LOCTITE®

BERGQUIST®

MATERIALS FOR WIRELESS INFRASTRUCTURE

5G TELECOM SOLUTIONS

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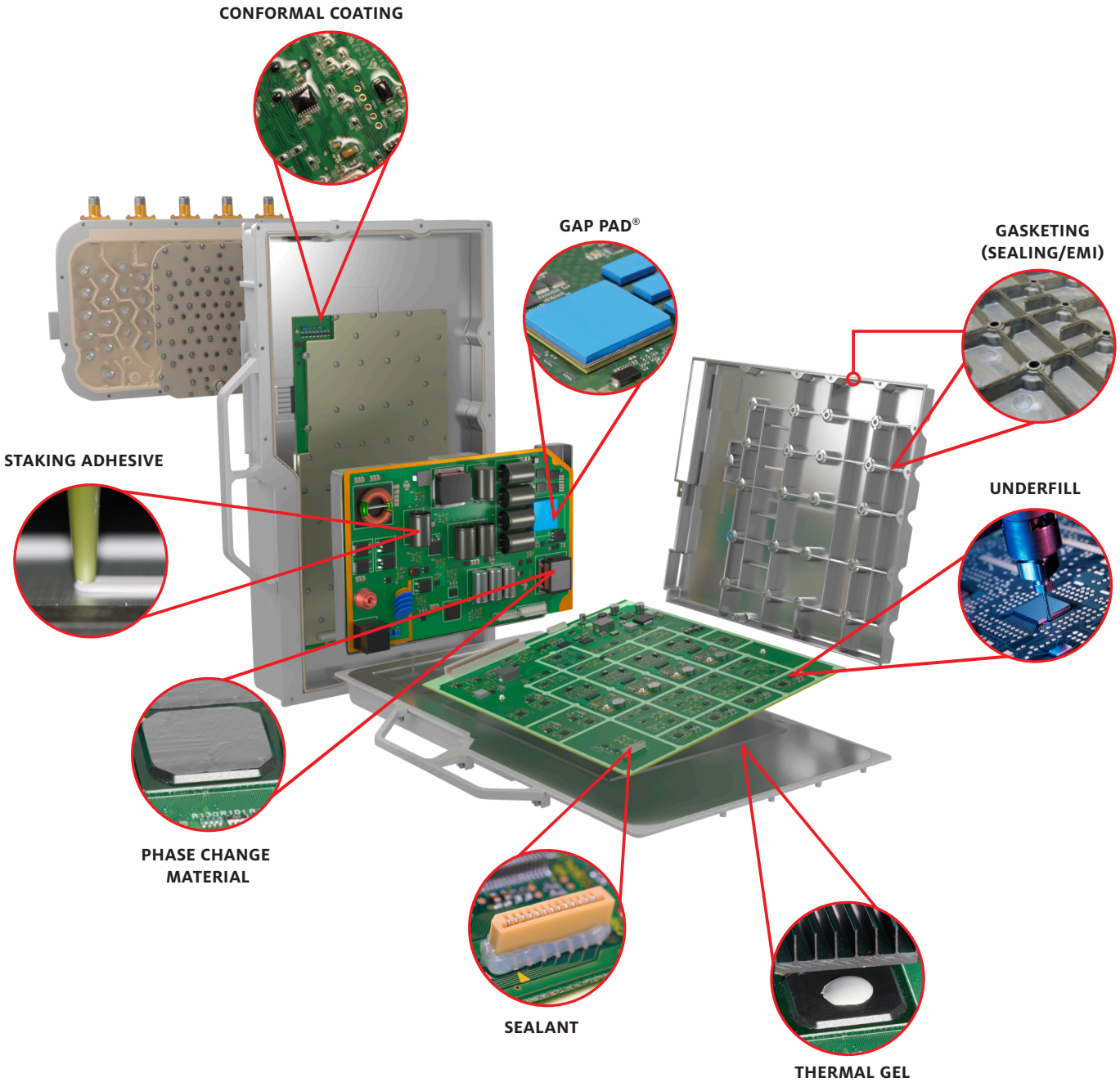
5G Telecom Solutions

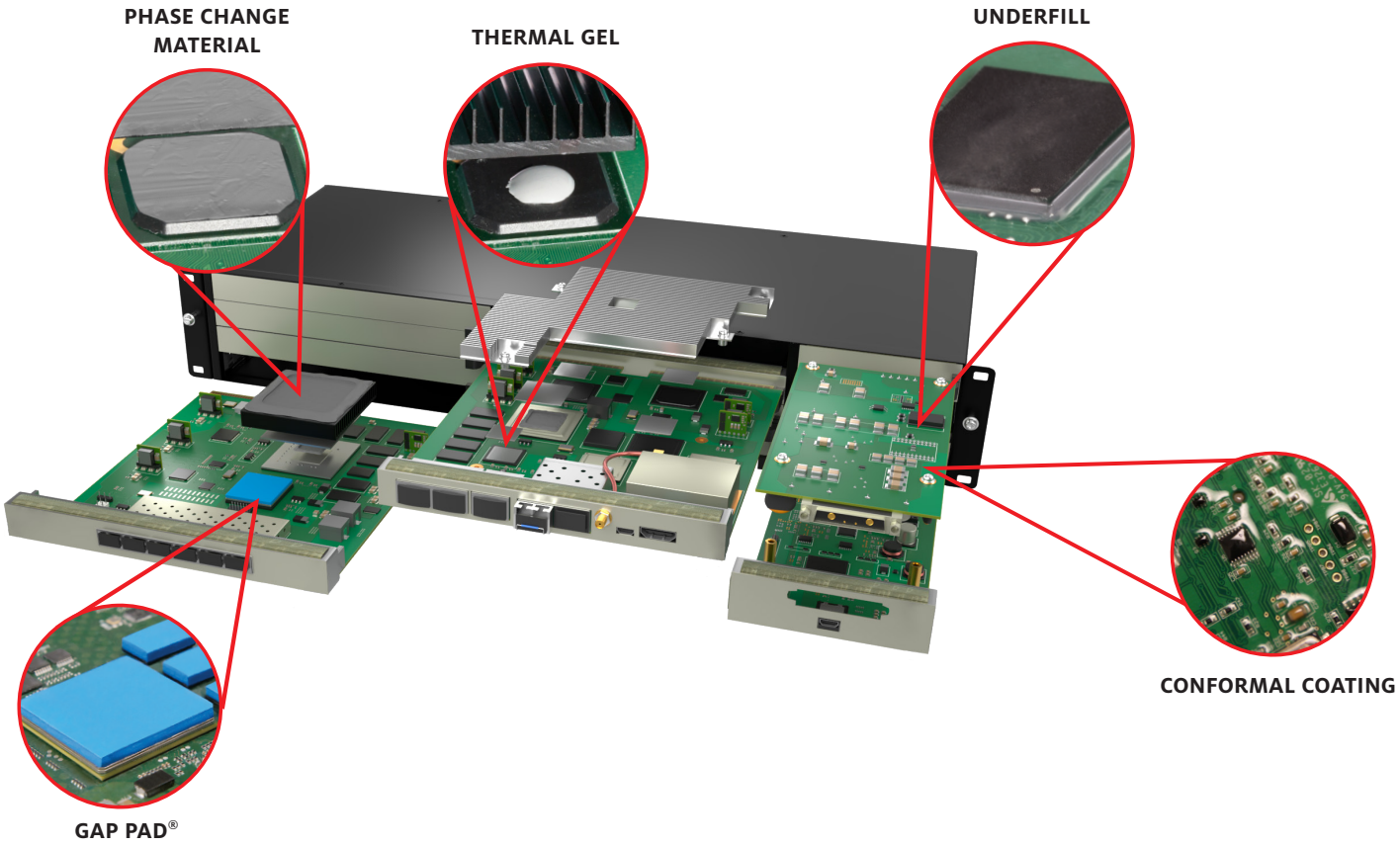
As the commercial telecom market embraces new 5G mobile communication standards and early phase rollouts, wireless infrastructure system design specialists are preparing for the full market deployment set to begin in 2020. The broad heterogeneous network required to facilitate 5G enhanced media broadband speeds and low data latency continues to place demands on functional components, with reduced form factors and increased performance expectations pushing power densities to new limits.

Because many of the telecom infrastructure components such as remote radio heads, base stations and fixed wireless network devices are positioned in outdoor environments, ensuring reliable long-term performance is critical. Unlike datacenters where active cooling can occur, commercial telecom infrastructure systems rely on strong electrical interconnects and robust thermal management solutions for dependable function. Henkel's award-winning bonding and protecting solutions, and *BERGQUIST* brand thermal control products have enabled the telecom sector for decades. Now, as the industry transitions to new 5G-capable designs, Henkel's applications expertise, formulation know-how and proven product performance will deliver once again for the telecom sector.

Material Solutions For Remote Radio Unit (RRU)

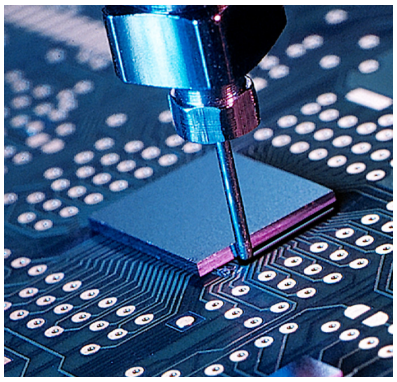


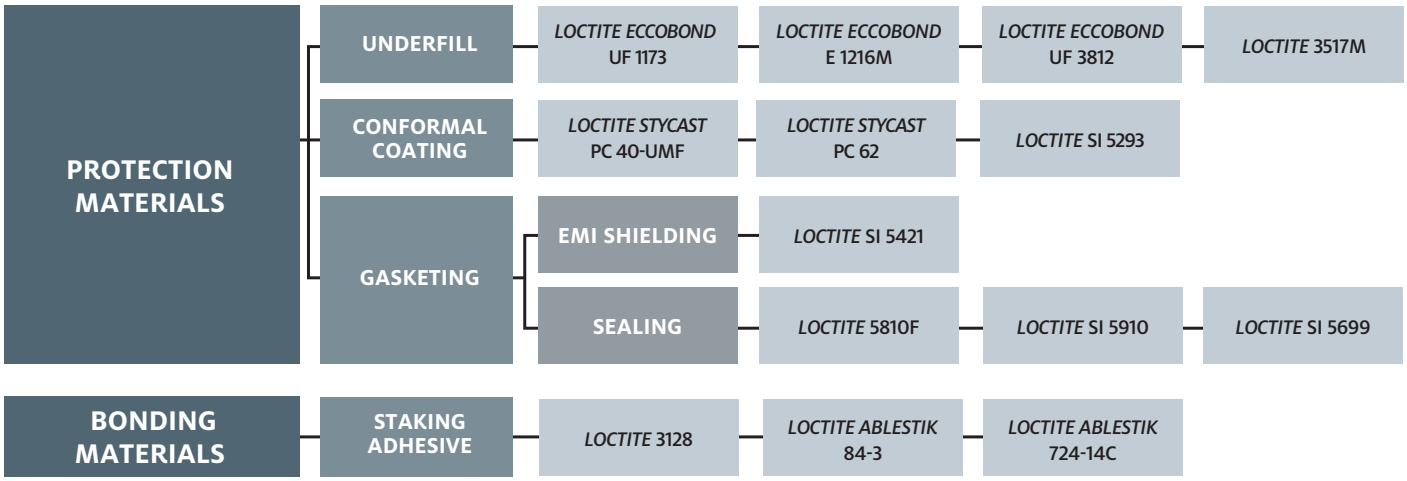
Material Solutions For Base Band Unit (BBU)



Bonding and Protection for Demanding Environments

For reliable 5G, electronics require protection against the environment, RF interference, in-operation stress, moisture and corrosion that can occur given the demanding conditions in which various network components are placed. Materials that secure enclosures, seal sensitive devices, provide interconnect protection for high-power components such as large ASICs used in antennas and base stations, and conformal coatings to protect critical remote radio PCBs from moisture and corrosion are all part of Henkel's expansive 5G materials portfolio.





Protection Materials

Product	Description	Viscosity (cP)	Coefficient of Thermal Expansion, CTE, (ppm/°C)		Glass Transition Temperature, T_g	Pot Life (day)
			Below T_g	Above T_g		
LOCTITE ECCOBOND UF 1173	Low CTE, high T_g underfill for extreme T-Cycle conditions	7,500	26	103	160	2
LOCTITE ECCOBOND E 1216M	Fast flow, non-anhydride underfill	4,000	35	131	125	3
LOCTITE ECCOBOND UF 3812	Room temperature flow, reworkable underfill	350	48	175	131	3
LOCTITE 3517M	Low temperature cure, reworkable underfill	2,600	65	191	78	7

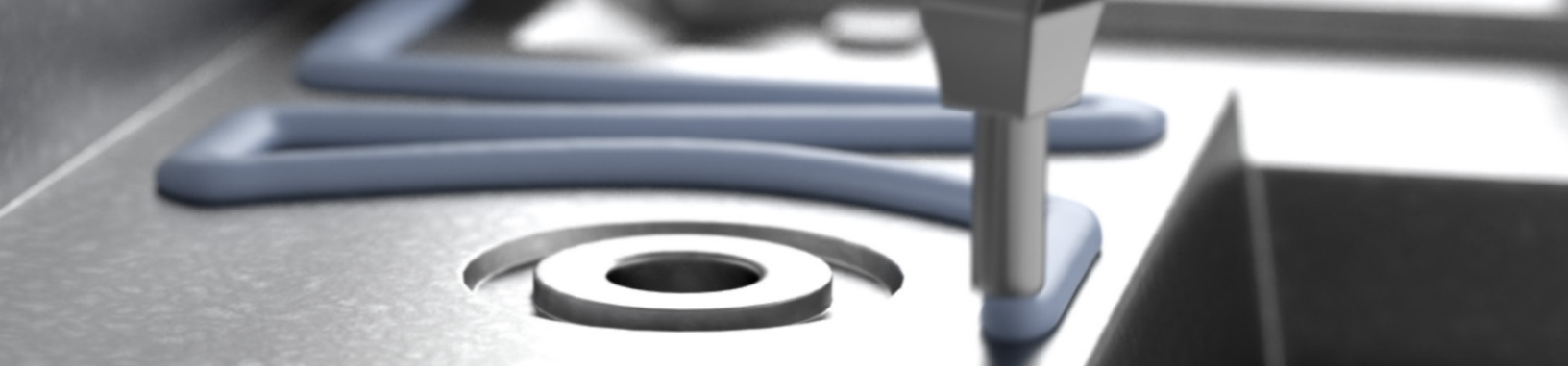
Product	Description	Cure Schedules	Viscosity (cP)	Operating Temperature Range
LOCTITE STYCAST PC 40-UMF	Rapidly gels and immobilizes when exposed to UV light and fully cures when exposed to atmospheric moisture	10 sec. UV + 3 days at RT	250	-40°C to 135°C
LOCTITE STYCAST PC 62	Conformal coating that provides environmental and mechanical protection. Toluene-free alternative with superior toughness, abrasion resistance and fluorescence under UV light	24 hr. at 25°C or 45 min. at 75°C	52	-40°C to 125°C
LOCTITE SI 5293	Repairable, solvent-free, medium viscosity, UV/moisture silicone	20 sec. UV + 3 days at RT	600	-40°C to 200°C

Protection Materials – Continued

Product	Description	Chemistry	Viscosity (cP)	Cure Condition (25°C / 50±5 % RH)	Cure Type
LOCTITE® SI 5421	Electrically conductive room temperature vulcanizing (RTV) silicone for bonding and gasketing of EMI/RFI shielded enclosures	Alkoxy Silicone	Paste	≤ 60 min.	RTV
LOCTITE 5810F	Form in place gasketing primarily designed for sealing plastic and metal housings on electronic components	Polyacrylate	Paste	≤ 120 min.	RTV
LOCTITE SI 5910	One-component, silicone sealant designed for sheet metal covers with good oil resistance	Oxime Silicone	Paste	≤ 40 min.	RTV
LOCTITE SI 5699	One-component, silicone sealant has excellent adhesion and can be used to seal electronic components	Oxime Silicone	Paste	≤ 30 min.	RTV

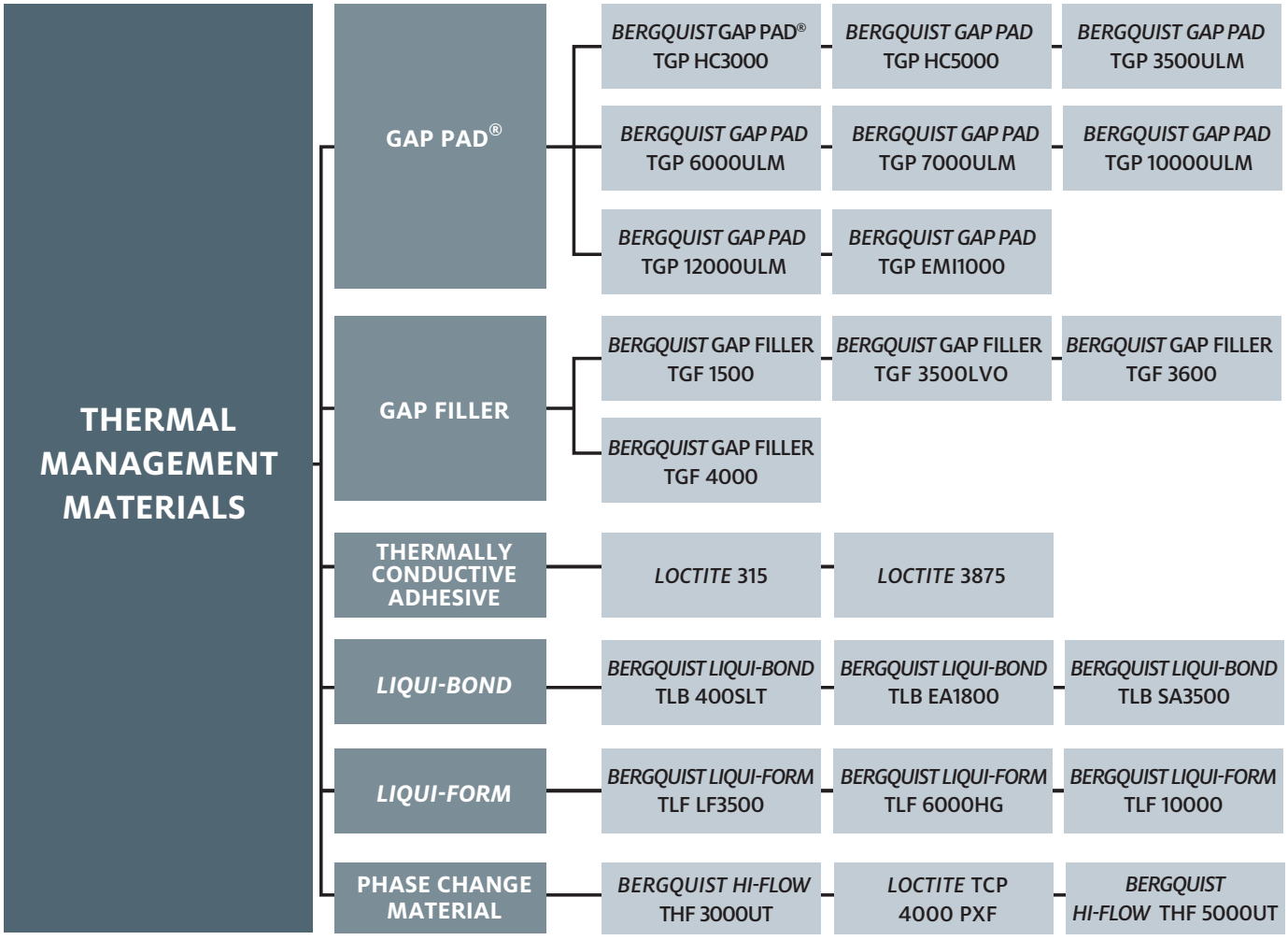
Bonding Materials

Product	Description	Viscosity (cP)	Volume Resistivity (Ω·cm)	Lap Shear Strength (psi)	Cure Condition
LOCTITE 3128	One part, heat curable epoxy designed to cure at low temperature and gives excellent adhesion on a wide range of materials in considerably short time	44,000	2.9×10^{16}	3,000	20 min. at 80°C
LOCTITE ABLESTIK 84-3	Electrically insulating material for chip attach applications that eliminates concerns of reliability and outgassing	50,000	3.5×10^{13}	2,700	1 hr. at 150°C
LOCTITE ABLESTIK 724-14C	Polyurethane adhesive with excellent adhesion even in cryogenic conditions. Can be cured at room and elevated temperatures	500,000	1×10^{10}	1,700	72 hr. at 25°C



Fail-Safe Thermal Management

5G telecom infrastructure components, most of which are positioned outdoors 24/7/365, are subjected to demanding conditions including extreme temperature swings, wind and moisture exposure and, vibration, to name a few. Not only must systems withstand these stresses, but they must do so while also packing exponentially more power and processing capability than their predecessors. With active cooling limited to environmental air flow, thermal management solutions for 5G infrastructure devices must be able to provide the consistent thermal relief necessary to ensure reliable performance and long lifespans. Thermal interface materials (TIMs) from Henkel are offered in multiple formats including pads, gels, liquids and adhesives to offer high-volume manufacturing compatibility, accommodate design complexities and maximize system reliability.



Thermal Management Materials

GAP PAD®

Product	Description	Chemistry	Thermal Conductivity (W/m·K)	Hardness	Dielectric Breakdown Voltage (Vac)	Volume Resistivity (Ω·m)	Reinforcement Carrier
BERGQUIST GAP PAD® TGP HC3000	High-compliance, thermally conductive, low modulus material	Silicone Base	3.0	15 (Shore 00)	> 5000	10^{10}	Fiberglass
BERGQUIST GAP PAD TGP HC5000	High-compliance, thermally conductive, low modulus material	Silicone Base	5.0	35 (Shore 00)	> 5000	10^{10}	Fiberglass
BERGQUIST GAP PAD TGP 3500ULM	Highly conformable, thermally conductive, ultra-low modulus material	Silicone Base	3.5	70 (Shore 000)	> 5000	10^{10}	With or without fiberglass
BERGQUIST GAP PAD TGP 6000ULM	A high performance, 6 W/m·K silicone thermal interface material, ultra-low modulus material	Silicone Base	6.0	60 (Shore 000)	> 5000	10^{10}	Fiberglass
BERGQUIST GAP PAD TGP 7000ULM	A 7 W/m·K, extremely soft *GAP PAD* with exceptional thermal performance at low pressures	Silicone Base	7.0	75 (Shore 000)	> 5000	1.2×10^{11}	–
BERGQUIST GAP PAD TGP 10000ULM	A 10 W/m·K, extremely soft *GAP PAD* with exceptional thermal performance at low pressures	Silicone Base	10	75 (Shore 000)	3,200	2.5×10^{11}	–
BERGQUIST GAP PAD TGP 12000ULM	A 12 W/m·K, extremely soft *GAP PAD* with exceptional thermal performance at low pressures	Silicone Base	12	68 (Shore 000)	6,200	1.5×10^{12}	–

Product	Technology	Application	Key Attributes	Thickness (in./mm)	Shore Hardness (Shore 00)	Thermal Conductivity (W/m·K)
BERQUIST GAP PAD TGP EMI1000	Silicone	EMI Absorbing	• EMI absorbing, highly conformable, electrically isolating and low hardness • Fiberglass reinforced for puncture, tear and shear resistance	0.508 – 3.175	5	1.0

GAP FILLER

Product	Description	Chemistry	Thermal Conductivity (W/m·K)	Hardness (Shore 00)	Dielectric Strength (V/mil)	Volume Resistivity (Ω·m)	Cure Schedule (25°C / 100°C)
BERGQUIST GAP FILLER TGF 1500	Thermally conductive, liquid gap filler material	2K, Silicone Base	1.8	50	400	10^{10}	5 hr./10 min.
BERGQUIST GAP FILLER TGF 3500LVO	Thermally conductive, low outgassing, liquid gap filling material	2K, Silicone Base	3.5	40	275	10^{10}	24 hr./30 min.
BERGQUIST GAP FILLER TGF 3600	Thermally conductive, liquid gap filling material	2K, Silicone Base	3.6	35	275	10^{10}	15 hr./30 min.
BERGQUIST GAP FILLER TGF 4000	Thermally conductive, liquid gap filler material	2K, Silicone Base	4	75	450	10^{10}	24 hr./30 min.

THERMALLY CONDUCTIVE ADHESIVE

Product	Description	Thermal Conductivity (W/m·K)	Cure Type	Dielectric Strength (kV/mm)	Volume Resistivity (Ω·cm)	Shear Strength (psi)
LOCTITE 315	Acrylic	0.8	Activator or Heat	678.18	1.3×10^{12}	1,000
LOCTITE 3875	Bead on Bead – Acrylate	1.75	Activator or Heat	26.7	4.3×10^{14}	2,400

LIQUI-BOND

Product	Description	Tensile Strength (psi)	Lap Shear (psi)	Dielectric Strength (V/mil)	Volume Resistivity (Ω·m)	Breaking Strength (lb/in.)
BERGQUIST LIQUI-BOND TLB 400SLT	High performance silicone adhesive sealant with an adaptable cure profile	300	300	250	10^{10}	25

Product	Description	Thermal Conductivity (W/m·K)	Hardness	Dielectric Strength (V/mil)	Volume Resistivity (Ω·m)	Shear Strength (psi)
BERGQUIST LIQUI-BOND TLB EA1800	Thermally conductive, two-part, liquid epoxy adhesive	1.8	90 (Shore D)	250	10^{10}	450
BERGQUIST LIQUI-BOND TLB SA3500	Thermally conductive,two-part, liquid silicone adhesive	3.5	90 (Shore A)	250	10^{10}	450

LIQUI-FORM

Product	Description	Chemistry	Thermal Conductivity (W/m·K)	Volumetric Expansion 25 – 275°C (ppm/°C)	Dielectric Strength	Volume Resistivity (Ω·m)	Dispense Rate (g/min.)
BERGQUIST LIQUI-FORM TLF LF3500	Thermally conductive, one-part, liquid formable gel material	1K, Silicone Base	3.5	200	250 V/mil	10^{10}	40
BERGQUIST LIQUI-FORM TLF 6000HG	Thermally conductive, one-part, liquid formable gel material	Silicone	6.0	–	10,50 V/mm	4.37×10^{11}	17
BERGQUIST LIQUI-FORM TLF 10000	Thermally conductive, pre-cured gel material	Silicone	10	–	7,080 V/mm	9.0×10^{13}	22

PHASE CHANGE MATERIAL

Product	Description	Key Attributes	Thermal Conductivity (W/m·K)	Thermal Impedence (°C·n²/W)	Thickness (mm)	Phase Change Temperature
LOCTITE® TCP 4000 PXF	Reworkable phase-change thermal interface material suitable for use between a heat sink and various heat generating components	• Low thermal resistance • Non silicone • No pump-out, dry-out or pull-out	3.4	PXF-8: 0.015 at 20 psi PXF-10: 0.023 at 20 psi	PXF-8: 0.2 PXF-10: 0.4	45°C

Product	Description	Key Attributes	Thermal Conductivity (W/m·K)	Thermal Impedence (°C·in²/W)	Phase Change Temperature	Thickness (mm)	Flammability Rating
BERGQUIST HI-FLOW THF 3000UT	Naturally tacky, thermally conductive phase change material, undergoes a phase change softening starting near 52°C	• Applied in high volumes to the target surface via low pressure from a roller or manual application	3.0	0.05 at 25 psi	52°C	0.127 – 0.254	UL 94 V-0

Product	Description	Material Thicknesses (Mil)	Phase Change Temperature	Operating Temperature	Thermal Conductivity (W/M·k)	Ul Flammability Rating
BERGQUIST HI-FLOW THF 5000UT	Reworkable phase change thermal interface material suitable for use between a heat sink and variety heat generating components	8, 10, 12, 16	45°C	-40 to 150°C	Multiple Thickness, ASTM D5470 5.3 Thin Bondline Materials, modified ASTM D5470 8.5	UL 94 V-0

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