Intel® 965 Express Chipset Family

Thermal and Mechanical Design Guidelines

- For the Intel® 82Q965, 82Q963, 82G965 Graphics and Memory Controller Hub (GMCH) and Intel® 82P965 Memory Controller Hub (MCH)

January 2007

Document Number: 313055-003

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Revision History

Revision	Description	Date
-001	• Initial Release	June 2006
-002	• Added 82Q965, 82G965, and 82Q963 GMCHs	July 2006
-003	• Updated idle power values in Table 2. • Updated enabled suppliers information. In Table 7.	January 2007

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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.

This document is for the following components:

- Intel® 82Q965 GMCH
- Intel® 82Q963 GMCH
- Intel® 82G965 GMCH
- Intel® 82P965 MCH

This document presents the conditions and requirements to properly design a cooling solution for systems that implement the 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 this component.

Note: Unless otherwise specified, the term (G)MCH refers to the Intel® 82Q965 GMCH, Intel® 82Q963 GMCH, Intel® 82G965 GMCH, and Intel® 82P965 MCH.

Note: In this document the use of the term chipset refers to the combination of the (G)MCH and the Intel ICH8.

Note: Unless otherwise specified, ICH8 refers to the Intel® I/O Controller Hub 8 (ICH8) desktop family.

1.1 Terminology

Term	Description
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® ICH8	Intel® I/O Controller Hub 8. The chipset component that contains the primary PCI interface, LPC interface, USB, ATA, and/or other legacy functions.
MCH	Memory Controller Hub. The chipset component that contains the processor and memory interfaces.
GMCH	Graphic Memory Controller Hub. The chipset component that contains the processor and memory interface and integrated graphics core.
T_A	The local ambient air temperature at 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 case temperature of the (G)MCH component. The measurement is made at the geometric center of the die.
$T_{C\text{-}MAX}$	The maximum value of T_C.
$T_{C\text{-}MIN}$	The minimum valued of T_C.
TDP	Thermal Design Power is specified as the maximum sustainable power to be dissipated by the (G)MCH. This is based on extrapolations in both hardware and software technology. Thermal solutions should be designed to TDP.
TIM	Thermal Interface Material: thermally conductive material installed between two surfaces to improve heat transfer and reduce interface contact resistance.
Ψ_{CA}	Case-to-ambient thermal solution characterization parameter (Psi). A measure of thermal solution performance using total package power. Defined as (T_C – T_A) / Total Package Power. Heat source size should always be specified for Ψ measurements.

1.2 Reference Documents

Document	Location / Document Number
Intel® 965 Express Chipset Family Datasheet	http://developer.intel.com/design/chipsets/datashts/313053.htm
Intel® I/O Controller Hub 8 (ICH8) Thermal Design Guidelines	http://developer.intel.com/design/chipsets/designex/313058.htm
Intel® Pentium® D Processor 840, 830 and 820 Datasheet	http://developer.intel.com/design/PentiumD//datashts/307506.htm
Intel® Pentium® D Processor 900 Sequence and Intel® Pentium® Processor Extreme Edition 955, 965 Datasheet	http://developer.intel.com/design/pentiumXE/datashts/310306.htm
Intel® Pentium® 4 Processor 6x1 Sequence Datasheet	http://developer.intel.com/design/pentium4/datashts/310308.htm
Intel® Pentium® D Processor, Intel® Pentium® Processor Extreme Edition, and Intel® Pentium® 4 Processor Thermal and Mechanical Design Guidelines	http://www.intel.com/design/pentiumXE/designex/306830.htm
Various System Thermal Design Suggestions	http://www.formfactors.org
Balanced Technology Extended (BTX) System Design Guide	http://www.formfactors.org/

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2 Product Specifications

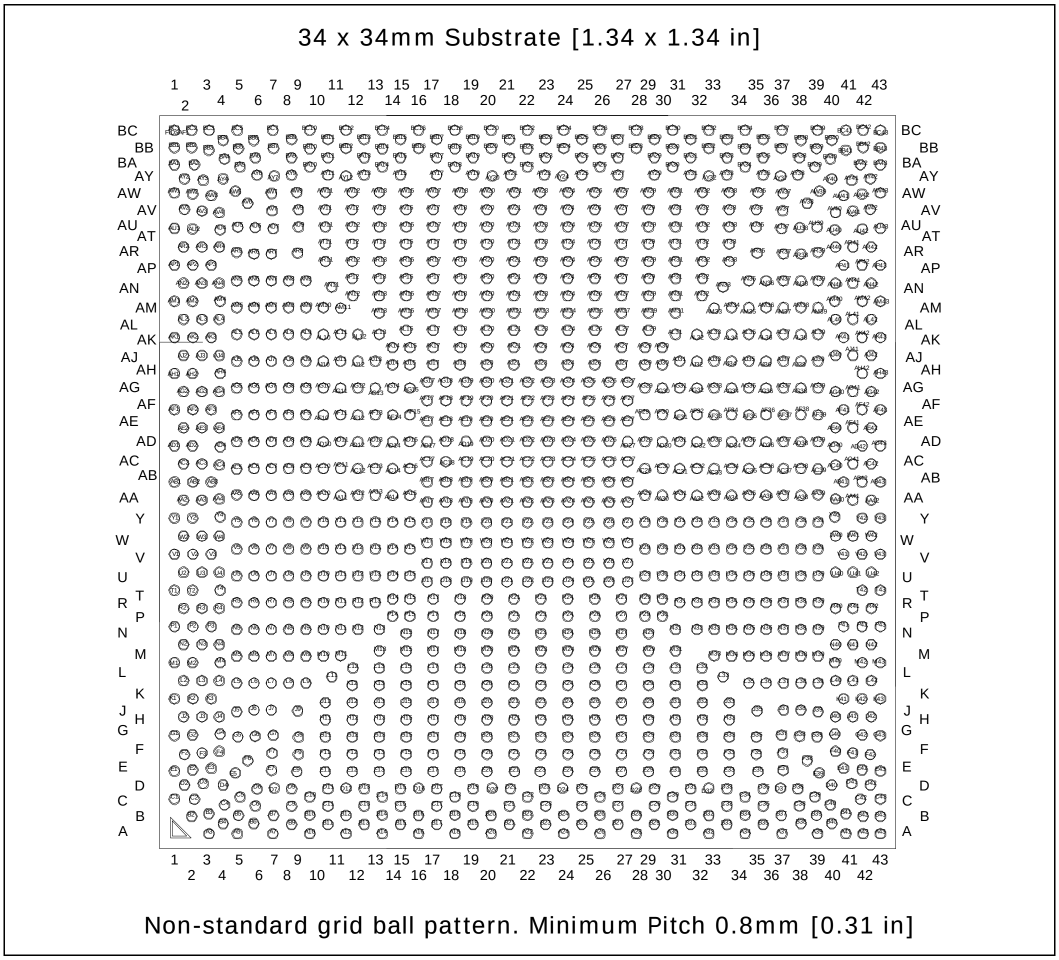
2.1 Package Description

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 1226 solder balls. The die size is 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. 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, refer to the *Intel® 965 Express Chipset Datasheet*.

Figure 1. (G)MCH Non-Grid Array



2.2 Package Loading Specifications

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

Table 1. Package 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 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 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 case temperature specified in Table 2 when operating at TDP. 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 should also operate above the minimum case temperature specification listed in Table 2.

2.4 Thermal Design Power (TDP)

2.4.1 Definition

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 chipset 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 component reliability over its useful life. The TDP value can be used for thermal design if the thermal protection mechanisms are enabled. The (G)MCH incorporates a hardware-based fail-safe mechanism to keep the product temperature within specifications in the event of unusually strenuous usage above the TDP power.

2.4.2 Methodology

2.4.2.1 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 knowledge of the past MCH 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 aspects of the (G)MCH is also included in the model. The projection for TDP assumes (G)MCH operation at T_{C-MAX}. The TDP estimate also accounts for normal manufacturing process variation.

2.4.2.2 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.

2.4.3 Specifications

The data in Table 2 is based on post-silicon power measurements of initial (G)MCH silicon. The system configuration is: two (2) DIMMs per channel, DDR2, FSB operating at the top speed allowed by the chipset with a processor operating at that system bus speed. FC-BGA packages have poor 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 2. Thermal Design Power

Component	System Bus Speed	Memory Frequency	T_{C-MIN}	T_{C-MAX}	Idle Power	TDP Value
82G965 GMCH	1066 MHz	800 MHz	0 °C	97°C	10.7 W	28 W
82Q965 GMCH	1066 MHz	800 MHz	0 °C	97°C	10.7 W	28 W
82Q963 GMCH	1066 MHz	800 MHz	0 °C	97°C	10.6 W	28 W
82P965 MCH	1066 MHz	800 MHz	0 °C	102 °C	9.3 W	19 W

NOTES:

1. Thermal specifications assume an attached heatsink is present.
2. Idle Power is based on a typical part in system booted to Windows* OS with no background applications running and the component has a 65 °C case temperature.
3. When an external graphics card is installed in a system with the 82G965, 82Q965 or 82Q963 GMCH, the TDP for these components will drop to approximately 19 W. The GMCH will detect the presence of the graphics card and disable the on-board graphics resulting in the lower TDP for the components.

2.4.4 $T_{CONTROL}$ Limit

Intel® Quiet System Technology (Intel® QST) monitors an embedded thermal sensor. The maximum operating limit when monitoring this thermal sensor is $T_{CONTROL}$. For the (G)MCH, this value as been defined as 95 °C. This value should be programmed into the appropriate Intel® QST register as the maximum sensor temperature for operation of the (G)MCH.

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3 Thermal Metrology

The system designer must measure temperatures in order 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 of the (G)MCH the T_C must be maintained at or below the maximum temperature listed in Table 2. The surface temperature measured 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 bead 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 K-type thermocouple bead to the center of the top surface of the die using cement with high thermal conductivity. 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)

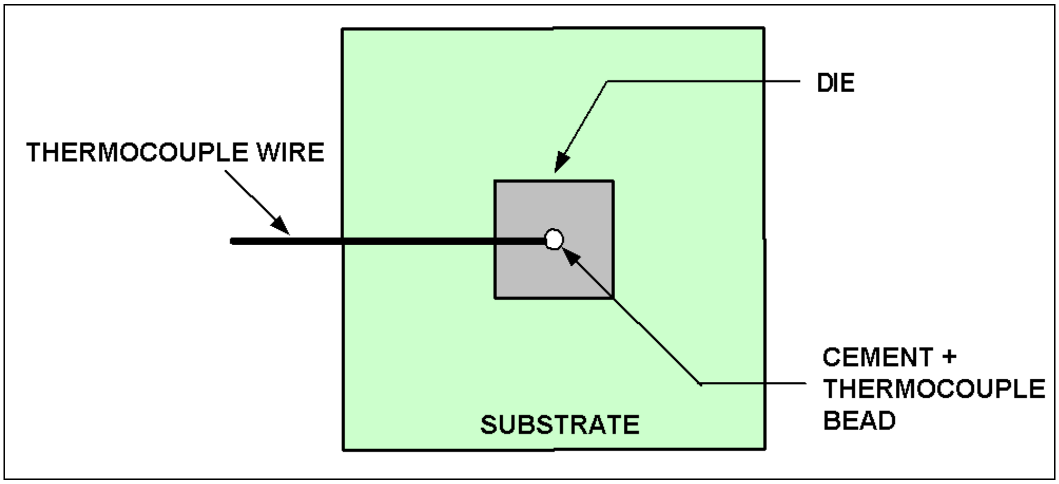
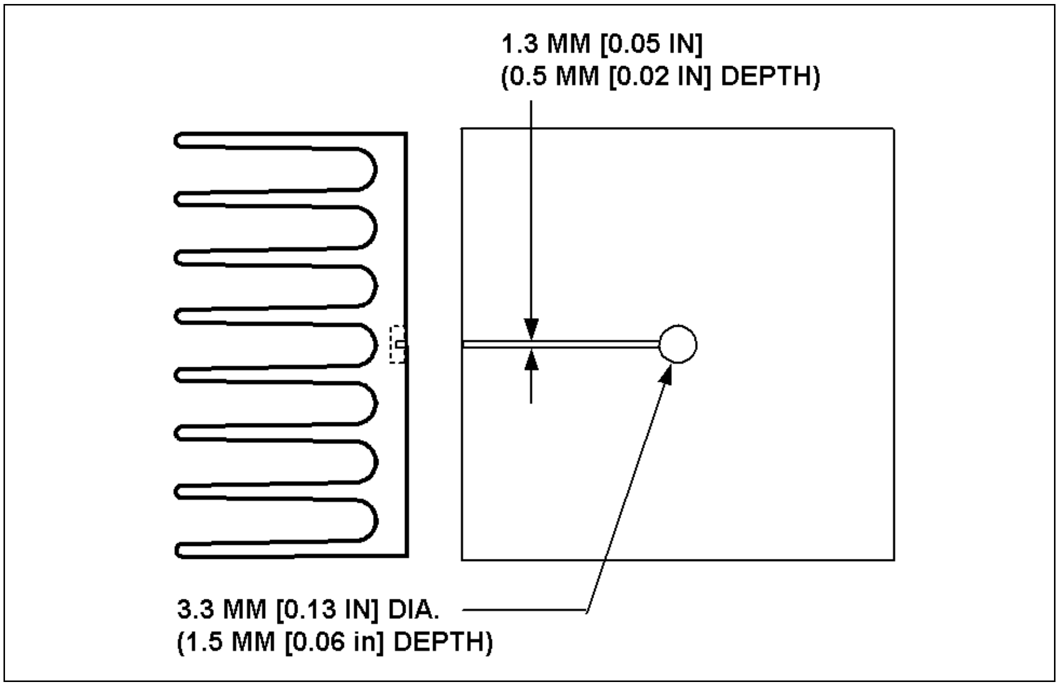


Figure 3. 0° Angle Attach Heatsink Modifications (generic heatsink side and bottom view)

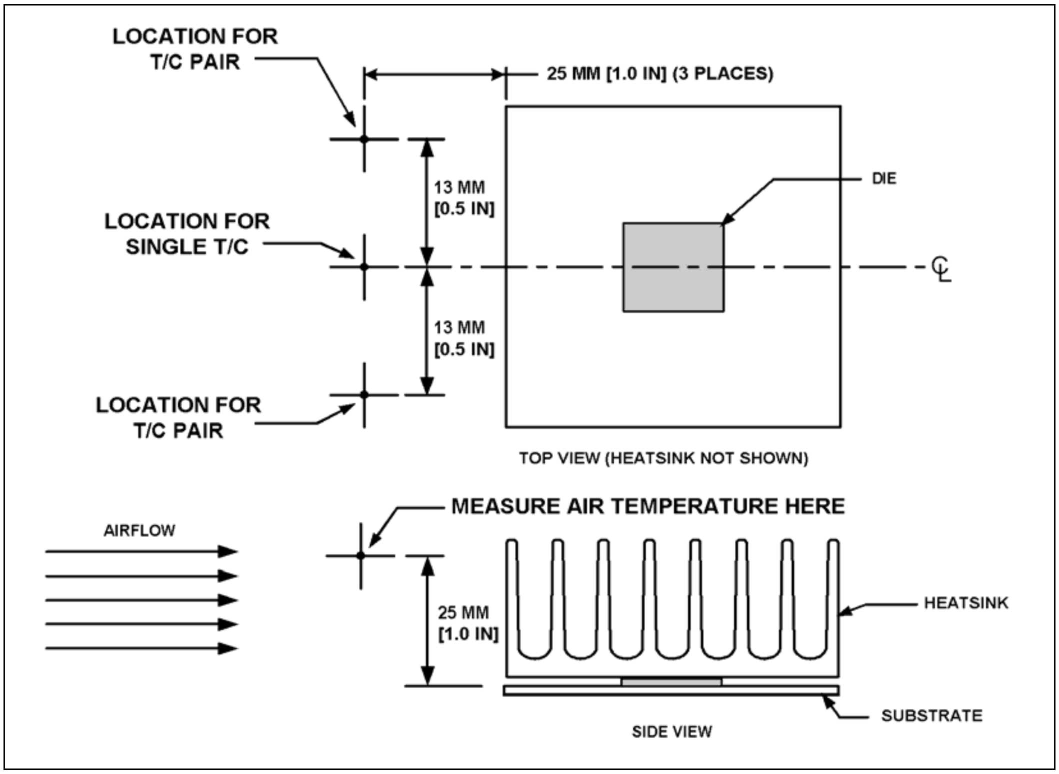


NOTE: Diagram not to scale

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.

Figure 4. Airflow and Temperature Measurement Locations



Airflow velocity can be measured using sensors that combine air velocity and temperature measurements. Typical airflow sensor technology may include hot wire anemometers. Figure 4 provides guidance for airflow velocity measurement locations which should be the same as used for temperature measurement. 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.

3.3 Thermal Mechanical Test Vehicle

A Thermal Mechanical Test Vehicle (TMTV) is available for early thermal testing prior to the availability of actual silicon. The TMTV contains a heater die and can be powered up to a desired power level to simulate the heating of a (G)MCH package. The TMTV also contains daisy chain functionality and can be used for mechanical testing. The TMTV needs to be surface mounted to a custom board designed to provide connectivity to the die heater and/or daisy chain depending on the needs of the user. The package ball connections are provided so the user may design and build a board to interface with the TMTV. Note that although the TMTV is designed to closely match the (G)MCH package mechanical form and fit, it is recommended that final validation be performed with actual production silicon. The TMTV mechanical features, including die size, ball count, etc., may not reflect those of the final production package.

Contact your Intel Field Sales Representative on the availability of the (G)MCH TMTV for your development needs.

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4 Reference Thermal Solution

The design strategy for the reference component thermal solution for the (G)MCH in ATX platforms reuses the ramp retainer, extrusion design and anchors from the (G)MCH thermal solution. The thermal interface material and a wire preload clip are being redesigned to meet the (G)MCH thermal requirements.

The BTX reference design for the (G)MCH include a new extrusion, clip with higher preload and a new thermal interface material. A slightly larger motherboard keep out zone than used by the (G)MCH thermal solution has been defined, see Figure 11

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 platform operating environment to assess impact to thermal solution selection.

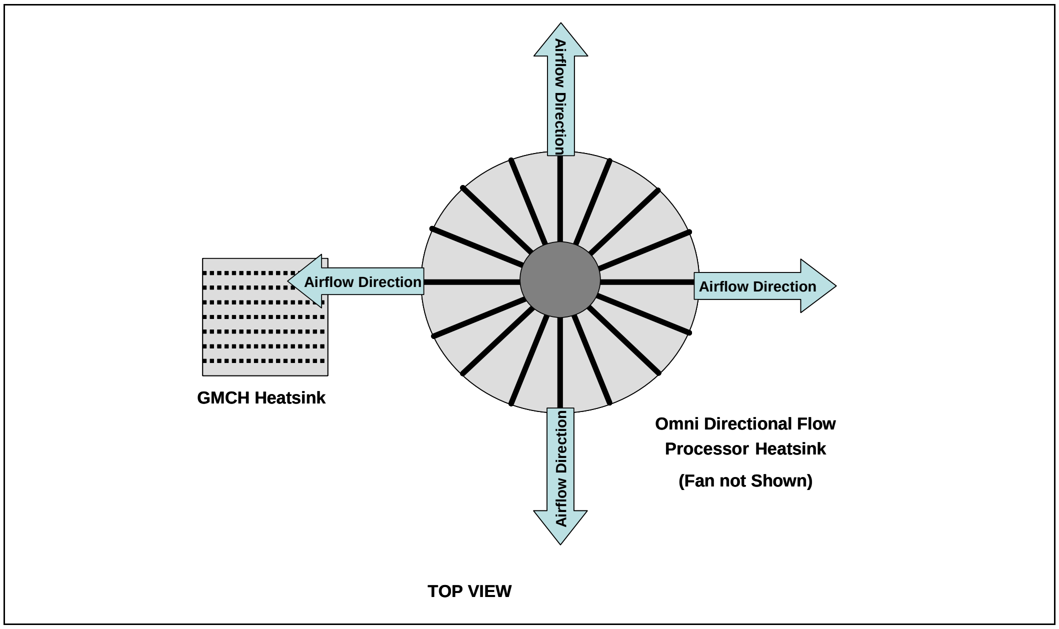
4.1.1 ATX Form Factor Operating Environment

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 local ambient air temperature, T_A, at the (G)MCH heatsink in an ATX platform is assumed to be 47°C. 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 multi-directional airflow, such as a radial fin or “X” pattern heatsink. Such heatsink can deliver airflow to both the (G)MCH and other areas like the voltage regulator, as shown in Figure 5. In addition, (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 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).

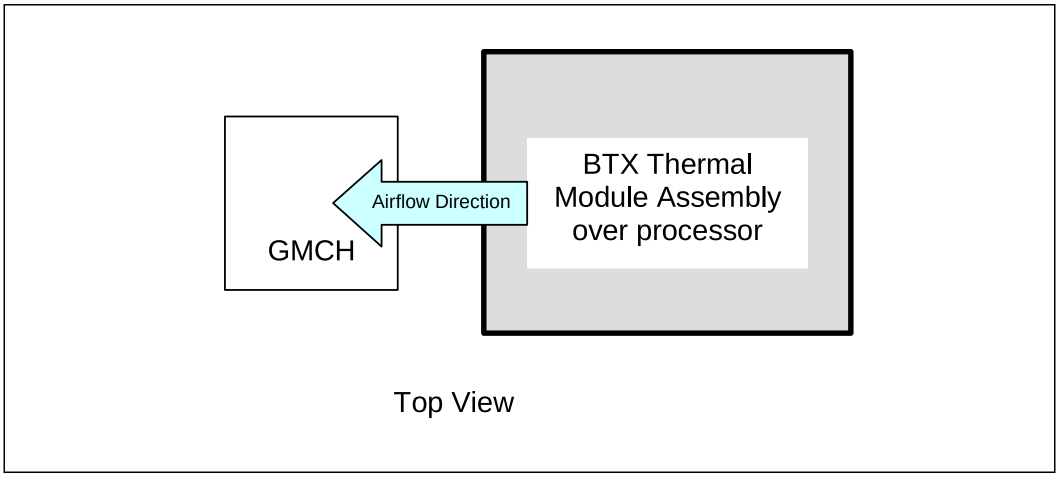
4.1.2 Balanced Technology Extended (BTX) Form Factor Operating Environment

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 that the local ambient air temperature is a projection based on the power for a 2005 platform, with processor TDP up to 130 W, and are subject to change in the next revision of this document.

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



4.2 Reference Design Mechanical Envelope

The motherboard component keep-out restrictions for the (G)MCH for 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 Appendix B, Figure 11.

4.3 Thermal Solution Assembly

The reference thermal solution for the (G)MCH for an ATX chassis is shown in Figure 7 and is an aluminum extruded heatsink that uses two ramp retainers, a wire preload clip, and four motherboard anchors. Refer to Appendix B for the mechanical drawings. 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 (Honeywell* PCM45F) is pre-applied to the heatsink bottom over an area which contacts the package die.

Note: The ATX design is similar in appearance to the Intel® 945G Express chipset thermal solution, but two critical items have been changed.

- A higher performance TIM
- A clip with a higher preload to meet the TIM preload requirements.

The combination of the two new items provide the performance increase to meet the (G)MCH thermal requirements.

The reference thermal solution for the (G)MCH in a BTX chassis is shown in Figure 8. The heatsink is aluminum extruded and utilizes 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 (Honeywell* PCM45F) is pre-applied to the heatsink bottom over an area in contact with the package die.

Figure 7. ATX (G)MCH Heatsink - Installed on Board

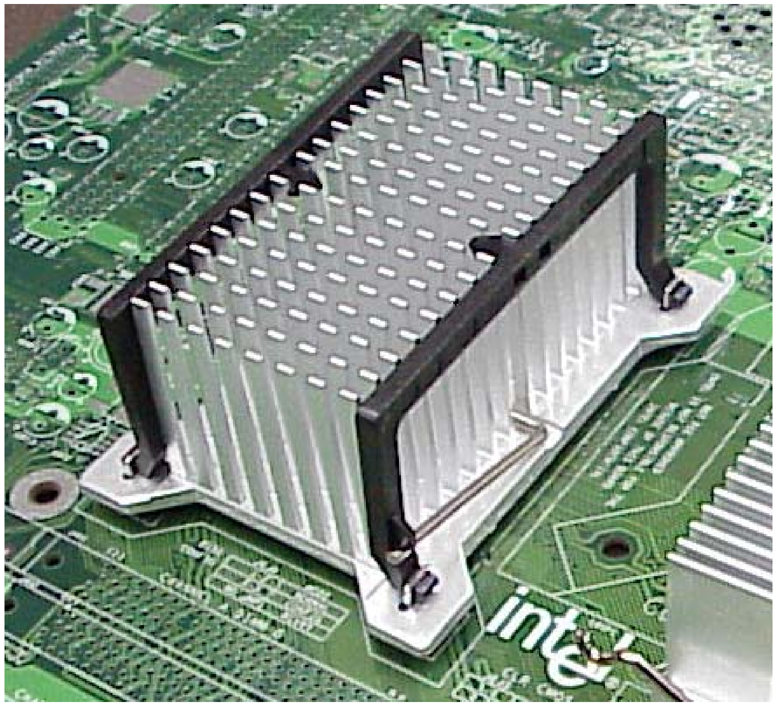
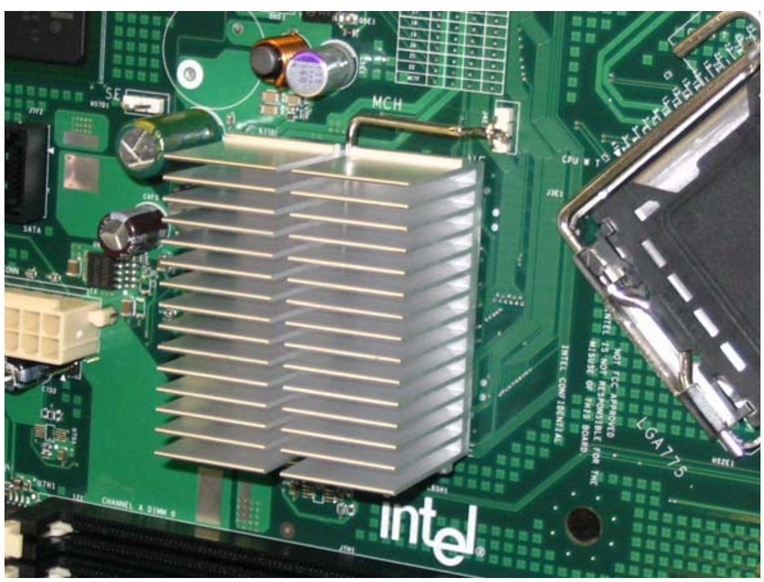


Figure 8. Balanced Technology Extended (BTX) (G)MCH Heatsink - Installed on Board



4.4 Environmental Reliability Requirements

The environmental reliability requirements for the reference thermal solution are shown in
Table 3 and 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.

The ATX testing will be performed with the sample board mounted on a test fixture and includes a processor heatsink with a mass of 550g. The test profiles are unpackaged board level limits.

Table 3. ATX Reference Thermal Solution Environmental Reliability Requirements (Board Level)

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, 4.3 m/s [170 in/s] minimum velocity change	Visual\Electrical Check \ Thermal Performance
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 Performance
Unbiased Humidity	• 85 % relative humidity / 85 °C, 576 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.

Table 4. Balanced Technology Extended (BTX) Reference Thermal Solution Environmental Reliability Requirements (System Level)

Test[1]	Requirement	Pass/Fail Criteria[2]
Mechanical Shock	• 2 drops for + and - directions in each of 3 perpendicular axes (i.e., total 12 drops). • Profile: 25g, Trapezoidal waveform, 5.7 m/s [225 in/sec] minimum velocity change.	Visual\Electrical Check\ Thermal Performance
Random Vibration	• Duration: 10 min/axis, 3 axes • Frequency Range: .001 g2/Hz @ 5Hz, ramping to .01 g2/Hz @20 Hz, .01 g2/Hz @ 20 Hz to 500 Hz • Power Spectral Density (PSD) Profile: 2.20 g RMS	Visual/Electrical Check\ Thermal Performance
Power Cycling	• 7500 cycles (on/off) of minimum temperature min 27 / max 96. • 1400 cycles (on/standby) min 35 / max 96. • A 15 second dwell at high / low temperature for both cycles.	Thermal Performance - TIM degradation
Unbiased Humidity	• 85 % relative humidity / 85 °C, 576 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.
3. Mechanical Shock minimum velocity change is based on a system weight of 20 to 29 lbs [9.08 kg to 13.166 kg].
4. For the chassis level testing the system will include: 1 HD, 1 ODD, 1 PSU, 2 DIMMs and the I/O shield.
5. BTX reference solution testing for shock and vibration is to mount the sample board mounted in a BTX chassis with a thermal module assembly having a maximum mass of 900 g. The test profiles are unpackaged system level limits.

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Appendix A Currently Enabled Suppliers

Currently enabled suppliers for the (G)MCH reference thermal solution are listed in Table 5 through Table 7.

Table 5. ATX Intel® Reference Heatsink Enabled Suppliers for Intel® 965 Express Chipset Family

ATX items	Intel Part Number	AVC	CCI	Foxconn	Wieson
heatsink & TIM	D31682-001	S902Y1000 1	335I833301 A	2Z802-032	
plastic clip	C85370-001	P10900002 4	334C863501 A	3EE77-002	
wire clip	D29082-001	A20800023 3	334I833301 A	3KS02-155	
anchor	C85376-001			2Z802-015	G2100C888-143

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, reliability, functionality, or compatibility of these devices. This list and/or these devices may be subject to change without notice.

Table 6. Balanced Technology Extended (BTX) Intel Reference Heatsink Enabled Suppliers for Intel® 965 Express Chipset Family

BTX items	Intel PN	AVC	CCI	Foxconn	Wieson
heatsink assembly (HS, wire clip & TIM)	D34258-001	S905Y0000 1	00I83320 1A	2ZQ99-066	
anchor, LF	A13494-008			HB9703E-DW	G2100C888-064H

Table 7. Supplier Contacts

Supplier	Contacts	Phone	email
AVC (Asia Vital Components)	David Chao	+886-2-2299-6930 ext. 7619	david_chao@avc.com.tw
	Raichel Hsu	+886-2-2299-6930 ext. 7630	raichel_hsi@avc.com.tw
CCI (Chaun Choung Technology)	Monica Chih	+886-2-2995-2666	monica_chih@ccic.com.tw
	Harry Lin	(714) 739-5797	hlinack@aol.com
Foxconn	Jack Chen	(714) 626-1233	jack.chen@foxconn.com
	Wanchi Chen	(714) 626-1376	wanchi.chen@foxconn.co m
Wieson Technologies	Beatrice Chang	+886-2-2647-1896 ext. 6395	beatrice@wieson.com
	Edwina Chu	+886-2-2647-1896 ext. 6390	edwina@wieson.com

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Appendix B Mechanical Drawings

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

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

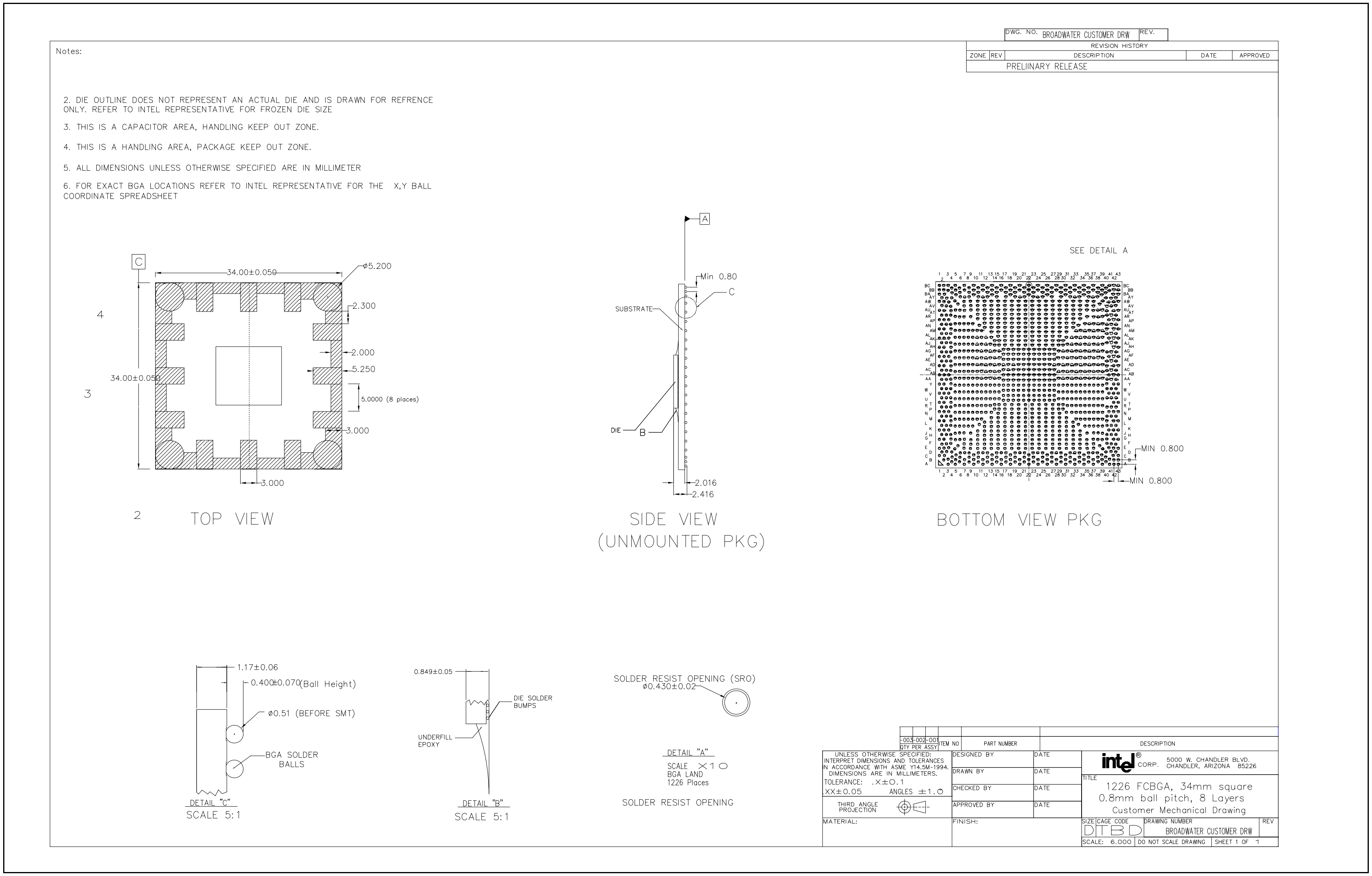


Figure 10. (G)MCH Component Keep-Out Restrictions for ATX Platforms

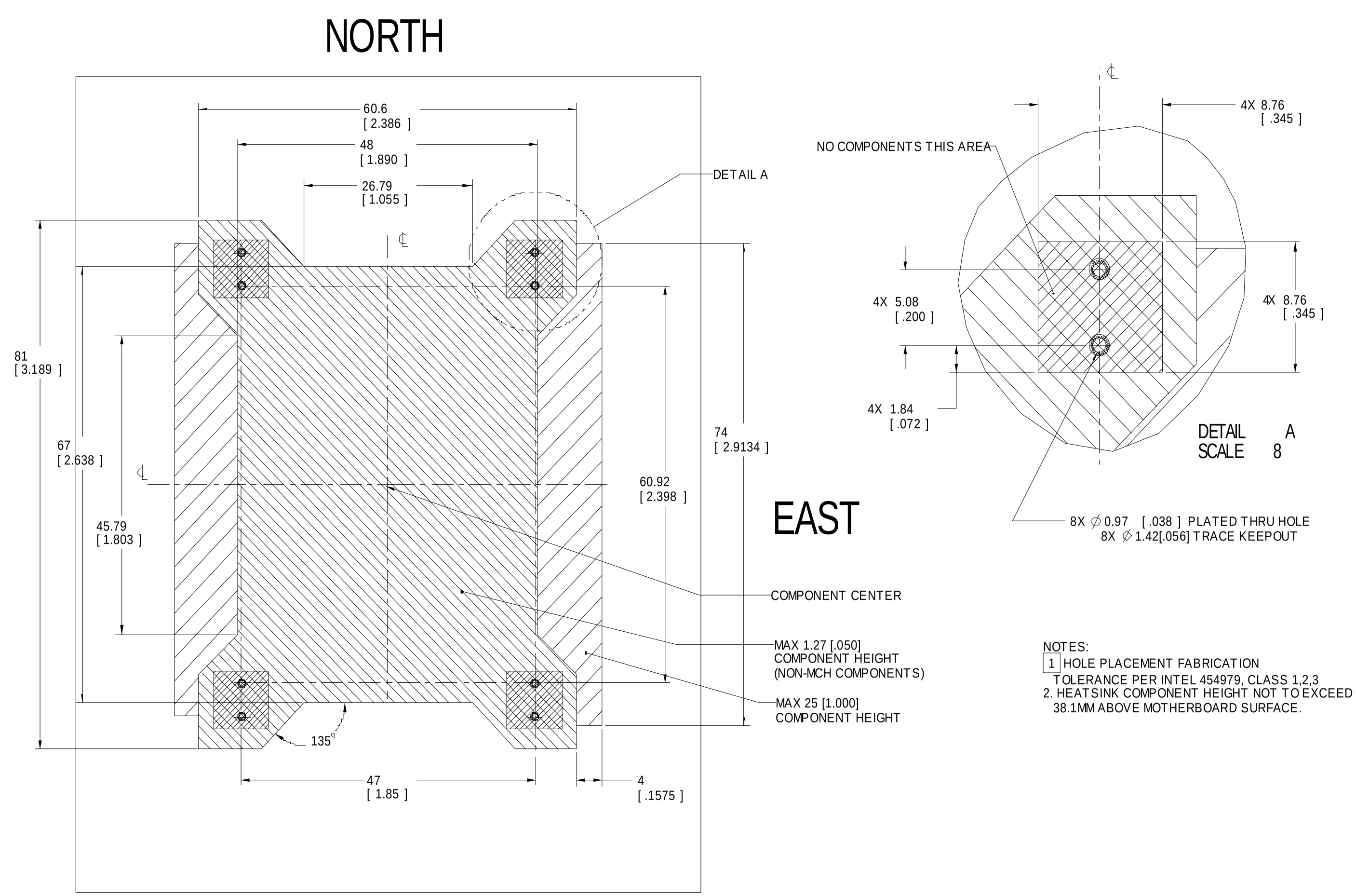


Figure 11. (G)MCH Component Keep-Out Restrictions for Balanced Technology Extended (BTX) Platforms

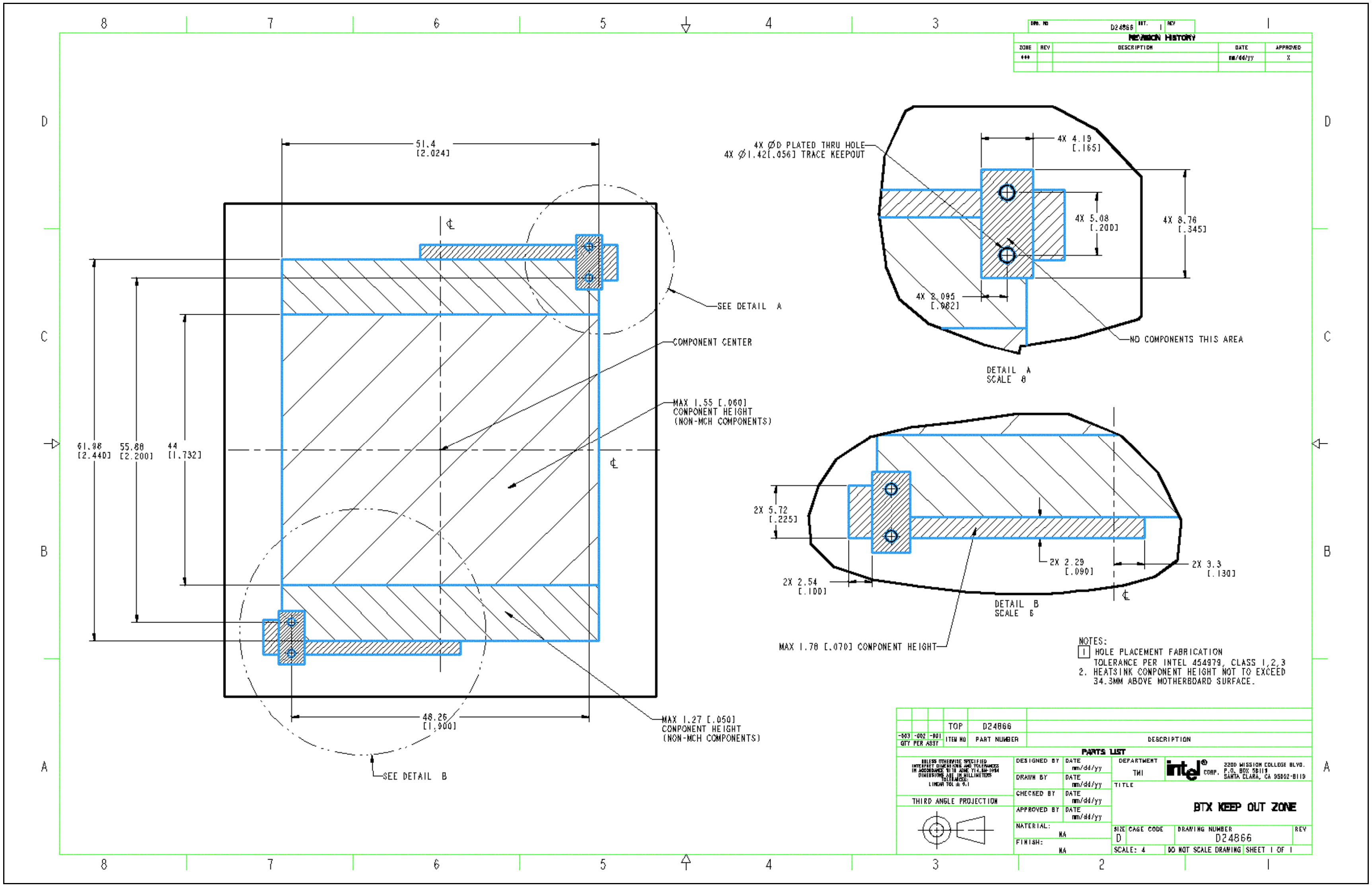


Figure 12. (G)MCH Reference Heatsink for ATX Platforms – Sheet 1

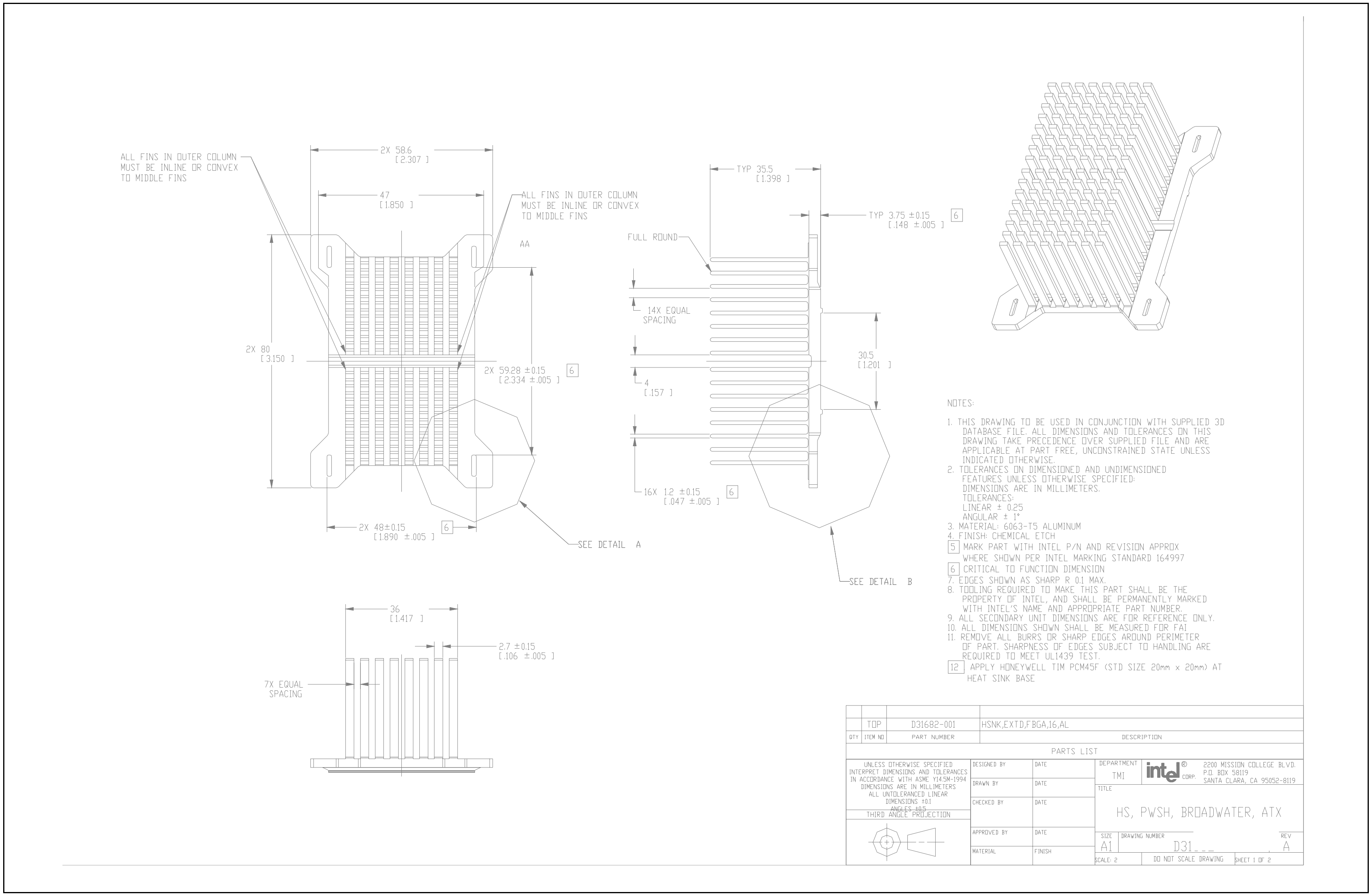


Figure 13. (G)MCH Reference Heatsink for ATX Platforms – Sheet 2

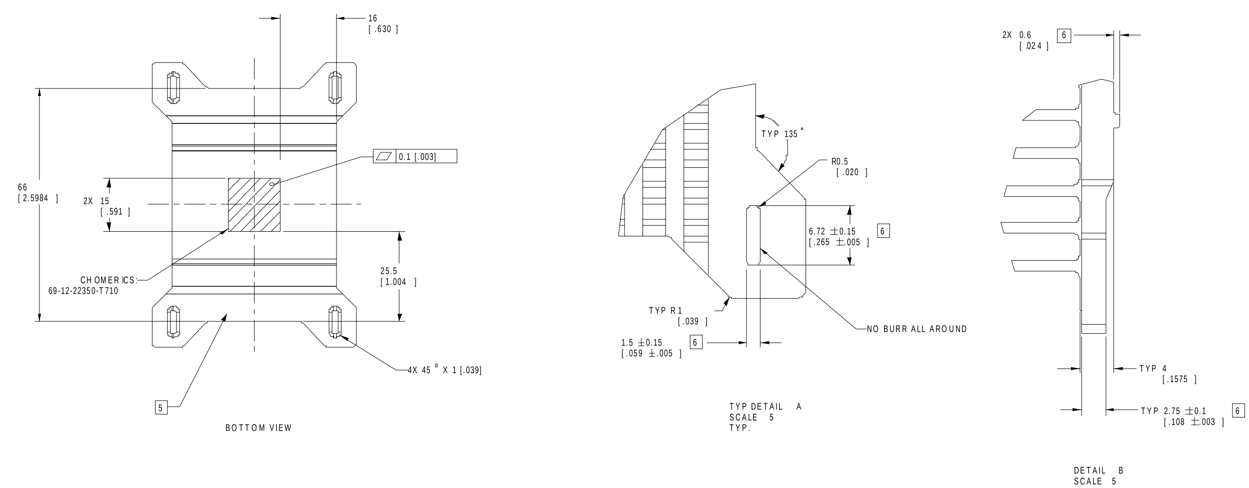
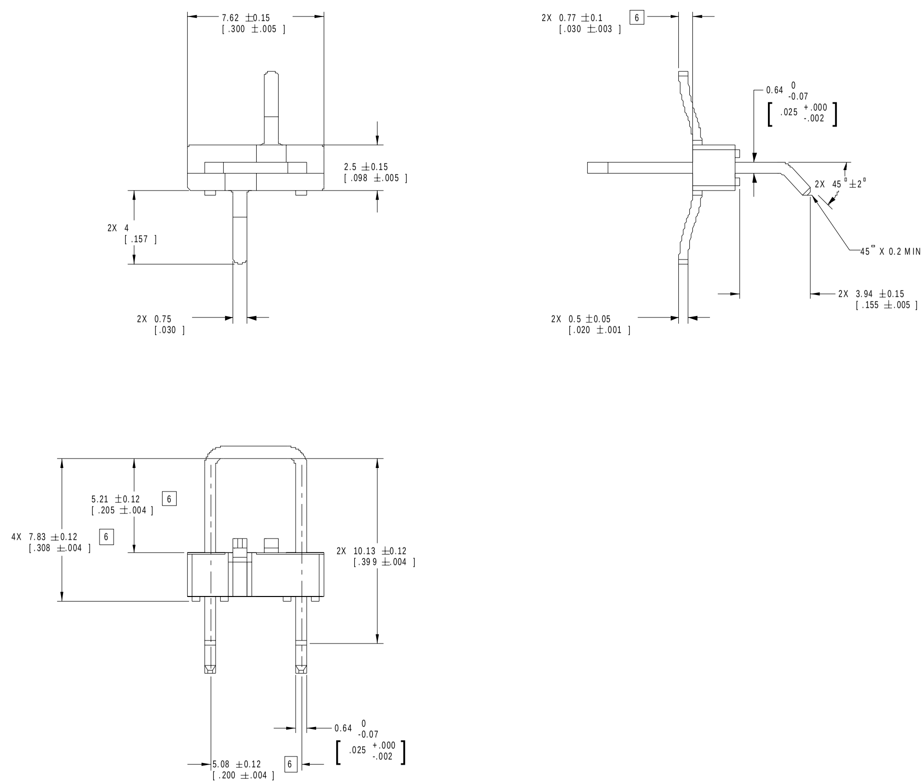
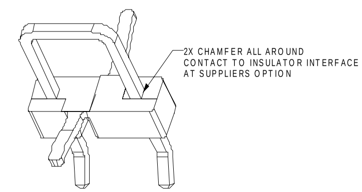


Figure 14. (G)MCH Heatsink for ATX Platforms – Anchor





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 > 10MM: LINEAR ±.08
   ANGLES: ± 0.5°
3. MATERIALS:
   INSULATOR: POLYCARBONATE THERMOPLASTIC, UL 94V-0, BLACK (739) (REF. GE LEXAN 3412R-739)
   CONTACT: BRASS OR EQUIVALENT UPON INTEL APPROVAL
   CONTACT FINISH: .000050u" MIN. NICKEL UNDER PLATING;
   SOLDER TAILS, 0.000100" MIN TIN ONLY SOLDER (LEAD FREE).
5. MARK WITH INTEL P/N AND REVISION PER INTEL MARKING STANDARD 164997; PER SEC 3.8 (POLYETHYLENE BAG)

[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.

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

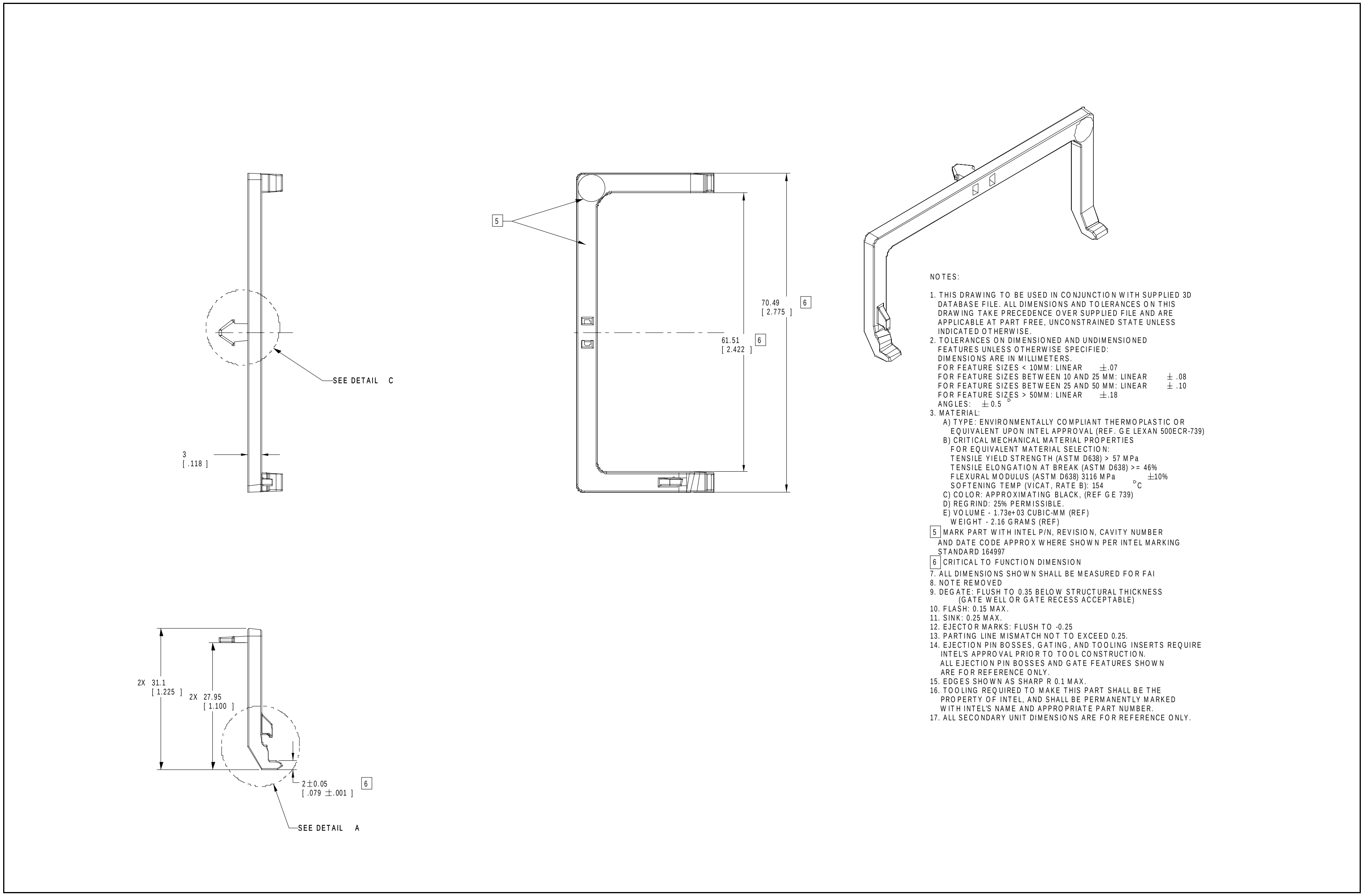


Figure 16. (G)MCH Reference Heatsink for ATX Platforms – Ramp Retainer Sheet 2

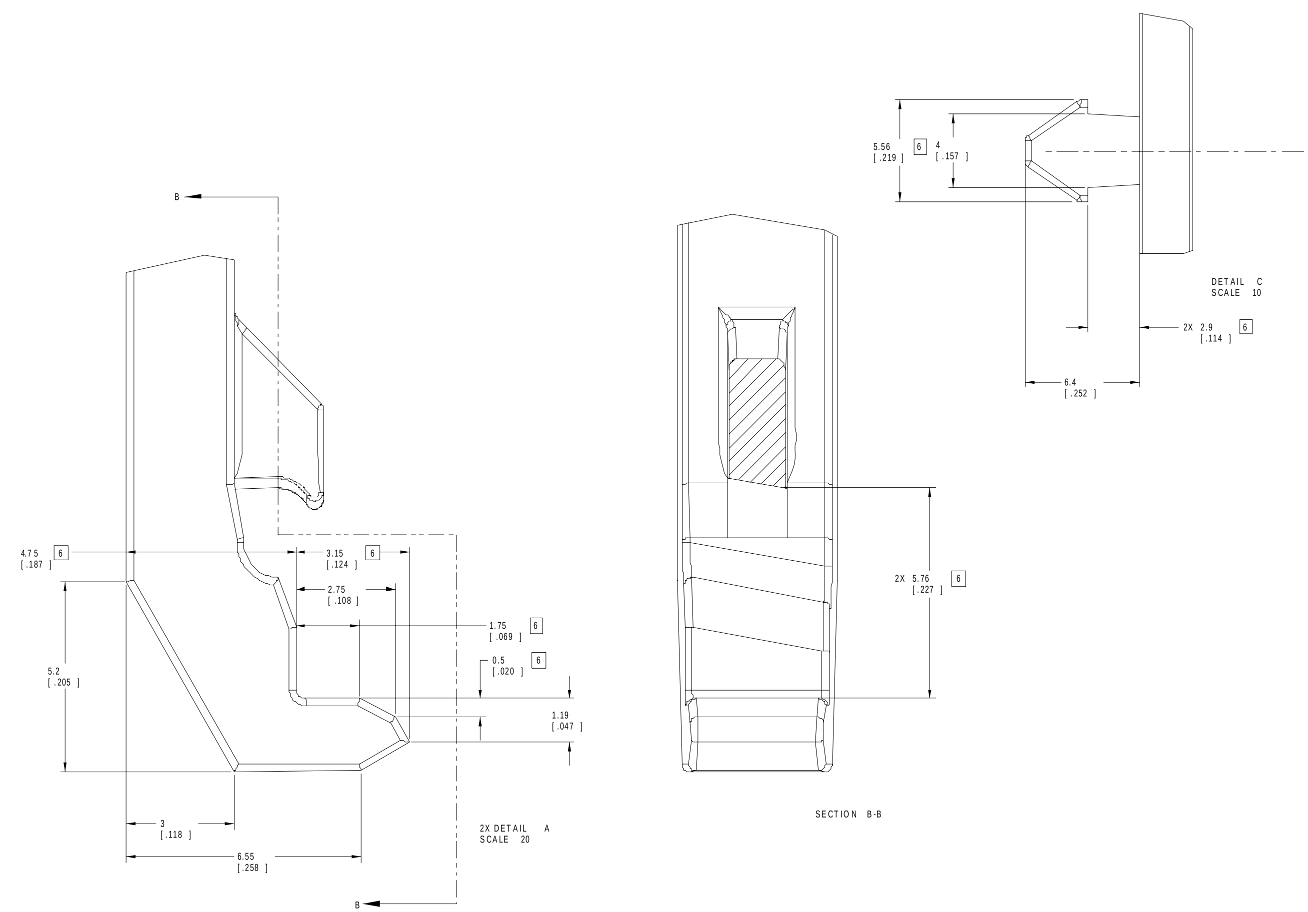


Figure 17. (G)MCH Reference Heatsink for ATX Platforms – Wire Preload Clip

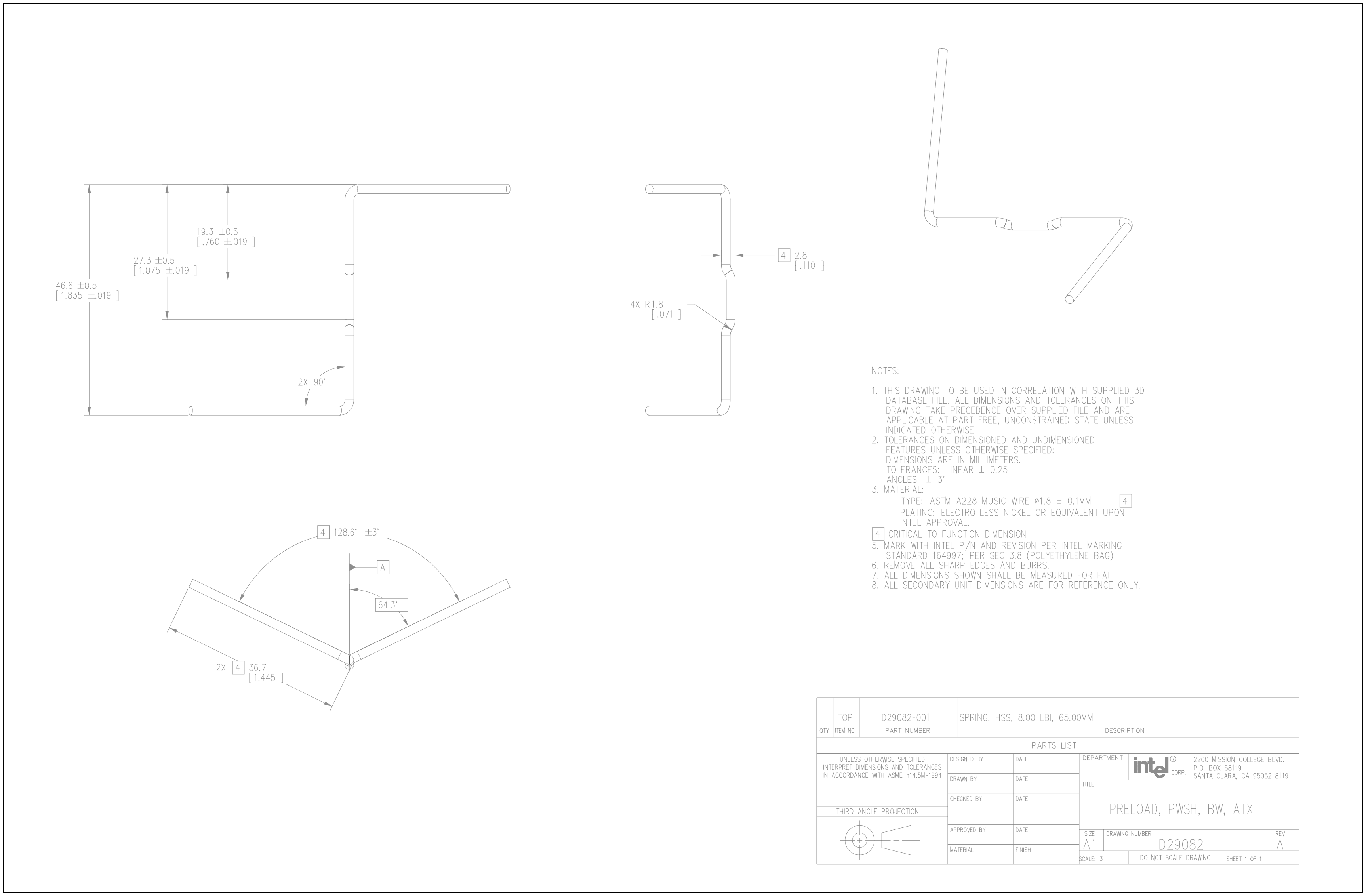
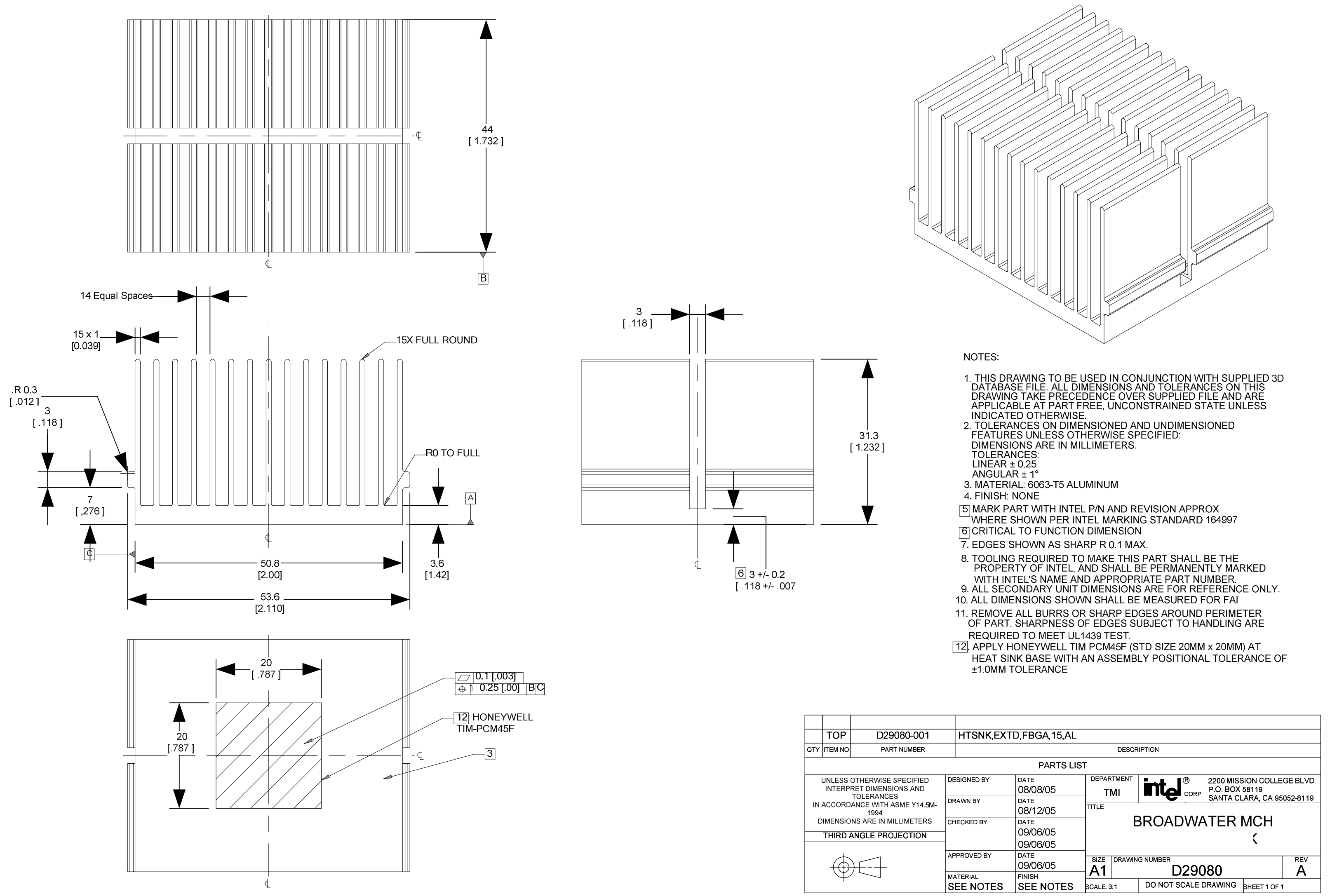


Figure 18. (G)MCH Reference Heatsink for BTX Platforms



NOTES:

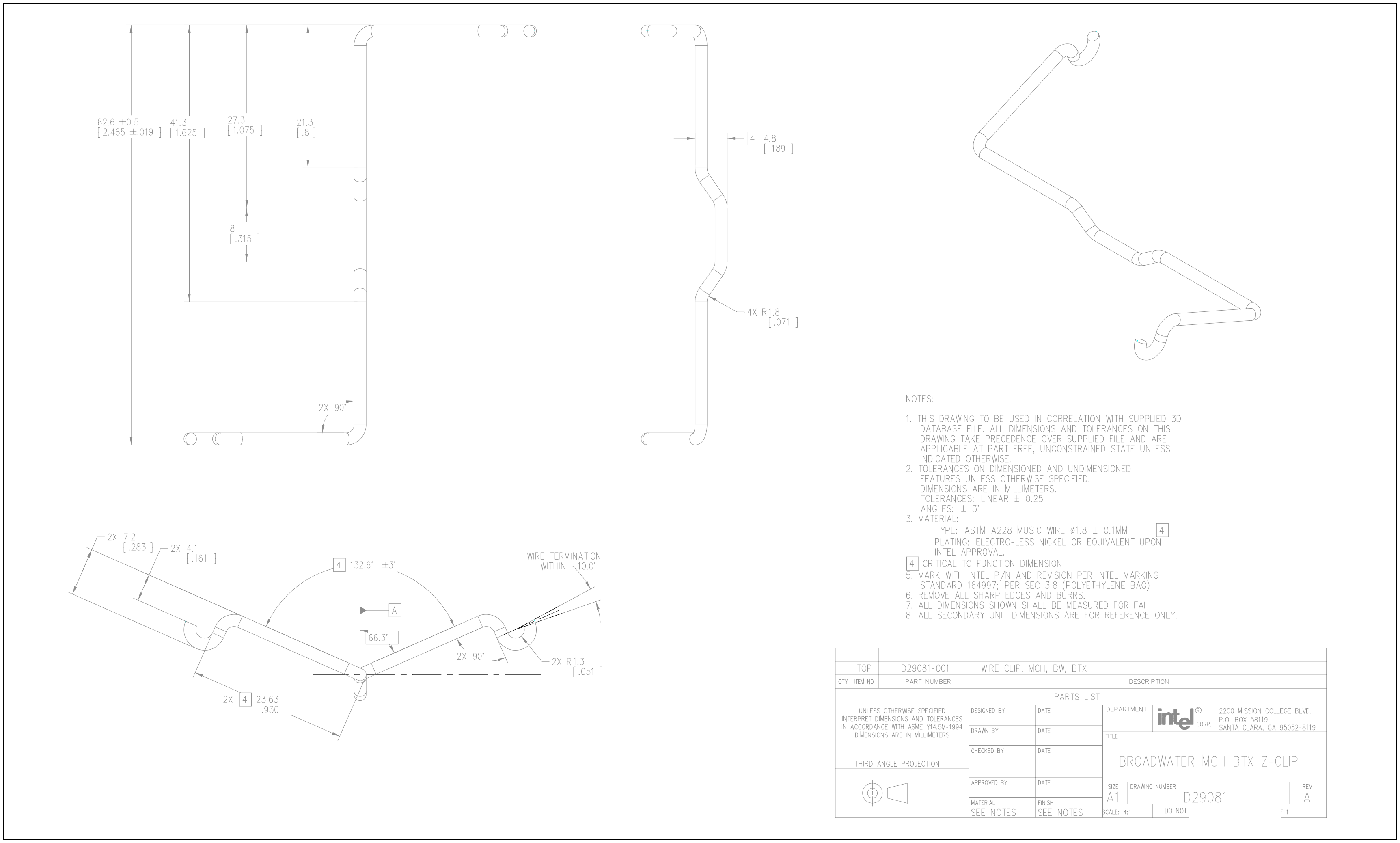
1. THIS DRAWING TO BE USED IN CONJUNCTION WITH SUPPLIED 3D DATABASE FILE. ALL DIMENSIONS AND TOLERANCES ON THIS DRAWING TAKE PRECEDENCE OVER SUPPLIED FILE AND ARE APPLICABLE AT PART FREE, UNCONSTRAINED STATE UNLESS INDICATED OTHERWISE.
2. TOLERANCES ON DIMENSIONED AND UNDIMENSIONED FEATURES UNLESS OTHERWISE 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 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 FAI
11. REMOVE ALL BURRS OR SHARP EDGES AROUND PERIMETER OF PART. SHARPNESS OF EDGES SUBJECT TO HANDLING ARE REQUIRED TO MEET UL1439 TEST.
12. APPLY HONEYWELL TIM PCM45F (STD SIZE 20MM x 20MM) AT HEAT SINK BASE WITH AN ASSEMBLY POSITIONAL TOLERANCE OF ±1.0MM TOLERANCE

QTY	ITEM NO	PART NUMBER	DESCRIPTION
	TOP	D29080-001	HTSNK,EXTD,FBGA,15,AL

PARTS LIST

UNLESS OTHERWISE SPECIFIED INTERPRET DIMENSIONS AND TOLERANCES IN ACCORDANCE WITH ASME Y14.5M-1994 DIMENSIONS ARE IN MILLIMETERS	DESIGNED BY	DATE 08/08/05	DEPARTMENT TMI; intel CORP 2200 MISSION COLLEGE BLVD. P.O. BOX 58119 SANTA CLARA, CA 95052-8119
THIRD ANGLE PROJECTION	DRAWN BY	DATE 08/12/05	TITLE BROADWATER MCH
	CHECKED BY	DATE 09/06/05 09/06/05	
	APPROVED BY	DATE 09/06/05	SIZE A1; DRAWING NUMBER D29080; REV A
	MATERIAL SEE NOTES	FINISH SEE NOTES	SCALE: 3:1; DO NOT SCALE DRAWING; SHEET 1 OF 1

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



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