



# **Single Edge Contact Connector 2 (S.E.C.C. 2) Thermal Interface Material Functional Requirements**

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## 1. Introduction and Specification Scope

The purpose of the Thermal Interface Material Functional Specification is to provide the design constraints and requirements for the thermal interface between the Single Edge Contact Cartridge 2 (S.E.C.C. 2) and heat sink to comply with S.E.C.C. 2 performance requirements set by Intel. This includes environmental testing outlined in *Support Component Test Requirements*. These constraints are compatible with the *Heat Sink and Heat Sink Attachment Functional Requirements for S.E.C.C. 2*. If the heat sink and S.E.C.C. 2 are not properly attached to one another, the quality of the thermal interface may degrade, possibly causing damage to the S.E.C.C. 2 processor or core package.

The thermal interface material (TIM) is typically a thermally conductive, conformal material applied to the heat sink before assembly to the processor. For the Intel design a fabric web impregnated with a phase change material is used, resulting in a maximum thermal resistance of  $0.75^{\circ}\text{C}/\text{W}$  when loaded initially with 12-20 lbf. Your thermal solution may require a different thermal resistance depending on your heat sink design/performance, heat sink attachment methodology, and target system environment.

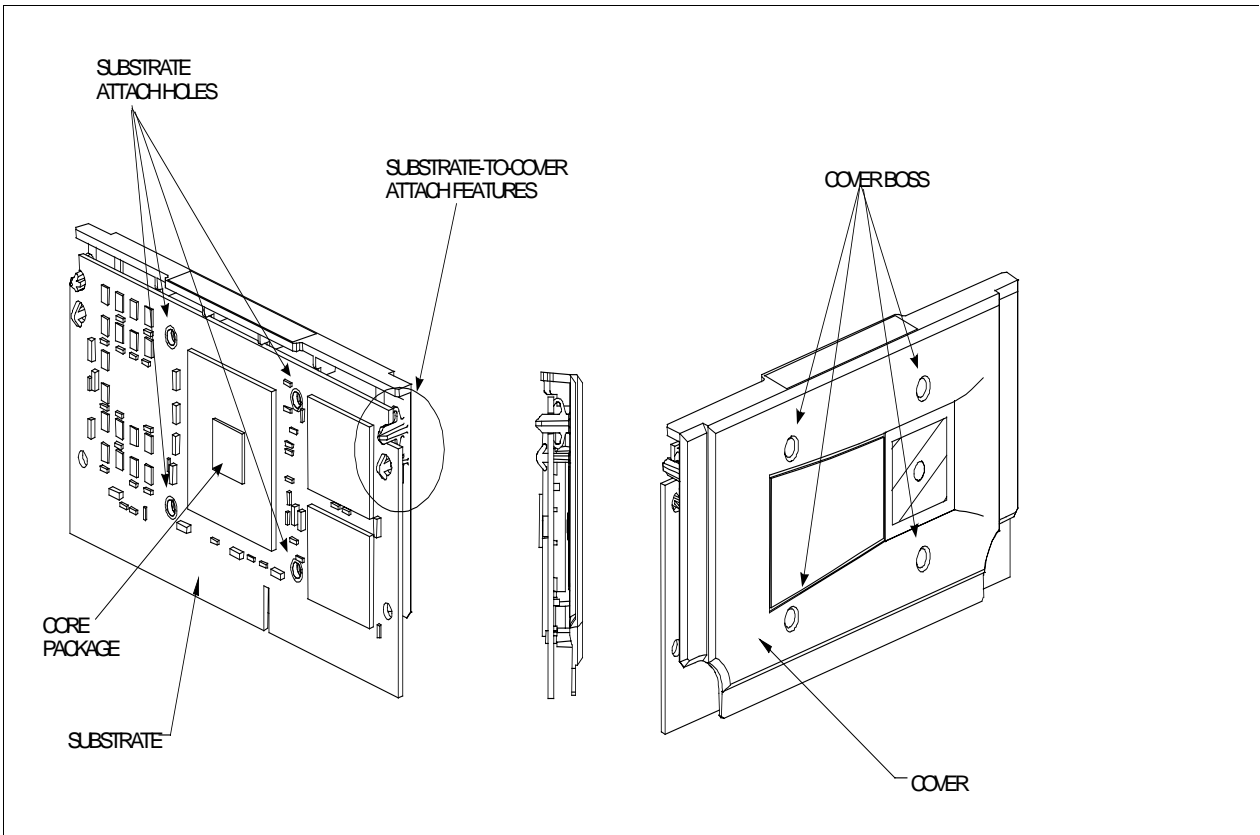
## 2. Thermal Requirements

The effective thermal impedance required for the thermal interface material is dependent upon the efficiency of the entire thermal solution (heat sink, heat sink attachment, and thermal interface material). It is recommended that material with  $0.98 \text{ cm}^2 \text{ }^{\circ}\text{C}/\text{W}$  ( $0.15 \text{ in}^2 \text{ }^{\circ}\text{C}/\text{W}$ ) or better be used.

## 3. Interface Requirements

### 3.1 S.E.C.C. 2 Package Overview

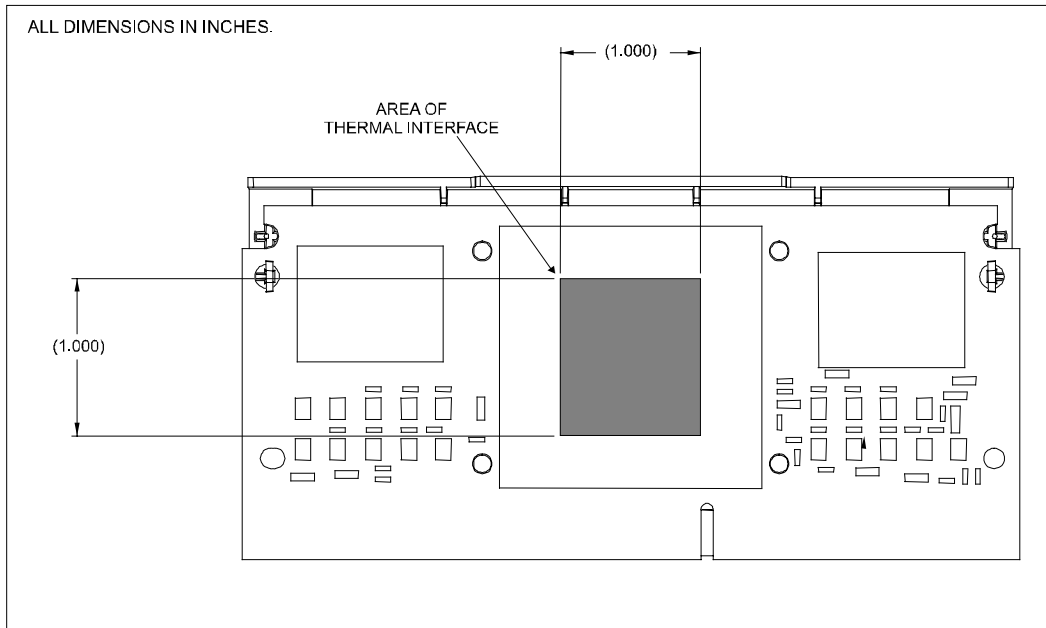
Fig. 1 shows the S.E.C.C. 2 assembly. This assembly is comprised of the substrate, either OLGA or PLGA (OLGA shown), and the S.E.C.C. 2 cover. The substrate is attached to the cover via snap features located in the upper right and left corners of the assembly. Note that the core package is exposed for interface with the heat sink.



**Fig. 1 General Views, S.E.C.C. 2 Assembly (OLGA substrate shown)**

### **3.2 Core Package Interface - PLGA**

Fig. 2 shows the S.E.C.C. 2 cover and PLGA substrate. Note that these are reference dimensions and have no associated tolerance.



**Fig. 2 S.E.C.C. 2 PLGA Assembly**

### 3.3 Core Package Interface - OLGA

Fig. 3 shows the OLGA substrate from the side of the thermal interface (primary side). Dimensions of interest are the dimensions of the thermal interface area of the core package. Note that these dimensions are reference dimensions and have no tolerances associated with them.

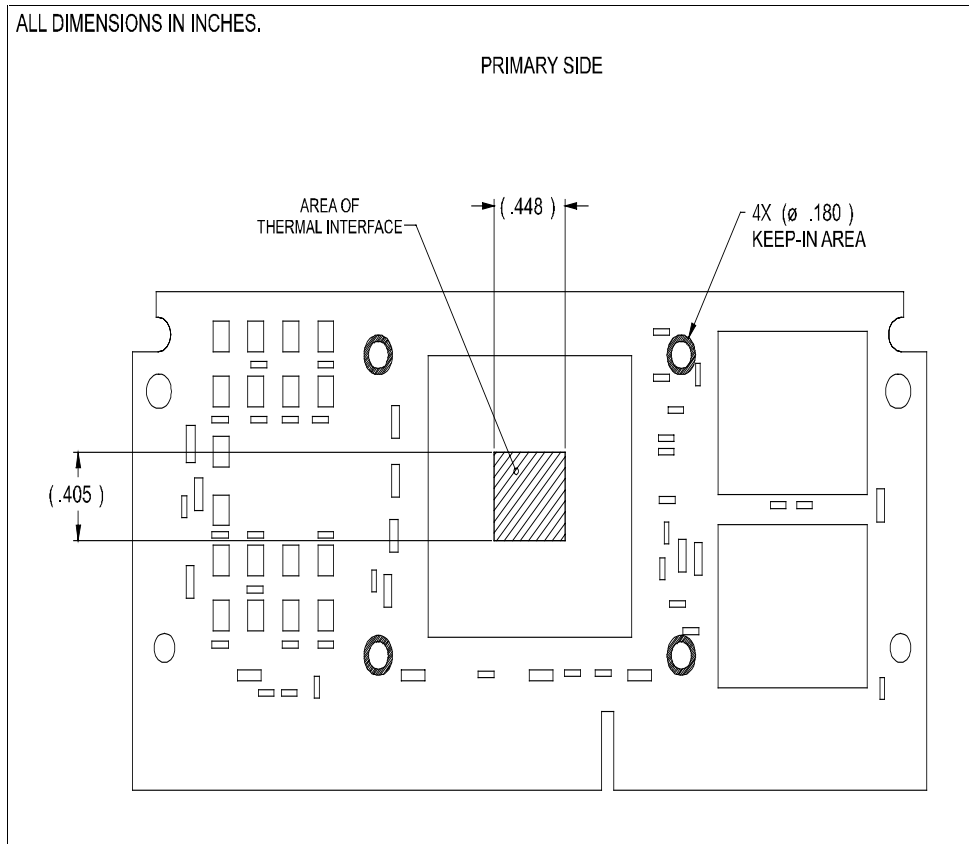
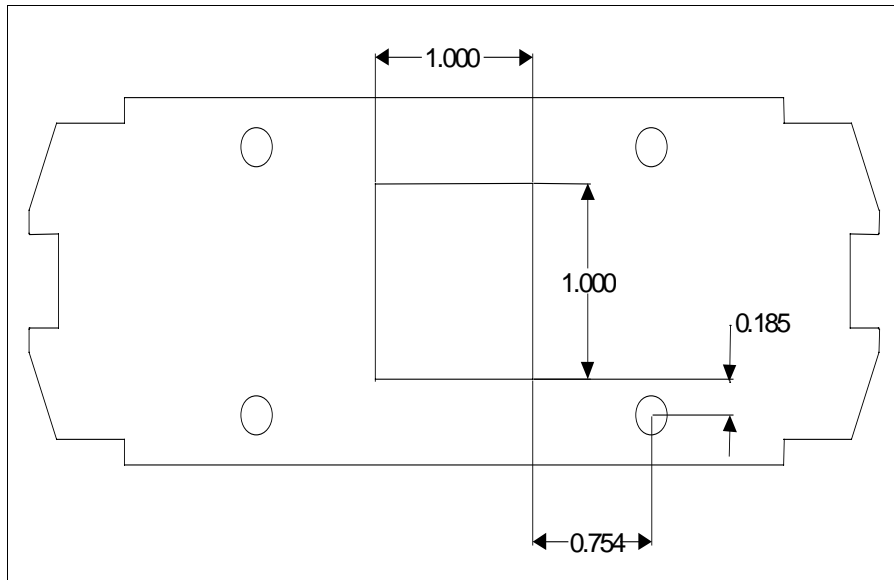


Fig. 3 S.E.C.C. 2 OLGA Substrate, Primary Side

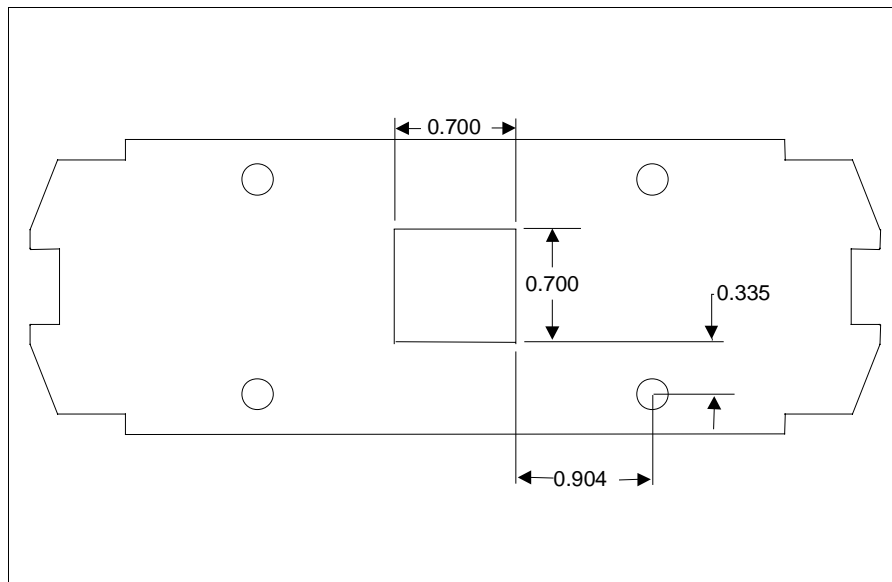
### 3.4 Heat Sink Interface - PLGA





**Fig. 4 S.E.C.C. 2 PLGA Interface Material Location**

### 3.5 Heat Sink Interface - OLGA



## 4. Mechanical Requirements

### 4.1 Component Level Survival Expectations

The intent of the mechanical requirements for the thermal interface material is to maintain proper operation and to guard against processor failures during environmental testing. For details see *Support Component Test Requirements*.

## **4.2 Interface Material Mechanical Load**

The heat sink attachment or attachment mechanism must not induce permanent stress into the S.E.C.C. 2 substrate with the exception of a uniform load not to exceed 25 lbf compressive to maintain the heat sink to processor thermal interface. Your heat sink and thermal interface will determine the minimum compressive force.

The Intel reference material requires an initial clamping force between 12 and 20 lbf. Note that studies have shown the initial force is most critical and that reduction of the force through spring relaxation over time have shown negligible effect on performance.

## **4.3 Heat Sink and Core Package Separation**

The thermal interface material must maintain a finite separation between the heat sink and the die package during all dynamic and assembly loading and environmental tests. The purpose of this separation is to prevent heat sink to die package contact which testing has shown can result in die damage and processor failure. This is especially critical with OLGA core packages. The separation media must be capable of absorbing and/or dampening shock loads to be effective in preventing die damage.

The Intel reference design maintains a minimum of 0.001" separation between the die and the heat sink for loading of 100 lbf over 0.25 in<sup>2</sup> surface.

#### **4.4 Thickness Requirement**

The TIM thickness is a component in the stackup of the processor-connector-retention-heatsink tolerance loop and thus should be considered when selecting or designing an interface material. Note that after application of clamping and thermal load, many TIMs become thinner. This change in dimension should be part of the considerations in selecting a heat sink attachment component and process. As these components and processes vary, as does the requirement for TIM thickness. The force to compress the TIM must not exceed load or deflection requirements as listed in *S.E.C.C. 2 Heat Sink and Heat Sink Attachment Functional Requirements*.

For the Intel reference design, the TIM should have an initial thickness between 0.006" and 0.003". After clamping and thermal loads are applied, the thickness must be  $.0033 \pm .0023$ ".

#### **4.5 Minimum Size Requirements**

The TIM minimum size requirements are driven by the size of the processor core package interface and the assembly tolerance for the heat sink attachment process and design. The minimum recommended size for TIM application is 0.7x0.7" for OLGA core package, 1.0x1.0" for PLGA package.

### **5. Electrical Requirements**

Volume resistivity must be a minimum of  $2.8 \times 10^{12}$  ohms-cm.

No dielectric requirement has been determined; however it should be noted that the lower dielectric materials may increase EMI emissions.

### **6. Material Requirements**

#### **6.1 Shelf Life**

There shall be no change in compliance, no dry out, no cracking, no separation of material within 6 months of manufacturing (at room temperature and 50% RH).

#### **6.2 Material Uniformity**

Material must be uniform with no voids or bubbles. There shall not be any resin pooling or resin bleed.

#### **6.3 Wetting Characteristics**

Material must completely wet and maintain intimate contact of critical interfaces (nickel, silicon oxide, aluminum oxide/anodized surface, copper) at room temperature under the load to be provided by the heat sink attachment solution.

For the Intel reference design, wetting must be complete using a 12 lbf load.

#### **6.4 Susceptibility to Contamination**

Material must be protected from contamination during shipping.

#### **6.5 Thermal Stability**

Thermal degradation onset is greater than 180°C and weight loss of less than 0.5% at 110°C for 1 hour.

#### **6.6 Fungal Resistance**

Material shall be resistant to fungal growth. Examples of non resistant materials include: Cellulose materials, animal and vegetable based adhesives, grease, oils, and, many hydrocarbons. Synthetic materials such as PVC formulations, certain Polyurethanes (e.g. polyester and some polyethers), plastics which contain organic fillers of laminating materials, paints, and varnishes also are susceptible to fungal growth. If materials are not fungal growth resistant, then MIL-STD-810E, Method 508.4 must be performed to determine material performance.

### **7. Qualification Testing Requirements**

#### **7.1 Storage Testing, High Temperature**

To ensure performance after exposure to high temperature storage conditions, material must be able to withstand 500hrs at 100°C without loss of thermal properties. This test should be performed with the TIM attached to the heatsink only.

#### **7.2 Storage Testing, High Humidity**

To ensure performance after exposure to high humidity storage conditions, material must be able to withstand 500hrs at 55°C/85% RH without loss of thermal properties. This test should be performed with the TIM attached to the heatsink only.

#### **7.3 Temperature Cycling**

To ensure performance in the thermally dynamic environment of desktop systems, material must be able to maintain thermal performance through 1000 thermal cycles between -40°C and 85°C. Testing is performed with the heat sink attached to the processor. See *Support Component Test Requirements* for test details.

#### **7.4 Vibration**

Heat sinks and processors assembled using the TIM must pass vibration requirements as specified in *Support Component Test Requirements*.

## **7.5 Shock**

Heat sinks and processors assembled using the TIM must pass vibration requirements as specified in *Support Component Test Requirements*.

## **8. Safety Requirements**

Heat sink interface material shall be consistent with the manufacture of units that meet the safety standards:

- UL Recognition-approved for flammability at the system level.
- All mechanical-support components must be a minimum UL94V-0.

## **9. Manufacturability Recommendations**

### **9.1 Purpose of Manufacturability Recommendations**

The intent of this section is to provide general guidelines for manufacturability of attaching a thermal interface to a heat sink. As individual suppliers have differing processes these guidelines may not apply in all situations; it is best to compare these recommendations with the process with which your material will be applied.

### **9.2 Incoming Condition to Heat Sink Supplier**

The TIM should be available in pre-cut/pre-slit patches of the size noted in section 4.4 and 4.5. Patches should be packaged in continuous rolls.

### **9.3 TIM to Heat Sink Application Method**

Application methods using a room temperature pressure sensitive adhesive is preferred over application methods requiring elevated temperatures. Application should not require any post-attachment cure process.

### **9.4 Pot Life**

For application methods requiring elevated temperatures, the TIM must maintain all properties effecting manufacturability for greater than 50 hours while at process conditions.

### **9.5 Material Reworkability**

Material should be reworkable and cleanable using a dry cloth or a wipe with water or isopropyl alcohol.

### **9.6 Material Adhesion**

Material must adhere to HS during all normal shipping and handling.

## 10. Summary of Thermal Interface Attributes

This table provides a summary of data provided in this document to successfully design interface materials that repeatedly produce an acceptable thermal performance for the interface between the processor and heat sink.

Attribute	Details	Comment
Thermal Impedance	0.98 cm <sup>2</sup> °C/W	Recommended - dependent on entire thermal solution. (§2)
Mechanical Load (static)	Not to exceed 20 lbf.	Required - function of S.E.C.C. 2 processor. (§4.2)
Mechanical Separation of HS and Core Package	0.001" Minimum	Recommended - must have a finite separation. (§4.3)
Material Thickness	No load - 0.006-0.003" Loaded - 0.056-0.001"	Required for use with Intel reference retention. (§4.4)
Material Size	0.7 x 0.7" for OLGA 1.1 x 1.1" for PLGA	Minimum sizes based on assembly tolerances. (§4.5)
Electrical Requirements	2.8 x 10 <sup>12</sup> ohms-cm (volume)	Required. (§5)
Shelf Life	6 month at RT/50%RH	Required. (§6.1)
Uniformity	No voids or bubbles. No resin pooling/bleed.	Required. (§6.2)
Wetting	Must completely wet applicable surfaces at minimal loading (12lbf)	Required. (§6.3)
Contamination	Must be protected during shipping	Recommended. (§6.4)
Thermal Stability	Thermal Degradation onset >180°C Weight Loss < 0.5% at 110°C for 1 hour	Required. (§6.5)
Fungal Resistance	Must be resistant.	Required. (§6.6)
Storage Testing, High Temp	100°C for 500 hrs, no thermal property losses	Required. (§7.1)
Storage Testing, High Humidity	55°C/85% RH for 500 hrs, no thermal property losses	Required. (§7.2)
Temperature Cycling	1000 cycles, -40°C to 85°C	Required. (§7.3)
Vibration	Profile per ECQS	Required. (§7.4)
Shock	Profile per ECQS	Required. (§7.5)
Safety Requirement	Must meet UL requirements	Recommended. (§8)
Packaging	Rolls w/ precut "patches"	Recommended. (§9.2)
Application Method	Room temperature preferred	Recommended. (§9.3)
Pot Life	>50 hrs at process condition	Recommended. (§9.4)
Reworkability	Cleanable w/dry cloth, water, or alcohol wipe.	Recommended. (§9.5)
Adhesion	Must stay on HS during normal shipping and handling.	Required. (§9.6)



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