# High Precision Foil Wraparound Surface Mount Chip Resistor
## with TCR of ±2 ppm/°C and Load Life Stability of ±0.01% (100 ppm)

### FEATURES

- Temperature coefficient of resistance (TCR): ±2 ppm/°C typical (–55°C to +125°C, +25°C ref.) (see table 1)
- Resistance range: 0.1 Ω to 10 Ω (for higher or lower values, please contact application engineering department)
- Resistance tolerance: to ±0.5%
- Load life stability:
- ±0.02% at 70°C, 2000 h at rated power
- Power rating: 0.25 W at +70°C
- Bulk Metal® Foil resistors are not restricted to standard values; specific “as required” values can be supplied at no extra cost or delivery (e.g., 0.2345 Ω vs. 0.2 Ω)
- Electrostatic discharge (ESD) at least to 25 kV
- **Thermal stabilization time <1 s (nominal value achieved within 10 ppm of steady state value)**
- Short time overload <0.005%
- Non-inductive, non-capacitive design
- Thermal EMF: 0.05 µV/°C typical
- Current noise: 0.010 $\mu V_{RMS}$/V of applied voltage (<–40 dB)
- Rise time: 1 ns effectively no ringing
- Voltage coefficient: <0.1 ppm/V
- Non inductive: <0.08 µH
- Non hot spot design
- Quick prototype quantities available, please contact: foil@vpgsensors.com
- For improved performances, please see VCS1610Z

### TERMINATIONS

- Two lead (Pb)-free options are available: Gold plated or tin plated
- Tin/lead plated

Pb-free Available
RoHS* COMPLIANT

### INTRODUCTION

**Why should I use the VCS1610?**

The VCS1610 is a current sensing solution that was developed with a low TCR to meet demands for new and stable resistive product solutions in the industry today. This resistor is most-often used to monitor a current that is directly proportional to some physical characteristic (such as pressure, weight, etc) being measured by an analog sensor. The resistor converts the current to a voltage that is representative of the physical characteristic and feeds that voltage into control circuits, instrumentation, or other indicators.

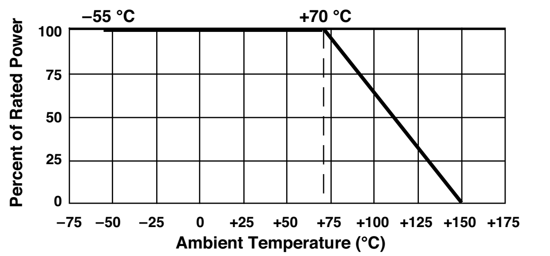
Variations induced in the resistor, not representative of the monitored characteristic, can be caused by high TCR response to both ambient temperature and self-heating and can feed erroneous signals into the system. Resistance is usually kept low to reduce the $I^2R$ self-heating (Joule effect) portion of the error while minimizing the stresses that cause long-term resistance changes. It is critical for this resistor to reach thermal equilibrium quickly in circuits that require fast response or where the current changes quickly.

The VCS1610 is used where the emphasis is on accuracy and repeatability under stress conditions in applications requiring precision resistor performance up to 0.25 W and up to 70°C. Applications as EB systems, switching power supplies, force-balanced scales all rely on current sense resistors to develop a precise voltage proportional to the current. The VCS1610 is a four terminal resistor which is essential to achieve high accuracy and stability.

**Note**

* This datasheet provides information about parts that are RoHS-compliant and/or parts that are non-RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS compliant. Please see the information/tables in this datasheet for details.

## Figure 1 – Power Derating Curve[1]




**Note**

[1] Power rating: 0.25 W at +70°C

## Table 1 – Tolerance and TCR Vs. Resistance Value (–55°C to +125°C, +25°C Ref.)

| VALUE (Ω) | TOLERANCE | TYPICAL TCR | MAXIMUM TCR |
|---|---|---|---|
| 0R5 to 10R | 0.5%, 1% | ±2 ppm/°C | ±10 ppm/°C |
| 0R1 to <0R5 | 0.5%, 1% | ±2 ppm/°C | ±15 ppm/°C |

**Note**

Tighter tolerances and higher values are available. Please contact application engineering: foil@vpgsensors.com

### Why use Kelvin connections?

Four-terminal connections or Kelvin connections are required in these low ohmic value resistors to measure a precise voltage drop across the resistive element.
The 4-terminal configuration eliminates the IR-drop error voltage that would be present in the voltage sense leads if a standard two-terminal resistor were used.

In current sense resistors the contact resistance and the terminations resistance may be greater than that of the resistive element itself so lead connection errors can be significant if only two terminal connections are used.

### Why is the VCS1610 vital in avoiding Thermal EMF (parasitic effect)?

When the junction of two dissimilar metals is heated, a voltage is generated across the junction creating a DC-offset error signal. This voltage is proportional to the temperature difference across the junction and is called a thermal electro-motive force (Thermal EMF), or thermo couple.

Thermal EMF is an important consideration in low ohmic current sensing resistors used mostly in DC circuits (there is no effect in AC circuitry). The VCS1610 is the ideal solution to minimize the effect of thermal EMF through the use of appropriate materials between the resistive layer and the terminations.

### Should I be concerned about the impact of ESD on my resistor?

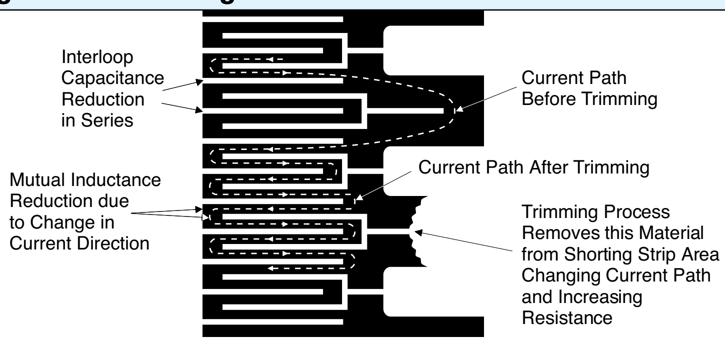
Electrostatic discharge (ESD) is known to produce catastrophic failures in thin-film and thick-film (cermet) resistors at only 3000 V. On the other hand, the Bulk Metal® Foil resistor withstands ESD events up to 25 kV because its thicker resistance element and greater metallic mass afford much higher energy-handling capability than either the much thinner thin-film resistor or the sparse, non-homogeneous metallic content of the thick film resistor.

### Should I be concerned about stability?

In order to select the resistor technology most appropriate to the application, a designer must take into account all normal and extraordinary stresses the resistor will experience in the application. In addition, the designer must consider the cost and reliability impact involved when it becomes necessary to add costly additional compensating circuitry when inadequate resistors are selected. The stability of Bulk Metal® Foil resistors, together with the advantages already mentioned, as well as the other basic advantages apparent in their specifications will not only provide unequalled performance in the circuit but will eliminate all the costs associated with extra compensation circuitry.

With VCS1610, only a minimal shift in resistance value will occur during its entire lifetime. Most of this shift takes place during the first few hundred hours of operation, and virtually no change is noted thereafter.

## Figure 2 – Trimming to Values

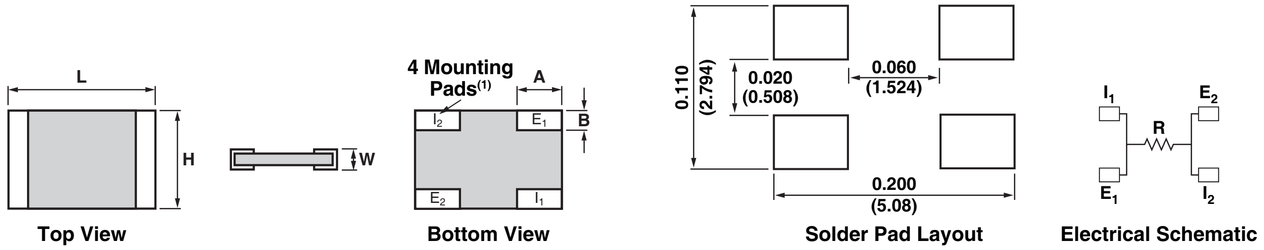



Foil shown in black, etched spaces in white

**Note**

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 Bulk Metal® Foil resistors.

## Figure 3 – Dimensions in inches (millimeters)

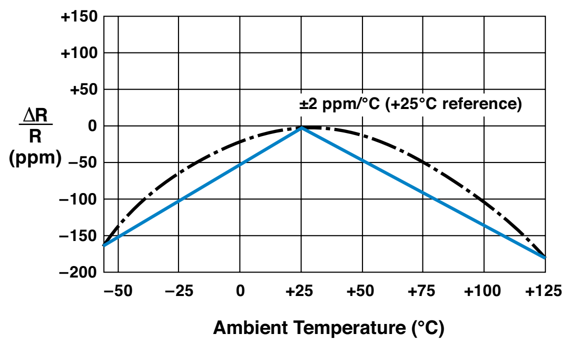



**Note**

**(1) I and E mounting pads are interchangeable**

| | INCHES | MILLIMETERS |
|---|---|---|
| L | 0.160±0.010 | 4.06±0.25 |
| H | 0.100±0.010 | 2.54±0.25 |
| W | 0.040 maximum | 1.02 maximum |
| A | 0.045±0.005 | 1.14±0.13 |
| B | 0.030±0.010 | 0.76±0.25 |

## Figure 4 – Typical Resistance/Temperature Curve




## Table 2 – Performance Specifications

| TEST | MIL-PRF-55342 ΔR LIMITS | TYPICAL ΔR LIMITS |
|---|---|---|
| **Thermal Shock** 5 × (–65°C to +150°C) | ±0.10% | ±0.005% (50 ppm) |
| **Low Temperature Operation,** –65°C, 45 min at $P_{nom}$ | ±0.10% | ±0.005% (50 ppm) |
| **Short Time Overload,** 6.25 × Rated Power, 5 sec | ±0.10% | ±0.005% (50 ppm) |
| **High Temperature Exposure,** +150°C, 100 h | ±0.10% | ±0.01% (100 ppm) |
| **Resistance to Soldering Heat,** 10 s to 12 s @ 260°C reflow method | ±0.2% | ±0.01% (100 ppm) |
| **Moisture Resistance,** MIL-202 method 106 | ±0.2% | ±0.01% (100 ppm) |
| **Load Life Stability,** +70°C for 2000 h at Rated Power | ±0.5% | ±0.02% (200 ppm) |

**Note**

Measurement error 0.001 R

**Table 3 – Global Part Number Information[1]**

**NEW GLOBAL PART NUMBER: Y11200R40500D9W (preferred part number format)**

| Y | 1 | 1 | 2 | 0 | 0 | R | 4 | 0 | 5 | 0 | 0 | D | 9 | W |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

DENOTES PRECISION
- **Y**

VALUE
- **R** = Ω

CHARACTERISTICS
- **0** = tin/lead plated
- **9** = tin plated
- **19** = gold plated
- **1 to 999** = custom

PRODUCT CODE
- **1120** = VCS1610

RESISTANCE TOLERANCE
- **D** = ±0.5%
- **F** = ±1.0%
- **G** = ±2.0%
- **J** = ±5.0%
- **K** = ±10.0%

PACKAGING
- **W** = waffle pack
- **R** = tape and reel

FOR EXAMPLE: ABOVE GLOBAL ORDER Y1120 0R40500 D 9 W:

TYPE: VCS1610
VALUES: 0.405 Ω
ABSOLUTE TOLERANCE: ±0.5%
TERMINATION: lead (Pb)-free
PACKAGING: waffle pack

**Note**

[1] For non-standard requests or additional values, please contact application engineering.

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