Intel® 5400 Chipset Memory Controller Hub (MCH)

Thermal/Mechanical Design Guidelines

November 2007

Reference Number: 318639 Revision: 001

INFORMATION IN THIS DOCUMENT IS PROVIDED IN CONNECTION WITH INTEL® PRODUCTS. EXCEPT AS PROVIDED IN INTEL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, INTEL ASSUMES NO LIABILITY WHATSOEVER, AND INTEL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO SALE AND/OR USE OF INTEL PRODUCTS, INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT, OR OTHER INTELLECTUAL PROPERTY RIGHT.

Intel may make changes to specifications, product descriptions, and plans at any time, without notice.

Designers must not rely on the absence or characteristics of any features or instructions marked "reserved" or "undefined." Intel reserves these for future definition and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to them.

The Intel® 5400 Chipset may contain design defects or errors known as errata, which may cause the product to deviate from published specifications. Current characterized errata are available upon request.

Contact your local Intel sales office or your distributor to obtain the latest specifications and before placing your product order.

Copies of documents which have an order number and are referenced in this document, or other Intel literature, may be obtained by calling

1-800-548-4725, or by visiting Intel's website at http://www.intel.com.

Intel, Xeon, and the Intel logo are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.

Copyright © 2007, Intel Corporation. All rights reserved.

* Other brands and names may be claimed as the property of others.

Contents

1 **Introduction** 7
  1.1 Design Flow 7
  1.2 Definition of Terms 8
  1.3 Reference Documents 9

2 **Packaging Technology** 11
  2.1 Non-Critical to Function Solder Joints 13
  2.2 Package Mechanical Requirements 14

3 **Thermal Specifications** 15
  3.1 Thermal Design Power (TDP) 15
  3.2 Case Temperature 15

4 **Thermal Simulation** 17

5 **Thermal Metrology** 19
  5.1 MCH Case Measurement 19
    5.1.1 Supporting Test Equipment 19
    5.1.2 Thermal Calibration and Controls 20
    5.1.3 IHS Groove 20
    5.1.4 Thermocouple Conditioning and Preparation 22
    5.1.5 Thermocouple to the IHS 22
    5.1.6 Curing Process 26
    5.1.7 Thermocouple Wire Management 27
  5.2 Power Simulation Software 28

6 **Reference Thermal Solution** 29
  6.1 Operating Environment 29
  6.2 Heatsink Performance 29
  6.3 Mechanical Design Envelope 30
  6.4 Board-Level Components Keepout Dimensions 31
  6.5 Tall Torsional Clip Heatsink Thermal Solution Assembly 31
    6.5.1 Heatsink Orientation 33
    6.5.2 Extruded Heatsink Profiles 34
    6.5.3 Mechanical Interface Material 34
    6.5.4 Thermal Interface Material 34
    6.5.5 Heatsink Clip 35
    6.5.6 Clip Retention Anchors 35
  6.6 Reliability Guidelines 36

A **Thermal Solution Component Suppliers** 37
  A.1 Tall Torsional Clip Heatsink Thermal Solution 37

B **Mechanical Drawings** 39

Figures

1-1 Thermal Design Process 8
2-1 MCH Package Dimensions (Top View) 11
2-2 MCH Package Dimensions (Side View) 11
2-3 MCH Package Dimensions (Bottom View) 12
2-4 Non-Critical to Function Solder Joints 13
5-1 IHS Groove Dimensions 21
5-2 Orientation of Thermocouple Groove Relative to Package Pin 22
5-3 Bending the Tip of the Thermocouple 22
5-4 Securing Thermocouple Wires with Kapton* Tape Prior to Attach 23
5-5 Thermocouple Bead Placement 24
5-6 Position Bed on the Groove Step 24
5-7 Using 3D Micromanipulator to Secure Bead Location 25
5-8 Measuring Resistance between Thermocouple and IHS 25
5-9 Applying in the Adhesive on the Thermocouple Bead 26
5-10 Thermocouple Wire Management in the Groove 27
5-11 Removing Excess Adhesive from the IHS 27
5-12 Filling the Groove with Adhesive 28
6-1 Tall Torsional Clip Heatsink Measured Thermal Performance versus Approach Velocity 30
6-2 Tall Torsional Clip Heatsink Volumetric Envelope for the Chipset MCH 31
6-3 Tall Torsional Clip Heatsink Board Component Keepout 32
6-4 Retention Mechanism Component Keepout Zones 33
6-5 Tall Torsional Clip Heatsink Assembly 34
6-6 Tall Torsional Clip Heatsink Extrusion Profile 35
B-1 Tall Torsional Clip Heatsink Assembly Drawing 40
B-2 Tall Torsional Heatsink Drawing 41
B-3 Tall Torsional Clip Heatsink Clip Drawing 42

Tables

3-1 Intel® 5400 Chipset with FSB 1333 MHz Thermal Specifications 15
3-2 Intel® 5400 Chipset with FSB 1600 MHz Thermal Specifications 15
5-1 Thermocouple Attach Support Equipment 19
6-1 Honeywell PCM45 F* TIM Performance as a Function of Attach Pressure 35
6-2 Reliability Guidelines 36
B-1 Mechanical Drawing List 39

Revision History

Document Number	Revision Number	Description	Date
318639	001	• Initial release of the document.	November 2007

§

1 Introduction

As the complexity of computer systems increases, so do the power dissipation requirements. Care must be taken to ensure that the additional power is properly dissipated. Typical methods to improve heat dissipation include selective use of ducting, and/or passive heatsinks.

The goals of this document are to:

- Outline the thermal and mechanical operating limits and specifications for the Intel® 5400 chipset.
- Describe reference thermal solutions that meet the specifications of the Intel® 5400 chipset.

Properly designed thermal solutions provide adequate cooling to maintain the Intel 5400 chipset case temperatures at or below thermal specifications. This is accomplished by providing a low local-ambient temperature, ensuring adequate local airflow, and minimizing the case to local-ambient thermal resistance. By maintaining the Intel 5400 chipset case temperature at or below the specified limits, a system designer can ensure the proper functionality, performance, and reliability of the chipset. Operation outside the functional limits can degrade system performance and may cause permanent changes in the operating characteristics of the component.

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

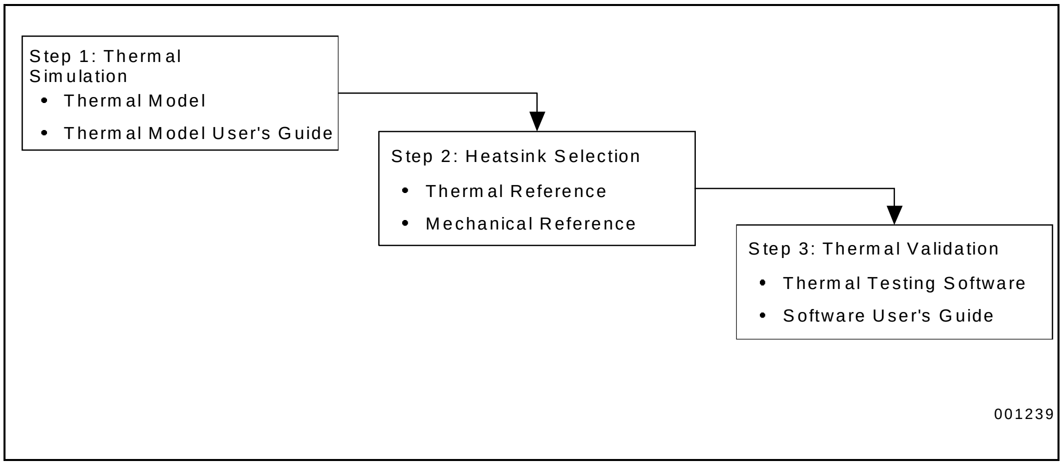
This document addresses thermal design and specifications for the Intel 5400 chipset component only. For thermal design information on other chipset components, refer to the respective component TMDG. For the PXH, refer to the *Intel® 6700PXH 64-bit PCI Hub Thermal/Mechanical Design Guidelines*. For the Intel® 631xESB/632xESB I/O Controller Hub, refer to the *Intel®* 631xESB/632xESB I/O Controller Hub Thermal/ Mechanical Design Guidelines.

Note: Unless otherwise specified, the term "MCH" refers to the Intel 5400 chipset.

1.1 Design Flow

To develop a reliable, cost-effective thermal solution, several tools have been provided to the system designer. Figure 1-1 illustrates the design process implicit to this document and the tools appropriate for each step.

Figure 1-1. Thermal Design Process


Step 1: Thermal Simulation
• Thermal Model
• Thermal Model User's Guide
Step 2: Heatsink Selection
• Thermal Reference
• Mechanical Reference
Step 3: Thermal Validation
• Thermal Testing Software
• Software User's Guide
001239

1.2 Definition of Terms

BGA	Ball grid array. A package type, defined by a resin-fiber substrate, onto which a die is mounted, bonded and encapsulated in molding compound. The primary electrical interface is an array of solder balls attached to the substrate opposite the die and molding compound.
BLT	Bond line thickness. Final settled thickness of the thermal interface material after installation of heatsink.
Intel® 631xESB/632xESB I/O Controller Hub	The chipset component that integrates an Ultra ATA 100 controller, six Serial ATA host controller ports, one EHCI host controller, and four UHCI host controllers supporting eight external USB 2.0 ports, LPC interface controller, flash BIOS interface controller, PCI interface controller, Azalia / AC’97 digital controller, integrated LAN controller, an ASF controller and a ESI for communication with the MCH. The Intel 631xESB/632xESB I/O Controller Hub component provides the data buffering and interface arbitration required to ensure that system interfaces operate efficiently and provide the bandwidth necessary to enable the system to obtain peak performance.
MCH	Memory controller hub. The chipset component that contains the processor interface, the memory interface, the PCI Express* interface and the ESI interface.
PXH	Intel® 6700PXH 64-bit Hub. The chipset component that performs PCI bridging functions between the PCI Express interface and the PCI Bus. It contains two PCI bus interfaces that can be independently configured to operate in PCI (33 or 66 MHz) or PCI-X* mode 1 (66, 100 or 133 MHz), for either 32 or 64 bit PCI devices.
PXH-V	Intel® 6702PXH 64-bit Hub. The chipset component that performs PCI bridging functions between the PCI Express interface and the PCI Bus. It contains one PCI bus interface that can be configured to operate in PCI (33 or 66 MHz) or PCI-X mode 1 (66, 100 or 133 MHz).
T_{case_max}	IHS temperature allowed. This temperature is measured at the geometric center of the top of IHS.

TDP	Thermal design power. Thermal solutions should be designed to dissipate this target power level. TDP is not the maximum power that the chipset can dissipate.

1.3 Reference Documents

The reader of this specification should also be familiar with material and concepts presented in the following documents:

- *Intel® 6700PXH 64-bit PCI Hub Thermal/Mechanical Design Guide*
- *Intel® 6700PXH 64-bit PCI Hub Datasheet*
- *Intel® 5400 Chipset Memory Controller Hub (MCH) Datasheet*
- *BGA/OLGA Assembly Development Guide*
- Various system thermal design suggestions (http://www.formfactors.org)

Note: Unless otherwise specified, these documents are available through your Intel field sales representative. Some documents may not be available at this time.

§

2 Packaging Technology

Intel 5400 chipset consist of three individual components: the Memory Controller Hub (MCH), the Intel 6700PXH 64-bit PCI Hub (PXH) and the Intel 631xESB/632xESB I/O Controller Hub. The Intel 5400 chipset component uses a 42.5 mm, 12-layer flip chip ball grid array (FC-BGA) package (see Figure 2-2 and Figure 2-3). For information on the PXH package, refer to the *Intel® 6700PXH 64-bit PCI Hub Thermal/Mechanical Design Guidelines*. For information on the ESB2 package, refer to the *Intel® 631xESB/632xESB I/O Controller Hub Thermal/Mechanical Design Guidelines*.

Figure 2-1. MCH Package Dimensions (Top View)

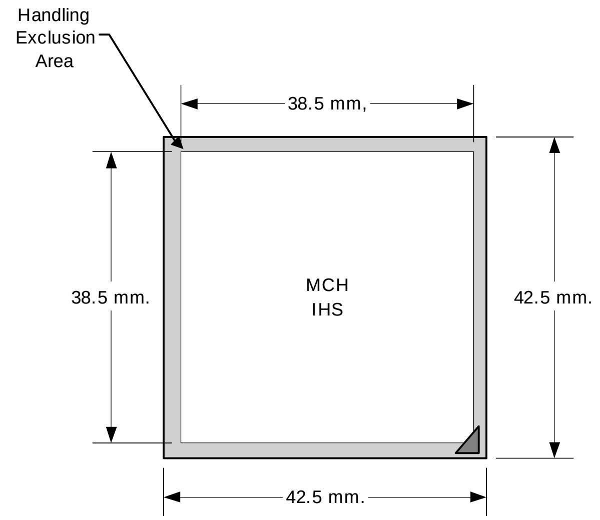
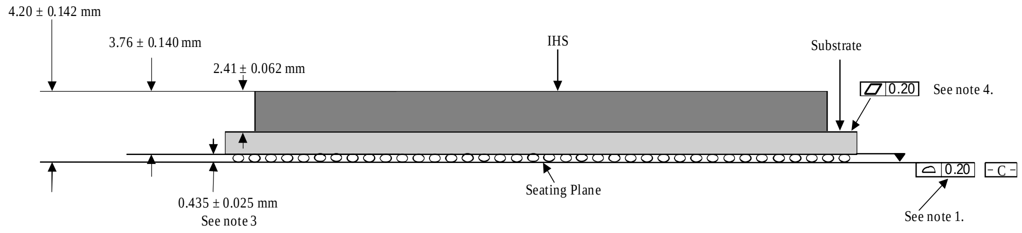
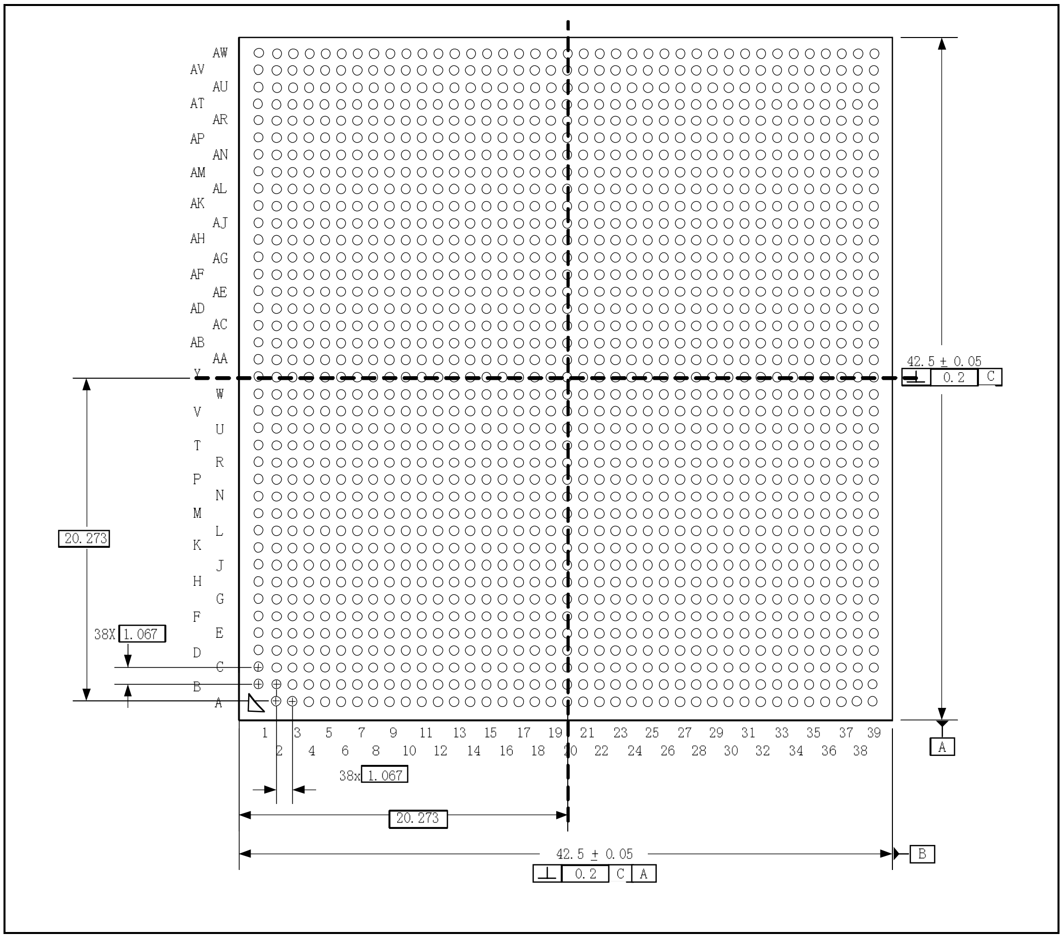

Handling
Exclusion
Area
38.5 mm,
38.5 mm.
MCH
IHS
42.5 mm.
42.5 mm.

Figure 2-2. MCH Package Dimensions (Side View)


4.20 ± 0.142 mm
3.76 ± 0.140 mm
2.41 ± 0.062 mm
IHS
Substrate
0.20
See note 4.
0.20
-C-
Seating Plane
0.435 ± 0.025 mm
See note 3
See note 1.

Notes:
1. Primary datum -C- and seating plan are defined by the spherical crowns of the solder balls(shown before motherboard attach)
2. All dimensions and tolerances conform to ANSI Y14.5M-1994
3. BGA has a pre-SMT height of 0.5mm and post-SMT height of 0.41-0.46mm
4. Shown before motherboard attach; FCBGA has a convex (dome shaped) orientation before reflow and is expected to have a slightly concave(bowl shaped) orientation after reflow

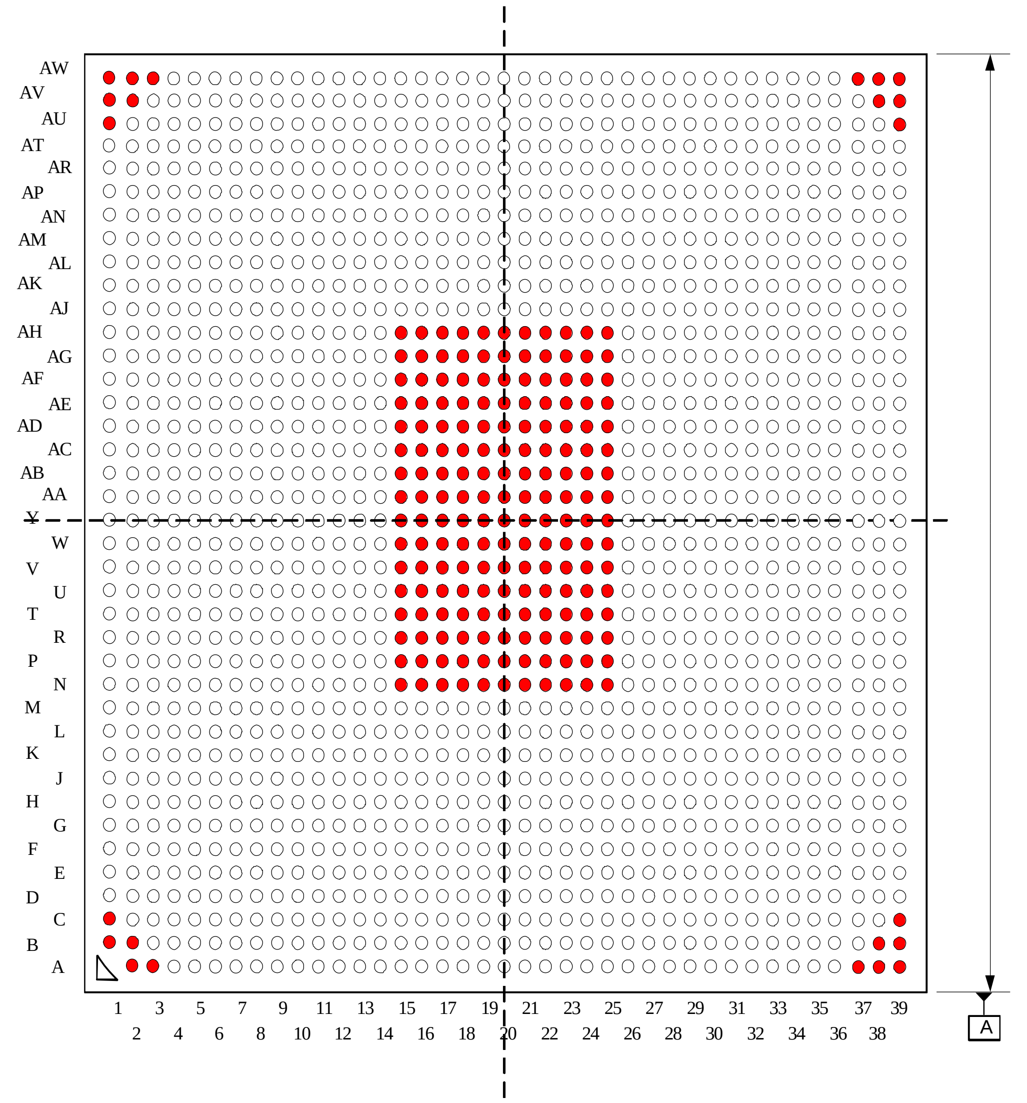
Figure 2-3. MCH Package Dimensions (Bottom View)


AW
AV
AU
AT
AR
AP
AN
AM
AL
AK
AJ
AH
AG
AF
AE
AD
AC
AB
AA
Y
W
V
U
T
R
P
N
M
L
K
J
H
G
F
E
D
C
B
A
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38
20.273
38X 1.067
38x 1.067
20.273
42.5 ± 0.05
0.2
C
A
42.5 ± 0.05
B
0.2
C
A

Notes:
1. All dimensions are in millimeters.
2. All dimensions and tolerances conform to ANSI Y14.5M-1994.

2.1 Non-Critical to Function Solder Joints

Figure 2-4. Non-Critical to Function Solder Joints


AW
AV
AU
AT
AR
AP
AN
AM
AL
AK
AJ
AH
AG
AF
AE
AD
AC
AB
AA
Y
W
V
U
T
R
P
N
M
L
K
J
H
G
F
E
D
C
B
A
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
A

Intel has defined selected solder joints of the MCH as non-critical to function (NCTF) when evaluating package solder joints post environmental testing. The MCH signals at NCTF locations are typically redundant ground or non-critical reserved, so the loss of the solder joint continuity at end of life conditions will not affect the overall product functionality. Figure 2-4 identifies the NCTF solder joints of the MCH package.

2.2 Package Mechanical Requirements

The Intel 5400 chipset package has an integrated heat spreader (IHS) that is capable of sustaining a maximum static normal load of 15 lbf. These mechanical load limits must not be exceeded during heatsink installation, mechanical stress testing, standard shipping conditions and/or any other use condition.

Note: The heatsink attach solutions must not include continuous stress to the chipset package with the exception of a uniform load to maintain the heatsink-to-package thermal interface.

Note: These specifications apply to uniform compressive loading in a direction perpendicular to the IHS top surface.

Note: This static load specification is based on limited testing for design characterization using Mechanical Test Board (MTB) which has the similar layout as the Intel Customer Reference Board (CRB). Loading limits are for the package only.

§

3 Thermal Specifications

3.1 Thermal Design Power (TDP)

Analysis indicates that real applications are unlikely to cause the MCH component to consume maximum power dissipation for sustained time periods. Therefore, in order to arrive at a more realistic power level for thermal design purposes, Intel characterizes power consumption based on known platform benchmark applications. The resulting power consumption is referred to as the Thermal Design Power (TDP). TDP is the target power level to which the thermal solutions should be designed. TDP is not the maximum power that the chipset can dissipate.

For TDP specifications, see Table 3-1 for the Intel 5400 chipset. FC-BGA packages have poor heat transfer capability into the board and have minimal thermal capability without thermal solution. Intel recommends that system designers plan for a heatsink when using Intel 5400 chipset.

3.2 Case Temperature

To ensure proper operation and reliability of the Intel 5400 chipset, the case temperature must be at or between the maximum/minimum operating temperature ranges as specified in Table 3-1 and Table 3-2. System and/or component level thermal solutions are required to maintain these temperature specifications. Refer to Chapter 5 for guidelines on accurately measuring package case temperatures.

Table 3-1. Intel® 5400 Chipset with FSB 1333 MHz Thermal Specifications

Parameter	Value	Notes
T_{case_max}	85.8°C	
T_{case_min}	5°C	
$TDP_{\text{with 1 active memory channel}}$	32.3 W	
$TDP_{\text{with 2 active memory channels}}$	33.2 W	
$TDP_{\text{with 4 active memory channels}}$	35.0 W	

Note: These specifications are based on post-silicon power measurement.

Table 3-2. Intel® 5400 Chipset with FSB 1600 MHz Thermal Specifications

Parameter	Value	Notes
T_{case_max}	83.8°C	
T_{case_min}	5°C	
$TDP_{\text{with 1 active memory channel}}$	35.3 W	
$TDP_{\text{with 2 active memory channels}}$	36.2 W	
$TDP_{\text{with 4 active memory channels}}$	38.0 W	

Note: These specifications are based on post-silicon power measurement.

§

4 Thermal Simulation

Intel provides thermal simulation models of the Intel 5400 chipset and associated users' guides to aid system designers in simulating, analyzing, and optimizing their thermal solutions in an integrated, system-level environment. The models are for use with the commercially available Computational Fluid Dynamics (CFD)-based thermal analysis tool FLOTHERM* (version 5.1 or higher) by Flomerics, Inc. Contact your Intel field sales representative to order the thermal models and users' guides.

§

5 Thermal Metrology

The system designer must make temperature measurements to accurately determine the thermal performance of the system. Intel has established guidelines for proper techniques to measure the MCH case temperatures. Section 5.1 provides guidelines on how to accurately measure the MCH case temperatures. Section Section 5.2 contains information on running an application program that will emulate anticipated maximum thermal design power (Figure 5-1).

5.1 MCH Case Measurement

Intel 5400 chipset cooling performance is determined by measuring the case temperature using a thermocouple. For case temperature measurements, the attached method outlined in this section is recommended for mounting a thermocouple.

Special care is required when measuring case temperature (T_C) to ensure an accurate temperature measurement. Thermocouples are often used to measure T_C. When measuring the temperature of a surface that is at a different temperature from the surrounding local ambient air, errors may be introduced in the measurements. The measurement errors can be caused by poor thermal contact between the thermocouple junction and the surface of the integrated heat spreader, heat loss by radiation, convection, by conduction through thermocouple leads, or by contact between the thermocouple cement and the heatsink base. To minimize these measurement errors, the approach outlined in the next section is recommended.

5.1.1 Supporting Test Equipment

To apply the reference thermocouple attach procedure, it is recommended that you use the equipment (or equivalent) given in. Table 5-1.

Table 5-1. Thermocouple Attach Support Equipment (Sheet 1 of 2)

Item	Description	Part number
Measurement and Output		
Microscope	Olympus Light microscope or equivalent	SZ-40
Digital Multi-meter	Digital Multi Meter for resistance measurement	Not Available
Test Fixture(s)		
Micromanipulator* (See note)	Micromanipulator set from YOU Ltd. or equivalent Mechanical 3D arm with needle (not included) to maintain TC bead location during the attach process.	YOU-3
Miscellaneous Hardware		
Super Bonder* 498 Thermal Cycling Resistant Instant Adhesive	Super glue w/thermal characteristics	49850
Adhesive Accelerator	Loctite 7452* for fast glue curing	18490
Kapton Tape	For holding thermocouple in place or equivalent	Not Available
Thermocouple	Omega, 36 gauge, “T” Type	5SRTC-TT-36-72

Table 5-1. Thermocouple Attach Support Equipment (Sheet 2 of 2)

Item	Description	Part number
Calibration and Control		
Ice Point* Cell	Omega, stable 0°C temperature source for calibration and offset	TRCIII
Hot Point* Cell	Omega, temperature source to control and understand meter slope gain	CL950-A-110

Note: Three axes set consists of (1ea. U-31CF), (1ea. UX-6-6), (1ea. USM6) and (1ea. UPN-1). More information available at: **http://www.narishige.co.jp/you_ltd/english/products/set/you-set.htm#3**

5.1.2 Thermal Calibration and Controls

It is recommended that full and routine calibration of temperature measurement equipment be performed before attempting to perform temperature case measurement of the Intel 5400 chipset. Intel recommends checking the meter probe set against known standards. This should be done at 0°C (using ice bath or other stable temperature source) and at an elevated temperature, around 80ºC (using an appropriate temperature source).

Note: Wire gauge and length should also be considered as some less expensive measurement systems are heavily impacted by impedance. There are numerous resources available throughout the industry to assist with implementation of proper controls for thermal measurements.

Note: It is recommended to follow company standard procedures and wear safety items like glasses for cutting the IHS and gloves for chemical handling.

Note: Ask your Intel field sales representative if you need assistance to groove and/or install a thermocouple according to the reference process.

5.1.3 IHS Groove

Cut a groove in the package IHS according to the drawing given in. Figure 5-1.

Figure 5-1. IHS Groove Dimensions

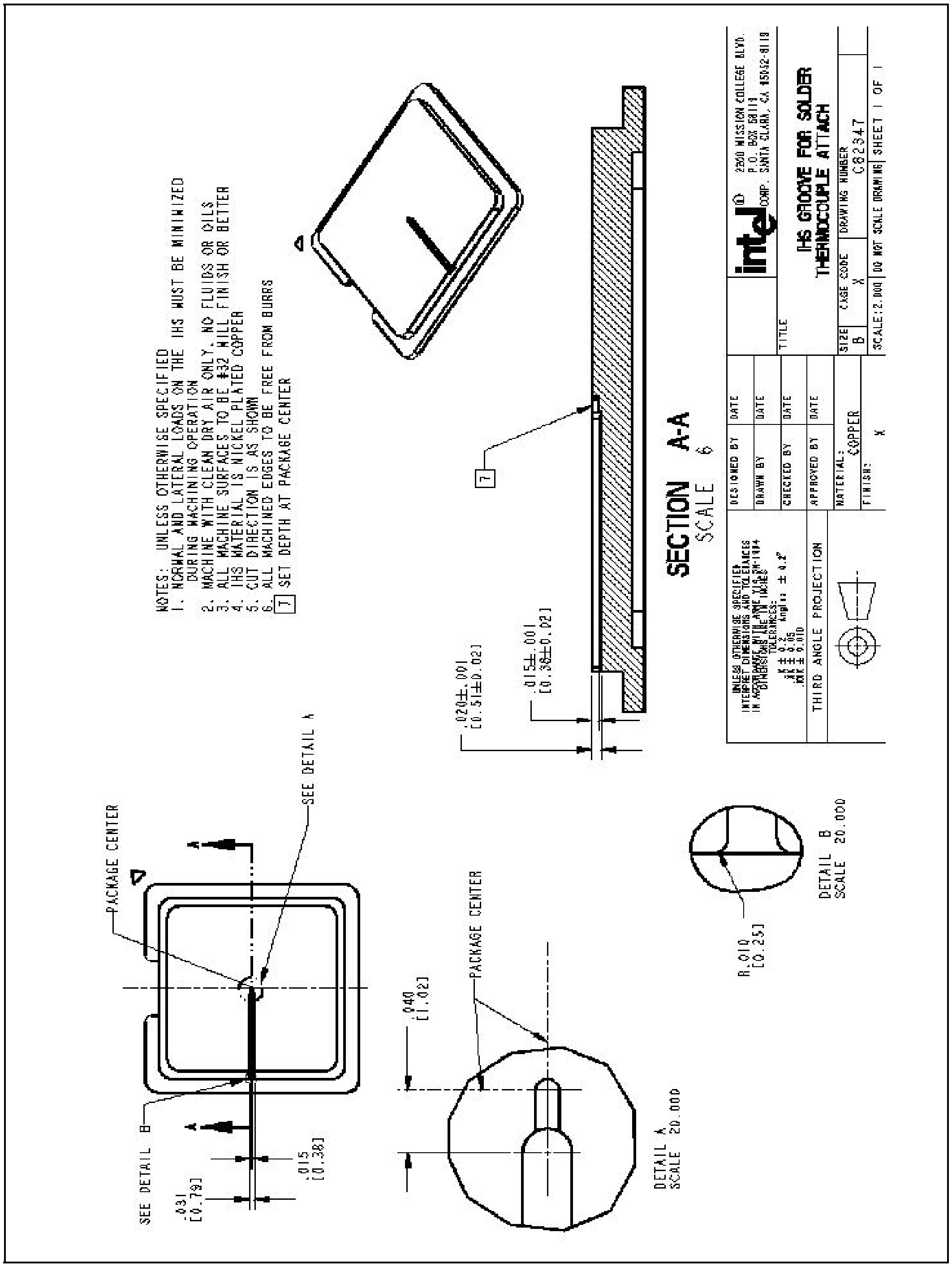
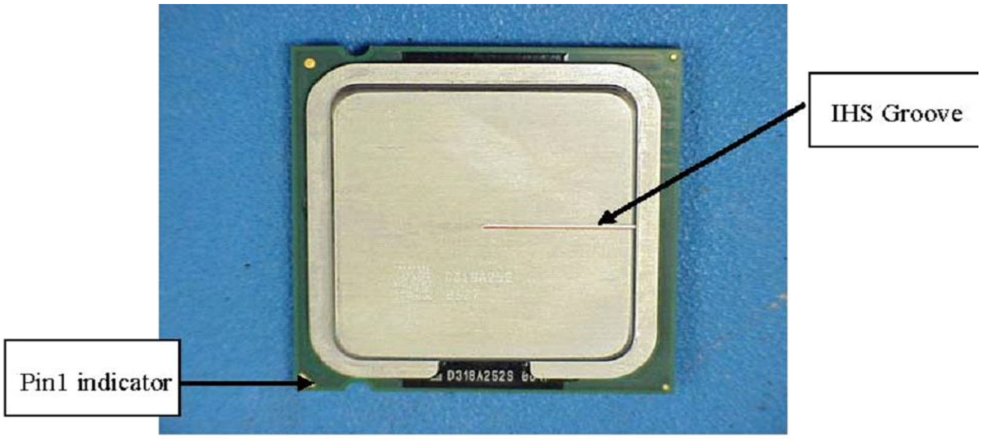

NOTES: UNLESS OTHERWISE SPECIFIED
1. NORMAL AND LATERAL LOADS ON THE IHS MUST BE MINIMIZED DURING MACHINING OPERATION
2. MACHINE WITH CLEAN DRY AIR ONLY. NO FLUIDS OR OILS
3. ALL MACHINE SURFACES TO BE #32 WILL FINISH OR BETTER
4. IHS MATERIAL IS NICKEL PLATED COPPER
5. CUT DIRECTION IS AS SHOWN
6. ALL MACHINED EDGES TO BE FREE FROM BURRS
7 SET DEPTH AT PACKAGE CENTER
SECTION A-A
SCALE 6
.020±.001
[0.51±0.02]
.015±.001
[0.38±0.02]
7
PACKAGE CENTER
SEE DETAIL A
SEE DETAIL B
A
A
.031
[0.79]
.015
[0.38]
PACKAGE CENTER
.040
[1.02]
DETAIL A
SCALE 20.000
R.010
[0.25]
DETAIL B
SCALE 20.000
UNLESS OTHERWISE SPECIFIED INTERPRET DIMENSIONS AND TOLERANCES IN ACCORDANCE WITH ASME Y14.5M-1994
DIMENSIONS ARE IN INCHES
TOLERANCES:
.X ± 0.2 Angles ± 0.2°
.XX ± 0.05
.XXX ± 0.010
THIRD ANGLE PROJECTION
DESIGNED BY
DATE
DRAWN BY
DATE
CHECKED BY
DATE
APPROVED BY
DATE
MATERIAL: COPPER
FINISH: X
intel CORP.
2200 MISSION COLLEGE BLVD.
P.O. BOX 58119
SANTA CLARA, CA 95052-8119
TITLE
IHS GROOVE FOR SOLDER THERMOCOUPLE ATTACH
SIZE B
CAGE CODE X
DRAWING NUMBER C62347
SCALE: 2.000
DO NOT SCALE DRAWING
SHEET 1 OF 1

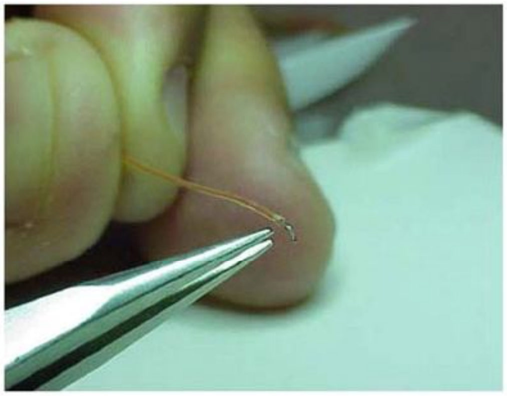
Figure 5-2. Orientation of Thermocouple Groove Relative to Package Pin



5.1.4 Thermocouple Conditioning and Preparation

1. Use a calibrated thermocouple as specified in Table 5-1.
2. Measure the thermocouple resistance by holding both wires on one probe and the tip of thermocouple to the other probe of the DMM (compare to thermocouple resistance specifications).
3. Straighten the wire for about 38 mm (1½ inch) from the bead to place it inside the channel.
4. Bend the tip of the thermocouple to approximately a 45 degree angle by 0.8 mm (0.030 inch) from the tip (Figure 5-3).

Figure 5-3. Bending the Tip of the Thermocouple



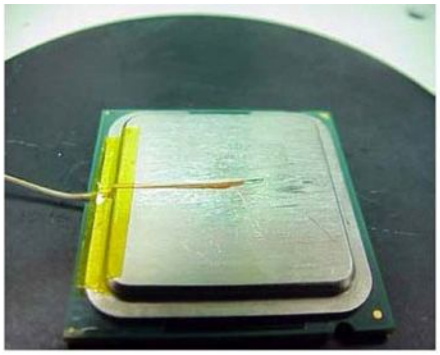
5.1.5 Thermocouple to the IHS

Caution: To avoid the impact on the thermocouple during the SMT process, reflow must be performed before attaching the thermocouple to the grooved MCH IHS.

1. Clean the thermocouple wire groove with isopropyl alcohol (IPA) and a lint free cloth removing all residues prior to thermocouple attachment.

2. Place the thermocouple wire inside the groove letting the exposed wire and bead extend about 3.2 mm (0.125 inch) past the end of groove. Secure it with Kapton* tape (Figure 5-4).
3. Lift the wire at the middle of groove with tweezers and bend the front of wire to place the thermocouple in the channel ensuring the tip is in contact with the end of the channel grooved in the IHS (Figure 5-5 A and B).
4. Place the MCH under the microscope unit (similar to the one used in Figure 5-8) to continue with process. It is also recommended to use a fixture to help holding the unit in place for the rest of the attach process.
5. Press the wire down about 6 mm (0.125 in.) from the thermocouple bead using the tweezers. Look in the microscope to perform this task. Place a piece of Kapton tape to hold the wire inside the groove (Figure 5-7). Refer to Figure 5-6 for detailed bead placement.
6. Using the micromanipulator, place the needle near to the end of groove on top of thermocouple. Using the X, Y, and Z axes on the arm, place the tip of needle on top of the thermocouple bead. Press down until the bead is seated at the end of groove on top of the step (see Figure 5-6 and Figure 5-7).
7. Measure resistance from thermocouple end wires (hold both wires to a DMM probe) to the IHS surface. This should be the same value as measured during the thermocouple conditioning see Section 5.1.4, step 2 and Figure 5-8.
8. Place a small amount of Loctite 498* adhesive in the groove where the bead is installed. Using a fine point device, spread the adhesive in the groove around the needle, the thermocouple bead and the thermocouple wires already installed in the groove during step 5. Be careful not to move the thermocouple bead during this step (Figure 5-9).

Figure 5-4. Securing Thermocouple Wires with Kapton* Tape Prior to Attach



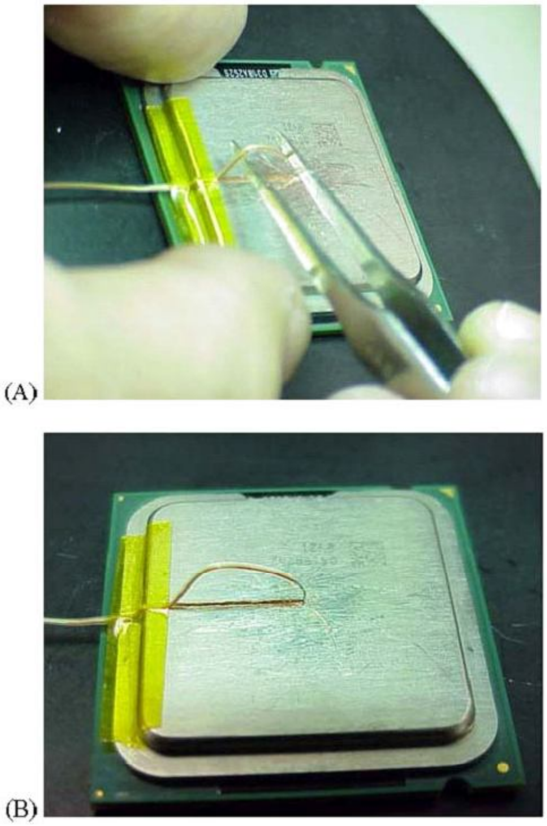


Figure 5-5. Thermocouple Bead Placement

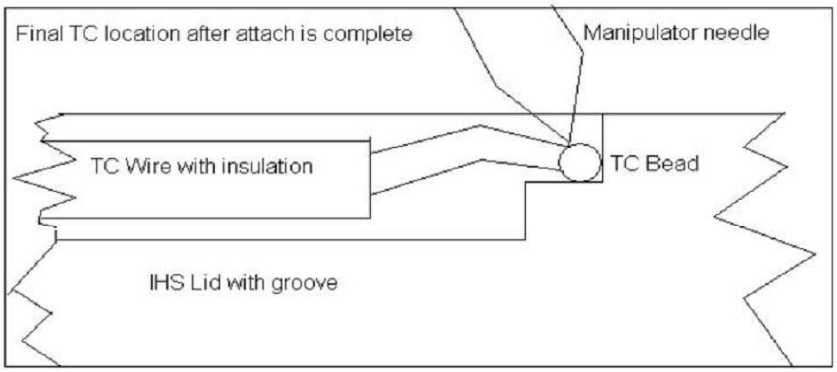

Final TC location after attach is complete
Manipulator needle
TC Wire with insulation
TC Bead
IHS Lid with groove

Figure 5-6. Position Bed on the Groove Step

Figure 5-7. Using 3D Micromanipulator to Secure Bead Location

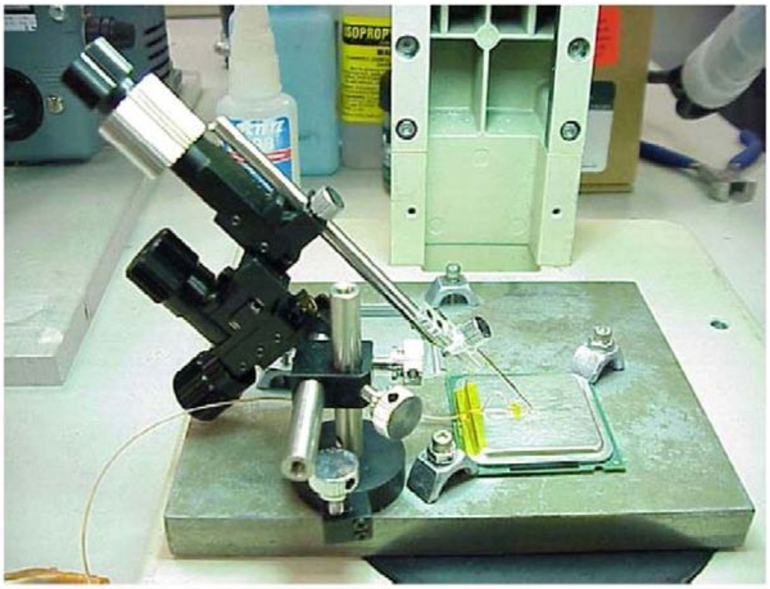


Figure 5-8. Measuring Resistance between Thermocouple and IHS

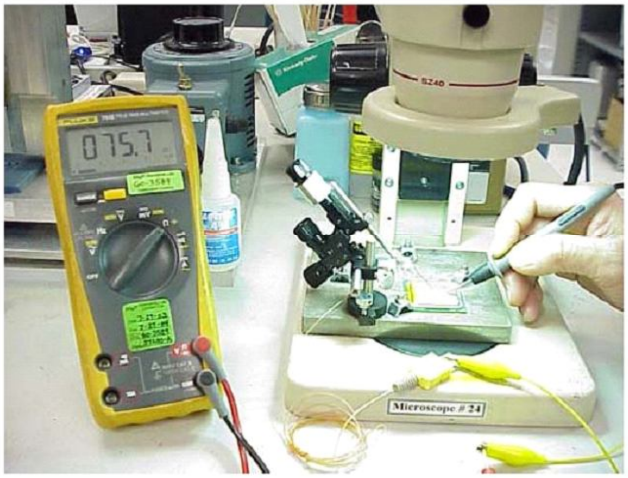
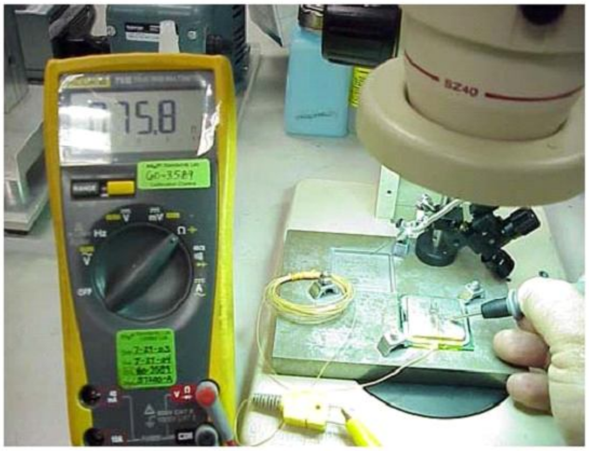

075.7
Microscope # 24

Figure 5-9. Applying in the Adhesive on the Thermocouple Bead



5.1.6 Curing Process

1. Let the thermocouple attach sit in the open air for at least half an hour. Using any curing accelerator like Loctite 7452 Accelerator for this step is not recommended. Rapid contraction of the adhesive during curing may weaken bead attach on the IHS.
2. Reconfirm electrical connectivity with DMM before removing the micromanipulator (Figure 5-8) (see Section Section 5.1.4 step 2).
3. Remove the 3D Arm needle by holding down the MCH unit and lifting the arm.
4. Remove the Kapton tape, straighten the wire in the groove so it is flat all the way to the end of the groove (Figure 5-11).
5. Using a blade, shave excess adhesive above the IHS surface (Figure 5-11).

Note: Take usual precautions when using open blades.

6. Install new Kapton tape to hold the thermocouple wire down and fill the rest of groove with adhesive (See Figure 5-12). Make sure the wire and insulation is entirely within the groove and below the IHS surface.
7. Curing time for the rest of the adhesive in the groove can be reduced using Loctite 7452 Accelerator.
8. Repeat step 5 to remove any access adhesive to ensure flat IHS for proper mechanical contact to the heatsink surface.

5.1.7 Thermocouple Wire Management

Figure 5-10. Thermocouple Wire Management in the Groove

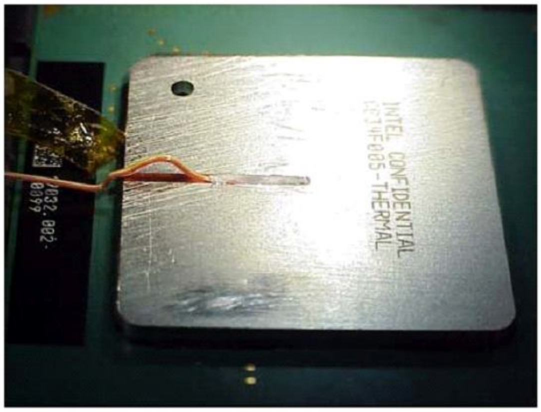

INTEL CONFIDENTIAL
CE34F005-THERMAL
7032.002-
0099

Figure 5-11. Removing Excess Adhesive from the IHS

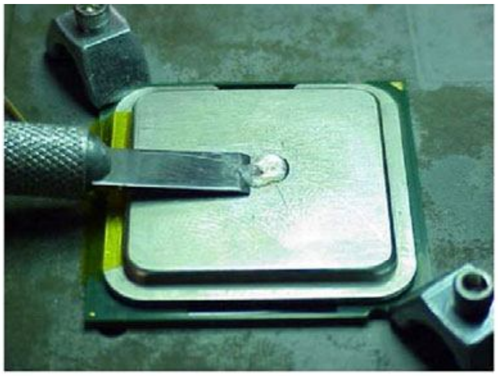
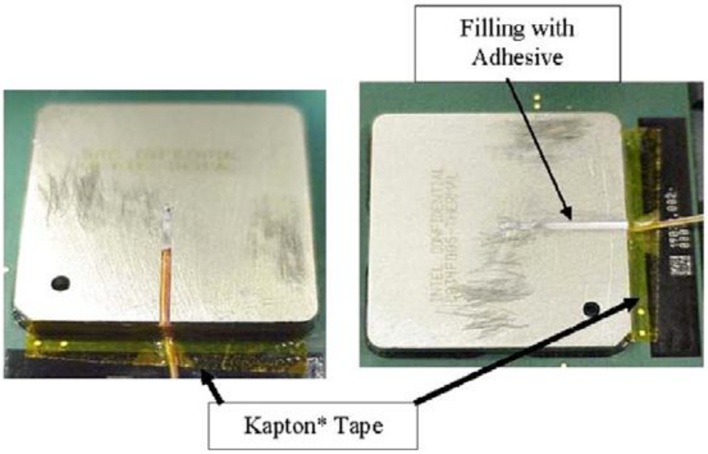


Figure 5-12. Filling the Groove with Adhesive



Note: Prior to installing the heatsink, be sure that the thermocouple wires remain below the IHS top surface by running a flat blade on top of the IHS for example.

5.2 Power Simulation Software

The power simulation software is a utility designed to dissipate the thermal design power on a Intel 5400 chipset when used in conjunction with the Intel® Xeon® processor 5300 (1333 MHz). The combination of the above mentioned processor(s) and the higher bandwidth capability of the Intel 5400 chipset enable higher levels of system performance. To assess the thermal performance of the chipset MCH thermal solution under "worst-case realistic application" conditions, Intel is developing a software utility that operates the chipset at near worst-case thermal power dissipation.

The power simulation software being developed should only be used to test thermal solutions at or near the thermal design power. Figure 1-1 shows a decision flowchart for determining thermal solution needs. Real world applications may exceed the thermal design power limit for transient time periods. For power supply current requirements under these transient conditions, please refer to each component's datasheet for the ICC (Max Power Supply Current) specification. Contact your Intel field sales representative to order the thermal models and users' guides.

§

6 Reference Thermal Solution

Intel has developed a reference thermal solution to meet the cooling needs of the Intel 5400 chipset under operating environments and specifications defined in this document. This section describes the overall requirements for the tall torsional clip heatsink reference thermal solution including critical-to-function dimensions, operating environment, and validation criteria. Other chipset components may or may not need attached thermal solutions depending on your specific system local-ambient operating conditions. For information on the PXH/PXH-V, refer to thermal specification in the *Intel® 6700PXH 64-bit PCI Hub (PXH) Thermal/Mechanical Design Guidelines*. For information on the Intel 631xESB/632xESB I/O Controller Hub, refer to thermal specification in the *Intel® 631xESB/632xESB I/O Controller Hub Thermal/Mechanical Design Guidelines*.

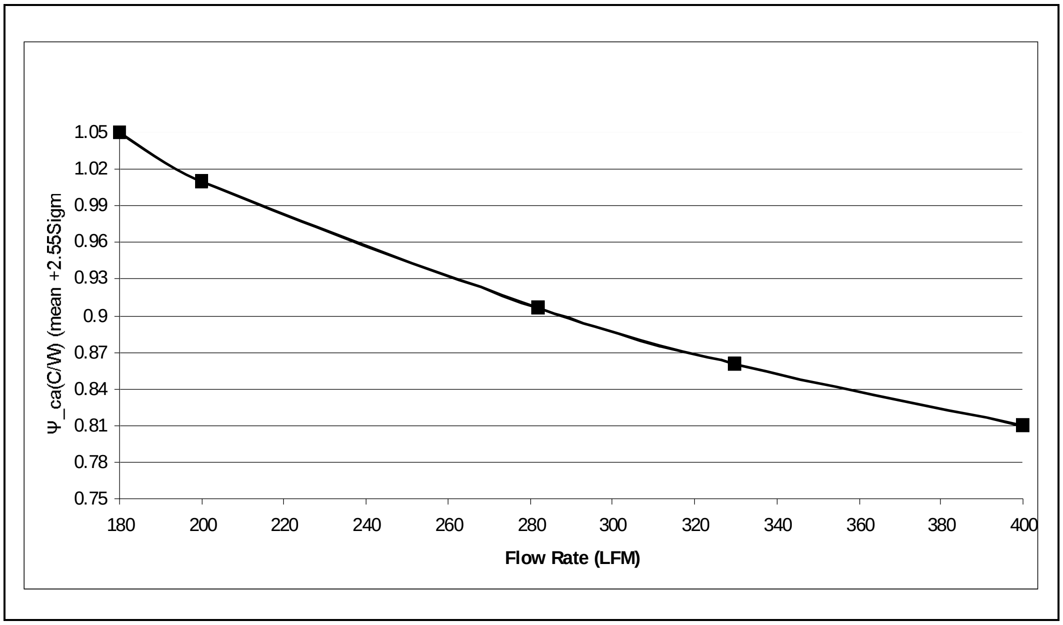
6.1 Operating Environment

The reference thermal solution was designed assuming a maximum local-ambient temperature of 53°C. The minimum recommended airflow velocity through the cross-section of the heatsink fins is 400 linear feet per minute (lfm). This thermal boundary condition is just a reference point which was picked up by Intel according to a specific reference system, customers may have their own thermal boundary condition determined, as long as the heatsink performance under that specific boundary condition can meet Intel 5400 chipset thermal specification. The approaching airflow temperature is assumed to be equal to the local-ambient temperature. The thermal designer must carefully select the location to measure airflow to obtain an accurate estimate. These local-ambient conditions are based on a 35°C external-ambient temperature at sea level. (External-ambient refers to the environment external to the system.)

6.2 Heatsink Performance

Figure 6-1 depicts the tested reference heatsink performance curve vs airflow velocity, which was characterized in wind tunnel using MCH only component level test board. Customers may need to identify their own specific air flow on the curve to get the heatsink Psi_ca value, which should be used in the later thermal calculation. Since this data was measured at sea level, a correction factor would be required to estimate thermal performance at other altitudes.

Figure 6-1. Tall Torsional Clip Heatsink Measured Thermal Performance versus Approach Velocity

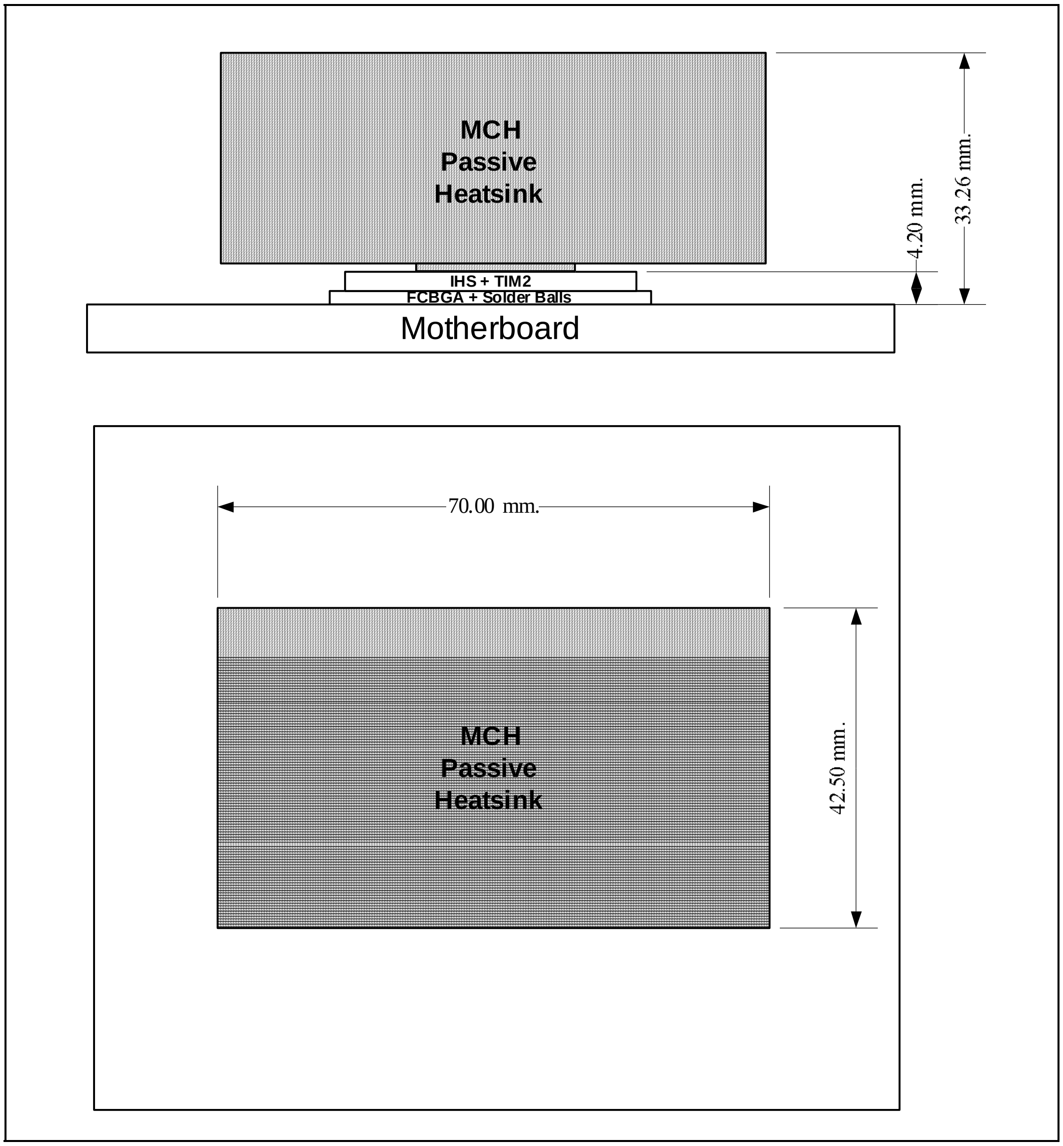


6.3 Mechanical Design Envelope

While each design may have unique mechanical volume and height restrictions or implementation requirements, the height, width, and depth constraints typically placed on the Intel 5400 chipset thermal solution are shown in Figure 6-2.

When using heatsinks that extend beyond the chipset MCH reference heatsink envelope shown in Figure 6-2, any motherboard components placed between the heatsink and motherboard cannot exceed 2 mm (0.07 in.) in height.

Figure 6-2. Tall Torsional Clip Heatsink Volumetric Envelope for the Chipset MCH


MCH
Passive
Heatsink
IHS + TIM2
FCBGA + Solder Balls
Motherboard
4.20 mm.
33.26 mm.
70.00 mm.
MCH
Passive
Heatsink
42.50 mm.

6.4 Board-Level Components Keepout Dimensions

The location of hole patterns and keepout zones for the reference thermal solution are shown in Figure 6-3 and Figure 6-4.

6.5 Tall Torsional Clip Heatsink Thermal Solution Assembly

The reference thermal solution for the chipset MCH is a passive extruded heatsink with thermal interface. It is attached using a clip with each end hooked through an anchor soldered to the board. Figure 6-5 shows the reference thermal solution assembly and associated components.

Full mechanical drawings of the thermal solution assembly and the heatsink clip are provided in Appendix B. Appendix A contains vendor information for each thermal solution component.

Figure 6-3. Tall Torsional Clip Heatsink Board Component Keepout

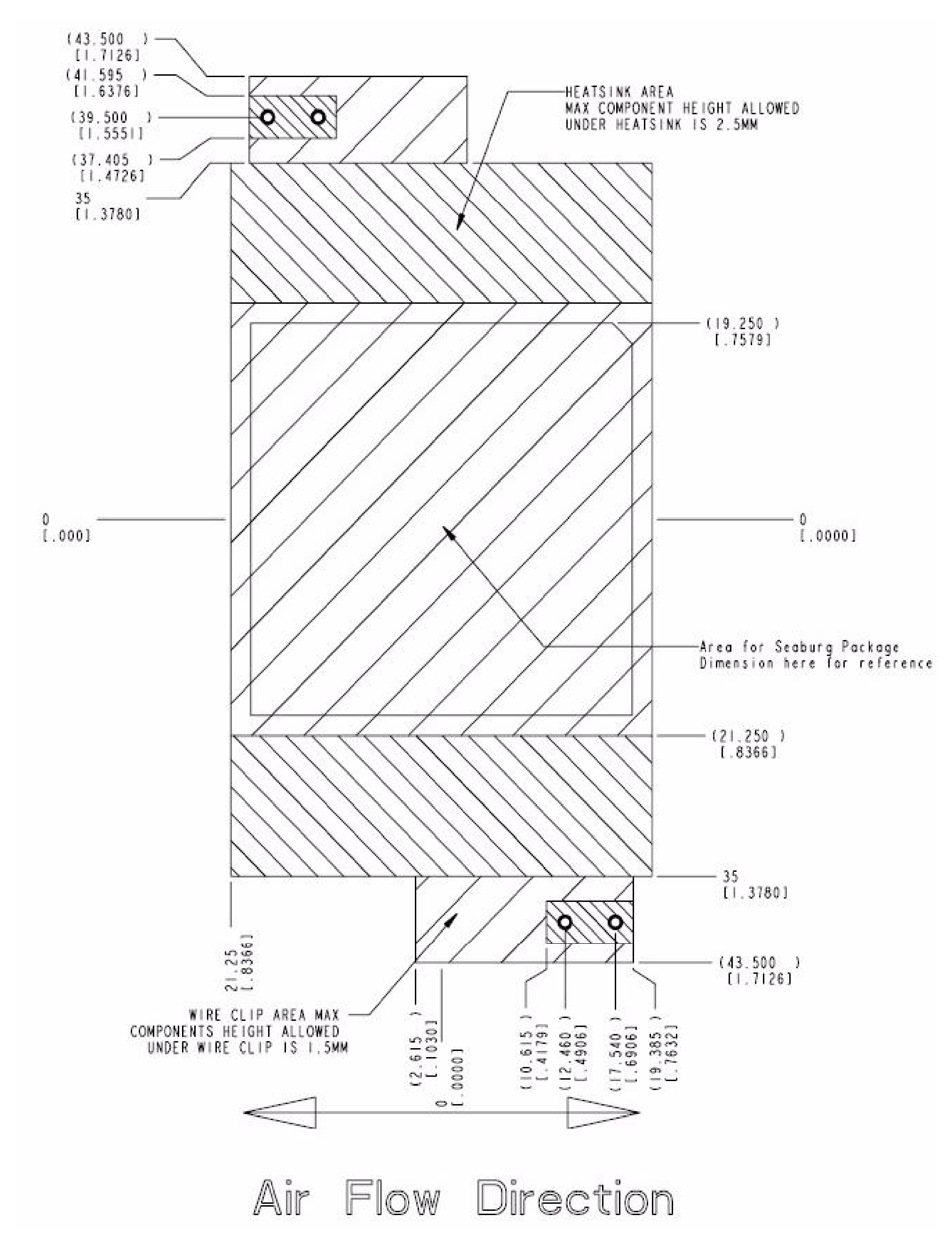
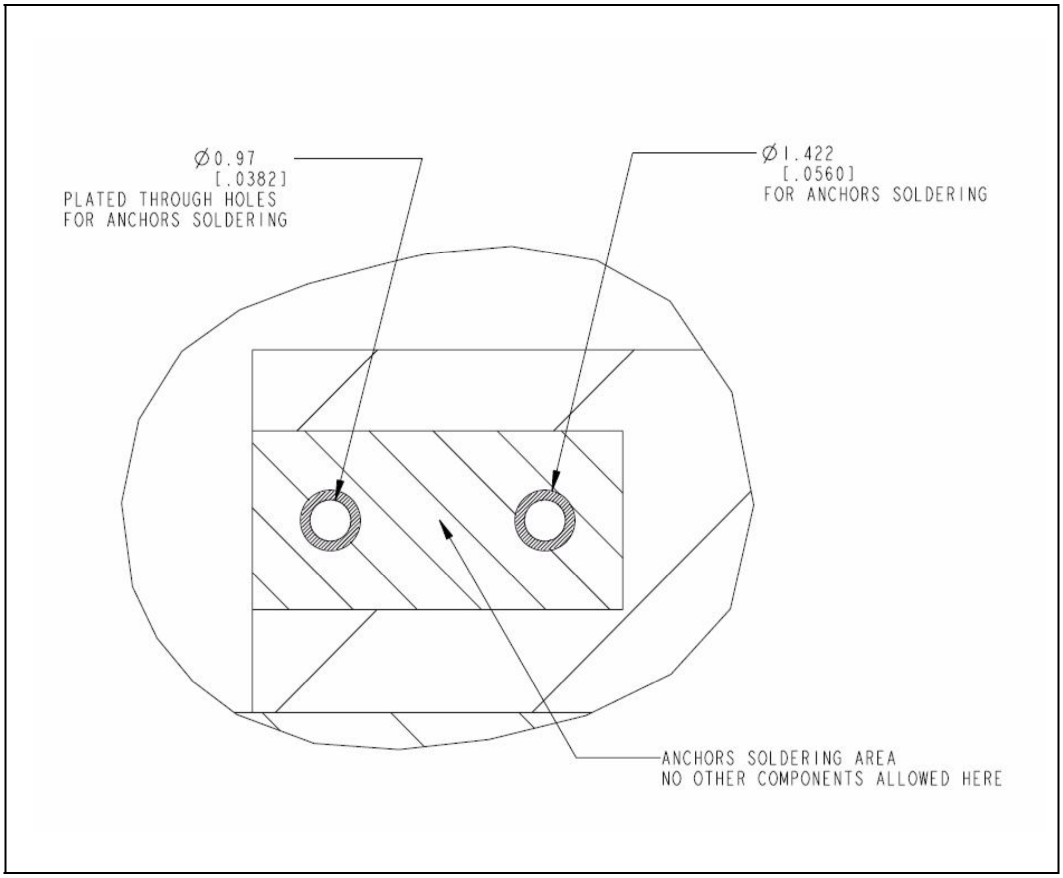

(43.500)
[1.7126]
(41.595)
[1.6376]
(39.500)
[1.5551]
(37.405)
[1.4726]
35
[1.3780]
HEATSINK AREA
MAX COMPONENT HEIGHT ALLOWED
UNDER HEATSINK IS 2.5MM
(19.250)
[.7579]
0
[.000]
0
[.0000]
Area for Seaburg Package
Dimension here for reference
(21.250)
[.8366]
35
[1.3780]
(43.500)
[1.7126]
21.25
[.8366]
WIRE CLIP AREA MAX
COMPONENTS HEIGHT ALLOWED
UNDER WIRE CLIP IS 1.5MM
(2.615)
[.1030]
0
[.0000]
(10.615)
[.4179]
(12.460)
[.4906]
(17.540)
[.6906]
(19.385)
[.7632]
Air Flow Direction

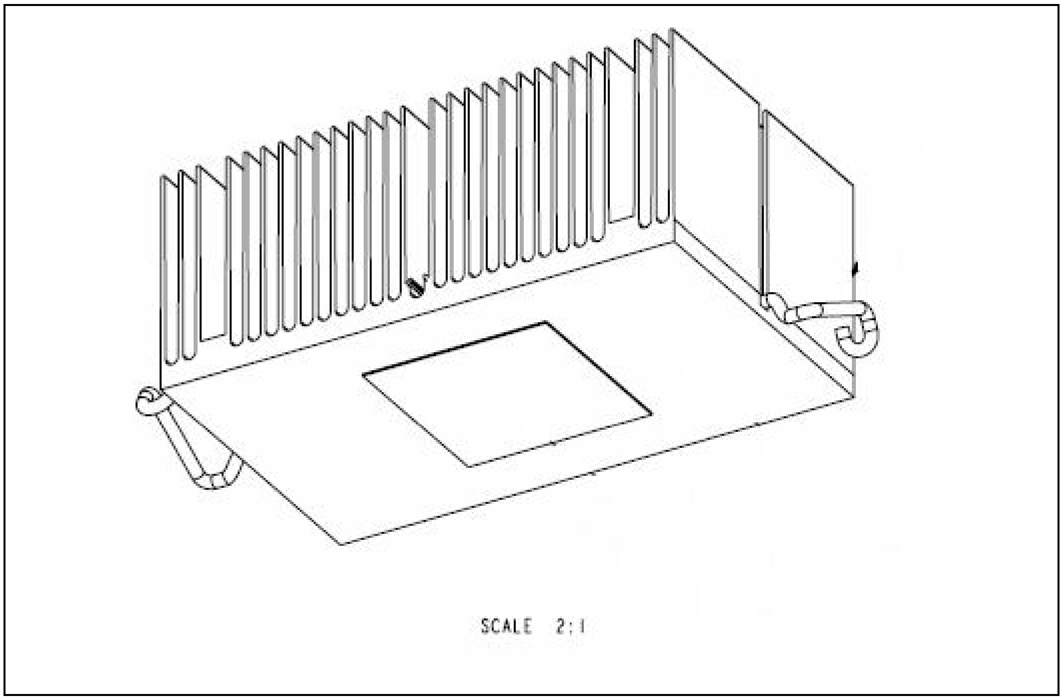
Figure 6-4. Retention Mechanism Component Keepout Zones


Ø0.97
[.0382]
PLATED THROUGH HOLES
FOR ANCHORS SOLDERING
Ø1.422
[.0560]
FOR ANCHORS SOLDERING
ANCHORS SOLDERING AREA
NO OTHER COMPONENTS ALLOWED HERE

6.5.1 Heatsink Orientation

Since this solution is based on a unidirectional heatsink, mean airflow direction must be aligned with the direction of the heatsink fins.

Figure 6-5. Tall Torsional Clip Heatsink Assembly



6.5.2 Extruded Heatsink Profiles

The reference thermal solution uses an extruded heatsink for cooling the chipset MCH. Figure 6-6 shows the heatsink profile. Appendix A lists a supplier for this extruded heatsink. Other heatsinks with similar dimensions and increased thermal performance may be available. Full mechanical drawing of this heatsink is provided in Appendix B.

6.5.3 Mechanical Interface Material

There is no mechanical interface material associated with this reference solution.

6.5.4 Thermal Interface Material

A thermal interface material (TIM) provides improved conductivity between the IHS and heat sink. The reference thermal solution uses Honeywell PCM45 F*, 0.25 mm (0.010 in.) thick, 25.4 mm x 25.4 mm (1.0 in. x 1.0 in.) square.

Note: Unflowed or "dry" Honeywell PCM45 F has a material thickness of 0.010 inch. The flowed or "wet" Honeywell PCM45F has a material thickness of ~0.003 inch after it reaches its phase change temperature.

6.5.4.1 Effect of Pressure on TIM Performance

As mechanical pressure increases on the TIM, the thermal resistance of the TIM decreases. This phenomenon is due to the decrease of the bond line thickness (BLT). BLT is the final settled thickness of the thermal interface material after installation of heatsink. The effect of pressure on the thermal resistance of the Honeywell PCM45 F TIM is shown in Table 6-1.

Intel provides both End of Line and End of Life TIM thermal resistance values of Honeywell PCM45F. End of Line and End of Life TIM thermal resistance values are obtained through measurement on a Test Vehicle similar to the chipset's physical attributes using an extruded aluminum heatsink. The End of Line value represents the TIM performance post heatsink assembly while the End of Life value is the predicted TIM performance when the product and TIM reaches the end of its life. The heatsink clip provides enough pressure for the TIM to achieve End of Line thermal resistance of 0.345°C inch^2/W and End of Life thermal resistance of 0.459°C inch^2/W.

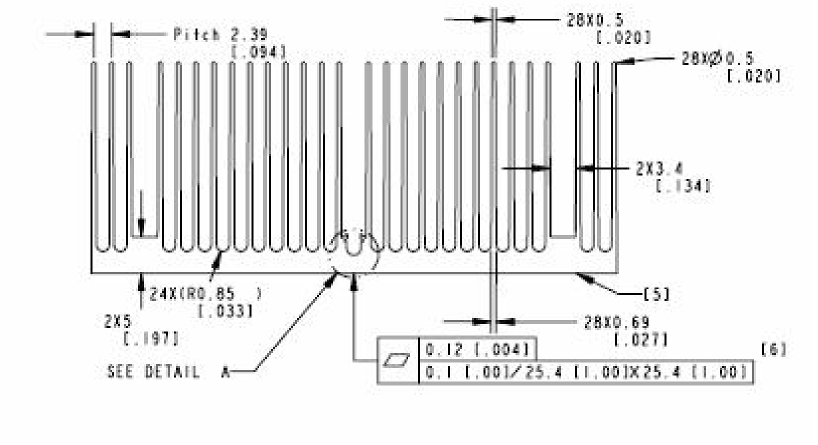
Table 6-1. Honeywell PCM45 F* TIM Performance as a Function of Attach Pressure

Pressure on IHS (PSI)	Thermal Resistance (°C × in^2) / W	
	End of Line	End of Life
2.18	0.391	0.551
4.35	0.345	0.459

6.5.5 Heatsink Clip

The reference solution uses a wire clip with hooked ends. The hooks attach to wire anchors to fasten the clip to the board. See Appendix B for a mechanical drawing of the clip.

Figure 6-6. Tall Torsional Clip Heatsink Extrusion Profile



6.5.6 Clip Retention Anchors

For chipset-based platforms that have very limited board space, a clip retention anchor has been developed to minimize the impact of clip retention on the board. It is based on a standard three-pin jumper and is soldered to the board like any common through-hole header. A new anchor design is available with 45° bent leads to increase the anchor attach reliability over time. See Appendix A for the part number and supplier information.

6.6 Reliability Guidelines

Each motherboard, heatsink and attach combination may vary the mechanical loading of the component. Based on the end user environment, the user should define the appropriate reliability test criteria and carefully evaluate the completed assembly prior to use in high volume. Some general recommendations are shown in Table 6-2.

Table 6-2. Reliability Guidelines

Test (1)	Requirement	Pass/Fail Criteria (2)
Mechanical Shock	50 g, board level, 11 msec, 3 shocks/axis	Visual Check and Electrical Functional Test
Random Vibration	7.3 g, board level, 45 min/axis, 50 Hz to 2000 Hz	Visual Check and Electrical Functional Test
Temperature Life	85°C, 2000 hours total, checkpoints at 168, 500, 1000, and 2000 hours	Visual Check
Thermal Cycling	–5°C to +70°C, 500 cycles	Visual Check
Humidity	85% relative humidity, 55°C, 1000 hours	Visual Check

Notes:
1. It is recommended that the above tests be performed on a sample size of at least twelve assemblies from three lots of material.
2. Additional pass/fail criteria may be added at the discretion of the user.

§

A Thermal Solution Component Suppliers

A.1 Tall Torsional Clip Heatsink Thermal Solution

Part	Intel Part Number	Supplier (Part Number)	Contact Information
Heatsink Assembly includes: • Unidirectional Fin Heatsink • Thermal Interface Material • Torsional Clip	D58512-001	AVC/CCI*	Rachel Hsu (Taiwan) 886-2-2299-6930 x 7630 raichel_hsi@avc.com.tw David Chao (Taiwan) 886-2-2299-6930 x 7619 david_chao@avc.com.tw Monica Chih (Taiwan) 866-2-29952666, x131 monica_chih@ccic.com.tw
Unidirectional Fin Heatsink (42.5 x 70.0 x 29.0 mm)	D58509-001	AVC/CCI	Rachel Hsu (Taiwan) 886-2-2299-6930 x 7630 raichel_hsi@avc.com.tw David Chao (Taiwan) 886-2-2299-6930 x 7619 david_chao@avc.com.tw Monica Chih (Taiwan) 866-2-29952666, x131 monica_chih@ccic.com.tw
Thermal Interface (PCM45F)	C34795-001	Honeywell PCM45 F*	Scott Miller 509-252-2206 scott.miller4@honeywell.com
Heatsink Attach Clip	D58514-001	AVC/CCI	Rachel Hsu (Taiwan) 886-2-2299-6930 x 7630 raichel_hsi@avc.com.tw David Chao (Taiwan) 886-2-2299-6930 x 7619 david_chao@avc.com.tw Monica Chih (Taiwan) 866-2-29952666, x131 monica_chih@ccic.com.tw
Solder-Down Anchor	A13494-005	Foxconn (HB96030-DW)*	Julia Jiang (USA) 408-919-6178 juliaj@foxconn.com

Note: Contact the supplier directly to verify time of component availability.

§

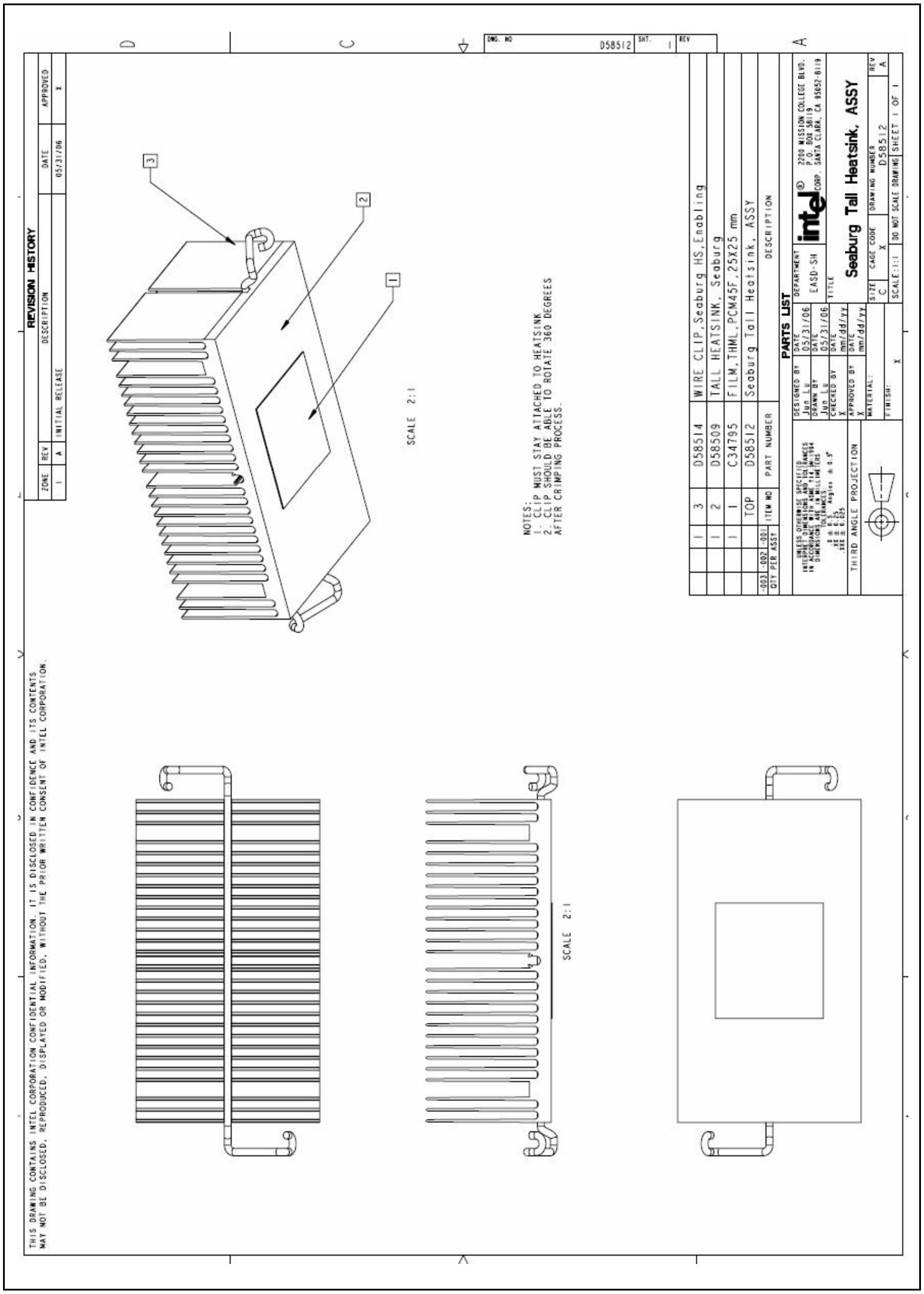
B Mechanical Drawings

Table B-1 lists the mechanical drawings included in this appendix.

Table B-1. Mechanical Drawing List

Drawing Description	Figure Number
Tall Torsional Clip Heatsink Assembly Drawing	Figure B-1
Tall Torsional Heatsink Drawing	Figure B-2
Tall Torsional Clip Heatsink Clip Drawing	Figure B-3

Figure B-1. Tall Torsional Clip Heatsink Assembly Drawing


THIS DRAWING CONTAINS INTEL CORPORATION CONFIDENTIAL INFORMATION. IT IS DISCLOSED IN CONFIDENCE AND ITS CONTENTS MAY NOT BE DISCLOSED, REPRODUCED, DISPLAYED OR MODIFIED, WITHOUT THE PRIOR WRITTEN CONSENT OF INTEL CORPORATION.
D
C
B
A
3
2
1
SCALE 2:1
SCALE 2:1
NOTES:
1. CLIP MUST STAY ATTACHED TO HEATSINK
2. CLIP SHOULD BE ABLE TO ROTATE 360 DEGREES AFTER CRIMPING PROCESS.
DWG. NO D58512 SHT. 1 REV
UNLESS OTHERWISE SPECIFIED INTERPRET DIMENSIONS AND TOLERANCES IN ACCORDANCE WITH ASME Y14.5M-1994
DIMENSIONS ARE IN MILLIMETERS
TOLERANCES:
.X ± 0.5 Angles ± 0.5°
.XX ± 0.25
.XXX ± 0.025
THIRD ANGLE PROJECTION
DESIGNED BY Jun Lu DATE 05/31/06
DRAWN BY Jun Lu DATE 05/31/06
CHECKED BY X DATE mm/dd/yy
APPROVED BY X DATE mm/dd/yy
MATERIAL:
FINISH: X
DEPARTMENT EASD-SH
intel® CORP. 2200 MISSION COLLEGE BLVD. P.O. BOX 58119 SANTA CLARA, CA 95052-8119
TITLE Seaburg Tall Heatsink, ASSY
SIZE C
CAGE CODE X
DRAWING NUMBER D58512
REV A
SCALE:1:1
DO NOT SCALE DRAWING
SHEET 1 OF 1

REVISION HISTORY

ZONE	REV	DESCRIPTION	DATE	APPROVED
1	A	INITIAL RELEASE	05/31/06	X

PARTS LIST

QTY PER ASSY -003	QTY PER ASSY -002	QTY PER ASSY -001	ITEM NO	PART NUMBER	DESCRIPTION
		1	3	D58514	WIRE CLIP, Seaburg HS, Enabling
		1	2	D58509	TALL HEATSINK, Seaburg
		1	1	C34795	FILM, THML, PCM45F, 25X25 mm
			TOP	D58512	Seaburg Tall Heatsink, ASSY

Figure B-2. Tall Torsional Heatsink Drawing

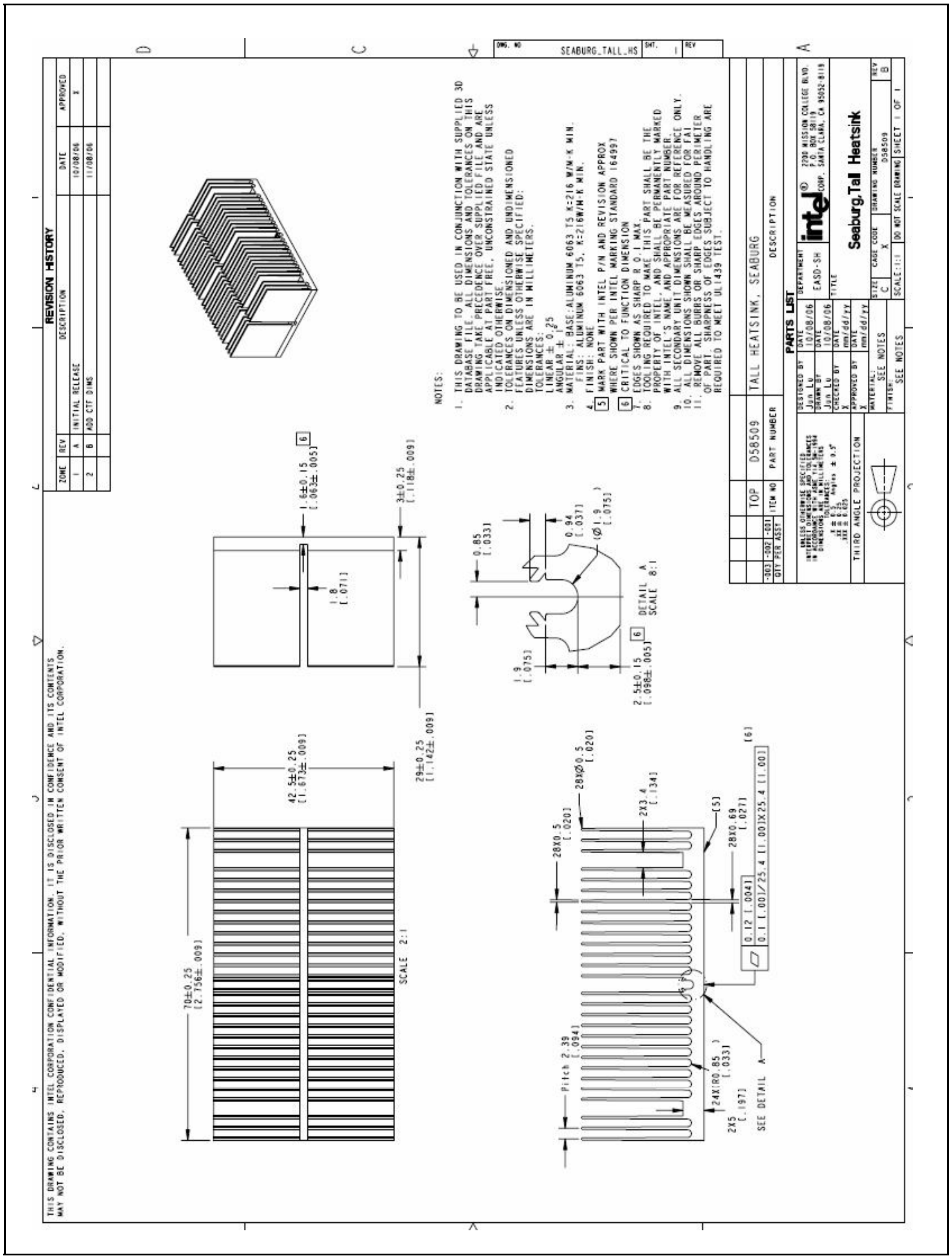
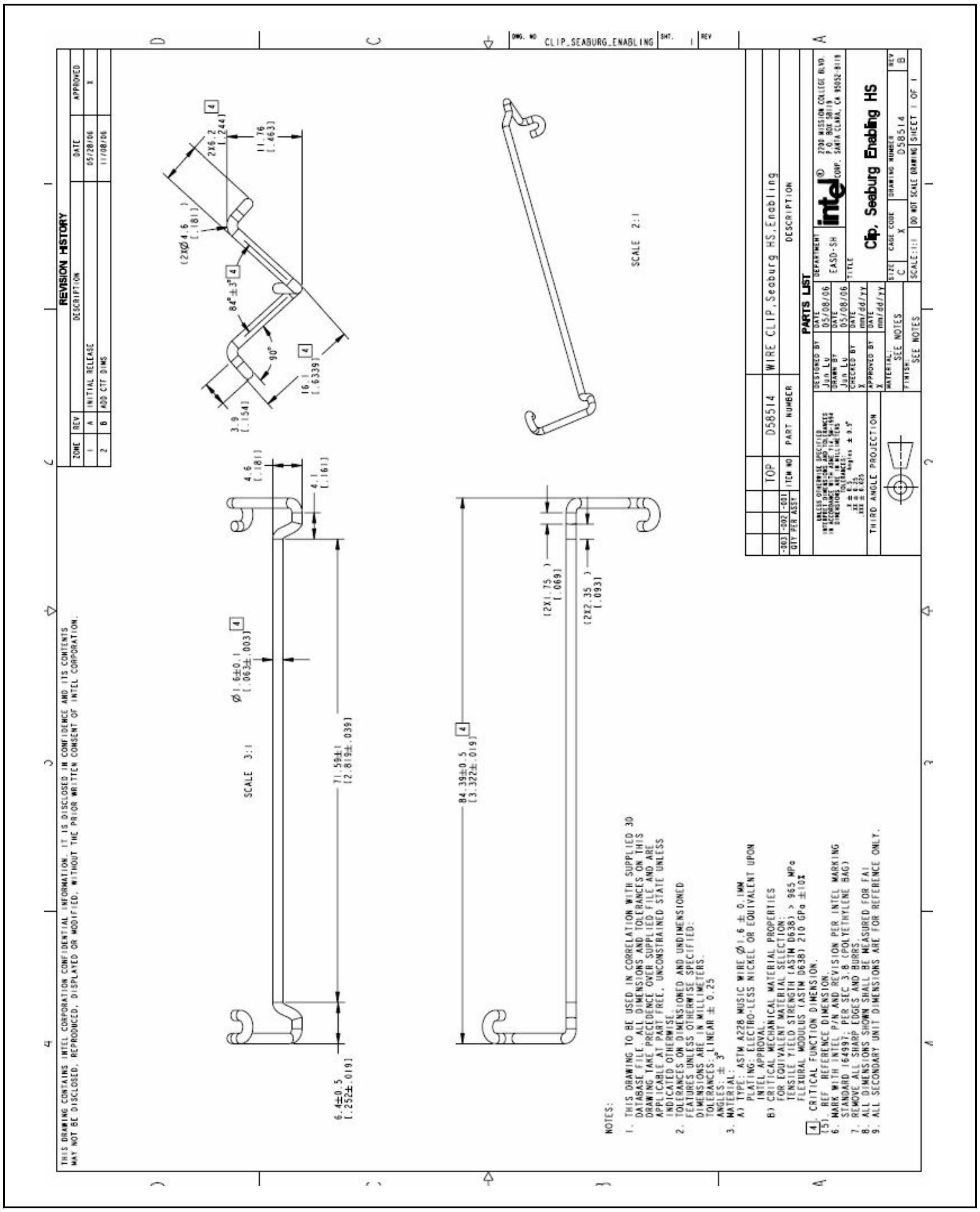

REVISION HISTORY
ZONE | REV | DESCRIPTION | DATE | APPROVED
1 | A | INITIAL RELEASE | 10/08/06 | X
2 | B | ADD CTT DIMS | 11/08/06
DWG. NO SEABURG_TALL_HS SHT. 1 REV
NOTES:
1. THIS DRAWING TO BE USED IN CONJUNCTION WITH SUPPLIED 3D DATABASE FILE. ALL DIMENSIONS AND TOLERANCES ON THIS DRAWING TAKE PRECEDENCE OVER SUPPLIED FILE AND ARE APPLICABLE AT PART FREE, UNCONSTRAINED STATE UNLESS INDICATED OTHERWISE.
2. TOLERANCES ON DIMENSIONED AND UNDIMENSIONED FEATURES UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS. TOLERANCES: LINEAR ± 0.25 ANGULAR ± 1°
3. MATERIAL: BASE: ALUMINUM 6063 T5 K=216 W/M-K MIN. FINS: ALUMINUM 6063 T5, K=216W/M-K MIN.
4. FINISH: NONE
5 MARK PART WITH INTEL P/N AND REVISION APPROX WHERE SHOWN PER INTEL MARKING STANDARD 164997
6 CRITICAL TO FUNCTION DIMENSION
7. EDGES SHOWN AS SHARP R 0.1 MAX.
8. TOOLING REQUIRED TO MAKE THIS PART SHALL BE THE PROPERTY OF INTEL, AND SHALL BE PERMANENTLY MARKED WITH INTEL'S NAME AND APPROPRIATE PART NUMBER.
9. ALL SECONDARY UNIT DIMENSIONS ARE FOR REFERENCE ONLY.
10. ALL DIMENSIONS SHOWN SHALL BE MEASURED FOR FLAT
11. REMOVE ALL BURRS OR SHARP EDGES AROUND PERIMETER OF PART. SHARPNESS OF EDGES SUBJECT TO HANDLING ARE REQUIRED TO MEET UL1439 TEST.
1.6±0.15 [.063±.005] 6
3±0.25 [.118±.009]
1.8 [.071]
0.85 [.033]
0.94 [.037]
(Ø1.9 [.075])
1.9 [.075]
2.5±0.15 [.098±.005] 6
DETAIL A SCALE 8:1
42.5±0.25 [1.673±.009]
29±0.25 [1.142±.009]
70±0.25 [2.756±.009]
SCALE 2:1
28XØ0.5 [.020]
28X0.5 [.020]
2X3.4 [.134]
[5]
28X0.69 [.027]
0.12 [.004]
0.1 [.00]/25.4 [1.00]X25.4 [1.00] [6]
Pitch 2.39 [.094]
24X(R0.85 [.033])
2X5 [.197]
SEE DETAIL A
THIS DRAWING CONTAINS INTEL CORPORATION CONFIDENTIAL INFORMATION. IT IS DISCLOSED IN CONFIDENCE AND ITS CONTENTS MAY NOT BE DISCLOSED, REPRODUCED, DISPLAYED OR MODIFIED, WITHOUT THE PRIOR WRITTEN CONSENT OF INTEL CORPORATION.
-003 -002 -001 | TOP | D58509 | TALL HEATSINK, SEABURG
QTY PER ASSY | ITEM NO | PART NUMBER | DESCRIPTION
PARTS LIST
DESIGNED BY Jun Lu DATE 10/08/06
DRAWN BY Jun Lu DATE 10/08/06
CHECKED BY X DATE mm/dd/yy
APPROVED BY X DATE mm/dd/yy
DEPARTMENT EASD-SH
intel CORP. 2200 MISSION COLLEGE BLVD. P.O. BOX 58119 SANTA CLARA, CA 95052-8119
TITLE Seaburg,Tall Heatsink
SIZE C CAGE CODE X DRAWING NUMBER D58509 REV B
SCALE: 1:1 DO NOT SCALE DRAWING SHEET 1 OF 1
MATERIAL: SEE NOTES
FINISH: SEE NOTES
THIRD ANGLE PROJECTION
A B C D

Figure B-3. Tall Torsional Clip Heatsink Clip Drawing


CLIP_SEABURG_ENABLING
REVISION HISTORY
ZONE REV DESCRIPTION DATE APPROVED
1 A INITIAL RELEASE 05/28/06 X
2 B ADD CTF DIMS 11/08/06 X
THIS DRAWING CONTAINS INTEL CORPORATION CONFIDENTIAL INFORMATION. IT IS DISCLOSED IN CONFIDENCE AND ITS CONTENTS MAY NOT BE DISCLOSED, REPRODUCED, DISPLAYED OR MODIFIED, WITHOUT THE PRIOR WRITTEN CONSENT OF INTEL CORPORATION.
2X6.2 [.244] 4
11.76 [.463]
(2XØ4.6) [.181]
84°±3° 4
90°
16.1 [.6339] 4
3.9 [.154]
SCALE 2:1
4.6 [.181]
4.1 [.161]
Ø1.6±0.1 [.063±.003] 4
SCALE 3:1
71.59±1 [2.819±.039]
6.4±0.5 [.252±.019]
84.39±0.5 [3.322±.019] 4
(2X1.75) [.069]
(2X2.35) [.093]
NOTES:
1. THIS DRAWING TO BE USED IN CORRELATION WITH SUPPLIED 3D DATABASE FILE. ALL DIMENSIONS AND TOLERANCES ON THIS DRAWING TAKE PRECEDENCE OVER SUPPLIED FILE AND ARE APPLICABLE AT PART FREE, UNCONSTRAINED STATE UNLESS INDICATED OTHERWISE.
2. TOLERANCES ON DIMENSIONED AND UNDIMENSIONED FEATURES UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS. TOLERANCES: LINEAR ± 0.25 ANGLES: ± 3°
3. MATERIAL:
A) TYPE: ASTM A228 MUSIC WIRE Ø1.6 ± 0.1MM PLATING: ELECTRO-LESS NICKEL OR EQUIVALENT UPON INTEL APPROVAL.
B) CRITICAL MECHANICAL MATERIAL PROPERTIES FOR EQUIVALENT MATERIAL SELECTION: TENSILE YIELD STRENGTH (ASTM D638) > 965 MPa FLEXURAL MODULUS (ASTM D638) 210 GPa ±10%
4 CRITICAL FUNCTION DIMENSION.
(5). REF REFERENCE DIMENSION.
6. MARK WITH INTEL P/N AND REVISION PER INTEL MARKING STANDARD 164997; PER SEC 3.8 (POLYETHYLENE BAG)
7. REMOVE ALL SHARP EDGES AND BURRS.
8. ALL DIMENSIONS SHOWN SHALL BE MEASURED FOR FAI
9. ALL SECONDARY UNIT DIMENSIONS ARE FOR REFERENCE ONLY.
-003 -002 -001 QTY PER ASSY
TOP ITEM NO
D58514 PART NUMBER
WIRE CLIP, Seaburg HS, Enabling DESCRIPTION
PARTS LIST
UNLESS OTHERWISE SPECIFIED INTERPRET DIMENSIONS AND TOLERANCES IN ACCORDANCE WITH ASME Y14.5M-1994 DIMENSIONS ARE IN MILLIMETERS
TOLERANCES: .X ± 0.5 .XX ± 0.25 .XXX ± 0.025 Angles ± 0.5°
THIRD ANGLE PROJECTION
DESIGNED BY Jun Lu DATE 05/08/06
DRAWN BY Jun Lu DATE 05/08/06
CHECKED BY X DATE mm/dd/yy
APPROVED BY X DATE mm/dd/yy
MATERIAL: SEE NOTES
FINISH: SEE NOTES
DEPARTMENT EASD-SH
intel® CORP. 2200 MISSION COLLEGE BLVD. P.O. BOX 58119 SANTA CLARA, CA 95052-8119
TITLE Clip, Seaburg Enabling HS
SIZE C CAGE CODE X DRAWING NUMBER D58514 REV B
SCALE: 1:1 DO NOT SCALE DRAWING SHEET 1 OF 1

§