



### INTRODUCTION

VISHAY PRECISION

GROUP

Bulk Metal<sup>®</sup> 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 destabillizing 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 <u>foil@vishavpq.com</u>.

TABLE 1 - RESISTANCE VERSUS TCR (- 55 °C to + 125 °C, + 25 °C ref.)				
RESISTOR <sup>(1) (2)</sup>	RESISTANCE VALUE (Ω)	TYPICAL TCR AND MAX SPREAD (ppm/°C)		
S10X(C) / (D)	80 to < 1M	± 2 ± 2.5		
S10 <b>X</b> (K)	80 to < 600K	± 1 ± 2.5		
S10X(C) / (D)	50 to < 80	± 2 ± 3.5		
S10 <b>X</b> (K)	50 10 < 80	± 1 ± 3.5		
S10X(C) / (D)	0.5 to < 50	± 2 ± 4.5		
S10 <b>X</b> (K)	0.5 10 < 50	± 1 ± 4.5		

<sup>(1)</sup> X refers to S Series model number - see Table 2

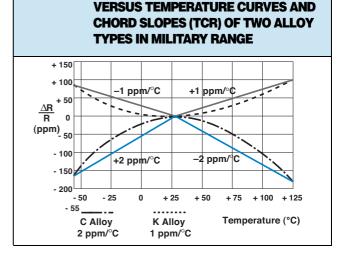
<sup>(2)</sup> (C) and (D) refer to C Foil Alloy Types; (K) refers to the K Foil Alloy type - see Figure 1

\* 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: ± 2 ppm/°C typical (see table 1)
- S10**X**K series: ± 1 ppm/°C typical (see table 1) ROHS • Power rating: to 1 W at + 125 °C
- Resistance tolerance: to ± 0.005 % (50 ppm)
- Load life stability:  $\pm$  0.005 % at 70 °C, 2000 h at rated power • Resistance range: 0.5  $\Omega$  to 1 M $\Omega$  (for higher or lower
- values, please contact Application Engineering)Vishay 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)
- Electrostatic discharge (ESD) at least to 25 kV
- Non inductive, non capacitive design
- Rise time: 1 ns effectively no ringing
- Current noise: 0.010 µV<sub>RMS</sub>/V of applied voltage (< 40 dB)</li>
- Thermal EMF: 0.05 μV/°C
- Voltage coefficient: < 0.1 ppm/V</li>
- Low inductance: < 0.08 μH</li>
- Non hot-spot design
- Terminal finishes available: lead (Pb)-free, tin/lead alloy
- Matched sets are available on request (TCR tracking: to 0.5 ppm/°C)
- Prototype quantities available in just 5 working days or sooner. For more information, please contact <u>foil@vishaypg.com</u>
- For better TCR performances please review the datasheets for the <u>Z Series</u> and <u>Z203</u>

FIGURE 1 - TYPICAL RESISTANCE CHANGE



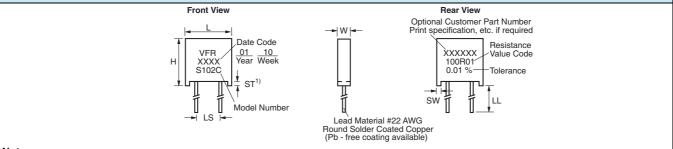


# **S** Series

# Vishay Foil Resistors



### FIGURE 2 - STANDARD IMPRINTING AND DIMENSIONS



#### Note

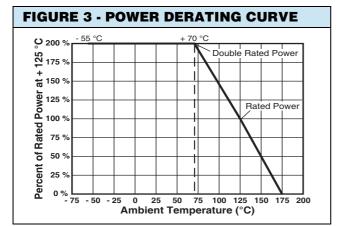
Standoffs provided to allow proper flushing of flux, debris, and contaminates from under resistor after all solder operations.
The standoffs shall be so located as to give a lead clearance of 0.010" minimum between the resistor body and the printed circuit board when the standoffs are seated on the printed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

TABLE 2 - MODEL SELECTION									
MODEL NUMBER	RESISTANCE RANGE (Ω)	MAXIMUM WORKING VOLTAGE	AMBIENT POWER RATING		AVERAGE WEIGHT	DIMENSIONS			TIGHTEST TOLERANCE VS. LOWEST
			at + 70 °C	at + 125 °C	IN GRAMS	INCHES	mm	F <sup>(1)</sup> (INCHES)	RESISTANCE VALUE
S102C (S102J) <sup>(2)</sup>	1 to 150K		0.6 W up to	0.3 W 100K		L: 0.300 ± 0.010	2.67 ± 0.25 7.62 ± 0.25 8.28 ± 0.25		
S102K (S102L) <sup>(2)</sup>	1 to 100K	300	0.4 W over	0.2 W 100K	0.6	$ \begin{array}{l} \text{ST: } 0.328 \pm 0.010 \\ \text{ST: } 0.010 \\ \text{min.} \\ \text{SW: } 0.040 \pm 0.005 \\ \text{LL: } 1.000 \pm 0.125 \\ \text{LS: } 0.150 \pm 0.005 \\ \end{array} $	$8.28 \pm 0.25$ 0.254 min. $1.02 \pm 0.13$ $25.4 \pm 3.18$ $3.81 \pm 0.13$		
S104D (S104F) <sup>(1)</sup>	1 to 500K		1.0 W up to	0.5 W 200K		W: 0.160 max. L: 0.575 max. H: 0.413 max.	nax. 14.61 max. (0.565)		
S104K	1 to 300K	350	0.6 W over	0.3 W 200K	1.4	ST: $0.035 \pm 0.005$ SW: $0.050 \pm 0.005$ LL: $1.000 \pm 0.125$ LS: $0.400 \pm 0.020$	$\begin{array}{c} \text{0.49 fillax.} \\ \text{0.889} \pm 0.13 \\ \text{1.27} \pm 0.13 \\ \text{25.4} \pm 3.18 \\ \text{10.16} \pm 0.51 \end{array}$	(0.413)	0.005 %/50 Ω 0.01 %/25 Ω 0.02 %/12 Ω 0.05 %/5 Ω
S105D (S105F) <sup>(1)</sup>	1 to 750K		1.5 W up to	0.75 W 300K	1.9	W: 0.160 max. L: 0.820 max. H: 0.413 max.	4.06 max. 20.83 max. 10.49 max.	(0.138) (0.890)	0.1 %/2 Ω 0.50 %/1 Ω
S105K	1 to 500K	350	0.8 W over	0.4 W 300K		$\begin{array}{c} \text{F: } 0.413 \text{ max.} \\ \text{ST: } 0.035 \pm 0.005 \\ \text{SW: } 0.050 \pm 0.005 \\ \text{LL: } 1.000 \pm 0.125 \\ \text{LS: } 0.650 \pm 0.020 \end{array}$	$\begin{array}{c} \text{10.49 max.} \\ \text{0.889} \pm 0.13 \\ \text{1.27} \pm 0.13 \\ \text{25.4} \pm 3.18 \\ \text{16.51} \pm 0.51 \end{array}$	(0.413) (0.7 ± 0.05)	1 %/0.5 Ω
S106D	0.5 to 1M		2.0 W up to	1.0 W 400K	1	W: 0.260 max. L: 1.200 max.	6.60 max. 30.48 max.		
S106K	0.5 to 600K	500	1.0 W over	0.5 W 400K	4.0	H: $0.413 \text{ max.}$ ST: $0.035 \pm 0.005$ SW: $0.050 \pm 0.005$ LL: $1.000 \pm 0.125$ LS: $0.900 \pm 0.020$	10.49 max. $0.889 \pm 0.13$ $1.27 \pm 0.13$ $25.4 \pm 3.18$ $22.86 \pm 0.51$		

#### Notes

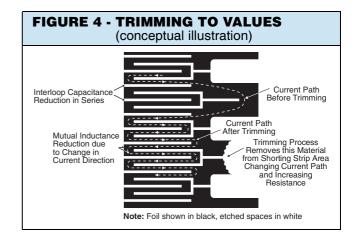
S104F and S105F have different package dimensions (see the third column of dimensions). All other specifications are the same.
0.200" (5.08 mm) lead spacing available - specify S102J for S102C, and S102L for S102K.

**Vishay Foil Resistors** 



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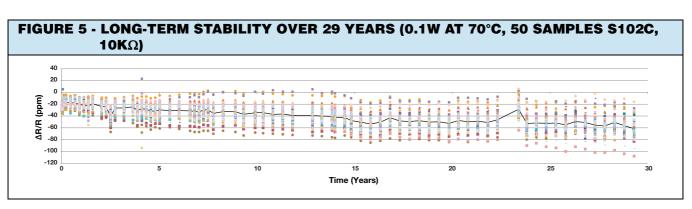
GROUP



	MIL-PRF-55182 CHAR J	S-SERIES MAXIMUM AR	S-SERIES TYPICAL AR
Test Group I			
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)
Test Group II			
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 (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)
Test Group III			
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 %	± 0.05 % (500 ppm)	± 0.01 % (100 ppm)
Test Group IV			
Shock	± 0.2 %	± 0.01 % (100 ppm)	± 0.002 % (20 ppm)
Vibration	± 0.2 %	± 0.01 % (100 ppm)	± 0.002 % (20 ppm)
Test Group V			
Life test at 0.3 W/+ 125 °C			
2000 h	± 0.5 %	± 0.015 % (150 ppm)	± 0.01 % (100 ppm)
10 000 h	± 2.0 %	± 0.05 % (500 ppm)	± 0.03 % (300 ppm)
Test Group Va			
Life test at 0.6 W (2 x rated power)/+ 70 °C, 2000 h	± 0.5 %	± 0.015 % (150 ppm)	± 0.01 % (100 ppm)
Test Group VI			
High temperature exposure (2000 h at + 175 °C)	± 2.0 %	± 0.1 % (1000 ppm)	± 0.05 % (500 ppm)
Test Group VII			
Voltage coefficient	5 ppm/V	< 0.1 ppm/V	< 0.1 ppm/V

<sup>(1)</sup> See Table 1.

## Vishay Foil Resistors



# 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)**

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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			
Stability <sup>(1)</sup>			
Load life at 2000 h	± 0.015 % (150 ppm)	Maximum $\Delta R$ at 0.3 W/+ 125 °C	
	± 0.005 % (50 ppm)	Maximum $\Delta R$ at 0.1 W/+ 70 °C	
Load life at 10 000 h	± 0.05 % (500 ppm)	Maximum $\Delta R$ at 0.3 W/+ 125 °C	
	± 0.01 % (100 ppm)	Maximum $\Delta R$ at 0.05 W/+ 125 °C	
Current Noise	0.010 µV	(RMS)/V of applied voltage (- 40 dB)	
High Frequency Operation			
Rise time	1.0 ns at 1 k $\Omega$		
Inductance (L) <sup>(2)</sup>	0.1 μH maximum; 0.08 μH typical		
Capacitance (C)	1.0 pF maximum; 0.5 pF typical		
Voltage Coefficient	< 0.1 ppm/V <sup>(3)</sup>		
Thermal Electromotive Force (EMF) <sup>(4)</sup>	0.1 μV/°C Maximum; 0.05 μV/°C typical		
	1 μV/W	(Model S102C)	

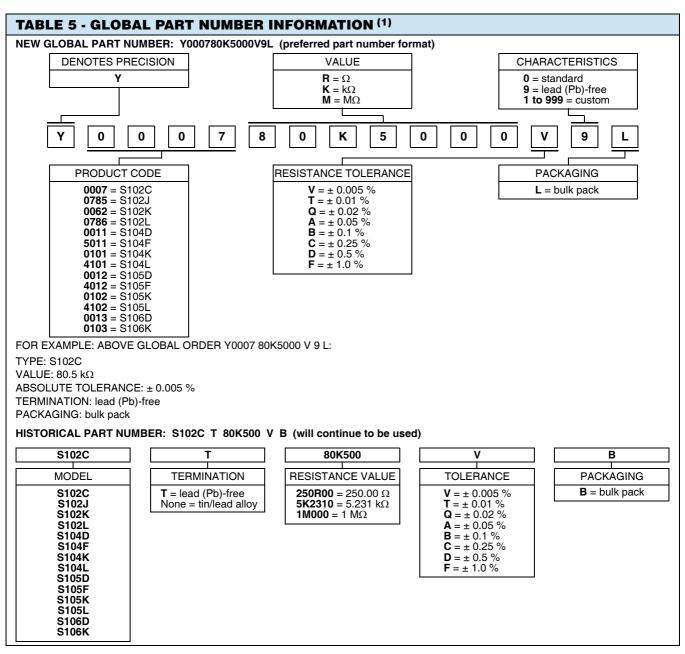
#### Notes

(1) Load life  $\Delta R$  maximum can be reduced by 80 %, please contact applications engineering department.

<sup>&</sup>lt;sup>(2)</sup> Inductance (L) due mainly to the leads.

 <sup>(3)</sup> The resolution limit of existing test equipment (within the measurement capability of the equipment, or "essentially zero".)
(4) µV/°C relates to EMF due to lead temperature difference and µV/watt due to power applied to the resistor.





#### Note

<sup>(1)</sup> For non-standard requests, please contact application engineering.



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