

# Breaking New Ground: The Evolution of VPG Foil Resistors' FRFS0402 Technology

In the ever-evolving world of electronic components, innovation is key to meeting the demands of cutting-edge technologies. VPG Foil Resistors has made a significant leap forward with the introduction of the FRFS0402 resistor, a groundbreaking component that set new standards in precision and performance. This article explores the revolutionary design and unique capabilities of the FRFS0402, highlighting how it addresses longstanding challenges and enhances a range of critical applications.

## Innovative Design

The FRFS0402 resistor from VPG Foil Resistors represents a major advancement in resistor technology. Its innovative flip-chip construction with standoffs is a notable departure from traditional designs, offering numerous benefits.

The FRFS0402, the smallest ultra-high-precision Bulk Metal® Foil technology resistor flip chip is based on the new generation Z1 Foil Technology of Bulk Metal Foil resistors. Size reduction and increased mounting density is a growing demand in the recent years. Flip chip resistors are a good solution for this issue. Compared with standard, wrap around terminal construction, the flip chip construction requires less surface on the PCB.

The standoff construction enhances mounting reliability and assembly efficiency by facilitating regular visual inspections and adding robustness to soldering points. This design innovation addresses common issues faced with flip-chip mounting, such as solder cracks and assembly challenges, ensuring a more durable and reliable component.

One of the main features of the FRFS0402 is its power rating. Thanks to the specially designed mechanical construction of terminals and improved heat dissipation provided by utilization of high thermal conductive metals within terminals construction, this resistor can handle a rated power of 100mW at +70°C.

Last, but not least, the design and manufacturing processes for flip chip resistors (comparing with wrap-around resistors) are less complex, making them generally much cheaper than standard surface mount resistors.

## Applications Across Industries

The versatility of the FRFS0402 makes it a valuable component across various industries. In the telecommunications sector, including 5G and fiber optics, the resistor's high precision and thermal stability ensure reliable performance in data transmission networks. Its ability to handle high temperatures and provide consistent performance under power makes it an ideal choice for high-temperature sensors and other critical applications.

In medical equipment, such as pacemakers and hearing aids, the FRFS0402's precise resistance and stability are crucial for maintaining accurate and reliable operation. The resistor's small size and robust construction also make it suitable for use in automated test equipment (ATE), mid-range audio systems, and handheld meters.

The FRFS0402's capabilities extend beyond telecommunications and medical applications. It also finds use in aviation, aerospace, military and defense applications, where its reliability and performance are essential for mission critical.

## Technological Advancements

The FRFS0402 builds upon VPG Foil Resistors' cutting-edge Bulk Metal® Foil technology - Z1 Foil Technology - incorporating the latest advancements to deliver superior performances:

### 1. Temperature Coefficient of Resistance

One of the biggest advantages of Z1-technology refers to (space grade) Z-foil with bulk structure of the originally melted solids of the well predicted and much more environmentally stable conductive phenomena thermal behavior surface properties. This Z-foil possesses the outstanding Temperature Coefficient of Resistance (TCR)

Utilizing Z1 Foil Technology, the FRFS0402 boasts TCR about 2 ppm/°C, over the temperature range of -55°C to +125°C, with +25°C as the reference.

### 2. Ultra-high Nominal Power and Load Life Stability

The Bulk Metal® Foil technology also provides additional advantages,

- Power rating. Thanks to the specially designed mechanical construction of terminals and improved heat dissipation provided by utilization of high thermal conductive metals within terminals construction, this resistor can handle a rated power of 100mW at +70°C – unique number/spec for those small mechanical dimensions (body size)
- Load Life Stability: ±0.01% typical at +70 °C, 2000 h (rated power)
- Short time overload capability of ≤0.01% (100 ppm)

### 3. Environmental Performance

Resistors that are part of electronic assemblies can be exposed to a wide variety of tense environmental conditions, including variations in humidity and/or moisture.

Enhancing resistance to moisture is essential for:

- ensuring the reliable and consistent performance of high precision resistors
- protecting them from corrosion and degradation
- extending their lifespan
- reducing the cost of maintenance and replacement

The most important advantages of the Z1 technology is based on implementation into VFR resistors construction entirely new uniquely combined advanced poly-imide/amide adhesive and polyimide overcoat materials.

This headmost combination of the high temperature and high thermal conductivity polyimide materials took the already soupier “resistance to moisture” performance of one-step further. For instance, Moisture Resistance tested in a frame of required by MIL-PRF-55342 condition has shown maximum resistance shift ± 100 ppm!!!

These features contribute to the FRFS0402's outstanding performance and reliability, setting it apart from other resistors in its class.

PERFORMANCE LIMITS (MIL-PRF-55342), *checked for 350Ω			
TEST	CONDITIONS	TYPICAL LIMIT % (PPM)	MAX LIMIT % (PPM)
Short Time Overload	6.25 x P <sub>nom.</sub>	±0.010 (100)	±0.010 (100)
High Temperature Exposure	+150°C, 100 hrs	±0.003 (30)	±0.005 (50)
Low Temperature Operation	- 65 °C, 45 min @ rated power (see table 2)	±0.002 (20)	±0.004 (40)
Moisture resistance	Per MIL-PRF-55342 (p. 4.8.9)	±0.007 (70)	±0.010 (100)
Load life test, 70°C, 2,000 h	@ rated power (see table 2)	±0.007 (70)	±0.010 (100)

## Moving Forward

Since its introduction, the FRFS0402 has been successfully implemented in various applications, demonstrating its effectiveness and reliability. VPG Foil Resistors is committed to ongoing innovation and is currently evaluating the expansion of the resistor's resistance range beyond the current values of 50 Ω to 3.5 kΩ.

For custom demands or prototype samples, interested parties can contact VPG Foil Resistors at [foil@vpgsensors.com](mailto:foil@vpgsensors.com).

The FRFS0402 represents a significant advancement in resistor technology, addressing key challenges and setting new benchmarks for precision and performance. As technology continues to evolve, VPG Foil Resistors remains at the forefront of innovation, offering solutions that meet the ever-growing demands of modern electronic applications.

The introduction of the FRFS0402 resistor underscores VPG Foil Resistors' dedication to pushing the boundaries of technology. With its innovative design, high performance, and versatile applications, the FRFS0402 is poised to make a lasting impact across various industries. As we look to the future, VPG Foil Resistors' commitment to innovation promises to deliver even more groundbreaking solutions that will shape the next generation of electronic components.