THIS DOCUMENT AND RELATED MATERIALS AND INFORMATION ARE PROVIDED "AS IS" WITH NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS, OR ANY WARRANTY OTHERWISE ARISING OUT OF ANY PROPOSAL, SPECIFICATION, OR SAMPLE. INTEL ASSUMES NO RESPONSIBILITY FOR ANY ERRORS CONTAINED IN THIS DOCUMENT AND HAS NO LIABILITIES OR OBLIGATIONS FOR ANY DAMAGES ARISING FROM OR IN CONNECTION WITH THE USE OF THIS DOCUMENT. Intel products are not intended for use in medical, life saving, life sustaining, critical control or safety systems, or in nuclear facility applications. Intel Corporation may have patents or pending patent applications, trademarks, copyrights, or other intellectual property rights that relate to the presented subject matter. The furnishing of documents and other materials and information does not provide any license, express or implied, by estoppel or otherwise, to any such patents, trademarks, copyrights, or other intellectual property rights. The hardware vendor remains solely responsible for the design, sale and functionality of its product, including any liability arising from product infringement or product warranty. Intel provides this information for customer’s convenience only. Use at your own risk. Intel accepts no liability for results if customer chooses at its discretion to implement these methods within its business operations. Intel makes no representations or warranties regarding the accuracy or completeness of the information provided. The Intel® Pentium® 4 Processor in the 775–Land LGA Package may contain design defects or errors known as errata, which may cause the product to deviate from published specifications. Current characterized errata are available on request.

Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families. See www.intel.com/products/processor_number for details.

Intel® EM64T requires a computer system with a processor, chipset, BIOS, operating system, device drivers and applications enabled for Intel EM64T. Processor will not operate (including 32-bit operation) without an Intel EM64T-enabled BIOS. Performance will vary depending on your hardware and software configurations. See www.intel.com/info/em64t for more information including details on which processors support Intel EM64T or consult with your system vendor for more information.

Intel® Virtualization Technology requires a computer system with a processor, chipset, BIOS, virtual machine monitor (VMM) and for some uses, certain platform software, enabled for it. Functionality, performance or other benefit will vary depending on hardware and software configurations. Intel Virtualization Technology-enabled VMM applications are currently in development.

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

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

Copyright © 2004–2005 Intel Corporation
Contents

1 Introduction ......................................................................................................................... 7
  1.1 Definition of Terms ................................................................................................. 8
  1.2 Reference Documents........................................................................................... 8
2 Packaging Technology ................................................................................................. 9
  2.1 Package Mechanical Requirements ................................................................... 10
3 Thermal Specifications .............................................................................................. 11
  3.1 Thermal Design Power (TDP) .............................................................................. 11
  3.2 Die Case Temperature Specifications ................................................................ 11
4 Thermal Simulation ...................................................................................................... 13
5 Thermal Metrology ........................................................................................................ 15
  5.1 Die Case Temperature Measurements ................................................................ 15
    5.1.1 Zero Degree Angle Attach Methodology .............................................. 15
6 Reference Thermal Solution ........................................................................................ 17
  6.1 Operating Environment ....................................................................................... 17
  6.2 Heatsink Performance ......................................................................................... 17
  6.3 Mechanical Design Envelope .............................................................................. 18
  6.4 Board-Level Components Keep-out Dimensions ................................................. 20
  6.5 Reference Heatsink Thermal Solution Assembly ................................................ 21
    6.5.1 Heatsink Orientation ................................................................................... 21
    6.5.2 Extruded Heatsink Profiles ......................................................................... 22
    6.5.3 Mechanical Interface Material ..................................................................... 22
    6.5.4 Thermal Interface Material ......................................................................... 23
    6.5.4.1 Effect of Pressure on TIM Performance ........................................... 24
    6.5.5 Heatsink Clip ............................................................................................... 24
    6.5.6 Clip Retention Anchors ............................................................................. 24
  6.6 Reliability Guidelines ........................................................................................... 25
7 Appendix A: Thermal Solution Component Suppliers ................................................. 27
8 Appendix B: Mechanical Drawings ............................................................................. 29
Figures
Figure 2-1. MCH Package Dimensions (Top View)............................................................9
Figure 2-2. MCH Package Dimensions (Side View)...........................................................9
Figure 2-3. MCH Package Dimensions (Bottom View).....................................................10
Figure 5-1. Thermal Solution Decision Flowchart.............................................................16
Figure 5-2. Zero Degree Angle Attach Methodology ........................................................16
Figure 5-3. Zero Degree Angle Attach Methodology (Top View)......................................16
Figure 6-1. Reference Heatsink Measured Thermal Performance versus Approach
   Velocity ......................................................................................................................18
Figure 6-2. Heatsink Volumetric Envelope for the MCH....................................................19
Figure 6-3. MCH Heatsink Board Component Keep-out ..................................................20
Figure 6-4. Retention Mechanism Component Keep-out Zones .......................................21
Figure 6-5. Plastic Wave Soldering Heatsink Assembly...................................................22
Figure 6-6. Plastic Wave Soldering Heatsink Extrusion Profile.........................................23
Figure 6-7. Plastic Wave Soldering Heatsink Assembly Drawing ....................................30
Figure 6-8. Plastic Wave Soldering Heatsink Drawing (1 of 2)...........................................31
Figure 6-9. Plastic Wave Soldering Heatsink Drawing (2 of 2)...........................................32
Figure 8-1. Plastic Wave Soldering Heatsink Ramp Clip Drawing (1 of 2).......................33
Figure 8-2. Plastic Wave Soldering Heatsink Ramp Clip Drawing (2 of 2).......................34
Figure 8-3. Plastic Wave Soldering Heatsink Wire Clip Drawing .....................................35
Figure 8-4. Plastic Wave Soldering Heatsink Solder-Down Anchor Drawing ..................36
Tables
Table 3-1. MCH Thermal Specifications...........................................................................11
Table 6-1. Honeywell* PCM 45F TIM Performance as a Function of Attach Pressure.... 24
Table 6-2. Reliability Guidelines .......................................................................................25
Table 7-1. MCH Heatsink Thermal Solution .....................................................................27
Table 8-1. Mechanical Drawing List..................................................................................29
## Revision History

<table>
<thead>
<tr>
<th>Revision Number</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>-001</td>
<td>Initial Release.</td>
<td>November 2005</td>
</tr>
</tbody>
</table>

§
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, fans, and/or passive heatsinks.

The goals of this document are to:

- Outline the thermal and mechanical operating limits and specifications for the Intel® 82975X Memory Controller Hub (MCH).
- Describe a reference thermal solution that meets the specification of the 82975X MCH.

Properly designed thermal solutions provide adequate cooling to maintain the MCH die temperatures at or below thermal specifications. This is accomplished by providing a low local-ambient temperature, ensuring adequate local airflow, and minimizing the die to local-ambient thermal resistance. By maintaining the MCH die 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 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 82975X MCH component only. For thermal design information on other chipset components, refer to the respective component datasheet. For the ICH7, refer to the Intel® I/O Controller Hub 7 (ICH7) Thermal Design Guidelines.

Note: Unless otherwise specified, the term MCH refers to the Intel® 82975X Memory Controller Hub.

Note: Unless otherwise specified, ICH7 refers to the Intel® 82801GB ICH7 and 82801GR ICH7R I/O Controller Hub 7 components.
1.1 Definition of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGA</td>
<td>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.</td>
</tr>
<tr>
<td>BLT</td>
<td>Bond line thickness. Final settled thickness of the thermal interface material after installation of heatsink.</td>
</tr>
<tr>
<td>ICH7</td>
<td>I/O Controller Hub 7. Seventh generation I/O Controller Hub component that contains additional functionality compared to previous ICH components. The I/O Controller Hub component that contains the primary PCI interface, LPC interface, USB2, ATA-100, and other I/O functions. It communicates with the MCH over a proprietary interconnect called DMI.</td>
</tr>
<tr>
<td>MCH</td>
<td>Memory Controller Hub. The chipset component that contains the processor interface, the memory interface, and the DMI.</td>
</tr>
<tr>
<td>$T_{case_max}$</td>
<td>Maximum die temperature allowed. This temperature is measured at the geometric center of the top of the package die.</td>
</tr>
<tr>
<td>$T_{case_min}$</td>
<td>Minimum die temperature allowed. This temperature is measured at the geometric center of the top of the package die.</td>
</tr>
<tr>
<td>TDP</td>
<td>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.</td>
</tr>
</tbody>
</table>

1.2 Reference Documents

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

<table>
<thead>
<tr>
<th>Document Title</th>
<th>Document Number / Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel® I/O Controller Hub 7 (ICH7) Datasheet</td>
<td><a href="http://developer.intel.com/design/chipsets/datashts/307013.htm">http://developer.intel.com/design/chipsets/datashts/307013.htm</a></td>
</tr>
<tr>
<td>Intel® 975X Express Chipset Datasheet</td>
<td><a href="http://developer.com/design/chipsets/datashts/310158.htm">http://developer.com/design/chipsets/datashts/310158.htm</a></td>
</tr>
<tr>
<td>BGA/OLGA Assembly Development Guide</td>
<td>Contact your Intel Field Sales Representative</td>
</tr>
<tr>
<td>Various system thermal design suggestions</td>
<td><a href="http://www.formfactors.org">http://www.formfactors.org</a></td>
</tr>
</tbody>
</table>
2 Packaging Technology

The Intel® 975X Express chipset consists of two individual components: the 82975X MCH and the ICH7. The MCH component uses a 34 mm squared, 6-layer flip chip ball grid array (FC-BGA) package (see Figure 2-1 through Figure 2-3). Unless otherwise specified, the dimensions in these figures are in millimeters. For information on the ICH7 package, refer to the Intel® I/O Controller Hub 7 (ICH7) Thermal Design Guidelines.

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

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

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

9

Thermal and Mechanical Design Guide
NOTES:
1. All dimensions are in millimeters.
2. All dimensions and tolerances conform to ANSI Y14.5M-1994.

2.1 Package Mechanical Requirements

The MCH package has an exposed bare die that is capable of sustaining a maximum static normal load of 10-lbf. The package is NOT capable of sustaining a dynamic or static compressive load applied to any edge of the bare die. These mechanical load limits must not be exceeded during heatsink installation, mechanical stress testing, standard shipping conditions and/or any other use condition.

Note:
1. The heatsink attach solutions must not result in continuous stress onto the chipset package with the exception of a uniform load to maintain the heatsink-to-package thermal interface.
2. These specifications apply to uniform compressive loading in a direction perpendicular to the bare die top surface.
3. These specifications are based on limited testing for design characterization. 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 chipset MCH to consume maximum power dissipation for sustained time periods. Therefore, 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 that the thermal solutions should be designed to meet. TDP is not the maximum power that the chipset can dissipate.

For MCH TDP specifications, refer to Table 3-1. FC-BGA packages have limited heat transfer capability into the board and have minimal thermal capability without a thermal solution. Intel recommends that system designers plan for one or more heatsinks when using the Intel® 975X Express chipset.

3.2 Die Case Temperature Specifications

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

Table 3-1. MCH Thermal Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{case,\text{max}}$</td>
<td>105 °C</td>
<td>—</td>
</tr>
<tr>
<td>$T_{case,\text{min}}$</td>
<td>5 °C</td>
<td>—</td>
</tr>
<tr>
<td>TDP$_{\text{dual channel}}$</td>
<td>13.5 W</td>
<td>DDR2-667</td>
</tr>
</tbody>
</table>

NOTE: These specifications are based on silicon characterization; however, they may be updated as further data becomes available.
Intel provides thermal simulation models of the MCH and associated user's 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 “FLOHERM™” (version 5.1 or higher) by Flomerics, Inc. Contact your Intel field sales representative to order the MCH thermal models and user's 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 die temperatures. Section 5.1 provides guidelines on how to accurately measure the MCH die temperatures. The flowchart in Figure 5-1 offers useful guidelines for thermal performance and evaluation.

5.1 Die Case Temperature Measurements

To ensure functionality and reliability, the $T_{\text{CASE}}$ of the MCH must be maintained at or between the maximum/minimum operating range of the temperature specification as noted in Table 3-1. The surface temperature at the geometric center of the die corresponds to $T_{\text{CASE}}$. Measuring $T_{\text{CASE}}$ requires special care to ensure an accurate temperature measurement.

Temperature differences between the temperature of a surface and the surrounding local ambient air can introduce errors in the measurements. The measurement errors could be due to a poor thermal contact between the thermocouple junction and the surface of the package, heat loss by radiation and/or convection, conduction through thermocouple leads, and/or contact between the thermocouple cement and the heatsink base (if a heatsink is used). For maximum measurement accuracy, only the Zero Degree ($0^\circ$) Angle thermocouple attach approach is recommended by Intel.

5.1.1 Zero Degree Angle Attach Methodology

1. Mill a 3.3 mm (0.13 in.) diameter and 1.5 mm (0.06 in.) deep hole centered on the bottom of the heatsink base.
2. Mill a 1.3 mm (0.05 in.) wide and 0.5 mm (0.02 in.) deep slot from the centered hole to one edge of the heatsink. The slot should be parallel to the heatsink fins (see Figure 5-2).
3. Attach thermal interface material (TIM) to the bottom of the heatsink base.
4. Cut out portions of the TIM as necessary to make room for the thermocouple wire and bead. The cutouts should match the slot and hole milled into the heatsink base.
5. Attach a 36 gauge or smaller calibrated K-type thermocouple bead or junction to the center of the top surface of the die using a high thermal conductivity cement. During this step, ensure no contact is present between the thermocouple cement and the heatsink base because any contact will affect the thermocouple reading. It is critical that the thermocouple bead makes contact with the die (see Figure 5-3).
6. Attach heatsink assembly to the MCH and route thermocouple wires out through the milled slot.
**Figure 5-1. Thermal Solution Decision Flowchart**

1. Start
2. Attach device to board using normal reflow process.
3. Attach thermocouples using recommended metrology. Setup the system in the desired configuration.
4. Run the Power program and monitor the device die temperature.
5. T_die > Specification? 
   - Yes: Heatsink Required
   - No: End
   - Select Heatsink
6. Attach thermocouples using recommended metrology. Setup the system in the desired configuration.
7. Run the Power program and monitor the device die temperature.
8. T_die > Specification? 
   - Yes: Heatsink Required
   - No: End
   - Select Heatsink
9. Attach device to board using normal reflow process.

**Figure 5-2. Zero Degree Angle Attach Methodology**

- 1.3 mm [0.05 in]
- 0.5 mm [0.02 in] depth
- 3.3 mm [0.13 in] dia.
- 1.5 mm [0.06 in] depth

**Figure 5-3. Zero Degree Angle Attach Methodology (Top View)**

- Thermocouple Wire
- Die
- Cement + Thermocouple Bead
- Substrate

**NOTE:** Not to scale.
6 Reference Thermal Solution

Intel has developed a reference thermal solution designed to meet the cooling needs of the MCH under operating environments and specifications defined in this document. This chapter describes the overall requirements for the Plastic Wave Soldering Heatsink (PWSH) 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 ICH7, refer to thermal specification in the Intel® I/O Controller Hub 7 (ICH7) Thermal Design Guidelines.

6.1 Operating Environment

The reference thermal solution was designed assuming a maximum local-ambient temperature of 55 °C. The minimum recommended airflow velocity through the cross section of the heatsink fins is 450 linear feet per minute (lfm). 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 measured thermal performance of the reference thermal solution versus approach air velocity. Since this data was measured at sea level, a correction factor would be required to estimate thermal performance at other altitudes.
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 MCH thermal solution are shown in Figure 6-2.

When using heatsinks that extend beyond the MCH reference heatsink envelope shown in Figure 6-2, any motherboard components placed between the heatsink and motherboard cannot exceed 2.2 mm (0.087 in.) in height.
Figure 6-2. Heatsink Volumetric Envelope for the MCH
6.4 Board-Level Components Keep-out Dimensions

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

**Figure 6-3. MCH Heatsink Board Component Keep-out**
6.5 Reference Heatsink Thermal Solution Assembly

The reference thermal solution for the 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: Mechanical Drawings. Appendix A: Thermal Solution Component Suppliers contains vendor information for each thermal solution component.
6.5.1 Heatsink Orientation

To enhance the efficiency of the reference thermal solution, it is important for the designer to orient the fins properly with respect to the mean airflow direction. Simulation and experimental evidence have shown that the MCH heatsink thermal performance is enhanced when the fins are aligned with the mean airflow direction (see Figure 6-3).

6.5.2 Extruded Heatsink Profiles

The reference thermal solution uses an extruded heatsink for cooling the MCH. Figure 6-5 shows the heatsink profile. Appendix A: Thermal Solution Component Suppliers 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: Mechanical Drawings.
6.5.3 Mechanical Interface Material

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

6.5.4 Thermal Interface Material

A TIM provides improved conductivity between the die and heatsink. The reference thermal solution uses Honeywell PCM 45F, 0.25 mm (0.010 in.) thick, 15 mm x 15 mm (0.59 in. x 0.59 in.) square.

>Note: Unflowed or “dry” Honeywell PCM 45F has a material thickness of 0.010 inch. The flowed or “wet” Honeywell PCM 45F has a material thickness of ~0.003 inches 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* PCM45F TIM is shown in Table 6-1. The heatsink clip provides enough pressure for the TIM to achieve a thermal conductivity of 0.17 °C inch²/W.

Table 6-1. Honeywell* PCM 45F TIM Performance as a Function of Attach Pressure

<table>
<thead>
<tr>
<th>Pressure (psi)</th>
<th>Thermal Resistance (°C × in²)/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.049</td>
</tr>
<tr>
<td>10</td>
<td>0.046</td>
</tr>
<tr>
<td>20</td>
<td>0.045</td>
</tr>
<tr>
<td>30</td>
<td>0.044</td>
</tr>
</tbody>
</table>

Note: All measured at 50 °C.

6.5.5 Heatsink Clip

The retention mechanism in this reference solution includes two different types of clips; one is ramp clip and the other is wire clip. Each end of the wire clip is attached to the ramp clip that in turn attaches to anchors to fasten the overall heatsink assembly to the motherboard. See Appendix B: Mechanical Drawings for a mechanical drawing of the clip.

6.5.6 Clip Retention Anchors

For Intel® 975X Express chipset-based platforms that have very limited board space, a clip retention anchor has been developed to minimize the impact of clip retention size on the board. It is based on a standard two-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: Thermal Solution Component Suppliers 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

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

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.
This list is provided by Intel solely as a convenience to customers. Intel has not tested, designed or validated these products and does not warrant user suitability or performance in any way. Customers are solely responsible for determining the suitability and application of these products for their designs.

Table 7-1. MCH Heatsink Thermal Solution

<table>
<thead>
<tr>
<th>Part Description</th>
<th>Intel Part Number</th>
<th>Supplier (Part Number)</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heatsink Assembly includes:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>—Pin-Fin Heatsink</td>
<td>C99237-001</td>
<td>CCI</td>
<td>Monica Chih (Taiwan) 866-2-29952666, x131 <a href="mailto:monica.chih@ccic.com.tw">monica.chih@ccic.com.tw</a></td>
</tr>
<tr>
<td>—Thermal Interface Material</td>
<td></td>
<td></td>
<td>Harry Lin (CCI/ACK-USA) 714-739-5797 <a href="mailto:hlinack@aol.com">hlinack@aol.com</a></td>
</tr>
<tr>
<td>—Ramp Clip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>—Wire Clip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pin-Fin Heatsink</td>
<td>C92139-001</td>
<td>CCI</td>
<td>Monica Chih (Taiwan) 866-2-29952666, x131 <a href="mailto:monica.chih@ccic.com.tw">monica.chih@ccic.com.tw</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Harry Lin (CCI/ACK-USA) 714-739-5797 <a href="mailto:hlinack@aol.com">hlinack@aol.com</a></td>
</tr>
<tr>
<td>Thermal Interface (PCM 45F)</td>
<td>C34795-001</td>
<td>Honeywell PCM 45F</td>
<td>Scott Miller 509-252-2206 <a href="mailto:scott.miller4@honeywell.com">scott.miller4@honeywell.com</a></td>
</tr>
<tr>
<td>Heatsink Ramp Clip</td>
<td>C92140-001</td>
<td>CCI</td>
<td>Monica Chih (Taiwan) 866-2-29952666, x131 <a href="mailto:monica.chih@ccic.com.tw">monica.chih@ccic.com.tw</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Harry Lin (CCI/ACK-USA) 714-739-5797 <a href="mailto:hlinack@aol.com">hlinack@aol.com</a></td>
</tr>
<tr>
<td>Heatsink Wire Clip</td>
<td>C85373-001</td>
<td>CCI</td>
<td>Monica Chih (Taiwan) 866-2-29952666, x131 <a href="mailto:monica.chih@ccic.com.tw">monica.chih@ccic.com.tw</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Harry Lin (CCI/ACK-USA) 714-739-5797 <a href="mailto:hlinack@aol.com">hlinack@aol.com</a></td>
</tr>
</tbody>
</table>
## Appendix A: Thermal Solution Component Suppliers

<table>
<thead>
<tr>
<th>Part</th>
<th>Intel Part Number</th>
<th>Supplier (Part Number)</th>
<th>Contact Information</th>
</tr>
</thead>
</table>
| Solder-Down Anchor | C85376-001       | Wieson                  | Rick Lin  
Deputy Manager/Project Sales  
Department  
Add.: 7F, No. 276, Section 1, Tatung Road, Hsichih City, Taipei Hsien, Taiwan  
Tel: 886-2-2647-1896 ext. 6342  
Mobile: 886-955644008  
Email: rick@wieson.com  
Website: www.wieson.com |

**NOTE:** The enabled components may not be currently available from all suppliers. Contact the supplier directly to verify time of component availability.
Appendix B: Mechanical Drawings

Table 8-1 lists the mechanical drawings included in this appendix.

Table 8-1. Mechanical Drawing List

<table>
<thead>
<tr>
<th>Drawing Description</th>
<th>Figure Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic Wave Soldering Heatsink Assembly Drawing</td>
<td>Figure 8-1</td>
</tr>
<tr>
<td>Plastic Wave Soldering Heatsink Drawing (1 of 2)</td>
<td>Figure 8-2</td>
</tr>
<tr>
<td>Plastic Wave Soldering Heatsink Drawing (2 of 2)</td>
<td>Figure 8-3</td>
</tr>
<tr>
<td>Plastic Wave Soldering Heatsink Ramp Clip Drawing (1 of 2)</td>
<td>Figure 8-4</td>
</tr>
<tr>
<td>Plastic Wave Soldering Heatsink Ramp Clip Drawing (2 of 2)</td>
<td>Figure 8-5</td>
</tr>
<tr>
<td>Plastic Wave Soldering Heatsink Wire Clip Drawing</td>
<td>Figure 8-6</td>
</tr>
<tr>
<td>Plastic Wave Soldering Heatsink Solder-Down Anchor Drawing</td>
<td>Figure 8-7</td>
</tr>
</tbody>
</table>
Figure 8-1. Plastic Wave Soldering Heatsink Assembly Drawing
Figure 8-2. Plastic Wave Soldering Heatsink Drawing (1 of 2)
Figure 8-3. Plastic Wave Soldering Heatsink Drawing (2 of 2)
Figure 8-4. Plastic Wave Soldering Heatsink Ramp Clip Drawing (1 of 2)
Figure 8-5. Plastic Wave Soldering Heatsink Ramp Clip Drawing (2 of 2)
Figure 8-6. Plastic Wave Soldering Heatsink Wire Clip Drawing
Figure 8-7. Plastic Wave Soldering Heatsink Solder-Down Anchor Drawing