Intel® 945G/945GZ/945GC/ 945P/945PL Express Chipset Family

Thermal and Mechanical Design Guidelines (TMDG)

- For the Intel® 82945G/82945GZ/82945GC Graphics Memory Controller Hub (GMCH) and Intel® 82945P/82945PL Memory Controller Hub (MCH)

February 2008

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Revision History

Revision Number	Description	Date
-001	• Initial Release	May 2005
-002	• Added Intel® 82945PL specifications	October 2005
-003	• Added Intel® 82945GZ specifications	December 2005
-004	• Added Intel® 82945GC specifications	February 2008

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1   *Introduction*

As the complexity of computer systems increases, so do power dissipation requirements. The additional power of next generation systems must be properly dissipated. Heat can be dissipated using improved system cooling, selective use of ducting, and/or active/passive heatsinks.

The objective of thermal management is to ensure that the temperatures of all components in a system are maintained within functional limits. The functional temperature limit is the range within which the electrical circuits can be 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 operating characteristics of the component. The goal of this document is to provide an understanding of the operating limits of the Intel® 82945G/82945GZ/82945GC Graphics and Memory Controller Hub (GMCH) and Intel® 82945P/82945PL Memory Controller Hub (MCH), and discuss a reference thermal solution.

The simplest and most cost-effective method to improve the inherent system cooling characteristics of the (G)MCH 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 presents the conditions and requirements to properly design a cooling solution for systems that implement the 82945G/82945GZ/82945GC GMCH or 82945P/82945PL MCH. Properly designed solutions provide adequate cooling to maintain the (G)MCH case temperature 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 (G)MCH case temperature at or below those recommended in this document, a system designer can ensure the proper functionality, performance, and reliability of these components.

Note: Unless otherwise specified, the information in this document applies to the Intel® 82945G/82945GZ/82945GC Graphics and Memory Controller Hub (GMCH) and the Intel® 82945P/82945PL Memory Controller Hub (MCH). The term (G)MCH refers to the 82945G GMCH, 82945GZ GMCH, 82945GC GMCH, 82945P MCH, and 82945PL MCH.

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

1.1 Terminology

Term	Description
BGA	Ball Grid Array. A package type defined by a resin-fiber substrate where a die is mounted and bonded. The primary electrical interface is an array of solder balls attached to the substrate opposite the die and molding compound.
FC-BGA	Flip Chip Ball Grid Array. A package type defined by a plastic substrate where a die is mounted using an underfill C4 (Controlled Collapse Chip Connection) attach style. The primary electrical interface is an array of solder balls attached to the substrate opposite the die. Note that the device arrives at the customer with solder balls attached.
Intel® ICH7	Intel® I/O Controller Hub 7. The chipset component that contains the primary PCI interface, LPC interface, USB, ATA, and/or other legacy functions.
GMCH	Graphic Memory Controller Hub. The chipset component that contains the processor and memory interface and integrated graphics device.
MCH	Memory Controller Hub. The chipset component that contains the processor and memory interface. It does not contain an integrated graphics device.
T_A	The measured ambient temperature locally to the component of interest. The ambient temperature should be measured just upstream of airflow for a passive heatsink or at the fan inlet for an active heatsink.
T_C	The measured case temperature of a component. For processors, T_C is measured at the geometric center of the integrated heat spreader (IHS). For other component types, it is generally measured at the geometric center of the die or case.
T_{C-MAX}	The maximum case/die temperature with an attached heatsink. This temperature is measured at the geometric center of the top of the package case/die.
T_{C-MIN}	The minimum case/die temperature with an attached heatsink. This temperature is measured at the geometric center of the top of the package case/die.
TDP	Thermal Design Power. TDP is specified as the highest sustainable power level of most or all of the real applications expected to be run on the given product, based on extrapolations in both hardware and software technology over the life of the component. Thermal solutions should be designed to dissipate this target power level.
TIM	Thermal Interface Material. TIM is the thermally conductive material installed between two surfaces to improve heat transfer and reduce interface contact resistance.
lfm	Linear Feet per Minute. Unit of airflow speed.
Ψ_{CA}	Case-to-ambient thermal characterization parameter (Psi). This is a measure of thermal solution performance using total package power. It is defined as (T_C – T_A) / Total Package Power. Heat source size should always be specified for Ψ measurements.

1.2   Reference Documents

Document	Comments
Intel® 945G/945GZ/945P/945PL Express Chipset Family Datasheet	http://developer.intel.com/design/chipsets/datashts/307502.htm
Intel® I/O Controller Hub 7 (ICH7) Datasheet	http://developer.intel.com//design/chipsets/datashts/307013.htm
Intel® I/O Controller Hub 7 (ICH7) Thermal Design Guidelines	http://developer.intel.com//design/chipsets/designex/307015.htm
Intel® Pentium® 4 Processor 670, 660, 650, 640, and 630 and Intel® Pentium® 4 Processor Extreme Edition Datasheet	http://developer.intel.com/design/pentium4/datashts/306382.htm
Intel® Pentium® 4 Processors 570/571, 560/561, 550/551,540/541, 530/531 and 520/521 Supporting Hyper-Threading Technology Datasheet	http://developer.intel.com/design/Pentium4/datashts/302351.htm
Intel® Pentium® D Processor 840, 830 and 820 Datasheet	http://developer.intel.com/design/PentiumD//datashts/307506.htm
Intel® Pentium® 4 Processor on 90 nm Process in the 775–Land LGA Package Thermal and Mechanical Design Guidelines	http://developer.intel.com/design/Pentium4/guides/302553.htm
Intel® Pentium® D® Processor and Intel® Pentium® Processor Extreme Edition 830 Thermal and Mechanical Design Guidelines	http://developer.intel.com/design/pentiumXE/designex/306830.htm
LGA775 Socket Mechanical Design Guide	http://developer.intel.com/design/pentium4/guides/302666.htm
Various System Thermal Design Suggestions	http://www.formfactors.org

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Thermal and Mechanical Design Guidelines

2 *Product Specifications*

This chapter provides the package description and loading specifications. The chapter also provides component thermal specifications and thermal design power descriptions for the (G)MCH.

2.1 Package Description

The (G)MCH is available in a 34 mm [1.34 in] x 34 mm [1.34 in] Flip Chip Ball Grid Array (FC-BGA) package with 1202 solder balls. The die size is currently 9.6 mm [0.378in] x 10.6 mm [0.417in]. A mechanical drawing of the package is shown in Figure 9, Appendix B.

2.1.1 Non-Grid Array Package Ball Placement

The (G)MCH package uses a "balls anywhere" concept. The minimum ball pitch is 0.8 mm [0.031 in], but ball ordering does not follow a 0.8-mm grid. Board designers should ensure correct ball placement when designing for the non-grid array pattern. For exact ball locations relative to the package, contact your Field Sales Representative.

Figure 1. (G)MCH Non-Grid Array

34mm x 34mm Substrate [1.34in x 1.34in]

Non-standard grid ball pattern. Minimum pitch = 0.8mm [0.031in]
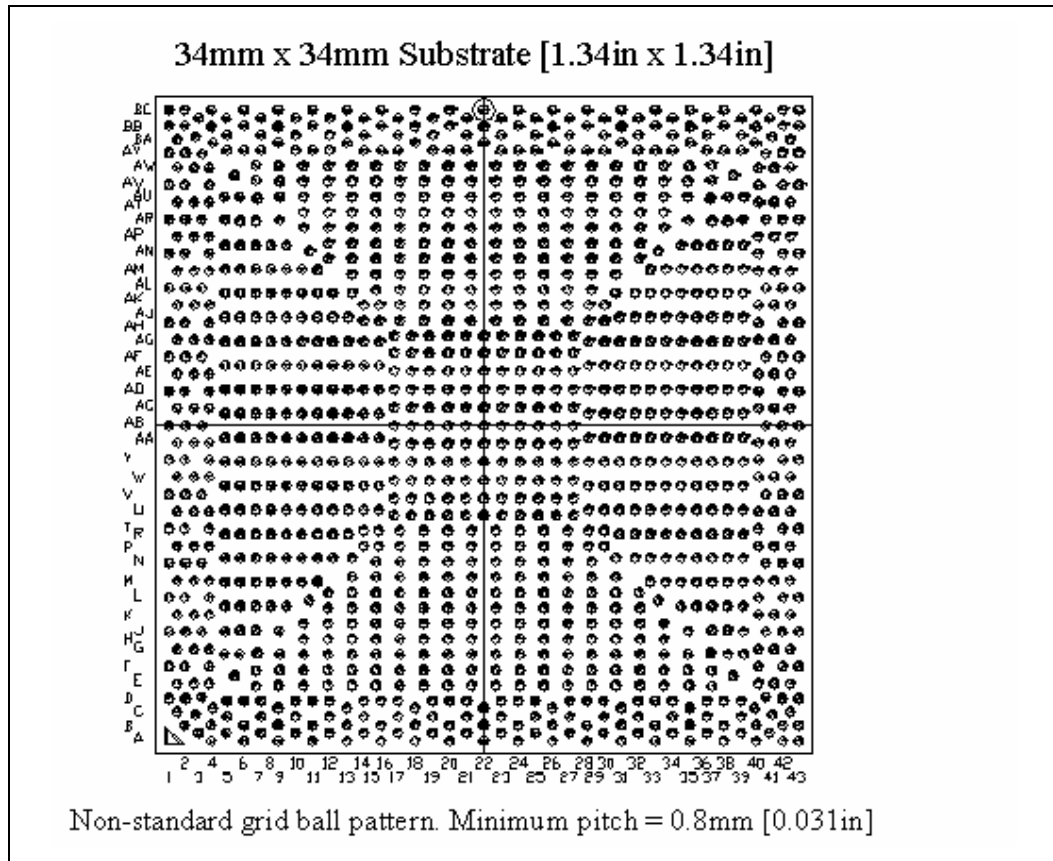
2.2 Package Loading Specifications

Table 1 provides static load specifications for the chipset package. This mechanical maximum load limit should not be exceeded during heatsink assembly, shipping conditions, or standard use conditions. Also, any mechanical system or component testing should not exceed the maximum limit. The chipset package substrate should not be used as a mechanical reference or load-bearing surface for the thermal and mechanical solution.

Table 1. (G)MCH Loading Specifications

Parameter	Maximum	Notes
Static	15 lbf	1,2,3

NOTES:
1. These specifications apply to uniform compressive loading in a direction normal to the (G)MCH package.
2. This is the maximum force that can be applied by a heatsink retention clip. The clip must also provide the minimum specified load on the (G)MCH package.
3. These specifications are based on limited testing for design characterization. Loading limits are for the package only.

2.3 Thermal Specifications

To ensure proper operation and reliability of the (G)MCH, the temperature must be at or below the maximum value specified in Table 2. System and component level thermal enhancements are required to dissipate the heat generated and maintain the (G)MCH within specifications. Chapter 3 provides the thermal metrology guidelines for case temperature measurements.

The (G)MCH must also operate above the minimum case temperature specification listed in Table 2.

Table 2.   (G)MCH Case Temperature Specifications

Parameter	Value
T_{C-MAX}	82945G/82945GZ/82945GC GMCH: 99 °C 82945P/82945PL MCH : 103°C
T_{C-MIN}	0 °C

NOTE: Thermal specifications assume an attached heatsink is present.

2.4 Thermal Design Power (TDP)

Thermal design power (TDP) is the estimated power dissipation of the (G)MCH based on normal operating conditions including V_{CC} and T_{C-MAX} while executing real worst-case power intensive applications. This value is based on expected worst-case data traffic patterns and usage of the (G)MCH and does not represent a specific software application. TDP attempts to account for expected increases in power due to variation in (G)MCH current consumption due to silicon process variation, processor speed, DRAM capacitive bus loading and temperature. However, since these variations are subject to change, the TDP cannot ensure that all applications will not exceed the TDP value.

The system designer must design a thermal solution for the (G)MCH such that it maintains T_C below T_{C-MAX} for a sustained power level equal to TDP. Note that the T_{C-MAX} specification is a requirement for a sustained power level equal to TDP, and that the case temperature must be maintained at temperatures less than T_{C-MAX} when operating at power levels less than TDP. This temperature compliance is to ensure (G)MCH reliability over its useful life. The TDP value can be used for thermal design if the (G)MCH thermal protection mechanisms are enabled. Intel chipsets incorporate a hardware-based fail-safe mechanism to help keep the product temperature within specifications in the event of unusually strenuous usage above the TDP power limit.

2.4.1 Methodology

2.4.1.1 Pre-Silicon

To determine TDP for pre-silicon products in development, it is necessary to make estimates based on analytical models. These models rely on extensive knowledge of the past chipset power dissipation behavior along with knowledge of planned architectural and process changes that may affect TDP. Knowledge of applications available today and their ability to stress various components of the chipset is also included in the model. Since the number of applications available today is beyond what Intel can test, only real world high-power applications are tested to predict TDP. The values determined are used to set specific data transfer rates. The projection for TDP assumes (G)MCH operation at T_{C-MAX}. The TDP estimate also includes a margin to account for process variation.

2.4.1.2 Post-Silicon

Once the product silicon is available, post-silicon validation is performed to assess the validity of pre-silicon projections. Testing is performed on both commercially available and synthetic high power applications and power data is compared to pre-silicon estimates. Post-silicon validation may result in a small adjustment to pre-silicon TDP estimates.

2.4.2 Application Power

Designing to the TDP can ensure that a particular thermal solution meets the cooling needs of future applications. Testing with currently available commercial applications has shown that the components may dissipate power levels below the published TDP specification in Section 2.4.3. Intel strongly recommends that thermal engineers design to the published TDP specification to develop a robust thermal solution that will meet the needs of current and future applications.

2.4.3 Specifications

The (G)MCH is estimated to dissipate the Thermal Design Power values provided in Table 3 when using two DIMMs of 667 MHz (553 MHz for the 82945PL/82945GZ) dual channel DDR2 with a 1066 MHz (800 MHz for the 82945PL/82945GZ/82945GC) processor system bus speed. For the 82945G/82945GZ/82945GC GMCH, the graphics core is assumed to run at 400 MHz. FC-BGA packages have limited heat transfer capability into the board and have minimal thermal capability without thermal solutions. Intel requires that system designers plan for an attached heatsink when using the (G)MCH.

Table 3. (G)MCH Thermal Design Power Specifications

Component	System Bus Speed	Memory Frequency	TDP Value
82945G GMCH	1066 MHz	667 MHz	22.2 W
82945GZ GMCH	800 MHz	533 MHz	22.2 W
82945GC GMCH	800 MHz	667 MHz	22.2 W
82945P MCH	1066 MHz	667 MHz	15.2 W
82945PL MCH	800 MHz	533 MHz	15.2 W

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3 Thermal Metrology

The system designer must measure temperatures to accurately determine the thermal performance of the system. Intel has established guidelines for proper techniques of measuring (G)MCH component case temperatures.

3.1 Case Temperature Measurements

To ensure functionality and reliability, the (G)MCH is specified for proper operation when T_C is maintained at or below the maximum temperature listed in Table 2. The surface temperature at the geometric center of the die corresponds to T_C. Measuring T_C requires special care to ensure an accurate temperature reading.

Temperature differences between the temperature of a surface and the surrounding local ambient air can introduce error 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, or contact between the thermocouple cement and the heatsink base (if a heatsink is used). To minimize these measurement errors a thermocouple attach with a zero-degree methodology is recommended.

3.1.1 Thermocouple Attach Methodology

1. Mill a 3.3 mm [0.13 in] diameter hole centered on bottom of the heatsink base. The milled hole should be approximately 1.5 mm [0.06 in] deep.
2. Mill a 1.3 mm [0.05 in] wide slot, 0.5 mm [0.02 in] deep, from the centered hole to one edge of the heatsink. The slot should be in the direction parallel to the heatsink fins (see Figure 3).
3. Attach thermal interface material (TIM) to the bottom of the heatsink base.
4. Cut out portions of the TIM 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, make sure 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 2).
6. Attach heatsink assembly to the (G)MCH and route thermocouple wires out through the milled slot.

Figure 2. 0° Angle Attach Methodology (top view, not to scale)
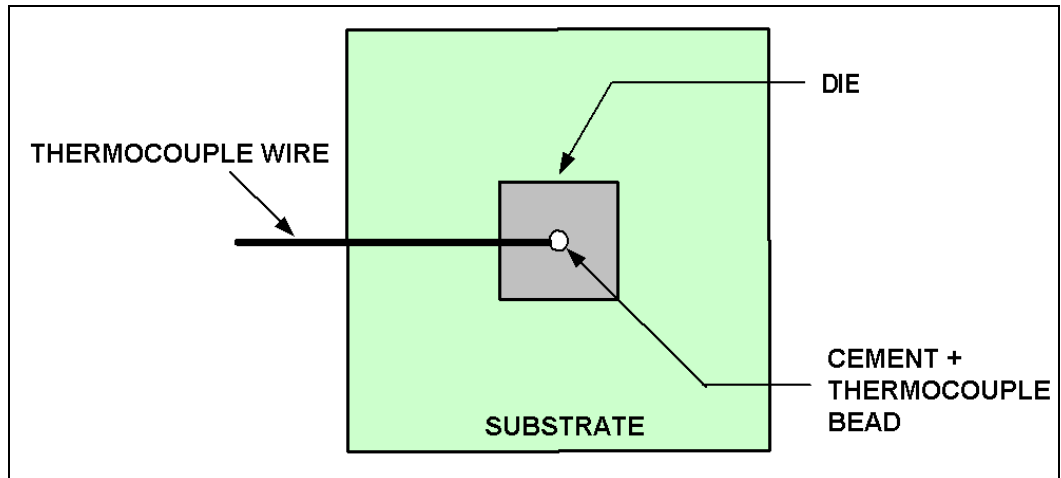
Figure 3. 0° Angle Attach Heatsink Modifications (generic heatsink side and bottom view shown, not to scale)
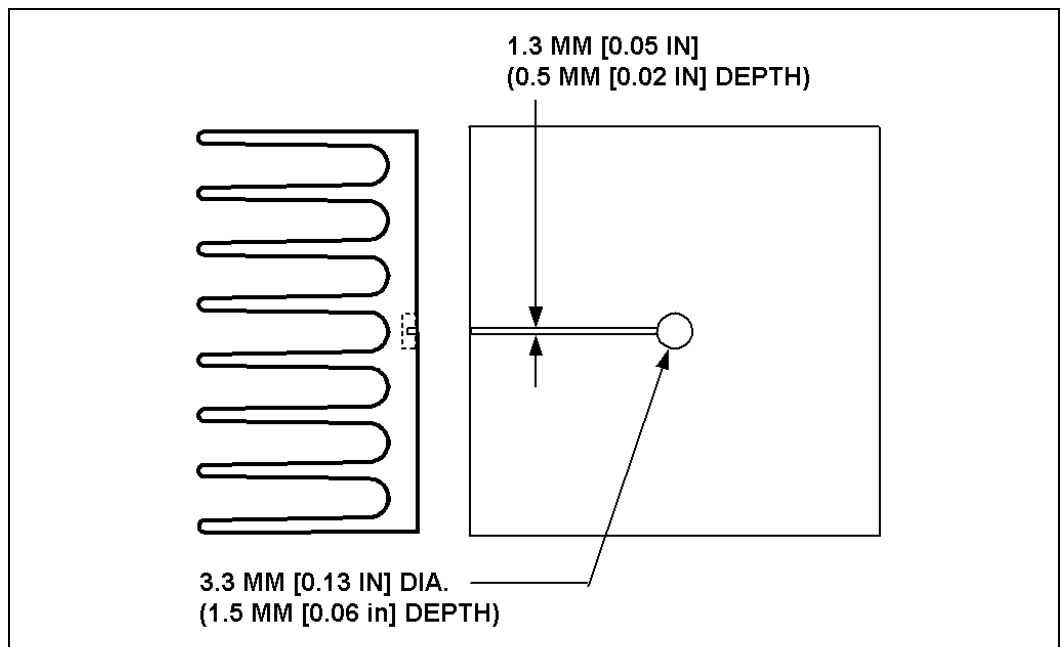
3.2 Airflow Characterization

Figure 4 describes the recommended location for air temperature measurements measured relative to the component. For a more accurate measurement of the average approach air temperature, Intel recommends averaging temperatures recorded from two thermocouples spaced about 25 mm [1.0 in] apart. Locations for both a single thermocouple and a pair of thermocouples are presented.

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Figure 4. Airflow Temperature Measurement Locations
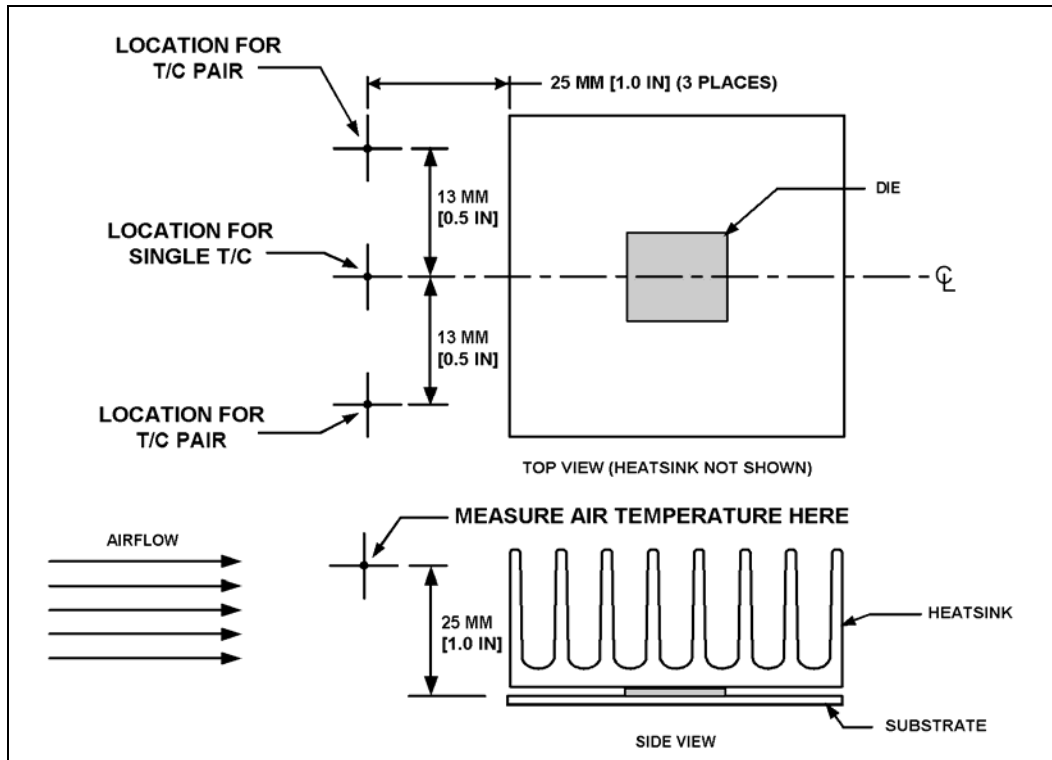
Airflow velocity should be measured using industry standard air velocity sensors. Typical airflow sensor technology may include hot wire anemometers. Figure 4 provides guidance for airflow velocity measurement locations. These locations are for a typical JEDEC test setup and may not be compatible with chassis layouts due to the proximity of the processor to the (G)MCH. The user may have to adjust the locations for a specific chassis. Be aware that sensors may need to be aligned perpendicular to the airflow velocity vector or an inaccurate measurement may result. Measurements should be taken with the chassis fully sealed in its operational configuration to achieve a representative airflow profile within the chassis.

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4   *Reference Thermal Solution*

The reference component thermal solution for the (G)MCH for ATX platforms uses two ramp retainers, a wire preload clip, and four custom MB anchors. The Intel Balanced Technology Extended (BTX) reference design uses a Z-clip attach for the (G)MCH heatsink. This chapter provides detailed information on operating environment assumptions, heatsink manufacturing, and mechanical reliability requirements for the (G)MCH.

4.1   Operating Environment

The operating environment of the (G)MCH will differ depending on system configuration and motherboard layout. This section defines operating environment boundary conditions that are typical for ATX and BTX form factors. The system designer should perform analysis on the platform operating environment to assess any impact to thermal solution selection.

4.1.1   ATX Form Factor Operating Environment

In ATX platforms, an airflow speed of 0.76 m/s [150 lfm] is assumed to be present 25 mm [1 in] in front of the heatsink air inlet side of the attached reference thermal solution. The system integrator should note that board layout may be such that there will not be 25mm [1in] between the processor heatsink and the (G)MCH. The potential for increased airflow speeds may be realized by ensuring that airflow from the processor heatsink fan exhausts in the direction of the (G)MCH heatsink. This can be achieved by using a heatsink providing omni directional airflow, such as a radial fin or "X" pattern heatsink. Such heatsinks can deliver airflow to both the (G)MCH and other areas like the voltage regulator, as shown in Figure 5. In addition, the (G)MCH board placement should ensure that the (G)MCH heatsink is within the air exhaust area of the processor heatsink.

Note that heatsink orientation alone does not ensure that 0.76 m/s [150 lfm] airflow speed will be achieved. The system integrator should use analytical or experimental means to determine whether a system design provides adequate airflow speed for a particular (G)MCH heatsink.

The local ambient air temperature, T_A, at the (G)MCH heatsink in an ATX platform is assumed to be 47 °C. The thermal designer must carefully select the location to measure airflow to get a representative sampling. These environmental assumptions are based on a 35 °C system external temperature measured at sea level.

Figure 5. Processor Heatsink Orientation to Provide Airflow to (G)MCH Heatsink on an ATX Platform
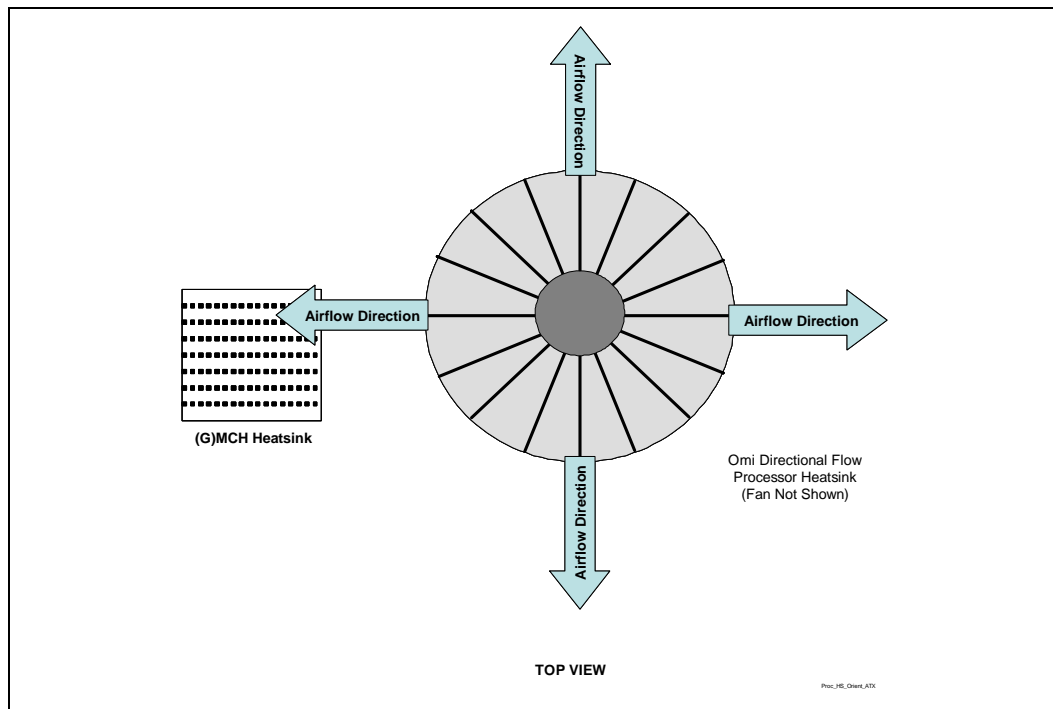
Other methods exist for providing airflow to the (G)MCH heatsink, including the use of system fans and/or ducting, or the use of an attached fan (active heatsink).

4.1.2 Balanced Technology Extended (BTX) Form Factor Operating Environment

The operating environment for the (G)MCH in typical BTX systems has not been profiled. This section provides operating environment conditions based on what has been exhibited on the Intel micro-BTX reference design. On a BTX platform, the (G)MCH obtains in-line airflow directly from the processor thermal module. Since the processor thermal module provides lower inlet temperature airflow to the processor, reduced inlet ambient temperatures are also often seen at the (G)MCH as compared to ATX. An example of how airflow is delivered to the (G)MCH on a BTX platform is shown in Figure 6.

The local ambient air temperature, T_A, at the (G)MCH heatsink in the Intel micro-BTX reference design is predicted to be ~45 °C. The thermal designer must carefully select the location to measure airflow to get a representative sampling. These environmental assumptions are based on a 35 °C system external temperature measured at sea level.

Note: The local ambient air temperature is a projection based on anticipated power increases on a 2005 platform and may be subject to change in future revisions of this document.

Figure 6. Processor Heatsink Orientation to Provide Airflow to (G)MCH Heatsink on a Balanced Technology Extended (BTX) Platform
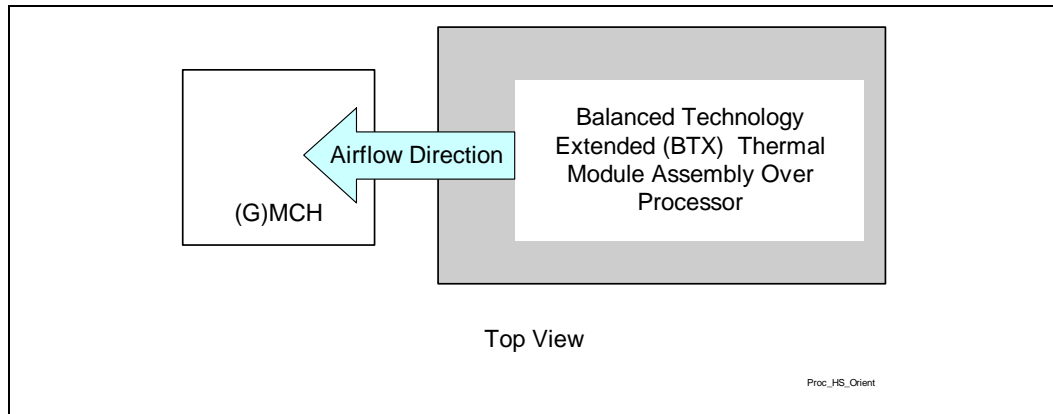
4.2 Mechanical Design Envelope

The motherboard component keep-out restrictions for the (G)MCH on an ATX platform are included in Appendix B, Figure 10. The motherboard component keep-out restrictions for the (G)MCH on a BTX platform are included in Figure 11.

System integrators should ensure no board or chassis components would intrude into the volume occupied by the (G)MCH thermal solution.

4.3 Thermal Solution Assembly

The reference thermal solution for the (G)MCH for an ATX platform is shown in Figure 7 and Appendix B and is an aluminum extruded heatsink that uses two ramp retainers, a wire preload clip, and four custom motherboard anchors. The heatsink is attached to the motherboard by assembling the anchors into the board, placing the heatsink over the (G)MCH and anchors at each of the corners, and securing the plastic ramp retainers through the anchor loops before snapping each retainer into the fin gap. The assembly is then sent through the wave process. Post wave, the wire preload clip is assembled using the hooks on each of the ramp retainers. The clip provides the mechanical preload to the package. A thermal interface material (Chomerics* T710) is pre-applied to the heatsink bottom over an area that contacts the package die.

The reference thermal solution for the (G)MCH for a BTX platform is shown in Figure 8. The heatsink is aluminum extruded and uses a Z-clip for attach. The clip is secured to the system motherboard via two solder-down anchors around the (G)MCH. The clip helps to provide a mechanical preload to the package via the heatsink. A thermal interface material (Chomerics* T710) is pre-applied to the heatsink bottom over an area in contact with the package die.

The ATX reference thermal solution differs from the BTX reference solution because a BTX platform requires a Support and Retention Mechanism (SRM) that helps to meet the mechanical requirements listed in Table 4.

Figure 7. ATX GMCH Heatsink Installed on Board

Thermal and Mechanical Design Guidelines
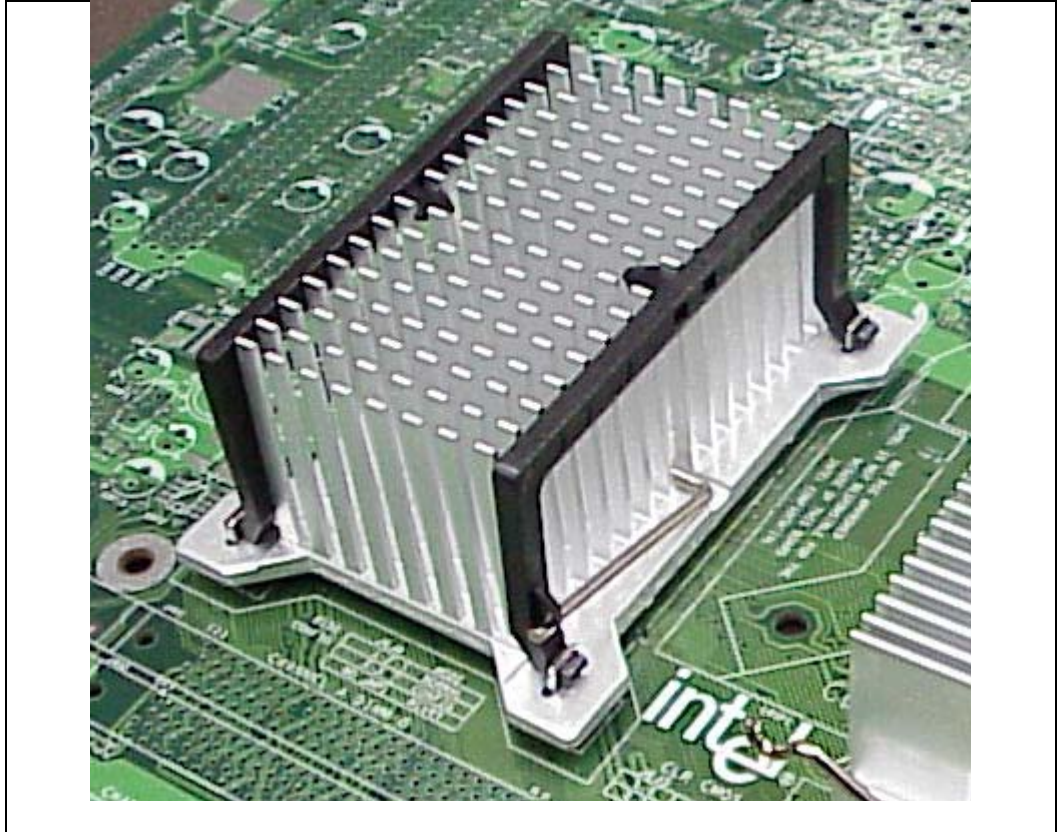
Figure 8. Balanced Technology Extended (BTX) GMCH Heatsink Installed on Board
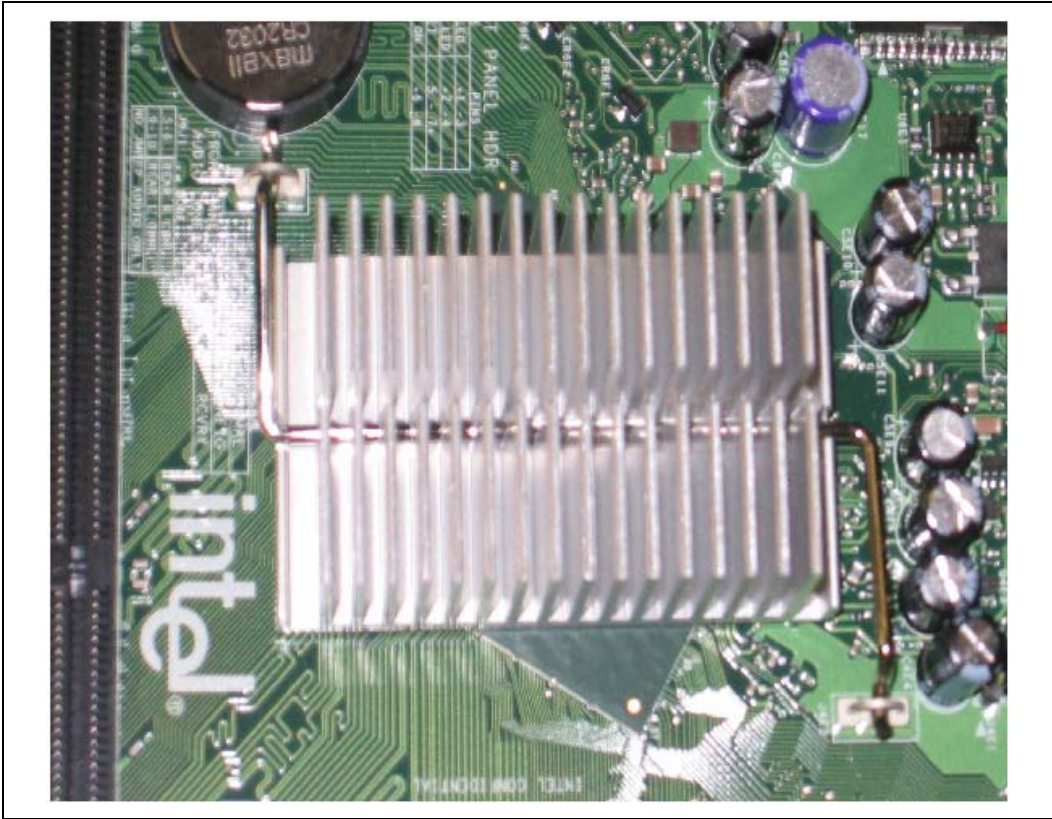
4.4 Environmental Reliability Requirements

The environmental reliability requirements for the reference thermal solution are shown in Table 4. These should be considered as general guidelines. Validation test plans should be defined by the user based on anticipated use conditions and resulting reliability requirements.

Table 4. Reference Thermal Solution Environmental Reliability Requirements

Test[1]	Requirement	Pass/Fail Criteria[2]
Mechanical Shock	• 3 drops for + and - directions in each of 3 perpendicular axes (i.e., total 18 drops). • Profile: 50 G trapezoidal waveform, 11 ms duration, 4.3 m/s [170 in/s] minimum velocity change. • Setup: Mount sample board on test fixture. Include 550 g processor heatsink.	Visual\Electrical Check
Random Vibration	• Duration: 10 min/axis, 3 axes • Frequency Range: 5 Hz to 500 Hz • Power Spectral Density (PSD) Profile: 3.13 g RMS	Visual/Electrical Check
Thermal Cycling	• -40 °C to +85 °C, 900 cycles	Thermal Performance
Unbiased Humidity	• 85 % relative humidity / 55 °C, 500 hours	Visual Check

NOTES:
1. The above tests should be performed on a sample size of at least 12 assemblies from 3 different lots of material.
2. Additional Pass/Fail Criteria may be added at the discretion of the user.

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Appendix A Enabled Suppliers

Current suppliers for the Intel® 945G/945GZ/945GC/945P/945PL Express chipset (G)MCH reference thermal solution are listed in Table 5 and Table 6.

Table 5.   (G)MCH ATX Intel Reference Heatsink Enabled Suppliers

Supplier	Intel Part Number	Vendor Part Number	Contact Information
CCI (Chaun Choung Technology Corp)	C85366-001 (heatsink) C85370-001 (ramp retainer) C85373-001 (wire clip)	00C863501A 334C863501A 334C863502A	Monica Chih - +886 (-2) - 29952666 monica_chih@ccic.com.tw Harry Lin - (714) 739-5797 hlinack@aol.com
WiesonElectronic Co.	C85376-001 (anchor)	G2100C888-143	Rick Lin - +886 (-2) - 26471896 ext.6342 rick@wieson.com.tw
Foxconn/HonHai Precision	C85366-001 (heatsink) C85370-001 (ramp retainer) C85373-001 (wire clip)	2Z802-016 3EE77-002 3KS02-066	Jack Chen – (714) 626-1233 Jack.chen@foxconn.com
Foxconn/HonHai Precision	C85376-001 (anchor)	2Z802-015	Jack Chen – (714) 626-1233 Jack.chen@foxconn.com

Note: These vendors and devices are listed by Intel as a convenience to Intel's general customer base, but Intel does not make any representations or warranties whatsoever regarding quality, availability, reliability, functionality, or compatibility of these devices. This list and/or these devices may be subject to change without notice.

Table 6. **(G)MCH Balanced Technology Extended (BTX) Intel Reference Heatsink Enabled Suppliers**

Supplier	Intel Part Number	Vendor Part Number	Contact Information
CCI (Chaun Choung Technology Corp.)	C57359-001	00C863401A	Monica Chih - +886 (-2) - 29952666 monica_chih@ccic.com.tw Harry Lin - (714) 739-5797 hlinack@aol.com
AVC (Asia Vital Components)	C57359-001	S909700001	David Chao - +886 (-2) -2299-6930 x619 david_chao@avc.com.tw
Foxconn/HonHai Precision	C57359-001	2Z802-010	Jack Chen — (714) 626-1233 Jack.chen@foxconn.com

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Appendix B Mechanical Drawings

The following table lists the mechanical drawings available in this document.

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NOTE: Unless otherwise specified, all figures in this appendix are dimensioned in millimeters. Dimensions shown in brackets are in inches.

Figure 9. (G)MCH Package Drawing

Mechanical Drawings
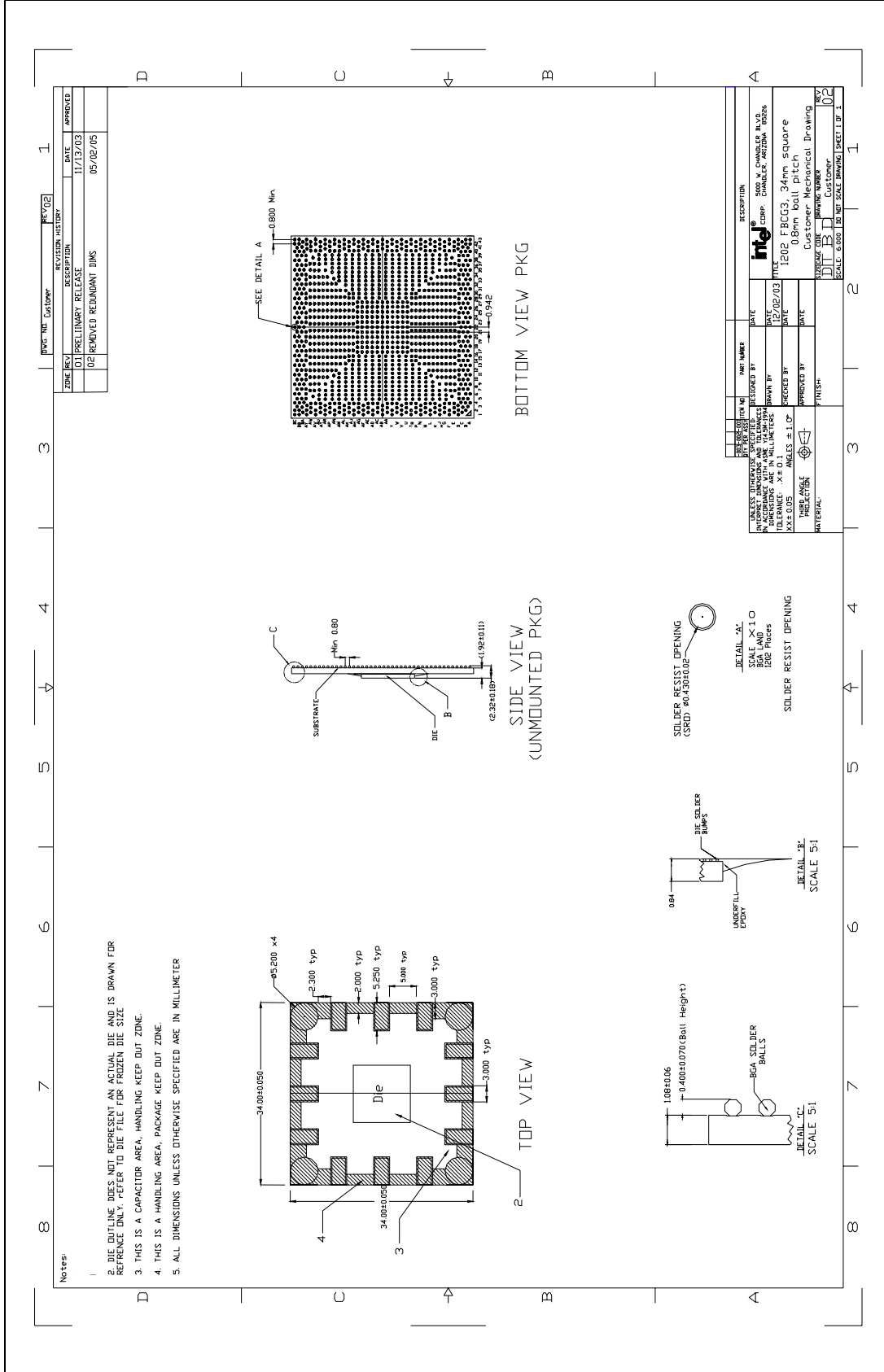
Figure 10. (G)MCH Component Keep-Out Restrictions for ATX Platforms

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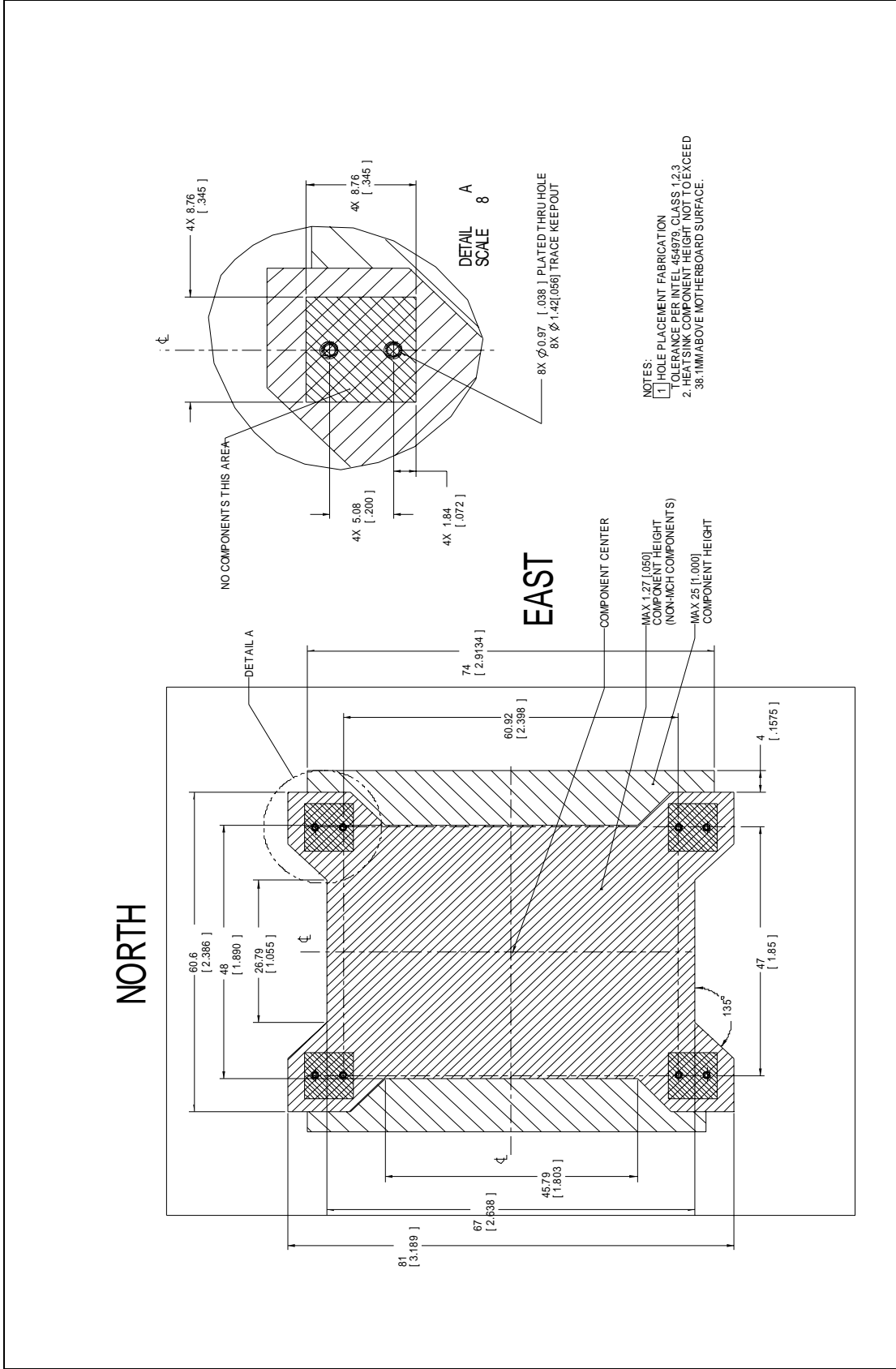
Figure 11. (G)MCH Component Keep-Out Restrictions for Balanced Technology Extended (BTX) Platforms

Mechanical Drawings

Figure 12. (G)MCH Reference Heatsink for ATX Platforms – Sheet 1

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: 6063-T5 ALUMINUM
4. FINISH: NONE
5. MARK PART WITH INTEL P/N AND REVISION APPROX WHERE SHOWN PER INTEL MARKING STANDARD 16497
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 FAI
11. REMOVE ALL BURRS OR SHARP EDGES AROUND PERIMETER OF PART. SHARPNESS OF EDGES SUBJECT TO HANDLING ARE REQUIRED TO MEET UL1499 TEST.

SEE DETAIL B

TYP 3.75 ±0.15 [.148 ± .005]

30.5 [1.201]

TYP 35.5 [1.398]

FULL ROUND

14X EQUAL SPACING

4 [.157]

16X 1.2 ±0.15 [.047 ± .005]

SEE DETAIL A

2X 59.28 ±0.15 [2.334 ± .005]

2X 58.6 [2.307]

47 [1.850]

2X 48 ±0.15 [1.890 ± .005]

2X 80 [3.150]

8X 2.7 ±0.15 [.106 ± .005]

36 [1.417]

7X EQUAL SPACING

Thermal and Mechanical Design Guidelines

Figure 13. (G)MCH Reference Heatsink for ATX Platforms – Sheet 2
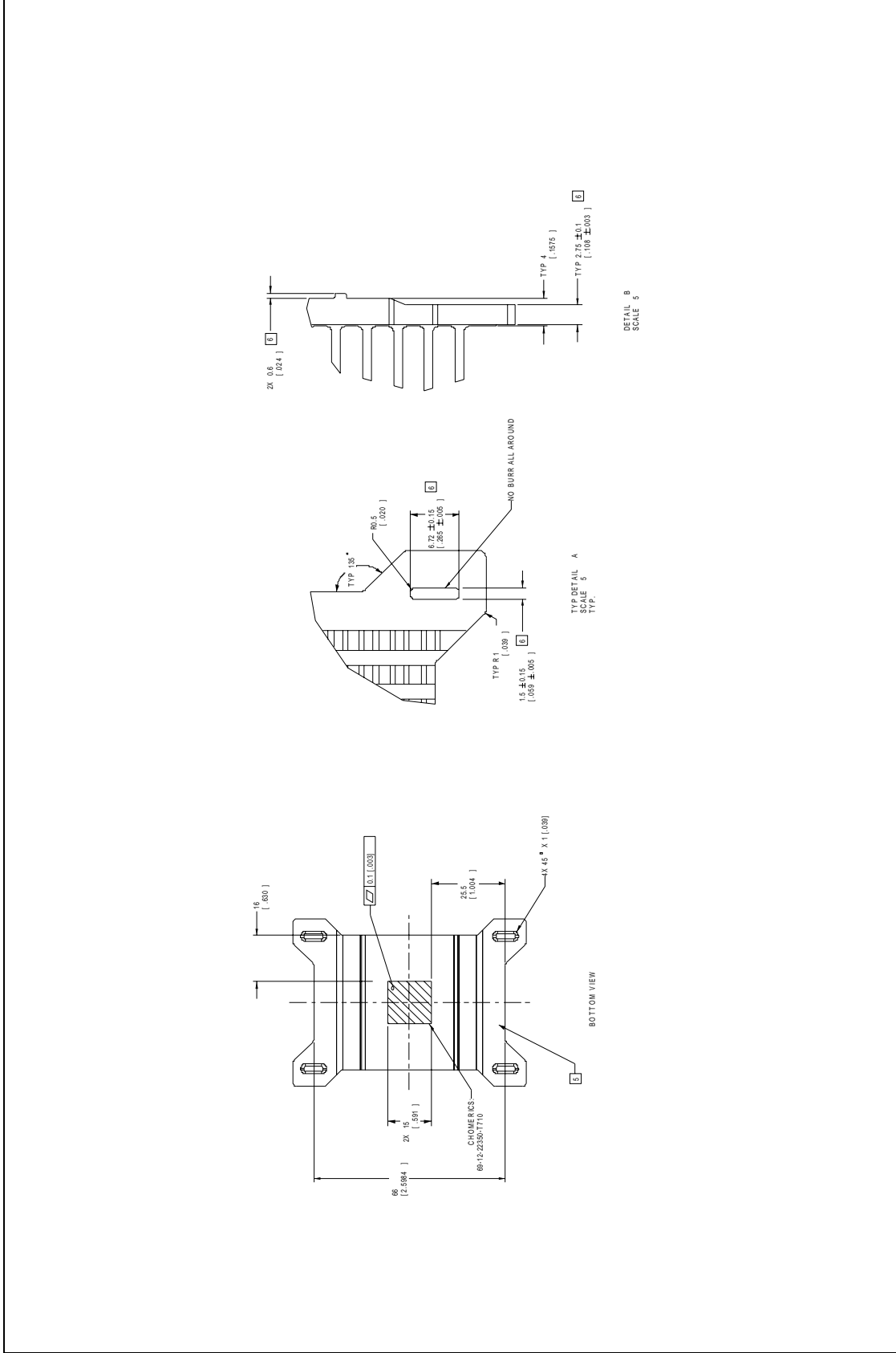
Mechanical Drawings

Figure 14. (G)MCH Reference Heatsink for ATX Platforms – Anchor

Figure 15. (G)MCH Reference Heatsink for ATX Platforms – Ramp Retainer Sheet 1

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.
   FOR FEATURE SIZES < 10MM LINEAR   ±.07
   FOR FEATURE SIZES BETWEEN 10 AND 25 MM: LINEAR   ±.07
   FOR FEATURE SIZES BETWEEN 25 AND 50 MM: LINEAR   ±.08
   FOR FEATURE SIZES > 50MM LINEAR   ±.18   ±.10
   ANGLES: ±0.5 °

3. MATERIAL:
   A) TYPE: ENVIRONMENTALLY COMPLIANT THERMOPLASTIC OR EQUIVALENT UPON INTEL APPROVAL (REF GE LEXAN 500ECR-739)
   B) CRITICAL MECHANICAL MATERIAL PROPERTIES FOR EQUIVALENT MATERIAL SELECTION:
   TENSILE YIELD STRENGTH (ASTM D638) > 57 MPa
   TENSILE ELONGATION AT BREAK (ASTM D638) >= 46%
   FLEXURAL MODULUS (ASTM D638) 3114 MPa
   SOFTENING TEMP (VICAT, RATE B) 154 °C
   C) COLOR: APPROXIMATING BLACK, (REF GE 739)
   D) REGRIND: 25% PERMISSIBLE.
   E) VOLUME - 1.73e+03 CUBIC-MM (REF)
   WEIGHT - 2.16 GRAMS (REF)

5. MARK PART WITH INTEL P/N, REVISION, CAVITY NUMBER AND DATE CODE APPROX WHERE SHOWN PER INTEL MARKING STANDARD 164997

6. CRITICAL TO FUNCTION DIMENSION

7. ALL DIMENSIONS SHOWN SHALL BE MEASURED FOR FAI

8. NOTE REMOVED

9. DEGATE: FLUSH TO 0.35 BELOW STRUCTURAL THICKNESS (GATE WELL OR GATE RECESS ACCEPTABLE)

10. FLASH - 0.15 MAX.

11. SINK - 0.25 MAX.

12. EJECTOR MARKS: FLUSH TO -0.25

13. PARTING LINE MISMATCH NOT TO EXCEED 0.25

14. EJECTION PIN BOSSES, GATING, AND TOOLING INSERTS REQUIRE INTEL'S APPROVAL PRIOR TO TOOL CONSTRUCTION. ALL EJECTION PIN BOSSES AND GATE FEATURES SHOWN ARE FOR REFERENCE ONLY.

15. EDGES SHOWN AS SHARP R 0.1 MAX.

16. 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.

17. ALL SECONDARY UNIT DIMENSIONS ARE FOR REFERENCE ONLY.

70.49 [2.775]

61.51 [2.422]

SEE DETAIL C

3 [.118]

2X 31.1 [1.225]

2X 27.95 [1.100]

2 ±0.05 [.079 ±.001]

SEE DETAIL A

Mechanical Drawings

Figure 16. (G)MCH Reference Heatsink for ATX Platforms – Ramp Retainer Sheet 2

DETAIL C
SCALE 10

2X 2.9 [.114]

6.4 [.252]

5.56 [.219]

4 [.157]

SECTION B-B

2X 5.76 [.227]

1.19 [.047]

1.75 [.069]

0.5 [.020]

2X DETAIL A
SCALE 20

3.15 [.124]

2.75 [.108]

6.55 [.258]

3 [.118]

4.75 [.187]

5.2 [.205]

Figure 17. (G)MCH Reference Heatsink for ATX Platforms – Wire Preload Clip

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: ± 1°
3. MATERIAL:
   A) TYPE: ASTM A228 MUSIC WIRE   Ø1.8 ± 0.1MM [4]
      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 TO FUNCTION DIMENSION
5. MARK WITH INTEL P/N AND REVISION PER INTEL MARKING STANDARD I64997 PER SEC 3.8 (POLYETHYLENE BAG)
6. REMOVE ALL SHARP EDGES AND BURRS.
7. ALL DIMENSIONS SHOWN SHALL BE MEASURED FOR FAI
8. ALL SECONDARY UNIT DIMENSIONS ARE FOR REFERENCE ONLY.

TYP R1.8 [.071]

46.6 ± 0.5 [1.835 ± .019]

19.3 ± 0.5 [.760 ± .019]

27.3 ± 0.5 [1.075]

FAR SIDE

FARSIDE

2X 90°

2.65 [.104]

SECTION A-A

37.06 [1.459]

61.74 ± 0.5 [2.431 ± .019]

27.7 [1.090]

Mechanical Drawings

Figure 18. (G)MCH Reference Heatsink for Balanced Technology Extended (BTX) Platforms

NOTES:
1. PROCUREMENT SPECIFICATION A02160 SHALL APPLY
2. REMOVE ALL BURRS AND SHARP EDGES
3 CRITICAL TO FUNCTION DIMENSIONS

C

(55.88)
[2.20]

(33)
[1.30]

B

16X 1.17
[.046]

2X 7.25 ±0.2
[.285 ±.007]

47.88
[1.885]

15X EQUAL SPACES
(1.94)
[.08]

R 0 TO FULL

A

3.4 ±0.2
[.134 ±.007]

3

FULL R

2X 1.17
[.046]

2X 1.2
[.047]

19
[.748]

19
[.748]

3±0.25
[.118 ±.009]

24.2
[.953]

(15)
[.591]

3±0.2
[.118 ±.007]   3

R 0 TO 0.5 [.020]

B C

0.08 [.003]

0.25 [.009]

Figure 19. (G)MCH Reference Heatsink for Balanced Technology Extended (BTX) Platforms – Clip

NOTES:
1. REMOVE ALL SHARP EDGES AND BURRS
2. MATERIAL: ASTM A228 MUSIC WIRE
3. TOTAL WIRE LENGTH = 121.9 MM
4. CRITICAL TO FUNCTION DIMENSIONS
5. PLATING: ELECTRO-LESS NICKEL

Mechanical Drawings

Figure 20. (G)MCH Reference Heatsink for Balanced Technology Extended (BTX) Platforms – Heatsink Assembly

Thermal and Mechanical Design Guidelines

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