INTRODUCTION

The FRFC is based on the new generation Z1- 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 Z-1 Foil 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 FRFC0805 (Z1-Foil) is an upgraded version of the VFC0805 (Z Foil) with double rated power of 200mW.

<table>
<thead>
<tr>
<th>TABLE 1 - TOLERANCE AND TCR VS. RESISTANCE VALUE(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESISTANCE VALUE (Ω)</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>250 to 8K</td>
</tr>
<tr>
<td>100 to &lt; 250</td>
</tr>
<tr>
<td>50 to &lt; 100</td>
</tr>
<tr>
<td>25 to &lt; 50</td>
</tr>
<tr>
<td>10 to &lt; 25</td>
</tr>
<tr>
<td>5 to &lt; 10</td>
</tr>
</tbody>
</table>

Features

- Temperature coefficient of resistance (TCR):
  - ± 0.05 ppm/°C typical (0 °C to + 60 °C)
  - ± 0.2 ppm/°C typical (- 55 °C to + 125 °C, + 25 °C ref.)
- Resistance range: 5 Ω to 8 kΩ (for higher values, please contact us)
- Tolerance: ± 0.01 % (100 ppm)
- Power coefficient “ΔR due to self heating” 5 ppm at rated power
- Power rating: 200 mW at + 70 °C (see table 2)
- Load life stability: ± 0.005 % at 70 °C, 2000 h at 200 mW.
- 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 in just 5 working days or sooner.

Notes

(1) For tighter performances and non-standard values higher than 8K, please contact VFR’s application engineering at foil@vishaypg.com

* Pb containing terminations are not RoHS compliant, exemptions may apply
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 chips.

**TABLE 2 - SPECIFICATIONS**

<table>
<thead>
<tr>
<th>CHIP SIZE</th>
<th>RATED POWER (mW) at +70 °C(1)</th>
<th>MAXIMUM VOLTAGE RATING (≤√PR)</th>
<th>RESISTANCE RANGE (Ω)</th>
<th>MAXIMUM WEIGHT (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0805</td>
<td>200 mW</td>
<td>40 V</td>
<td>5 to 8K</td>
<td>5.2</td>
</tr>
</tbody>
</table>

**TABLE 3 - PERFORMANCES**

<table>
<thead>
<tr>
<th>TEST OR CONDITION</th>
<th>TYPICAL ΔR LIMITS</th>
<th>MAXIMUM ΔR LIMITS (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Shock 5 x (-65 °C to +150 °C)</td>
<td>± 0.003 % (30 ppm)</td>
<td>± 0.005 % (50 ppm)</td>
</tr>
<tr>
<td>Low Temperature Operation, -65 °C, 45 min at rated power</td>
<td>± 0.005 % (50 ppm)</td>
<td>± 0.01 % (100 ppm)</td>
</tr>
<tr>
<td>Short Time Overload, 6.25 x rated power, 5 s</td>
<td>± 0.005 % (50 ppm)</td>
<td>± 0.01 % (100 ppm)</td>
</tr>
<tr>
<td>High Temperature Exposure, +150 °C, 100 h</td>
<td>± 0.003 % (30 ppm)</td>
<td>± 0.005 % (50 ppm)</td>
</tr>
<tr>
<td>High Temperature Exposure, +175 °C, 100 h</td>
<td>± 0.005 % (50 ppm)</td>
<td>± 0.01 % (100 ppm)</td>
</tr>
<tr>
<td>Resistance to Soldering Heat, +245 °C for 5 sec, +235°C for 30 sec</td>
<td>± 0.005 % (50 ppm)</td>
<td>± 0.01 % (100 ppm)</td>
</tr>
<tr>
<td>Moisture Resistance</td>
<td>± 0.005 % (50 ppm)</td>
<td>± 0.01 % (100 ppm)</td>
</tr>
<tr>
<td>Load Life Stability +70 °C for 2000 h at rated power</td>
<td>± 0.005 % (50 ppm)</td>
<td>± 0.01 % (100 ppm)</td>
</tr>
<tr>
<td>Load Life Stability +70 °C for 2000 h at 100 mW</td>
<td>± 0.003 % (30 ppm)</td>
<td>± 0.005 % (50 ppm)</td>
</tr>
</tbody>
</table>

Notes

(1)See Table 3

(2)As shown + 0.01 Ω to allow for measurement errors at low values.
TABLE 4 - DIMENSIONS AND LAND PATTERN in inches (millimeters)

<table>
<thead>
<tr>
<th>CHIP SIZE</th>
<th>L ± 0.005 (0.13)</th>
<th>W ± 0.005 (0.13)</th>
<th>THICKNESS MAXIMUM</th>
<th>D ± 0.003 (0.076)</th>
<th>Z</th>
<th>G</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>0805</td>
<td>0.079 (2.01)</td>
<td>0.049 (1.24)</td>
<td>0.025 (0.64)</td>
<td>0.010 (0.25)</td>
<td>0.078 (1.98)</td>
<td>0.053 (1.35)</td>
<td>0.049 (1.24)</td>
</tr>
</tbody>
</table>

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\(^{(1)}\)

Load Life Test for 2000 hr @ 0.1W and 0.2W, +70°C
FRFC0805; Average of n=34 resistors per each size and power

FIGURE 6 - THERMAL SHOCK TEST\(^{(1)}\)

Thermal Shock
5 and 100 x (–65°C to +150°C), n=10 per each value

Note
(1) As shown including +0.01Ω for measurement errors at low values.
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 $\frac{\Delta R}{R} = f(T)$ 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)

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)

<table>
<thead>
<tr>
<th>PRODUCT CODE</th>
<th>VALUE</th>
<th>CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4072 = FRFC0805</td>
<td>R = Ω</td>
<td>0 = standard</td>
</tr>
<tr>
<td></td>
<td>K = kΩ</td>
<td>9 = lead (Pb)-free</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 to 999 = custom</td>
</tr>
</tbody>
</table>

Y = DENOTES PRECISION

<table>
<thead>
<tr>
<th>Y</th>
<th>4</th>
<th>0</th>
<th>7</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>R</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>C</th>
<th>9</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y407210R0000C9W</td>
<td>R = 10.0 Ω</td>
<td>0 = standard</td>
<td>9 = lead (Pb)-free</td>
<td>1 to 999 = custom</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESISTANCE TOLERANCE

- T = ± 0.01 %
- Q = ± 0.02 %
- A = ± 0.05 %
- B = ± 0.10 %
- C = ± 0.25 %
- D = ± 0.50 %
- F = ± 1.00 %

PACKAGING

- R = tape and reel
- W = waffle pack

FOR EXAMPLE: ABOVE GLOBAL ORDER Y4072 10R000 C 9 W:
- TYPE: FRFC0805
- VALUE: 10.0 KΩ
- 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)

<table>
<thead>
<tr>
<th>MODEL</th>
<th>OHMIC VALUE</th>
<th>TCR</th>
<th>RESISTANCE TOLERANCE</th>
</tr>
</thead>
</table>
| FRFC0805 | 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 %

<table>
<thead>
<tr>
<th>TERMINATION</th>
<th>PACKAGING</th>
</tr>
</thead>
<tbody>
<tr>
<td>S = lead (Pb)-free</td>
<td>T = tape and reel</td>
</tr>
<tr>
<td>B = tin/lead</td>
<td>W = waffle pack</td>
</tr>
</tbody>
</table>

Note

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