

**AUTOMOTIVE GRADE**

## Overview of Automotive Grade Products

**AUTOMOTIVE GRADE PRODUCTS****DISCRETE SEMICONDUCTORS**

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

**PASSIVE COMPONENTS**

- Capacitors
  - Aluminum
  - Tantalum
  - Ceramic
  - Film
- Resistors
  - Film
  - Wirewound
  - Power Metal Strip®
  - Thick Film Power
- Inductors
  - IHLP®
  - IHTH





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## 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-Q200-Qualified:** Automotive Grade Products are qualified to the latest AEC qualification standards and presented for approval using PPAP.

### Manufacturing

- **TS16949 Facility:** All Automotive Grade Products are produced in facilities certified to TS16949.
- **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.





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Discrete Semiconductors	Description / Families	Packages
<b>Rectifiers</b>	<ul style="list-style-type: none"> <li>Schottky (Planar / TMBS<sup>®</sup>)</li> <li>Ultrafast Recovery (GPP / Planar / FRED Pt<sup>®</sup> / HEXFRED<sup>®</sup>)</li> <li>Standard / Fast Recovery (GPP / Planar)</li> <li>Avalanche Rectifiers (GPP)</li> </ul>	eSMP <sup>®</sup> Series (MicroSMP, SMP, SMF, SMPC, SMPA, SlimSMA, SlimDPAK, SMPD), SMA, SMB, SMC, FlatPAK 5 x 6, Superectifier <sup>®</sup> , D <sup>2</sup> PAK (TO-263AB), DPAK (TO-252AA), ITO-220AB, ITO- 220AC, TO-220AB, TO-220AC, TO-220AC 2L, TO-247 AC, TO-247 AD 2L, TO-247AD 3L, TO-262AA
<b>TVS</b>	<ul style="list-style-type: none"> <li>PAR<sup>®</sup> TVS (automotive)</li> <li>TRANSZORB<sup>®</sup> TVS</li> </ul>	eSMP <sup>®</sup> Series (MicroSMP, SMP, SMPC, SlimSMA), SMA, SMB, SMC, SMD
<b>ESD Protection</b>	<ul style="list-style-type: none"> <li>± 30 kV contact or air discharge ESD protection</li> <li>Single-line and dual-line (bi-directional)</li> </ul>	eSMP <sup>®</sup> Series (SMF), SOT-23, SOT-323, SOD-323, CLP0603
<b>Small-Signal Diodes (Switching, Schottky, and Zener)</b>	<ul style="list-style-type: none"> <li>Industry-standard part numbers</li> <li>Planar technology</li> <li>T<sub>j,max</sub> = 150 / 175 °C</li> <li>Very low leakage current</li> <li>2 / 5 % Zener voltage tolerance</li> <li>Low profile / flat lead and gull wing lead surface mount packages</li> </ul>	eSMP <sup>®</sup> Series (SMF, MicroSMF), SOT-23, SOD-123, SOD-323, DO-214AC
<b>MOSFETs</b>	<ul style="list-style-type: none"> <li>N-channel and p-channel TrenchFET<sup>®</sup> power MOSFETs               <ul style="list-style-type: none"> <li>Avalanche-rated cell density process</li> <li>Very low on-resistance</li> <li>Optimized logic-level and standard-level types</li> </ul> </li> </ul>	PowerPAK <sup>®</sup> 1212-8, PowerPAK SO-8L, DPAK (TO-252), TO-262, TO-263, TO-220, reverse DPAK, bare die, SO-8, TSOP-6, SOT-23, SC-70, SQ
<b>Optoelectronics</b>	<ul style="list-style-type: none"> <li>LED: full color palette including white</li> <li>Infrared emitters: 830 nm, 850 nm, 870 nm, 890 nm, and 940 nm</li> <li>Photodiodes, phototransistors – peak sensitivity matches emitters: 400 nm to 1100 nm, 790 nm to 970 nm</li> <li>Ambient light sensors: peak sensitivity of 540 nm</li> <li>Optical sensors: reflective sensors, slotted interrupters</li> </ul>	PLCC-2, PLCC-2 Plus, PLCC-4, PLCC-4 multicolor, PLCC-6, Little Star <sup>®</sup> , TELUX, 1206, 0805, 0603, 1.8 mm gullwing, reverse gullwing, MiniLED, custom packages



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Passive Components		Description / Families		Packages	
<b>CAPACITORS</b>					
<b>Aluminum Electrolytic</b>		<ul style="list-style-type: none"> <li>Very long life, high ripple current, low ESR, high temperature up to 150 °C, low impedance</li> </ul>			
		- Radial		160 RLA, 146 RTI, 140 RTM, 150 RMI, 152 RMH	
		- SMD		160 CLA, 146 CTI, 140 CRH, 150 CRZ	
<b>Tantalum</b>		TP3	High performance, low ESR	Cases A, B, C, D, and E	
		TH3	High temperature: 150 °C	Cases A, B, C, D, and E	
		TH4	High temperature: 175 °C	Cases B, C, and D	
		TP8	Small case sizes, maximum capacitance	Cases: 0603, 0805, low-profile A & B	
<b>Ceramic</b>	<b>Surface-Mount MLCC</b>	Matte tin terminations including Polymer layer (Soft-/Flex-) option		<ul style="list-style-type: none"> <li>SMD (GA...31G Automotive series GREEN for soldering)</li> <li>SMD (GA...34G Automotive series GREEN for silver epoxy bonding)</li> <li>SMD (VJ...31X ROHS Automotive series)</li> <li>SMD (VJ...31 and VJ...34 Automotive series)</li> </ul>	
		AgPd terminations for conductive epoxy assembly			
		C0G (NP0), X7R and X8R			
		Size 0402 up to 1812 with ranges from 16 V to 3000 V			
		Excellent ESD performance: 100 V (0805, 10 nF) up to 22 kV ESD, 200 V (0805, 10 nF) up to 25 kV ESD			
		Vishay GREEN series exceeds ROHS and ELV requirements			
	<b>Leaded MLCC</b>	A...R Series, K...R Series			<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>
		<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> </ul>			
		HOTCap® (K... H series) <ul style="list-style-type: none"> <li>Radial crimped or straight leads</li> <li>Tin plated copper</li> <li>Maximum operating temperature: 175 °C</li> </ul>			50 V <sub>DC</sub> , 100 V <sub>DC</sub> , 200 V <sub>DC</sub> Class 1 and class 2 ceramic Lead spacing of 2.5 mm and 5.0 mm
<b>Ceramic Singlelayer</b>	AY2 Series X1/Y2 safety capacitor <ul style="list-style-type: none"> <li>Radial leaded, straight leads</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>, Y2, 300 V<sub>AC</sub> (IEC 60384-14.3)</li> <li>Lead spacing of 5 mm, 7.5 mm, and 10.0 mm</li> </ul>		
<b>Film Capacitor</b>		MKT DC lacquered radial		5 mm - 27.5 mm: BFC2 365-366-367-368-369-467-468-469	
		MKT DC potted radial		10 mm - 27.5 mm: MKT 1820	
		MKP RFI Y2 potted radial		7.5 mm - 27.5 mm: BFC2 338 6	
		MKT RFI X2 potted radial		15 mm - 27.5 mm: F1772-2 310V X2 (≤ 470 nF)	
		MKP DC-Link potted radial		27.5 mm - 52.5 mm: MKP 1848 DC-Link	



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<b>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 up to 5 MHz</li> </ul> </li> <li>1616 to 8787 (-5A suffix)               <ul style="list-style-type: none"> <li>High operating temperature, up to +155 °C</li> </ul> </li> <li>1616 to 8787 (-8A suffix)               <ul style="list-style-type: none"> <li>High operating temperature, up to +180 °C</li> </ul> </li> </ul>
<b>IHTH</b>	<ul style="list-style-type: none"> <li>High current, through-hole</li> <li>High operating temperature range from -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 and 1125
<b>RESISTORS*</b>		
<b>Film</b>	<ul style="list-style-type: none"> <li>MELF (SMM, MMA, MMB, MMU)</li> <li>Carbon film MELF (2.2 Ω to 200 kΩ)</li> <li>Thin film (TNPW e3-size 0402-1210, TNPU e3, MC AT, MC HP, ACAS AT all sizes)</li> <li>WSF (10 Ω to 100 kΩ)</li> </ul>	Most SMD packages available
<b>Wirewound</b>	<ul style="list-style-type: none"> <li>WSC, WSN, WSZ</li> <li>SR (1 W to 5 W radial leads)</li> </ul>	2515 to 7532 packaging (inch)
<b>Power Metal Strip®</b>	WSH	2818
	WSK	0612, 2512
	WSL	0603, 0805, 1020, 1206, 2010, 2512, 2816, 3921, 5931, 2726, 4026, 3637
	WSL high power	WSLxxx...18
	WSLP	0603, 0805, 1206, 2010, 2512, 3921, 5931, 2726, 4026
	WSLS	2512
	WSLT	2010...18, 2512, 3921, 5931, 2726, 4026
	WSMS	2908
	WSR	4527 (2, 3 and 5 [high power])
<b>Thick Film Power</b>	D2TO020 and D2TO035: <ul style="list-style-type: none"> <li>SMD power resistor, 20 W and 35 W at 25 °C</li> <li>Wide resistive range from 0.01 Ω to 550 kΩ</li> <li>Non-inductive</li> </ul>	D <sup>2</sup> PAK / TO-263
	LTO100: <ul style="list-style-type: none"> <li>Power resistor, 100 W at 25 °C</li> <li>Wide resistive range from 0.15 Ω to 1 MΩ</li> <li>Non-inductive</li> </ul>	TO-247
	DTO25: <ul style="list-style-type: none"> <li>SMD power resistor, 25 W at 25 °C, min 3 W on PCB</li> <li>Wide resistive range from 0.016 Ω to 700 kΩ</li> <li>Non-inductive</li> </ul>	DPAK / TO-252

\*Flame Retardance testing might not be applicable to all resistor technologies. Contact Vishay Sales or Product Marketing for additional information.



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<b>NON-LINEAR RESISTORS</b>		
<b>NTC Thermistors</b>	NTCS <ul style="list-style-type: none"> <li>• Tolerance on R25 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 0603, 0805