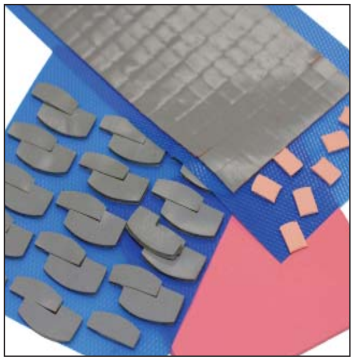

aerospace
climate control
electromechanical
filtration
fluid & gas handling
hydraulics
pneumatics
process control
sealing & shielding

Thermal Interface Materials For Electronics Cooling

Products & Custom Solutions Catalog

Parker Chomerics

ENGINEERING YOUR SUCCESS.

Customer Responsibility and Offer of Sale Statement

CUSTOMER RESPONSIBILITY

WARNING – USER RESPONSIBILITY

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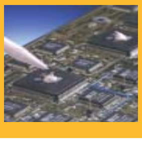
Thermal Management

Products & Custom Solutions Catalog

Introduction

Chomerics, a division of Parker Hannifin Corporation (NYSE:PH), is a global provider of EMI shielding, thermal interface materials, plastics and optical products. Chomerics specializes in providing products and services to OEM and CEM electronics companies in the telecommunications, information technology, consumer, power conversion, medical device, defense, and transportation markets.

Since 1961, Chomerics has been a leader in the development of electrically conductive elastomers for use as extruded, molded and form-in-place EMI gaskets for telecommunications and electronics applications. Chomerics also offers an extensive family of thermal interface materials, which transfer heat from electronic components to heat sinks. Careful management of thermal interfaces is crucial to maintaining the reliability and extending the life of electronic devices and equipment. As each new electronic product generation requires higher power in smaller packages, the challenges associated with thermal management become more intense. Thermal material drivers include:

- Lower thermal impedance
- Higher thermal conductivity
- Greater compliance and conformability
- High reliability
- Greater adhesion
- Ease of handling, application and use
- Long service life

Chomerics has a successful history of providing thermal materials expertise and commitment to developing new, high performance products to meet the thermal challenges of systems designers.

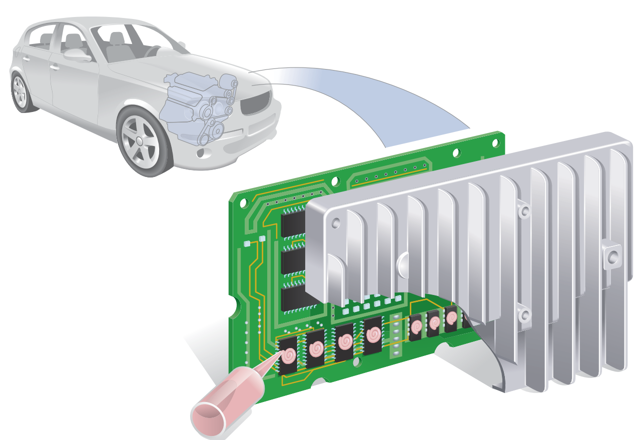
Chomerics products have been designed into thousands of applications and help assure the performance, integrity, survivability and maintainability of communications equipment, radar, aircraft, computers, control systems, telecommunications, consumer devices, automotive and industrial electronics. Our customers are supported with comprehensive applications engineering, supply chain and fabrication services worldwide.

Thermal Interface Materials (TIMs) for Light Emitting Diode (LED) and Industrial Applications

Gap Filler Pad and Dispensed Gels for Telecommunications

TIMs for Military and Aerospace Applications

Dispensed Gels in Automotive Electronic Control Unit (ECU) Application



Parker Chomerics Capabilities include:

THERMAL MANAGEMENT & CONTROL

- Thermally conductive gap filler pads
- Fully cured dispensable thermal gels
- Silicone-free thermal pads
- Phase-change materials (PCM)
- Polymer solder hybrids (PSH)
- Dispensable thermal compounds
- Thermal grease
- Dielectric pads
- Thin flexible heat spreaders
- Custom integrated thermal/EMI assemblies

EMI SHIELDING & COMPLIANCE

- Conductive elastomers – molded, extruded, and form-in-place (FIP)
- Conductive foam based gaskets – fabric-over-foam and z-axis foam
- Conductive compounds – adhesives, sealants and caulks
- RF absorbing materials
- EMI shielding plastics and injection molding services
- Coatings – direct metallization and conductive paints
- Metal gaskets – Springfingers, metal mesh and combination gaskets
- Foil laminates and conductive tapes
- EMI shielding vents – commercial and military honeycomb vents
- Shielded optical windows
- Cable shielding – ferrites and heat-shrink tubing/ wire mesh tape/zippered cable shielding
- Compliance and safety test services

OPTICAL DISPLAY PRODUCTS

- EMI shielding filters (conductive coating & wire mesh)
- Anti-reflective/contrast enhancement filters
- Plastic or glass laminations
- Hard coated lens protectors
- Touchscreen lenses

PLASTIC INJECTION MOLDING

- PREMIER® and other filled, electrically-conductive plastics
- Traditional thermoplastics
- EMI and cosmetic coating services
- EMI and environmental gasket integration
- Assembly, pad printing, hot stamping, welding, and heat staking
- Insert molding, two-shot molding, and overmolding capability

About Parker Hannifin Corporation

With annual sales exceeding $13 billion, Parker Hannifin is the world's leading diversified manufacturer of motion and control technologies and systems, providing precision-engineered solutions for a wide variety of mobile, industrial and aerospace markets. The company's products are vital to virtually everything that moves or requires control, including the manufacture and processing of raw materials, durable goods, infrastructure development and all forms of transport. Traded on the New York Stock Exchange under the symbol "PH," Parker is strategically diversified, value-driven and well positioned for global growth as the industry consolidator and supplier of choice.

Heat Transfer Fundamentals

Introduction

The objective of thermal management programs in electronic packaging is the efficient removal of heat from the semiconductor junction to the ambient environment. This process can be separated into three major phases:

1. heat transfer within the semiconductor component package;
2. heat transfer from the package to a heat dissipater (the initial heat sink);
3. heat transfer from the heat dissipater to the ambient environment (the ultimate heat sink)

The first phase is generally beyond the control of the system level thermal engineer because the package type defines the internal heat transfer processes. In the second and third phases, the packaging engineer's goal is to design an efficient thermal connection from the package surface to the initial heat spreader and on to the ambient environment. Achieving this goal requires a thorough understanding of heat transfer fundamentals as well as knowledge of available interface materials and how their key physical properties affect the heat transfer process.

Basic Theory

The rate at which heat is conducted through a material is proportional to the area normal to the heat flow and to the temperature gradient along the heat flow path. For a one dimensional, steady state heat flow the rate is expressed by Fourier's equation:

$$(1) \qquad Q = kA\frac{\Delta T}{d}$$

Where:
k = thermal conductivity, W/m-K
Q = rate of heat flow, W
A = contact area, m^2
d = distance of heat flow, m
T = temperature difference, C

Thermal conductivity, k, is an intrinsic property of a homogeneous material which describes the material's ability to conduct heat. This property is independent of material size, shape or orientation. For non-homogeneous materials, those having glass mesh or polymer film reinforcement, the term "relative thermal conductivity" is appropriate because the thermal conductivity of these materials depends on the relative thickness of the layers and their orientation with respect to heat flow.

Another inherent thermal property of a material is its thermal resistance, **R** , as defined in Equation 2.

$$(2) \qquad R = A\frac{\Delta T}{Q}$$

This property is a measure of how a material of a specific thickness resists the flow of heat. The relationship between **k** and **R** is shown by substituting Equation (**2**) into (**1**) and rearranging to form (**3**)

$$(3) \qquad k = \frac{d}{R}$$

Equation 3 shows that for homogeneous materials, thermal resistance is directly proportional to thickness. For non-homogeneous materials, the resistance generally increases with thickness but the relationship may not be exactly linear.

Thermal conductivity and thermal resistance describe heat transfer within a material once heat has entered the material. Because real surfaces are never truly flat or

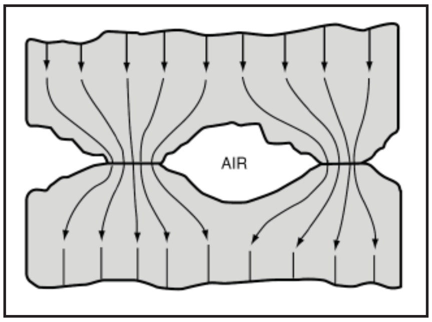


Figure 1a. Schematic representation of two surfaces in contact and heat flow across the interface

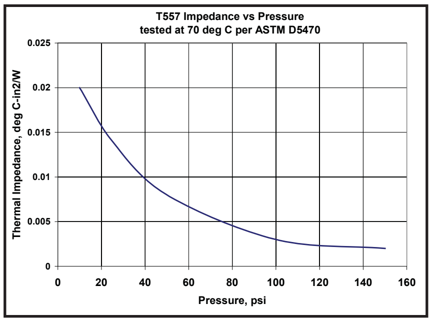


Figure 1b. T557 PCM compressed between two contacting surfaces. As the material softens and deflects, thermal impedence drops.

smooth, the contact plane between a surface and a material can also produce a resistance to the flow of heat. Figure 1a depicts surface irregularities on a micro scale and surface warp on a macro scale. Actual contact occurs at the high points, leaving air-filled voids where the valleys align. Air voids resist the flow of heat and force more of the heat to flow through the contact points. This constriction resistance is referred to as surface contact resistance ($R_{contact}$) and can be a factor at all contacting surfaces.

The thermal impedance [Θ] of a material is defined as the sum of its thermal resistance ($R_{material}$) and any contact resistance ($R_{contact}$) between it and the contacting surfaces as defined in Equation 4.

$$(4) \qquad \Theta = R_{material} + R_{contact}$$

Surface flatness, surface roughness, clamping pressure, material thickness, the presence of pressure sensitive adhesive (PSA) and compressive modulus have a major impact on contact resistance. Because these surface conditions can vary from application to application, thermal impedance of a material will also be application dependent.

Thermal Interface Materials (TIMs)

Heat generated by a semiconductor must be removed to the ambient environment to maintain the junction temperature of the component within safe operating limits. Often this heat removal process involves conduction from a package surface to a heat spreader that can more efficiently transfer the heat to the ambient environment. The spreader has to be carefully joined to the package to minimize the thermal resistance of this newly formed thermal joint.

Attaching a heat spreader to a semiconductor package surface requires that two commercial grade surfaces be brought into intimate contact. These surfaces are usually characterized by a microscopic surface roughness superimposed on a macroscopic non-planarity that can give the surfaces a concave, convex or twisted shape. When two such surfaces are joined, contact occurs only at the high points. The low points form air-filled voids. Typical contact area can consist of more than 90 percent air voids, which represents a significant resistance to heat flow.

Thermally conductive materials are used to eliminate these interstitial air gaps from the interface by conforming to the rough and uneven mating surfaces. Because the TIM has a greater thermal conductivity than the air it replaces, the resistance across the joint decreases, and the component junction temperature will be reduced. A variety of material types have been developed in response to the changing needs of the electronic packaging market. These materials can be categorized as follows:

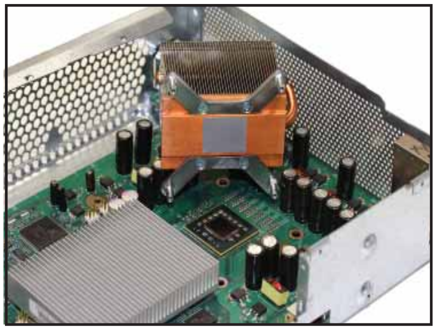
THERMATTACH® Adhesive Tapes

Phase-Change Materials

THERMFLOW® materials are formulated with polymer resins that are loaded with thermally conductive fillers. They combine the high thermal performance of grease with the ease of handling and "peel-and-stick" application of pads. They are used between high performance microprocessors, graphics processors, chipsets and heat sinks.

- Can achieve less than 0.06 °C-in^2/W thermal impedance
- Conform at operating temperature to minimize thermal path thickness
- Excellent surface "wetting" eliminates contact resistance

Phase change materials behave like thermal greases after they reach their melt temperature, typically 45–62°C: their viscosity rapidly diminishes and they flow throughout the thermal joint to fill the gaps that were initially present. This process requires some compressive force, usually a few psi, to bring the two surfaces together and cause the material to flow. This process continues until the two surfaces come into contact at a minimum of three points, or the joint becomes so thin that the viscosity of the material prevents further flow. PCM materials inherently do not provide electrical isolation because they may allow the two surfaces to make contact; however, variations with dielectric films are available. These materials have demonstrated excellent long-term reliability and performance.



THERMFLOW® Phase-Change Materials

Polymer Solder Hybrids

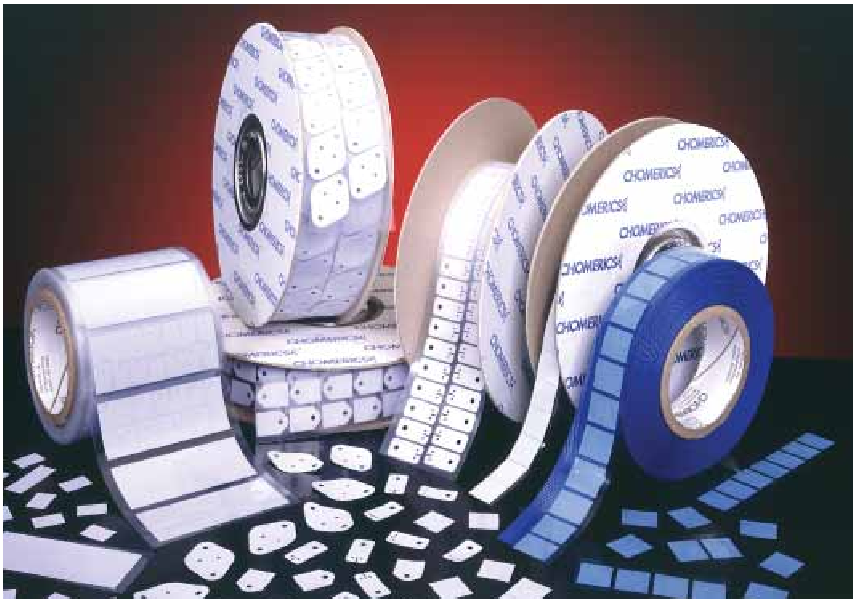
These THERMFLOW® materials incorporate low-melt metal alloy fillers which flow at temperatures around 65°C and provide ultra low thermal impedance, less than 0.1 °C-cm2/W at minimum bond line thickness.

Thermal Tapes

THERMATTACH® tapes are formulated with acrylic or silicone based pressure sensitive adhesive (PSA) loaded with thermally conductive fillers. They are designed to securely bond heat sinks to power dissipating components without an additional clamping mechanism.

- Acrylic based adhesives for metal or ceramic packages
- Silicone based adhesive for bonding plastic packages to heat sinks
- Limited gap filling properties require reasonable surface flatness
- High shear strength at elevated temperatures

Thermal tapes are used primarily for their mechanical adhesive properties, and to a lesser extent for their thermal properties. The thermal conductivity of these tapes is moderate and their thermal performance in an application is dependent on the contact area that can be achieved between the bonding surfaces.



CHO-THERM® Insulator Pads

Gap Fillers

THERM-A-GAP™ gap fillers are a family of low modulus (soft), thermally conductive silicone and non-silicone elastomers for applications where heat must be conducted over a large and variant gap between a semiconductor component and a heat dissipating surface.

- Soft binder provides low modulus for conformability at low pressures
- Low modulus allows materials to make up for large tolerance stack ups
- Low pressure applications

Gap fillers are used to bridge large gaps between hot components and a cold surface. The gaps are not only large, but their tolerances can be ±20 % or greater. This means that the gap filler must have sufficient compliance to fill such spaces without stressing components beyond their safe limits. Non-silicone gap fillers are available for silicone sensitive applications.

Gap fillers are supplied in pad-form over a wide range of thickness, 0.25 to 5mm, and can be molded into complex shapes. THERM-A-GAP GELs are also supplied as pre-cured, single component compounds that can be dispensed over the heat generating component.

These unique gel materials result in much lower mechanical stress on delicate components than even the softest gap-filling pads. They are ideal for filling variable gaps between multiple components and a common heat sink.

Thermal gels are silicone-based formulations that are loaded with conductive fillers and are cross-linked to form a low-modulus paste. They are highly conformable and provide low thermal impedance like greases but are designed to overcome the pump-out and dry-out issues of grease.

Form-In-Place Compounds

THERM-A-FORM™ compounds are reactive, two-component silicone RTVs (room temperature vulcanizing materials) that can be used to form thermal pathways in applications where the distance between a component and a cold surface is highly variable. They are dispensed onto the component and readily conform over complex geometries and then cured in place.

- Low-modulus, ceramic filled compounds
- Fill gaps ranging from 0.005 to 0.25 inch without stressing components
- Can cure at room temperature
- Localized encapsulating of components

Form-in-Place Compounds and THERM-A-GAP Gels

Insulating Pads

CHO-THERM® insulating pads were developed as a user-friendly alternative to greased mica insulators to be used between discrete power devices and heat sinks.

- Silicone binder provides high temperature stability and good electrical insulation properties
- Glass mesh reinforcement provides cut-through resistance
- High mounting pressure required to minimize contact resistance
- U.L. recognized flammability ratings

This class of product is characterized by high thermal conductivity, very high dielectric strength and volume resistivity. Pads must conduct very large heat loads from discrete power semiconductors to heat sinks, while providing long-term electrical insulation between the live component case and the grounded heat sink.

Thermal Greases

Thermal greases are formulated with silicone or hydrocarbon oils that are loaded with conductive fillers. They are viscous liquids that are typically stenciled or screen printed onto the heat spreader or heat sink. Greases have good surface wetting characteristics and flow easily to fill up voids at the interfaces resulting in low thermal impedance even at low application pressure.

Key Properties of Thermal Interface Materials

Thermal Properties

The key properties of interface materials are thermal impedance and thermal conductivity.

Thermal Impedance

This is the measure of the total resistance to the flow of heat from a hot surface through an interface material into a cold surface. Thermal impedance is measured according to the ASTM D5470 test method. Although the current version of this method is specific to high durometer insulating pad materials tested at high clamping forces, the method has been successfully adapted for use with low durometer materials as well as fluid compounds.

Thermal impedance can be measured using ASTM D5470 at several clamping forces to generate a pressure versus thermal impedance plot as shown in Figure 2. This type of data can be used to generate information about the ability of a material to conform to surfaces to minimize contact resistance. Care must be taken with this type of data because contact resistance is also highly influenced by surface characteristics. To minimize the impact of test equipment variations, this type of work is best performed with the same test surfaces for all materials being tested.

Thermal Conductivity

Thermal impedance data measured according to ASTM D5470 can be used to calculate the thermal conductivity of an interface material. Rearranging Equation (3) to give Equation (5)

$$(5)\quad R_{material} = \frac{d}{k}$$

and substituting into Equation (4) yields Equation (6).

$$(6)\quad \Theta = \frac{d}{k} + R_{contact}$$

Equation (6) shows that for a homogeneous material, a plot of thermal impedance [Θ] versus thickness (d) is a straight line whose slope is equal to the inverse of the thermal conductivity and the intercept at zero thickness is the contact resistance shown in Figure 2. Thickness can be varied by either stacking up different layers of the material or by preparing the material at different thicknesses.

Coefficient of Thermal Expansion

CTE is the tendency of a material to change in volume in response to changes in temperature.

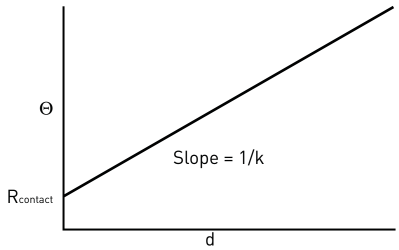


Figure 2. Thermal Impedance vs. Thickness

Heat Capacity

Heat capacity or thermal mass represents the ability of a material to store heat.

Electrical Properties

Voltage Breakdown

This is a measure of how much voltage differential a material can withstand under a specific set of test conditions. This property is usually measured using ASTM D149 where a test specimen is subjected to ramped alternating current voltage such that dielectric failure is reached within twenty seconds after the start of the test. Five specimens are tested and the average voltage breakdown is calculated and reported. The value is an average, not a minimum. Voltage Breakdown can be converted to Dielectric Strength by dividing the voltage breakdown value by the specimen thickness where the dielectric failure occurred. This test is an indication of the ability of a material to withstand high voltages, but does not guarantee how a material will behave over time in a real application. The value is influenced by several factors. Humidity and elevated temperature will reduce the voltage breakdown because absorbed water will degrade the electrical properties of the material.

The size of the test electrode will affect the observed breakdown voltage. A larger test electrode will typically yield a lower breakdown voltage. The presence of partial discharge, as well as mechanical stresses imposed on the interface material, also reduce voltage breakdown.

Volume Resistivity

Volume resistivity is a measure of the bulk electrical resistance of a unit cube of a material. When determined per ASTM D257, volume resistivity can give an indication of how well an interface material can limit leakage current between an active component and its grounded metal heat sink. As with voltage breakdown, volume resistivity can be significantly lowered by humidity and elevated temperature.

Elastomeric Properties

Interface materials exhibit properties typical of highly filled elastomers, namely compression deflection, compression set and stress relaxation.

Compression Deflection

Compression deflection refers to resultant forces a material exerts while being deflected. As a compressive load is applied, the elastomer material is deformed but the volume of the material remains constant. The compression deflection characteristics can vary, depending on part geometry (i.e., thickness and surface area), rate of deflection, size of probe, etc.

Stress Relaxation

When a compressive load is applied to an interface material, there is an initial deflection followed by a slow relaxation process whereby some of the load is relieved. This process continues until the compressive load is balanced by the cohesive strength of the material.

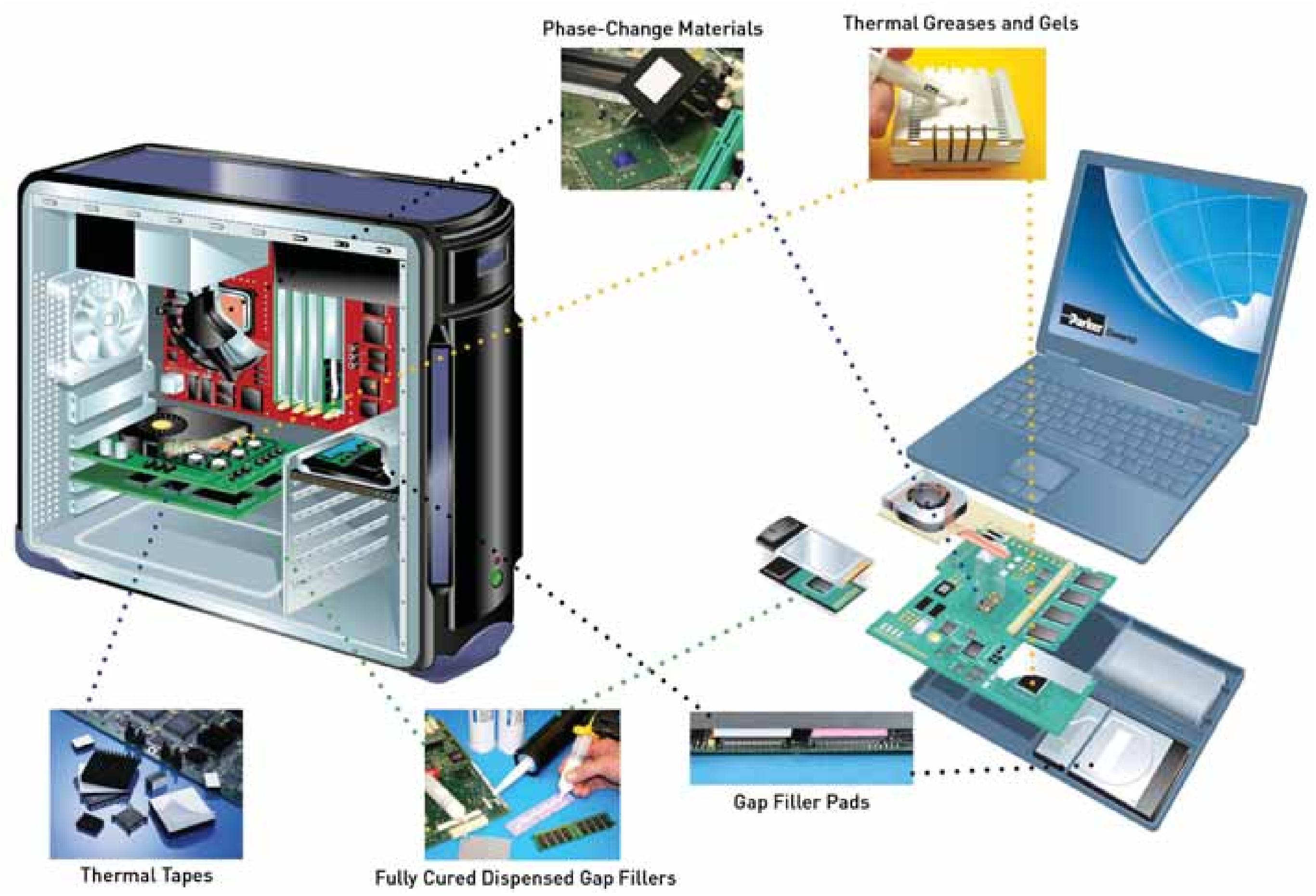
Compression Set

Compression set is the result of stress relaxation. After a material has been subjected to a compressive load for an extended time, part of the deflection becomes permanent and will not be recoverable after the load is reduced.

Thermal Conductivity Conversion Guide

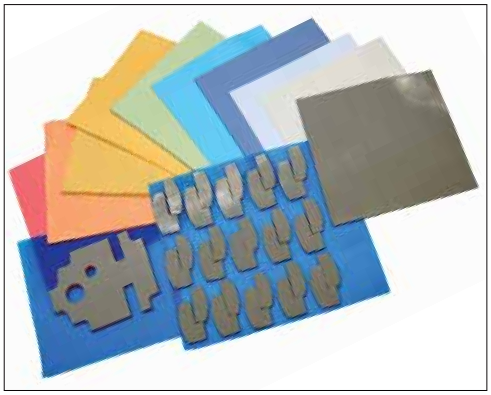
From	Cal / sec-cm-°C		BTU-in / hr-ft²-°F		W / m-K	
Multiplier	4.2×10^{2}	2.9×10^{3}	0.14	3.4×10^{-4}	6.94	2.4×10^{-3}
To	W / m-K	BTU-in / hr-ft²-°F	W / m-K	Cal / sec-cm-°C	BTU-in / hr-ft²-°F	Cal / sec-cm-°C

Thermal Interface Materials (TIMs) for Consumer Electronics and Information Technology



THERM-A-GAP™ HCS10,569,570,579 and 580

Thermally Conductive Gap Filler Pads



Description

THERM-A-GAP™ gap-filler sheets and pads offer excellent thermal properties and highest conformability at low clamping forces.

Features / Benefits

- Ultra low deflection force
- High thermal conductivity
- High tack surface reduces contact resistance
- "A" version offers high strength acrylic PSA for permanent attachment
- UL recognized V-0 flammability
- RoHS compliant

All products are available on aluminum foil "A" or on "clean break" glass "G" fiber carrier. As with all previous Chomerics gap-fillers, the "A" versions have a high strength acrylic pressure sensitive adhesive (PSA) for permanent attachment to the cold surfaces.

THERM-A-GAP™ HCS10, 569, 570, 579 and 580 Thermally Conductive Pads

	Typical Properties	HCS10	569	570	579	580	Test Method
Physical	Color	Orange / Grey Carrier	Grey	Blue	Pink	Yellow	Visual
Physical	Standard Carriers: G = Woven glass - no PSA A = Aluminum foil - with PSA Custom Carriers: PN = PEN film carrier KT = Thermally Enhanced Polyimide Carrier	A or G	A, G or PN	A or G	A, G, PN or KT	A or G	--
Physical	Standard Thicknesses*, inch (mm)	0.010 - 0.200 (0.25 - 5.0)	0.010 - 0.200 (0.25 - 5.0)	0.020 - 0.200 (0.5 - 5.0)	0.010 - 0.200 (0.25 - 5.0)	0.020 - 0.200 (0.5 - 5.0)	ASTM D374
Physical	Specific Gravity	2.0	2.2	2.2	2.9	2.9	ASTM D792
Physical	Hardness, Shore 00	4	10	25	30	45	ASTM D2240
Physical	Percent Deflection @ Various Pressures** (0.125 in thick sample) @ 5 psi (34 kPa) @ 10 psi (69 kPa) @ 25 psi (172 kPa) @ 50 psi (345 kPa)	% Deflected 26 36 59 73	% Deflected 20 30 50 65	% Deflected 10 15 25 35	% Deflected 22 33 55 68	% Deflected 7 10 20 30	ASTM C165 MOD (0.125 in "G" Type, 0.50 in dia. probe, 0.025 in/min rate)
Physical	Operating Temperature Range, °F (°C)	-67 to 392 (-55 to 200)	-67 to 392 (-55 to 200)	-67 to 392 (-55 to 200)	-67 to 392 (-55 to 200)	-67 to 392 (-55 to 200)	--
Thermal	Thermal Conductivity, W/m-K @ 25 psi	1	1.5	1.5	3	3	ASTM D5470
Thermal	Thermal Impedance, °C-in²/W (°C-cm²/W) @ 10 psi, @ 0.04 in. (1mm) thick, "G" version	1.5 (9.7)	1.4 (9.1)	1.4 (9.1)	0.7 (4.5)	0.7 (4.5)	ASTM D5470
Thermal	Heat Capacity, J/g-K	1	1	1	1	1	ASTM E1269
Thermal	Coefficient of Thermal Expansion, ppm/K	N/A	250	250	150	150	ASTM E831
Electrical	Dielectric Strength, V_{AC}/mil (KV_{AC}/mm)	200 (8)	200 (8)	200 (8)	200 (8)	200 (8)	ASTM D149
Electrical	Volume Resistivity, ohm-cm	10^{14}	10^{14}	10^{14}	10^{14}	10^{14}	ASTM D257
Electrical	Dielectric Constant @1,000 kHz	5.3	6.5	6.5	8.0	8.0	ASTM D150
Electrical	Dissipation Factor @ 1,000 kHz	0.013	0.013	0.013	0.010	0.010	Chomerics Test
Regulatory	Flammability Rating (See UL File E140244 for Details)	V-0	V-0	V-0	V-0	V-0	UL 94
Regulatory	RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Chomerics Certification
Regulatory	Outgassing, % TML (% CVCM)	0.44 (0.13)	0.42 (0.08)	0.35 (0.09)	0.19 (0.06)	0.18 (0.05)	ASTM E595
Regulatory	Shelf Life, months from date of shipment G (A)	36 (18)	36 (18)	36 (18)	36 (18)	36 (18)	Chomerics

*Thickness tolerance, in(mm) ±10% nominal thickness @ 0.1in (2.5mm) or less; ± 0.01in (0.25mm) @ nominal thickness greater than 0.1in (2.5mm). Custom thicknesses may be available upon request.
**The typical deflection range is approximately 5-40%
***Laminated polyester film provides low abrasion on one side as well as improved dielectric isolation.

TYPICAL APPLICATIONS

- Telecommunications equipment
- Consumer electronics
- Automotive electronics (ECUs)
- LEDs, lighting
- Power conversion
- Desktop computers, laptops, servers
- Handheld devices
- Memory modules
- Vibration dampening

HANDLING INFORMATION

These products are defined by Chomerics as “articles” according to the following generally recognized regulatory definition for articles:

An article is a manufactured item “formed to a specific shape or design during manufacturing,” which has “end use functions” dependent upon its size and shape during end use and which has generally “no change of chemical composition during its end use.”

In addition:

- There is no known or anticipated exposure to hazardous materials/substances during routine and anticipated use of the product.
- The product’s shape, surface, and design is more relevant than its chemical composition.

These materials are not deemed by Chomerics to require an MSDS. For further questions, please contact Chomerics at 781-935-4850.

With Glass Carrier

HCS10A
With Aluminium PSA Carrier

PRODUCT ATTRIBUTES

HCS10

- Economical solution
- Highest conformability gap filler sheet

569

- Economical combination of thermal performance and conformability

570

- Best for molding complex parts and vibration dampening

579

- Combination of excellent thermal performance and conformability
- Lowest outgassing

580

- Best for molding complex parts and vibration dampening
- Lowest outgassing

Ordering Information

Part Number:

6W — **XX** — **YYYYY** — **ZZZZ**

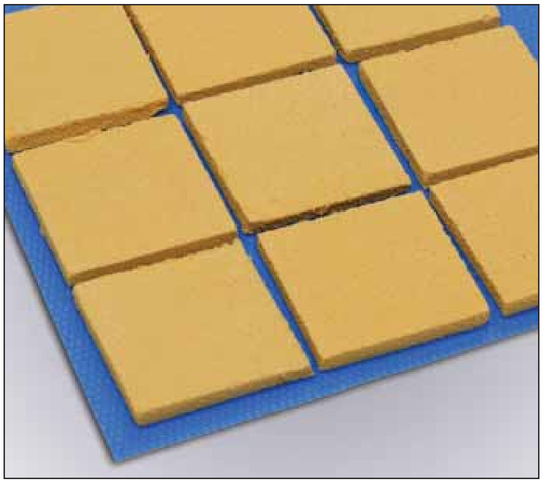
W	XX	YYYYY	ZZZZ
1 = OEM Sheet - No PSA ("G" carrier and HCS10) 2 = OEM Sheet with PSA 1 side ("A" Carrier only)	Material thickness* is in ten mil increments (e.g. 10 = 0.100" or 2.54 mm) (e.g. 02 = 0.020" or 0.50 mm)	**OEM Part Number Examples** 0909 = (9" X 9" Sheet / 22.9 cm X 22.9 cm).	**THERM-A-GAP™ Material Code** **HCS10G & HCS10A** **G569 & A569** **G570 & A570** **G579 & A579** **G580 & A580** (THERM-A-GAP™ 174, 274, 574 and TS15 are legacy products and are available upon special request.)
9 = Custom configuration	11 = Custom, no PSA ("G" carrier and HCS10) 12 = Custom, with PSA 1 side ("A" Carrier only)	**Thermally conductive pads are available in the following formats.** **Distributor Part Numbers** - 18" X 18" Sheets 0.010 in = 28539 0.015 in = 28540** 0.020 in = 20698 0.030 in = 20913 0.040 in = 20684 0.050 in = 27395 0.060 in = 20991 0.070 in = 20685 0.080 in = 21259 0.100 in = 20672 0.120 in = 27102 0.130 in = 20675 0.140 in = 27100 0.150 in = 27101 0.160 in = 20686 0.180 in = 27103 0.200 in = 20687 **Custom configuration** (Please contact Chomerics for a pre-assigned part number, for custom widths, part sizes, etc.)	

* See typical properties table for thicknesses.
** Minimum thickness for G579 material.

Custom die-cut parts on sheets, or as individual parts
“A” version offered die-cut (up to 40 mil) on continuous rolls (higher volumes)
Custom thicknesses available upon request
(up to 1” thick)
Custom molded designs and ribbed sheets

THERM-A-GAP™ 974, G974 and 976

High Thermal Conductivity Gap Filler Pads



Description

THERM-A-GAP™ 97X gap fillers offer the highest thermal conductivity for low to moderate clamping force applications.

Features/Benefits

- High thermal conductivity
- 974 and G974 supplied with PSA for ease of use
- 976 is softer compared to similar high conductivity materials

Typical Applications

- Telecommunications equipment
- Consumer electronics
- Automotive electronics (ECUs)
- LEDs, lighting
- Power conversion
- Power semiconductors

THERM-A-GAP™ 974, G974 and 976 Thermally Conductive Gap Filler Pads

	Typical Properties	974	G974	976	Test Method
Physical	Color	Blue	Blue	Gold	Visual
	Carrier	PSA	Fiberglass with PSA	None	--
	Standard Thicknesses*, in (mm)	0.020 - 0.060 (0.51 - 1.52)	0.010 - 0.100 (0.25 - 2.54)	0.040 - 0.200 (1.00 - 5.08)	ASTM D374
	Specific Gravity	1.40	1.40	1.30	ASTM D792
	Hardness, Shore A	40	40	10	ASTM D2240
	Penetrometer, mm	25	25	60	Chomerics
	Percent Deflection @ Various Pressures (0.060 in thick sample) @ 5 psi (34 kPa) @ 10 psi (69 kPa) @ 25 psi (172 kPa) @ 50 psi (345 kPa)	% Deflected 7 11 12 13	% Deflected 7 11 12 13	% Deflected 6 10 11 45	ASTM C165 MOD (0.060" thick, 0.50 in diameter, 0.025 in/min rate)
Thermal	Thermal Conductivity, W/m-K	6.0	5.0	6.5	ASTM D5470
	Thermal Impedance, °C-in²/W (°C-cm²/W) 50 psi (@ 345 kPa), 0.040 in (1 mm)	0.45 (2.9)	0.51 (3.3)	0.30 (1.9)	ASTM D5470
	Heat Capacity, J/g-K	0.9	0.9	0.9	ASTM E1269
	Coefficient of Thermal Expansion, ppm/°C	100	100	100	ASTM E831
	Operating Temperature Range, °F (°C)	-67 to 392 (-55 to 200)	-67 to 392 (-55 to 200)	-67 to 392 (-55 to 200)	--
Electrical	Dielectric Strength, Vac/mil (KVac/mm)	200 (5.1)	200 (5.1)	200 (5.1)	ASTM D149
	Volume Resistivity, ohm-cm	10^{14}	10^{14}	10^{14}	ASTM D257
	Dielectric Constant @1,000 kHz	3.2	3.2	3.2	ASTM D150
	Dissipation Factor @ 1,000 kHz	< 0.001	< 0.001	< 0.001	Chomerics Test
Regulatory	Flammability Rating (See UL File E140244 for Details)	Not Tested	V-0	V-0	UL 94
	Outgassing, % TML (% CVCM)	0.59 (0.18)	0.59 (0.18)	0.64 (0.21)	ASTM E595
	RoHS Compliant	Yes	Yes	Yes	Chomerics Certification
	Shelf Life, months from date of shipment	12	12	24	Chomerics

*Thickness tolerance, in. (mm) ±10% nominal thickness @ 2.5mm (100 mil) or less;
± 0.25mm (10mil) @ nominal thickness greater than 2.5mm (100 mil). Custom thicknesses may be available upon request.

Product Attributes

974

- Excellent thermal performance
- Acrylic PSA for improved application

G974

- Excellent thermal performance
- Acrylic PSA for improved application
- Fiberglass reinforced for improved tear strength and improved rework capabilities

976

- Superior thermal performance
- Low compression force under pressure
- Minimal stress on components

Material Handling

These products are defined by Chomerics as "articles" according to the following generally recognized regulatory definition for articles:

An article is a manufactured item "formed to a specific shape or design during manufacturing," which has "end use functions" dependent upon its size and shape during end use and which has generally "no change of chemical composition during its end use."

In addition:

- There is no known or anticipated exposure to hazardous materials/substances during routine and anticipated use of the product.
- The product's shape, surface, and design is more relevant than its chemical composition.

These materials are not deemed by Chomerics to require an MSDS. For further questions, please contact Chomerics at 781-935-4850.

Ordering Information

THERM-A-GAP products are available in the following formats.
Contact Chomerics for custom widths, part sizes, etc.

- Full Sheets, 9"x12" to 20"x25"
- Die-cut parts on sheets
- Custom die-cut parts on sheets, or as individual parts

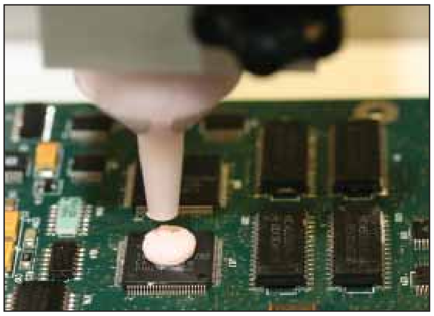
Part Number: 6W — XX — YYYYY — ZZZZ

W	XX	YYYYY	ZZZZ
1 = Sheet - No PSA (976 only) 2 = Sheet with PSA 1 side (974/G974 only)	Material thickness* is in ten mil increments (e.g. 10 = 0.100" or 2.54 mm) (e.g. 02 = 0.020" or 0.50 mm)	0912 = (9" X 12" Sheet / 22.9 cm X 30.5 cm). 2025 = (20" X 25" Sheet / 50.8 cm X 63.5 cm).	ZZZZ = 974, G974, or 976
9 = Custom configuration	11 = Custom, no PSA (976 only) 12 = Custom, with PSA 1 side (974/G974 only)	YYYYY = Custom configuration (Please contact Chomerics for a pre-assigned part number if necessary)	

* See typical properties table for thicknesses.

THERM-A-GAP™ Gels

Dispensable, Very Low Compression Force, Thermal Gap Fillers



Description

THERM-A-GAP™ Gels are highly conformable, pre-cured, single-component compounds. The cross-linked gel structure provides superior long term thermal stability and reliable performance. These unique materials result in much lower mechanical stress on delicate components than even the softest gap-filling sheets. They are ideal for filling variable gaps between multiple components and a common heat sink.

Features / Benefits

- Dispensable
- Fully cured
- Highly conformable at low pressures
- No refrigeration, mixing or filler settling issues in storage
- Single dispensable TIM can eliminate multiple pad part sizes/numbers
- Reworkable

Typical Applications

- Automotive electronic control units (ECUs)
  - Engine control
  - Transmission control
  - Braking/traction control
- Power conversion equipment
- Power supplies and uninterruptible power supplies
- Power semiconductors
- MOSFET arrays with common heat sinks
- Televisions and consumer electronics

THERM-A-GAP™ Dispensed Thermal Gels

	Typical Properties	T630/T630G	T635	T636	Test Method
Physical	Color	White	White	Yellow	Visual
Physical	Flow Rate, cc/min - 30cc taper tip, 0.130" orifice, 90psi (621 kPa)	10	8	8	Chomerics
Physical	Specific Gravity	2.25	1.50	1.20	ASTM D792
Physical	Percent Deflection @ Various Pressures (0.5 psi) (1 psi) (2 psi) (3 psi) (4 psi) (5 psi)	% Deflection -- 36 47 54 59 63	% Deflection -- 13 33 43 50 56	% Deflection -- 6 23 35 43 48	Modified ASTM C165 Dispensed 1.0 cc of material Brought 1" x 1" probe down to 0.100" Test rate 0.025 in/min
Physical	Typical minimum bondline thickness, in (mm)	0.004 (0.10)/ 0.010 (0.25)	0.015 (0.38)	0.015 (0.38)	--
Thermal	Thermal Conductivity, W/m-K	0.7	1.7	2.4	ASTM D5470
Thermal	Heat Capacity, J/g-K	1.1	0.9	0.9	ASTM E1269
Thermal	Coefficient of Thermal Expansion, ppm/K	350	400	400	ASTM E831
Thermal	Operating Temperature Range, °F (°C)	-67 to 392 (-55 to 200)	-67 to 392 (-55 to 200)	-67 to 392 (-55 to 200)	--
Electrical	Dielectric Strength, V_{AC} / mil (KV_{AC}/mm)	200 (8.0)	200 (8.0)	200 (8.0)	ASTM D149
Electrical	Volume Resistivity, ohm-cm	10^{14}	10^{14}	10^{14}	ASTM D257
Electrical	Dielectric Constant @1,000 kHz	5.5	4.0	4.0	ASTM D150
Electrical	Dissipation Factor @ 1,000 kHz	0.010	0.003	0.003	Chomerics
Regulatory	Flammability Rating (See UL File E140244 for Details)	V-0	Not Tested	V-0	UL 94
Regulatory	RoHS Compliant	Yes	Yes	Yes	Chomerics Certification
Regulatory	Outgassing, % TML (%CVCM)	0.55 (0.14)	Not Tested	0.49 (0.18)	ASTM E595
Regulatory	Shelf Life, months from date of manufacture	18	18	18	Chomerics

Product Attributes

T630 / T630G

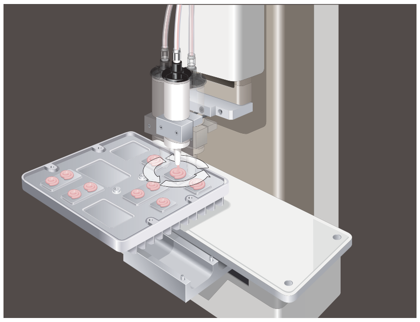
- Years of proven reliability in high-volume automotive applications
- General use material
- Good thermal performance
- Lowest deflection force required
- Minimal stress on components
- "G" version has 0.010" glass beads as compression stops for electrical isolation

T635

- Excellent thermal performance
- Low deflection force required
- Minimal stress on components

T636

- Superior thermal performance
- Solves the toughest heat transfer problems
- Low deflection force required
- Minimal stress on components



Consult Applications Engineering for automated dispensing equipment recommendations

Ordering Information

These materials are available in the following formats. Contact Chomerics for custom packaging sizes, etc.

6W XX YYYYY – ZZZZ

	W	XX	YYYYY	ZZZZ
GELS	5 = Standard Packaging	00	THERM-A-GAP GEL	0030 = 30cc Taper Tip Tube
			T630(G), T635 & T636	0300 = 300cc Aluminum Cartridge (Caulking Style)
	9 = Custom Configuration	11	25177	T630 (G) = 1 Gallon Pail (1125cc, 5Kg)*
			32768	T635 = 1 Gallon Pail (2800cc, 4.2Kg)*
			32769	T636 = 1 Gallon Pail (2800cc, 3.4Kg)*
			Custom Part Number	THERM-A-GAP Gel Material Code T630(G), T635 & T636

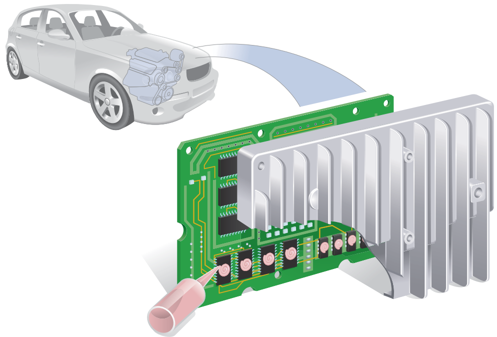
**High volume dispensing equipment required. Please contact Applications Engineering for additional support. Other custom container sizes may be available upon request.*

Dispensing Equipment Options	Optional Supplier	Description
Hand-Gun Pneumatic Dispensing 300cc cartridges	Bergdahl Associates	SEMCO® Model 550
Hand-Gun Pneumatic Dispensing 180cc (6oz) cartridges	Bergdahl Associates	Model 250A-6oz Sealant Gun
http://www.bergdahl.com		
Pneumatic Shot Size Controllers 30cc, 180cc and 300cc Shot Size Dispensing Equipment	EFD	Ultra 2400 Series
		Ultra 1400 Series
		Ultra 870 Series
30cc/55cc Adapter Assembly	EFD	10000D5152
Dispensing Sleeve to support 6oz (180cc) SEMCO Tubes	EFD	5192-6
http://www.efd-inc.com		

SEMCO is a trademark of PPG Aerospace

THERM-A-GAP™ GEL 8010 & GEL 30

High Performance Fully Cured Dispensable GELS



Description

Parker Chomerics fully cured dispensable GELs eliminate timeconsuming hand assembly, decreasing installation costs and reducing customer manufacturing and purchasing (logistical) complexity. These products require no mixing or curing, providing superior design flexibility.

- Provides low thermal impedance at thin and thick gaps, allowing use of common heat spreaders
- Proven reliability in extreme temperature cycling and shock & vibration
- Deflects easily under very low compressive forces, decreasing stress on components thus decreasing component failures.

Typical Applications

- Automotive Electronic Control Units (ECU's)
- Power Supplies & Semiconductors
- Memory & Power Modules
- Microprocessors / Graphics Processors
- Flat Panel Displays & Consumer Electronics

Features/Benefits

- Easily dispensable
- Fully-cured / No pump out
- High bulk thermal conductivity
- Low thermal impedance
- Ultra low compression force
- High tack surface & reworkable
- Proven long-term reliability

	Typical Properties	GEL 8010	GEL 30	Test Method
Physical	Color	White	Pink	Visual
Physical	Flow Rate, grams/min - 30cc syringe with no tip attachment 0.100" orifice, 90psi (621 kPa)	60	20	Chomerics
Physical	Specific Gravity	2.70	3.20	ASTM D792
Physical	Percent Deflection @ Various Force Levels (See graph on following page)	% Deflection	% Deflection	Modified ASTM C165 Dispensed 1.0 cc of material Brought 1" x 1" probe down to 0.100" Test rate 0.025 in/min
Physical	Typical minimum bondline thickness, in (mm)	0.002 (0.05)	0.004 (0.10)	Chomerics
Thermal	Thermal Conductivity, W/m-K	3.0	3.5	ASTM D5470
Thermal	Heat Capacity, J/g-K	1	1	ASTM E1269
Thermal	Coefficient of Thermal Expansion, ppm/K	150	150	ASTM E831
Thermal	Operating Temperature Range, °F (°C)	-67 to 392 (-55 to 200)	-67 to 392 (-55 to 200)	Chomerics
Electrical	Dielectric Strength, Vac / mil (KVac/mm)	200 (8.0)	200 (8.0)	ASTM D149
Electrical	Volume Resistivity, ohm-cm	10^{14}	10^{14}	ASTM D257
Electrical	Dielectric Constant @100 kHz	6.3	7.0	ASTM D150
Electrical	Dissipation Factor @ 100 kHz	0.002	0.002	Chomerics
Regulatory	Flammability Rating	V-0	V-0	UL 94
Regulatory	RoHS Compliant	Yes	Yes	Chomerics Certification
Regulatory	Outgassing, % TML (CVCM)	1.33 (0.34)	0.15 (0.05)	ASTM E595
Regulatory	Shelf Life, months from date of manufacture	18	18	Chomerics

Product Attributes

GEL 8010

- Thin bondline gel (approximately 2-10 mils)
- Low thermal impedance gel
- Stencil printable with no pump out
- Ideal for high-volume dispensing
- Proven long-term reliability

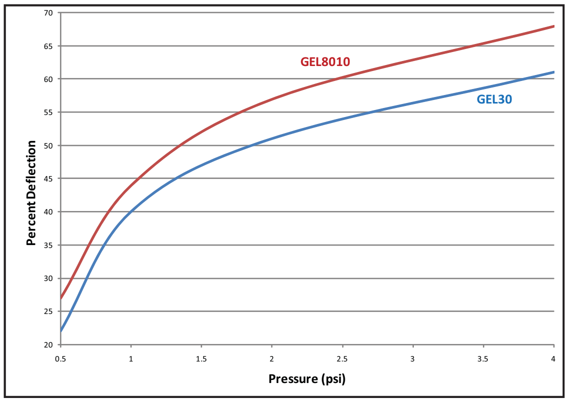
GEL 30

- Accommodates a variety of bond line thicknesses for application to multiple devices
- Gel 30 has been successfully used to fill a variety of different gap thickness. Please reference the Gel 30 Reliability test report for additional details and surface recommendations.
- High Bulk Thermal Conductivity
- Excellent performance-to-price
- Compatible with high volume, automated dispense processes
- Meets Telcordia (Bellcore) silicone specifications

Installation Guidelines

Thermal gels are supplied in plastic syringes and aluminum cartridges. Apply pressure to the rear of the cartridge, simply dispense the desired amount onto components or cooling plates. The gel is reworkable and excess material can be easily wiped off.

Since GEL 8010 gel is conformable, the gel can be stencil printed onto the plates. The thickness of the printed gel can be adjusted depending on the component type and size, but about 6mil thickness is recommended.



Percent Deflection vs. Pressure

Ordering Information

6W — XX — YYYYY — ZZZZ

	W	XX	YYYYY	ZZZZ
GELS	5 = Standard Packaging	00	THERM-A-GAP GEL 8010 & GEL 30	0030 = 30cc Taper Tip Tube
				0300 = 300cc Aluminum Cartridge (Caulking Style)
	9 = Custom Configuration	11	33579	GEL 8010 = 1 Gallon Pail (2800cc, 7.6Kg)*
			28020	GEL 30 = 1 Gallon Pail (2800cc, 9Kg)*
			Custom Part Number	THERM-A-GAP GEL Material Code GEL 8010 & GEL 30

**High volume dispensing equipment required. Please contact Applications Engineering for additional support.*
Other custom container sizes may be available upon request

Dispensing Equipment Options	Optional Supplier	Description
Hand-Gun Pneumatic Dispensing 300cc cartridges	Bergdahl Associates	SEMCO® Model 550
http://www.bergdahl.com		
Pneumatic Shot Size Controllers 30cc, 180cc and 300cc Shot Size Dispensing Equipment	EFD	Ultra 2400 Series
		Ultra 1400 Series
		Ultra 870 Series
30cc/55cc Adapter Assembly	EFD	10000D5152
Dispensing Sleeve to support 6oz (180cc) Semco Tubes	EFD	5192-6
http://www.efd-inc.com		

SEMCO is a trademark of PPG Aerospace

THERMFLOW®

Non-Silicone, Phase-Change Thermal Interface Pads

Completely fills interfacial air gaps and voids for best thermal performance

Description

THERMFLOW® phase-change Thermal Interface Materials (TIMs) completely fill interfacial air gaps and voids. They also displace entrapped air between power dissipating electronic components. Phase-change materials are designed to maximize heat sink performance and improve component reliability.

Upon reaching the required melt temperature, the pad will fully change phase and attain minimum bond-line thickness (MBLT) - less than 0.001 inch or 0.0254mm, and maximum surface wetting. This results in practically no thermal contact resistance due to a very small thermal resitance path.

At room temperature, THERMFLOW materials are solid and easy to handle. This allows them to be consistently and cleanly applied as dry pads to a heat sink or component surface. THERMFLOW material softens as it reaches component operating temperatures. With light clamping pressure it will readily conform to both mating surfaces.

This ability to completely fill air gaps and voids typical of component packages and heat sinks allows THERMFLOW pads to achieve performance superior to any other thermal interface materials.

Standard THERMFLOW products are electrically non-conductive however metal-to-metal contact is possible after the material undergoes phase-change, decreasing their electrical isolation properties. PC07DM-7 is the only phase-change materials recommended for use as a dielectric insulator.

Chomerics offers two types of phase change materials—traditional thermal interface pads and Dual Phase Change Polymer Solder Hybrids.

Dual Phase Change Polymer Solder Hybrid Materials

Dual Phase Change Thermal Interface Materials consist of binder and fillers which both phase-change to exhibit the lowest thermal impedance of the phase-change family.

These Thermal Interface Materials provide superior long term reliability performance.

For optimum performance, the pads must be exposed to temperatures above 64°C during operation or by a burn-in cycle to achieve lowest thermal impedance and highest thermal performance.

Features/Benefits

- Low thermal impedance
- Proven solution – years of production use in personal computer OEM applications
- Demonstrated reliability through thermal cycling and accelerated age testing
- Can be pre-applied to heat sinks
- Protective release liner prevents contamination of material prior to final component assembly
- Tabs available for easy removal of release liner (T710, T725*, T557, T777, PCO7DM)
  * T725 is only offered with a tab
- Available in custom die-cut shapes, kiss-cut on rolls
- RoHS Compliant

Typical Applications

- Microprocessors
- Graphics Processors
- Chipsets
- Memory Modules
- Power Modules
- Power Semiconductors

Handling Information

These products are defined by Chomerics as "articles" according to the following generally recognized regulatory definition for articles:

An article is a manufactured item "formed to a specific shape or design during manufacturing," which has "end use functions" dependent upon its size and shape during end use and which has generally "no change of chemical composition during its end use."

In addition:

- There is no known or anticipated exposure to hazardous materials/substances during routine and anticipated use of the product.
- The product's shape, surface, and design is more relevant than its chemical composition.

These materials are not deemed by Chomerics to require an MSDS. For further questions, please contact Chomerics at 781-935-4850.

Application

Material may flow when oriented vertically, especially at higher temperatures. This does not affect thermal performance, but should be considered if appearance is important.

Clean Up

THERMFLOW material can be removed with solvens such a toluene, MEK or isopropyl alcohol.

THERMFLOW® Non-Silicone, Phase-Change Thermal Interface Pads

	Typical Properties	PC07DM-7	T710 with PSA	T725	T766 / T766-06	T557	T558	T777	Test Method
Physical	Color	Pink	Light gray / off-white	Pink	Purple / Gray foil	Gray	Gray / Gray foil	Gray	Visual
Physical	Carrier	1 mil polyester	2 mil Fiberglass	None - Free Film	1 mil Metal Foil	None - Free film	1 mil Metal Foil	None - Free film	--
Physical	Standard Thicknesses, in (mm)	0.007 (0.178)	0.0055 (0.138)	0.005 (0.125)	0.0035 (0.088) 0.006 (0.152)	0.005 (0.125)	0.0045 (0.115)	0.0045 (0.115)	ASTM D374
Physical	Specific Gravity	1.1	1.15	1.1	2.6	2.4	3.65	1.95	ASTM D792
Physical	Phase Transition Temperature, °C	55	45	55	55	45 / 62***	45 / 62***	45 / 62***	ASTM D3418
Physical	Weight Loss, 125°C for 48 Hours	<0.5%	<0.5%	<0.5%	<0.5%	<0.5%	<0.5%	<0.5%	--
Thermal	Thermal Impedance @ 70°C, °C-in²/W (°C-cm²/W)	Minimum Bond-line Thickness	Minimum Bond-line Thickness @ 50°C	2.9 mil	Minimum Bond-line Thickness	Minimum Bond-line Thickness	Minimum Bond-line Thickness	Minimum Bond-line Thickness	--
Thermal	@ 10 psi (69 kPa) @ 25 psi (172 kPa) @ 50 psi (345 kPa)	0.35 (2.2) 0.30 (1.93) 0.28 (1.81)	0.23 (1.48) 0.16 (1.03) 0.12 (0.77)	0.11 (0.71) 0.06 (0.39) 0.04 (0.26)	0.15 (0.97) 0.09 (0.58) 0.06 (0.39)	0.02 (0.13) 0.015 (0.097) 0.008 (0.052)	0.03 (0.19) 0.013 (0.084) 0.0097 (0.06)	0.02 (0.13) 0.015 (0.097) 0.0055 (0.035)	ASTM D5470
Thermal	Operating Temperature Range, °F (°C)	-67 to 257 (-55 to 125)	-67 to 257 (-55 to 125)	-67 to 257 (-55 to 125)	-67 to 257 (-55 to 125)	-67 to 257 (-55 to 125)	-67 to 257 (-55 to 125)	-67 to 257 (-55 to 125)	--
Electrical	Volume Resistivity, ohm-cm	10^{14}	10^{14}	10^{14}	10^{14} Metal Foil*	Nonconductive **	Nonconductive** / Metal Foil*	Nonconductive**	ASTM D257
Electrical	Voltage Breakdown (kVac)	5	N/A	N/A	N/A	N/A	N/A	N/A	ASTM D149
Regulatory	Flammability Rating	Not Tested	Not Tested	V-0	Not Tested	Not Tested	Not Tested	V-0	UL 94
Regulatory	RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Chomerics Certification
Regulatory	Shelf Life, months from date of shipment	12	12	12	12	12	12	12	Chomerics

*Phase-change material exhibits 10^{14} ohm-cm volume resistivity. Metal foil is electrically conductive.

**The phase-change material is electrically non-conductive. However, as it contains dispersed solder for enhanced thermal properties, it can exhibit through-conductivity at thinner bond line thickness (approximately <2 mils). It should not be used as an electrical insulator.

*** The lower phase-transition temperature is for the polymer. The higher value is for the low melting alloy filler.

TRADITIONAL PHASE CHANGE MATERIALS (PCM)

PC07DM-7

- Utilizes proven T725 phase-change material
- Polyester dielectric layer offers excellent mechanical and electrical insulation properties
- Inherently tacky – no adhesive required
- Good thermal properties
- Tabs available for easy removal

T710

- General use material
- Good thermal performance
- Low deflection force required
- Fiberglass provides dielectric standoff
- Only available with adhesive
- Tabs available for easy removal

T725

- Excellent thermal performance
- Inherently tacky – no adhesive required
- Ideal for vertical applications
- Sticky nature limits flowing in vertical applications
- Tabs available for easy removal

T766

- Excellent thermal performance
- Protective foil eliminates top liner
- Inherently tacky – no adhesive required
- Sticky nature limits flowing in vertical applications
- Also available at 0.006" thick

POLYMER SOLDER HYBRID MATERIALS (PSH)

T557

- Superior thermal performance
- For attachment remove white release liner first
- Dispersed solder filler offers added thermal performance
- Resin system designed for higher temperature reliability
- Inherently tacky – no adhesive required
- Tabs available for easy removal

T558

- Superior thermal performance
- Conformal foil allows clean break/rework and eliminates top liner
- Dispersed solder filler offers added thermal performance
- Resin system designed for higher temperature reliability
- Inherently tacky – no adhesive required

T777

- Superior thermal performance
- Ideal solution for mobile microprocessors
- Dispersed solder filler offers added thermal performance
- Resin system designed for higher temperature reliability
- Inherently tacky – no adhesive required
- Tabs available for easy removal

Ordering Information

THERMFLOW materials are supplied in several standard formats (see part number guide below).

Custom die-cut shapes can also be provided on kiss-cut rolls by Chomerics' extensive network of distributor/ fabricators. To ease release liner removal, an optional tab can be added.

Standard tolerances for slitting widths and individually cut pieces are ±0.020 inch (±0.51 mm).

Part Number:

6W – XX – YYYY – ZZZZ

6W	XX	YYYY	ZZZZ
4 = Roll stock	10 = 100 ft. 40 = 400 ft. XX = Custom length	YYYY =Roll stock width: Examples 0100 = 1" 0750 = 7.5" 2400 = 24"	ZZZZ = Material class (T710, T725, T766, T557, T558, T777, PC07DM-7)
6 = Roll stock with PSA (T710 only)			
9 = Custom die-cut part	11 = without PSA 12 = with PSA one side (T710 Only)	Custom Part Number. Contact Chomerics	

Parker Chomerics

THERMATTACH® Double-Sided Thermal Tapes
Thermally Conductive Attachment Tapes

Description

THERMATTACH® double-sided thermal interface tapes provide exceptional bonding properties between electronic components and heat sinks, eliminating the need for mechanical fasteners.

THERMATTACH® tapes are proven to offer excellent reliability when exposed to thermal, mechanical, and environmental conditioning. They are offered in a variety of configurations, as detailed in the typical properties table.

Features / Benefits

- Offered in various forms to provide thermal, dielectric, and flame retardant properties
- Offered in custom die-cut configurations to suit a variety of applications
- Eliminates the need for mechanical attachment (i.e. screws, clips, rivets, fasteners)
- Proven reliability under various mechanical, thermal, and environmental stresses
- Embossed version available
- UL recognized V-0 flammability
- Meets RoHS specifications
- No curing required, unlike epoxy or acrylic preforms or liquid systems
- Easily reworkable

Typical Applications

- Mount heat sinks to components dissipating < ~25 W
- Attach heat sinks to PC (esp. graphics) processors
- Heat sink attachment to motor control processors
- Telecommunication infrastructure components

Product Attributes

T418

- Superior adhesive strength
- Best conformability to components
- UL94 V-0 rated
- Good thermal performance

T412

- Good adhesion
- Superior thermal performance
- General use tape with added thermal conductivity of Al foil layer

T411

- Designed for adhesion to plastic packages
- Attaches to low surface energy packages
- UL94 V-0 rated

T404/T414

- Excellent dielectric strength due to polyimide carrier
- Good thermal performance
- UL94 V-0 rated

T405

- General use tape with added thermal conductivity of Al foil layer
- Excellent thermal performance
- UL94 V-0 rated

Thermally Conductive Attachment Tapes

	Typical Properties	T418	T412	T404 / T414	T405 / T405-R	T411	Method
Physical	Recommended for Plastic Component Attachment	No	No	No	No	Yes	--
	Color	Light Yellow	Gray	Beige	White	Clear / Metallic	--
	Embossed	Optional	Standard	Standard	Standard	No	--
	Reinforcement Carrier	Fiberglass	Aluminum Mesh	Filled Polyimide	Aluminum	Aluminum Mesh	Visual
	Thickness, inch (mm)	0.010 (0.25)	0.009 (0.23)	0.005 (0.127)	0.006 (0.15)	0.010 (0.25)	ASTM D374
	Thickness Tolerance, inch (mm)	± 0.001 (0.025)	± 0.001 (0.025)	± 0.001 (0.025)	± 0.001 (0.025)	± 0.001 (0.025)	--
	Adhesive CTE, ppm/°F	300	300	300	300	400	ASTM D3386
	Glass Transition Temperature Range °F (°C)	-4 (-20)	-22 (-30)	-22 (-30)	-22 (-30)	-58 (-50)	ASTM D1356
	Operating Temperature Range, °F (°C)	-22 to +257 (-30 to + 125)	-22 to +257 (-30 to + 125)	-22 to +257 (-30 to + 125)	-22 to +257 (-30 to + 125)	-58 to +302 (-50 to +150)	--
Thermal	Thermal Impedance °C-in^2 / W (°C-cm^2/W) @ 300psi	1.2 (7.7)	0.30 (2.0)	0.6 (3.7)	0.5 (3.4)	1.0 (6.5)	ASTM D5470
	Thermal Conductivity W/m-K	0.5	1.4	0.4	0.5	0.5	ASTM D5470
Electrical	Voltage Breakdown (kVac)	5	N/A	5	N/A	NA	ASTM D149
	Volume Resistivity, (ohm-cm)	1.0 X 10^{13}	1.0 X 10^{2}	3.0 X 10^{14}	N/A	NA	ASTM D257
Mechanical / Adhesion	Lap Shear Al-Al @25°C, psi (kPa)	150 (1,034)	70 (480)	100 (689)	100 (689)	40 (270)	ASTM D1002
	90° Peel Adhesion to 0.002" aluminum foil, lbf /in (N/cm)	4.0 (6.9)	1.0 (1.76)	1.5 (2.6)	1.5 (2.6)	2.0 (3.5)	ASTM D1000
	Die Shear Adhesion after 400 psi attachment, psi (kPa) – 2 hour sample dwell time 77°F (25°C)	150 (1,034)	135 (931)	130 (897)	125 (862)	110 (759)	Chomerics # 54
	Creep Adhesion, days 77°F (15°C) 302°F (125°C)	>50 >10	>50 >10	>50 >10	>50 >10	>50 >10	PSTC-7
Regulatory	Flammability Rating (See UL File E140244)	V-0	Not Tested	V-0	V-0	V-0	UL94
	RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Chomerics Certification
	Shelf-Life, months from shipment	12	12	12	12	12	Chomerics
	Outgassing, % TML (% CVCM)	Not Tested	0.14 (0.00)	0.56 (0.02)	0.25 (0.01)	Not Tested	ASTM E595

Ordering Information

**These attachment tapes are available in the following formats.
Contact Chomerics for custom widths, part sizes, etc.**

Sheets form, roll form, or die-cut parts. Offered on continuous rolls.
A general ordering information table is included below for reference.

Part Number: 6W — XX — YYYY — ZZZZ

<table>
<tr><th>6W</th><th>XX</th><th>YYYY</th><th>ZZZZ</th></tr>
<tr><td>W = 0 (Standard Part)</td><td>XX = 13 for PSA two sides</td><td>YYYY = 4 digit alpha/numeric part number. Contact Chomerics.</td><td rowspan="3">Material Type
ZZZZ =
T405
T405-R
T411
T412
T418</td></tr>
<tr><td>W = 7 (Roll of material)</td><td>XX = 10 (100 foot roll)
XX = 40 (400 foot roll)</td><td>YYYY = 0750 for 7.5" wide
YYYY = 1150 for 11.5" wide
YYYY = 2400 for 24" wide
For T404/T414 Only:
YYYY= 0600 for 6"wide
YYYY= 0900 for 9" wide
YYYY= 1900 for 19" wide*</td></tr>
<tr><td>W = 9 (Custom part)</td><td>XX = 13 for PSA two sides</td><td>YYYYY = Custom Part Number. Contact Chomerics</td></tr>
</table>

* for T404/T414 only

Handling Information

These products are defined by Chomerics as "articles" according to the following generally recognized regulatory definition for articles:

An article is a manufactured item "formed to a specific shape or design during manufacturing," which has "end use functions" dependent upon its size and shape during end use and which has generally "no change of chemical composition during its end use."

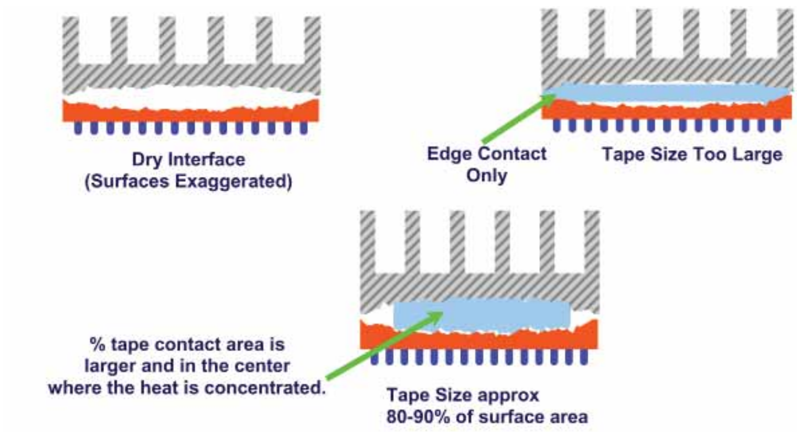
In addition:

- There is no known or anticipated exposure to hazardous materials/substances during routine and anticipated use of the product.
- The product's shape, surface, and design is more relevant than its chemical composition.

These materials are not deemed by Chomerics to require an MSDS. For further questions, please contact Chomerics at 781-935-4850.

Materials Needed

- Clean lint-free cloth rag
- Industrial solvent
- Rubber gloves



For optimal performance, Chomerics recommends interface flatness of 0.001 in/in (0.025 mm/25 mm) to 0.002 in/in (0.050 mm/25 mm) maximum.

Step 1: Ensure that bonding surfaces are free from oil, dust, or any contamination that may affect bonding. Using rubber gloves, wipe surfaces with a cloth dampened with industrial solvents such as MEK, toluene, acetone or isopropyl alcohol.

Step 2: Cut tape to size* and remove a liner or remove pre-cut tape from roll.

*Note: Due to variations in heat sink surfaces, Chomerics' data indicates that it sometimes is beneficial to be cut slightly smaller than the area of the heat sink. See illustration.

Step 3: Apply to center of heat sink bonding area and smooth over entire surface using moderate hand pressure / rubbing motion. A roller may be useful to help smooth the part to the surface by rolling from the center out to beyond the edges of the part. This ensures optimal contact between tape and heat sink.

Step 4: Center heat sink onto component and apply using any one of the recommended temperature/ pressure options:

> **Minimum:** 10 psi at room temperature for 15 seconds
>
> **PREFERRED:** 30 psi at room temperature for 5 seconds

More pressure equals better wetting out of the adhesive to the contact surfaces. A twisting motion during assembly of the substrates will typically improve wetting.

Note that typically 70% of the ultimate adhesive bond strength is achieved with initial application, and 80-90% is reached within 15 minutes. Ultimate adhesive strength is achieved within 36 hours; however the next manufacturing step can typically occur immediately following the initial application.

Removal Instructions

Materials needed: Single-edged razor blade or a small, thin-bladed pocketknife; soft, thin metal spatula. Use safety precautions when handling sharp instruments and organic solvents.

Step 1: Carefully insert the blade edge into the bond line at a corner between the heat sink and the component. The penetration need not be very deep.

Step 2: Remove the blade and insert the spatula into the wedge. Slowly twist the spatula blade so that it exerts a slight upward pressure.

Step 3: As the two surfaces start to separate, move the spatula blade deeper into the bond line and continue the twisting motion and upward force.

Step 4: After the two components are separated, the tape can be removed and discarded. If adhesive remains on the component surfaces, it must be removed. Wipe with a clean rag (lint-free) dabbed with MEK, toluene, or isopropyl alcohol. Use sufficient solvent to remove all adhesive.

Step 5: Solvent cleaned components must be verified 100% free of cleaning solvent prior to reattachment of adhesive.

Relative Thermal Performance

Thermally Conductive Attachment Tapes						
	Typical Properties	T418	T412	T404 / T414	T405 / T405-R	T411
Performance*	Ceramic Attachment	5	3	4	4	4
	Metal Attachment	5	3	4	4	4
	Plastic Attachment	N/R	N/R	N/R	N/R	5
	Dielectric Performance	3	N/R	5	N/R	N/R
	Thermal Performance	2	5	3	4	2

* Performance rated on a scale of 1-5, 5 being the best. N/R = Not Recommended.

THERM-A-FORM™ T64x and 164x Series

Cure-in-Place Potting and Underfill Materials

Description

THERM-A-FORM™ thermally conductive silicone elastomer products are dispensable form-in-place compounds designed for heat transfer without excessive compressive force in electronics cooling applications. These versatile liquid reactive materials can be dispensed and then cured into complex geometries for cooling of multi-height components on a PCB without the expense of a molded sheet. Each compound is available in ready-to-use cartridge systems, eliminating weighing, mixing, and degassing procedures.

THERM-A-FORM™ Cure-in-Place Potting and Underfill Materials

	Typical Properties	T647	T646	T644	T642	1642	1641	Test Method
Physical	Color	Gray	Yellow	Pink	Blue	Blue	White	Visual
	Binder	Silicone	Silicone	Silicone	Silicone	Silicone	Silicone	--
	Filler	Aluminum Oxide	Aluminum Oxide	Boron Nitride	Boron Nitride	Aluminum Oxide	Aluminum Oxide	--
	Number of Components	2-part	2-part	2-part	2-part	2-part	1-part	--
	Mix Ratio	1 : 1	1 : 1	1 : 1	10 : 1	100 : 3	N/A	--
	Specific Gravity	2.80	2.45	1.45	1.50	2.30	2.10	ASTM D792
	Hardness, Shore A	25	50	15	70	76	56	ASTM D2240
	Viscosity, poise	> 5000	> 5000	3000	2500	2500	3000	ASTM D2196
	Pot Life, minutes	300	300	360	60	60	30	Time to 2X Starting Viscosity at 23 °C
	Cure Cycles	3 min. @ 150 °C 60 min. @ 60 °C 48 hrs. @ 23 °C	3 min. @ 150 °C 60 min. @ 60 °C 48 hrs. @ 23 °C	3 min. @ 150 °C 60 min. @ 60 °C 72 hrs. @ 23 °C	3 min. @ 150 °C 30 min. @ 70 °C 48 hrs. @ 23 °C	60 min. @ 100 °C 4 hrs. @ 65 °C 1 week @ 23 °C	48 hrs. @ 23 °C @ 50% RH	Chomerics
	Brittle Point, °F (°C)	-67 (-55)	-67 (-55)	-67 (-55)	-67 (-55)	-103 (-75)	-103 (-75)	ASTM D2137
	Extractable Silicone, %	4	8.5	15	1 - 2	Not Tested	Not Tested	Chomerics
Thermal	Thermal Conductivity, W/m-K	3.00	0.90	1.20	1.20	0.95	0.90	ASTM D5470
	Heat Capacity, J/g-K	0.9	1.0	1.0	1.0	1.0	1.0	ASTM E1269
	Coefficient of Thermal Expansion, ppm/K	150	250	300	300	200	150	ASTM E831
	Operating Temperature Range, °F (°C)	-58 to 302 (-50 to 150)	-58 to 302 (-50 to 150)	-58 to 302 (-50 to 150)	-58 to 302 (-50 to 150)	-94 to 392 (-70 to 200)	-94 to 392 (-70 to 200)	--
Electrical	Dielectric Strength, KVac/mm (Vac / mil)	10 (250)	10 (250)	20 (500)	20 (500)	20 (500)	20 (500)	ASTM D149
	Volume Resistivity, ohm-cm	1.0×10^{14}	1.0×10^{14}	1.0×10^{13}	1.0×10^{13}	1.0×10^{13}	1.0×10^{13}	ASTM D257
	Dielectric Constant @1,000 kHz	8	6.5	4.0	4.0	3.9	3.9	ASTM D150
	Dissipation Factor @ 1,000 kHz	0.010	0.013	0.001	0.001	0.010	0.010	Chomerics
Regulatory	Flammability Rating (See UL File E140244)	UL 94-V0	UL 94-V0	Not Tested	Not Tested	Not Tested	Not Tested	UL 94
	RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Chomerics Certification
	Outgassing, % TML (%CVCM)	Not Tested	0.17 (0.10)	0.39 (0.29)	0.32 (0.21)	0.40 (0.18)	Not Tested	ASTM E595
	Shelf Life, months from date of manufacture	3	3	3	3	12	6	Chomerics

Features / Benefits

- Dispensable form-in-place gap filling, potting, sealing, and encapsulating
- Excellent blend of high thermal conductivity, flexibility, and ease of use
- Conformable to irregular shapes without excessive force on components
- Ready-to-use cartridge system eliminates weighing, mixing, and de-gassing steps
- Variety of kit sizes and configurations available to suit any application (handheld twin-barrel cartridges, Semco® tubes, and pneumatic applicators)
- Vibration damping

Product Attributes

1641

- One-component moisture-cure RTV, supplied with primer 1086 (primer is not required for cure but promotes adhesion)
- Non-acetic acid generating

1642

- General duty, economical thermal solution
- Two-component thermally conductive encapsulant/sealant/caulk/potting compound, supplied with primer 1087. (primer is not required for cure but promotes adhesion)

T642

- High thermal performance with flexibility
- Ideal for underfilling
- Low outgassing

T644

- Very low modulus material for transferring heat from fragile electronic components

T646

- Provides combination of high thermal performance and low cost

T647

- Superior thermal performance while maintaining low modulus
- Flows into complex geometries to maintain intimate contact with components

Application Instructions

35cc and 45cc Kits (See Figure 1)

Push safety latch (A) upward. Insert the pushrod (B) into the applicator with the pushrod gear teeth facing downward. Insert the cartridge (C) into the slots on top of the applicator. Push the retainer clamp (D) down firmly to lock the cartridge in place. Remove the cartridge cap (E) with a 1/4 turn counter-clockwise. Attach the static mixer (F) to the cartridge. (For the 10:1 cartridge, make certain that the small notch on the mixer tube face is toward the large barrel containing Part A.) Turn the mixer tube 1/4 turn clockwise to lock it in place. Cut the tip of the mixing nozzle to obtain the desired bead size, or attach a needle with the Luer adapter. After use, discard the static mixer and replace the cap on any remaining material.

Ordering Information

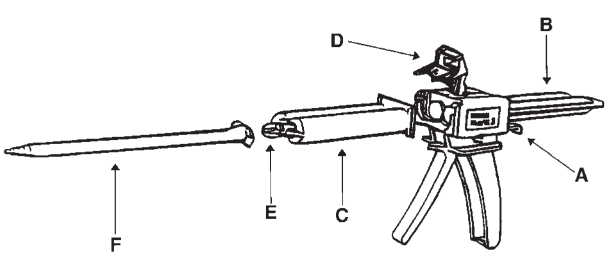


Figure 1: Typical Applicator

Product	Part Number	Volume (mass)	Description
1641	65-00-1641-0000	2.5 fluid ounces (70 grams)	1-Component squeeze tube
	65-01-1641-0000	12 fluid ounces (340 grams)	1-Component SEMCO® cartridge
1642	65-00-1642-0000	277 grams (approx 120 cc)	1-Pint Plastic jar A / vial of B
T642	65-00-T642-0035	35 cc (53 grams)	10:1 Dual element Cartridge
	65-00-T642-0250	250 cc (372 grams)	
T644	65-00-T644-0045	45 cc (68 grams)	1:1 Dual element Cartridge
	65-00-T644-0200	200 cc (300 grams)	
T646	65-00-T646-0045	45 cc (115 grams)	
	65-00-T646-0200	200 cc (507 grams)	
T647	65-00-T647-0045	45 cc (125 grams)	
	65-00-T647-0200	200 cc (560 grams)	

Mixpac® Dispensing Systems are available from multiple sources. When contacting Mixpac® equipment suppliers, reference cartridge volume (cc) and dual element cartridge A:B mix ratio. Refer to table for volume and mix ratio information.

MIXPAC is a trademark of ConProTec, Inc.
SEMCO is a trademark of PPG Aerospace.

THERMAL GREASES

High-Performance and General Duty Thermal Greases

Description

Chomerics thermal greases offer a range of performance covering the simplest to the most demanding thermal requirements. These materials are screened, stenciled or dispensed and require virtually no compressive force to conform under typical assembly pressures.

The excellent surface wetting results in low interfacial resistance.

- **T670** is offered with a very high bulk thermal conductivity of 3 W/m-K. Product offers low impedance as it will achieve a thin bondline of about 0.001 in.
- **T660** contains solder fillers for extremely low thermal impedance at thinner bondline thicknesses (down to about 0.001in.).
- **T650** is a general duty grease for typical applications.

Features/Benefits

- Silicone based materials conduct heat between a hot component and a heat sink or enclosure
- Fills interface variable tolerances in electronics assemblies and heat sink applications
- Dispensable, highly conformable materials require no cure cycle, mixing or refrigeration
- Thermally stable and require virtually no compressive force to deform under typical assembly pressures
- Supports high power applications requiring material with minimum bond line thickness and high conductivity
- Ideal for rework and field repair situations

Thermal Greases

	Typical Properties	T650	T660	T670	Test Method
Physical	Color	Pale Blue	Light Gray	White	Visual
	Specific Gravity	2.3	2.4	2.6	ASTM D792
	Viscosity, cps	190,000	170,000	350,000	NA
	Operating Temperature Range, °F (°C)	-58 to 392 (-50 to +200)	-58 to 392 (-50 to +200)	-58 to 392 (-50 to +200)	NA
	Phase Transition Temperature, °F (°C)	N/A	144 (62)	N/A	ASTM D3418
	Weight Loss % @150°C, 48 Hours	0.21	0.17	< 0.2	TGA
Thermal	Thermal Conductivity, W/m-K	0.8	0.9	3.0	ASTM D5470
	Thermal Impedance,°C-in^2/W (°C-cm^2/W) @ 100 psi	0.02 (0.13) @ 50°C 0.02 (0.13) @ 65°C	0.02 (0.13) @ 50°C 0.009 (0.06) @ 65°C	0.01 (0.07) @ 50°C 0.01 (0.07) @ 65°C	ASTM D5470
	Heat Capacity, J/g-K	1	1	1	ASTM E1269
	Coefficient of Thermal Expansion, ppm/K	300	300	150	ASTM E831
Electrical	Volume Resistivity, ohm-cm	10^{14}	N/A	10^{14}	ASTM D257
	Voltage Breakdown Vac/mil	150*	N/A*	150*	ASTM D149
Regulatory	Flammability Rating	Not Tested	Not Tested	Not Tested	UL 94
	RoHS Compliant	Yes	Yes	Yes	Chomerics Certification
	Outgassing, % TML	0.21	0.17	<0.2	ASTM E595
	Shelf Life, months from date of manufacture**	12	12	12	Chomerics

*Not recommended for dielectric applications.
** Material may settle during storage, remixing may be required

Thermal Greases

Typical Applications

- Mobile, desktop, server CPUs
- Engine and transmission control modules
- Memory modules
- Power conversion equipment
- Power supplies and UPS
- Power semiconductors

Product Attributes

T670 Highest Thermal Performance

- High bulk thermal conductivity
- Extremely low thermal impedance at thin and thick bondline thicknesses
- Stencil screen printed part application

T660 High Performance

- Dispersed solder spheres for high performance applications above 62°C
- Excellent thin bondline performance (less than 0.002 - 0.003 in)

T650 General Duty

- Used on general purpose applications

Material Application

T650

Material is supplied in various syringe or bulk packaging (see ordering information) for dispensing onto components or heat sinks. Excess material can be wiped with a clean cloth and suitable solvent.

T660

Packaging the same as T650.
For optimum performance, the processor should be allowed to reach temperatures greater than 65ºC (149°F). This causes the solder fillers to melt and conform to the mating surfaces, obtaining a minimum bondline thickness at the interface. This process only needs to occur one time to achieve optimum thermal performance of the grease.

T670

T670 high performance thermal grease is supplied in easy access metal cans or pails. Mix with a spatula and remove the desired amount onto the component or stencil screen. Stencil desired pad part size onto heat sink for immediate assembly or shipping.

Ordering Information

Part Number Examples
65-00-T650-0160 = T650 Material in a 160 cc (8 ounce container)

65-00-T670-3790 = T670 Material in a 3790 cc (gallon pail)

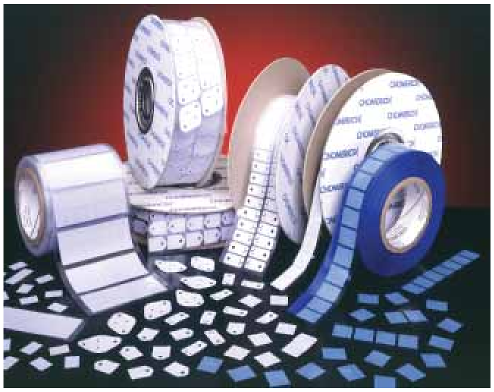
Part Number:

65 — 00 — YYYY — ZZZZ

YYYY = Material (T670, T660 , or T650)	ZZZZ = Volume in cc -0080 = 80 cc in 8 ounce container -0160 = 160 cc in 8 ounce container -3790 = 1 gallon pail

CHO-THERM®

Commercial Grade Thermally Conductive Electrical Insulator Pads



Description

CHO-THERM® Commercial Grade Thermal Insulator Pads are designed for use where solid thermal and electrical properties are required at an economical price. These products are offered as dry pads, or with an optional adhesive (PSA) layer for attachment. Materials with PSA are available die-cut on continuous rolls. Versions are offered with either polyimide or fiberglass reinforcement to protect pads against tear, cut-through and punctures.

Features / Benefits

- Good thermal properties
- Good to excellent dielectric strength
- Excellent mechanical strength and puncture resistance
- Available with and without acrylic PSA
- UL recognized V-0 flammability rating
- Meet RoHS specifications
- Available on continuous rolls for easy peel and stick application

CHO-THERM® Commercial Grade Thermal Insulator Pads

	Properties	T609	T444	1674	T441			Method
Physical	Material	Silicone	Non-silicone	Silicone	Silicone			--
	Color	Lt. Green	Beige	Blue	Pink			Visual
	Reinforcement Carrier	Fiberglass	Kapton® MT	Fiberglass	Fiberglass			Visual
	Thickness, inch (mm)	0.010 (0.25)	0.003 (0.08)	0.010 (0.25)	0.008 (0.20)	0.013 (0.33)	0.018 (0.46)	ASTM D374
	Thickness Tolerance, inch (mm)	0.001 (± 0.025)	0.0005 (± 0.013)	0.001 (± 0.025)	0.001 (± 0.025)	0.001 (± 0.025)	0.001 (± 0.025)	--
	Operating Temperature Range, °F (°C)	-40 to +392 (-40 to +200)	-40 to +392 (-40 to +200)	-40 to +392 (-40 to +200)	-40 to +392 (-40 to +200)	-40 to +392 (-40 to +200)	-40 to +392 (-40 to +200)	--
Thermal	Thermal Impedance, °C-in^2/W (°C-cm^2 / W) @ 300 psi*	0.33 (2.1)	0.37 (2.4)	0.41 (2.6)	0.41 (2.6)	0.56 (3.6)	0.64 (4.1)	ASTM D5470
	Thermal Conductivity, W/m-K	1.5	0.4	1.0	1.1	1.1	1.1	ASTM D5470
	Heat Capacity, J/g-°C	1.0	1.0	1.0	1.0	1.0	1.0	ASTM E1296
	Coefficient of Thermal Expansion, ppm/°C	150	400	300	300	300	300	ASTM E831
Electrical	Voltage Breakdown Dry, Vac	4,000	5,000	2,500	8,700	11,400	13,800	ASTM D149
	Voltage Breakdown Wet, Vac	Not Tested	Not Tested	Not Tested	8,100	10,500	12,900	ASTM D149
	Volume Resistivity Dry, ohm-cm	10^{14}	10^{14}	10^{14}	10^{14}	10^{14}	10^{14}	ASTM D257
	Volume Resistivity Wet, ohm-cm	Not Tested	Not Tested	Not Tested	10^{14}	10^{14}	10^{14}	ASTM D257
Mechanical	Tensile Strength, psi (Mpa)	3,900 (26.9)	3,000 (20.7)	1,500 (10.3)	2,800 (19.3)	2,500 (17.3)	2,000 (13.8)	ASTM D412
	Tear Strength, lb/in (kN/m)	300 (52.5)	150 (26.3)	100 (17.5)	135 (23.6)	110 (19.3)	70 (12.25)	ASTM D642
	Elongation, %	30	NA	2	40	40	40	ASTM D412
	Hardness, Shore A	70	90	85	80	80	80	ASTM D2240
	Specific Gravity	2.10	1.70	2.45	2.45	2.45	2.45	ASTM D792
Regulatory	Flammability Rating (See UL File E140244)	V-0	V-0	Not Tested	V-0	V-0	V-0	UL94
	RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Chomerics Certification
	Outgassing, % TML (%CVCM)	Not Tested	Not Tested	0.45 (0.20)	Not Tested	Not Tested	Not Tested	ASTM E595
	Shelf-Life, months from shipment, Dry Pad (with PSA)	indefinite (6)	(12)	indefinite (12)	indefinite (12)	indefinite (12)	indefinite (12)	Chomerics

KAPTON is a trademark of E.I. DuPont de Nemours and Company.
*Tested without PSA. PSA typically adds 0.05 °C-in^2/W (0.30 °C-cm^2/W)

Typical Applications

- Power conversion equipment
- Power supplies and UPS
- Power semiconductors
- Automotive electronics
- Motor and engine controllers
- Televisions and consumer electronics

Product Attributes

T609

- Good thermal and dielectric properties
- Economically priced
- Best value for moderate to high performance pad
- PSA version available in economical kiss-cut format on continuous rolls

T441

- Superior dielectric strength (wet and dry)
- Economically priced
- Excellent for outdoor, high-humidity power supplies
- PSA version available in economical kiss-cut format on continuous rolls

1674

- Original commercial grade pad with good thermal and electrical performance
- Available in economical kiss-cut format on continuous rolls (with and without PSA)
- Passes NASA outgassing

T444

- Non-silicone with excellent dielectric and mechanical strength (polyimide interlayer)
- Strong acrylic adhesive (one side)
- Available in economical kiss-cut format on continuous rolls

Handling Information

These products are defined by Chomerics as "articles" according to the following generally recognized regulatory definition for articles:

An article is a manufactured item "formed to a specific shape or design during manufacturing," which has "end use functions" dependent upon its size and shape during end use and which has generally "no change of chemical composition during its end use."

In addition:

- There is no known or anticipated exposure to hazardous materials/substances during routine and anticipated use of the product.
- The product's shape, surface, and design is more relevant than its chemical composition.

These materials are not deemed by Chomerics to require an MSDS. For further questions, please contact Chomerics at 781-935-4850.

Ordering Information

Thermal insulator pads are available in the following formats.
Contact Chomerics for custom widths, part sizes, etc.

Die-cut parts on continuous rolls
Slit rolls starting at 0.5" wide; maximum width is material specific
Custom die-cut parts on sheets, or as individual parts

Part Number: 6W — XX — YYYY — ZZZZ

6W	XX	YYYY	ZZZZ
W = 0 Standard die-cut Part	11 = without PSA 12 = with PSA one side	YYYY = For standard die-cut parts, please see tables on pages 37 to 39	ZZZZ = Material class (1674, T441, T444, T609)
W = 4 Roll Stock W = 6 Roll Stock with PSA	10= 100 ft Roll Stock 40 = 400 ft Roll Stock	0075= 0.75 in 0100= 1.00 in 0150= 1.50 in 0200= 2.00 in 1150 = 11.5 in. 2400 = 24 in. (T444*) 0800 = 8 in. 1600 = 16 in. (1674*) 1100 = 11 in. 2200 = 22 in. (T441*)	
W = 9 Custom die-cut part	11 = without PSA 12 = with PSA one side	YYYYY = Custom Part Number. Contact Chomerics	

* Standard bulk roll width

CHO-THERM®

High Power Thermally Conductive Electrical Insulator Pads

Description

CHO-THERM® HIGH-POWER THERMAL INSULATOR PADS are thermally conductive materials designed for use where the highest possible thermal, dielectric, and mechanical properties are required.

Fiberglass cloth reinforcement strengthens CHO-THERM® pads against tear, cut-through and punctures.

These materials are available in sheet form and die-cut configurations. An optional acrylic adhesive layer (with PSA) is available on one or two sides. With a proven track record spanning several decades in multiple applications, these products are the first choice for high-end power supplies, industrial, aerospace, and military/avionics applications.

Available in several different forms to suit various applications.

Features / Benefits

- Excellent thermal properties
- High dielectric strength
- Excellent mechanical strength and puncture resistance
- 100% inspected for dielectric properties on every sheet
- Acrylic PSA attachment option available
- UL recognized flammability ratings
- Meets RoHS specifications
- Extremely low NASA outgassing
- Proven through decades of use in demanding military and aerospace applications

CHO-THERM® High Power Insulator Pads

	Typical Properties	T500	1678	1671	Method
Physical	Color	Green	Pink	White	Visual
	Reinforcement Carrier	Fiberglass	Fiberglass	Fiberglass	--
	Thickness, inch (mm)	0.010 (0.25)	0.010 (0.25)	0.015 (0.38)*	ASTM D374
	Thickness Tolerance, inch (mm)	± 0.002 (0.050)	± 0.002 (0.050)	± 0.002 (0.050)	--
	Operating Temperature Range, °F (°C)	-40 to +392 (-40 to +200)	-40 to +392 (-40 to +200)	-40 to +392 (-40 to +200)	--
Thermal	Thermal Impedance, °C-in²/W (°C-cm² / W) @ 300 psi**	0.19 (1.2)	0.20 (1.26)	0.23 (1.48)	ASTM D5470
	Thermal Conductivity, W/m-K	2.1	2.0	2.6	ASTM D5470
	Heat Capacity (J/g-°C)	1.0	1.0	1.0	ASTM E1269
	Coefficient of Thermal Expansion (ppm/K)	250	250	250	ASTM E831
Electrical	Voltage Breakdown Dry, (Vac)	4,000	2,500	4,000	ASTM D149
	Volume Resistivity Dry, (ohm-cm)	10^{16}	10^{16}	10^{16}	ASTM D149
	Dielectric Constant at 1,000 kHz	3.5	3.6	3.6	ASTM D150
	Dissipation Factor at 1,000 kHz	0.003	0.007	0.007	Chomerics Test
Mechanical	Tensile Strength, psi (Mpa)	3,000 (20.7)	3,000 (20.7)	3,000 (20.7)	Chomerics
	Tear Strength, lb/in (kN/m)	400 (70)	200 (35)	400 (70)	Chomerics
	Elongation, %	20	20	15	Chomerics
	Hardness, Shore A	80	80	80	ASTM D2240
	Specific Gravity	1.60	1.55	1.55	ASTM D792
Regulatory	Flammability Rating (See UL File E140244)	V-0	V-0	HB	UL 94
	RoHS Compliant	Yes	Yes	Yes	Chomerics Certification
	Outgassing, % TML (%CVCM)	0.40 (0.10)	0.55 (0.12)	0.76 (0.07)	ASTM E595
	Shelf-Life, months from shipment, Dry Pad (with PSA)	indefinite (18)	indefinite (18)	indefinite (18)	Chomerics

* 1671 material is available in custom thicknesses.
** Tested without PSA. PSA typically adds 0.05 °C-in²/W (0.30 °C-cm²/W)

Typical Applications

- Power conversion equipment
- Power supplies and UPS
- Power semiconductors
- Automotive electronics
- Motor and engine controllers
- Televisions and consumer electronics

Product Attributes

T500

- Best thermal performance
- Excellent dielectric properties

1671

- Highest reliability in rigorous applications
- Proven in aerospace/defense applications

1678

- Economically-priced
- Low thermal impedance

Handling Information

These products are defined by Chomerics as "articles" according to the following generally recognized regulatory definition for articles:

An article is a manufactured item "formed to a specific shape or design during manufacturing," which has "end use functions" dependent upon its size and shape during end use and which has generally "no change of chemical composition during its end use."

In addition:

- There is no known or anticipated exposure to hazardous materials/substances during routine and anticipated use of the product.
- The product's shape, surface, and design is more relevant than its chemical composition.

These materials are not deemed by Chomerics to require an MSDS. For further questions, please contact Chomerics at 781-935-4850..

Ordering Information

Thermal insulator pads are available in the following formats. Contact Chomerics for custom widths, part sizes, etc.

Sheets 8" X 8" or 8" X 10"
Custom die-cut parts on sheets, or as individual parts

Part Number: 6W — XX — YYYY — ZZZZ

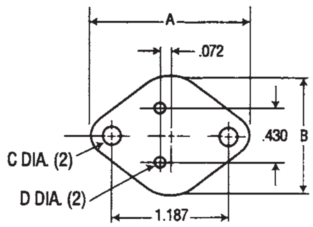
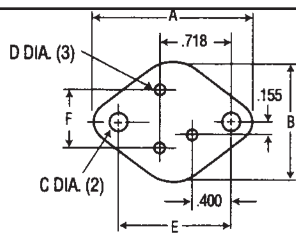
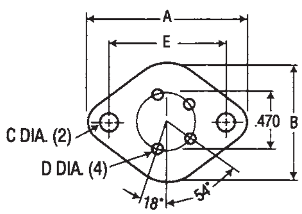
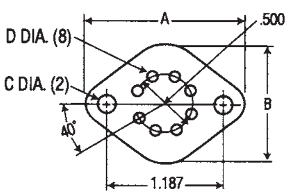
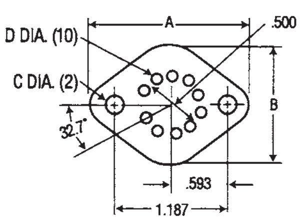
W	XX	YYYY	ZZZZ
W = 0 Standard die-cut part	11 = without PSA 12 = with PSA one side 13 = PSA 2 Sides	YYYY = Custom 4- part alpha/numeric part number. See pages 37 to 39 or contact Chomerics.	ZZZZ = Material class (T500, 1671, or 1678)
W = 1 Sheet stock W = 2 Sheet stock with PSA 1 Side W = 3 Sheet stock with PSA 2 Sides	XX = material thickness in mils (1671 material available up to 60 mils)	0808 = 8" X 8" Sheet 0810 = 8" X 10" Sheet	
W = 9 Custom die-cut part	11 = without PSA 12 = with PSA one side 13 = with PSA both sides	YYYYY = Custom Part Number. Contact Chomerics	

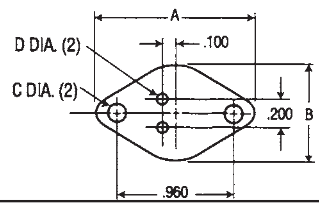
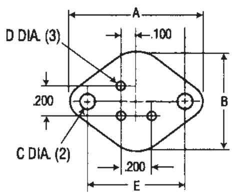
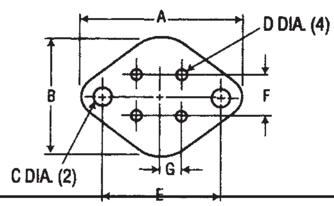
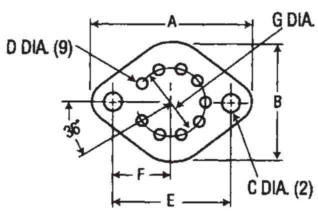
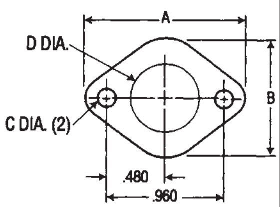
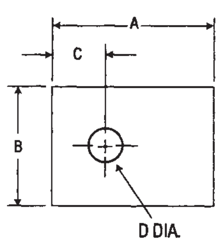
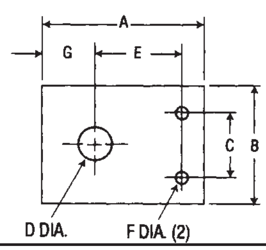
How to Order Die-Cut CHO-THERM® Insulators

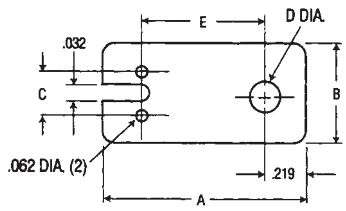
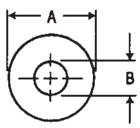
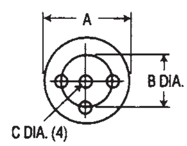
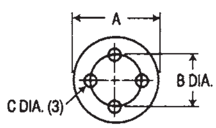
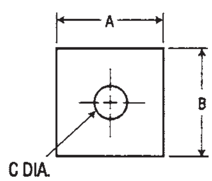
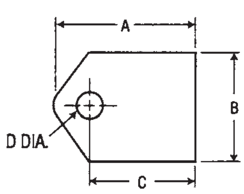
Standard die-cut parts are ordered using the following part number system. For custom parts, contact Chomerics.

Part Number: **60** — **XX** — **YYYY** — **ZZZZ**

- 60 = standard die cut part
- 11 = No PSA
12 = PSA one side
13 = PSA both sides
- Standard Configuration Drawing Number
- CHO-THERM® Material Example: 1671, T500, etc.

Recommended Screw Torque	Configuration	Dimensions (inches)							Ordering Number
		A	B	C	D	E	F	G	
#4-40 5 in-lb #6-32 6 in-lb	TO-3 	1.563 1.563 1.593 1.650 1.650 1.650 1.650 1.650 1.650 1.700 1.730 1.780 1.780 1.780 2.07	1.050 1.050 1.100 1.065 1.140 1.140 1.140 1.140 1.140 1.187 1.250 1.250 1.250 1.250 1.56	0.140 0.140 0.156 0.140 0.122 0.140 0.165 0.140 0.165 0.156 0.156 0.140 0.165 0.140 0.122	0.080 0.140 0.070 0.046 0.062 0.093 0.062 0.046 - 0.062 0.062 0.093 0.094 0.046 0.062				WW-XX-D065-ZZZZ WW-XX-4305-ZZZZ WW-XX-4511-ZZZZ WW-XX-D370-ZZZZ WW-XX-D371-ZZZZ WW-XX-6875-ZZZZ WW-XX-D372-ZZZZ WW-XX-D373-ZZZZ WW-XX-D374-ZZZZ WW-XX-4996-ZZZZ WW-XX-5442-ZZZZ WW-XX-D375-ZZZZ WW-XX-D376-ZZZZ WW-XX-D377-ZZZZ WW-XX-D378-ZZZZ
#4-40 5 in-lb #6-32 6 in-lb	3 LEAD TO-3 	1.65	1.140	0.140	0.093	1.187	0.430		WW-XX-D379-ZZZZ
#4-40 5 in-lb #6-32 6 in-lb	4 LEAD TO-3 	1.560 1.563	1.050 1.050	0.158 0.156	0.080 0.063	1.170 1.187			WW-XX-D380-ZZZZ WW-XX-D381-ZZZZ
#4-40 5 in-lb #6-32 6 in-lb	8 LEAD TO-3 	1.650	1.187	0.156	0.60				WW-XX-D382-ZZZZ
#4-40 5 in-lb #6-32 6 in-lb	10 LEAD TO-3 	1.650	1.140	0.165	0.040				WW-XX-D383-ZZZZ

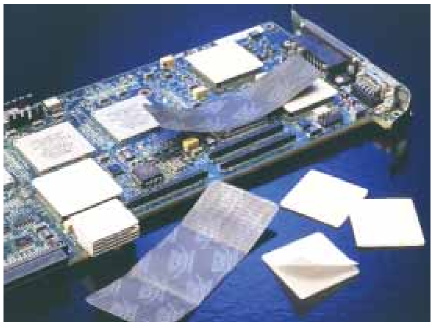
Recommended Screw Torque	Configuration	Dimensions (inches)							Ordering Number
		A	B	C	D	E	F	G	
#4-40 3 in-lb #6-32 4 in-lb	TO-66 	1.250 1.312 1.375 1.440	0.700 0.762 0.825 1.000	0.140 0.140 0.140 0.140	0.062 0.062 0.062 0.075				WW-XX-4353-ZZZZ WW-XX-5527-ZZZZ WW-XX-4997-ZZZZ WW-XX-D384-ZZZZ
#4-40 3 in-lb #6-32 4 in-lb	3 LEAD TO-66 	1.275	0.750	0.156	0.100	0.960			WW-XX-D385-ZZZZ
#4-40 3 in-lb #6-32 4 in-lb	4 LEAD TO-66 	1.312	0.762	0.140	0.062	0.960	0.200	0.100	WW-XX-D386-ZZZZ
#4-40 3 in-lb #6-32 4 in-lb	9 LEAD TO-66 	1.440	1.000	0.140	0.055	0.960	0.480	0.325	WW-XX-D387-ZZZZ
#4-40 3 in-lb #6-32 4 in-lb	MULTI LEAD TO-66 	1.35	0.800	0.140	0.400				WW-XX-D388-ZZZZ
#4-40 2 in-lb	TO-220 	0.437 0.437 0.500 0.610 0.687 0.710 0.750 0.750 0.750 0.750 0.750 0.750 0.855 0.855 0.860 1.125 1.410	0.312 0.312 0.385 0.560 0.562 0.500 0.410 0.500 0.500 0.500 0.600 0.600 0.562 0.630 0.740 0.625 0.810	0.140 0.140 0.170 0.245 0.218 0.160 0.225 --- 0.187 0.187 0.240 0.240 0.218 0.230 0.200 0.200 0.355	0.093 0.122 0.120 0.125 0.125 0.141 0.156 --- 0.147 0.125 0.150 0.115 0.125 0.093 0.160 0.145 0.147				WW-XX-D389-ZZZZ WW-XX-D390-ZZZZ WW-XX-D391-ZZZZ WW-XX-D392-ZZZZ WW-XX-5791-ZZZZ WW-XX-8302-ZZZZ WW-XX-D393-ZZZZ WW-XX-8531-ZZZZ WW-XX-6956-ZZZZ WW-XX-D394-ZZZZ WW-XX-D395-ZZZZ WW-XX-D396-ZZZZ WW-XX-D397-ZZZZ WW-XX-D398-ZZZZ WW-XX-D399-ZZZZ WW-XX-D400-ZZZZ WW-XX-D401-ZZZZ
#4-40 2 in-lb		0.910 0.983	0.500 0.750	0.200 0.432	0.125 0.156	0.580 0.665	0.046 0.101	0.265 0.217	WW-XX-D402-ZZZZ WW-XX-D403-ZZZZ

Recommended Screw Torque	Configuration	Dimensions (inches)							Ordering Number
		A	B	C	D	E	F	G	
#4-40 2 in-lb	**TYPE II TO-220** 	1.00	0.500	0.200	0.141	0.626			WW-XX-4969-ZZZZ
#10-32 2 in-lb #25-28 7 in-lb	DIODE WASHERS DO-4  DO-5	0.360 0.510 0.510 0.512 0.625 0.750 0.800 0.800 0.812 0.812 0.875 1.000 1.000 1.180 1.250 1.500 1.500	0.260 0.140 0.200 0.161 0.195 0.125 0.190 0.260 0.115 0.145 0.313 0.140 0.255 0.515 0.380 0.200 0.500						WW-XX-D404-ZZZZ WW-XX-D405-ZZZZ WW-XX-D406-ZZZZ WW-XX-D407-ZZZZ WW-XX-4659-ZZZZ WW-XX-D408-ZZZZ WW-XX-D409-ZZZZ WW-XX-D410-ZZZZ WW-XX-D411-ZZZZ WW-XX-D412-ZZZZ WW-XX-D413-ZZZZ WW-XX-D414-ZZZZ WW-XX-4661-ZZZZ WW-XX-D415-ZZZZ WW-XX-D416-ZZZZ WW-XX-D417-ZZZZ WW-XX-D418-ZZZZ
	TO-36 	1.063	0.690	0.200					WW-XX-4306-ZZZZ
	TO-5 and TO-18 3 holes  4 holes	0.250 0360 0.390 0.250 0.360 0.390	0.100 0.200 0.200 0.100 0.200 0.200	0.036 0.040 0.040 0.036 0.040 0.040					WW-XX-D419-ZZZZ WW-XX-4374-ZZZZ WW-XX-D420-ZZZZ WW-XX-D421-ZZZZ WW-XX-D422-ZZZZ WW-XX-D423-ZZZZ
#4-40 2 in-lb	RECTIFIER 	1.000 1.125 1.250	1.000 1.125 1.250	0.187 0.140 0.200					WW-XX-D424-ZZZZ WW-XX-D425-ZZZZ WW-XX-D426-ZZZZ
#4-40 2 in-lb	TIP PACKAGE 	0.865 0.865 0.984 0.984 1.260	0.650 0.650 0.787 0.787 0.787	0.650 0.650 --- 0.780 0.984	0.140 0.140 --- 0.142 0.142				WW-XX-5792-ZZZZ WW-XX-D427-ZZZZ WW-XX-D428-ZZZZ WW-XX-D429-ZZZZ WW-XX-D430-ZZZZ

(1 in-lb = 1.152 kg-cm)

T-WING® Heat Spreaders

Thin Heat Spreaders



Description

Chomerics' family of thin heat spreaders provides a low-cost, effective means of cooling IC devices in restricted spaces where conventional heat sinks are inappropriate.

T-Wing spreaders consist of 5oz. (0.007inch/0.18mm thick) flexible copper foil between electrically insulating films. High strength silicone PSA (pressure-sensitive adhesive) provides a strong bond to the component. The compliant nature of these "thermal wing" heat spreaders permits nearly 100% adhesive contact with non-flat package surfaces, optimizing thermal and mechanical performance.

Features/Benefits

- Component junction temperature reduction of 10-20°C is common
- Easily added to existing designs to lower component temperatures and improve reliability
- Custom shapes available for complex designs

Typical Applications

- Microprocessors
- Memory modules
- Laptop PCs and other high density, handheld portable electronics
- High speed disk drives

Design Details

- Low profile (0.33mm/0.013in) allows use in limited space environments
- Easy peel and stick adhesion to all surfaces, including packages with residual silicone mold release
- Offers low cost cooling for many package types
- Low application force (<5psi/ 0.03MPa) minimizes risk of damage to component
- Available in a range of standard sizes
- Pliable nature allows conformance to concave or otherwise non-flat surfaces for optimal thermal and mechanical performance
- Light weight (0.039 oz/inch2)
- Standard parts are scored for easy forming and alignment
- Easy removal for device replacement
- Available die-cut on continuous rolls

Typical Properties			Test Method
Physical	Color	Black	Visual
	Total Thicknesses, inches (mm)	0.013 (0.33)	ASTM D374
	PSA Type	Silicone based	--
	PSA thickness, inches (mm)	0.002 (0.05)	Visual
	Insulator Type	Black polyester	--
	Insulator Layer Thickness, inches (mm)	0.001 (0.025)	--
	Weight, oz/inch^2	0.039	--
	Themal Conductor	Copper	--
	Maximum Operating Temperature °F (°C)	257 (125)	--
	Thermal Conductor Thickness, inches (mm)	0.007 (0.178)	--
Electrical	Dielectric Strength, Vac/mil (KVac/mm)	5,000 (200) for each dielectric layer	ASTM D149
	Volume Resistivity, (ohm-cm)	N/A	ASTM D149
	Dielectric Constant @1,000 MHz	N/A	ASTM D150
	Dissipation Factor @ 1,000 kHz	N/A	Chomerics Test
Regulatory	Flammability Rating (See UL File E140244)	V-0	UL 94
	RoHS Compliant	Yes	Chomerics Certification
	Shelf Life, months from date of manufacture	12	Chomerics

T-Wing® Heat Spreaders

Typical Thermal Properties (Performed on surface of 196 lead 3 Watt PQFP package)			Standard Part Size inches(mm)					
Environment*	Sizes (inches)	Without T-Wing	0.5x2 (12.7x50.8)	0.5x3 (12.7x76.2)	0.75x3 (19.1x76.2)	1x3 (25.4x76.2)	1x4 (25.4x101.6)	1.5x4 (38.1x101.6)
Restricted Convection**	Thermal Resistance Rj-a (°C/W)	26	25	23	23	22	20	19
	Case Temperature (°C)	92	82	78	76	72	70	68
100 LFM***	Thermal Resistance Rj-a (°C/W)	18	16	14	14	14	13	12
	Case Temperature (°C)	68	57	52	49	46	44	44

* Measured values do not account for heat losses through bottom of case and leads. Ambient temperature range from 21°C to 24°C
** Restricted convection in a simulated notebook computer environment-a 1x5x6inch (2.54x12.7x15.2cm) plexiglass box
*** T-Wing long axis perpendicular to air flow direction in wind tunnel

Notes
Rj-a = thermal resistance from junction to ambient
LFM = airflow rate (linear feet per minute)

Typical Adhesion Performance

Test	Procedure	Result	Test Method
Lap Shear - Room Temperature	apply/60 min. R.T. dwell/R.T. pull	960 oz/in² (414 kPa)	ASTM D1000
Lap Shear - Elevated Temperature	apply/60 min. R.T. dwell/100°C pull	53 oz/in² (23 kPa)	ASTM D1000
90° Peel - Room Temperature	apply/1 min. R.T. dwell/R.T. pull	40 oz/in (441 g/cm)	ASTM B571/D2861
90° Peel - Elevated Temperature	apply/60 min. R.T. dwell/100°C pull	20 oz/in (220g/cm)	ASTM B571/D2861
Creep Adhesion, days	275°F (135°C), 7 oz/in² (3 kPa), on aluminum	>80 days, no failure	P.S.T.C. No. 7

Environmental Stress Thermal Performance

Environment	Before	After
Heat Aging		
Rj-a (°C/W) Restricted Convection	20.3	20.6
Rj-a (°C/W) 100 LFM	12.7	13.1
High Temperature/Humidity		
Rj-a (°C/W) Restricted Convection	21.4	21.4
Rj-a (°C/W) 100 LFM	14.1	14
Temperature Cycling		
Rj-a (°C/W) Restricted Convection	21.4	21.7
Rj-a (°C/W) 100 LFM	14.1	13.9

Note: Tested with a 1” x 4” (25.4 x 101.6 mm) T-WING

Environmental Stress Adhesive Performance

Environment	90° Peel Strength	
	oz/in	(gm/cm)
Control	36	393
Heat Aging	36	393
High Temperature/Humidity	46	514
Temperature Shock	38	424
Temperature Cycling	30	335

Note: Average of three samples tested per ASTM B571/D2861.

Testing Summary

Summaries of test procedures used for T-Wing heat spreaders are described below. Thermal performance, adhesion strength and visual inspection were used as pass/fail criteria.

Apparatus

Anatek® Thermal Analyzer: The ATA was used to measure Rj-a before and after environmental stressing. **PQFP:** 196 lead, plastic PQFPs known to contain silicone mold release were evaluated. **T-Wing Heat Spreader:** 1 inch x 4 inch TWing parts were applied to the PQFP packages with a 5 psi (0.03 MPa) mounting pressure.

Thermal Performance

Various sizes of T-Wing heat spreaders were applied to a 196 lead PQFP using less than 5 psi (0.03 MPa) bonding pressure. Within 30 minutes of application, the test boards were mounted in an Analysis Tech® thermal analyzer. The devices were heated to equilibrium (45 to 60 minutes) with approximately 3 watt load on 3 x 3 inch (7.6 x 7.6 cm) test boards. Two test environments were used: restricted convention, achieved with a 1 x 5 x 6 inch (2.5 x 12.7 x 15.2 cm) plexiglass box; and 100 LFM (30m/min) air flow. Results were obtained using thermocouples for Tc (centered on case) and Rj-a.

Environmental Stressing

Control: Specimens were maintained for 1000 hours at standard laboratory conditions, 23°C, 35-60% RH.

Heat Aging: Test specimens were placed in a forced convection hot air oven maintained at 150°C ±5°C for 1000 hours. Test specimens were then removed and tested.

Elevated Temperature/High Humidity: Specimens were placed in a humidity chamber maintained at 85°C ±2°C and 90%-0 +10% RH for 1000 hours.

Temperature Cycling: Specimens were subjected to 500 cycles from -50°C to +150°C in a Tenney Temperature Cycling Oven.

Temperature Shock: Specimens were subjected to 100 temperature shocks by immersion into -50° and +150°C liquids. Temperatures were monitored with thermocouples.

Evaluation Procedure

Visual: All test specimens were examined for de-bonding, delamination or other signs that the tape was failing after environmental stress.

Thermal Performance: T-Wing was applied to the PQFP with 5 psi mounting pressure. After a one hour dwell, the Rj-a of each specimen was measured at 100 LFM and under restricted convection conditions. The Rj-a was again measured after environmental stressing.

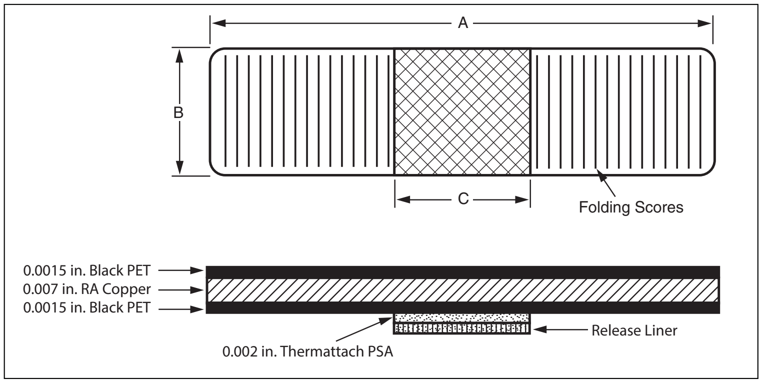
90° Peel Strength: A T-Wing heat spreader was applied to each PQFP with 5 psi mounting pressure. The specimens were subjected to environmental stress and then tested for 90° peel strength at room temperature.

Ordering Information

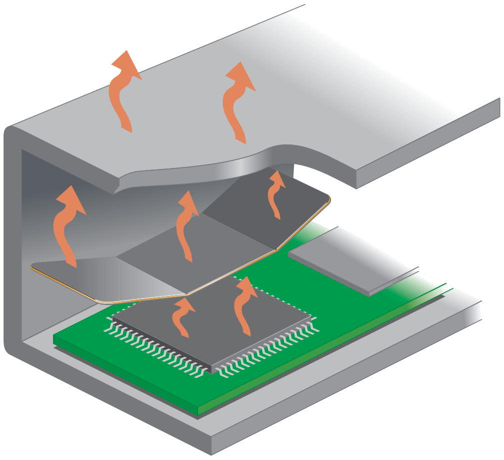
Available in standard sizes 1,000 parts per plastic tray. Also available die-cut on continuous rolls.

Part Numbers	Size (inches/mm)		
	A: Length inches (mm)	B: Width inches (mm))	C: Adhesive Width inches (mm)
60-12-20264-TW10	2.0 (50.8)	0.50 (12.7)	0.50 (12.7)
60-12-20265-TW10	3.0 (76.2)	0.50 (12.7)	0.50 (12.7)
60-12-20266-TW10	3.0 (76.2)	0.75 (19.1)	0.75 (19.1)
60-12-20267-TW10	3.0 (76.2)	1.00 (25.4)	1.00 (25.4)
60-12-20268-TW10	4.0 (101.6)	1.00 (25.4)	1.00 (25.4)
60-12-20269-TW10	4.0 (101.6)	1.50 (38.1)	1.50 (38.1)

Figure 1.



Dimensions are typical



Ordering Information

Standard Parts: Refer to table below for Part Numbers and sizes. T-Wing heat spreaders are available in standard packages of 100 parts/pkg.

Custom Parts: Custom configured T-Wing parts are also available. Contact Chomerics' Applications Engineering Department for details.

Results

Visual: There was no visual evidence of T-Wing adhesion failure to the PQFP after the environmental stresses.

Thermal Performance: The before and after thermal resistances are given in Table 4. The data shows that the thermal resistances were essentially unchanged by the exposures.

90° Peel Strength: The results of the peel strength tests are given above. The data shows that the average peel strength actually increases with high temperature/humidity and temperature shock, while remaining unchanged with heat aging and decreasing slightly with temperature cycling.

Application Instructions

Materials needed: Clean cotton cloth or rag, industrial solvent, rubber gloves.

Step 1: For best results, clean the top surface of the component using a lint-free cotton cloth.

Step 2: Wipe the bonding surface of the component with an industrial solvent, such as MEK, acetone or isopropyl alcohol. In the case of a plastic package, select a cleaner that will not chemically attack the plastic substrate. Do not touch the cleaned surface during any part of the assembly process. If the surface has been contaminated, repeat Steps 1 and 2.

Step 3: Remove the clear release liner from the T-Wing part, exposing the pressure-sensitive adhesive (PSA). Avoid touching exposed adhesive with fingers.

Step 4: For best bond strength and contact area, center the exposed PSA onto the component. Press and smooth the entire T-Wing bonding area with firm finger pressure of about 5 psi, for 5 seconds.

Note: Bond strength will increase as a function of time as the adhesive continues to wet out the bonding surface. Increasing any of the application variables (pressure, temperature and time) can improve bonding results.

Thermal Management Glossary

Alumina (Al_2O_3): A relatively inexpensive ceramic in powder or sintered sheet form. Its thermal conductivity of 30 W/m-K and excellent dielectric properties make it useful in low to moderate power commercial applications.

Ambient Temperature: The temperature of the air surrounding a heat source.

Apparent Thermal Conductivity: This value differs from bulk thermal conductivity as apparent thermal conductivity also includes contact resistance when measured, as described in the *Heat Transfer Fundamentals* section of this guide. Also see Thermal Conductivity.

Arcing: An electrical discharge between the edges of metal semiconductor package and the metal heat sink on which it is mounted.

Binder: A polymer (i.e. silicone, urethanes, acrylic, epoxy etc.) used in thermal interface materials to provide desired mechanical, thermal and electrical properties and hold in a stable form the fillers whose primary purpose is the transfer of heat. Binders are also good electrical insulators.

Bondline Thickness: Average thickness between heat spreading device and components.

Boron Nitride (BN): A non-abrasive ceramic material that has higher thermal conductivity than alumina. Because it is an expensive raw material, it is usually used in high performance interface materials.

Breakdown Voltage: The amount of voltage required to cause a dielectric failure through an insulator when tested under a set of specific conditions. This value does not imply that the insulator can be operated at those voltages.

Burr: A thin ragged fin left on the edge of a piece of metal (semiconductor package or heat sink) by a cutting or punching tool.

Calorie: A unit of energy equal to the quantity of heat required to raise the temperature of 1 gram of water by one degree Celcius.

Ceramic: A name given to oxides of metals. Ceramics are usually hard, heat and corrosion resistant and high dielectric strength powders that can be formed into shapes by fusion or sintering.

Chamfer: A bevel cut into the edge of heat sink mounting holes.

Coefficient of Thermal Expansion (CTE) : A measure of a material's change in volume in response to a change in temperature.

Compression Set: The permanent deformation of an elastomeric material caused by a compressive force.

Conduction: The transfer of heat energy through matter.

Convection: The transfer of heat that results from motion of a fluid (gas or liquid).

Corona: An electrical discharge within or on an insulator accompanied by ionization of the air within or contacting the surface of the insulator. Also called partial discharge. It is the main mode of insulation failure exposed to long term AC voltages.

Creep Distance: The distance that an insulator has to extend beyond the edge of a semiconductor package to prevent arcing.

Cure-In-Place: Any material that is dispensed as a liquid and cures in the application.

Cut-Through: A phenomenon that occurs when sharp edges or burrs on the metal semiconductor package or heat sink cut through the thermal pads and reduce or eliminate their insulating strength.

Compression / Deflection: The change in thickness of an elastomeric interface material in response to a compressive load. Because these materials are incompressible, deflection is accompanied by a proportional increase in area.

Degreaser or Degreasing Solvent: The solvent used to clean flux and other organic residues off printed circuit boards after they are manufactured. Interface materials must be able to tolerate exposure to degreasing solvents without degrading performance.

Dielectric: A material that acts as an insulator.

Dielectric Constant: See Permittivity.

Dielectric Strength: The voltage gradient, expressed as kV/mm, that will cause a dielectric failure in an insulating material under very specific test conditions. Dielectric strength does not imply that the insulator can withstand those potential gradients for an extended period of time.

Durometer: An instrument for measuring the hardness of rubber. Measures the resistance to the penetration of an indentor point into the surface of the rubber.

Electronic Control Unit or Electronic Control module (ECU/ECM): Various electronic coltrollers, typically used in automotive applications. (i.e. steering anf braking)

Electrical Insulator: A material having high electrical resistivity and high dielectric strength and therefore suitable for separating components at different potentials to prevent electrical contact between them.

Filler: A fine, dispersible ceramic or metallic powder (i.e. boron nitride, alumina, graphite, silver flake, etc.) whose thermal conductivity is at least twenty times greater than that of the binder.

Flow Rate: The volume, mass, or weight of a fluid passing through a device of any type, per unit of time, expressed in gallons -or liters-per-hour.

Flux: An organic compound used to enhance the wetting and adhesion of metal solder to the copper surfaces on printed circuit boards.

Footprint: The area of the base of an electronic device which comes in contact with a thermal interface material.

Hard Tooling: A die cutting tool manufactured from a machined metal block. The cost is high, therefore it is normally used when long runs are anticipated.

Hardness: A measure of the ability of a material to withstand penetration by a hard pointed object. Regarding thermal interface materials, this property is usually inversely proportional to the ability of a material to conform to uneven surfaces.

Hardness Shore A (Shore D, Shore 00): An instrument reading on a scale of 0 to 100 measuring the hardness of a material. There are three scales: Shore 00, A and D. Shore 00 is used for soft rubbers like gels, Shore A is used for hard rubbers and Shore D for inelastic plastics.

Heat (Q): A form of energy generated by the motion of atoms or molecules. Heat energy is expressed in units of joules.

Heat Capacity: The measure of a materials ability to store heat.

Heat Flow: The rate at which heat is flowing per unit time expressed as Watts.

Heat Flux (Q/A): The rate of heat flow per unit surface area expressed as Watts / cm^2.

Heat Transfer: The movement of heat from one body to another (solid, liquid, gas, or a combination) by means of conduction, convection, or radiation.

Interface: A boundary that exists between any two contacting surfaces. There are five types of interfaces that can exist between the different forms of matter: gas-liquid, liquid-liquid, gas-solid, liquid-solid, and solid-solid.

Junction: The junction is the active part of a semiconductor, usually silicon, where the current flow causes heat to be generated.

MBLT: Minimum bond line thickness. When two opposing substrates obtain closest possible distance under pressure.

Micro-inch: This unit of measure, a millionth of an inch, is used to describe the roughness of a surface and is the average distance between the peaks and valleys on the surface.

Mil: A unit of length equal to one-thousandth of an inch.

PCM: Abbreviation of phase change material.

Permeability: A measure of a material's ability to align its magnetic domains in response to an applied magnetic field.

Permittivity: A measure of a dielectric material's ability to polarize in response to an applied electric field, and transmit the electric field through the material.

Polyimide: An organic polymer with exceptional electrical insulation and high temperature capabilities. In film form, it is used on everything from printed circuit boards to space suits.

Power Supply: A self contained unit which converts AC current to DC for use in electronic devices.

Pressure Sensitive Adhesive (PSA): An adhesive that is tacky at normal temperatures and requires only slight pressure to form a permanent bond. A PSA requires no further cure to maintain the bond.

PSH: Class of polymer solder hybrid. A synergistic blend of eutectic solder and specialty polymers. They provide a highly reliable thermal interface material with a resin carrier and filler content that both melt to obtain minimum bond line thickness.

Radiation: A heat transfer process whereby heat is given off through electromagnetic radiation, usually infrared rays.

Reinforcement: A woven glass mesh or polymer film that is used as a support in thermal interface materials.

Permanent Set: Permanent Set is defined as the amount of residual displacement in a rubber part after the distorting load has been removed.

Relaxation: Stress Relaxation is a gradual increase in deformation of an elastomer under constant load over time, accompanied by a corresponding reduction in stress level.

Rheology: The science of the deformation and flow of materials.

Semiconductor: An electronic material that can be an insulator under one condition and switch to a conductor under a different condition

Shear-Thinning: A characteristic of a fluid whereby the fluid's viscosity decreases with increased shear stress. Materials the exhibit shear-thinning are also described as pseudoplastic. Filled polymer resins commonly exhibit this behavior. (Example: toothpaste is shear-thinning. It does not flow when left alone, but when squeezed with increased force, it flows more readily.)

Silicon: A non-metallic element occurring extensively in the earth's crust in silica and silicates. Silicon is the basis for the junction found in most semiconductor devices.

Solder: A mixture of metals that is used to connect electronic devices to the copper patterns on a printed circuit board.

Solvent Resistance: The ability of thermal management products to resist swelling when exposed to organic solvents such as degreasing solvents, hydraulic fluids, coolants and jet fuel.

Specific Gravity: The ratio of the density of a substance to the density of water. The specific gravity of water is 1 at standard condition temperature and pressure.

Specific Heat: The amount of heat per unit mass required to raise the temperature by one degree Celsius. (See Heat Capacity.)

Steel Mill Die: A die cutting tool of moderate cost, cast from steel. It is used for high speed cutting.

Steel Rule Die: A low cost die cutting tool manufactured by shaping sharpened steel foil to the desired shape and fixing in a plywood and steel rule metal. It is used for short runs.

Surface Finish: A measure of the roughness of a surfaces, usually expressed in units of micro-inches.

Swelling: A phenomenon that results when an elastomer is exposed to a degreasing solvent and the elastomer absorbs the solvent. The volume of the elastomer increases and its physical strength is greatly reduced. In this swollen state, the elastomer can be easily damaged and should not be subjected to any mechanical stress until the elastomer has been dried.

Tear Strength: A measure of the ability of a material to withstand tearing/ ripping stresses. It is usually measured in pounds force per inch of thickness.

Temperature: A measure of the average kinetic energy of a material. The standard unit of temperature is a Kelvin, (K). Temperature determines the direction of heat flow between any two systems in thermal contact. Heat will always flow from the area of higher temperature (T source) to one of lower temperature (T sink).

Temperature Gradient (ΔT): The difference in temperatures in the direction of the heat flow between two points in a system.

Tensile Strength: A measure of the ability of a material to withstand a tension (pulling apart) force. It is usually measured in MPa or psi of material cross section.

Thermal Conductivity (K): A quantitative measure of the ability of a material to conduct heat expressed in units of W/m-K.

Thermal Contact Resistance (R_i): The resistance to the flow of heat caused by interstitial air trapped in the irregularities of between contacting solid surfaces. Units are K-cm^2/W.

Thermogravimetric Analysis: Chemical analysis by the measurement of weight changes of a system or compound as a function of increasing temperature.

Thermal Impedance (θ): Thermal impedance is the sum of the thermal resistance of an interface material and the thermal resistances at the interfaces in contact with the material. K-in^2 / Watt.

Thermal Interface Materials (TIMs): Materials that are inserted between two contacting solid surfaces and aid heat flow by eliminating gaps between the irregular surfaces. Interstitial air is replaced by material that is significantly more conductive than air.

Thermal Resistivity: The quantitative measure of a material's resistance to the conduction of heat. (It is the inverse of thermal conductivity.)

Thermocouple: A thermoelectric device consisting of two dissimilar metallic wires fused into a bead which generates a voltage proportional to the temperature of the bead.

Thixotropy: a characteristic of a fluid whereby the fluid's viscosity decreases as a function of time at a fixed shear rate. Viscosity tends to re-build with time as the shear stress is reduced. (Example: gels and colloids are often thixotropic. The longer they are shaken in a can, the more readily they flow)

Tolerance: The permissible variations in the dimensions or other characteristic of a part or substance.

Torque: A turning or twisting that is equal to the value of the force (f) multiplied by the rotational distance over which it is applied (usually measured in ft-lbs.).

Viscoelastic material: A material whose response to a deforming load combines both viscous (does not recover its original shape/ size when load removed) and elastic (will recover size/shape when load removed) qualities. The common name for such a material is "plastic."

Volume Resistivity: A measure of a material's inherent electrical resistance expressed as ohm-cm.

Watt: An SI unit of power equal to one joule per second.

Notes:

Notes:

Parker Chomerics Capabilities include:

THERMAL MANAGEMENT & CONTROL

- Thermally conductive gap filler pads
- Fully cured dispensable thermal gels
- Silicone-free thermal pads
- Phase-change materials (PCM)
- Polymer solder hybrids (PSH)
- Dispensable thermal compounds
- Thermal grease
- Dielectric pads
- Thin flexible heat spreaders
- Custom integrated thermal/EMI assemblies

EMI SHIELDING & COMPLIANCE

- Conductive elastomers – molded, extruded, and form-in-place (FIP)
- Conductive foam based gaskets – fabric-over-foam and z-axis foam
- Conductive compounds – adhesives, sealants and caulks
- RF absorbing materials
- EMI shielding plastics and injection molding services
- Coatings – direct metallization and conductive paints
- Metal gaskets – Springfingers, metal mesh and combination gaskets
- Foil laminates and conductive tapes
- EMI shielding vents – commercial and military honeycomb vents
- Shielded optical windows
- Cable shielding – ferrites and heat-shrink tubing/wire mesh tape/zippered cable shielding
- Compliance and safety test services

OPTICAL DISPLAY PRODUCTS

- EMI shielding filters (conductive coating & wire mesh)
- Anti-reflective/contrast enhancement filters
- Plastic or glass laminations
- Hard coated lens protectors
- Touchscreen lenses

PLASTIC INJECTION MOLDING

- PREMIER® and other filled, electrically-conductive plastics
- Traditional thermoplastics
- EMI and cosmetic coating services
- EMI and environmental gasket integration
- Assembly, pad printing, hot stamping, welding, and heat staking
- Insert molding, two-shot molding, and overmolding capability

About Parker Hannifin Corporation

With annual sales exceeding $13 billion, Parker Hannifin is the world's leading diversified manufacturer of motion and control technologies and systems, providing precision-engineered solutions for a wide variety of mobile, industrial and aerospace markets. The company's products are vital to virtually everything that moves or requires control, including the manufacture and processing of raw materials, durable goods, infrastructure development and all forms of transport. Traded on the New York Stock Exchange under the symbol "PH," Parker is strategically diversified, value-driven and well positioned for global growth as the industry consolidator and supplier of choice.

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