Chassis Air Guide Design Guide

Version 1.0

Revision History

Version	Revision History	Date
1.0	Initial release	May 2002

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1.0 Introduction

1.1 Scope

This document explores the design, implementation and performance of a ducting solution to cool the internal components of a personal computer enclosure. Design recommendations are presented for implementation within a mid-tower desktop style enclosure. The target audiences for this document are: computer enclosure engineers, designers, and system integrators.

1.2 Overview

The newest personal computer technologies, including those for processor, chipset, memory, and graphics, pose significant thermal challenges to the system designer. As the market transitions to faster computing speeds and enhanced features in reduced platform sizes, both the heat and heat density generated by these devices will continue to increase. Such increases in component-level power force the designer to reconsider the thermal solutions used at the chip, package, board and system-level. Passive and active heatsinks have proven to be a reliable and relatively economical solution to keep pace with an increasingly challenging thermal environment. To continue using these heatsink technologies, consideration to the system-level thermal solution must be given.

In the past, system designers focused on improving system thermal environments by adding fans and optimizing vent locations. This remains a very important aspect of system thermal design. However, the increasing costs and complexities of package-level thermal solutions requires more advanced system level technologies in order to find a more balanced and cost-effective approach for the system. If the computer enclosure can provide cooler internal temperatures much of this expense can be mitigated. With the proper balance of system and package solutions, the integrator can minimize the overall system cost.

In an environment of increasing thermal loads, the processor is generally the most demanding component in terms of system thermal design. Processor thermal solutions commonly use a copper or aluminum heatsink with an active fan providing airflow. The processor die temperature can be directly correlated to the temperature of the air flowing into the active fan and heatsink. The lower the temperatures, the lower processor die temperature. Most computer enclosures typically provide an internal thermal environment of approximately 40-45°C, at a 35°C room temperature. This document provides a reference design of one solution to lower the processor thermal environment to approximately 38°C. The reference design, or duct, is called the Chassis Air Guide.

1.3 Recommended Chassis for Chassis Air Guide

This design guide refers to a chassis with the features listed below. However, the ingredients and design techniques described here could be adapted to other chassis:

- Fits a standard ATX or microATX motherboard
- Supports two external 5.25-inch peripheral bays, one external 3.5-inch peripheral bay, and one or two internal 3.5-inch peripheral bays
- Includes one standard PS/2-sized power supply or SFX / PS3-size for smaller chassis
- Includes up to four add-in card slots including a graphics card
- Does not use a single-piece chassis cover
- Provides single system-fan cooling with provision for at least 1 80-mm fan (Note that this statement excludes the fan in the Power Supply)
- Internal power supply with fan exhausting system enclosure
- Accommodates standard ATX I/O shield
- Provides for front connector I/O compliant with *Intel® Front Panel I/O Connectivity Design Guide*

1.4 Related Documents

Document	**Location**
ISO 7779-“Acoustics—Measurement of Airborne Noise Emitted by Information Technology and Telecommunications Equipment”	http://www.iso.ch/
ATX Thermal Design Suggestions	http://www.formfactors.org
EMC Design Suggestions	http://www.formfactors.org
microATX Motherboard Interface Specification 1.0	http://www.formfactors.org
ATX Motherboard Specification	http://www.formfactors.org
Performance microATX Thermal Design Suggestions v1.0	http://www.formfactors.org

2.0 Chassis Considerations

2.1 Chassis Air Guide Description

The following design is intended to achieve a temperature rise (Trise) of less than 3°C to standard ATX and microATX tower style chassis. The design focus is to lower the processor thermal environment temperature while allowing for some core (processor, chipset) area movement based on varying mainboard layout designs. The overall goal is to provide a cooling solution that can be easily integrated into current and future chassis designs while being adaptable for different mainboards at a minimum cost and integration impact.

Figure 1 is a chassis that is similar to many microATX chassis platforms currently available. The three-piece Chassis Air Guide is shown attached to the chassis side panel. The Chassis Air Guide consists of a hollow tube with a flared end that guides cool room ambient air towards the processor. It has no fans and is therefore a completely passive cooling solution. It relies entirely on the internal systems fans to guide air to the processor and other system components. To properly function, it requires a ventilation opening on the chassis side panel. This is discussed further in section 2.6. The design of the Chassis Air Guide limits the use of one-piece chassis top and side covers. A side panel as seen in Figure 1 is recommended for ease of installation.

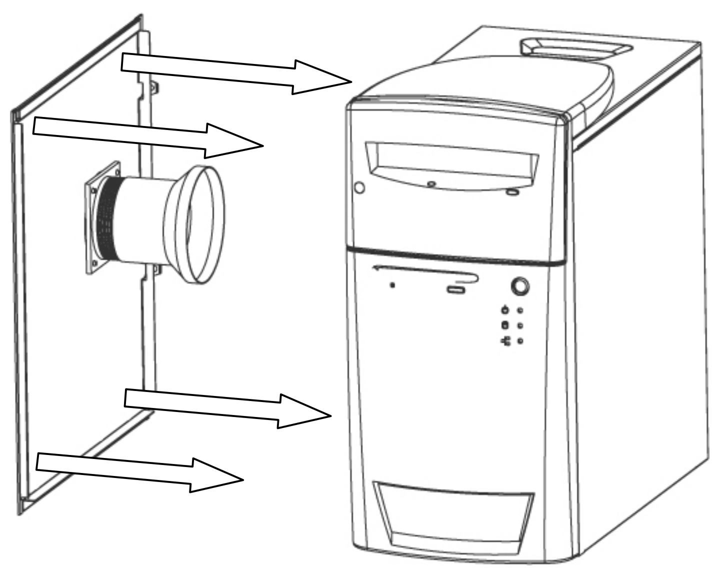

Figure 1. Typical Tower Platform With Chassis Air Guide

2.2 Chassis Air Guide Typical Airflow Pattern

Figure 2 depicts one example of the airflow pattern expected when using the Chassis Air Guide. This system platform has a typical 80mm rear system fan and a 80mm fan on the power supply. Both fans exhaust (blow out) from the chassis, thereby providing airflow for system component cooling. This fan configuration causes a slight depressurization of the chassis interior with respect to the outside atmosphere. As a result, all other chassis openings become intake vents. The primary intake vents are now the front bezel openings and the Chassis Air Guide. The processor fan heatsink combination is now able to draw outside air directly and remains a vital part of processor cooling.

Airflow balancing remains very important to ensure the adequate cooling of other system components. This involves providing the proper amount of open area in the front and side of the enclosure so that all components will receive the required airflow volume. Without proper balancing, some components may operate cooler than required while others may operate in a higher temperature environment. Airflow balancing is difficult to manage, but done properly, will allow all system components to operate within the recommended temperature range.

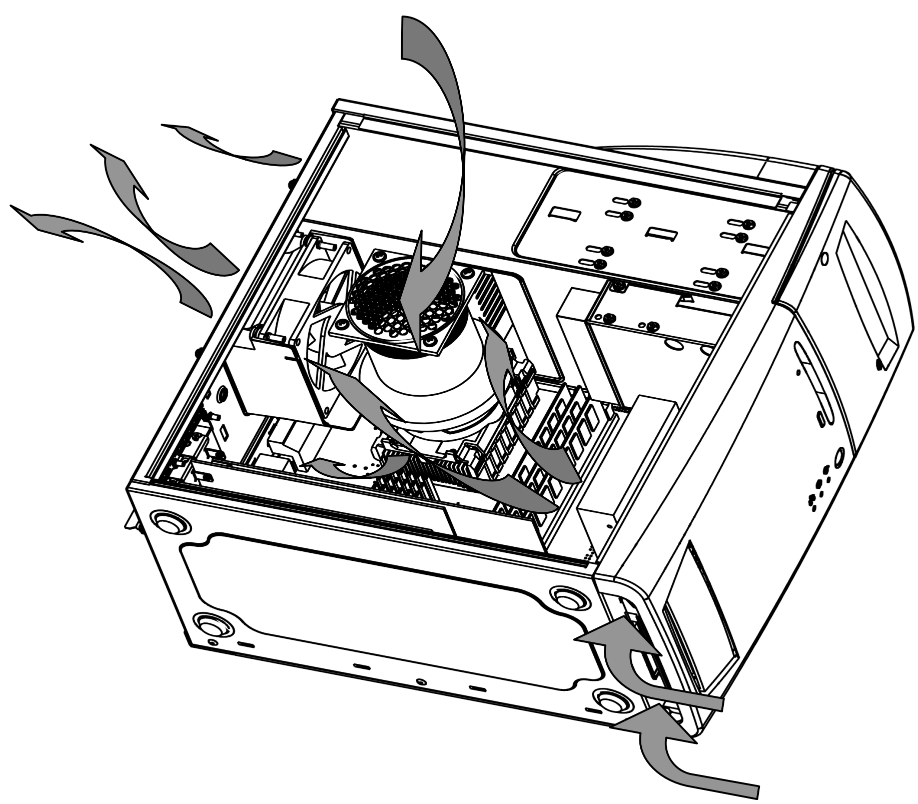

Figure 2. Chassis Air Guide Typical Airflow Pattern

2.3 Chassis Air Guide Assembly Stack

The Chassis Air Guide seen in Figure 3 is shown as a three-piece design.

The three parts of the Chassis Air guide are:

- Upper Duct
- Flange
- Lower Duct

This design has advantages over a single or two-piece design. The three-piece design can be elongated by hand to allow for different chassis widths. This allows for one tool to be used for many chassis sizes. The Flange can be molded or stamped in plastic or metal, with plastic having some weight and cost advantages. The Flange piece can be screwed into place on the chassis side panel, allowing for support of the Upper Duct and holding it in position.

With this configuration, the Lower Duct can be installed by sliding onto the Upper Duct. It is recommended that the Upper and Lower Ducts have corrugation ribs or other device to hold the two pieces firmly in place after final system assembly has taken place.

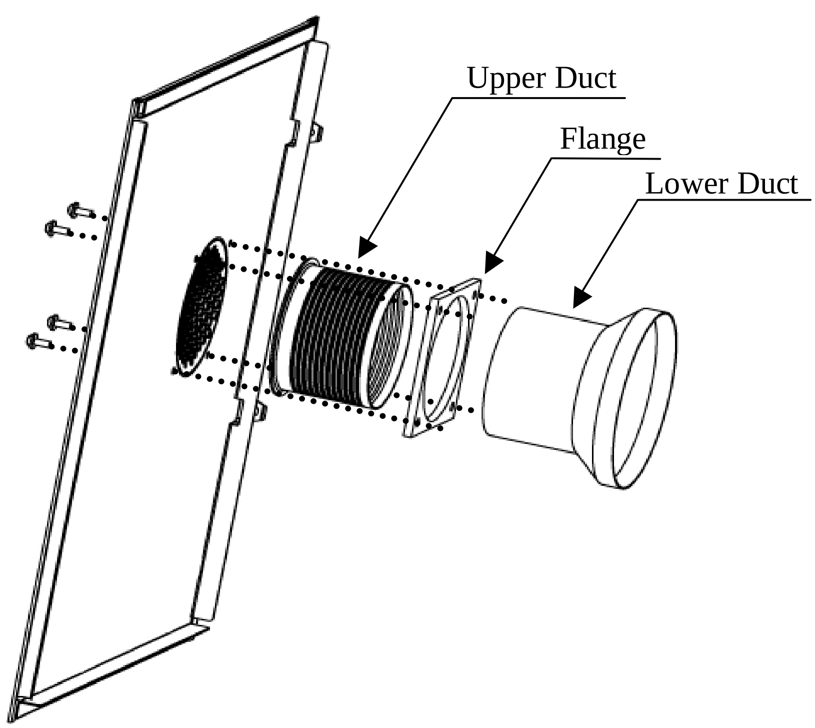

Figure 3. Chassis Air Guide Exploded View With Screws

2.4 Separation Distance

The Chassis Air Guide should not be in direct contact with the processor heatsink and fan. A separation distance is necessary in order to improve ease of assembly and cool other system components. The separation distance shown in Figure 4 is not only critical to the processor thermal performance but also the overall system cooling. If the separation distance is greater than 20mm, the cooling performance for the processor will suffer as the cool air will disperse before reaching the processor fan heatsink. If the separation distance is less than 12mm, other system components may not get adequate cool airflow, as the processor will receive the majority of the intake air.

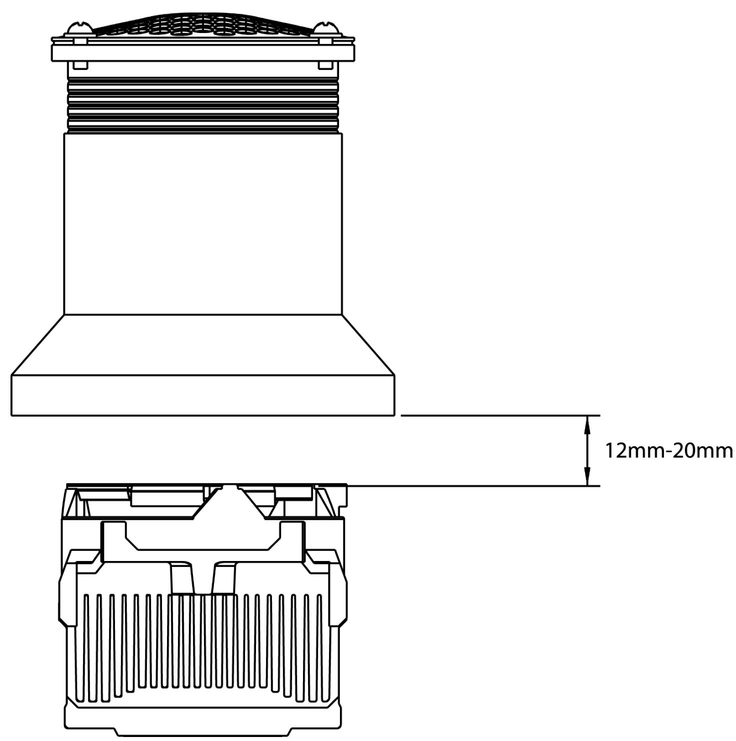

Figure 4. Separation Distance From Active Fan Heatsink

2.5 System Fans

Rear Chassis System Exhaust Fan:
The system fans have proven to remain a very valuable part of the overall system solution. The system fans create a low-pressure environment in the system relative to the external system pressure. This creates a pressure gradient that forces cooler external air to flow into the system through the air guide. A 80mm or larger rear fan providing a minimum of 39CFM (in free air) of flow is recommended to exhaust the chassis in conjunction with the Chassis Air Guide. Using the rear fan to pressurize the chassis should not be done when using the Chassis Air Guide and will render this solution completely ineffective.

Special Note: Some duct instantiations may utilize a system pressurizing rear fan. This will be a design choice based on overall system and ducting solution design.

Power Supply Fan:
The power supply fans seen in the market today have shown to be adequate to support the chassis air guide as defined in this document. A power supply fan should exhaust the chassis to assist with system cooling. A power supply fan that pressurizes the chassis with warm air will reduce the effectiveness of the Chassis Air Guide. No changes or special considerations are needed in this area to support the Chassis Air Guide.

Processor Active Fan Heat Sink:
Much the same as the rear system exhaust fan, the processor cooling fan remains a critical piece of the overall cooling solution. An active fan heatsink is needed to maintain airflow to properly cool the processor when using the Chassis Air Guide. Do not use a passive processor cooling solution with the Chassis Air Guide. The Chassis Air Guide is intended to only provide the *path* for cool air to be drawn to the processor core area. The air guide will not push cool air; rather the chassis system fans *draw* the cooler, external air to themselves.

2.6 Venting Location

The Chassis Air Guide does require a side vent as seen in Figure 5. It is recommended that this vent have an open effective area of 60% or greater. This will maximize the thermal performance gains and still contain EMI effectively. The holes can be any shape but care should be taken to ensure proper EMI containment. The vent should protrude from the chassis side panel as shown in Figure 5 to mitigate vent blocking if the system should be placed against a wall, desk or other obstruction. This is only one implementation and many other possibilities exist to prevent vent blocking.

The vent for this ducting solution is best located with respect to the standard ATX mounting holes as defined in the ATX Mainboard Interface Specification. Please see section 7.6 for the mechanical drawing demonstration the proper location of this ducting solution.

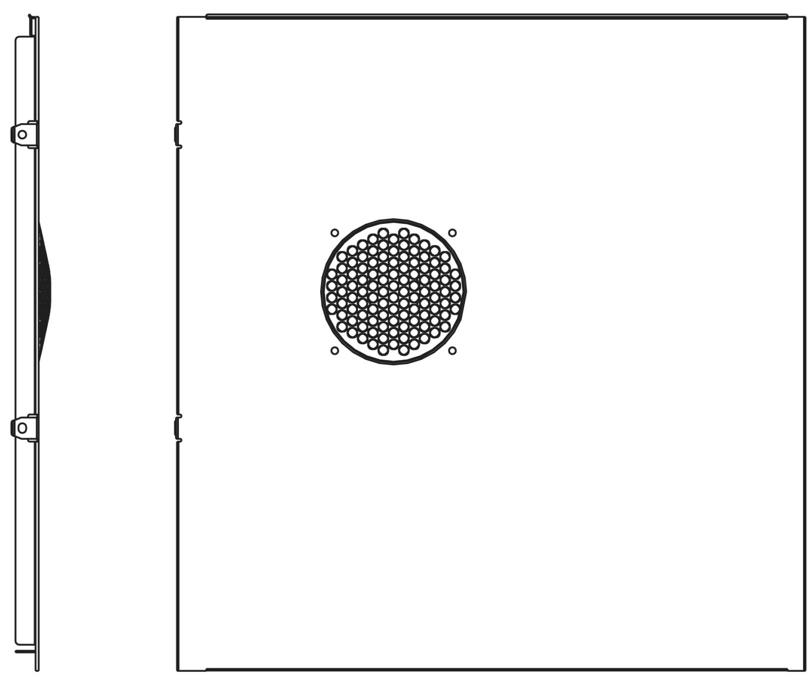

Figure 5. Chassis Side Panel With 60% Open Vent

2.7 Attach Mechanisms

The design guide demonstrates using four screws to hold the Chassis Air Guide securely in place. Platform designers may use other attach mechanisms but special attention should be made with regards to shock and vibration and ease of installation.

4.0 Dynamics

The basic structural requirement is that the duct must survive shipping without damage to itself or any other system ingredient. Because the shipping environment involves mechanical shock loads, the duct should be designed for impact resistance. The following mechanical testing describes the recommended minimum shock and vibration environment a duct should be able to survive when installed in a computer enclosure.

4.1 Shock Test

Unpackaged
25 g, 11 ms Trapezoidal; ~ 170 in/sec
2 drops in each of the 6 directions applied to each of the samples.

4.2 Vibration Test

Unpackaged
Sine sweep: 5 Hz to 500 Hz @ 0.5 g +/- 10%; @ 0.5 octaves/min; Dwell 15 min at each of 3 resonant points
Random Profile: 5 Hz @ 0.01 g^2/Hz to 20 Hz @0.02g^2/Hz (slope up)
20 Hz to 500 Hz @ 0.02 g^2/Hz (flat);
Input acceleration 3.13g RMS
10 min/axis for all axes on all samples
Random control limit tolerance is +/- 3 dB

4.3 Pass Criteria

- No visible damage.
- No displaced or dislodged components of the duct.
- No damage caused by the duct to any other system components.

5.0 Process Selection

The process by which the parts for a duct design are produced are numerous and varied with each having advantages and disadvantages. Below are two processes that have proven to be cost effective and produce the quality needed for a system platform duct. The three-piece Chassis Air Guide can be constructed in high volume for a relatively low cost using the processes listed below. The Upper Duct and Lower Duct (see section 2.3) would best be constructed using a Vacuum Forming process while the Flange is best suited for an injection molding process.

There may be other processes or materials available that deserve taking the time to explore. New processes or process improvements may become available that will aid in the manufacturability and production of a ducting solution.

5.1 Vacuum Forming Process

The vacuum forming process utilizes the natural atmospheric pressure to force heat softened thermoplastic sheet into or over a molding form. After the sheet has cooled on the molding form (tool) it retains its shape. The trim is then removed. Parts can be large or small using material less then 1mm thick up to 10mm or more. Vacuum forming is a very cost effective method for producing small or large quantities of molded plastic parts.

5.2 Injection Molding Process

Injection molding is the most widely used polymeric fabrication process. It evolved from metal die casting, however, unlike molten metals; polymer melts have a high viscosity and cannot simply be poured into a mold. Instead a large force must be used to inject the polymer into the hollow mold cavity. Identical parts are produced through a cyclic process involving the melting of a pellet or powder resin followed by the injection of the polymer melt into the hollow mold cavity under high pressure.

6.0 Regulatory Considerations

The unit and its design must meet a number of regulatory Safety, EMC and Ecology concerns. Specific requirements for Information Technology Equipment vary somewhat by country, however, the overall standards are somewhat unified and are based upon the following standards:

Note: Certain countries may require formal certifications and many require a Declaration of Conformance (DOC) be placed in the manual or on the box. In Europe the CE mark and a DOC is required for every computing device.

6.1 Electromagnetic Interference Radiation

The Electromagnetic Interference (EMI) performance of a system is determined by the degree of noise suppression designed into the system motherboard and the provisions for EMI containment in the chassis design, including placement of internal subsystems and cables. Requirements call for compliance to stringent electromagnetic compatibility (EMC) limits such as the CISPR-22 European standard or the FCC “B” United States standard. Open chassis requirements for board manufacturers suggest that most EMI needs to be suppressed at the board level. The chassis, however, should provide at least 6 dB of EMI attenuation or Shielding Effectiveness (SE) throughout the spectrum. The goal of 6 dB assumes board complies with FCC Part 15 (Open Box Test). Boards that have higher expected emissions will likely require additional containment. These standards, along with higher processor and video frequencies, call for additional chassis containment provisions. Basic design principles have not changed, but as frequencies continue to increase, the shorter wavelengths require more frequent ground contacts and smaller apertures in the chassis design. At very high frequencies, this becomes impractical because the ground points become so close that continuous gaskets would be needed, and vent holes would need to be so small that they would impede airflow.

EMC Standards:
47 CFR Parts 2 and 15 (USA)
ICES-003 (Canada)
EN55022:1998 (European Union Emissions)
EN55024:1998 (European Union Immunity)
Other International requirements based upon CISPR 22

6.2 Safety

This design guide is not intended to cover all safety aspects that may pertain to different countries and regulatory bodies. These listed below are a starting point for your reference, but the manufacturer is ultimately responsible to ensure safety standards are adhered to.

Safety Standards:
IEC 60590 (International)
UL/CSA 60950 (USA and Canada)
EN60590 (European Union)

6.3 Ecology

This design guide is not intended to cover every aspect of designing a product to meet every International regulation, however, the following standards and programs may cover Ecology issues that may or may not apply to your product.

Ecological Standards
ECMA TR70:
Energy Star
TCO '99, Blue Angel

Ecological Programs
Participation in waste electronics recycling program.
Participation in a packaging-recycling program.

7.0 Mechanical Drawings

7.1 Flange, Chassis Air Guide

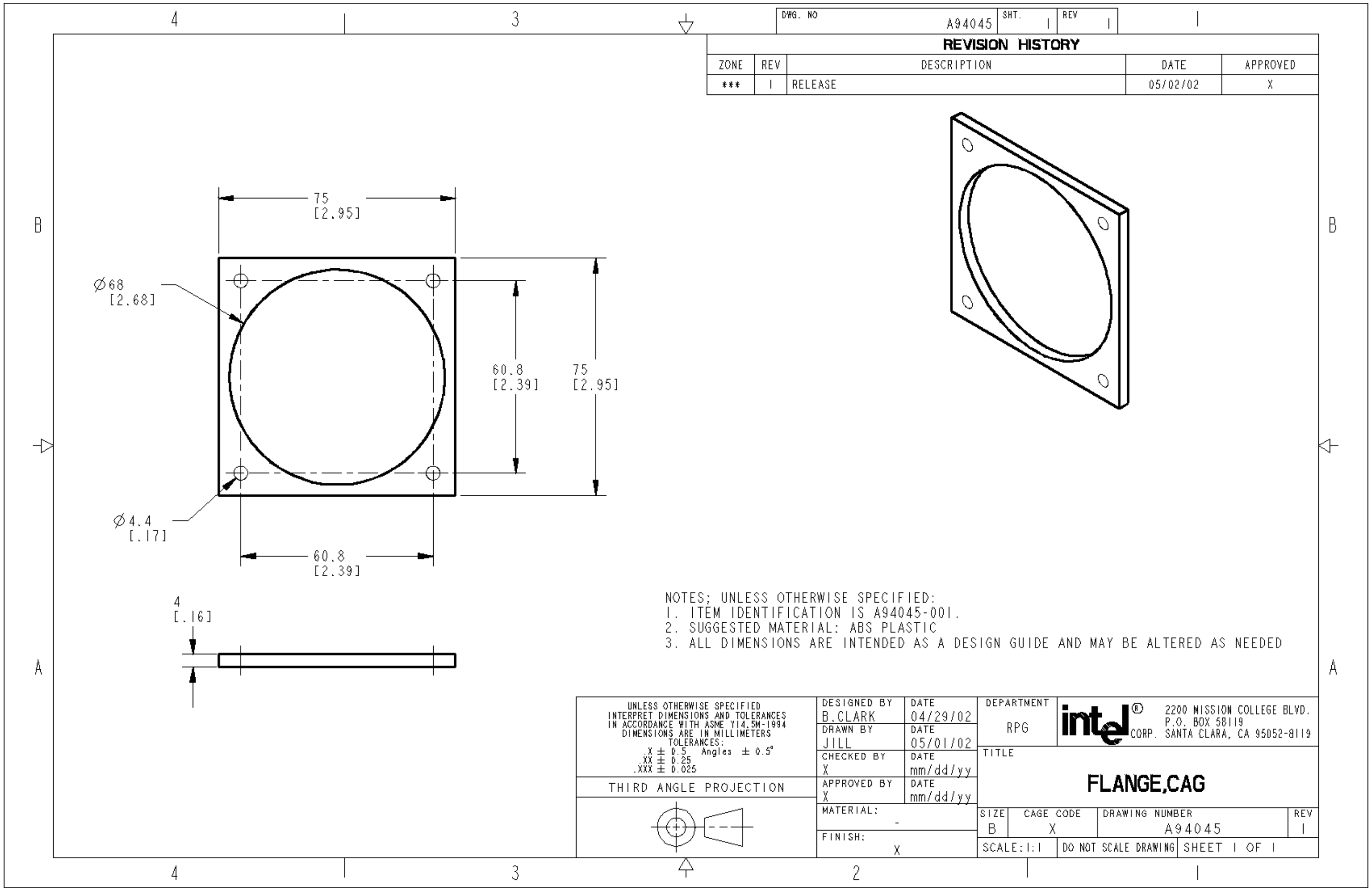

Figure 6. Flange, Chassis Air Guide

7.2 Upper Duct, Chassis Air Guide

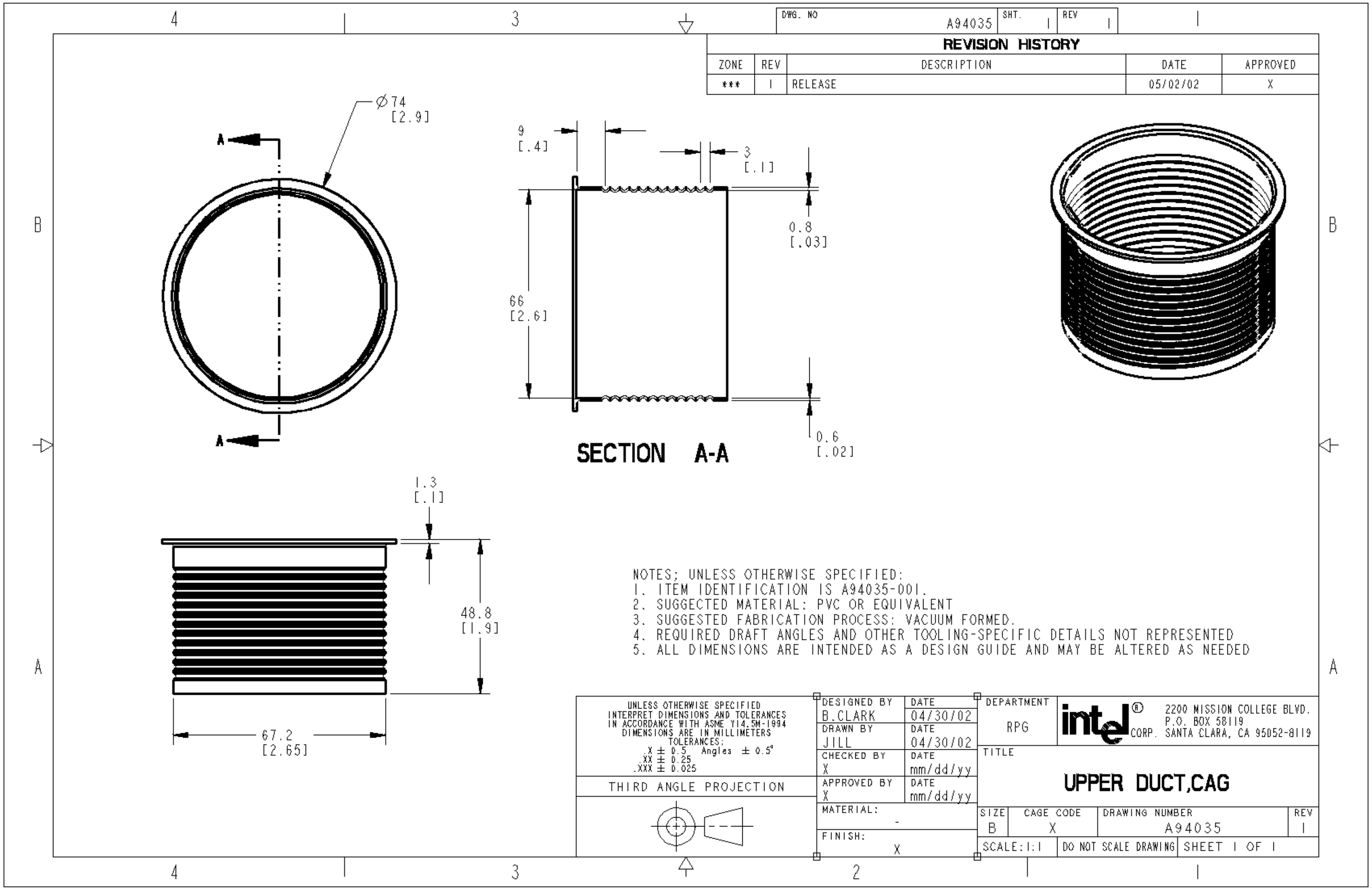

Figure 7. Upper Duct, Chassis Air Guide

7.3 Lower Duct, Chassis Air Guide

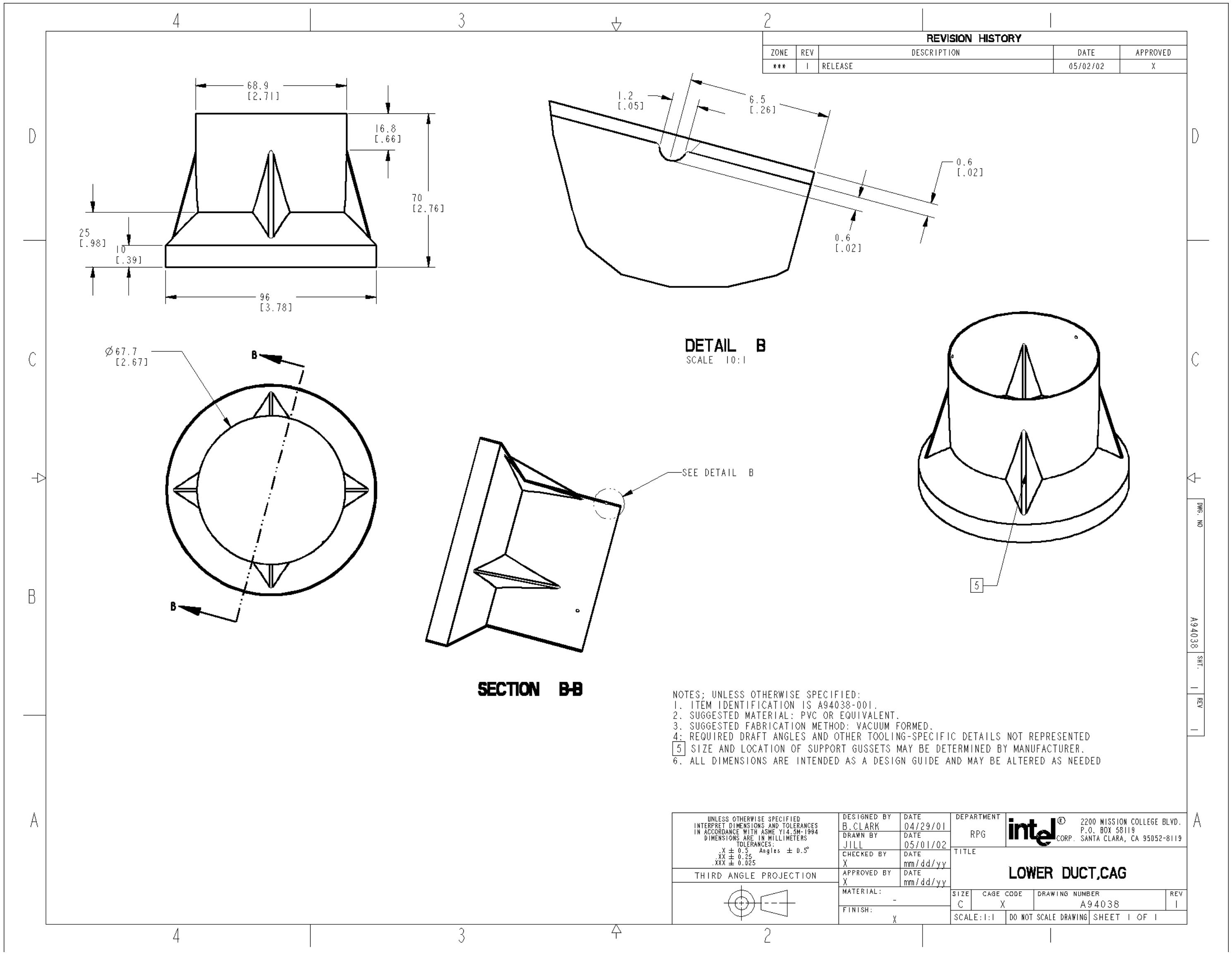

Figure 8. Lower Duct, Chassis Air Guide

7.4 Duct Assembly, Chassis Air Guide

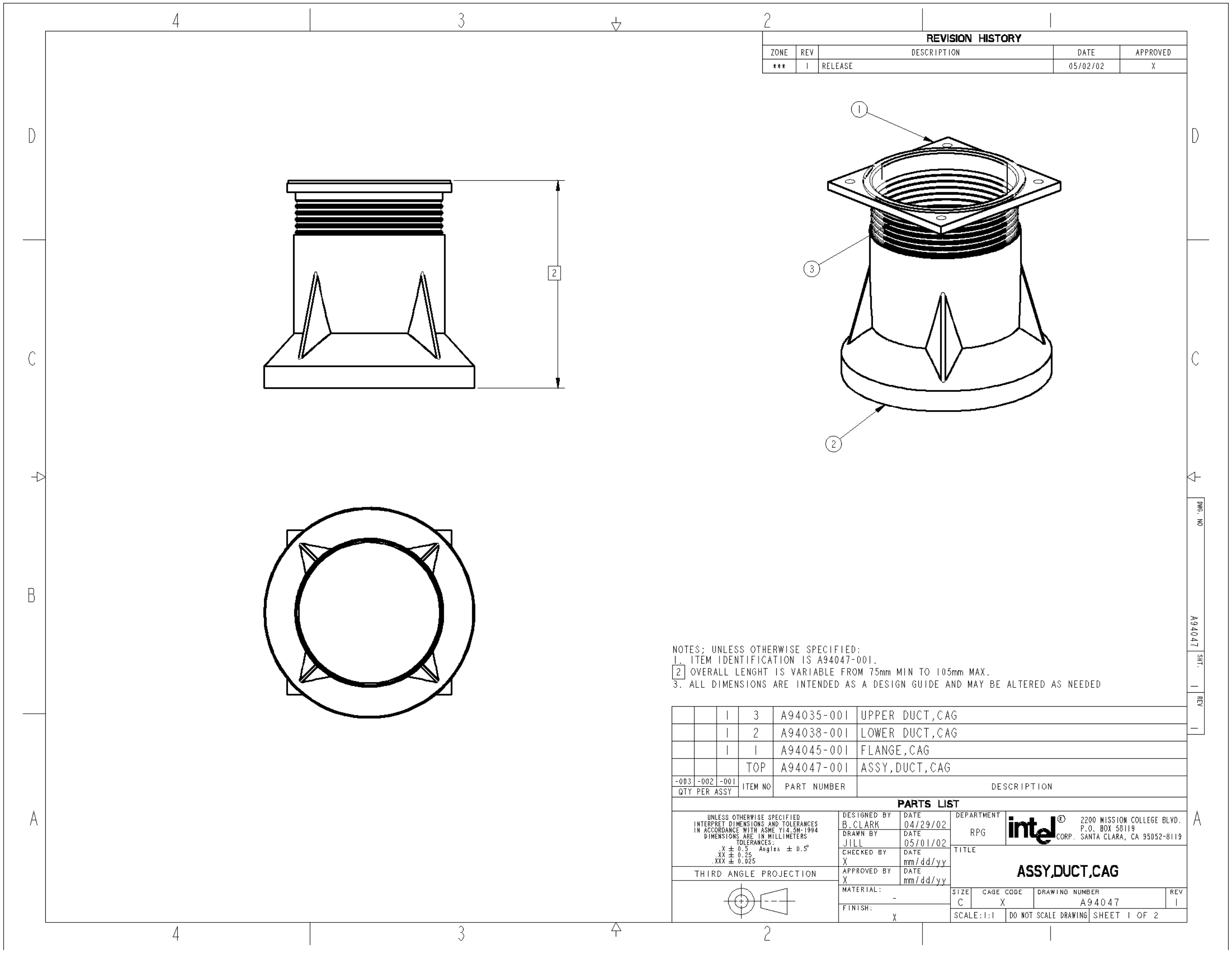

Figure 9. Duct Assembly Chassis Air Guide

7.5 Vent Pattern, Chassis Air Guide

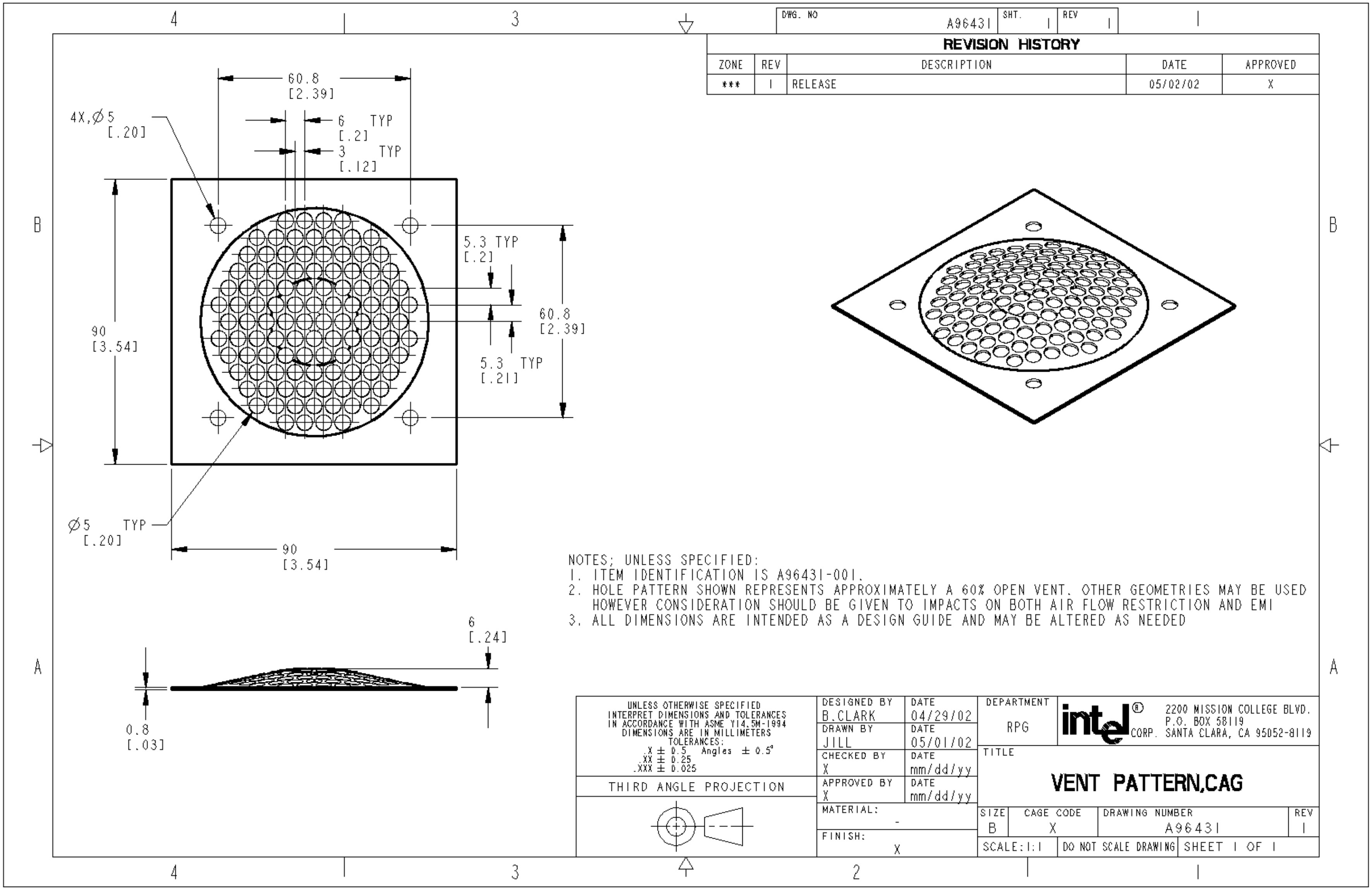

Figure 10. Vent Pattern, Chassis Air Guide

7.6 Chassis Air Guide Center Location

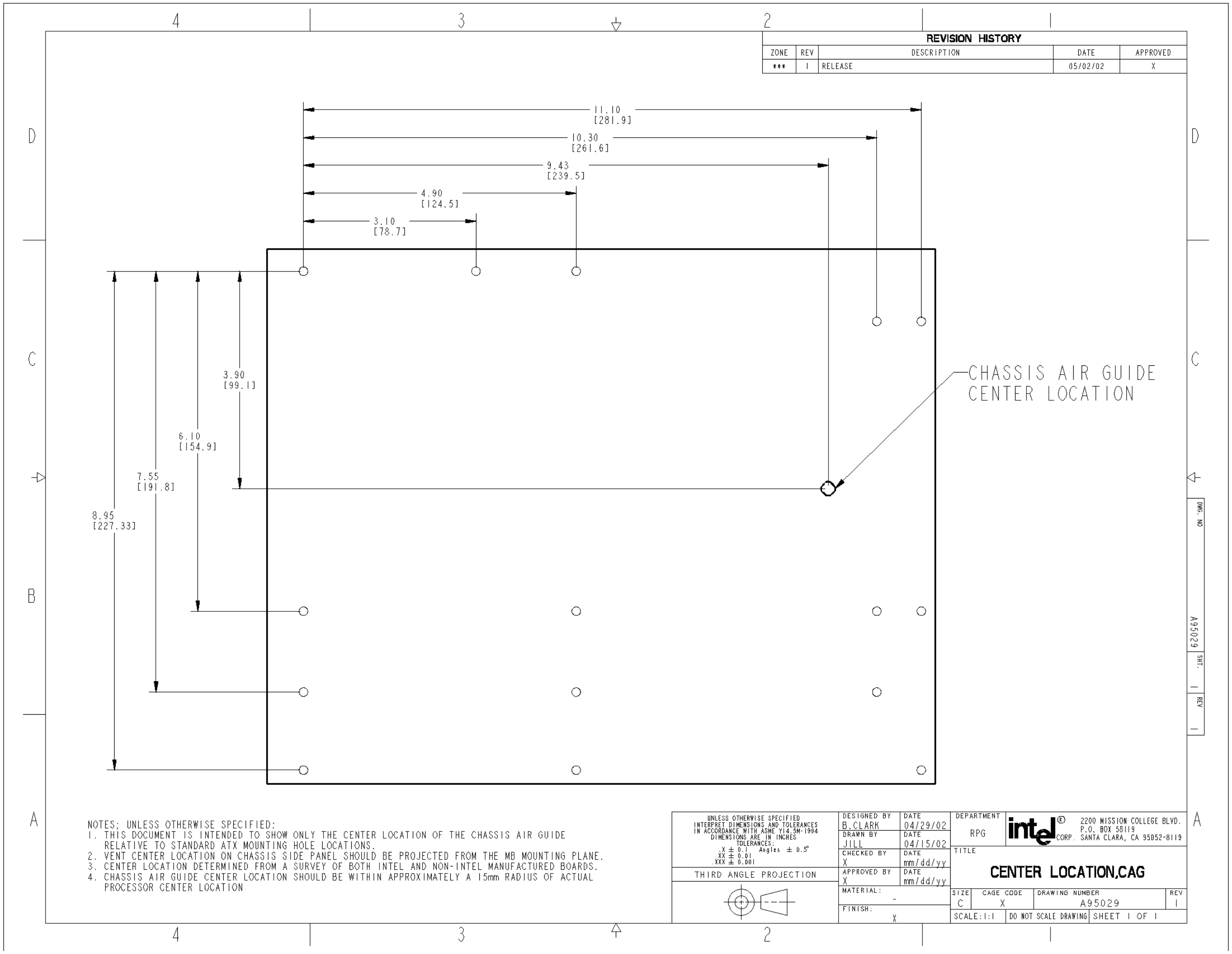

Figure 11. Chassis Air Guide Center Location