



# Automotive Grade PRODUCTS OVERVIEW



## DISCRETE SEMICONDUCTORS

### Diodes / Rectifiers

- ESD Protection Diodes
- Rectifiers (Schottky, Standard / Fast Recovery, and Ultrafast Recovery)
- Small Signal Diodes (Schottky, Switching, Zener)
- Transient Voltage Suppressors (TVS)

### MOSFETs

- TrenchFET® N-Channel and P-Channel Power MOSFETs

### Optoelectronics

- LEDs and IR Emitters
- Photodiodes and Phototransistors
- Sensors (Ambient Light, Reflective, Proximity, Gesture Recognition)
- Optocouplers

### Power ICs

- Analog Switches

TrenchFET is a registered trademark of Siliconix incorporated  
IHLP and Power Metal Strip are registered trademarks of Vishay Intertechnology

## PASSIVE COMPONENTS

### Capacitors

- Aluminum Electrolytic
- Ceramic
- Film
- Tantalum

### Inductors

- IHLP®
- IHTH

### Non-Linear Resistors

- NTC Thermistors

### Resistors

- Film
- Power Metal Strip®
- Thick Film Power
- Wirewound

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## AUTOMOTIVE GRADE

### Overview of Automotive Grade Products

#### PROGRAM DESCRIPTION

Vishay has incorporated key automotive industry quality initiatives into an Automotive Grade product line. The goal is zero defects. The requirements cover design, qualification, and manufacturing, and are used to continuously improve Vishay products and processes. Products fulfilling the Vishay Automotive Grade requirements, described below, earn our Automotive Grade stamp on their datasheets.

##### Design

- **Robust Design Policy:** new and modified products are designed using design rules, DFMEA, and lessons learned. The design rules ensure Automotive Grade products are robust through manufacturing and assembly. Testing to failure confirms that design margins meet the demands of automotive use
- **Safe Launch:** Vishay's Safe Launch Policy ensures that everything from design through production roll-out happens according to plan. Process corner evaluation, yield analysis, process capability review, and reliability testing are all incorporated

##### Qualification

- **AEC-Q100, AEC-Q101, AEC-Q102, AEC-Q200 qualified:** Automotive Grade products are qualified to the latest AEC qualification standards and presented for approval using PPAP

##### Manufacturing

- **IATF16949 Facility:** all Automotive Grade products are produced in facilities certified to IATF16949
- **Maverick Lot Program:** the Maverick Lot Program employs part average testing (PAT), statistical yield limit (SYL), and statistical bin limit (SBL) according to AEC-Q001 and AEC-Q002 to identify statistically different parts and lots
- **Periodic Verification to AEC Requirements (Reliability Monitoring):** product families are verified to AEC Stress Test Qualification standards every two years

##### Continuous Improvement

- **Error Proofing:** error proofing is performed during the entire process to identify and eliminate potential causes of defects
- **Lessons Learned / Look Across:** all continual improvement actions are linked to lessons learned and look across programs to ensure improvement everywhere in the company





# AUTOMOTIVE GRADE

## Overview of Automotive Grade Products

Discrete Semiconductors	Description / Families	Packages	RoHS-Compliant?
<b>Rectifiers</b>	<ul style="list-style-type: none"> <li><a href="#">Avalanche (GPP)</a></li> <li><a href="#">Schottky (planar / TMBS®)</a></li> <li><a href="#">Standard and fast recovery (GPP / planar)</a></li> <li><a href="#">Ultrafast recovery (GPP / planar / FRED Pt® / HEXFRED®)</a></li> </ul>	eSMP® Series [MicroSMP (DO-219AD), SMP (DO-220AA), SMF (DO-219AB), SMP (TO-277A), SMPA (DO-221BC), SlimSMA (DO-221AC), SlimSMAW (DO-221AD), SlimDPAK (TO-252AE), SMPD (TO-263AC)], SMA (DO-214AC), SMB (DO-214AA), SMC (DO-214AB), FlatPAK 5 x 6, D²PAK (TO-263AB), DPAK (TO-252AA), ITO-220AB, ITO-220AC, TO-220AB, TO-220AC, TO-220AC 2L, TO-247AC, TO-247AD 2L, TO-247AD 3L, TO-262AA	Yes
<b>TVS</b>	<ul style="list-style-type: none"> <li><a href="#">PAR® TVS (automotive)</a></li> <li><a href="#">TRANSZORB® TVS</a></li> </ul>	eSMP® Series [MicroSMP (DO-219AD), SMP (DO-220AA), SMP (TO-277A), SlimSMA (DO-221AC)], SMA (DO-214AC), SMB (DO-214AA), SMC (DO-214AB), DO-218AB, DO-218AC	Yes
<b>Diodes</b>	<p><b>ESD Protection</b></p> <ul style="list-style-type: none"> <li>± 30 kV contact or air discharge ESD protection</li> <li>Single line and dual line (bidirectional)</li> </ul>	eSMP® Series [SMF (DO-219AB)], SOT-23, SOT-323, SOD-323, CLP0603	Yes
	<p><b>Small Signal Diodes (Schottky, Switching, Zener)</b></p> <ul style="list-style-type: none"> <li>Industry standard part numbers</li> <li>Planar technology</li> <li>T<sub>j</sub> max. = 150 °C to 175 °C</li> <li>Very low leakage current</li> <li>2 % / 5 % Zener voltage tolerance</li> <li>Low profile / flat lead and gullwing lead surface-mount packages</li> </ul>	eSMP® Series [SMF (DO-219AB), MicroSMF (DO-219AC)], SMA (DO-214AC), SOT-23, SOD-123, SOD-323, DO-214AC	Yes
<b>MOSFETs</b>	<p><b>N-Channel and P-Channel TrenchFET® Power MOSFETs</b></p> <ul style="list-style-type: none"> <li>Voltages from 330 V (n-channel) to -200 V (p-channel)</li> <li>Low on-resistance R<sub>DS(ON)</sub></li> <li>Efficient switching / PWM</li> <li>Robust in avalanche and 100 % tested</li> <li>Standard and logic level gate families</li> <li>ESD-protected gate option</li> <li>AEC-Q101 qualified</li> <li>Temperature rating of 175 °C</li> </ul>	<p><b>Through-Hole</b></p> <ul style="list-style-type: none"> <li>TO-220, TO-262, TO-247</li> </ul> <p><b>Surface-Mount PowerPAK®</b></p> <ul style="list-style-type: none"> <li>PowerPAK® 8 x 8L (8 mm x 8 mm)</li> <li>PowerPAK® SO-8L (5 mm x 6 mm)</li> <li>PowerPAK® 1212-8 (3 mm x 3 mm)</li> <li>PowerPAK® SC-70 (2 mm x 2 mm)</li> </ul> <p><b>Surface-Mount Conventional</b></p> <ul style="list-style-type: none"> <li>SOIC-8, TSOP-6, SOT-23, SC-70, TO-252, TO-252 reverse lead, TO-263, TO-263-7L</li> </ul>	Yes
<b>Optoelectronics</b>	<ul style="list-style-type: none"> <li><a href="#">LEDs</a>: full color palette including white</li> <li><a href="#">Infrared emitters</a>: 850 nm, 890 nm, and 940 nm</li> <li><a href="#">Photodiodes, phototransistors - peak sensitivity matches emitters</a>: 400 nm to 1100 nm, 790 nm to 970 nm</li> <li><a href="#">Analog ambient light sensors</a>: peak sensitivity of 540 nm</li> <li><a href="#">Optical sensors</a>: reflective sensors, slotted interrupters</li> <li><a href="#">Digital light sensors</a>: proximity sensors, gesture sensors, ambient light sensors (peak sensitivity of 540 nm), RGB sensors (650 nm, 550 nm, 450 nm)</li> <li><a href="#">Optocouplers</a>: 5 mA phototransistor couplers</li> </ul>	PLCC-2, PLCC-2 Plus, PLCC-4, PLCC-4 multicolor, PLCC-6, Little Star®, TELUX, 1206, 0805, 0603, 1.8 mm gullwing, reverse gullwing, QFN, MiniLED, SMD, custom packages	Yes
<b>ICs</b>	<p><b>Analog Switches</b></p> <ul style="list-style-type: none"> <li>1.8 V to 5.5 V single supply operation and power down protection</li> <li>Dual DPDT / quad SPDT switch fits both analog and digital signals</li> </ul>	miniQFN16	Yes

eSMP, TMBS, FRED Pt, HEXFRED, Superrectifier, PAR, TRANSZORB, and Little Star are registered trademarks of Vishay Intertechnology  
TrenchFET and PowerPAK are registered trademarks of Siliconix incorporated



# AUTOMOTIVE GRADE

## Overview of Automotive Grade Products

Passive Components	Description / Families	Packages / Information	RoHS-Compliant?
<b>CAPACITORS</b>			
<b>Aluminum Electrolytic</b>	<b>Axial</b>		
	<ul style="list-style-type: none"> <li>Very long lifetime, high temperature, and ripple current</li> </ul>	<a href="#">120 ATC</a>	RoHS 2
	<b>Radial</b>		
	<ul style="list-style-type: none"> <li>High vibration capability, temperature up to 150 °C</li> </ul>	<a href="#">260 RLA-V</a> , <a href="#">246 RTI-V</a> , <a href="#">250 RMI-V</a>	RoHS 2
	<ul style="list-style-type: none"> <li>Very long lifetime, high ripple current, high temperature up to 150 °C, low ESR</li> </ul>	<a href="#">160 RLA</a> , <a href="#">146 RTI</a> , <a href="#">140 RTM</a> , <a href="#">150 RMI</a> , <a href="#">152 RMH</a>	RoHS 2
	<b>SMD</b>		
<ul style="list-style-type: none"> <li>Very long lifetime, high ripple current, high temperature up to 150 °C, low ESR</li> </ul>	<a href="#">160 CLA</a> , <a href="#">146 CTI</a> , <a href="#">140 CRH</a> , <a href="#">150 CRZ</a>	RoHS 2	
<ul style="list-style-type: none"> <li>High vibration capability, temperature up to 150 °C</li> </ul>	<a href="#">260 CLA-V</a> , <a href="#">246 CTI-V</a> , <a href="#">250 CRZ-V</a>	RoHS 2	
<b>Ceramic</b>	<b>Ceramic Singlelayer</b>		
	<b><a href="#">AY1 Series, X1 / Y1 Safety Capacitors</a></b> <ul style="list-style-type: none"> <li>Radial leaded, straight leads, or inline kinked</li> <li>Tin-plated copper-clad steel wire, 0.6 mm</li> <li>Temperature cycle: 1000 cycles (-55 °C to +125 °C)</li> </ul>	<ul style="list-style-type: none"> <li>Safety Class X1, 760 V<sub>AC</sub> (IEC 60384-14.4)</li> <li>Safety Class Y1, 500 V<sub>AC</sub> (IEC 60384-14.4)</li> <li>Lead spacing of 10.0 mm and 12.5 mm</li> </ul>	Yes
	<b><a href="#">AY2 Series, X1 / Y2 Safety Capacitors</a></b> <ul style="list-style-type: none"> <li>Radial leaded, straight leads, or inline kinked</li> <li>Tin-plated copper-clad steel wire, 0.6 mm</li> <li>Temperature cycle: 3000 cycles (-55 °C to +125 °C)</li> </ul>	<ul style="list-style-type: none"> <li>Safety Class X1, 440 V<sub>AC</sub> (IEC 60384-14.4)</li> <li>Safety Class Y2, 300 V<sub>AC</sub> (IEC 60384-14.4)</li> <li>Lead spacing of 5 mm, 7.5 mm, and 10.0 mm</li> </ul>	Yes
	<b>Leaded MLCCs</b>		
	<b><a href="#">A...R Series, K...R Series</a></b> <ul style="list-style-type: none"> <li>Axial, radial crimped, or straight leads</li> <li>Tin-plated copper-clad steel wire, 0.5 mm</li> <li>Nickel wire on request for K...R series</li> </ul>	<ul style="list-style-type: none"> <li>50 V<sub>DC</sub>, 100 V<sub>DC</sub>, 200 V<sub>DC</sub></li> <li>Class 1 and Class 2 ceramic</li> <li>Lead spacing of 2.5 mm and 5.0 mm</li> </ul>	Yes
	<b><a href="#">HOTCap® (K...H Series)</a></b> <ul style="list-style-type: none"> <li>Radial crimped or straight leads</li> <li>Tin-plated copper-clad steel wire, 0.5 mm and 0.6 mm</li> <li>Maximum operating temperature: 200 °C</li> </ul>	<ul style="list-style-type: none"> <li>50 V<sub>DC</sub>, 100 V<sub>DC</sub>, 200 V<sub>DC</sub></li> <li>Class 1 and Class 2 ceramic</li> <li>Lead spacing of 2.5 mm and 5.0 mm</li> </ul>	Yes
	<b>Surface-Mount MLCCs</b>		
<ul style="list-style-type: none"> <li>Matte tin terminations including polymer layer (soft- / flex-) option</li> <li>AgPd terminations for conductive epoxy assembly</li> <li>C0G (NP0), X7R, and X8R</li> <li>Size 0402 up to 1812 with ranges from 16 V to 3000 V</li> <li>Excellent ESD performance:               <ul style="list-style-type: none"> <li>- 0603 in X7R (10 nF / 100 V) 25 kV ESD AD</li> <li>- 0805 and 1206 in X7R up to 25 kV ESD AD</li> </ul> </li> <li>Vishay Green series: no use of RoHS and ELV exemptions</li> </ul>	<ul style="list-style-type: none"> <li><a href="#">SMD (GA...31G automotive series, Vishay Green for soldering)</a></li> <li><a href="#">SMD (GA...34G automotive series, Vishay Green for silver epoxy bonding)</a></li> </ul>	Yes	
	<ul style="list-style-type: none"> <li><a href="#">SMD (VJ...31X RoHS automotive series)</a></li> </ul>	Yes, with exemptions	
	<ul style="list-style-type: none"> <li><a href="#">SMD (GA...31G automotive series)</a></li> <li><a href="#">SMD (GA...34G automotive series)</a></li> </ul>	Available	



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Passive Components	Description / Families	Packages / Information	RoHS-Compliant?
<b>CAPACITORS</b>			
<b>Film</b>	<a href="#">MKP1848 DC-Link</a> <ul style="list-style-type: none"> <li>High RMS current capabilities</li> <li>Lifetime &gt; 100 000 h at <math>U_{NDC}</math> and 70 °C</li> </ul>	27.5 mm to 52.5 mm pitch <ul style="list-style-type: none"> <li>450 <math>V_{DC}</math> up to 1200 <math>V_{DC}</math></li> <li>From 1 <math>\mu F</math> to 400 <math>\mu F</math></li> </ul>	Yes
	<a href="#">MKT1820 General Purpose MKT</a> <ul style="list-style-type: none"> <li>Operation temperature up to 125 °C, 150 °C for limited time</li> <li>Low voltage DC-link for 48 V boardnet</li> </ul>	10 mm to 27.5 mm pitch <ul style="list-style-type: none"> <li>63 <math>V_{DC}</math> up to 1000 <math>V_{DC}</math></li> <li>AEC-Q200 from 220 nF up to 100 <math>\mu F</math></li> </ul>	Yes
	<a href="#">F339 X2 305 <math>V_{AC}</math> THB Interference Suppression, Class X2</a> <ul style="list-style-type: none"> <li>Compliant with IEC 60384-14: 2013/AMD1: 2016 grade IIB: 85 °C, 85 % RH, 500 h at <math>U_{RAC}</math></li> <li>Robustness under high humidity for standard across the line applications</li> </ul>	15 mm to 27.5 mm pitch <ul style="list-style-type: none"> <li>100 nF up to 4.7 <math>\mu F</math></li> </ul>	Yes
	<a href="#">F340 Y2 305 <math>V_{AC}</math> THB Interference Suppression, Class Y2</a> <ul style="list-style-type: none"> <li>Compliant with IEC 60384-14: 2013/AMD1: 2016 grade IIIB: 85 °C, 85 % RH, 1000 h at <math>U_{RAC}</math></li> <li>High robustness under high humidity for standard line bypass (between line and ground) Y2 applications</li> </ul>	15 mm to 37.5 mm pitch <ul style="list-style-type: none"> <li>10 nF up to 1 <math>\mu F</math></li> </ul>	Yes
	<a href="#">MKP339 X2 310 <math>V_{AC}</math> Interference Suppression, Class X2</a> <ul style="list-style-type: none"> <li>For standard across the line X2 applications</li> </ul>	7.5 mm to 27.5 mm pitch <ul style="list-style-type: none"> <li>1 nF up to 4.7 <math>\mu F</math></li> </ul>	Yes
	<a href="#">MKT370 General Purpose MKT</a> <ul style="list-style-type: none"> <li>Blocking and coupling, bypass and energy reservoir</li> </ul>	5 mm pitch <ul style="list-style-type: none"> <li>680 pF up to 1.5 <math>\mu F</math></li> </ul>	Yes
<b>Tantalum</b>	<a href="#">TP3</a> <ul style="list-style-type: none"> <li>High performance, low ESR</li> </ul>	Cases A, B, C, D, and E	RoHS 2
	<a href="#">TP8</a> <ul style="list-style-type: none"> <li>Small case sizes, maximum capacitance</li> </ul>	Cases: 0603, 0805, low profile A and B	RoHS 2
	<a href="#">TH3</a> <ul style="list-style-type: none"> <li>High temperature: 150 °C</li> </ul>	Cases A, B, C, D, and E	RoHS 2
	<a href="#">TH4</a> <ul style="list-style-type: none"> <li>High temperature: 175 °C</li> </ul>	Cases B, C, and D	RoHS 2



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<b>INDUCTORS</b>			
<b>Power Inductors</b>	<b>IHLP®</b> <ul style="list-style-type: none"> <li>• Low profile, high current, surface-mount</li> <li>• Shielded construction</li> <li>• Handles high transient current spikes without hard saturation</li> <li>• Ultra low buzz noise due to composite construction</li> </ul>	<ul style="list-style-type: none"> <li>• 1616 to 6767 (-A1 and -1A suffix)               <ul style="list-style-type: none"> <li>- Frequency range to 5 MHz</li> </ul> </li> <li>• 1212 to 8787 (-5A suffix)               <ul style="list-style-type: none"> <li>- High operating temperature up to +155 °C</li> </ul> </li> <li>• 1212 to 8787 (-8A suffix)               <ul style="list-style-type: none"> <li>- High operating temperature up to +180 °C</li> </ul> </li> </ul>	Yes
	<b>IHTH</b> <ul style="list-style-type: none"> <li>• High current, through-hole</li> <li>• High operating temperature range: -55 °C to +155 °C</li> <li>• Shielded construction</li> <li>• Handles high transient current spikes without hard saturation</li> <li>• Ultra low buzz noise due to composite construction</li> </ul>	0750, 1125, 1500	Yes
	<b>IHLM</b> <ul style="list-style-type: none"> <li>• Low profile, high current, surface-mount</li> <li>• Encapsulated body offers improved environmental protection</li> <li>• Shielded construction</li> <li>• Handles high transient current spikes without hard saturation</li> <li>• Ultra low buzz noise due to composite construction</li> </ul>	2525	Yes
	<b>IHLE</b> <ul style="list-style-type: none"> <li>• Low profile, high current, surface-mount</li> <li>• Integrated E-shield for maximum EMI reduction</li> <li>• High operating temperature range: -55 °C to +155 °C</li> <li>• Shielded construction</li> <li>• Handles high transient current spikes without hard saturation</li> <li>• Ultra low buzz noise due to composite construction</li> </ul>	2525, 3232, 4040, 5050	Yes
	<b>IHCL</b> <ul style="list-style-type: none"> <li>• Low profile, high current, surface-mount coupled inductor</li> <li>• High operating temperature range: -55 °C to +155 °C</li> <li>• Shielded construction</li> <li>• Handles high transient current spikes without hard saturation</li> <li>• Ultra low buzz noise due to composite construction</li> </ul>	4040, 5050	Yes
	<b>IHLD</b> <ul style="list-style-type: none"> <li>• Low profile, high current, dual inductor</li> <li>• Two inductors in one package</li> <li>• High operating temperature range: -55 °C to +155 °C</li> <li>• Shielded construction</li> <li>• Handles high transient current spikes without hard saturation</li> <li>• Ultra low buzz noise due to composite construction</li> </ul>	2525, 3232, 4032	Yes

IHLP is a registered trademark of Vishay Intertechnology



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Passive Components	Description / Families	Packages / Information	RoHS-Compliant?
<b>NON-LINEAR RESISTORS <sup>(1)</sup></b>			
<b>NTC Thermistors</b>	<a href="#">NTCS0402</a> , <a href="#">NTCS0603</a> , <a href="#">NTCS0805</a> <ul style="list-style-type: none"> <li>Tolerance on <math>R_{25}</math> down to 1 %</li> <li>Suitable for wave or reflow soldering</li> <li>NiSn terminations</li> <li>Fully glass coated and protected</li> </ul>	SMD sizes: 0402, 0603, 0805	Yes

**Note**

<sup>(1)</sup> Flame retardance test may not be applicable to some resistor technologies. Contact Vishay Sales or Product Marketing for more information



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## Overview of Automotive Grade Products

Passive Components	Description / Families	Packages / Information	RoHS-Compliant?
<b>RESISTORS <sup>(1)</sup></b>			
<b>Film</b>	<a href="#">Carbon Film MELF (CMA)</a>	Most SMD packages available	RoHS 2
	<a href="#">Carbon Film MELF (CMB)</a>		RoHS 2
	<a href="#">MELF (SMM, MMA, MMB, MMU)</a>		RoHS 2
	<a href="#">Thin Film (MC AT, MC HP, TNPW e3, TNPU e3, TNPV e3)</a>		RoHS 2
	<a href="#">Networks and Arrays - Thin Film (ACAS AT)</a>		
	<a href="#">WSF</a> • 10 Ω to 100 kΩ		RoHS 2
<b>Power Metal Strip<sup>®</sup></b>	<a href="#">WSBS</a>	8518	Yes
	<a href="#">WSHM, WSHP</a>	2818	Available
	<a href="#">WSK0612, WSK2512</a>	0612, 2512	Available
	<a href="#">WSK</a>	1216	RoHS 2
	<a href="#">WSL0603, WSL0805, WSL1020, WSL1206, WSL2010, WSL2512, WSL2816, WSL3637</a>	0603, 0805, 1020, 1206, 2010, 2512, 2816, 3637	Available
	<a href="#">WSL2726, WSL3921, WSL4026, WSL5931</a>	2726, 3921, 4026, 5931	RoHS 2
	<a href="#">WSLF</a>	2512	RoHS 2
	<a href="#">WSL High Power</a>	WSLxxx...18	Available
	<a href="#">WSLP</a>	0603, 0805, 1206, 2010, 2512	Available
	<a href="#">WSLP2726, WSLP3921, WSLP4026, WSLP5931</a>	2726, 3921, 4026, 5931	RoHS 2
	<a href="#">WSLS</a>	2512	Available
	<a href="#">WSLT2010...18, WSLT2512</a>	2010...18, 2512	Available
	<a href="#">WSLT2726, WSLT3921, WSLT4026, WSLT5931</a>	2726, 3921, 4026, 5931	RoHS 2
	<a href="#">WSMS</a>	2908	Yes
	<a href="#">WSR4527 (2 and 3 high power), WSR4527 (5 high power)</a>	4527 (2, 3, and 5 {high power})	Available
<b>Thick Film Power</b>	<a href="#">D2TO20 and D2TO35</a> • SMD power resistor, 20 W and 35 W at 25 °C • Wide resistance range: 0.01 Ω to 550 kΩ • Non-inductive	D <sup>2</sup> PAK (TO-263)	Yes
	<a href="#">LTO100</a> • Power resistor, 100 W at 25 °C • Wide resistance range: 0.015 Ω to 1 MΩ • Non-inductive	TO-247	Yes
	<a href="#">LTO 150</a> • Power resistors, 150 W at 45 °C • Broad resistance range: 0.03 Ω to 1.3 MΩ • Non-inductive	TO-247	Yes
	<a href="#">DTO25</a> • SMD power resistor, 25 W at 25 °C, min 3 W on PCB • Wide resistance range: 0.016 Ω to 700 kΩ • Non-inductive	DPAK (TO-252)	Yes
<b>Wirewound</b>	<a href="#">SR (1 W to 5 W, radial leads)</a>	2515 to 7532 packaging (inch)	Available
	<a href="#">WSC, WSN</a>		

**Note**

<sup>(1)</sup> Flame retardance test may not be applicable to some resistor technologies. Contact Vishay Sales or Product Marketing for more information

*Power Metal Strip is a registered trademark of Vishay Intertechnology*