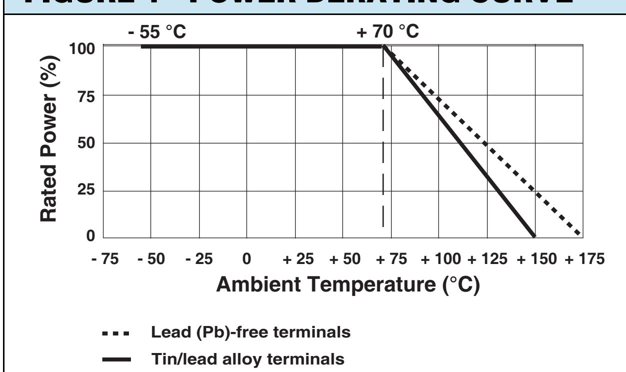
FEATURES

- Temperature coefficient of resistance (TCR): ± 0.2 ppm/°C typical (- 55 °C to + 125 °C, + 25 °C ref.)
- Resistance range: 5 Ω to 125 kΩ (for higher values, please contact us)
- Tolerance: to ± 0.01 % (100 ppm)
- Power coefficient "ΔR due to self heating" 5 ppm at rated power
- **Power rating: 750 mW at + 70 °C (see table 2)**
- **Load life stability: ± 0.005% typical at 70 °C, 2000 h (rated power)**
- 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)
- Non-inductive, non-capacitive design
- Short time overload ≤ 0.005 % (50 ppm)
- **Electrostatic discharge (ESD) at least to 25kV**
- Thermal stabilization time < 1 s (nominal value achieved within 10 ppm of steady state value)
- Non hot spot design
- Rise time: 1 ns effectively no ringing
- Current noise: 0.010 μVRMS/V of applied voltage (< - 40 dB)
- Voltage coefficient: 0.1 ppm/V
- Non-inductive: 0.08 μH
- Terminal finishes available: lead (Pb)-free, tin/lead alloy
- Matched sets are available per request
- Prototype quantities available, please contact foil@vpgsensors.com

Pb-free Available

RoHS* COMPLIANT

FIGURE 1 - POWER DERATING CURVE

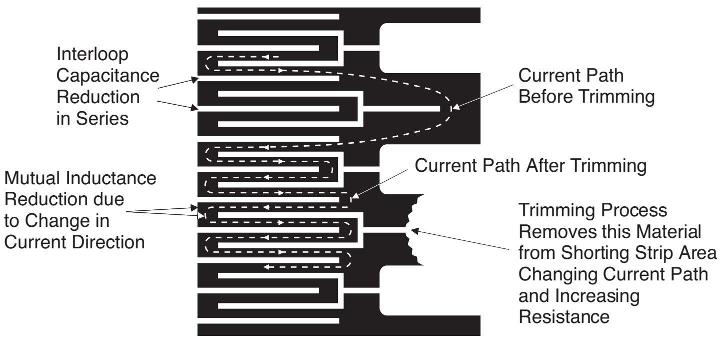


Notes

(1) For tighter performances and non-standard values, please contact VFR's application engineering at foil@vpgsensors.com

* This datasheet provides information about parts that are RoHS-compliant and/or parts that are non-RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS compliant. Please see the information/tables in this datasheet for details.

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 VFR resistors.

TABLE 2 - SPECIFICATIONS

CHIP SIZE	RATED POWER (mW) at + 70 °C	MAXIMUM VOLTAGE RATING ($\leq \sqrt{P \times R}$)	RESISTANCE RANGE (Ω)	MAXIMUM WEIGHT (mg)
0805	200	40	5 to 8K	5.2
1206	300	86	5 to 25K	10.3
1506	400	109	5 to 30K	12
2010	500	187	5 to 70K	25
2512	750	306	5 to 125K	35

TABLE 3 - FRFC PERFORMANCE LIMITS (MIL-PRF-55342)

TEST	CONDITIONS	TYPICAL LIMIT % (PPM)	MAX LIMIT % (PPM)(1)
Short Time Overload	6.25 x $P_{nom.}$	± 0.005% (50)	± 0.01% (100)
High Temperature Exposure	+150°C, 100 hrs	± 0.005% (50)	± 0.01% (100)
Low Temperature Operation	- 65 °C, 45 min @ rated power (see table 2)	± 0.005% (50)	± 0.01% (100)
Moisture Resistance	Per MIL-PRF-55342 (p. 4.8.9)	± 0.005% (50)	± 0.03% (300)
Load Life Test, 70°C, 2,000 h	@ rated power (see table 2)	± 0.005% (50)	± 0.01% (100)
Resistance to Soldering Heat	P.4.8.8.1	± 0.005% (50)(2)	± 0.01% (100)(2)
Thermal Shock	5 x (- 65 °C to + 150 °C)	± 0.001% (10)	± 0.005% (50)
Thermal Shock	100 x (- 65 °C to + 150 °C)	± 0.003% (30)	± 0.01% (100)

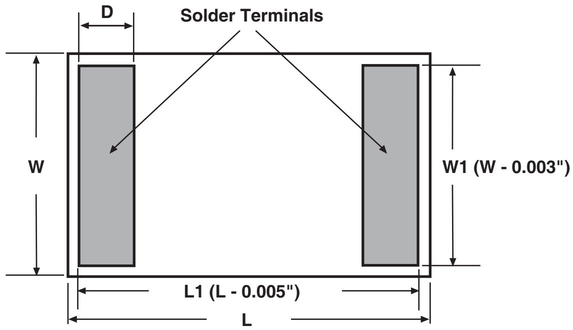
(1) As shown + 0.01 Ω to allow for measurement errors at low values.

(2) For R<100 Ω, the performance depends on PCB design and assembly.

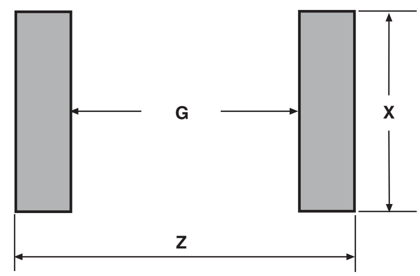
For any questions, contact
foil@vpgsensors.com

TABLE 4 - DIMENSIONS AND LAND PATTERN in inches (millimeters)

BOTTOM VIEW (showing terminals for mounting)



LAND PATTERN



CHIP SIZE	L ± 0.005 (0.13)	W ± 0.005 (0.13)	THICKNESS MAXIMUM	D ± 0.005 (0.13)	Z	G	X
0805	0.079 (2.01)	0.049 (1.24)	0.025 (0.64)	0.010 (0.25)	0.078 (1.98)	0.053 (1.35)	0.049 (1.24)
1206	0.126 (3.20)	0.062 (1.57)	0.025 (0.64)	0.015 (0.38)	0.125 (3.18)	0.090 (2.29)	0.062 (1.57)
1506	0.150 (3.81)	0.062 (1.57)	0.025 (0.64)	0.012 (0.30)	0.150 (3.81)	0.120 (3.05)	0.062 (1.57)
2010	0.200 (5.08)	0.100 (2.54)	0.025 (0.64)	0.020 (0.51)	0.199 (5.05)	0.153 (3.89)	0.100 (2.54)
2512	0.250 (6.35)	0.126 (3.20)	0.025 (0.64)	0.024 (0.61)	0.250 (6.35)	0.196 (4.98)	0.126 (3.20)

Notes

- Avoid the use of cleaning agents which could attack epoxy resins, which form part of the resistor construction
- Vacuum pick up is recommended for handling
- Soldering iron is not recommended

FIGURE 3 - CHIP CONFIGURATION

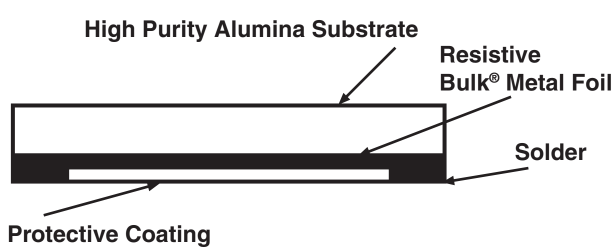
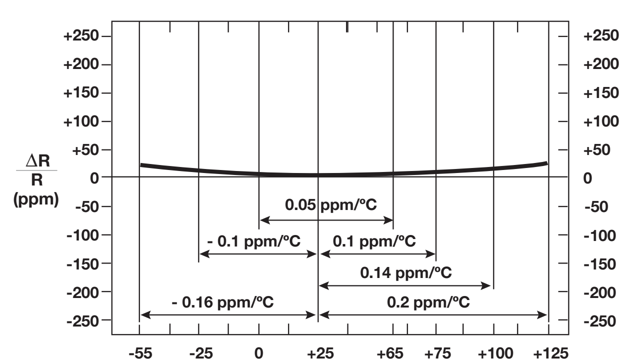


FIGURE 4 - TYPICAL RESISTANCE/ TEMPERATURE CURVE
(for more details, see table 1)



Note

- The TCR values for < 100 Ω are influenced by the termination composition and result in deviation from this curve

FIGURE 5 - LOAD LIFE TEST

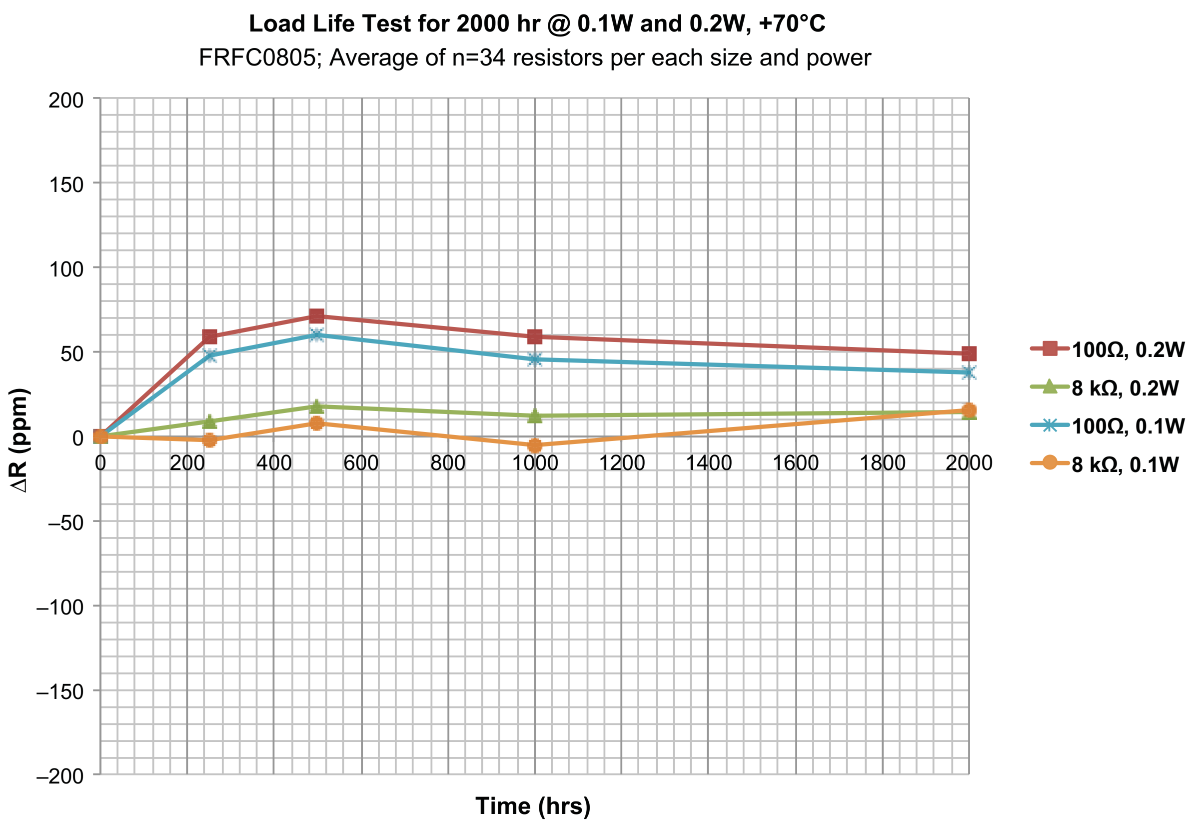
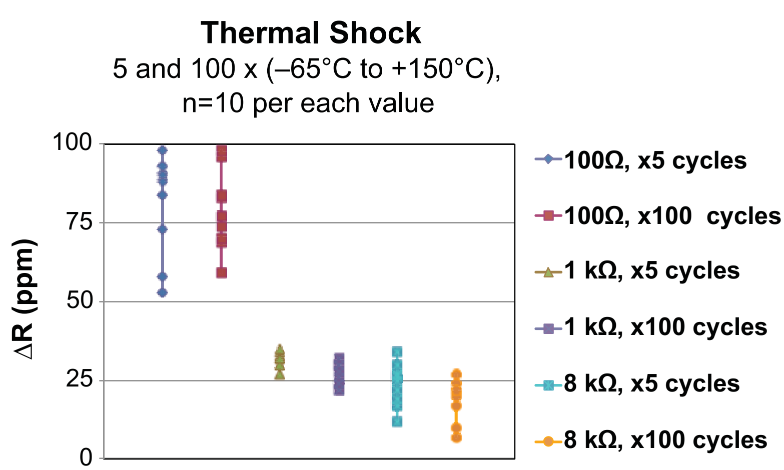


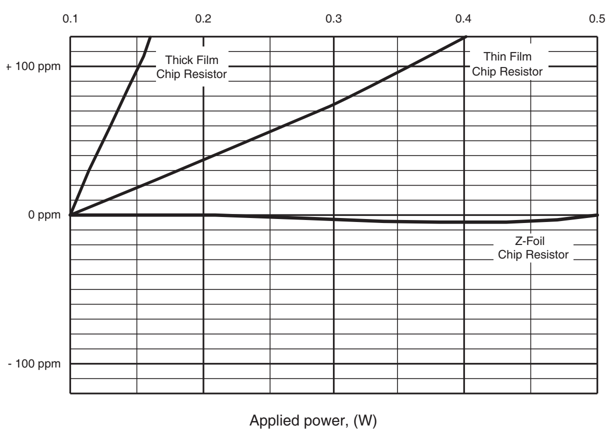
FIGURE 6 - THERMAL SHOCK TEST



POWER COEFFICIENT OF RESISTANCE (PCR)

The TCR of a resistor for a given temperature range is established by measuring the resistance at two different ambient temperatures: at room temperature and in a cooling chamber or oven. The ratio of relative resistance change and temperature difference gives the slope of ΔR/R = f (T) curve. This slope is usually expressed in parts per million per degree Centigrade (ppm/°C). In these conditions, a uniform temperature is achieved in the measured resistance. In practice, however, the temperature rise of the resistor is also partially due to self-heating as a result of the power it is dissipating (self-heating). As stipulated by the Joule effect, when current flows through a resistance, there will be an associated generation of heat. Therefore, the TCR alone does not provide the actual resistance change for precision resistor. Hence, another metric is introduced to incorporate this inherent characteristic – the Power Coefficient of Resistance (PCR). PCR is expressed in parts per million per Watt or in ppm at rated power. In the case of Z-based Bulk Metal® Foil, the PCR is 5 ppm typical at rated power or 4 ppm per Watt typical for power resistors.

FIGURE 7 - BEHAVIOR OF THREE DIFFERENT RESISTOR TECHNOLOGIES UNDER APPLIED POWER (POWER COEFFICIENT TEST)



Value: 1K

POST MANUFACTURING OPERATIONS (PMO) ENHANCE THE ALREADY SUPERIOR STABILITY OF FOIL RESISTORS

These Post Manufacturing Operations (PMOs) are uniquely applicable to resistors made of resistive foil and they take the already superior stability of Vishay Foil resistors one step further. They constitute an exercising of the resin that bonds the foil to the substrate, the foil, the alumina,the molding and the contacts. The operations employed are:

- Temperature Cycling/Thermal Shock
- Short Time Overload/Power Shot (Accelerated Load Life)
- Power Conditioning

Temperature Cycling

Temperature Cycling is done initially in the chip stage of all production and will eliminate any fallout. The cycling exercises the Foil and the contacts without reducing its initial bonding strength. A small reduction in resistance is tolerable during this PMO.

Short Time Overload (Accelerated Load Life)

Short Time Overload (STO) occurs when a circuit is subjected at one point in time to a temporary, unexpected high pulse (or overload) that can result in device failure. This STO is performed on all resistors during manufacturing, with a function to eliminate any hot spots if they exist.

Power Conditioning

The standard load life curve of a Foil resistor exhibits a significant portion of its change in the first 250-500 hours, after which the curve begins to stabilize. The power conditioning exercise applies a load for a specified amount of time to eliminate this knee in the load life curve. Upon delivery, the resistor will be on the flat part of the curve for your convenience. The power conditioning is a function of the application and should be worked out between our Applications Engineering department and your design team.

Can We Use PMO on Other Resistor Technologies?

Applying these same operations to resistors of Thick Film, Thin Film, and Wirewound have vastly different consequences and can drive these devices out of tolerance or open circuit. These devices experience too many failures to discuss here. On the other hand, these operations are an enhancement to Foil resistor performance and should be considered when the level of stability required is beyond the published limits for standard products.

TABLE 5 - GLOBAL PART NUMBER INFORMATION [1]

NEW GLOBAL PART NUMBER: Y407210R0000C9W (preferred part number format)

Y	4	0	7	2	1	0	R	0	0	0	0	C	9	W

DENOTES PRECISION	VALUE	CHARACTERISTICS
Y	**R** = Ω **K** = kΩ	**0** = standard **9** = lead (Pb)-free **1 to 999** = custom

PRODUCT CODE	RESISTANCE TOLERANCE	PACKAGING
4072 = FRFC0805 **4073** = FRFC1206 **4074** = FRFC1506 **4075** = FRFC2010 **4076** = FRFC2512	**T** = ± 0.01 % **Q** = ± 0.02 % **A** = ± 0.05 % **B** = ± 0.10 % **C** = ± 0.25 % **D** = ± 0.50 % **F** = ± 1.00 %	**R** = tape and reel **W** = waffle pack

FOR EXAMPLE: ABOVE GLOBAL ORDER Y4072 10R0000 C 9 W:
TYPE: FRFC0805
VALUE: 10.0 Ω
ABSOLUTE TOLERANCE: ± 0.25%
TERMINATION: lead (Pb)-free
PACKAGING: waffle pack

HISTORICAL PART NUMBER: FRFC0805 10R000 TCR0.2 C S W (will continue to be used)

FRFC0805	**10R000**	**TCR0.2**	**C**	**S**	**W**
MODEL	OHMIC VALUE	TCR	RESISTANCE TOLERANCE	TERMINATION	PACKAGING
FRFC0805 **FRFC1206** **FRFC1506** **FRFC2010** **FRFC2512**	10.0 Ω	Characteristic	**T** = ± 0.01 % **Q** = ± 0.02 % **A** = ± 0.05 % **B** = ± 0.10 % **C** = ± 0.25 % **D** = ± 0.50 % **F** = ± 1.00 %	**S** = lead (Pb)-free **B** = tin/lead	**T** = tape and reel **W** = waffle pack

Note

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

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