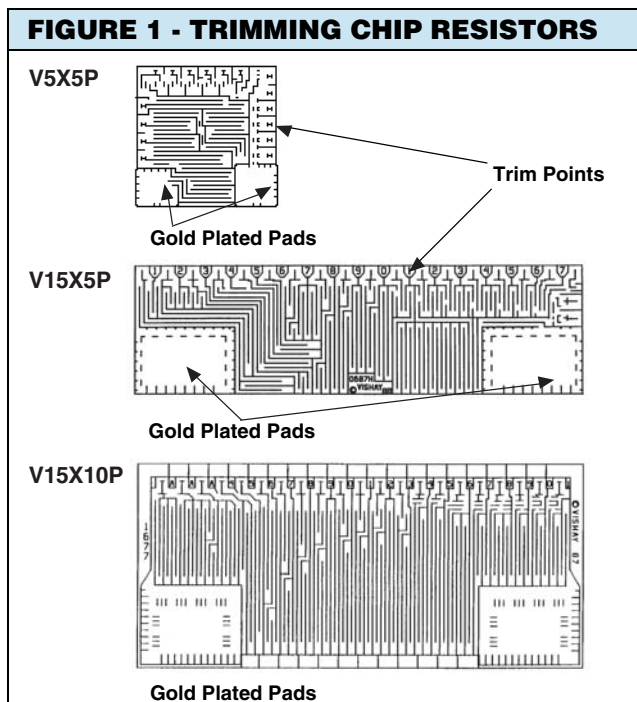


**Bulk Metal® Foil Technology Discrete Chips with TCR of 2 ppm/°C,
Tolerance to 0.005 %, and Load Life Stability of ± 0.01 %
for 10 000 h for use in Hybrid Circuits**



FEATURES

- Temperature coefficient of resistance (TCR):
Absolute: $\pm 2.0 \text{ ppm/}^\circ\text{C}$ (-55°C to $+125^\circ\text{C}$, $+25^\circ\text{C}$ ref.)
TCR tracking: to $0.5 \text{ ppm/}^\circ\text{C}$ ⁽¹⁾⁽²⁾
- Resistance tolerance:
Absolute to $\pm 0.01 \%$ (user trimmable to $\pm 0.005 \%$)
Match: to 0.01%
- Power rating: 50 mW to 150 mW at $+70^\circ\text{C}$
- Load life stability: $\pm 0.01 \%$ at $+70^\circ\text{C}$, 10 000 h at rated power
- Resistance range: 5Ω to $80 \text{ k}\Omega$ (see table 2)
- 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)
- Hybrid chips are also available for high temperature applications, please contact us for more details
- Short time overload: $\leq 0.02 \%$
- Electrostatic discharge (ESD) up to 25 000 V
- Non-inductive, non-capacitive design
- Rise time: 1 ns effectively no ringing
- Thermal stabilization time $< 1 \text{ s}$ (nominal value achieved within 10 ppm of steady state value)
- Current noise: $0.010 \mu\text{V}_{\text{RMS}}/\text{V}$ of applied voltage ($< -40 \text{ dB}$)
- Non-inductive: $< 0.08 \mu\text{H}$
- Pattern design minimizing hot spots



RoHS
COMPLIANT

The typical pattern and trimming illustrations show that the V5X5P resistor has 16 trimming points, the V15X5P has 20 and the V15X10P has 21. These trimming points are arranged around the chip periphery and are clearly indicated. Trimming to the desired resistance value and tolerance is accomplished by cutting the trim points, thereby producing specific incremental changes in the chip's resistance value relative to the original prevalue; up to $+20 \%$ for the V5X5P, $+30 \%$ for the V15X5P, and $+50 \%$ for the V15X10P (not all trim points need be used; the ΔR necessary to adjust the pre-value to the desired final value dictates which trim points need to be used).

Monitoring of circuit output while "actively" trimming readily permits adjustment of the chip to $\pm 0.005 \%$.

Actual trimming charts are supplied on request for all images.

Vishay precision chip resistors offer an order of magnitude of improvement over other chip resistors in hybrid applications. With a maximum Temperature Coefficient of Resistance (TCR) of $\pm 5 \text{ ppm/}^\circ\text{C}$, selected TCR tracking to $0.5 \text{ ppm/}^\circ\text{C}$ and factory supplied resistance tolerances to $\pm 0.01 \%$, they provide the user with accuracy and stability not available in other chip resistor products. If desired they can be user trimmed to any value within $\pm 0.005 \%$, where the value remains stable after trimming. Load life stability is

0.015% ΔR maximum under full rated power for 2000 h at $+70^\circ\text{C}$.

The Vishay precision trimming system allows for adjustment to precise resistance values without concern over mechanical override and control problems encountered in laser or air abrade trimming of solid geometry resistance patterns. This ability to trim resistor chips to tolerance levels never before available to hybrid manufacturers, now gives a project manager the ability to increase the value-added level of their hybrid services. More of the profit thus available can be retained within the facility. Now, instead of buying precision resistors in separate packages or modules (which require additional PC board real estate) and integrating them into a system, the project manager can utilize Vishay precision resistor chips or matched sets to manufacture the entire hybrid circuit in-house. Eliminates the need to "pin-out" for precision resistor requirements because the precision resistors are inside - part of the hybrid microcircuit design.

Vishay precision chip resistors are available either factory-trimmed to exact resistance values (option T) or ready for user trimming (option U); user trimming can be done either before or after bonding - using standard epoxies - onto the hybrid circuit substrate using standard laser, air abrade, or manual adjustment techniques. However care should be taken that no carbonization occurs when laser trimming.

TABLE 1 - TOLERANCE AND TCR VS. RESISTANCE VALUE⁽¹⁾

VALUE (Ω)	STANDARD TOLERANCE (%)	TYPICAL TCR AND MAX SPREAD - 55 °C to + 125 °C, + 25 °C Ref. (ppm/°C) ⁽²⁾
500 to 80K	± 0.01	$\pm 2 \pm 3$
100 to < 500	± 0.02	$\pm 2 \pm 4$
50 to < 100	± 0.02	$\pm 2 \pm 5$
20 to < 50	± 0.05	$\pm 2 \pm 6$
10 to < 20	± 0.05	$\pm 2 \pm 8$
5 to < 10	± 0.1	$\pm 2 \pm 10$

Note

- (1) For tighter performances or high temperature applications, please contact application engineering.
 (2) The TCR results show 4 terminal measurements. To view TCR results for 2 terminal measurements and for different gold wire lengths, refer to the nomogram on page 6.

FIGURE 2 - TYPICAL RESISTANCE/ TEMPERATURE CURVE

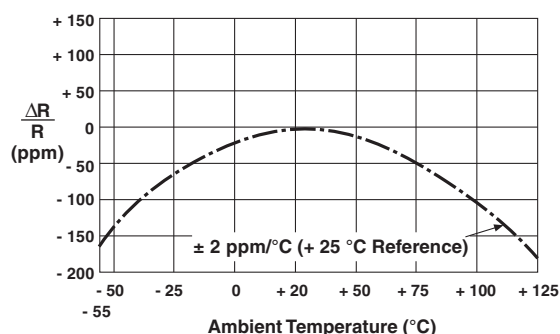


FIGURE 3 - DIMENSIONS in inches (millimeters)

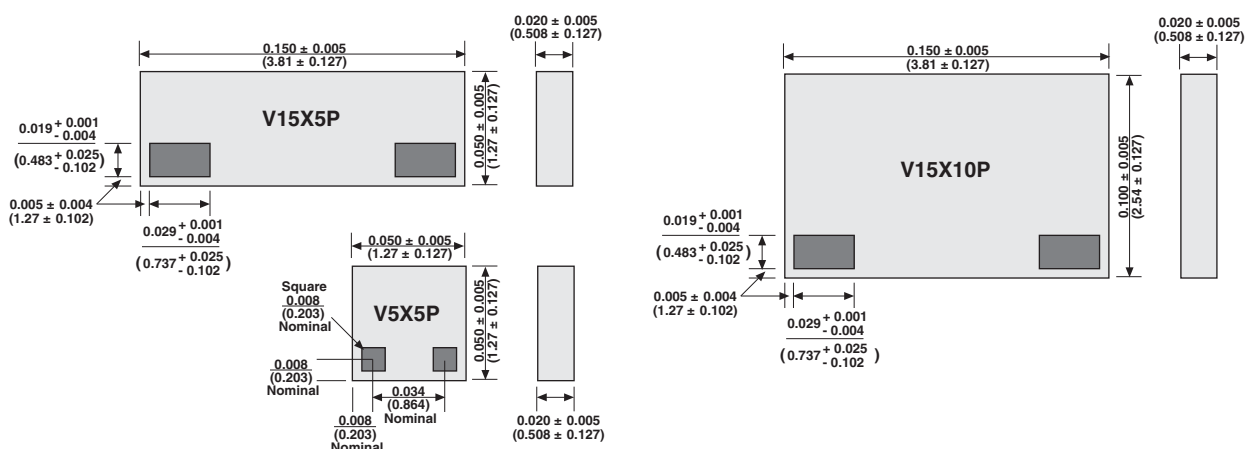


TABLE 2 - PRECISION CHIP RESISTOR SPECIFICATIONS (2)

Resistance range	5 Ω to 10 k Ω (model V5X5P) 5 Ω to 33 k Ω (model V15X5P) 33 k Ω to 80 k Ω (model V15X10P)
TCR (- 55 °C to + 125 °C, + 25 °C Ref. (ppm/°C))	see Table 1
Trimming range (Approximate adjustment capability)	0 to 1.2 x nominal prevalue (V5X5P)* 0 to 1.3 x nominal prevalue (V15X5P) 0 to 1.5 x nominal prevalue (V15X10P) Note * The V5X5P chips are being gradually redesigned for a higher trimming factor - 1.3 or more instead of 1.2. For information about the availability of a specific resistance value, contact the factory.
Resistance tolerance	Option T (trimmed to value at Vishay)* $\pm 0.01\%$; $\pm 0.02\%$; $\pm 0.05\%$; $\pm 0.1\%$; $\pm 0.25\%$; $\pm 0.5\%$; $\pm 1\%$; $\pm 5\%$ Option U (for user trimming to any value within $\pm 0.005\%$) G.F. = Good for values Note * See table 1 for resistance/tolerance limits
Power rating (at + 70 °C ambient temperature), (see figure 3)	V5X5P: 0.05 W (22 V maximum) V15X5P: 0.1 W (54 V maximum) V15X10P: 0.15 W (100 V maximum)
High frequency operation Rise time Inductance Capacitance	1 ns without ringing 0.1 μ H maximum; 0.08 μ H typical 1.0 pF maximum; 0.5 pF typical
Current noise	< 0.010 μ V _{RMS} /V of applied voltage (< - 40 dB)
Voltage coefficient	< 0.1 ppm/V
Working voltage	22 V (model V5X5P) 54 V (model V15X5P) 100 V (model V15X10P)

TABLE 3 - ENVIRONMENTAL PERFORMANCE COMPARISON

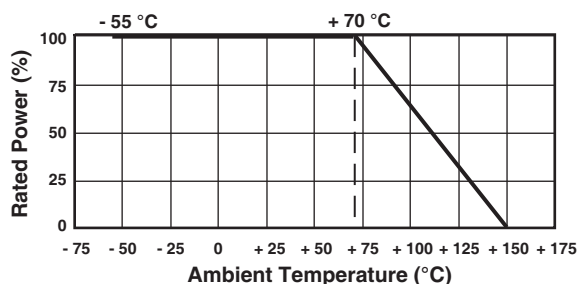
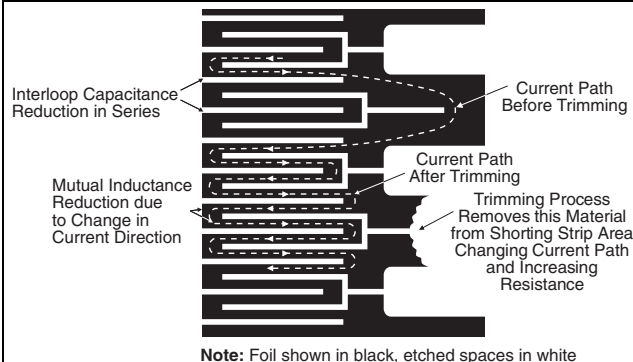
	TYPICAL VISHAY	MAXIMUM
Test group I Thermal shock	$\pm 0.02\%$	$\pm 0.04\%$
Test group II Low temperature operation Short time overload High temperature exposure Resistance to bonding exposure	$\pm 0.005\%$ $\pm 0.02\%$ $\pm 0.02\%$ $\pm 0.02\%$	$\pm 0.01\%$ $\pm 0.04\%$ $\pm 0.05\%$ $\pm 0.05\%$
Test group III Moisture resistance	$\pm 0.03\%$	$\pm 0.1\%$
Test group IV (Load Life Stability) 2000 h at + 70 °C 10 000 h at + 70 °C	$\pm 0.005\%$ $\pm 0.01\%$	$\pm 0.015\%$ $\pm 0.05\%$

Notes

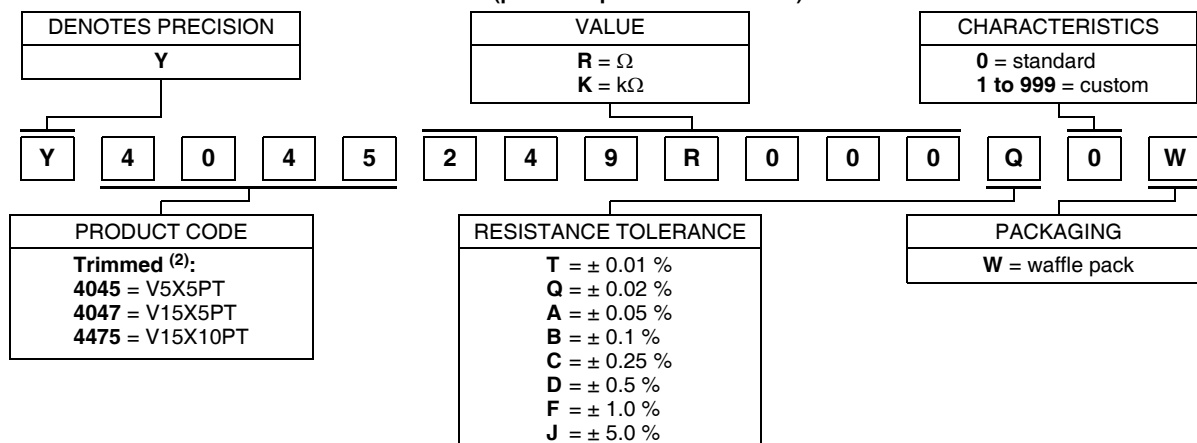
- (1) TCR tracking is a measure of the similarity of resistance value change in two or more resistors which are undergoing the same temperature changes. Tracking could be expressed as the difference in the temperature coefficients of the resistors, expressed in ppm/°C as $(\Delta R_1/R_1 - \Delta R_2/R_2) \times 10^{-6}/\Delta T$ °C.
- (2) Selected TCR tracking is available for specially ordered lots of resistors. The selected TCR tracking can be 3, 2, 1 and as close as 0.5 ppm/°C throughout the full temperature range. Should close TCR tracking be required for differing resistance values, contact the factory.

FIGURE 4 - POWER DERATING CURVE

Discrete chips suitable for working temperatures of up to + 200 °C are available on request.

**FIGURE 5 - TRIMMING TO VALUES**
(conceptual illustration)**TABLE 4 - GLOBAL PART NUMBER INFORMATION** (trimmed option) ⁽¹⁾⁽²⁾

NEW GLOBAL PART NUMBER: Y4045249R000Q0W (preferred part number format)



FOR EXAMPLE: ABOVE GLOBAL ORDER Y4045 249R000 Q 0 W:

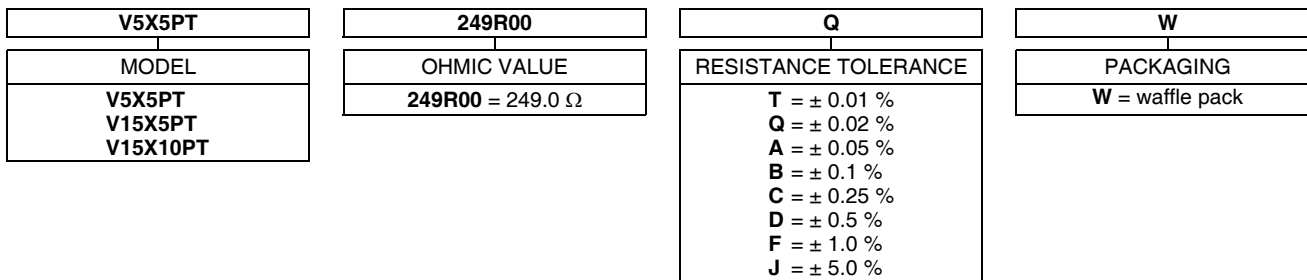
TYPE: V5X5P trimmed

VALUE: 249.0 Ω

ABSOLUTE TOLERANCE: ± 0.02 %

PACKAGING: waffle pack

HISTORICAL PART NUMBER: V5X5PT 249R00 Q W (will continue to be used)

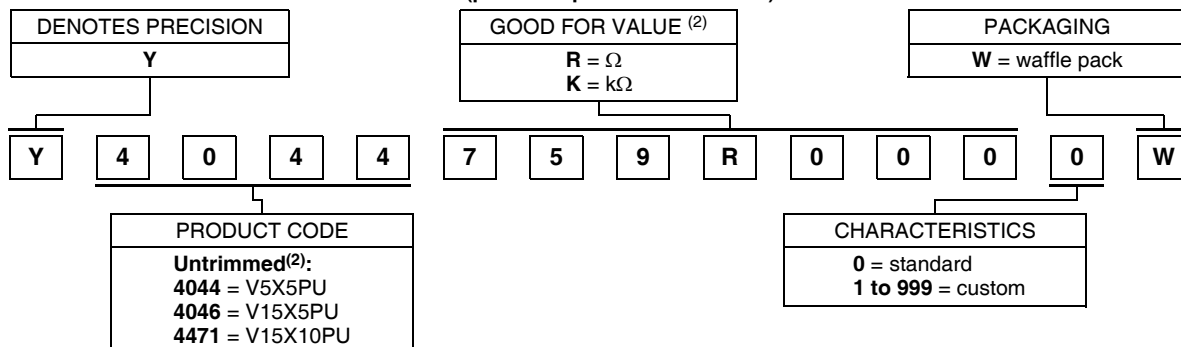
**Notes**

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

⁽²⁾ Vishay Foil Resistors to supply chips trimmed to the purchaser's exact resistance and tolerance specifications, ready for insertion into a hybrid microcircuit with no further processing other than bonding and termination. Specify exact resistance value(s) and tolerance(s).

TABLE 5 - GLOBAL PART NUMBER INFORMATION (untrimmed option) ⁽¹⁾⁽²⁾

NEW GLOBAL PART NUMBER: Y4044759R000W (preferred part number format)



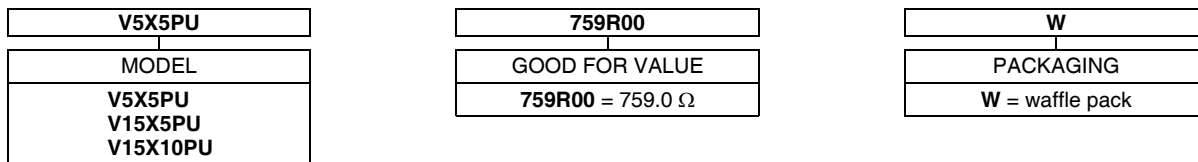
FOR EXAMPLE: ABOVE GLOBAL ORDER Y4044 759R000 0 W:

TYPE: V5X5P untrimmed

GOOD FOR VALUE: 759.0 Ω

PACKAGING: waffle pack

HISTORICAL PART NUMBER: V5X5PU 759R00 W (will continue to be used)



Notes

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

⁽²⁾ To order user trimmable chips specify the final resistance value desired.

EFFECTS OF GOLD WIRE

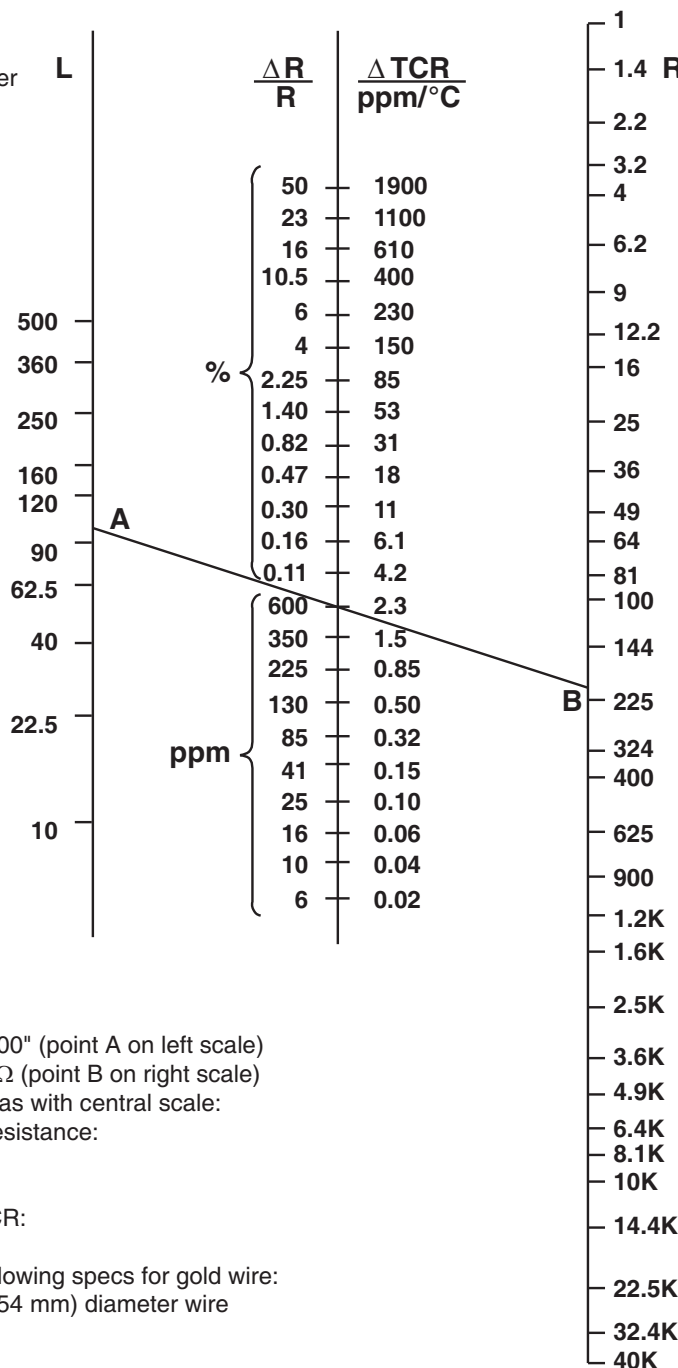
The bonding of the gold wires to the chip has an effect on the overall resistance and on the temperature coefficient, according to the length of wire used.

The nomogram below shows the effect on both parameters with varying lengths of 0.001" (0.0254 mm) diameter gold wire.

NOMOGRAM

Change of resistance and TCR due to a length L of gold wire added at wire bonding.

thousandths of an inch
total length of 2 gold
wires of 0.001" diameter



EXAMPLE:

Total length of wires L = 0.100" (point A on left scale)

Resistance of chip R = 200 Ω (point B on right scale)

Read on intersection of line as with central scale:

On left side - change of resistance:

$$\frac{\Delta R}{R} = 600 \text{ ppm}$$

On right side - change of TCR:

$$\Delta TCR = + 2.3 \text{ ppm}/^{\circ}C$$

Nomogram based on the following specs for gold wire:

- 1.2 Ω/inch for 0.001" (0.0254 mm) diameter wire
- TCR 3900 ppm/°C

Disclaimer

ALL PRODUCTS, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE.

Vishay Precision Group, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "VPG"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained herein or in any other disclosure relating to any product.

The product specifications do not expand or otherwise modify VPG's terms and conditions of purchase, including but not limited to, the warranty expressed therein.

VPG makes no warranty, representation or guarantee other than as set forth in the terms and conditions of purchase.

To the maximum extent permitted by applicable law, VPG disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Information provided in datasheets and/or specifications may vary from actual results in different applications and performance may vary over time. Statements regarding the suitability of products for certain types of applications are based on VPG's knowledge of typical requirements that are often placed on VPG products. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. You should ensure you have the current version of the relevant information by contacting VPG prior to performing installation or use of the product, such as on our website at vpgsensors.com.

No license, express, implied, or otherwise, to any intellectual property rights is granted by this document, or by any conduct of VPG.

The products shown herein are not designed for use in life-saving or life-sustaining applications unless otherwise expressly indicated. Customers using or selling VPG products not expressly indicated for use in such applications do so entirely at their own risk and agree to fully indemnify VPG for any damages arising or resulting from such use or sale. Please contact authorized VPG personnel to obtain written terms and conditions regarding products designed for such applications.

Product names and markings noted herein may be trademarks of their respective owners.

Copyright Vishay Precision Group, Inc., 2014. All rights reserved.