Grounded Heat Sink Bonding Film
7373

Technical Data | **October, 1998**

Product Description

3M™ Grounded Heat Sink Bonding Film 7373 is a hybrid epoxy/acrylate adhesive system, filled with silver-coated glass beads for Z-axis electrical conductivity (through the film thickness only). Ideal for bonding Printed Circuit Boards (PCB's) to heat sinks in high frequency power amplifiers, bonding film 7373 provides high strength, electrically conductive bonds that are durable and exhibit low thermal impedance.

Bonding film 7373 can be bonded using a standard PCB laminating press with the heat and pressure conditions described below. During the bonding process the conductive particles become compressed between the PCB and heat sink, thereby establishing electrical contact, while the adhesive cures to bond the parts together. Bonding film 7373 creates a tough, resilient bond that is less susceptible to brittle (fracture) failures than typical epoxy adhesive films, providing greater electrical stability and overall reliability.

Handling and Bonding

To apply bonding film 7373 to either the PCB or the heat sink, start at one edge (or, better yet, the middle of the board) and roll the adhesive down. Next remove the liner. To complete the pre-tacking process, place the PCB and heat sink together and roll again to laminate.

Tip: Die-cut sheets can be kept from prematurely tacking to the PCB during alignment by several methods: 1. Lay the bonding film 7373 die cut with tacky adhesive face exposed and facing up on tooling pins. Align the PCB over the pins and press down to make contact to the adhesive in the center of the die-cut. Next use a roller to laminate the rest of the part. Take the PCB off the tooling pins, remove the liner from bonding film 7373 and use the tooling pins to align the heat sink to the PCB. Roll again to 'pre-tack' the PCB to the heat sink, or, 2. Place 'slip sheets' having a matte finish (400 grit sandpaper has been used) on the PCB, then gently lay the exposed face of bonding film 7373 on top and align to tooling pins, etc. The slip sheets can then be pulled out as a roller is used to laminate the adhesive to the PCB.

The pre-tacked PCB/heat sink assembly is then placed in a well-aligned laminating press and bonded under heat and pressure (nominally 250 psi, 30 minutes at 160°C). This enables the conductive particles to establish electrical connection between the substrates while the adhesive cures. After the press cycle is completed the PCB is populated with components and reflowed in standard SMT fashion.

Typical Properties

Note: The following values are representative of properties and performance, but are not to be used for specification purposes. Electronic circuit materials, surface preparations and assembly conditions vary widely; users are responsible for thoroughly evaluating the product under the conditions of intended use to determine performance characteristics in their application. Properties are given for cured adhesive except as noted.

Property	Value
Adhesive Type	Filled Acrylate / Epoxy Hybrid
Liner Type	Poly-coated Kraft + Silicone Release
Adhesive Thickness	2.0 ± 0.5 mils
Liner Thickness	4 mils
Filler Particles	Silver-coated Glass Beads
Average Particle Size	1.5 mils
Minimum Cure Time	30 minutes[1,2]
Nominal Cure Temp	160°C[1]
Nominal Bond Pressure	250 lbs/in^2 [1]
Softening Point	120°C
Modulus	300 MPa
Poisson Ratio	0.5 (est.)
Elongation to Break	30%
Coeff. of Thermal Exp.	
-50°C to 30°C	Not Discernable
30°C to 120°C	-400 ppm/°C (Contraction)[3]
120°C to 150°C	-2400 ppm/°C (Contraction)[3]
150°C to 220°C	+200 ppm/°C (Expansion)
Low Angle Peel/Fracture Strength	10 lbs/in-width[4,5]
Lap Shear Strength	1000 lbs/in^2 [5]
Contact Resistance (Gold Surf.)	0.3 milli-ohms-cm^2 [5,6,7]
Contact Resistance (Alum. Surf.)	1.0 milli-ohms-cm^2 [5,8]
Min. Electr. Contact Area Req.	2500 mils^2
Thermal Impedance	0.5 (est.) °C-in^2/W
Temp. Excursion Range	-55 to 230°C (Solder Reflow)[6,9]
Solder Reflow	3 repetitions - Pass[6,9]
Solder Float	10 minutes - Pass[9]
85°C / 85% RH	500 hrs - Pass[6,9]
Liq.-Liq. Shock -40°/+125°C	250 cycles - Pass[6,9]
Air-Air Shock -55°/+125°C	0 cyc./200 cyc./500 cyc. (Data Below)
Resistance Values, Au/Cu H.S.	< 20 μΩ/< 20 μΩ/< 20 μΩ[5,6]
Resistance Values, Au/Al H.S.	< 20 μΩ/25 μΩ /40 μΩ[5,7]
Resistance Values, Bare Al H.S.	20 μΩ/1 mΩ/4 mΩ (2000 cycles)[5,8]
Storage (uncured)	Room Temperature, 1 Year

[1] For a given application optimal values may differ depending on parts being bonded.
[2] Total bond time required will depend on thermal properties of bond equipment.
[3] It is not uncommon for rubbery materials to contract with increasing temperature.
[4] Measured by driving a thin wedge between bonded parts (low angle fracture/peel).
[5] Sample assemblies measured as-bonded (not solder reflowed).
[6] Immersion gold/copper-clad PCB & immersion-gold on solid copper heat sink, 2" x 4" contact area.
[7] Immersion gold/copper-clad PCB & immersion-gold/alum. heat sink, 2" x 4" contact area.
[8] Immersion gold/copper-clad PCB & bare aluminum heat sink, 2" x 4" contact area
[9] Information supplied by customers on populated boards having passed reflow. Pass meant no physical degradation and electrical resistance stable to 0.5 mΩ or better.

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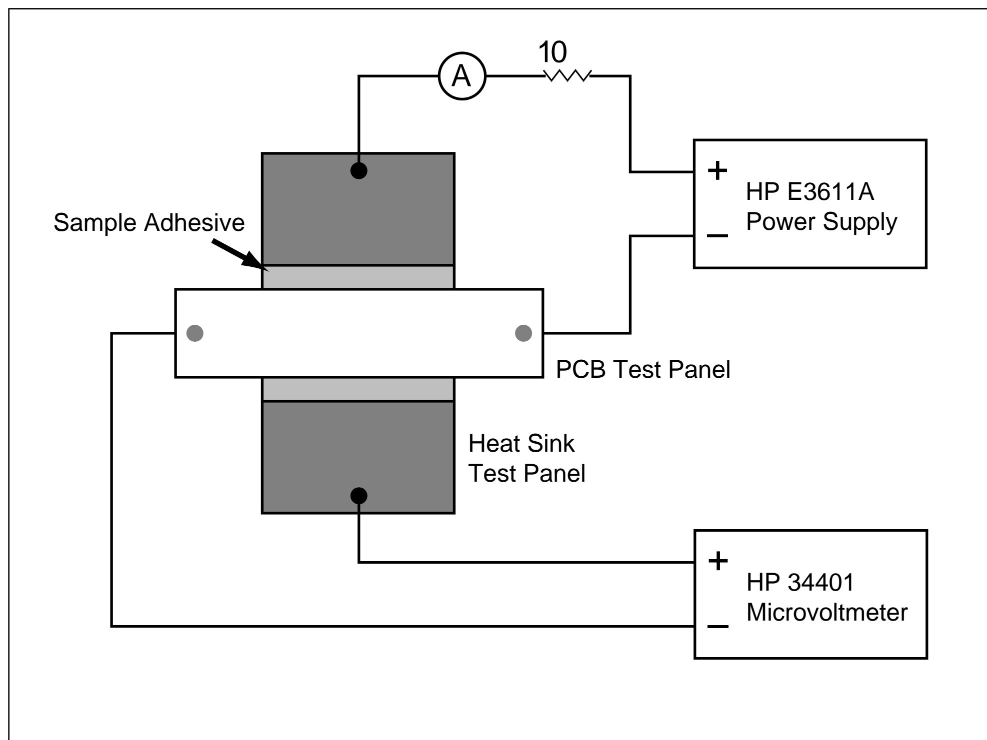
Detail of Test Results

I. Contact resistance following bonding process.

PCB test panels consisting of immersion-gold/electroless nickel/copper-clad GETEK® or Teflon®-based circuit board material (one conductor layer 35 microns thick, no circuit pattern) were bonded to a heat sink. Heat sinks consisted of either (i) 30 mil thick solid copper sheet with an immersion gold /electroless nickel surface, (ii) 90 mil thick aluminum, or (iii) 90 mil thick aluminum with an immersion-gold/electroless nickel/copper-clad surface. The PCB panel was cut to 2" x 8" panels and the heat sinks were cut to 4" x 8". Adhesive bonds were made in a press (160°C for 30 minutes at 250 PSI) with the panels crossed in a T arrangement allowing 4-pt. (Kelvin) resistance measurements to be taken according to the diagram below. The power supply was set to deliver a current of 1 A, so the contact resistance through the adhesive was equal to the voltage drop measured at the microvoltmeter divided by 1 A. Results are reported in the preceeding table, where the resistance was multiplied by the contact area to give an area-normalized value in milli-Ω-cm^2.



II. Contact resistance after air-air shock.

Test panel assemblies from the above were subjected to air-air shock, -55°C/125°C having a 5 minute dwell at the extremes with an approx. 2 minute transition. Resistance was measured after samples had been allowed to equilibrate at room temperature for an hour. The performance of the bare aluminum surface heat sink was clearly inferior to that with gold surface finish.

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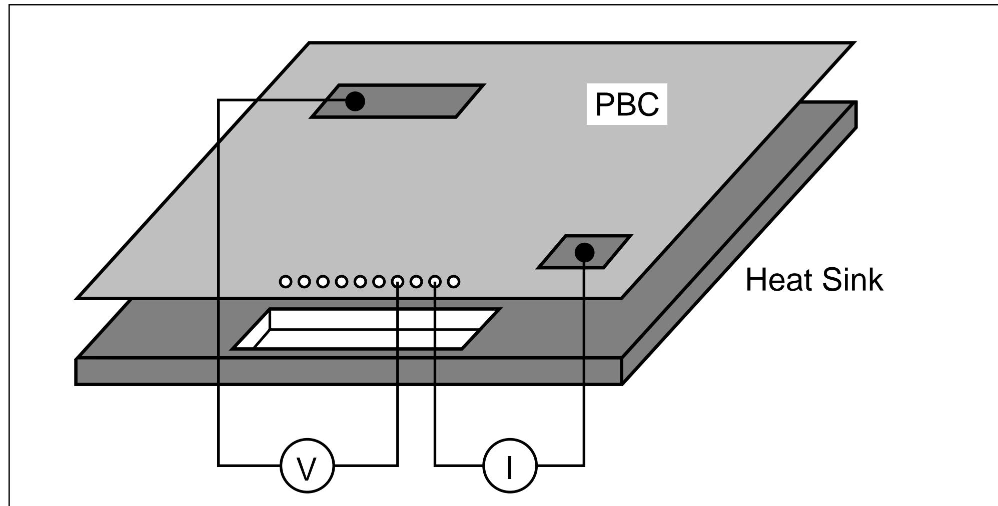
Detail of Test Results *(continued)*

III. Contact resistance in customer assembly.

A bonded PCB / heat sink assembly was probed by making contact to PCB pins connected to the ground plane metallization on the back of the PCB (in the area of a cutout of the heat sink); connection to screw holes in the heat sink was made in areas where cutouts on the PCB existed. A four point resistance arrangement was made using a 1 A current, as pictured below.



The measurements on assemblies with either bare aluminum or gold-coated aluminum heat sinks were both in the range of 0.2 mΩ or less prior to reflow.

IV. Adhesion – Toughness / Low Angle Peel

Bonded PCB / heat sink test panels (see II. above) were sheared to yield 1" wide strips. The adhesion between the PCB and heat sink layers was measured by driving a 45 mil thick stainless steel wedge between the parts at 0.5"/min., producing a low peel angle as pictured below. The relatively slow rate (two minutes to drive the wedge one inch) was chosen to represent thermal stresses acting during board processing or thermal cycling.

The schematic force displacement curve shown in the picture represents a typical result. The curve shows a peak or critical force necessary to start the peel front, followed by a relatively flat plateau. Measured peel values in this plateau are typically 10 lbs./in. width or more.

3M bonding film 7373 was formulated to create tough, non-brittle bonds. More brittle adhesives will typically show lower overall force values, with fractures (see dashed line in schematic) interrupting the curve. Bonding film 7373 is less prone to such brittle fractures, thus providing a more reliable bond. It should be noted that given fast enough wedge rates – i.e. 12"/min. - brittle fracture can be induced in the bond. However, in such cases the peak load is higher, e.g. 15 lbs./in. or more, and is significantly higher than more brittle adhesives.

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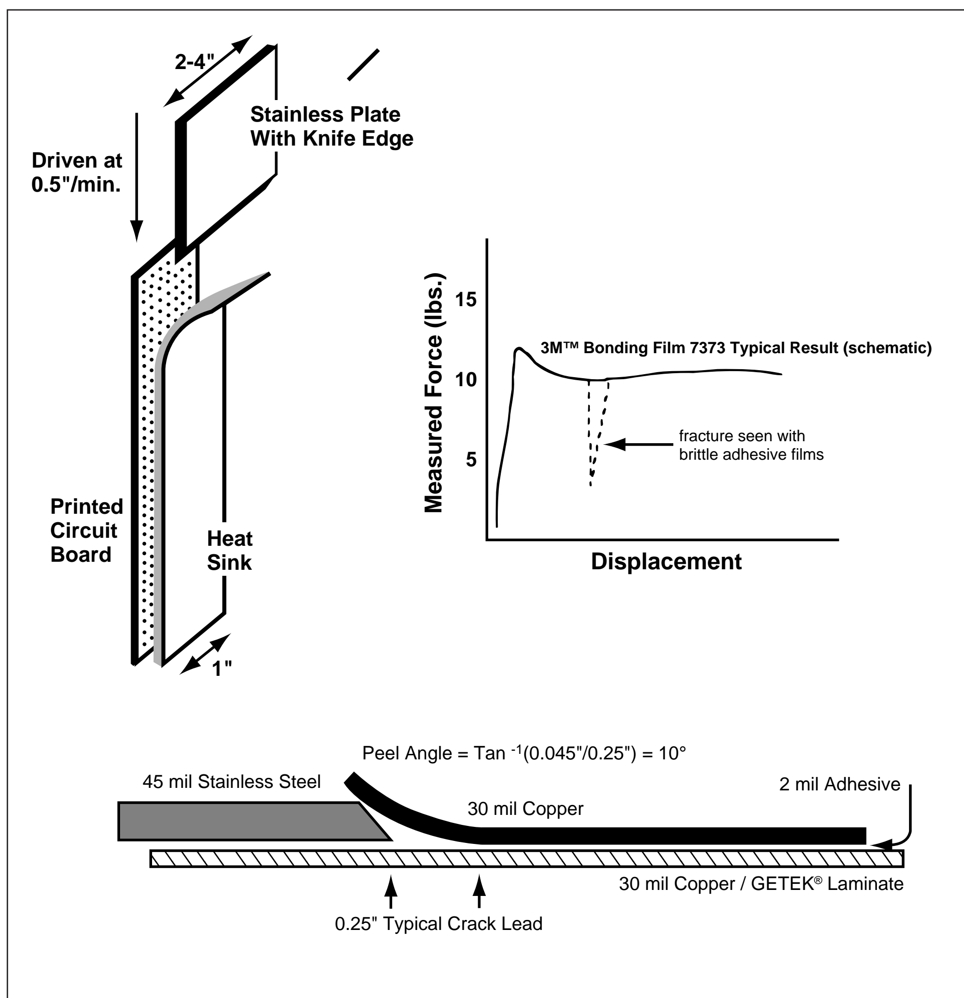
Detail of Test Results
(continued)



V. Adhesion - Shear Strength

A pair of stainless steel panels was bonded using nominal bonding conditions, and the lap shear strength was measured according to ASTM D1002.

Ordering Information

Standard Roll Sizes:

Available Lengths:
- Minimum: 36 yds. (32.9 m)
- *Maximum: 108 yds. (98.8 m)

Available Widths:
- *Minimum: 1 in. (25 mm)
- Maximum: 14 in. (356 mm)

*Special requirements for narrow-widths or long-lengths should be discussed with 3M customer service or technical service representatives.

Sheets:

3M representatives can offer information about third party fabricators for sheeted and die cut versions.

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Precautionary Information

Refer to product label and Material Safety Data Sheet for safety and health information before using this product.

For Additional Information

To request additional product information or to arrange for sales assistance, call toll free 1-800-362-3550. Address correspondence to: 3M Bonding Systems Division, 3M Center, Building 220-7E-01, St. Paul, MN 55144-1000. Our fax number is 651-733-9175. In Canada, phone: 1-800-364-3577. In Puerto Rico, phone: 1-809-750-3000. In Mexico, phone: 5-728-2180.

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ISO 9002

This Bonding Systems Division product was manufactured under a 3M quality system registered to ISO 9002 standards.

Bonding Systems Division

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