Intel® 82571EB & 82572EI Thermal Design Considerations

Thermal Application Note AP-490, Rev. 1.1

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Revision 1.1

Contents

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Revision History

Date	Revision	Page #	Description
October, 2003	0.5		Rev 0.5
August, 2004	0.7		Rev 0.7
March, 2005	0.7		C1 silicon power
November, 2005	1.0		Thermal Diode
June, 2009	1.1		Add 82572, updated thermal tables

Reference Documents and Information Sources

Document Name or Information Source	Available Form
Integrated Circuit Thermal Measurement Method-Electrical Test Method	EIA/JESD51-1
Integrated Circuits Thermal Test Method Environmental Conditions – Natural Convection (Still Air)	EIAJESD51-2

Product Package Thermal Specification

Table 1 - Package Thermal Characteristics in Standard JEDEC Environment

Package Type	ΘJA	ΨJT
17mm 256FCBGA5-6L **No thermal solution**	**28.1°C/W**	**2.3°C/W**
17mm 256FCBGA5-6L **With thermal solution**	**19.5°C/W**	**3.9°C/W**

The thermal parameters defined above are based on simulated results of packages assembled on standard multilayer 4s2p 1.0-oz Cu layer board in a natural convection environment. The maximum case temperature is based on the maximum junction temperature and defined by the relationship, Tcase-max = Tjmax – (Ψ_{JT} x Power) where Ψ_{JT} is the junction-to-package top thermal characterization parameter. If the case temperature exceeds the specified Tcase max, thermal enhancements such as heat sinks or forced air will be required. Θ_{JA} is the package junction-to-air thermal resistance.

Note: Thermal models are available upon request (Flotherm 2-Resistor, Delphi, Detailed or Icepak Detailed format)

1 Introduction

This document describes the thermal characteristics for Intel® 82571EB and 82572EI. Use this document to properly design a thermal solution for systems implementing the 82571EB and 82572EI.

Properly designed solutions provide adequate cooling to maintain the 82571EB or 82572EI case temperature (Tcase) at or below those listed in Table 2. Ideally, this is accomplished by providing a low local ambient temperature and creating a minimal thermal resistance to that local ambient temperature. Heat sinks may be required if case temperatures exceed those listed in Table 2. Any attempt to operate the 82571EB or 82572EI outside of these operating limits may result in improper functionality or permanent damage to the Intel component and potentially other components within the system. Maintaining the proper thermal environment is essential to reliable, long-term component/system operation.

1.1 Intended Audience

The intended audience for this document is System Design Engineers using the 82571EB or 82572EI. System designers are required to address component and system-level thermal challenges as the market continues to adopt products with higher-speeds and port densities. New designs may be required to provide better cooling solutions for silicon devices depending on the type of system and target operating environment.

1.2 Measuring the Thermal Conditions

This document provides a method for determining the operating temperature of the 82571EB or 82572EI in a specific system based on case temperature. Case temperature is a function of the local ambient and internal temperatures of the component. This document specifies a maximum allowable Tcase for the 82571EB and 82572EI.

1.3 Thermal Considerations

In a system environment, the temperature of a component is a function of both the system and component thermal characteristics. System-level thermal constraints consist of the local ambient temperature at the component, the airflow over the component and surrounding board, and the physical constraints at, above, and surrounding the component that may limit the size of a thermal enhancement (heat sink).

The component's case/die temperature depends on:

- component power dissipation
- size
- packaging materials (effective thermal conductivity)
- type of interconnection to the substrate and motherboard
- presence of a thermal cooling solution
- power density of the substrate, nearby components, and motherboard

All of these parameters are pushed by the continued trend of technology to increase performance levels (higher operating speeds, MHz) and power density (more transistors). As operating frequencies increase and packaging size decreases, the power density increases and the thermal cooling solution space and airflow become more constrained. The result is an increased emphasis on system design to ensure that thermal design requirements are met for each component in the system.

1.4 Importance of Thermal Management

The thermal management objective is to ensure that all system component temperatures are maintained within functional limits. The functional temperature limit is the range in which the electrical circuits are expected to meet specified performance requirements. Operation outside the functional limit can degrade system performance, cause logic errors, or cause component and/or system damage. Temperatures exceeding the maximum operating limits may result in irreversible changes in the component operating characteristics. Also note that sustained operation at component maximum temperature limit may affect long-term device reliability (see Section 3 for additional information.)

1.5 What you will find in This Document

This document contains the following sections:

2, “Packaging Terminology” provides definitions for package terminology used in this document.

3, “Thermal Specifications” provides 82571EB and 82572EI case temperature specifications and where to find power requirements. This section also discusses thermal packaging techniques

4, “Thermal Attributes” provides 82571EB and 82572EI thermal characteristic data, package mechanical attributes, and package thermal characteristic data. Use this section to determine your thermal solution requirements.

5, “Thermal Enhancements (If Required)”discusses the use of heat sinks: heat sink attach methods, heat sink interfacing, and heat sink reliability.

6,“Measurements for Thermal Specifications” Provides instructions for measuring 82571EB oo 82572EI case temperature with and without a heat sink.

8, “Conclusion”

2 Packaging Terminology

The following is a list of packaging terminology used in this document:

FCBGA Flip Chip Ball Grid Array: A surface mount package using a combination of flip chip and BGA structure whose PCB-interconnect method consists of eutectic solder ball array on the interconnect side of the package. The die is flipped and connected to an organic build-up substrate with C4 bumps. An integrated heat spreader (IHS) may be present for larger FCBGA packages for enhanced thermal performance.

Junction: Refers to a P-N junction on the silicon. In this document, it is used as a temperature reference point (for example, $Theta_{\_JA}$ refers to the "junction" to "ambient" thermal resistance.)

Ambient: Refers to local ambient temperature of the bulk air approaching the component. It can be measure by placing a thermocouple approximately 1" upstream from the component edge.

Lands: The pads on the PCB to which BGA Balls are soldered.

PCB: Printed Circuit Board.

Printed Circuit Assembly (PCA): An assembled PCB.

Thermal Design Power (TDP): The estimated maximum possible/expected power generated in a component by a realistic application. Use Maximum power requirement numbers from Table 1.

LFM: Linear Feet per Minute (airflow)

3 Thermal Specifications

To ensure proper operation and reliability of the 82571EB or 82572EI, the thermal solution must maintain a case temperature at or below the values specified in Table 2. System-level or component-level thermal enhancements are required to dissipate the generated heat if the case temperature exceeds the maximum temperatures listed in Table 2

Analysis indicates that real applications are unlikely to cause the 82571EB or 82572EI to be at Tcase-max for sustained periods of time. Given that Tcase should reasonably be expected to be a distribution of temperatures, sustained operation at Tcase-max may be indicative that the given thermal solution will also result in situations where Tcase exceeds the specified maximum value. Such thermal designs may affect long-term reliability of the 82571EB or 82572EI and the system, and sustained performance at Tcase-max should be evaluated during the thermal design process and steps taken to further reduce the Tcase temperature.

Good system airflow is critical to dissipate the highest possible thermal power. The size and number of fans, vents, and/or ducts, and, their placement in relation to components and airflow channels within the system determine airflow. Acoustic noise constraints may limit the size and types of fans, vents and ducts that can be used in a particular design.

To develop a reliable, cost-effective thermal solution, all of the system variables must be considered. Use system-level thermal characteristics and simulations to account for individual component thermal requirements.

Table 2 82571EB/82572EI Absolute Thermal Absolute Maximum Rating

82571EB/82572EI Application	TDP (W)[1]	Tcase Max-hs[2] (°C)[3]
minimum	2.1	102
82571EB_C0	3.0	98
82571EB/82572EI_D0	3.4	97

1. Maximum power, also known as Thermal Design Power (TDP), is a system design target associated with the maximum component operating temperature specifications. Maximum power values are determined based on typical DC electrical specification and maximum ambient temperature for a worst-case realistic application running at maximum utilization.
2. Tcase Max- hs is defined as the maximum case temperature with the defaualt thermal solution attached.
3. This is a not to exceed maximum allowable case temperature.

3.1 Case Temperature

The 82571EB and 82572EI are designed to operate properly as long as the Tcase is not exceeded. Section 6.1, “Case Temperature Measurements” discusses proper guidelines for measuring the case temperature.

4 Thermal Attributes

4.1 Designing for Thermal Performance

Appendix A&B documents the PCB and system design recommendations required to achieve the 82571EB/82572EI thermal performance documented herein.

4.2 Typical System Definitions

The following system example is used to generate thermal characteristics data:

The heat sink case assumes the default enhanced thermal solution (see 5.3, “Extruded ”).

The evaluation board is a four-layer 4 x 4 inch PCB.

All data is preliminary and is not validated against physical samples.

Your system design may be significantly different.

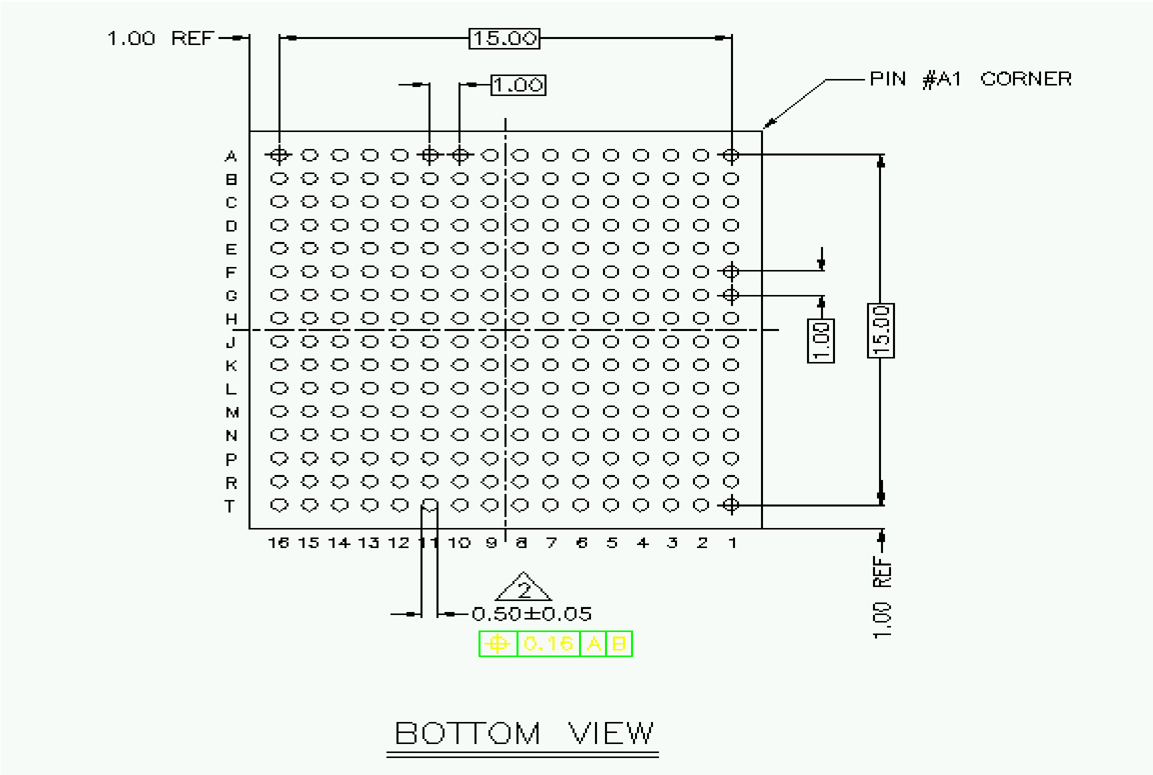
A larger board size with more than six Cu layers may increase the 82571EB or 82572EI thermal performance.

4.3 82571EB/82572EI Thermal Attributes

4.3.1 82571EB/82572EI Package Mechanical Attributes

The 82571EB and 82572EI is packaged in a 17mm 256FCBGA-6L. The mechanical drawing is shown in Figure 1

Figure 1 82571EB/82572EI 17mm 256FCBGA-6L Mechanical Drawing (Bottom View)



4.3.2 82571EB/82572EI Package Thermal Characteristics

Table 3 aids in determining the optimum airflow and heat sink combination for the 82571EB and 82572EI. Figure 2 shows the required local ambient temperature versus airflow for a typical 82571EB/82572EI system (see 4.2, "Typical System Definitions" for a typical system definition)

Table 3 shows Tcase as a function of airflow and ambient temperature at the TDP for a typical 82571EB/82572EI system.

Note:

Note: Your system design may vary considerably from the typical system board environment used to generate

Note: Thermal models are available upon request (Flotherm: 2-Resistor, Delphi, or Detailed). Contact your local Intel sales representative if you would like to receive 82571EB/82572EI thermal models

Figure 2 - Max. Allowable Ambient Temperature vs. Air Flow with heat sink

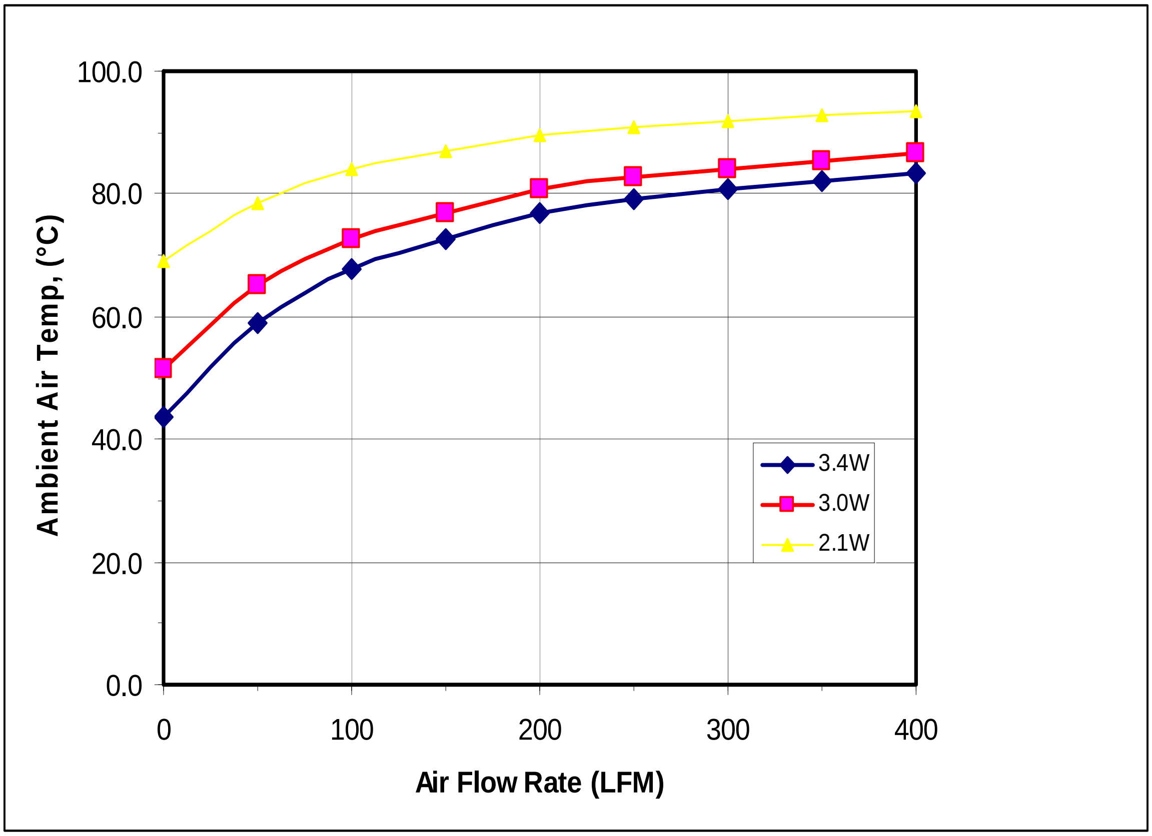


Table 3 Expected Tcase (^{o}C) for Heat Sink Attached at TDP of 2.1W

Heat Sink Attached							Tcase Max =		102C
85 C amb.	115	105	100	97	94	93	92	91	90
80 C amb.	110	100	95	92	89	88	87	86	85
75 C amb.	105	95	90	87	84	83	82	81	80
70 C amb.	100	90	85	82	79	78	77	76	75
65 C amb.	95	85	80	77	74	73	72	71	70
60 C amb.	90	80	75	72	69	68	67	66	65
55 C amb.	85	75	70	67	64	63	62	61	60
50 C amb.	80	70	65	62	59	58	57	56	55
45 C amb.	75	65	60	57	54	53	52	51	50
Air Flow LFM	**0**	**50**	**100**	**150**	**200**	**250**	**300**	**350**	**400**

Table 4a Expected Tcase (^{o}C) for Heat Sink Attached at TDP of 3.0W

Heat Sink Attached								Tcase Max =	98C
85 C amb.	132	119	111	107	103	101	100	99	97
80 C amb.	127	114	106	102	98	96	95	94	92
75 C amb.	122	109	101	97	93	91	90	89	87
70 C amb.	117	104	96	92	88	86	85	84	82
65 C amb.	112	99	91	87	83	81	80	79	77
60 C amb.	107	94	86	82	78	76	75	74	72
55 C amb.	102	89	81	77	73	71	70	69	67
50 C amb.	97	84	76	72	68	66	65	64	62
45 C amb.	92	79	71	67	63	61	60	59	57
Air Flow LFM	0	50	100	150	200	250	300	350	400

Table 5b Expected Tcase (^{o}C) for Heat Sink Attached at TDP of 3.4W

Heat Sink Attached								Tcase Max =	97C
85 C amb.	140	125	116	111	107	105	103	102	100
80 C amb.	135	120	111	106	102	100	98	97	95
75 C amb.	130	115	106	101	97	95	93	92	90
70 C amb.	125	110	101	96	92	90	88	87	85
65 C amb.	120	105	96	91	87	85	83	82	80
60 C amb.	115	100	91	86	82	80	78	77	75
55 C amb.	110	95	86	81	77	75	73	72	70
50 C amb.	105	90	81	76	72	70	68	67	65
45 C amb.	100	85	76	71	67	65	63	62	60
Air Flow LFM	0	50	100	150	200	250	300	350	400

Note: The underlined value(s) indicate airflow/local ambient combinations that exceed the allowable case temperature for the 82571EB or 82572EI. See 4.2, “Typical System Definitions” for system definitions.

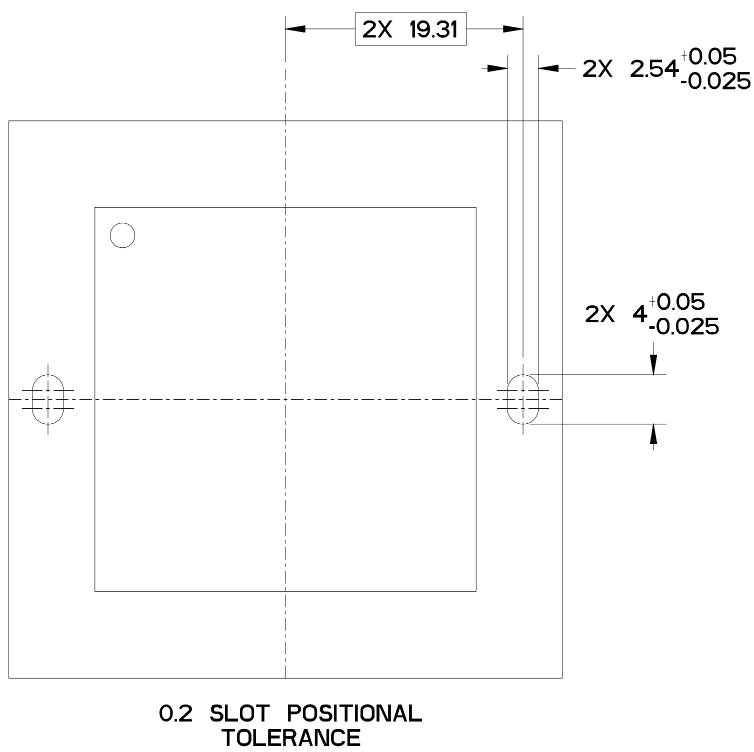
5 Thermal Enhancements (If Required)

One method frequently used to improve thermal performance is to increase the component's surface area by attaching a metallic heat sink to the component top. Increasing the surface area of the heat sink reduces the thermal resistance from the heat sink to the air increasing heat transfer.

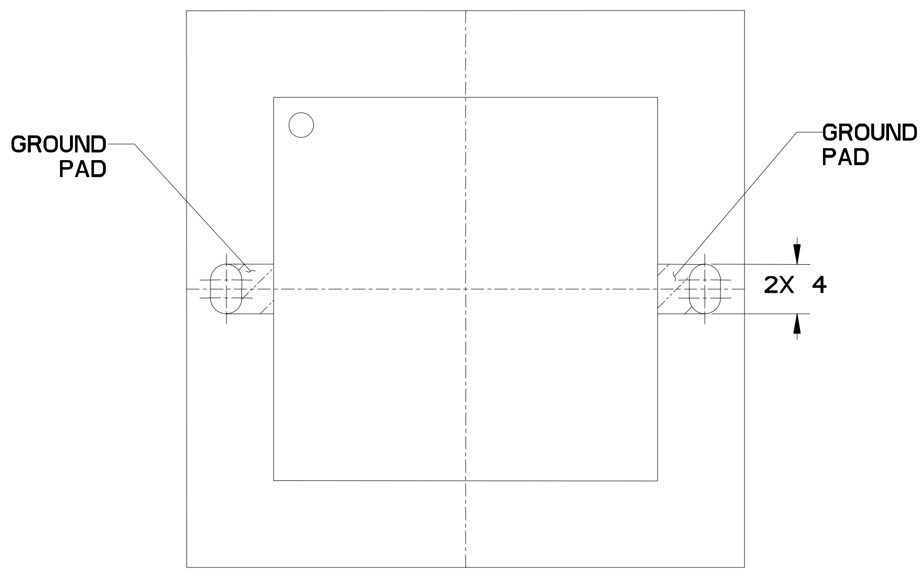
5.1 Clearances

To be effective, a heat sink requires a pocket of air around it free of obstructions. Though each design may have unique mechanical restrictions, the recommended clearance zones for a heat sink used with the 82571EB or 82572EI are shown in Figure 3

Figure 3 - 82571EB/82572EI Heat Sink Volume Restrictions



Primary Side



Secondary Side

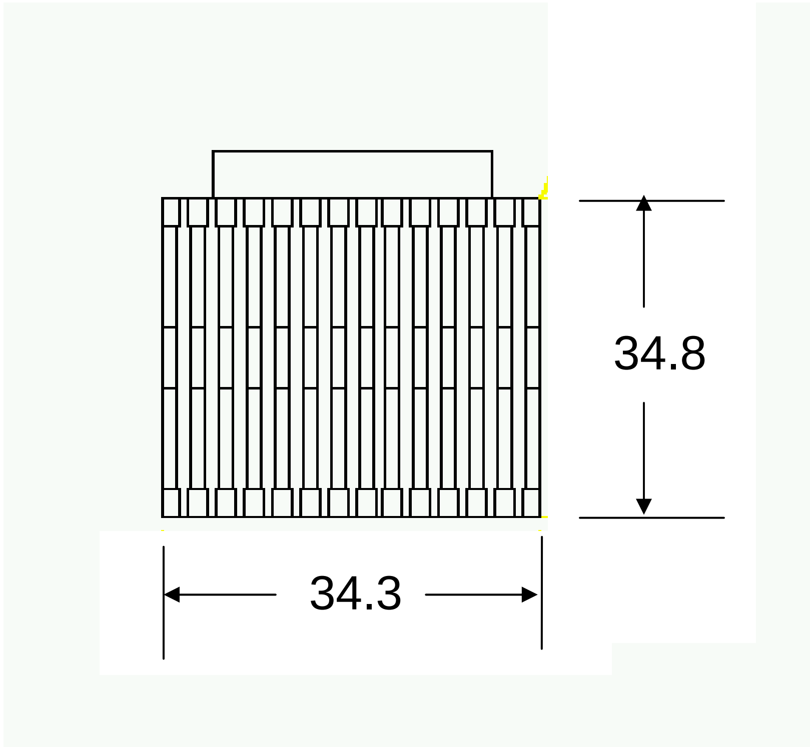
5.2 Default Enhanced Thermal Solution

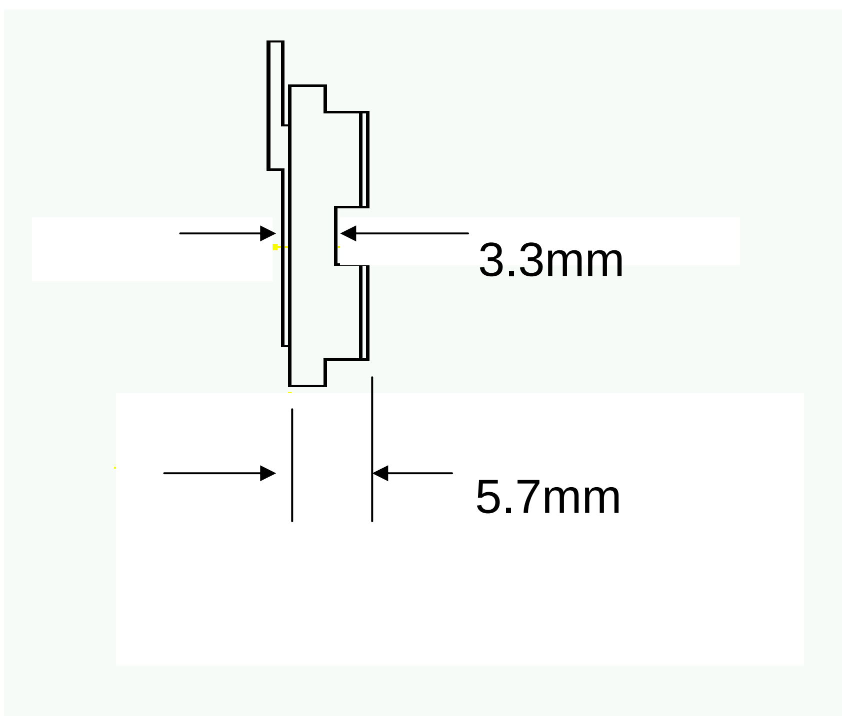
If you have no control over the end-user's thermal environment or if you wish to bypass the thermal modeling and evaluation process, use the Default Enhanced Thermal Solution (discussed in the following section). The Default Enhanced Thermal Solution replicates the performance defined in Table 3 at the thermal design power. If the case temperature continues to exceed the appropriate value listed in Table 23 after implementing the Default Enhanced Thermal Solution, additional cooling is needed, see Figure 2, "- Max. Allowable Ambient Temperature vs. Air Flow." This may be achieved by improving airflow to the component and/or adding additional thermal enhancements.

5.3 Extruded Heat sinks

If required, the following extruded heat sink is the suggested 82571EB/82572EI thermal solution. Figure 4 shows the heat sink drawing. Other equivalent heat sinks and their sources are provided in Appendix A, "Heat sink and Attach Suppliers".

Figure 4 - 82571EB/82572EI Extruded Heat sink (dimensions in millimeters)





5.4 Attaching the Extruded Heat sink

The extruded heat sink may be attached using clips with a phase change thermal interface material.

5.4.1 Clips

A well-designed clip, in conjunction with a thermal interface material (tape, grease, etc.) often offers the best combination of mechanical stability and rework-ability. Use of a clip requires significant advance planning as mounting holes are required in the PCB. Use non-plated mounting with a grounded annular ring on the solder side of the board surrounding the hole. For a typical low-cost clip, set the annular ring inner diameter to 150 mils and an outer diameter to 300 mils. Define the ring to have at least eight ground connections. Set the solder mask opening for these holes with a radius of 300 mils.

5.4.2 Thermal Interface Material (PCM45F)

The recommended thermal interface is PCM45F from Honeywell. The PCM45F thermal interface pads are phase change materials formulated for use in high performance devices requiring minimum thermal resistance for maximum heat sink performance and component reliability. These pads consist of an electrically non-conductive, dry film that softens at device operating temperatures resulting in “greasy-like” performance. Alternate recommended TIM is PCM45F from Honeywell for cost saving purposes. However, Intel has not fully validated the PCM45F TIM.

Following the manufacturers recommended attach procedure list for the recommended thermal interface.

1. Ensure that the component surface and heat sink are free from contamination. Using proper safety precautions, clean the package top with a lint-free wipe and Isopropyl Alcohol.
2. Pre heat the heat sink to 50 C. Remove the Honeywell PCM45F from the carrier. For best result, Peel the TIM off of the carrier by peeling back the carrier at 180 degrees.
3. Carefully position the pad onto heat sink.
4. Apply 10 PSI pressure to the PCM45F pad and let the heat sink cool to room temperature (25C).
5. Remove top liner. Peel back at 180 degrees to prevent voids and achieve best results.
6. Dents and minor scratches in the material will not affect performance since the material is designed to flow at typical operating temperatures. Honeywell pads can be removed for rework using a single-edged razor and then cleaning the surface with isopropyl (IPA) solvent.

Note: Each PCA, system and heat sink combination varies in attach strength. Carefully evaluate the reliability of tape attaches prior to high-volume use (See Sect. **5.5**, "Reliability").

Figure 5 PCM45F attach process (in roll formal

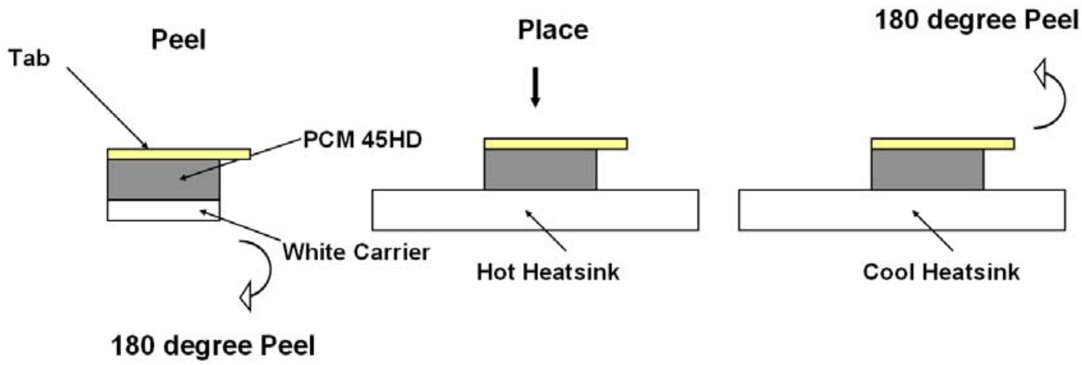
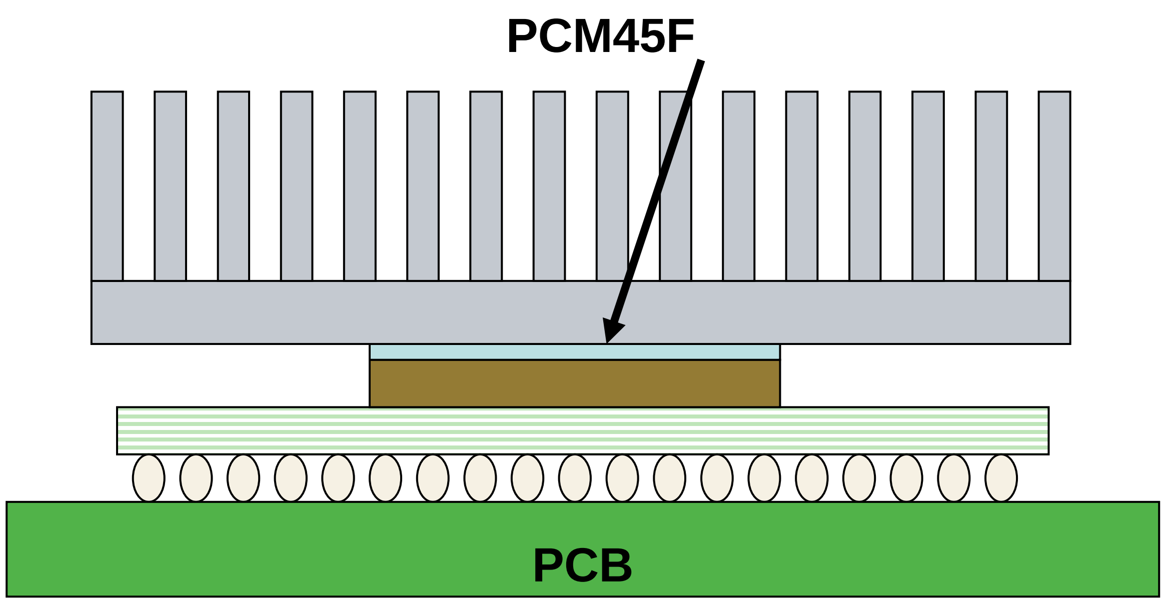


Figure 6 Completing the attach process



5.5 Reliability

Each PCA, system and heat sink combination varies in attach strength and long-term adhesive performance. Carefully evaluate the reliability of the completed assembly prior to high-volume use. Some reliability recommendations are shown in Table 4.

Table 4 Reliability Validation

Test [1]	Requirement	Pass/Fail Criteria [2]
Mechanical Shock	50G, board level 11 ms trapezoidal pulse, 3 shocks/axis	Visual & Electrical Check
Random Vibration	7.3G, board level 45 minutes/axis, 50 to 2000 Hz	Visual & Electrical Check
High-Temperature Life	85 °C 2000 hours total Checkpoints occur at 168, 500, 1000, and 2000 hours	Visual & Mechanical Check
Thermal Cycling	Per-Target Environment (for example: -40 °C to +85 °C) 500 Cycles	Visual & Mechanical Check
Humidity	85% relative humidity 85 °C, 1000 hours	Visual & Mechanical Check

1. Performed the above tests on a sample size of at least 12 assemblies from 3 lots of material (total = 36 assemblies).

2. Additional Pass/Fail Criteria can be added at your discretion.

5.6 Thermal Interface Management for Heat-Sink Solutions

To optimize the 82571EB/82572EI heat sink design, it is important to understand the interface between the heat spreader and the heat sink base. Specifically, thermal conductivity effectiveness depends on the following:

- Bond line thickness
- Interface material area
- Interface material thermal conductivity

5.6.1 Bond Line Management

The gap between the heat spreader and the heat sink base impacts the heat-sink's solution performance. The larger the gap between the two surfaces, the greater the thermal resistance. The thickness of the gap is determined by the flatness of both the heat sink base and the heat spreader, plus the thickness of the thermal interface material (for example, PSA, thermal grease, epoxy) used to join the two surfaces.

The planarity of the 82571EB/82572EI package is 8 mils.

5.6.2 Interface Material Performance

The following two factors impact the performance of the interface material between the heat spreader and the heat sink base:

- Thermal resistance of the material
- Wetting/filling characteristics of the material

5.6.2.1 Thermal Resistance of the Material

Thermal resistance describes the ability of the thermal interface material to transfer heat from one surface to another. The higher the thermal resistance, the less efficient is the heat transfer. The thermal resistance of the interface material has a significant impact on the thermal performance of the overall thermal solution. The higher the thermal resistance, the larger the temperature drop is required across the interface.

5.6.2.2 Wetting/Filling Characteristics of the Material

The wetting/filling characteristic of the thermal interface material is its ability to fill the gap between the heat spreader top surface and the heat sink. Since air is an extremely poor thermal conductor, the more completely the interface material fills the gaps, the lower the temperature-drop across the interface, increasing the efficiency of the thermal solution.

6 Measurements for Thermal Specifications

Determining the thermal properties of the system requires careful case temperature measurements. Guidelines for measuring 82571EB/82572EI case temperature are provided in Section 6.1, “Case Temperature Measurements”.

6.1 Case Temperature Measurements

Maintain 82571EB/82572EI Tcase at or below the maximum case temperatures listed in Table 2 to ensure functionality and reliability. Special care is required when measuring the case temperature to ensure an accurate temperature measurement. Use the following guidelines when making case measurements:

- Measure the surface temperature of the case in the geometric center of the case top.
- Calibrate the thermocouples used to measure Tcase before making temperature measurements.
- Use 36-gauge (maximum) K-type thermocouples.

Care must be taken to avoid introducing errors into the measurements when measuring a surface temperature that is a different temperature from the surrounding local ambient air. Measurement errors may be due to a poor thermal contact between the thermocouple junction and the surface of the package, heat loss by radiation, convection, conduction through thermocouple leads, and/or contact between the thermocouple cement and the heat-sink base (if used).

6.1.1 Attaching the Thermocouple (No Heat Sink)

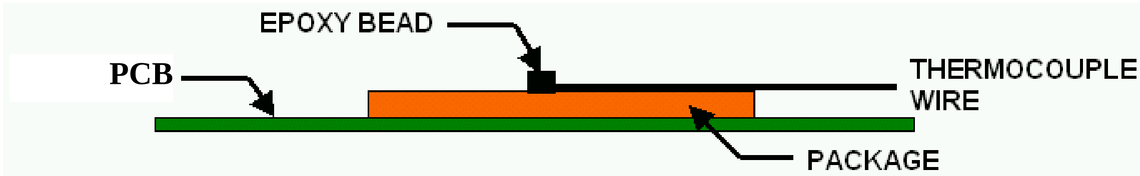
The following approach is recommended to minimize measurement errors for attaching the thermocouple with no heat sink:

- Use 36 gauge or smaller diameter K type thermocouples.
- Ensure that the thermocouple has been properly calibrated.
- Attach the thermocouple bead or junction to the top surface of the package (case) in the center of the heat spreader using high thermal conductivity cements.

Note: It is critical that the entire thermocouple lead be butted tightly to the heat spreader.

- Attach the thermocouple at a 0° angle if there is no interference with the thermocouple attach location or leads (refer Figure 7) This is the preferred method and is recommended for use with non-enhanced packages.

Figure 7 - Technique for Measuring Tcase with 0° Angle Attachment, No Heat Sink



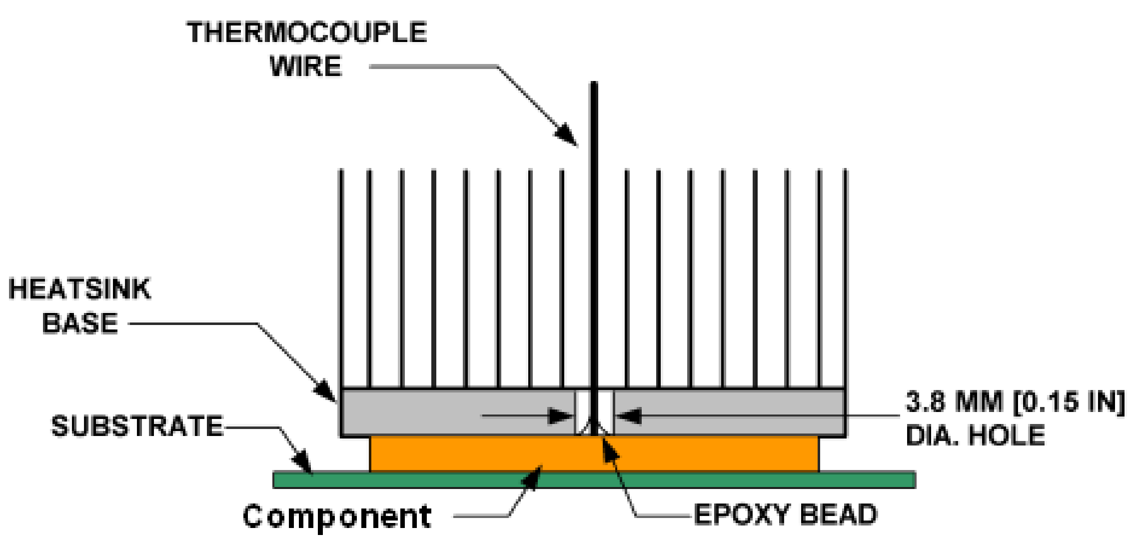
6.1.2 Attaching the Thermocouple (Heat Sink)

- The following approach is recommended to minimize measurement errors for attaching the thermocouple with heat sink:
- Use 36 gauge or smaller diameter K-type thermocouples.
- Ensure that the thermocouple is properly calibrated.
- Attach the thermocouple bead or junction to the case's top surface in the geometric center using high thermal conductivity cement.

Note: It is critical that the entire thermocouple lead be butted tightly against the case.

- Attach the thermocouple at a 90° angle if there is no interference with the thermocouple attach location or leads (refer to Figure 8). This is the preferred method and is recommended for use with packages with heat sinks.
- For testing purposes, a hole (no larger than 0.150" in diameter) must be drilled vertically through the center of the heat sink to route the thermocouple wires out.
- Ensure there is no contact between the thermocouple cement and heat sink base. Any contact affects the thermocouple reading.

Figure 8 - Technique for Measuring Tcase with 90° Angle Attachment



7 Thermal Diode

The 82571EB/82572EI processor incorporates an on-die diode that may be used to monitor the die temperature (junction temperature). A thermal sensor located on the motherboard or a stand-alone measurement kit, may monitor the die temperature of the 82571EB/82572EI for thermal management or characterization.

Table 6 - Thermal Diode Parameters

Symbol	Min	Typical	Max	Unit	Notes
I forward bias	5		300	uA	1
n_ideality	1.0181	1.0192	1.0216		2,4
ESR	3.4 @20C	5.3 @80C	6.1 @100C	ohm	3

Note:

1. Intel does not support or recommend operation of the thermal diode under reverse bias.
2. At room temperature with a forward bias of 630 mV.
3. ESR: Effective Series Resistance - needed for various TD measurement tools.
4. n_ideality is the diode ideality factor parameter, as represented by the diode equation:

$$I = I_0\left(e^{\frac{eV_D}{nkT}} - 1\right)$$

Table 7 - Thermal Diode Interface

Pin Name	Pin/Ball Number	Pin Description
THERMDA	D4	Diode anode (p_junction)
THERMDC	D5	Diode cathode (n_junction)

8 Conclusion

Increasingly complex systems require better power dissipation. Care must be taken to ensure that the additional power is properly dissipated. Heat can be dissipated using improved system cooling, selective use of ducting, passive or active heat sinks, or any combination.

The simplest and most cost effective method is to improve the inherent system cooling characteristics through careful design and placement of fans, vents, and ducts. When additional cooling is required, thermal enhancements may be implemented in conjunction with enhanced system cooling. The size of the fan or heat sink can be varied to balance size and space constraints with acoustic noise.

This document has presented the conditions and requirements to properly design a cooling solution for systems implementing the 82571EB or 82572EI. Properly designed solutions provide adequate cooling to maintain the 82571EB/82572EI case temperature at or below those listed in Table 2. Ideally, this is accomplished by providing a low local ambient temperature and creating a minimal thermal resistance to that local ambient temperature. Alternatively, heat sinks may be required if case temperatures exceed those listed in Table 2.
By maintaining the 82571EB/82572EI case temperature at or below those recommended in this document, the 82571EB/82572EI will function properly and reliably.

Use this document to understand the 82571EB/82572EI thermal characteristics and compare them to your system environment. Measure the 82571EB/82572EI case temperatures to determine the best thermal solution for your design.

Appendix A Heat Sink and Attach Suppliers

Part	Part number	Supplier	Contact information
Heatsink	728443-002	Foxconn	Hon Hai Precision Industry Co. Ltd Contact: Susiey Chen TBD TBD Tel: TBD Fax: TBD susiey.chen@foxconn.com
Clip	C63585-001	CCI	Chaun-Choung Tech. Corp. Contact: Monica Chih 12F NO123-1 Hsing-De Rd. Sanchung, Taipei, Taiwan, ROC Tel: 886-2-29952666 Fax: 886-2-29958258 monica_chih@ccic.com.tw
Thermal interface	PCM45F included with heatsink size = 20mm^2	Honeywell	North America Technical Contact: Paula Knoll 1349 Moffett Park Dr. Sunnyvale, CA 94089 Cell: 1-858-705-1274 Business: 858-279-2956 paula.knoll@honeywell.com
TBD	TBD	TBD	TBD TBD TBD Tel: TBD Fax: TBD TBD@TBD.com

Appendix B PCB Guidelines

The following general PCB design guidelines are recommended to maximize the thermal performance of FCBGA packages:

1. When connecting ground (thermal) vias–to the ground planes, do not use thermal-relief patterns.
2. Thermal-relief patterns are designed to limit heat transfer between the vias and the copper planes, thus constricting the heat flow path from the component to the ground planes in the PCB.
3. As board temperature also has an effect on the thermal performance of the package, avoid placing 82571EB or 82572EI adjacent to high power dissipation devices.
4. If airflow exists, locate the components in the mainstream of the airflow path for maximum thermal performance. Avoid placing the components downstream, behind larger devices or devices with heat sinks that obstruct the air flow or supply excessively heated air.

Note: The above guidelines are not all inclusive and are defined to give you known, good design practices to maximize the thermal performance of the components.