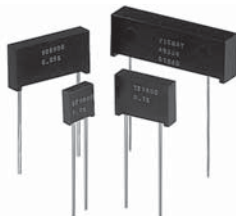


## High Precision Foil Resistor with TCR of $\pm 2.0 \text{ ppm}/^\circ\text{C}$ , Tolerance of $\pm 0.005 \%$ and Load Life Stability of $\pm 0.005 \%$



### INTRODUCTION

Bulk Metal® Foil (BMF) technology outperforms all other resistor technologies available today for applications that require high precision and high stability.

This technology has been pioneered and developed by Vishay Foil Resistors (VFR), and products based on this technology are the most suitable for a wide range of applications. BMF technology allows the production of customer-oriented products, designed to satisfy specific challenging technical requirements.

The S series of BMF resistors offers low TCR, excellent load life stability, tight tolerance, fast response time, low current noise, low thermal EMF and low voltage coefficient, all in one resistor.

The S series is virtually insensitive to destabilizing factors. The resistor element is a solid alloy that displays the desirable bulk properties of its parent material, thus it is inherently stable and noise free. The standard design of these resistors provides a unique combination of characteristics found in no other single resistor.

VFR's application engineering department is available to advise and to make recommendations. For non-standard technical requirements and special applications, please contact [foil@vpgsensors.com](mailto:foil@vpgsensors.com).

**TABLE 1 - RESISTANCE VERSUS TCR**  
(- 55 °C to + 125 °C, + 25 °C ref.)

| RESISTOR <sup>(1) (2)</sup> | RESISTANCE VALUE ( $\Omega$ ) | TYPICAL TCR AND MAX SPREAD ( $\text{ppm}/^\circ\text{C}$ ) |
|-----------------------------|-------------------------------|------------------------------------------------------------|
| S10X(C) / (D)               | 80 to < 1M                    | $\pm 2 \pm 2.5$                                            |
| S10X(K)                     | 80 to < 600K                  | $\pm 1 \pm 2.5$                                            |
| S10X(C) / (D)               | 50 to < 80                    | $\pm 2 \pm 3.5$                                            |
| S10X(K)                     |                               | $\pm 1 \pm 3.5$                                            |
| S10X(C) / (D)               | 0.5 to < 50                   | $\pm 2 \pm 4.5$                                            |
| S10X(K)                     |                               | $\pm 1 \pm 4.5$                                            |

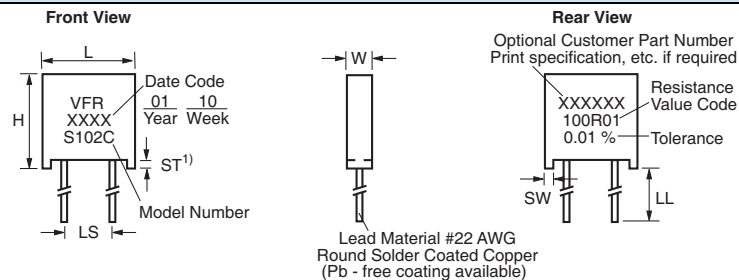
(1) X refers to S Series model number - see Table 2

(2) (C) and (D) refer to C Foil Alloy Types; (K) refers to the K Foil Alloy type - see Figure 1

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

### FEATURES

- Temperature coefficient of resistance (TCR):
  - 55 °C to + 125 °C, 25 °C ref.
  - S10XC / D series:  $\pm 2 \text{ ppm}/^\circ\text{C}$  typical (see table 1)
  - S10XK series:  $\pm 1 \text{ ppm}/^\circ\text{C}$  typical (see table 1)
- Power rating: to 1 W at + 125 °C
- Resistance tolerance: to  $\pm 0.005 \%$  (50 ppm)
- Load life stability:  $\pm 0.005 \%$  at 7

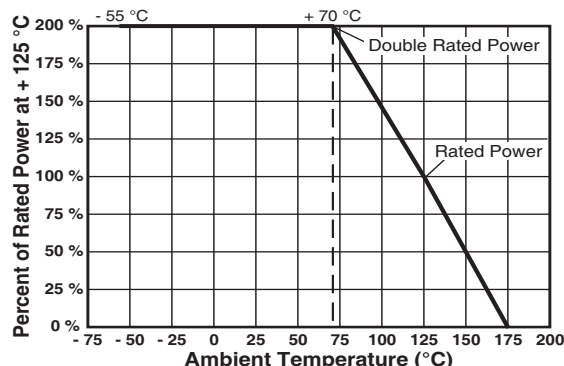
**FIGURE 2 - STANDARD IMPRINTING AND DIMENSIONS****Note**

- Standoffs provided to allow proper flushing of flux, debris, and contaminants from under resistor after all solder operations.
- The standoffs shall be so located as to give a lead clearance of 0.010" minimum between the resistor body and the printed circuit board when the standoffs are seated on the printed circuit board.

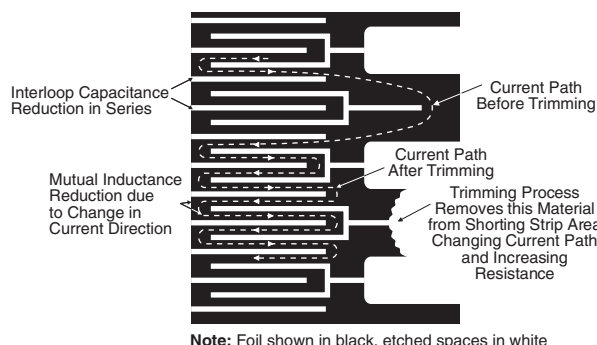
**TABLE 2 - MODEL SELECTION**

| MODEL NUMBER      | RESISTANCE RANGE ( $\Omega$ ) | MAXIMUM WORKING VOLTAGE | AMBIENT POWER RATING |             | AVERAGE WEIGHT IN GRAMS | DIMENSIONS            |                 |                | TIGHTEST TOLERANCE VS. LOWEST RESISTANCE VALUE                                                                                                    |
|-------------------|-------------------------------|-------------------------|----------------------|-------------|-------------------------|-----------------------|-----------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
|                   |                               |                         | at + 70 °C           | at + 125 °C |                         | INCHES                | mm              | F (1) (INCHES) |                                                                                                                                                   |
| S102C (S102J) (2) | 1 to 150K                     | 300                     | 0.6 W                | 0.3 W       | 0.6                     | W: 0.105 $\pm$ 0.010  | 2.67 $\pm$ 0.25 |                | 0.005 %/50 $\Omega$<br>0.01 %/25 $\Omega$<br>0.02 %/12 $\Omega$<br>0.05 %/5 $\Omega$<br>0.1 %/2 $\Omega$<br>0.50 %/1 $\Omega$<br>1 %/0.5 $\Omega$ |
| S102K (S102L) (2) | 1 to 100K                     |                         | up to 100K           | 0.2 W       |                         | L: 0.300 $\pm$ 0.010  | 7.62 $\pm$ 0.25 |                |                                                                                                                                                   |
|                   |                               |                         | 0.4 W                |             |                         | H: 0.326 $\pm$ 0.010  | 8.28 $\pm$ 0.25 |                |                                                                                                                                                   |
|                   |                               |                         | over 100K            |             |                         | ST: 0.010 min.        | 0.254 min.      |                |                                                                                                                                                   |
|                   |                               |                         |                      |             |                         | SW: 0.040 $\pm$ 0.005 | 1.02 $\pm$ 0.13 |                |                                                                                                                                                   |

**FIGURE 3 - POWER DERATING CURVE**

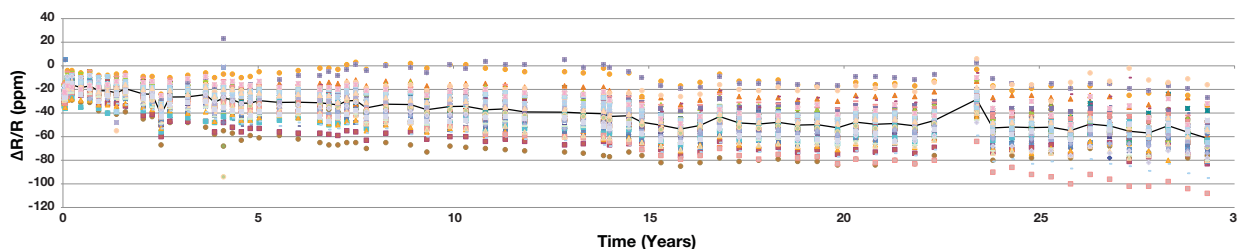


**FIGURE 4 - TRIMMING TO VALUES**  
(conceptual illustration)



**TABLE 3 - ENVIRONMENTAL PERFORMANCE COMPARISON**

|                                                               | MIL-PRF-55182<br>CHAR J | S-SERIES<br>MAXIMUM $\Delta R$ | S-SERIES<br>TYPICAL $\Delta R$ |
|---------------------------------------------------------------|-------------------------|--------------------------------|--------------------------------|
| <b>Test Group I</b>                                           |                         |                                |                                |
| Thermal shock, 5 x (- 65 °C to + 150 °C)                      | ± 0.2 %                 | ± 0.01 % (100 ppm)             | ± 0.002 % (20 ppm)             |
| Short time overload, 6.25 x rated power                       | ± 0.2 %                 | ± 0.01 % (100 ppm)             | ± 0.003 % (30 ppm)             |
| <b>Test Group II</b>                                          |                         |                                |                                |
| Resistance temperature characteristics <sup>(1)</sup>         | ± 25 ppm/°C             | ± 6.5 ppm/°C                   | ± 2.0 ppm/°C                   |
| Low temperature storage (24 h at - 65 °C)                     | ± 0.15 %                | ± 0.01 % (100 ppm)             | ± 0.002 % (20 ppm)             |
| Low temperature operation<br>(45 min, rated power at - 65 °C) | ± 0.15 %                | ± 0.01 % (100 ppm)             | ± 0.002 % (20 ppm)             |
| Terminal strength                                             | ± 0.2 %                 | ± 0.01 % (100 ppm)             | ± 0.002 % (20 ppm)             |
| <b>Test Group III</b>                                         |                         |                                |                                |
| Dielectric Withstanding Voltage (DWV)                         | ± 0.15 %                | ± 0.01 % (100 ppm)             | ± 0.002 % (20 ppm)             |
| Resistance to solder heat                                     | ± 0.1 %                 | ± 0.01 % (100 ppm)             | ± 0.005 % (50 ppm)             |
| Moisture resistance                                           | ± 0.4 %                 |                                |                                |

**FIGURE 5 - LONG-TERM STABILITY OVER 29 YEARS (0.1W AT 70°C, 50 SAMPLES S102C, 10KΩ)**


### STANDARD OPERATIONS AND TEST CONDITIONS

#### A. Standard Test Operations:

##### By 100 % Inspection

- Short-time overload (6.25 x rated power for 5 s)
- Resistance - tolerance check
- Visual and mechanical

##### By Sample Inspection

- TCR
- Environmental tests per table 3 on a quarterly basis to establish performance by similarity

#### B. Standard Test Conditions:

- Lead test point: 0.5" (12.7 mm) from resistor body
- Temperature: + 23 °C ± 2 °C
- Relative humidity: per MIL-STD-202

### IMPROVED PERFORMANCE TESTING (IPT)

The preceding information is based on product directly off the production line. Improved performance (meaning increased time stability with load and other stresses) is available through factory conducted "Improved Performance Testing". The test routine is usually tailored to the user's stability objectives and IPT-processed resistors can exhibit improved load-life stability levels of less than 50 ppm.

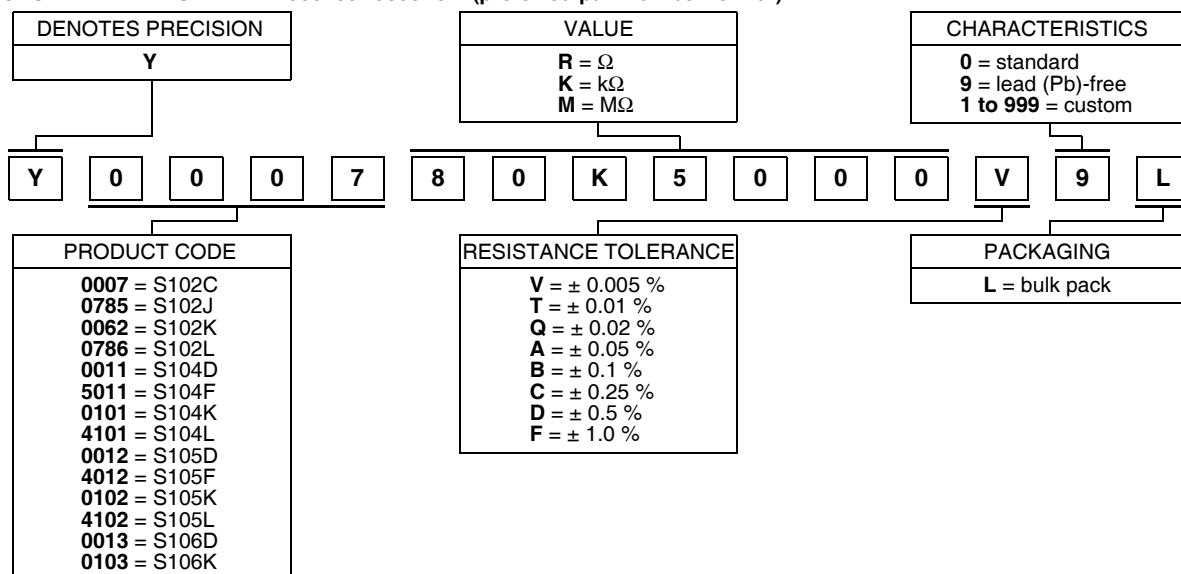
Various screen test routines are available and all anticipated stresses must be taken into account before settling on one specific test routine. VFR's application engineering department is prepared to discuss and recommend appropriate routines given the full spectrum of anticipated stresses and stability requirements.

**TABLE 4 - "S" SERIES SPECIFICATIONS**

|                                                         |                                                     |
|---------------------------------------------------------|-----------------------------------------------------|
| <b>Stability <sup>(1)</sup></b>                         |                                                     |
| Load life at 2000 h                                     | ± 0.015 % (150 ppm)    Maximum ΔR at 0.3 W/+ 125 °C |
|                                                         | ± 0.005 % (50 ppm)    Maximum ΔR at 0.1 W/+ 70 °C   |
| Load life at 10 000 h                                   | ± 0.05 % (500 ppm)    Maximum ΔR at 0.3 W/+ 125 °C  |
|                                                         | ± 0.01 % (100 ppm)    Maximum ΔR at 0.05 W/+ 125 °C |
| <b>Current Noise</b>                                    | 0.010 μV    (RMS)/V of applied voltage (- 40 dB)    |
| <b>High Frequency Operation</b>                         |                                                     |
| Rise time                                               | 1.0 ns at 1 kΩ                                      |
| Inductance (L) <sup>(2)</sup>                           | 0.1 μH maximum; 0.08 μH typical                     |
| Capacitance (C)                                         | 1.0 pF maximum; 0.5 pF typical                      |
| <b>Voltage Coefficient</b>                              | < 0.1 ppm/V <sup>(3)</sup>                          |
| <b>Thermal Electromotive Force (EMF) <sup>(4)</sup></b> |                                                     |
|                                                         | 0.1 μV/°C Maximum; 0.05 μV/°C typical               |
|                                                         | 1 μV/W    (Model S                                  |

**TABLE 5 - GLOBAL PART NUMBER INFORMATION (1)**

NEW GLOBAL PART NUMBER: Y000780K5000V9L (preferred part number format)



FOR EXAMPLE: ABOVE GLOBAL ORDER Y0007 80K5000 V 9 L:

TYPE: S102C

VALUE: 80.5  $k\Omega$

ABSOLUTE TOLERANCE:  $\pm 0.005\%$

TERMINATION: lead (Pb)-free

PACKAGING: bulk pack

HISTORICAL PART NUMBER: S102C T 80K500 V B (will continue to be used)

| S102C                                                                                                                      | T                                           | 80K500                                                                      | V                                                                                                | B         |
|----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-----------|
| MODEL                                                                                                                      | TERMINATION                                 | RESISTANCE VALUE                                                            | TOLERANCE                                                                                        | PACKAGING |
| S102C<br>S102J<br>S102K<br>S102L<br>S104D<br>S104F<br>S104K<br>S104L<br>S105D<br>S105F<br>S105K<br>S105L<br>S106D<br>S106K | T = lead (Pb)-free<br>None = tin/lead alloy | 250R00 = 250.00 $\Omega$<br>5K2310 = 5.231 $k\Omega$<br>1M000 = 1 $M\Omega$ | V = $\pm 0.005\%$<br>T = $\pm 0.01\%$<br>Q = $\pm 0.02\%$<br>A = $\pm 0.05\%$<br>B = $\pm 0.1\%$ |           |

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