MATERIALS FOR AUTOMOTIVE RADARS
BONDING, CONNECTING, PROTECTING AND THERMAL SOLUTIONS
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INTRODUCTION

ADAS: DRIVING NEXT-GENERATION AUTOMOTIVE SAFETY

The growth of Advanced Driver Assistance Systems (ADAS) is unprecedented. What were once considered high-end luxuries are now becoming common, optional – sometimes even standard – features on today’s mid- and upper-range vehicles. Working in isolation or collaborating to deliver notifications, warnings, and interventional actions to enhance driver safety, camera and radar sensor technologies are critical to ADAS advancement. While camera technology is the go-to sensor for visual object detection, radar offers more complete and exacting information as it measures an object’s speed and distance from the vehicle. With this data, features like adaptive cruise control, emergency braking and rear collision warnings offer real-time alerts that greatly improve driver, passenger and pedestrian safety. Ultimately, the radar’s functional reliability depends on the integrity of its components and this reality is driving radar designers and manufacturers toward Henkel electronic material solutions.

REAL-TIME NOTIFICATION DEMANDS CAPABLE MATERIALS

Today’s automotive radar systems provide critical information for accident avoidance. Continuous sensing of a vehicle’s distance from an object through measurement of the object’s position and velocity, gives drivers a real-time view for informed decision-making and collision prevention. The reliability of the electronics within radars – including chips, components and interconnects – is essential to long-term, dependable functionality, making Henkel’s advanced materials fundamental to radar performance. Connecting materials such as solders provide robust interconnection of components to the printed circuit board (PCB). And, as radars become smaller and more compact while packing more powerful function, high performance thermal management solutions, along with PCB and component protection are essential.
PRODUCT PORTFOLIO

MATERIALS FOR ADAS RADARS

Connecting
- Electrically Conductive Adhesives
- Solder Materials

Protecting
- Board Level Underfills
- Conformal Coatings
- EMI Shielding Materials
- Module Sealants

Thermal
- EMI Shielding & Thermal Interface Materials
- Thermal Interface Materials
Module Sealant

EMI Shielding Material

Solder Material

Electrically Conductive Adhesive

Board Level Underfill
CONNECTING FUNCTIONALITY

Joining all of the components of a radar system for collaborative operation and high reliability is the job of Henkel’s portfolio of advanced connecting materials. Electrical interconnection at the board level is facilitated through high-reliability, lead-free, halogen-free solder formulations and a wide range of electrically conductive adhesives, an area where Henkel’s expertise spans decades. Our scientists and engineering teams developing materials understand the reliability requirements, application-specific considerations, processability objectives and manufacturing demands to advise on the best solutions for optimal results, which is why the world’s top automotive electronics manufacturers choose Henkel. When seconds count, reliable connections matter.
# ELECTRICALLY CONDUCTIVE ADHESIVES

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Volume Resistivity (Ω·cm)</th>
<th>Glass Transition Temperature, T&lt;sub&gt;g&lt;/sub&gt; (°C)</th>
<th>Coefficient of Thermal Expansion, CTE (ppm/°C)</th>
<th>Modulus at 25°C (MPa)</th>
<th>Recommended Cure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acrylate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| LOCTITE ABLESTIK CA 3556HF | Acrylate electrically conductive adhesive    | • One component  
• Fast, low-temperature cure  
• Excellent flexibility  
• Good adhesion  
• Low contact resistance | 2.5 × 10<sup>3</sup> | -30                            | 95                             | 278                    | 650                   | 2 min. at 110°C     |
| **Epoxy**             |                                                  |                                                    |                           |                                               |                                               |                        |                        |
| LOCTITE ABLESTIK CE 3101WLV | Epoxy electrically conductive adhesive        | • Pb-free alternative to solder  
• Low-temperature cure  
• Stable contact resistance | 8 × 10<sup>-4</sup> | 114                            | 45                             | 225                    | 4,500                 | 10 min. at 120°C  |
| **Silicone**          |                                                  |                                                    |                           |                                               |                                               |                        |                        |
| LOCTITE ABLESTIK ICP 4000 | Silicone electrically conductive adhesive     | • One component  
• High flexibility  
• Excellent electrical conductivity  
• High-temperature performance  
• Pb-free alternative to solder  
• High electrical current carrying capability  
• Low-temperature cure  
• Outstanding elongation performance  
• Low outgassing | 6 × 10<sup>-5</sup> | -45                            | N/A                           | 330                    | 101                  | 1 hr. at 130°C |

# SOLDER MATERIALS

## Cored Wire

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Approximate Flux Content (% by Weight)</th>
<th>Diameter Range (mm)</th>
<th>Pb-Free Alloy</th>
<th>SnPb Alloy</th>
<th>IPC J-STE-004B Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Halogen-Free, No-Clean</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| LOCTITE C 400 | Cored solder wire  | • Clear residue  
• Increased flux content for improved wetting on challenging surfaces  
• Award-winning multiple flux core technology that ensures consistent distribution of flux throughout the solder wire  
• Suitable for manual and robotic soldering | 2.2                                   | 0.38 – 1.63                      | 90iSC  
99C  
SAC305  
SAC387 | Sn60  
Sn62  
Sn63 | ROL0                     |
| **Halide-Free, No-Clean** |                    |                                                                                |                                       |                     |                     |             |                             |
| LOCTITE C 502 | Cored solder wire  | • Clear residue  
• Good wetting on difficult substrates  
• Medium activity flux | 2.7                                   | 0.25 – 1.63                      | SAC387  
SAC305  
99C | Sn60  
Sn62  
Sn63 | ROM1                     |
| LOCTITE C 511 | Cored solder wire  | • Amber residue  
• Good wetting on difficult substrates  
• Heat stable  
• Medium activity flux | 2.7                                   | 0.38 – 1.63                      | SAC387  
SAC305  
99C | Sn60  
Sn62  
Sn63 | ROM1                     |
| **Halide-Containing, Water Wash** |                    |                                                                                |                                       |                     |                     |             |                             |
| LOCTITE HYDX | Cored solder wire  | • High activity flux  
• Excellent wetting on difficult substrates | 2.0                                   | 0.38 – 1.63                      | 99C  
SAC305  
SAC387 | Sn60  
Sn62  
Sn63 | ORH1                     |
## Liquid Flux

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Solid Content (% by Weight)</th>
<th>Acid Value (mg KOH/g)</th>
<th>Application</th>
<th>IPC J-STE-004B Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Halide-Containing, Water Wash</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| LOCTITE HYDX-20 | Liquid Flux | • Highly water soluble  
• Residues designed to be cleaned with deionized water  
• Solders onto copper, brass, nickel and mild steel efficiently  
• Compatible with Pb-free and SnPb wave solder processes | 20 | 24 | Spray/Foam | ORH1 |
| **Halide-Free, No-Clean** | | | | | | |
| LOCTITE MF 210 | Liquid flux | • Resin-free flux designed to solder onto surfaces known to have poor solderability  
• Recommended for applications where high throughput is required  
• Compatible with Pb-free and SnPb wave solder processes | 2.9 | 22.5 | Spray/Foam | ORM0 |
| LOCTITE MF R301 | Liquid flux | • Higher solids flux for better wetting on surfaces known to have reduced solderability  
• Minimizes bridging on complex geometries  
• Fully Pb-free and dual wave compatible  
• Solvent-based flux may be thinned with isopropyl alcohol (IPA)  
• Compatible with Pb-free and SnPb wave solder processes | 6.0 | 40 | Spray/Foam | ROM0 |
| **Halogen-Free, VOC-Free, No-Clean** | | | | | | |
| LOCTITE MF 300 | Liquid flux | • General-purpose, resin-free, water-based flux with special formulation designed to minimize solder balling  
• Compatible with Pb-free and SnPb wave solder processes | 4.6 | 37 | Spray/Foam | ORM0 |
| **Halogen-Free, No-Clean** | | | | | | |
| LOCTITE MF 390HR | Liquid flux | • Exceptional through-hole fill  
• Recommended for automotive applications and general electrical soldering applications  
• Compatible with Pb-free and SnPb wave solder processes | 6.0 | 20 – 25 | Spray/Foam | ROL0 |
# CONNECTING MATERIALS FOR ADAS RADARS

## SOLDER MATERIALS – CONTINUED

### Solder Paste

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Alloy</th>
<th>Particle Size Distribution</th>
<th>IPC J-STE-004B Classification</th>
<th>Optimal Shelf Life</th>
<th>Reflow Atmosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCTITE GC 10</td>
<td>Pb-free, solder paste</td>
<td>• RoHS-compliant&lt;br&gt;• Excellent resistance to high humidity&lt;br&gt;• Industry leader in paste transfer efficiency&lt;br&gt;• Improved stability at different storage and operating temperatures&lt;br&gt;• Extended stencil life up to 72 hr.&lt;br&gt;• Extended abandon time up to 24 hr.&lt;br&gt;• Suitable for high-density, small to large boards</td>
<td>SAC305</td>
<td></td>
<td>Rolo</td>
<td>1 year at 26.5°C</td>
<td>Designed for air; suitable with nitrogen</td>
</tr>
<tr>
<td>LOCTITE HF 212</td>
<td>Pb-free, solder paste</td>
<td>• High tack&lt;br&gt;• Low voiding&lt;br&gt;• RoHS-compliant&lt;br&gt;• Excellent fine pitch coalescence&lt;br&gt;• Designed for medium to large boards</td>
<td>90SC&lt;br&gt;SAC307&lt;br&gt;SAC305&lt;br&gt;SAC387</td>
<td>Rolo</td>
<td>6 months at 0°C – 10°C</td>
<td>Air and nitrogen</td>
<td></td>
</tr>
</tbody>
</table>
PROTECTING MATERIALS FOR ADAS RADARS

A FULL RANGE OF PROTECTION

Building the radar module with high-performance electronic interconnect materials is just the start. Protecting radar systems from adverse environmental conditions and external interference is equally essential to lasting, dependable performance. Henkel’s award-winning protection materials can be found throughout modern-day automotive radar systems, and for good reason. Our conformal coating solutions protect the PCB from moisture and chemical contaminants, which are plentiful in an automotive environment. Once the PCBs are populated with high-value components like micro-BGAs, the fine-pitch solder connections need to be protected from vibration and shock. Market-leading LOCTITE underfill formulations deliver added solder joint reliability to defend against stress, while Henkel module sealants keep contaminants out of the enclosure. Likewise, innovative Henkel EMI shielding solutions in multiple formats offer vital radio-frequency interference protection at all levels – from the chip to the board to the mid-frame – and effectively isolate the antennae and logic features of the radar system from each other.
## PROTECTING MATERIALS FOR ADAS RADARS

### BOARD LEVEL UNDERFILLS

**Capillary Underfills**

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Modulus at 25°C (MPa)</th>
<th>Glass Transition Temperature, $T_g$ (°C)</th>
<th>Coefficient of Thermal Expansion, CTE (ppm/°C)</th>
<th>Pot Life</th>
<th>Recommended Cure</th>
</tr>
</thead>
</table>
| **LOCTITE ECCOBOND E 1172 A** | Non-reworkable, capillary flow, epoxy underfill | • Snap curable  
• Fast cure at low temperatures  
• One component  
• Non-anhydride curing chemistry  
• Void-free | 10,000 | 135 | 27 | 85 | 48 hr. at 25°C | 6 min. at 135°C |
| **LOCTITE E 1216M**     | Non-reworkable capillary flow underfill     | • Snap or inline cure  
• Fast, void-free underfill of area array devices  
• Excellent stability during shipping, storage and use  
• Excellent adhesion and strength  
• Non-anhydride curing chemistry | 2,970 | 125 | 35 | 131 | 5 days at 25°C | 3 min. at 165°C |
| **LOCTITE ECCOBOND FP4531** | Capillary flow underfill                   | • Snap curable  
• Fast flow  
• High adhesion strength  
• Proven workability at high temperatures  
• Qualified in automotive reliability conditions | 7,600 | 161 | 28 | 104 | 24 hr. at 25°C | 7 min. at 160°C |
### Cornerbond & Edgebond Underfills

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Viscosity at 25°C (cP)</th>
<th>Glass Transition Temperature, T&lt;sub&gt;g&lt;/sub&gt; (°C)</th>
<th>Coefficient of Thermal Expansion, CTE (ppm/°C)</th>
<th>Pot Life</th>
<th>Recommended Cure</th>
</tr>
</thead>
</table>
| LOCTITE 3508NH | Reworkable epoxy underfill | • One component  
• Reflow curable  
• Eliminates post-reflow dispense and cure steps  
• Reworkable  
• Halogen-free | 70,000 | 118 | 65 | 175 | 30 days at 25°C | Cure during Pb-free solder reflow profile at 245°C |
| LOCTITE 3705 | Acrylate underfill | • One component  
• Thixotropic  
• Medium viscosity  
• Fast UV cure  
• No post cure required  
• Good adhesion to a variety of substrates | 44,000 | -39 (T<sub>g</sub>1)  
77 (T<sub>g</sub>2) | 66 | 151 | 30 days at 25°C | 80 sec. at 30 mW/cm² |

### CONFORMAL COATINGS

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Viscosity at 25°C (cP)</th>
<th>Operating Temperature (°C)</th>
<th>Volume Resistivity (Ω·cm)</th>
<th>Color</th>
<th>Recommended Cure</th>
</tr>
</thead>
</table>
| LOCTITE SI 5290 | Silicone conformal coating | • One component  
• Designed for severe temperature environments and high-reliability automotive applications  
• Solvent-free | 100 – 350 | -53 – 200 | 2 × 10¹⁴ | Transparent amber to yellow | 20 – 40 sec. at 70 mW/cm² + 72 hr. at 50% relative humidity |
| LOCTITE SI 5293 | Silicone conformal coating | • One component  
• Exhibits positive fluorescence under UV light  
• Repairable  
• Solvent-free  
• Designed for severe temperature environments and high-reliability automotive applications | 400 – 800 | -40 – 200 | 1 × 10¹⁶ | Transparent amber to yellow | 20 – 40 sec. per side at 70 mW/cm² + 72 hr. at 50% relative humidity |
| LOCTITE STYCAST PC 40-UMF | Urethane acrylate conformal coating | • One component  
• VOC-free  
• Conforms to IPC-CC-880 requirements | 250 | -40 – 135 | 3.5 × 10¹⁴ | Clear | 10 sec. at 300 – 600 mW/cm² + 2 – 3 days at atmospheric moisture |
| LOCTITE STYCAST UV 7993 | Urethane conformal coating | • One component  
• Solvent-free  
• Good moisture resistance  
• Excellent chemical resistance | 120 | -40 – 130 | 2.2 × 10¹⁴ | Translucent yellow | 5 sec. at 400 – 700 mW/cm² + 100 hr. at 50% relative humidity |
## EMI SHIELDING MATERIALS

### Assembly-Level EMI Shielding Coatings

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Attenuation</th>
<th>Sheet Resistance (Ω/sq/25 μm)</th>
<th>Surfaces</th>
<th>Coverage at 10 μm (m²/kg)</th>
<th>Recommended Cure</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCTITE EDAG 437 E&amp;C</td>
<td>Cu-filled, thermoplastic EMI shielding coating</td>
<td>• Burnish resistant&lt;br&gt;• Excellent environmental resistance&lt;br&gt;• Stable electrical properties after heat cycling&lt;br&gt;• Excellent shielding against radiated electromagnetic interference (EMI) and protection against electrostatic discharge (ESD)&lt;br&gt;• Room temperature cure</td>
<td>50 – 70 dB at 50 μm</td>
<td>&lt; 0.5</td>
<td>Plastic</td>
<td>23</td>
<td>30 min. at 25°C</td>
</tr>
<tr>
<td>LOCTITE EDAG 440 A5 E&amp;C</td>
<td>Ni-filled, thermoplastic EMI shielding coating</td>
<td>• Excellent shielding against radiated electromagnetic interference (EMI)&lt;br&gt;• Protection against electrostatic discharge (ESD)&lt;br&gt;• Stable in difficult environmental conditions such as high humidity or heat&lt;br&gt;• Room temperature or heat cure</td>
<td>50 – 70 dB at 50 μm</td>
<td>&lt; 0.5</td>
<td>Plastic</td>
<td>17</td>
<td>20 min. at 70°C</td>
</tr>
<tr>
<td>LOCTITE EDAG 1415M E&amp;C</td>
<td>Ag-filled, thermoplastic EMI shielding coating</td>
<td>• Excellent shielding against radiated electromagnetic interference (EMI)&lt;br&gt;• Maintains low resistance after exposure to heat, cold, humidity and salt spray&lt;br&gt;• Air drying system that requires no primer or top coat&lt;br&gt;• Room temperature or heat cure</td>
<td>60 dB at 25 μm</td>
<td>&lt; 0.015</td>
<td>Plastic</td>
<td>9</td>
<td>30 min. at 70°C</td>
</tr>
</tbody>
</table>

### Assembly-Level EMI Shielding Gasketing

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Attenuation</th>
<th>Shore A Hardness</th>
<th>Volume Resistivity (Ω-cm)</th>
<th>Tensile Lap Show Strength, N/m² (TLSS)</th>
<th>Recommended Cure</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCTITE SI 5421</td>
<td>Ag-filled, silicone gasketing material</td>
<td>• Room temperature cure&lt;br&gt;• Low stress&lt;br&gt;• High flexibility</td>
<td>80 dB at 10 MHz</td>
<td>50 – 65</td>
<td>&lt; 1 × 10³</td>
<td>0.7</td>
<td>24 hr. at 25°C</td>
</tr>
</tbody>
</table>

### Package-Level EMI Shielding Coatings

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Attenuation</th>
<th>Volume Resistivity (Ω-cm)</th>
<th>Surfaces</th>
<th>Coating Thickness (μm)</th>
<th>Recommended Cure</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCTITE ABLESTIK EMI 8660S</td>
<td>Package-level, conformal EMI shielding coating</td>
<td>• Thinly spray-coated material provides uniform coverage on top and sidewalls of package&lt;br&gt;• Excellent adhesion to mold compound&lt;br&gt;• Excellent EMI shielding performance at &gt; 100 MHz</td>
<td>90 dB at 3 μm</td>
<td>1.5 × 10⁻⁸</td>
<td>Epoxy mold compound, Copper</td>
<td>3 – 5</td>
<td>1 hr. at 175°C in air</td>
</tr>
<tr>
<td>LOCTITE ABLESTIK EMI 8880S</td>
<td>Package-level, conformal EMI shielding coating</td>
<td>• Thinly spray-coated material provides uniform coverage on top and sidewalls of package&lt;br&gt;• Excellent adhesion to mold compound&lt;br&gt;• Excellent EMI shielding performance at &gt; 10 MHz</td>
<td>90 dB at 3 μm</td>
<td>7.9 × 10⁻⁸</td>
<td>Epoxy mold compound, Copper</td>
<td>3 – 5</td>
<td>1 hr. at 175°C in air</td>
</tr>
</tbody>
</table>
## Module Sealants

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Shore A Hardness</th>
<th>Tensile Strength (MPa)</th>
<th>Recommended Cure</th>
</tr>
</thead>
<tbody>
<tr>
<td>BERGQUIST TLB 400 SLT</td>
<td>High performance, two-part, silicone adhesive sealant with an adaptable cure profile</td>
<td>• Fast and adaptable cure (at room or elevated temperatures)&lt;br&gt;• Strong and elastic bond&lt;br&gt;• Thixotropic – designed for automated dispensing as form-in-place gasket (FIPG)&lt;br&gt;• Room temperature storage&lt;br&gt;• Self-fixture time of 12 hr. at 25°C</td>
<td>40</td>
<td>2.1</td>
<td>7 days at 25°C</td>
</tr>
<tr>
<td>LOCTITE SI 5210</td>
<td>One component silicone sealant and adhesive paste</td>
<td>• An ultra-fast curing, non-corrosive, thixotropic room temperature vulcanizing (RTV) silicone designed for potting, selective sealing, vibration dampening and repair/rework applications on circuit boards&lt;br&gt;• Effective for automotive electronics applications or other harsh environments&lt;br&gt;• Tack free time of ≤ 5 min. at 22°C and 50% relative humidity</td>
<td>48</td>
<td>2.8</td>
<td>7 days at 22°C and 50% relative humidity</td>
</tr>
<tr>
<td>LOCTITE SI 5900</td>
<td>One component silicone sealant and adhesive paste</td>
<td>• Excellent resistance to automotive engine oils&lt;br&gt;• Ability to withstand high joint movement&lt;br&gt;• Excellent adhesion to a wide variety of plastic substrates, as well as glass, ceramics and metals&lt;br&gt;• Thixotropic paste&lt;br&gt;• Tack free time of 7 – 24 min. at 25°C and 50% relative humidity</td>
<td>31 – 46</td>
<td>≥ 1.7</td>
<td>7 days at 25°C and 50% relative humidity</td>
</tr>
</tbody>
</table>
RADARS THAT KEEP THEIR COOL

The ability to offer driver assistance for collision avoidance, pedestrian detection, blind spot notification and, in some cases, even initiate emergency braking make radar systems very cool, safety-enhancing technology. Keeping them cool is imperative. As radar technology has become more compact and powerful, components have diminished in size, yet expanded in function. And, with this dynamic, increased heat generation is the result. In fact, thermal management is one of the most essential pieces of the reliability puzzle. If parts overheat, they don’t function. Henkel’s BERGQUIST brand thermal interference materials are the undisputed market leader for effective thermal management solutions. Our award-winning, low-stress gap filling thermal interface materials are enabling high-performance function of digital signal (DSP) and microcontroller (MCU) processors, as well as providing thermal relief from heat generation at the mid-frame. High conformity GAP PADS and automated, throughput-enhancing liquid form-in-place gap fillers effectively absorb and dissipate heat so radars can keep their cool.
## EMI SHIELDING AND THERMAL INTERFACE MATERIALS

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Thermal Conductivity (W/m·K)</th>
<th>Modulus at 25°C (kPa)</th>
<th>EMI Absorption at 2.4 GHz (dB/cm)</th>
<th>Thickness (mm)</th>
<th>Flammability Rating</th>
</tr>
</thead>
</table>
| BERGQUIST GAP PAD EMI 1.0 | Thermally conductive, conformable EMI absorbing material | • Electromagnetic interference (EMI) absorbing  
• Fiberglass reinforced for puncture, shear and tear resistance  
• Electrically isolating | 1 | 69 | -2.8 | 0.508 – 3.175 | UL 94 V-0 |

### GAP FILLER

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Thermal Conductivity (W/m·K)</th>
<th>Viscosity at 25°C (cP)</th>
<th>Dielectric Strength (V/25 µm)</th>
<th>Flammability Rating</th>
<th>Recommended Cure</th>
</tr>
</thead>
</table>
| BERGQUIST GAP FILLER 1100SF | Silicone-free, thermally conductive liquid gap filling material | • No silicone outgassing or extraction  
• Ultra-conforming material designed for fragile and low-stress applications  
• Ambient and accelerated cure schedules  
• 100% solids – no cure by-products | 1.1 | 450,000 | 400 | UL 94 V-0 | 24 hr. at 25°C |
| BERGQUIST GAP FILLER 1500 | Thermally conductive liquid gap filling material | • Optimized shear thinning characteristics for ease of dispensing  
• Excellent slump resistance  
• Ultra-conforming with excellent wet-out for low-stress interface applications  
• 100% solids – no cure by-products  
• Excellent low- and high-temperature mechanical and chemical stability  
• Ambient and accelerated cure schedules | 1.8 | 25,000 | 400 | UL 94 V-0 | 5 hr. at 25°C |
| BERGQUIST GAP FILLER 1500 LV | Thermally conductive liquid gap filling material | • Low volatility for silicone sensitive applications  
• Ultra-conforming with excellent wet-out  
• 100% solids – no cure by-products  
• Excellent low- and high-temperature, chemical and mechanical stability  
• Ambient or accelerated cure schedules | 1.8 | 20,000 | 400 | UL 94 V-0 | 8 hr. at 25°C |
| BERGQUIST GAP FILLER 3500LV | Thermally conductive liquid gap filling material | • Low volatility for outgassing sensitive applications  
• Ultra-conforming with excellent wet-out for low-stress interfaces on applications  
• 100% solids – no cure by-products  
• Ambient or accelerated cure schedules | 3.5 | 45,000 | 275 | UL 94 V-0 | 24 hr. at 25°C |
| BERGQUIST GAP FILLER 3500S35 | Thermally conductive liquid gap filling material | • High thermal performance  
• Thixotropic nature makes it easy to dispense  
• Ultra-conforming material designed for fragile and low-stress applications  
• Ambient or accelerated cure schedules | 3.6 | 150,000 | 275 | UL 94 V-0 | 15 hr. at 25°C |
| BERGQUIST GAP FILLER 4000 | Thermally conductive liquid gap filling material | • High thermal performance  
• Extended working time for manufacturing flexibility  
• Ultra-conforming with excellent wet-out  
• 100% solids – no cure by-products  
• Excellent low- and high-temperature, chemical and mechanical stability  
• Ambient or accelerated cure schedules | 4.0 | 50,000 | 450 | UL 94 V-0 | 24 hr. at 25°C |
# THERMAL MATERIALS FOR ADAS RADARS

## GAP PAD

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Thermal Conductivity (W/m•K)</th>
<th>Modulus at 25°C (kPa)</th>
<th>Dielectric Breakdown Voltage</th>
<th>Thickness (mm)</th>
<th>Flammability Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>BERGQUIST GAP PAD 1000SF</td>
<td>Silicone-free, thermally conductive gap filling material</td>
<td>• No silicone outgassing</td>
<td>0.9</td>
<td>234</td>
<td>6,000 V at 250 µm</td>
<td>0.254 – 3.175</td>
<td>UL 94 V-1</td>
</tr>
<tr>
<td>BERGQUIST GAP PAD 2200SF</td>
<td>Silicone-free, thermally conductive gap filling material</td>
<td>• Medium compliance with easy handling</td>
<td>2</td>
<td>228</td>
<td>5,000 V at 250 µm</td>
<td>0.254 – 3.175</td>
<td>UL 94 V-0</td>
</tr>
<tr>
<td>BERGQUIST GAP PAD 2202SF</td>
<td>Silicone-free, high performance, thermally conductive gap filling material</td>
<td>• Minimal compression set, 12.7 µm film provides tack-free surface, tacky side allows for ease of handling and placement</td>
<td>2</td>
<td>1,500</td>
<td>5,000 V at 250 µm</td>
<td>0.254 – 3.175</td>
<td>UL 94 V-0</td>
</tr>
<tr>
<td>BERGQUIST GAP PAD 3004SF</td>
<td>Silicone-free, high performance, thermally conductive gap filling material</td>
<td>• Excellent thermal performance, 6.4 µm polyethylene terephthalate (PET) provides easy disassembly, leaving no residue, tacky side allows for ease of handling and placement</td>
<td>3</td>
<td>2,450</td>
<td>6,000 V at 250 µm</td>
<td>0.254 – 3.175</td>
<td>UL 94 V-0</td>
</tr>
<tr>
<td>BERGQUIST GAP PAD HC3.0</td>
<td>Thermally conductive gap filling material</td>
<td>• High-compliance, low compression stress, fiberglass reinforced for shear and tear resistance, low modulus</td>
<td>3</td>
<td>110</td>
<td>5,000 V at 500 µm</td>
<td>0.508 – 3.175</td>
<td>UL 94 V-0</td>
</tr>
<tr>
<td>BERGQUIST GAP PAD HC5.0</td>
<td>Thermally conductive gap filling material</td>
<td>• Highly conformable, exceptional thermal performance, high-compliance, low compression stress, fiberglass reinforced for shear and tear resistance, low modulus</td>
<td>5</td>
<td>121</td>
<td>5,000 V at 500 µm</td>
<td>0.508 – 3.175</td>
<td>UL 94 V-0</td>
</tr>
<tr>
<td>BERGQUIST GAP PAD VO ULTRA SOFT</td>
<td>Thermally conductive gap filling material</td>
<td>• Highly conformable, low hardness, “gel-like” modulus, decreased strain, puncture, shear and tear resistant, electrically isolating</td>
<td>1</td>
<td>55</td>
<td>6,000 V at 500 µm</td>
<td>0.508 – 6.350</td>
<td>UL 94 V-0</td>
</tr>
</tbody>
</table>
## PHASE CHANGE MATERIALS

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Description</th>
<th>Key Attributes</th>
<th>Thermal Conductivity (W/m·K)</th>
<th>Phase Change Temperature (°C)</th>
<th>Dielectric Strength (V/25 μm)</th>
<th>Thickness (mm)</th>
<th>Flammability Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aluminum Carrier</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| BERGQUIST HI-FLOW 225F-AC| Phase change thermal interface material    | • Low thermal impedance  
• Can be manually or automatically applied to the surfaces of room-temperature heat sinks  
• Foil reinforced, adhesive coated  
• Soft phase change compound | 1                                          | 55                                          | N/A                               | • 0.102          | UL 94 V-0        |
| LOCTITE TCF 1000        | Non-insulating, phase change thermal interface material | • Low thermal impedance  
• Coated on aluminum foil  
• Used between any non-isolated heat dissipating component and a heat sink or chassis | 1                                          | 60                                          | N/A                               | • 0.06 – 0.2     | None             |
| LOCTITE TCF 2000        | Non-insulating, phase change thermal interface material | • Used between any non-isolated heat dissipating component and a heat sink or chassis  
• High thermal conductivity | 3                                          | 51                                          | N/A                               | • 0.076          | UL 94 V-0        |
| **Polyimide Carrier**   |                                            |                                                                                                       |                             |                              |                     |                 |                   |
| LOCTITE EIF 1000        | High-performance, phase change thermal Interface material | • High dielectric strength  
• Excellent cut-through resistance | 0.45                                      | 60                                          | > 5,000                          | • 0.05 – 0.2     | UL 94 V-0        |
| BERGQUIST HI-FLOW 300P  | High-performance, phase change thermal interface material | • Field-proven polyimide film  
• Excellent dielectric performance  
• Excellent cut-through resistance  
• Outstanding thermal performance in an insulated pad | 1.6                                       | 55                                          | 5,000                              | • 0.102 – 0.127  | UL 94 V-0        |
| **No Carrier**          |                                            |                                                                                                       |                             |                              |                     |                 |                   |
| BERGQUIST HI-FLOW 565UT | High-performance, phase change thermal interface material | • Very low thermal impedance  
• High thermal conductivity  
• Naturally tacky  
• Tabulated for ease of assembly | 3                                          | 52                                          | N/A                               | • 0.127          | UL 94 V-0        |

<table>
<thead>
<tr>
<th><strong>Conductivity (W/m·K)</strong></th>
<th><strong>Thermal Materials</strong></th>
<th><strong>Dielectric Strength (V/25 μm)</strong></th>
<th><strong>Thickness (mm)</strong></th>
<th><strong>Flammability Rating</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.102 – 6.350</td>
<td>Aluminum Carrier</td>
<td>0.06 – 0.2</td>
<td>0.102</td>
<td>UL 94 V-0</td>
</tr>
<tr>
<td>0.06 – 0.2</td>
<td>LOCTITE TCF 1000</td>
<td>N/A</td>
<td>• 0.102</td>
<td>UL 94 V-0</td>
</tr>
<tr>
<td>0.076</td>
<td>LOCTITE TCF 2000</td>
<td>N/A</td>
<td>• 0.076</td>
<td>UL 94 V-0</td>
</tr>
<tr>
<td>0.05 – 0.2</td>
<td>LOCTITE EIF 1000</td>
<td>N/A</td>
<td>• 0.05 – 0.2</td>
<td>UL 94 V-0</td>
</tr>
<tr>
<td>0.102 – 0.127</td>
<td>BERGQUIST HI-FLOW 300P</td>
<td>N/A</td>
<td>• 0.102 – 0.127</td>
<td>UL 94 V-0</td>
</tr>
<tr>
<td>0.127</td>
<td>BERGQUIST HI-FLOW 565UT</td>
<td>N/A</td>
<td>• 0.127</td>
<td>UL 94 V-0</td>
</tr>
</tbody>
</table>
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AROUND THE GLOBE.

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