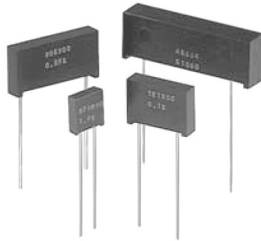


High Precision Foil Resistor with TCR of ± 2.0 ppm/ $^{\circ}\text{C}$, Tolerance of ± 0.005 % and Load Life Stability of ± 0.005 %



Product may not
be to scale

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.

Our application engineering department is available to advise and to make recommendations. For non-standard technical requirements and special applications, please contact us.

FEATURES

- Temperature coefficient of resistance (TCR): - 55 $^{\circ}\text{C}$ to + 125 $^{\circ}\text{C}$, 25 $^{\circ}\text{C}$ ref.
 - CE-S10XC / D series: ± 2 ppm/ $^{\circ}\text{C}$ typical (see table 1)
 - CE-S10XK series: ± 1 ppm/ $^{\circ}\text{C}$ typical (see table 1)
- Power rating: to 1 W at + 125 $^{\circ}\text{C}$
- Resistance tolerance: to ± 0.005 % (50 ppm)
- Load life stability: ± 0.005 % at 70 $^{\circ}\text{C}$, 2000 h at rated power
- Resistance range: 0.5 Ω to 1 M Ω (for higher or lower values, please contact Application Engineering)
- Charcroft 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 $\mu\text{VRMS/V}$ of applied voltage (< - 40 dB)
- Thermal EMF: 0.05 $\mu\text{V}/^{\circ}\text{C}$
- Voltage coefficient: < 0.1 ppm/V
- Low inductance: < 0.08 μH
- Non hot-spot design
- Terminal Finishes Available:
 - RoHS Compliant
 - Tin/Lead Alloy with minimum 5%, nominally 10% Lead content
- Matched sets are available on request (TCR tracking: to 0.5 ppm/ $^{\circ}\text{C}$)
- For better TCR performances please review the datasheets for the Z Series

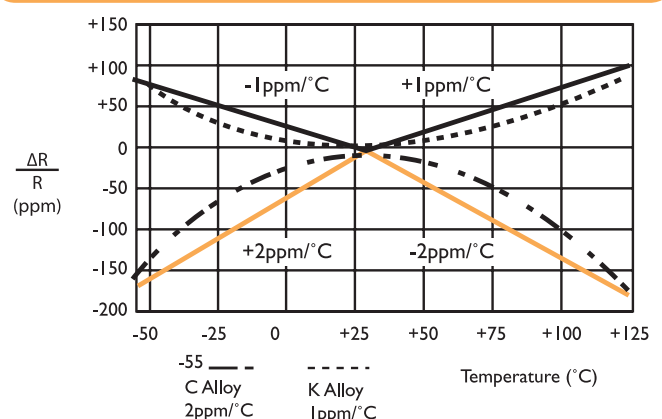
TABLE 1 -RESISTANCE VERSUS TCR
(- 55 $^{\circ}\text{C}$ to + 125 $^{\circ}\text{C}$, + 25 $^{\circ}\text{C}$ ref.)

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

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

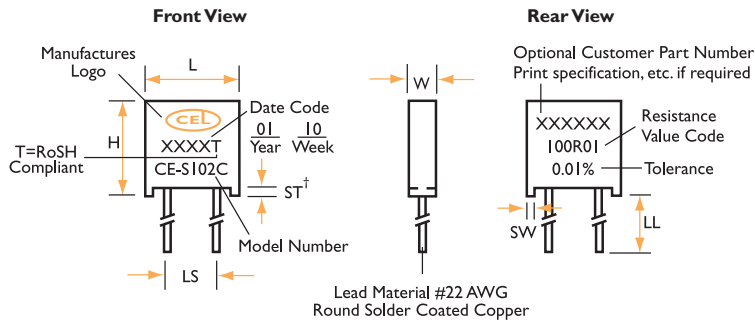
(2) (C) and (D) refer to C Foil Alloy Types; (K) refers to the K Foil Alloy type - see Figure 1

FIGURE 1 -TYPICAL RESISTANCE CHANGE VERSUS TEMPERATURE CURVES AND CHORD SLOPES (TCR) OF TWO ALLOY TYPES IN MILITARY RANGE



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

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 (Ω)	MAXIMUM WORKING VOLTAGE ²	AMBIENT POWER RATING ³ @+70 $^{\circ}\text{C}$ @+125 $^{\circ}\text{C}$	AVERAGE WEIGHT IN GRAMS	DIMENSIONS		TIGHTEST TOLERANCE% VS. LOWEST RESISTANCE VALUE Ω
					mm	*F mm	
CE-S102C (CE-S102J) ²	1 to 150K	300	0.6 W up to 100K 0.3 W	0.6	W: 2.67 $\pm$ 0.25 L: 7.62 $\pm$ 0.25 H: 8.28 $\pm$ 0.25 ST: 0.254 Minimum SW: 1.02 $\pm$ 0.13 LL: 25.4 $\pm$ 3.18 LS: 3.81 $\pm$ 0.13		$\pm 0.005 / 50$
CE-S102K (CE-S10L) ²	1 to 100K		0.4 W over 100K 0.2 W				
CE-S104D (CE-S104F) ¹	1 to 500K	350	1.0 W up to 200K 0.5 W	1.4	W: 4.06 Maximum L: 14.61 Maximum H: 10.49 Maximum ST: 0.889 $\pm$ 0.13 SW: 1.27 $\pm$ 0.13 LL: 25.4 $\pm$ 3.18 LS: 10.16 $\pm$ 0.51	(3.51) (14.35) (10.49)	$\pm 0.01 / 25$ $\pm 0.02 / 12$
CE-S104K	1 to 300K		0.6 W over 200K 0.3 W				
CE-S105D (CE-S105F) ¹	1 to 750K	350	1.5 W up to 300K 0.75 W	1.9	W: 4.06 Maximum L: 20.83 Maximum H: 10.49 Maximum ST: 0.889 $\pm$ 0.13 SW: 1.27 $\pm$ 0.13 LL: 25.4 $\pm$ 3.18 LS: 16.51 $\pm$ 0.51	(3.51) (22.61) (10.49)	$\pm 0.05 / 5$ $\pm 0.1 / 2$ $\pm 0.5 / 1$
CE-S105K	1 to 500K		0.8 W over 300K 0.4 W			(17.78 $\pm$ 0.51)	
CE-S106D	0.5 to 1M	500	2.0 W up to 400K 1.0 W	4.0	W: 6.60 Maximum L: 30.48 Maximum H: 10.49 Maximum ST: 0.889 $\pm$ 0.13 SW: 1.27 $\pm$ 0.13 LL: 25.4 $\pm$ 3.18 LS: 22.86 $\pm$ 0.51		
CE-S106K	0.5 to 600K		1.0 W over 400K 0.5 W				

Notes

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

FIGURE 3 - POWER DERATING CURVE

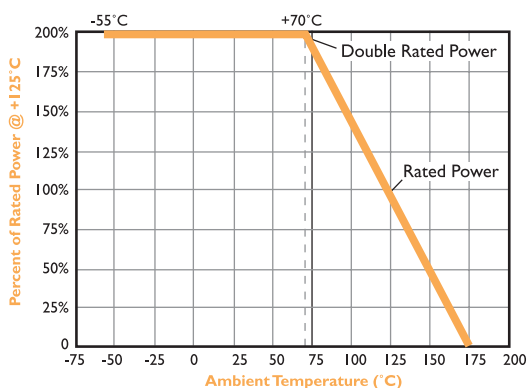
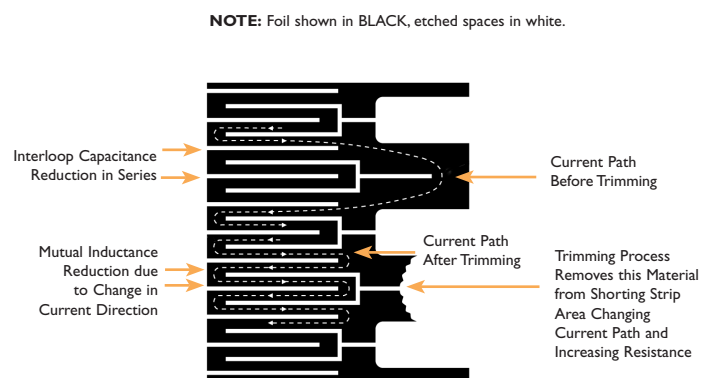


FIGURE 4 - TRIMMING TO VALUES (conceptual illustration)



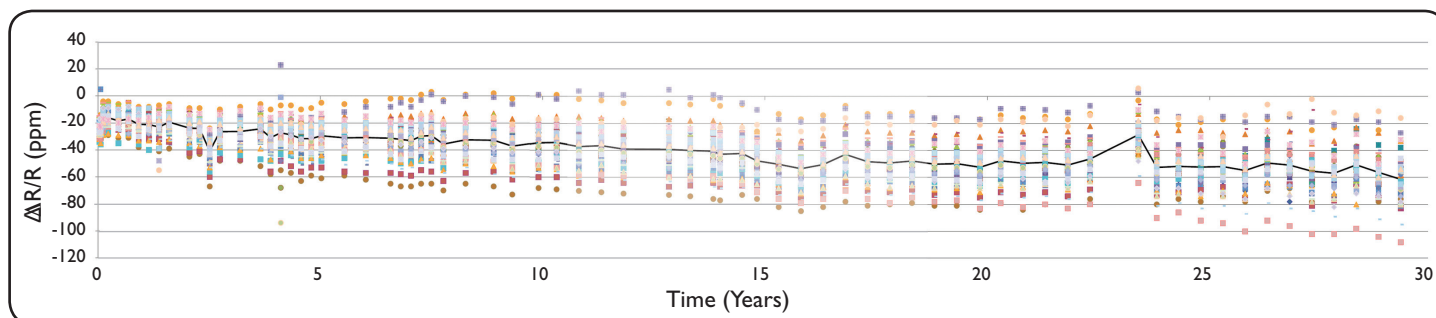
**High Precision Foil Resistor with TCR of ± 2.0 ppm/°C,
Tolerance of ± 0.005 % and Load Life Stability of ± 0.005 %**

TABLE 3 - ENVIRONMENTAL PERFORMANCE COMPARISON

	MIL-PRF-55182 CHAR J	S-SERIES MAXIMUM ΔR	S-SERIES TYPICAL ΔR
Test Group I Thermal Shock 5 x (- 65 °C to + 150 °C) Short time overload, 6.25 x rated power	$\pm 0.2\%$ $\pm 0.2\%$	$\pm 0.01\%$ (100 ppm) $\pm 0.01\%$ (100 ppm)	$\pm 0.002\%$ (20 ppm) $\pm 0.003\%$ (30 ppm)
Test Group II Resistance temperature characteristics ⁽¹⁾ Low temperature storage (24 h at - 65 °C) Low Temp Operation Terminal Strength	$\pm 25\text{ppm}/^\circ\text{C}$ $\pm 0.15\%$ $\pm 0.15\%$ $\pm 0.2\%$	$+ 6.5\text{ppm}/^\circ\text{C}$ $\pm 0.01\%$ (100 ppm) $\pm 0.01\%$ (100 ppm) $\pm 0.01\%$ (100 ppm)	$\pm 2.0 \text{ ppm}/^\circ\text{C}$ $\pm 0.002\%$ (20 ppm) $\pm 0.002\%$ (20 ppm) $\pm 0.002\%$ (20 ppm)
Test Group III Dielectric Withstanding Voltage (DWV) Resistance to Solder Heat Moisture Resistance	$\pm 0.15\%$ $\pm 0.1\%$ $\pm 0.4\%$	$\pm 0.01\%$ (100 ppm) $\pm 0.01\%$ (100 ppm) $\pm 0.05\%$ (500 ppm)	$\pm 0.002\%$ (20 ppm) $\pm 0.005\%$ (50 ppm) $\pm 0.01\%$ (100 ppm)
Test Group IV Shock Vibration	$\pm 0.2\%$ $\pm 0.2\%$	$\pm 0.01\%$ (100 ppm) $\pm 0.01\%$ (100 ppm)	$\pm 0.002\%$ (20 ppm) $\pm 0.002\%$ (20 ppm)
Test Group V Life Test @ 0.3 W/+125°C 2,000 Hours 10,000 Hours	$\pm 0.5\%$ $\pm 2.0\%$	$\pm 0.015\%$ (150 ppm) $\pm 0.05\%$ (500 ppm)	$\pm 0.01\%$ (100 ppm) $\pm 0.03\%$ (300 ppm)
Test Group Va Life test at 0.6 W (2 x rated power)/+ 70 °C, 2000 h	$\pm 0.5\%$	$\pm 0.015 \%$ (150 ppm)	$\pm 0.01 \%$ (100 ppm)
Test Group VI High temperature exposure (2000 h at + 175 °C)	$\pm 2.0\%$	$\pm 0.1 \%$ (1000 ppm)	$\pm 0.05 \%$ (500 ppm)
Test Group VII Voltage Coefficient	5 ppm/V	< 0.1 ppm/V	< 0.1 ppm/V

(1) See Table I.

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



STANDARD OPERATIONS & 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: 12.7 mm from resistor body
- Temperature: $+ 23^\circ\text{C} \pm 2^\circ\text{C}$
- Relative humidity: per MIL-Std-202

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

TABLE 4 - "S" SERIES SPECIFICATIONS

Stability ¹ Load Life at 2,000 hours. Load Life at 10,000 hours.	$\pm 0.015\%$ (150 ppm)	Maximum ΔR @ 0.3W/+ 125 $^{\circ}$ C
	$\pm 0.005\%$ (50 ppm)	Maximum ΔR @ 0.1W/+ 70 $^{\circ}$ C
	$\pm 0.05\%$ (500 ppm)	Maximum ΔR @ 0.3W/+ 125 $^{\circ}$ C
	$\pm 0.01\%$ (100 ppm)	Maximum ΔR @ 0.05 W/+ 125 $^{\circ}$ C
Current Noise	0.010 μ V	(RMS)/Volt of applied voltage (-40dB)
High Frequency Operation Rise/Decay Time Inductance (L) ² Capacitance (C)	1.0ns at 1k Ω	
	0.1 μ H maximum; 0.08 μ H typical	
	1.0pF maximum; 0.5pF typical	
Voltage Coefficient	< 0.1ppm/V ³	
Thermal Electromotive Force (EMF) ⁴	0.1 μ V/ $^{\circ}$ C 1 μ V/W	Maximum; 0.05 μ V/ $^{\circ}$ C typical (Model CE-S102C)

1. Load life ΔR Maximum can be reduced by 80%, please contact our Application Engineering Department.
2. Inductance (L) due mainly to the leads.
3. The resolution limit of existing test equipment (within the measurement capability of the equipment, or "essentially zero.")
4. μ V/ $^{\circ}$ C relates to EMF due to lead temperature difference and μ V/watt due to power applied to the resistor.

ORDERING INFORMATION

CE-S102C
CE-S102J
CE-S102K
CE-S102L
CE-S104D
CE-S104F
CE-S104K
CE-S104L
CE-S105D
CE-S105F
CE-S105K
CE-S105L
CE-S106D
CE-S106K

MODEL NO.

T = RoHS compliant
None = Tin/Lead alloy

TERMINATION

250R00

RESISTANCE VALUE

V = $\pm 0.005\%$
T = $\pm 0.01\%$
Q = $\pm 0.02\%$
A = $\pm 0.05\%$
B = $\pm 0.1\%$
C = $\pm 0.25\%$
D = $\pm 0.5\%$
F = $\pm 1.0\%$

TOLERANCE

TR = Tape & Reel
(CE-S102 & CE-S102L only)

None = Bulk

PACKAGING

Specify Charcraft S Series resistors
as follows: