Mechanical Assembly and Customer Manufacturing Technology for S.E.P. Packages

Application Note AP-826

July 1998

Order Number: 243734-001

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1.0 INTRODUCTION

The Intel® Celeron™ processor is the next processor in the Intel P6 processor family line of Intel processors. The Intel Celeron processor, like the Pentium Pro processor, implements a Dynamic Execution micro-architecture — a unique combination of multiple branch prediction, data flow analysis and speculative execution. This enables the Intel Celeron processor to deliver higher performance than the Pentium processor, while maintaining binary compatibility with all previous Intel architecture processors. The Intel Celeron processor also executes MMX™ technology instructions for enhanced media and communication performance. The Pentium II processor utilizes multiple low-power states such as AutoHALT, Stop-Grant, Sleep and Deep Sleep to conserve power during idle times.

1.1 Purpose of this Document

This application note is meant to familiarize the reader with the S.E.P. package technology developed by Intel and related issues for the Personal Computer Original Equipment Manufacturer (PC OEM) The first section details the manufacturing technology used by Intel for the S.E.P. package. The second half of the document describes an enabled mechanical solution for use in PC OEM systems and impacts that solution has on the PC OEM manufacturing process.

1.2 References

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

- *Intel Celeron™ Processor at 266 MHz and 300 MHz* datasheet (Order Number 243658)
- AP-485, *Intel Processor Identification with the CPUID Instruction* (Order Number 241618)
- AP-585, *Pentium® II Processor GTL+ Guidelines* (Order Number 243330)
- AP-586, *Pentium® II Processor Thermal Design Guidelines* (Order Number 243333)
- AP-587, *Pentium® II Processor Power Distribution Guidelines* (Order Number 243332)
- AP-589, *Pentium® II Processor Electro-Magnetic Interference* (Order Number 243334)
- *Intel Celeron™ Processor Specification Update* (Order Number 243748)
- *Pentium® II Processor I/O Buffer Models*, IBIS Format (Electronic Form)
- *Pentium® II Processor Developer's Manual* (Order Number 243341)
- *Packaging* Databook (Order Number 240800)
- *Slot 1 Connector Design Guidelines*, located at the following Intel website:

Intel website http://developer.intel.com/design/celeron/or http://www.intel.com

2.0 Single Edge Processor Package

The Intel® Celeron™ processor family is the first microprocessor product family from Intel Corporation to utilize the Single Edge Processor (S.E.P.) package technology. The S.E.P. package utilizes surface mount technology on a substrate with an edge finger connection.

The S.E.P. package utilizes a Slot 1 form factor. It consists of a substrate with an edge finger connection. Passive components and the processor core are mounted on a single side of the substrate. Four through holes on the substrate allow for heatsink installation.

The edge finger connection maintains socketability for system configuration and fits within existing Pentium® II processor-based systems. The edge finger connection uses a connector that is noted as the 'Slot 1 connector' in this and other documentation.

2.1 Package Terminology

The following terms are used throughout this document and are explained here for clarification:

- **Intel® Celeron™ processor family** - family of processors designed for Basic PCs. The introductory Intel Celeron processor is the first to use the S.E.P. package.
- **Package** - The new processor packaging technology is called a "Single Edge Processor Package". Examples of other processor packaging technology are BGA (ball grid array), S.E.C. cartridge (Single Edge Contact Cartridge).
- **Gold fingers** - The exposed gold connectors that make electrical connection to the Slot 1 connector (also known as “edge fingers”).
- **Processor substrate** -The structure on which the components are mounted with the S.E.P. package (with or without components attached).
- **Processor core** - The processor's execution engine.

Figure 1. S.E.P. Package — Front or Primary Side View

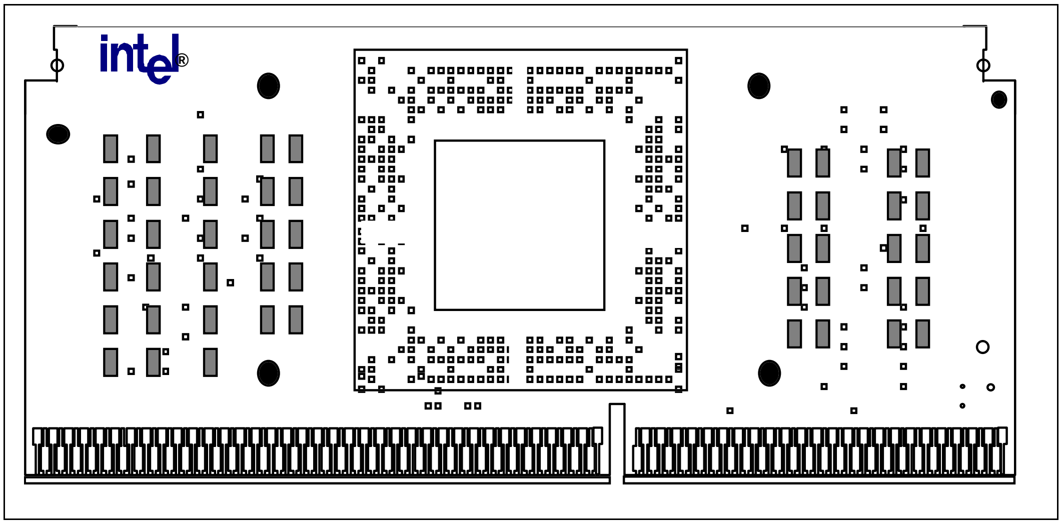
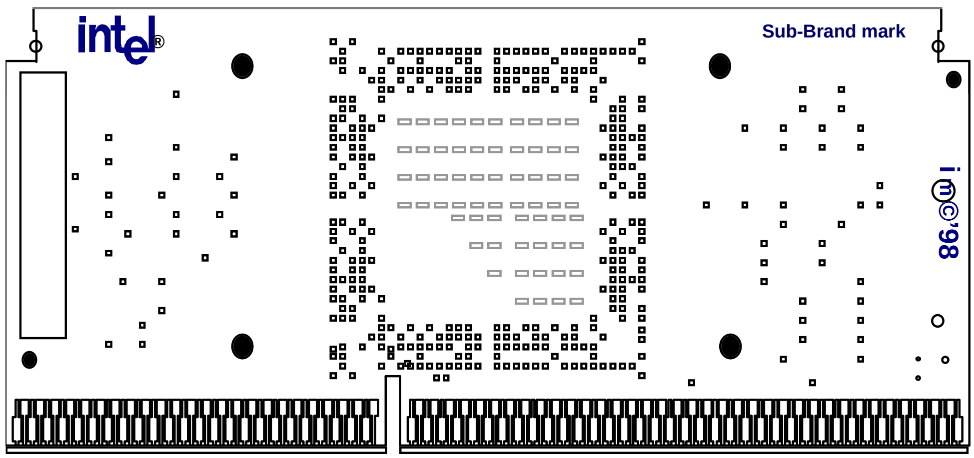


Figure 2. S.E.P. Package — Back or Secondary Side View



Additional terms referred to in this and other related documentation are the Mechanical Support Pieces (MSPs), which are used on the system to connect the processor to the system motherboard, and retention of the processor during system shock and vibration. The MSPs represent one solution for retention of the processor in the Slot 1 connector. This application note focuses on the use of these pieces:

- **Slot 1 Connector** - The connector that the S.E.P. package plugs into.
- **Retention mechanisms (RM)** - Mechanical pieces that hold the Package in the Slot 1 connector. There are multiple RM configurations.
- **Heatsink clip** - A metal piece that holds the heatsink firmly to the processor core.
- **Retention Mechanism Attach Mount** - A mechanical piece which secures a screw type retention mechanism to the motherboard.

Other mechanical solutions are not investigated in detail in this document.

2.2 S.E.P. Package Design and Construction

2.2.1 Package Design

The design of the S.E.P. package and materials used in the package undergo testing to assure the highest quality. Testing is performed across multiple lots and the correlation of lot data to manufacturing performance at Intel is determined. Suppliers also undergo quality audits in order to demonstrate manufacturability and quality-to-performance specifications.

2.2.2 Package Substrate

The S.E.P. package contains active and passive components mounted onto the primary side of the substrate. The substrate has contact fingers on one edge that provide the electro-mechanical connection to the Slot 1 connector (and thus to the system motherboard) (see Figure 3). The substrate is fabricated of normal FR-4 based organic laminate material and has a minimum flammability rating of 94V–0. Copper trace and power plane parametrics, along with other key performance and manufacturing designs, have been selected to provide optimum electrical performance. The edge finger contacts are plated with gold over a nickel barrier layer for a reliable substrate edge finger to Slot 1 connector electrical contact. The edge fingers are equally distributed between the primary and secondary sides of the substrate (121 edge finger contacts per side, 242 total contacts for the S.E.P. package). The contact areas of these edge fingers are maximized by using a two-sided staggered design for the placement of the fingers. A key slot is provided in the edge finger array, off center of the card length, to prevent improper placement of the S.E.P. package substrate into the Slot 1 connector (see Figure 3 and Figure 4). See the *Intel Celeron™ Processor at 266 MHz and 300 MHz* datasheet for detailed mechanical dimensions and signal listing for the substrate edge fingers.

Figure 3. Mechanical Schematic of S.E.P. Package Substrate

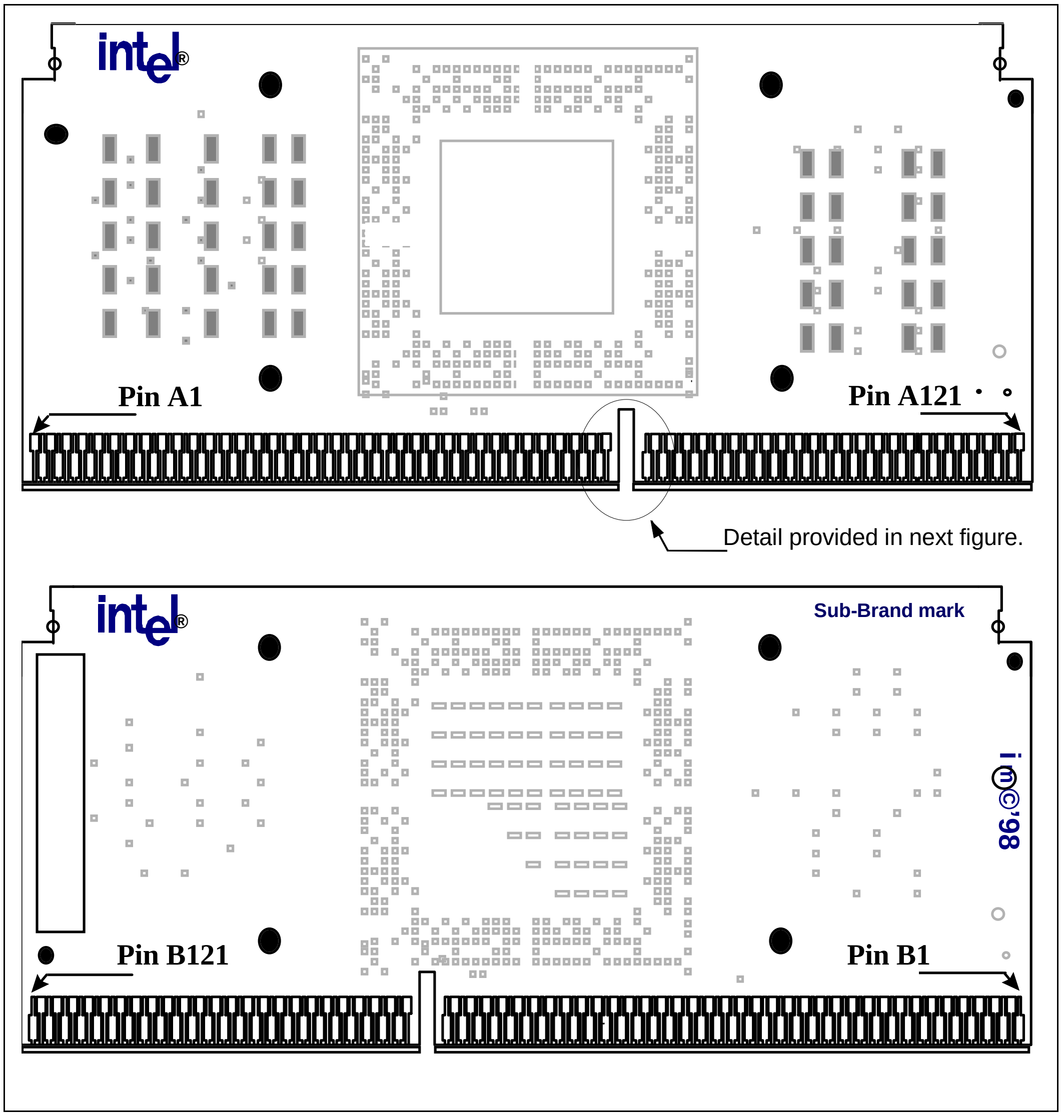
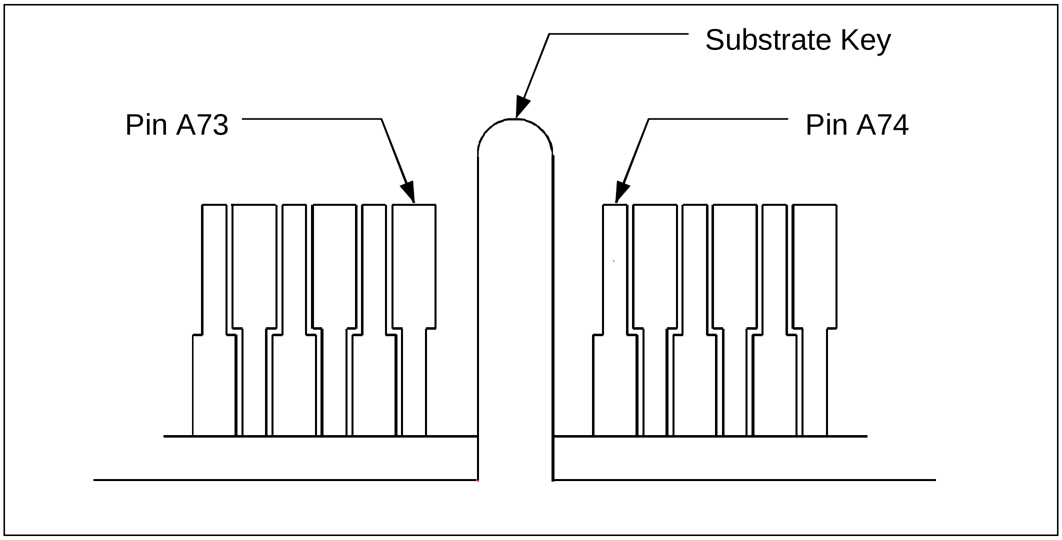


Figure 4. Substrate Edge Finger Contact and Key Detail

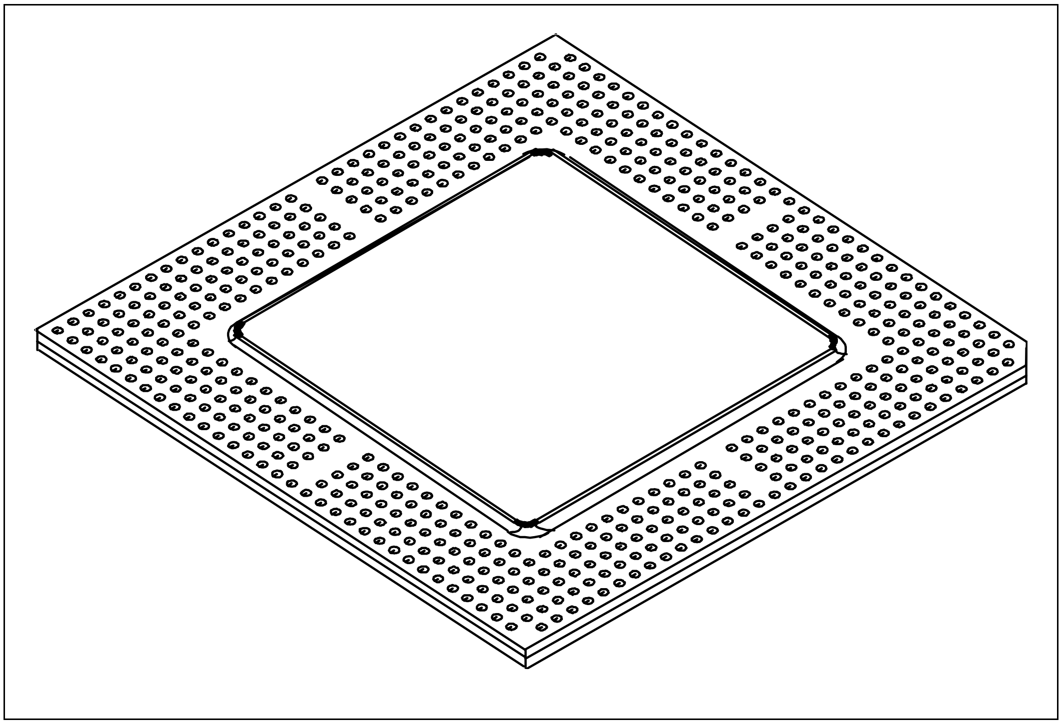


The edge fingers are specified to last for a maximum of 50 insertions. This is to ensure an upper limit for the contact resistance to the Slot 1 connector (and meet electrical performance requirements). Insertion/extraction cycling above 50 insertions may cause an increase in the contact resistance and a degradation in the material integrity of the edge finger gold plating (and possible oxidation buildup). The actual number of insertions before processor failure will vary based upon system configuration and environmental conditions.

2.2.3 Processor Core Package Body Materials

The S.E.P. package processor core may vary by product. For initial product release, the processor core for the S.E.P. package consists of the silicon logic die, mounted and interconnected to a multilayer plastic laminate body (also referred to as a Plastic Land Grid Array (PLGA) (see Figure 5).The laminate structure is Bismaleimide Triazine (BT) resin with laminated copper foil interconnects. The logic die is gold wedge wire bonded to the component package. The cavity of the logic core body is encapsulated with a high temperature thermoset polymer coating to provide mechanical and environmental protection. The logic core package to substrate interconnects use eutectic tin-lead (SnPb) solder balls. See the product datasheet for details on your specific product.

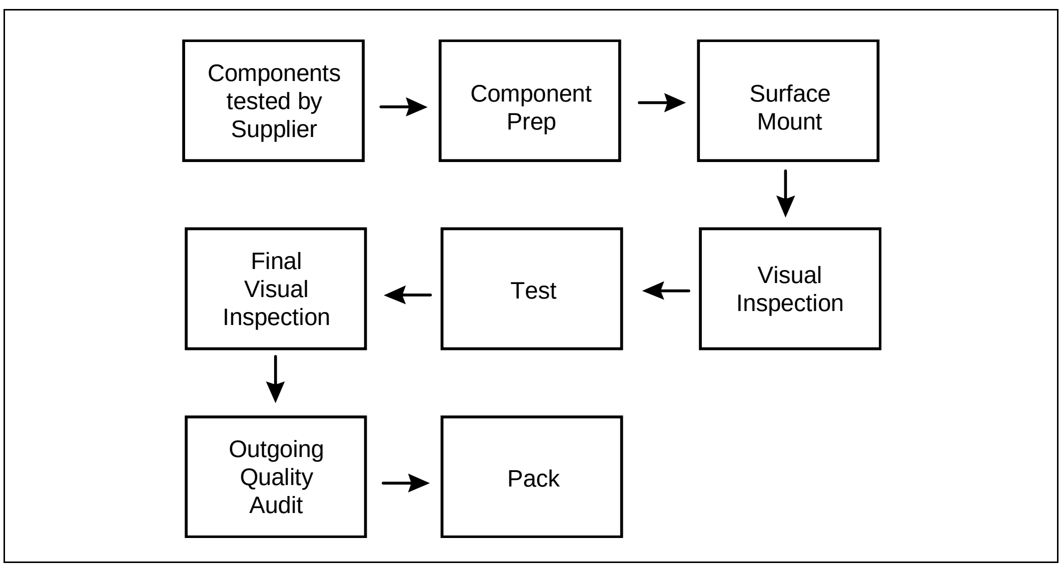
Figure 5. Example Processor Core (PLGA)



2.3 Package Assembly and Test

The processor core and other components are assembled onto the substrate using traditional SMT processes and methodologies. The S.E.P. package assembly and test flow is shown in Figure 6.

Figure 6. S.E.P. Package Assembly/Test Process Flow



2.4 Package Handling and Shipping Media

The S.E.P. package was designed to be a robust packaging solution for processors. As a result, sealed, desiccant, ESD protective bags are not required during shipping of the processors from Intel.

This section provides additional handling guidelines and information on the shipping media used for the processors. The Intel Celeron processor at 266 MHz and 300 MHz datasheet (order number 243658) contains specific operational and storage specifications for the processor.

2.4.1 Intel Celeron™ Processor Shipping Media Description

The S. E. P. package processors are packaged in a shipping box using a thermo-formed ESD plastic (industry name is XEROSTAT 1000) insert base with the substrate edge fingers down. The ESD plastic insert is an electrically dissipative, Recycled High Density Polyethylene (RHDPE) molded plastic (See Figure 7 and Figure 8). The insert cover is then attached over the S.E.P. card processors to secure them during shipment. The closed insert is placed into the carbon lined outer box to achieve full ESD protection. There are 50 S.E.P. packages per insert. The outer box is constructed from corrugated cardboard and has a conductive carbon coating inside to dissipate any electrostatic charge.

Figure 7. Intel® Celeron™ Processor Shipping Box — Exploded View

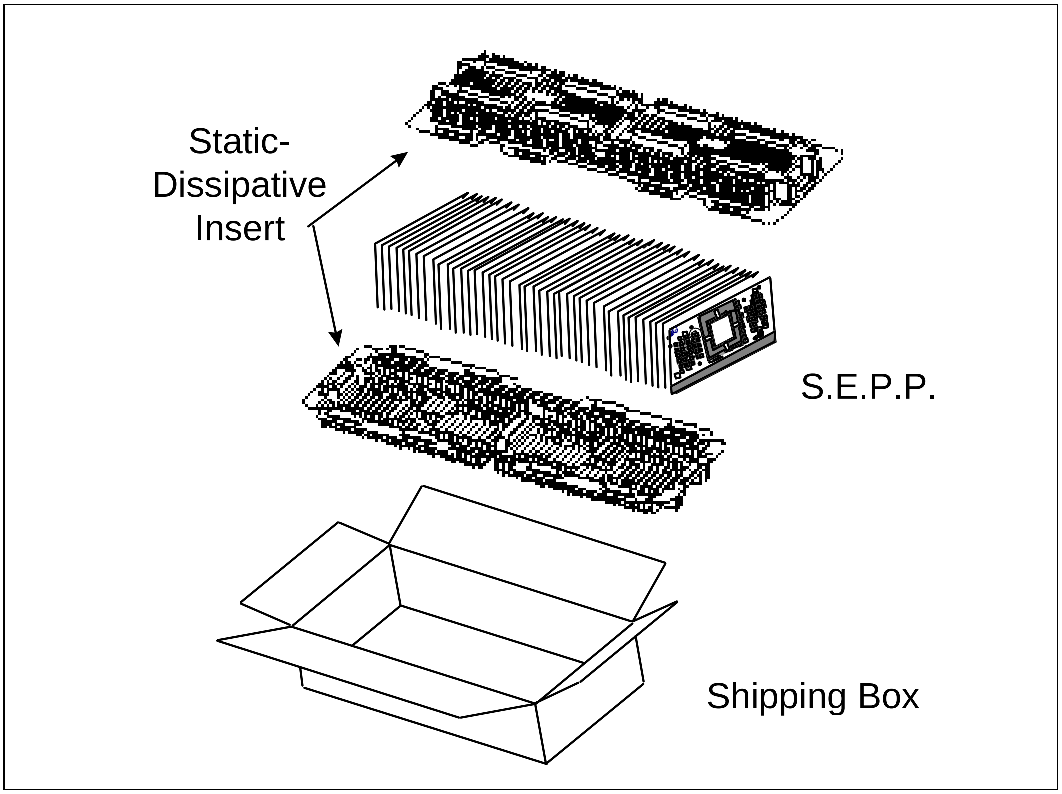
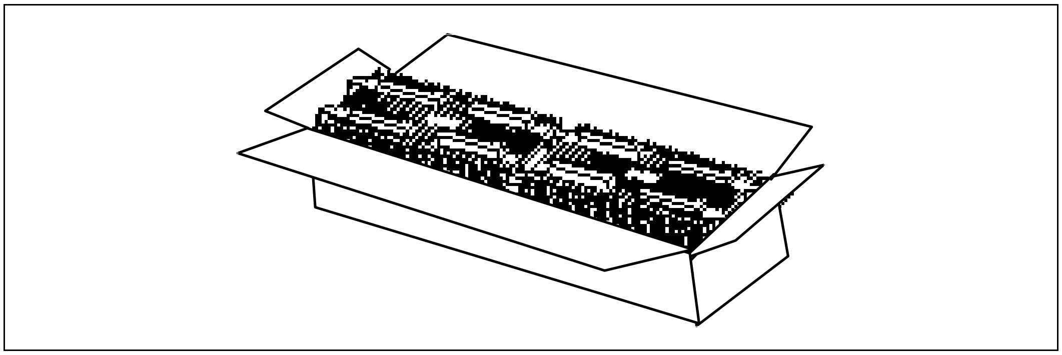


Figure 8. Intel® Celeron™ Processor Shipping Box — Assembled View



2.4.2 S.E.P. Package Handling Precautions for ESD Protection

The S.E.P. package processor must be unpacked at ESD workstations. Electrical fields are able to penetrate electrical devices. An ungrounded person handling a component or computer board in a non-static shielding container can cause a large charge to be transferred through the container into the sensitive electronic device.

Eliminating static electricity in the work place is accomplished by grounding operators, equipment (including the use of dissipative table mats) and parts (components and computer boards). Grounding prevents static charge buildup and electrostatic potential differences. Electrical field damage is averted by transporting products in special electrostatic shielding packages (i.e. antistatic or dissipative carriers). Refer to the Packaging Databook (order number 240800) for detailed information, guideline and recommendations on proper precautions against component damage due to ESD. The Packaging Databook (order number 240800) also contains information on package handling, electrical overstress and other information.

2.4.3 Package Handling

The package is **not** meant to survive severe mishandling. When handling material, it is recommended that clean, lint free gloves or finger cots are worn to ensure the S.E.P. packages are free from contaminates. Also, avoid contact of foreign material with the substrate edge fingers. Dropping the processor from a workstation table top to the floor can cause processor contamination or damage.

Avoid S.E.P. package substrate deflections induced during handling and/or assembly. The S.E.P. package cannot exceed 0.160” deflection as measured from the end of the substrate in the direction of the heatsink and 0.080” deflection as measure from the end of the substrate in the direction away from the heatsink.

2.4.4 Package Enabling

Intel has provided reference designs for the enabled components which are utilized with the Intel Celeron processor in the Basic PC systems. The enabled components include, Retention Mechanism, heatsink, thermal interface material, and heatsink attach clip. The paragraphs below describe the handling of each of these components during integration.

2.4.5 Retention Mechanism

The retention mechanism is used to guide the S.E.P. package and heatsink assembly into the Slot 1 connector and when fully seated, provides structural support. Insertion force of a S.E.P. package and heatsink assembly into a connector with a retention mechanism is 35 lbs. maximum. Extraction force in the same configuration is a maximum of 25 lbs.

System mounting of retention mechanism is mounted on the primary side of planar. Installation and removal of the retention mechanism utilizes normal tools such as Phillips screwdriver, pliers, and Allen wrench. Caution must be taken not to damage the motherboard or S.E.P. package during retention mechanism installation or removal.

2.4.6 Thermal Interface Material

The purpose of the thermal interface material is to assure good heat transfer between the S.E.P. Package and the unit heatsink. This material can be applied by the heatsink supplier. This material is typically applied by the heatsink supplier. This material may/may not be applied by the heatsink vendor. Additionally, a plastic cover may/may not be applied over the thermal interface material to protect it during shipping. If the heatsink has thermal interface material with a protective plastic cover, ensure that this protective cover is removed prior to attaching the heatsink.

2.4.7 Heatsink and Heatsink Attachment

The heatsink attachment mechanism must not induce permanent stress or flex on the S.E.P. package substrate with the exception of a uniform load not to exceed 20 psi compressive loads to maintain the heatsink to processor thermal interface. Metal attach mechanisms, like heatsink clips, must have sharp edges removed to avoid damage or create any contact wear points on the S.E.P. package substrate. The metal attach mechanisms also must be shielded from electrical contact with the S.E.P. package substrate. The metal attach mechanisms also must be shielded from electrical contact with the S.E.P. package substrate with the exception of the S.E.P. package substrate through holes.

During heatsink attach, handle all components with clean gloves. It is recommended that the units be removed singly from the packaging as needed to attach heatsinks. It is recommended that an operator should grip the substrate by the upper edges. Contact with bottom edge fingers (i.e., gold fingers) should be avoided to prevent contamination of damage to the gold fingers.

2.5 S.E.P. Package Quality and Reliability

The S.E.P. package was submitted to normal reliability stress evaluations. Table 1 lists the environmental test conditions which were used in the study.

After each of the stress conditions described in Table 1, electrical end-point testing was performed to verify that the processor under test had not degraded. All processors under stress passed after every environmental stress test exposure.

Table 1. Environmental Test Conditions for S.E.P. Package

Test	Condition	Duration	Test Configuration
Temperature Cycling	-40°C to 85°C	1000 cycles 15 min soak at each extreme	S.E.P. Package
Random Vibration	5 Hz to 20 Hz 0.01 g^2/Hz sloping to 0.02 g^2/Hz (flat) 20 Hz – 500 Hz 0.02 g^2/Hz (flat)	10 min/axis	S.E.P. Package, Slot 1 Connector, and Retention Mechanism
Mechanical Shock	Trapezoidal 50G Velocity change of 170 in/sec	Three drops in each of six directions	S.E.P. Package, Slot 1 Connector, and Retention Mechanism
Humidity	85%RH: 55^{o}C	500 hours	S.E.P. Package

2.6 Package Change Control

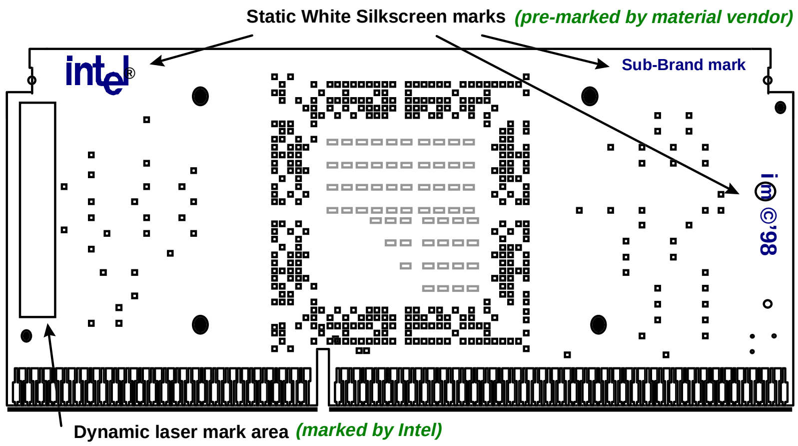
New products at Intel undergo development phases prior to production. Once the product has gone through the development phases and entered into production, it is still possible that changes may occur. A change is any modification that could impact performance, appearance, quality, reliability, functionality, interchangeability, cleanliness, handling, or manufacturability of the supplied materials. This may apply to any change in the raw materials used directly or indirectly in the supplier's manufacturing process (including changing suppliers), any change in the manufacturing flow, or any change in handling or shipping materials used internally or in shipment to Intel.

In the event that a change is made to the S.E.P. package, Intel will qualify the changed material prior to approving the change for implementation. For any form, fit or function change, Intel will notify customers using the same criteria used for other Intel components.

2.7 S.E.P. Package Marking

In order to identify S.E.P. package (and processor) history, each unit is marked with the lot number for factory planning and logistics, and shop floor control links to the actual units. See Figure 9 for details on marking of the S.E.P. package.

Figure 9. S.E.P. Package Marking



Dynamic Laser Marks

GRP1LN1	GRP1LN2
GRP2LN1	GRP2LN2

GRP1LN1 contains: Lot number

GRP1LN2 contains: S Spec Number or QDF Number

GRP2LN1 contains: Speed/Bus Frequency.

GRP2LN2 contains: Factory of Origin

2.7.1 Package Core Processor Marking

The core processor on the primary side of the S.E.P. package is also marked with information for traceability. However, the markings will not be visible when the heatsink is attached.

2.8 Package Processor Return Policy

The processor should be returned directly to the local Quality Support Center via your components Customer Quality Engineer (CQE) contact or sales contact. Within the U.S., the S.E.P. package can also be returned via the 1-800-628-8686 (Intel hotline). The following procedure is only applicable for returns needing technical analysis. All other returns need to be handled through the normal RMA process. The processor should be returned in the condition which it was purchased (heatsinks should only be left on boxed processors purchased with heatsinks). A description of the failure mode should be enclosed. S.E.P. package returns will follow normal microprocessor FACR process and throughput commitments.

Processor should be returned in appropriate packing

- Incorporate ESD dissipative boxes or bags
- Place unit into an ESD bag and wrap unit with at least two to four inches of wrapping. For multiple returns, ensure that individual units are wrapped and cushioned with at least two to four inches of bubble wrap or foam between units and between unit and outer box.

3.0 Processor Enabling Mechanism

The Slot 1 connector and S.E.P. package do not provide the needed mechanical integrity during transport and sever movement; therefore, other mechanical solutions are required to secure the S.E.P. package in the Slot 1 connector. Intel has enabled two such solutions (commonly known as RM—retention mechanisms); other solutions are not discussed in the document. Although Intel has conducted shock and vibration testing and validation on the solution mentioned in this document, customers need to perform validation for their system configuration.

The main difference between the S.E.P. package and the S.E.C. cartridge in terms of the retention mechanism is that the S.E.P. package does not utilize a cartridge to surround the substrate. Instead, the S.E.P. package utilizes special heatsink geometry that interfaces with the RM's as shown in Figure 11. In the S.E.C. cartridge design the deflecting features that 'snapped' into place were integrated into the cartridge design. In the S.E.P. package design the deflecting elements are the RM's and the motherboard itself while the S.E.P. package and heatsink assembly is rigid.

The two RM configurations are the captive fastener RM and the plastic fastener RM. The captive fastener RM consists of the Captive Fastener Retention Mechanism (CFRM), the Heatsink Assembly (HSA) and the Retention Mechanism Assembly Mount (RMAM). The plastic fastener RM consists of the Plastic Fastener Retention Mechanism (PFRM), the Heatsink Assembly (HSA) and the plastic fasteners. The RM holds the processor into the Slot 1 connector during mechanical shock and vibration. The RMAM attaches the RM to the motherboard for the CFRM, while the plastic fasteners perform the same function for the PFRM. The RM holds the S.E.P. package and Heatsink Assembly by integral heatsink features that must be present for the RM to function correctly. The required features in the heatsink design is detailed in the Single Edge Processor Package Retention Mechanism, Heatsink attachment, and Heatsink Functional Specification (doc # 711696). Please note that example heatsinks are shown throughout Section 3.0, Section 4.0, and Section 5.0. Heatsinks and thermal solutions beyond the specific retention features are the responsibility of the OEM manufacturer. Figure 10 provides the basic motherboard footprint for the Slot 1 connector, RMAM and RM pieces. Mechanical dimensions and other structural information for the RMs are located in the *Slot 1 Connector Design Guidelines* and the *Mechanical Support Pieces for S.E.P. Package*, both located at the Intel website. Intel does not supply the RMs or equipment described in this application note. Refer to the Intel Celeron Processor Support Components Guide, located at the Intel website for supplier information. From Chapter 3 onward, unless otherwise specified, the heatsink and support mechanical pieces refer to Intel's enabled solution.

Figure 10. Motherboard Footprint for RM and Slot 1 Connector

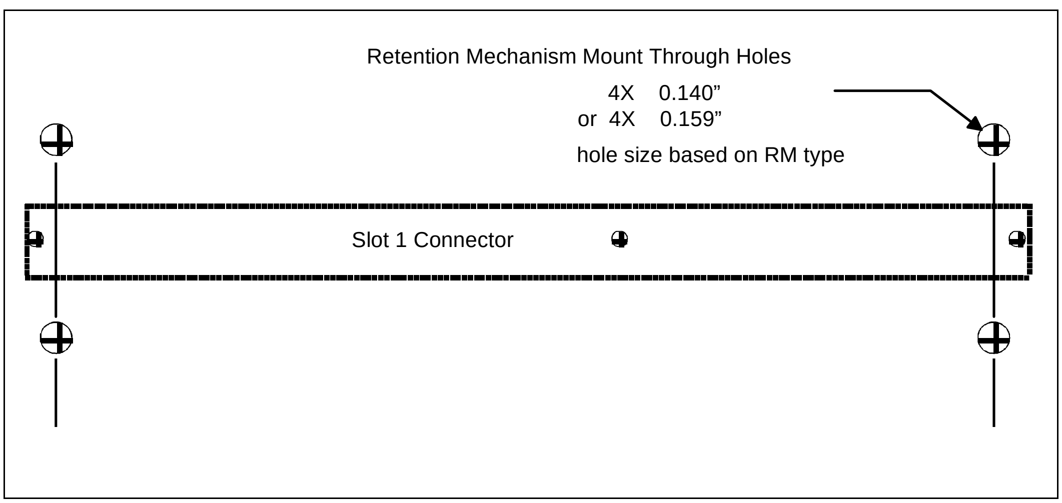


Figure 11. S.E.P. Package Before Insertion into Retention Mechanism

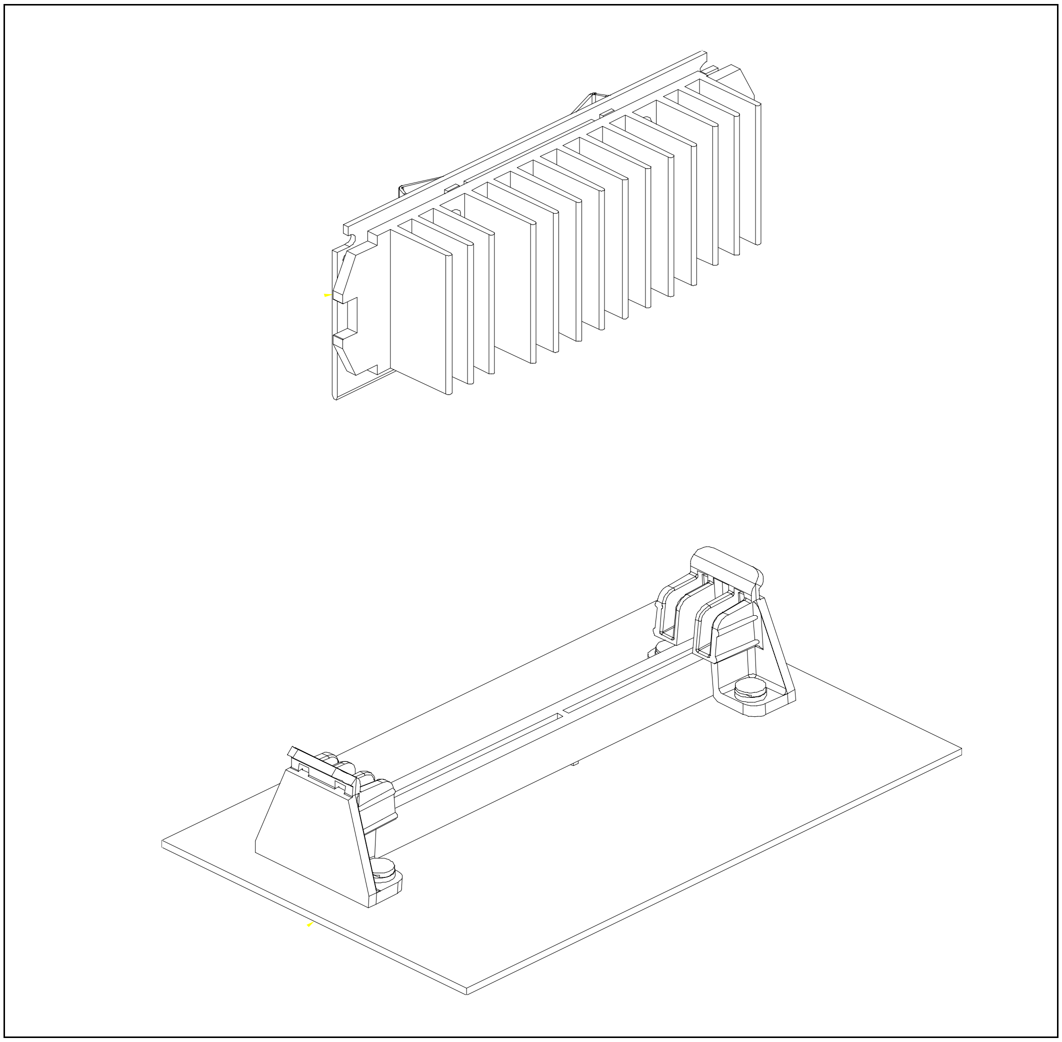
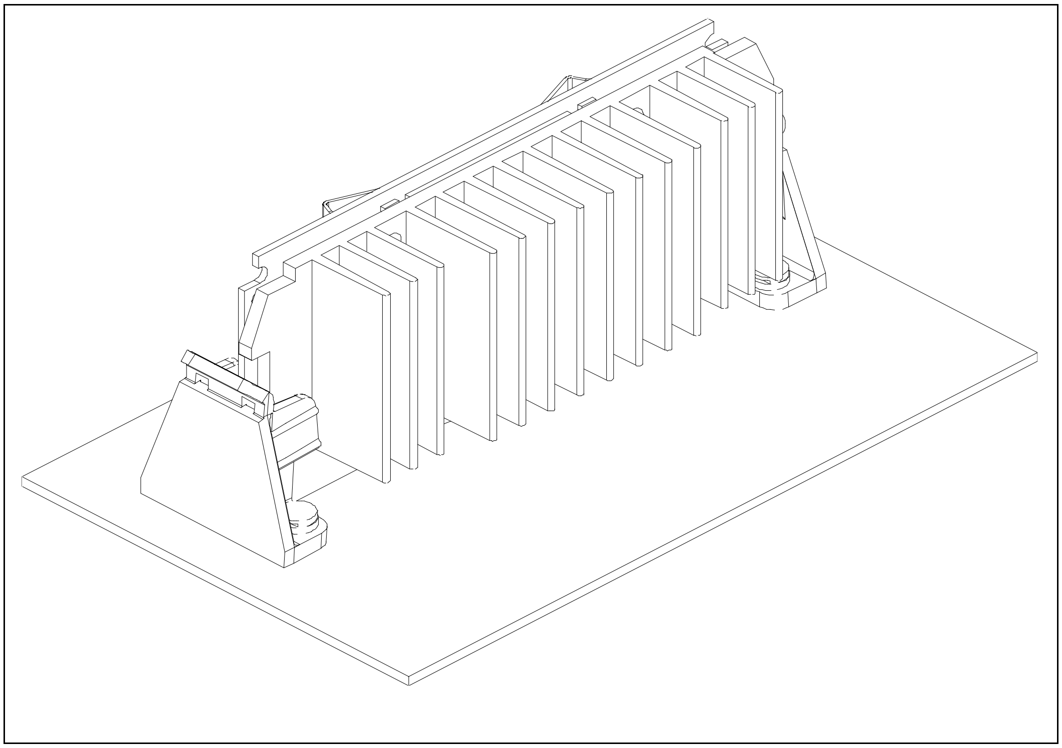


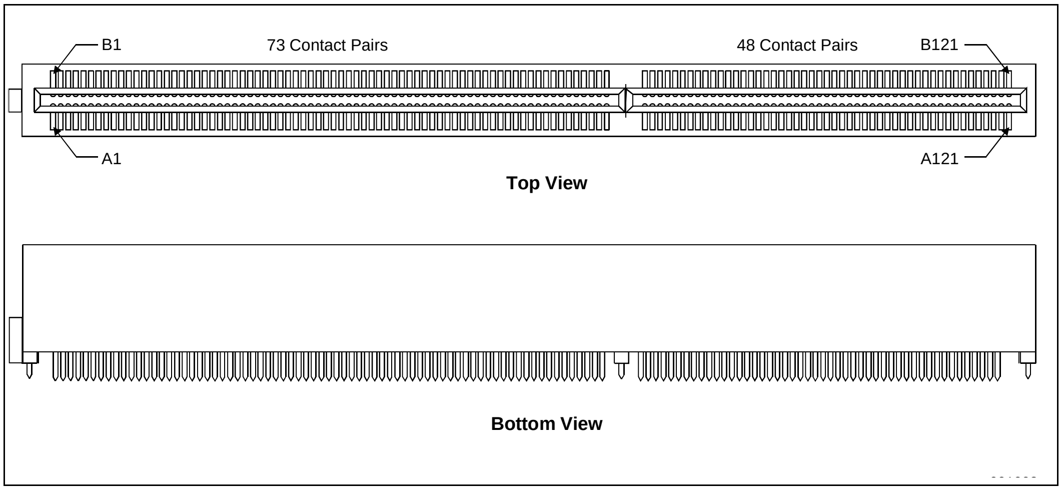
Figure 12. S.E.P. Package Installed in a Retention Mechanism (RM) with Plastic Fasteners



3.1 Slot 1 Connector

The Slot 1 connector (Figure 13) is a 242 contact, 1.0 mm pitch, edge connector intended for the S.E.C. cartridge and S.E.P. package technologies. The Slot 1 connector mounts on the motherboard and allows insertion and removal of the processor from the motherboard (see Figure 11 and Figure 12). Mechanical, electrical and other technical details of the Slot 1 connector can be found in the *Slot 1 Connector Guidelines*, as located on the Intel website.

Figure 13. Slot 1 Connector



3.1.1 Other Connector Form Factors: Restrictions and Requirements

The Slot 1 connector is only one of the possible connector solutions for the S.E.P. package. Any other solution for providing the electro-mechanical connection between the processor and the motherboard must meet the processor specifications as defined in the *Intel Celeron*™ *Processor at 266MHz and 300MHz Datasheet*.

3.2 Retention Mechanism

3.2.1 Retention Mechanism Mechanical Description

The retention mechanism (RM) holds the S.E.P. package in the Slot 1 connector during mechanical shock and vibration. The RM is symmetrical; identical parts can be installed at either end of the Slot 1 connector to receive the S.E.P. package. The RM comes in two styles described in the next two sections. The Plastic Fastener RM uses push pin plastic fasteners which uses a push/pry assembly/disassembly process. The Captive Fastener RM utilizes the Retention Mechanism Attach Mount (RMAM) and a Phillips screwdriver assembly and disassembly process.

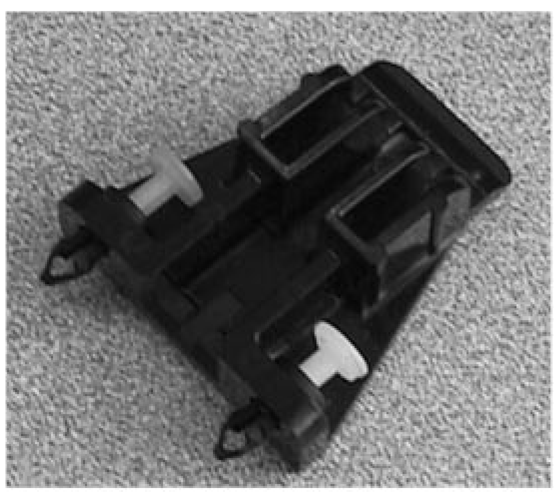
Correct orientation of the S.E.P. package is achieved when the 'substrate key' and the Slot 1 connector key are engaged. The RM also aids in processor alignment to the Slot 1 connector during insertion of the processor.

The S.E.C. cartridge uses the cartridge latch to lock in with the RM, while the S.E.P. package relies on heatsink notch features for RM engagement. The RM contains draft angles, lead-ins and chamfers for smooth travel of the processor down the RM posts and into the connector.

3.2.2 S.E.P. Package only Retention Mechanism with Plastic Fastener Description

The retention mechanism with plastic fasteners comes in as an assembly (Figure 14). The total part count for one complete retention mechanism assembly is six: two retention mechanism's and four plastic fastener assemblies.

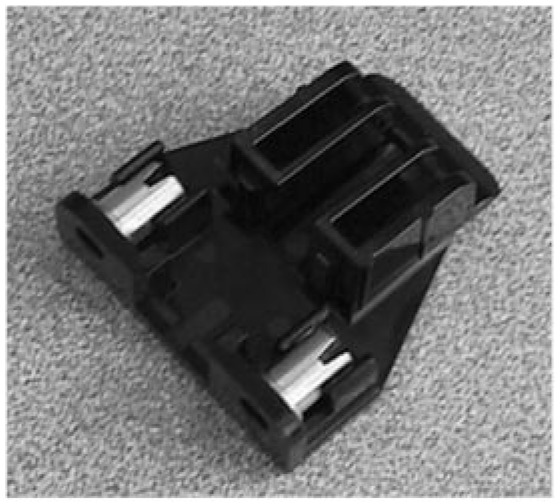
Figure 14. S.E.P. Package Only Retention Mechanism with Plastic Fastener



3.2.3 S.E.P. Package only Retention Mechanism with Captive Fasteners Description

The captive fastener version of the retention mechanism comes as an assembly with two brass captive nuts installed into integral clip features on the RM (Figure 15). The total part count for one complete retention mechanism assembly is four (two retention mechanisms with two captive nuts each and two retention mechanism attach mounts).

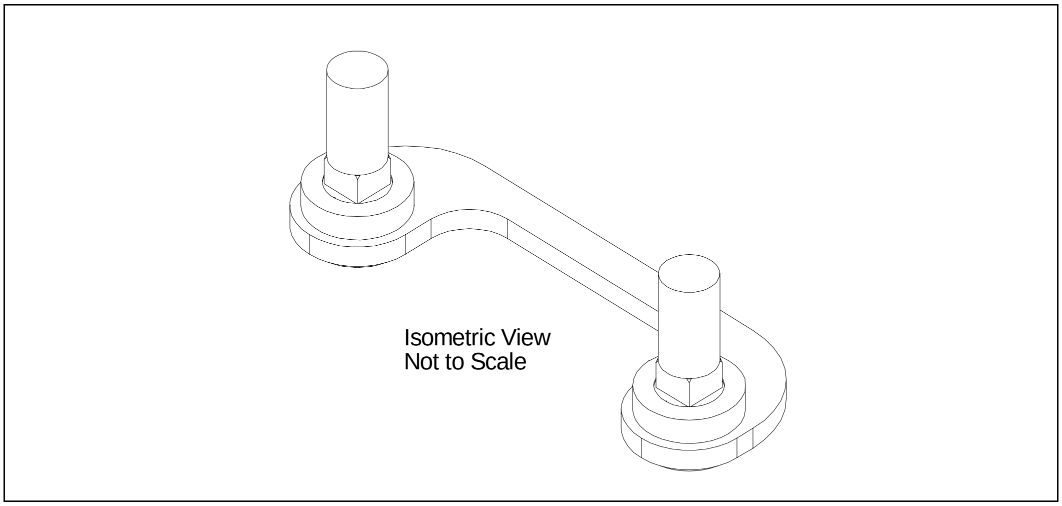
Figure 15. S.E.P. Package Only Retention Mechanism with Captive Fastener



3.2.4 Mechanical Retention Mechanism Attach Mount

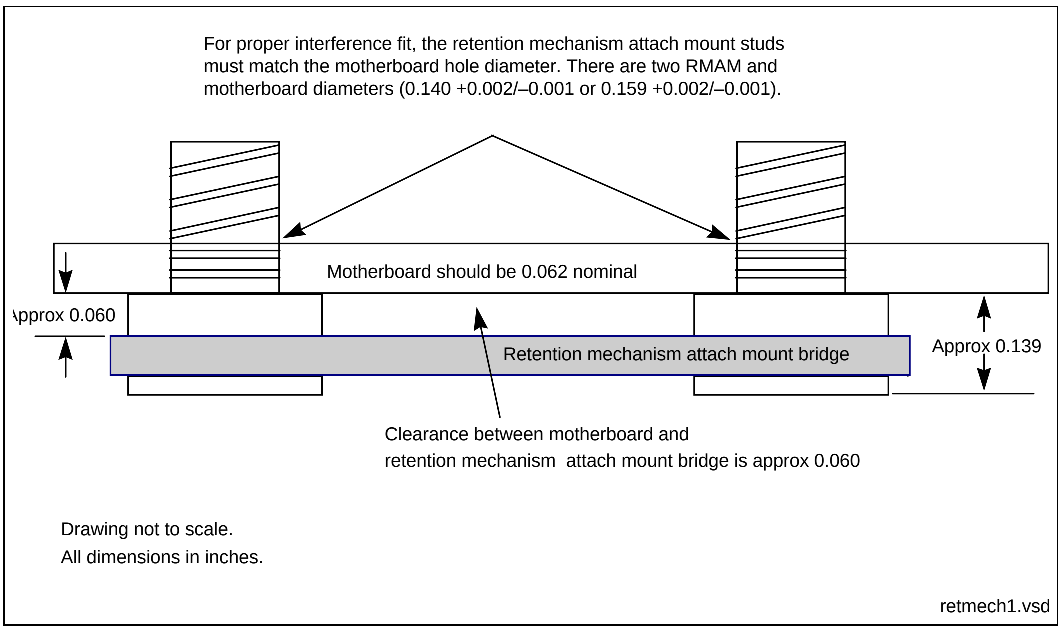
The Retention Mechanism Attach Mount (RMAM) is a small assembly that is part of the mechanical support pieces for RM attachment to the motherboard (see Figure 16). The RMAM holds the retention mechanism to the motherboard using the captured nuts on the retention mechanism. The RMAM requires approximately 44 lbs-f to insert into the motherboard. The RMAM studs are threaded and are fabricated from brass, and the bridge is molded plastic. The RMAM is designed to be inserted from the bottom of the motherboard. See the *Mechanical Support Pieces for SEC Cartridge Processors* for further mechanical details of the RMAM that are not presented here. (see Figure 17 which provides details on RMAM and motherboard interaction, providing depths underneath the motherboard itself).

Figure 16. Retention Mechanism Attach Mount Assembly



Note: RMAM studs are threaded for use with the RM captured nuts.

Figure 17. Retention Mechanism Attach Mount Motherboard Interaction Details



Note: The area underneath the retention mechanism attach mount bridge can be used for routing and traces, but should be considered a keepout zone for components.

Note: The trace keepout for all layers around the holes should be 0.350 inch diameter.

4.0 Motherboard Integration Manufacturing Guidelines

The S.E.P. package and enabling mechanism (RM) introduce manufacturing concerns and issues that differ from the S.E.C. cartridge and previous generations. It is important to understand the impact to manufacturing for each of these parts. All parts are recommended as a robust solution for the S.E.P. package.

This section addresses issues surrounding motherboard manufacturing and preparation. Section 5.0 addresses issues surrounding system integration. At each step, manufacturing information and third party contacts for specific manufacturing tooling and hardware will be provided when available.

Utilizing the S.E.P. package technology requires manufacturing steps which are different from traditional OEM motherboard and systems manufacturing. The S.E.P. package requires a Slot 1 connector and retention mechanism option (plastic fastener). The heatsink assembly for the S.E.P. package may be attached using a special fixture or by a manual process. Motherboard and systems manufacturing should carefully evaluate the integration of the processor and mechanical support pieces with respect to the manufacturing environment.

4.1 Introduction and Suggested Integration Flow

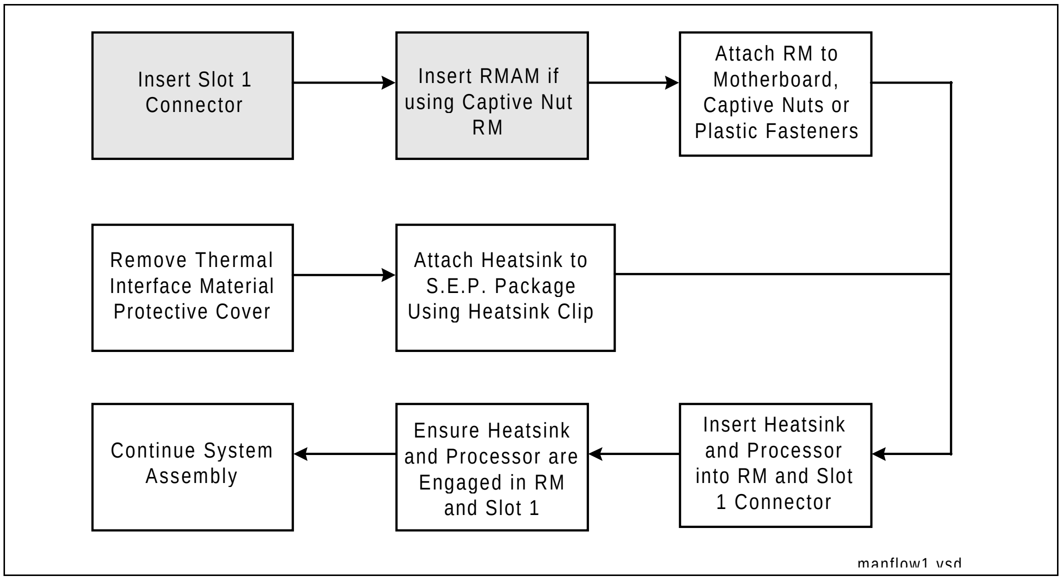
Table 2 and Figure 18 provide the overall list of materials and suggested manufacturing flow for the integration of the S.E.P. package (and RM) into the motherboard and system manufacturing flow. Motherboard related items highlighted in each are covered in this section. The other materials and manufacturing steps are covered in Section 5.0, “System Integration Manufacturing Guidelines” on page 23.

As shown in Figure 18, it is recommended to perform Slot 1 connector installation and RMAM (if applicable) mounting during the motherboard manufacturing process. The Slot 1 connector mounts similar to other edge connectors (PCI, ISA, AGP), but has specific requirements to ensure correct integration with the other MSP. The RMAM is a bottom-side integration piece; a specific press is available for high volume manufacturing environments.

Table 2. Intel® Celeron™ Processor Enabled Mechanical Solution and Materials List

Assembly Type	Quantity per Board and System
Board Assembly	
Slot 1 Connector	1
Retention Mechanism Attach Mount (if using an S.E.P. Package retention mechanism with Captive Fasteners)	2
System Assembly	
Heatsink	1
Thermal Interface (Chomerics 70-10)	1
Heatsink Clip	1
Retention Mechanism	2

Figure 18. Suggested Motherboard/System Integration Manufacturing Flow (Bolded Boxes Covered in this Section)



4.1.1 Recommended Slot 1 Connector Insertion Steps and Requirements

Note: Only use Slot 1 connectors which are stored correctly in the supplier packaging. It is not recommended to use components which are loose or stacked without completely inspecting the component leads for alignment.

1. Pick the Slot 1 connectors, one at a time, from the supplier packaging and ensure that no contact is made with the lead area of the component. Supplier packaging should be placed on the line so the retention features do not rest on the packaging material.
2. Place the Slot 1 connectors on the board so that all the leads are within their corresponding PTH (Plated Through Hole) using the retention features as a guide, and allow it to rest on the retention feature before the application of any insertion force.
3. Ensure that the Slot 1 connector stands vertically, that is, does not tend to lean to one side or another and sit evenly on the board, (if this happens, remove the Slot 1 connector and inspect the lead alignment). Note: Depending on the vendor, the Slot 1 connector may not stand vertically and will have to be held in place by hand.
4. Apply uniform insertion force to 2 positions on the Slot 1 connector (1/3 and 2/3 along the length of the component). Ensure that the Slot 1 connector enters the board smoothly. An operator can listen for the sound of a lead bending on the substrate.

Figure 19. Slot 1 Connector, Retention Features Highlighted

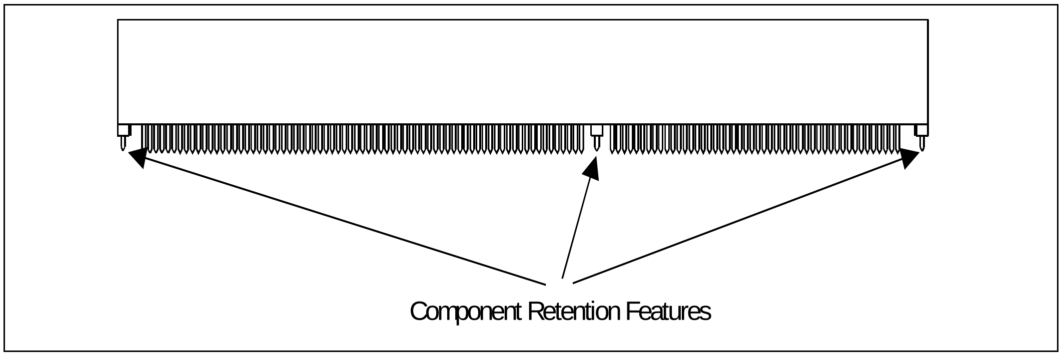


Figure 20. Slot 1 Connector Mounted in Motherboard

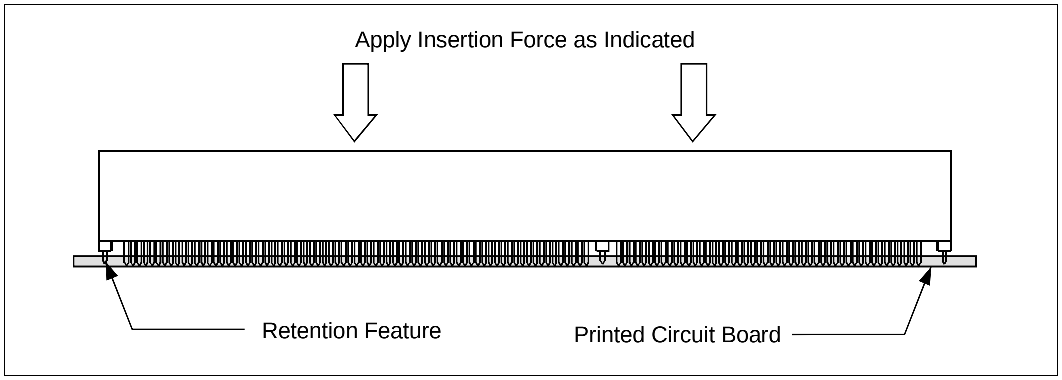


Figure 21. Recommended Process Capability to Ensure Correct Interaction of S.E.P. Package and Mechanical Support Pieces

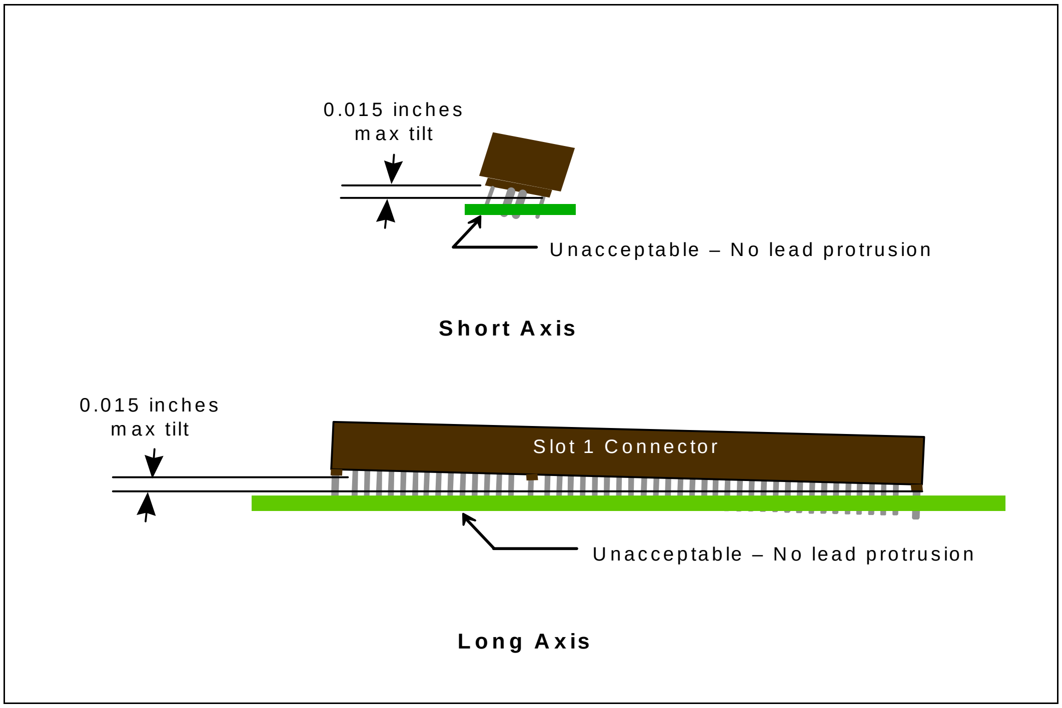
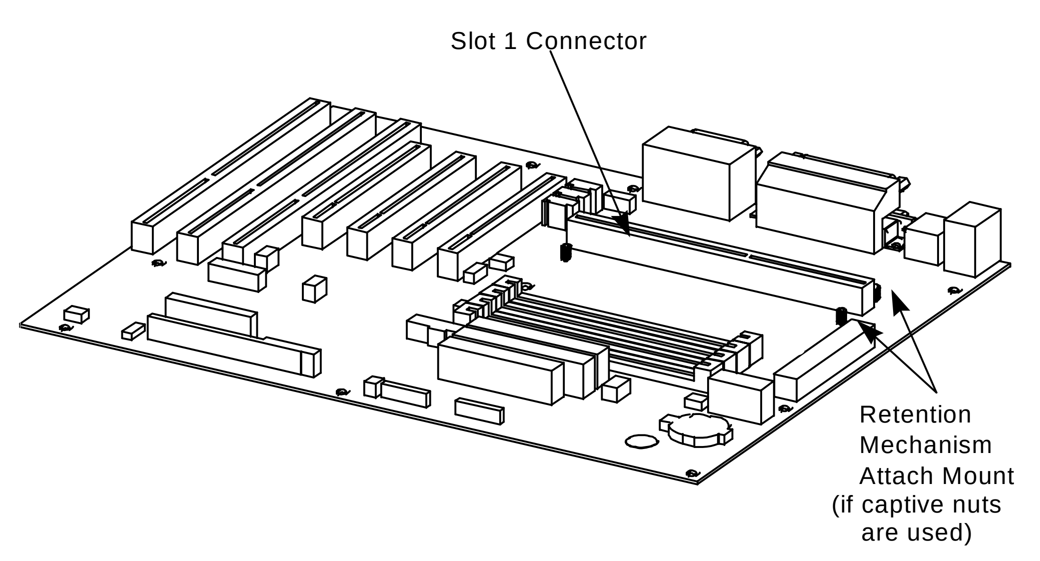


Figure 22. ATX Motherboard with Slot 1 Connector and RMAM (for captive nuts only) Installed



4.2 Retention Mechanism Attach Mount Installation

For the RMAM to work correctly, the attach mount stud must be fully inserted into the motherboard with a snug fit. The attach mount stud must be straight (normal or perpendicular) to the motherboard for purposes of attaching Retention Module. Figure 24 shows a motherboard with Slot 1 connector and RMAM installed. Figure 23 and Figure 24 show detail of the installed RMAM.

4.2.1 Attach Mount Assembly Criteria

The RMAM studs should be protruding through the board on the top side as in, Figure 22, Figure 23, and Figure 24. The RMAM studs are designed to contact the motherboard hole in four locations in the hole, rather than around the entire circumference of the motherboard itself. There should be no cracking of the laminate around the holes through which the attach mount studs protrude. Cracks will typically be emanating radially from the hole edges. Cracks would occur due to an incorrect assembly that uses either too much force, incorrectly aligned studs, incorrectly sized holes in motherboard or incorrectly manufactured RMAM.

Figure 23. Attach Mount Installed in Motherboard

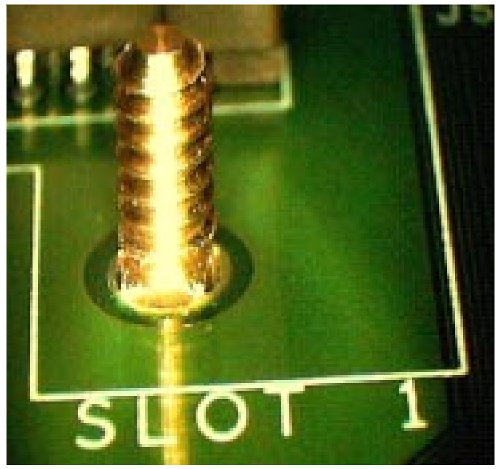
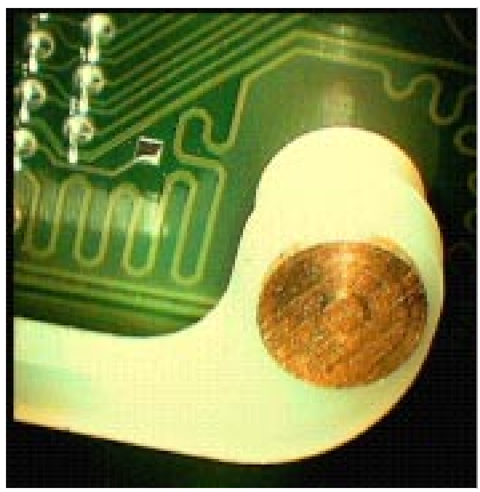


Figure 24. Attach Mount Installed in Motherboard, Bottom View



4.2.1.1 HVM Enabled Procedures and Equipment for RMAM installation

Intel has enabled a set of machinery for efficient installation of the RMAM in High Volume Manufacturing (HVM) environments. The machinery is a press which performs the insertion of the RMAM into the motherboard, from the bottom side. The machine is pneumatically driven, and requires motherboard specific fixtures to properly hold the motherboard and RMAM. The machine can also be used to rework (i.e., remove) an incorrectly processed RMAM. The *Pentium® II Processor Suppliers Guide*, provides a list of suppliers for equipment for HVM presses, and fixtures.

5.0 System Integration Manufacturing Guidelines

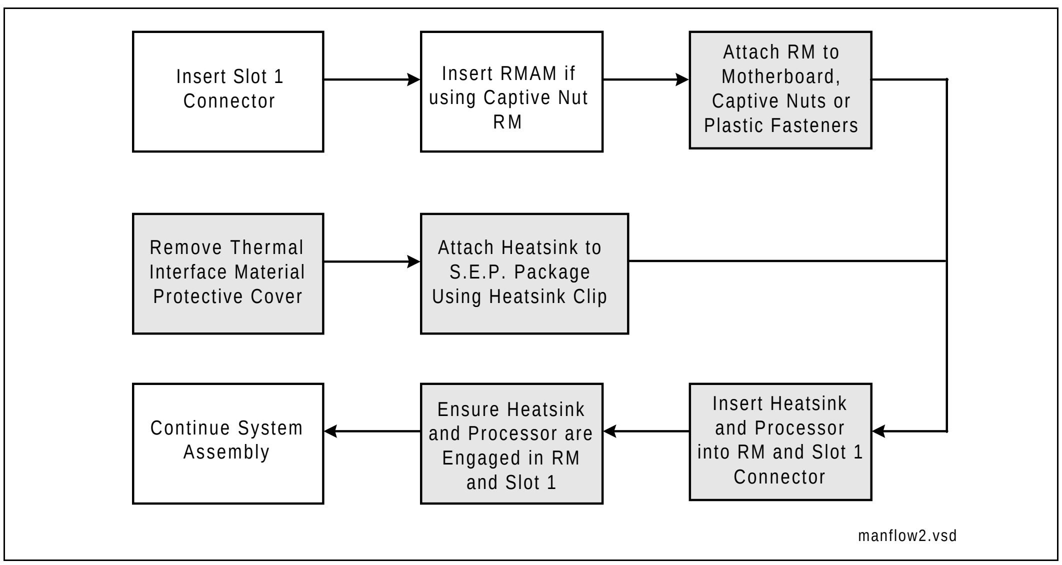
5.1 Introduction and Suggested Integration Flow

Table 3 and Figure 18 provide the overall list of materials, manufacturing flow for the integration of the S.E.P. package and RM into the motherboard, and system flow. System integration related items highlighted in each are covered in this section. The other materials and manufacturing steps are covered in Section 4.0, "Motherboard Integration Manufacturing Guidelines" on page 18.

Table 3. Intel® Celeron™ Processor Enabled Mechanical Solution and Materials List

Assembly Type	Quantity per Board and System
Board Assembly	
Slot 1 Connector	1
Retention Mechanism Attach Mount	2
Retention Mechanism Attach Mount (if using an S.E.P. Package retention mechanism with Captive Fasteners)	
System Assembly	
Heatsink	1
Thermal Interface	1
Heatsink Clip	1
Retention Mechanism	2

Figure 25. Suggested Motherboard/System Integration Manufacturing Flow (Bolded Boxes Covered in this Subsection)



5.2 Heatsink Attachment to the Substrate

The S.E.P. package is enabled for heatsink clip attachment of thermal solutions only. Two methods for attaching the heatsink clip are described in this section, they are the manual-based technique and the tool-fixture-based technique. The required parts for either process are the S.E.P. package, the heatsink clip and the heatsink. The environmental requirements are that all parts are placed on static free bench using proper operator grounding and ESD mat. Thermal solutions must provide adequate thermal conduction paths to remove the heat generated by the processor and dissipate that heat into the system environment. The system environment must then ensure adequate overall circulation to properly cool the processor and other internal components

5.2.1 Manual Heatsink Attachment Method

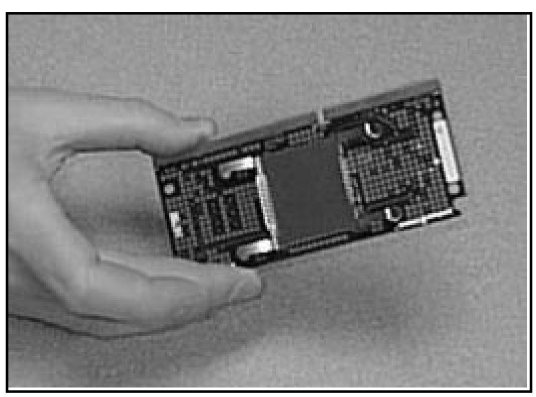
Note: Figure 26 through Figure 30 are shown for illustration purpose only. The operator should always exercise proper handling procedures and wear protective gloves. Do NOT touch the Edge Fingers.

The process for installing the heatsink manually is depicted in the Figure 26 through Figure 30.

1. Carefully insert all four heatsink clip legs into S.E.P. package (Figure 26). Note that the clip base must be located on the non-primary side (Figure 27)

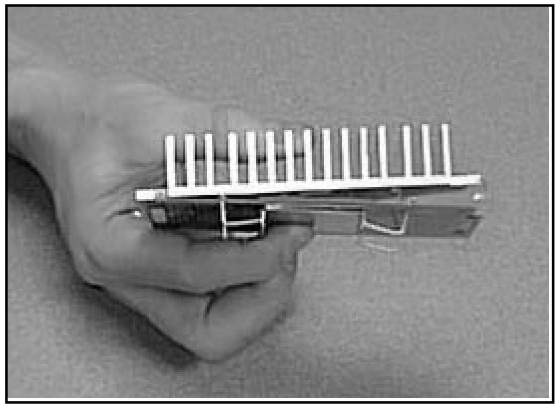
Figure 26. Insert Heatsink Clip Legs

Figure 27. Clip Base on Secondary (Non-Primary) Side



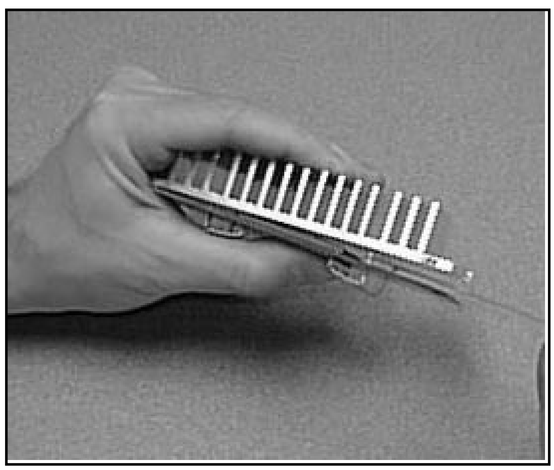
2. Fully engage two legs of the clip into the heatsink (Figure 27).

Figure 28. Engage Two Legs of the Clip into Heatsink



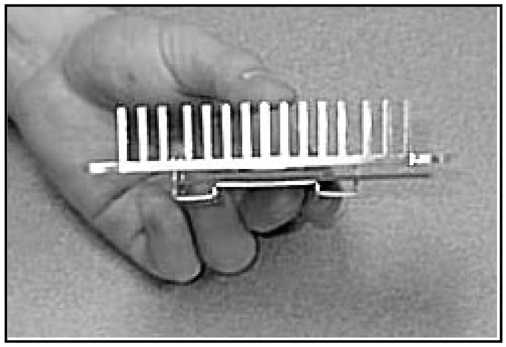
3. Grasp the heatsink clip assembly between the clip base and the heatsink (Figure 28). Do not bend or apply pressure directly to S.E.P. package.
4. Using a nonmetallic bar stock or screw driver, push the remaining two clip legs into the heatsink (Figure 29). Caution: Take care not to contact passives or scratch S.E.P. package when using screw driver or bar stock.

Figure 29. Grasp Heatsink Clip Assembly Between Clip Base and Heatsink



5. Verify that all the feet on the clip are fully engaged and seated on the heatsink (Figure 30).

Figure 30. Verify All Feet Are Fully Engaged



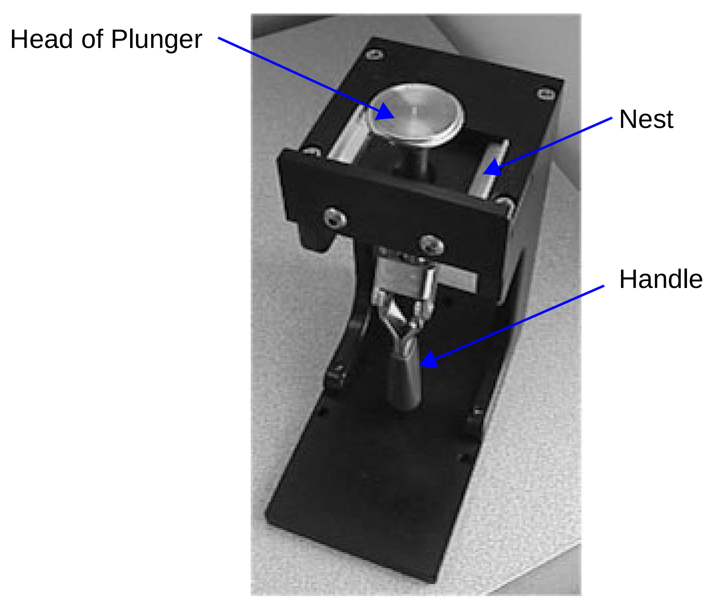
Reverse the process steps to remove the clip from the S.E.P. package.

5.2.2 HVM Enabled Procedures and Equipment for Production Heatsink Attachment

Intel has enabled a fixture for efficient heatsink and clip attachment to the S.E.P. package in High Volume Manufacturing (HVM) environments. The machine installs the four legs of the heatsink clip simultaneously, reducing the overall time for heatsink installation. Through the actuation of a lever, the machine applies force to the heatsink clip in such a way that the S.E.P. package and heatsink can be lowered down onto the legs in a top-down fashion. When the lever is released the clip legs relax and the assembly is ready to be installed onto the motherboard. Note that this equipment can be automated if high volume production requires higher throughput.

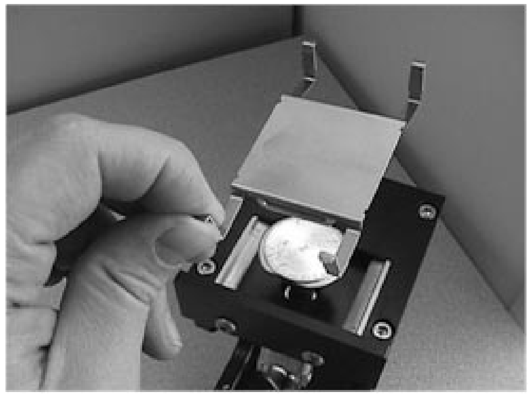
1. Lower the handle of the fixture. Raising the head of the plunger above the nest.

Figure 31. HVM Heatsink Attachment Fixture



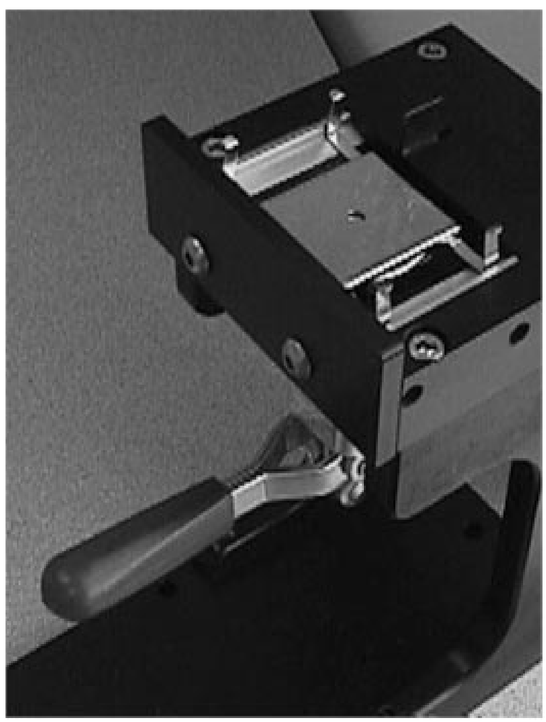
2. Place a clip on the head of the plunger with the “legs” of the clip pointing to the front and rear of the fixture. Rotate the clip 90^{o} securing the clip on the plunger head. The clip has a mylar backing – Do NOT remove the mylar backing. The clip seats against the S.E.P package substrate. If there is no mylar backing, an electrical short condition could arise when the metal clip makes contact with traces.

Figure 32. Place Clip on Fixture



3. Raise the handle of the fixture lowering the clip into the nest. This action pushes the legs together and allows the S.E.P. package and the heatsink to easily fit onto the clip
4. Slip the S.E.P. package over the legs of the clip. A slight rocking motion maybe required.

Figure 33. Clip Rotated and Lowered into Nest



5. Apply thermal interface material on core package. Note: skip to step #6 if thermal interface material is provided with the heatsink.
6. Slip the heatsink over the legs of the heatsink clip. Note: If the thermal interface material is attached to the heatsink, remove any protective backing to expose the interface material. Ensure that a thermal interface has been applied before you assemble the heatsink.

Figure 34. S.E.P. Package Placed Over Clip Legs

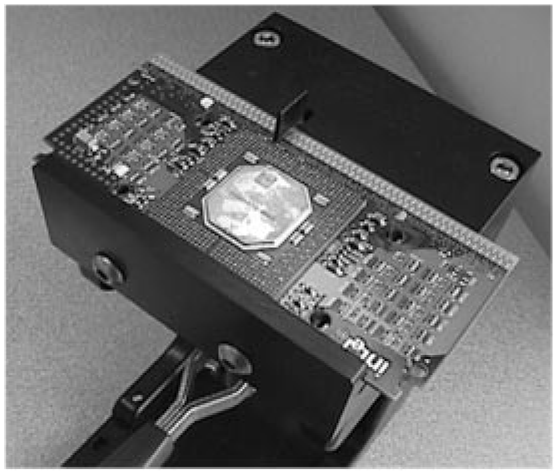


Figure 35. Heatsink Placed Over Clip Legs

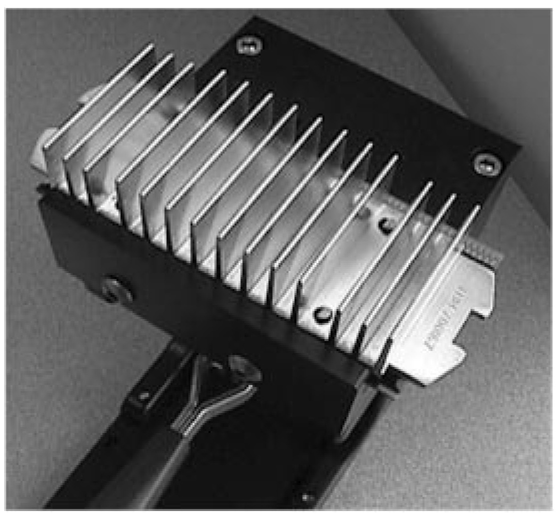
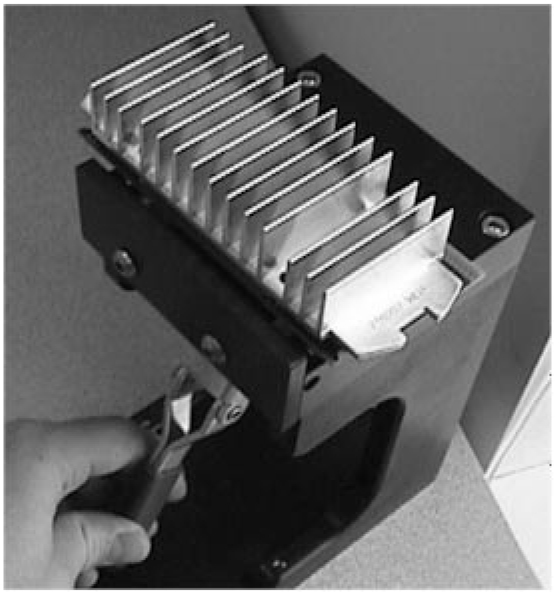


Figure 36. Lower Handle to Raise Plunger and Assembly

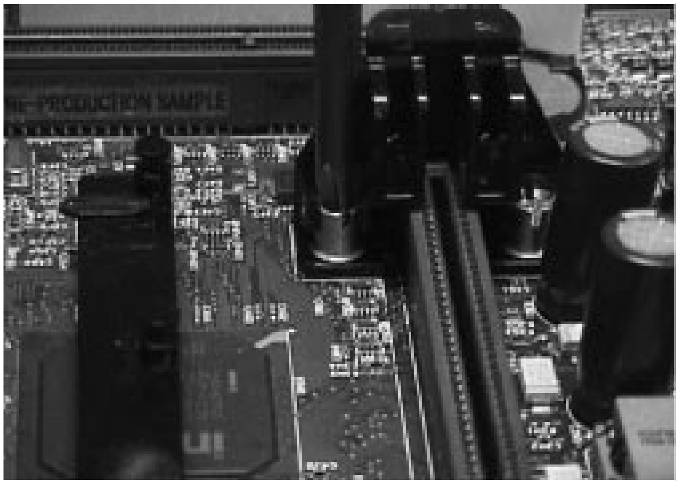


7. Lower the handle of the fixture, raising the head of the plunger and the finished assembly above the nest. Rotate the assembly 90^o to remove it from the plunger.

5.2.3 Manual Installation of the Captive Fastener Retention Mechanism

To install the captive fastener RM simply orient the RM at either end of the Slot 1 connector. The parts are symmetrical and fit either end of the connector. Using a Phillips screw driver rotate each of the four captive nuts in a clockwise direction while pushing down slightly to start the thread engagement (see Figure 37). Tighten to 6 psi. Do not over-tighten as damage to the brass nuts could occur.

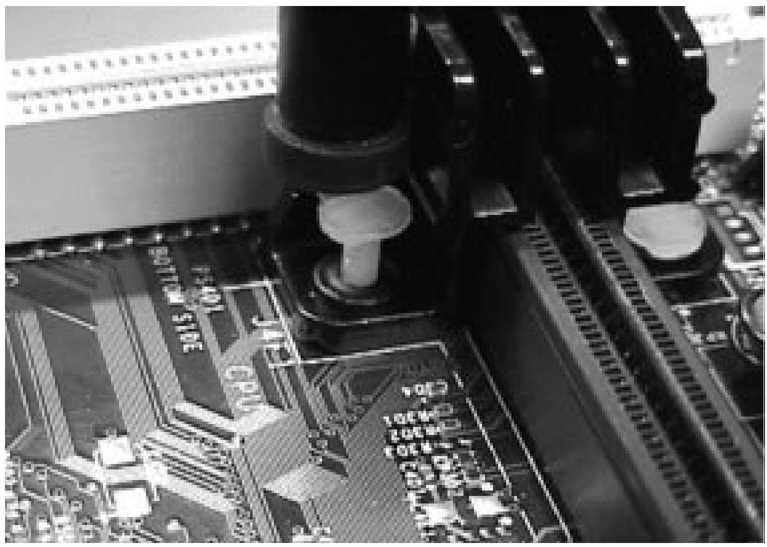
Figure 37. Manual Installation of Captive Nut Fastener



5.2.4 Manual Installation of the Plastic Fastener Retention Mechanism

Prepare the RM's by first inserting the plastic fastener assemblies into each of the four holes. Be sure that the white plastic pins are raised up from the black plastic component of the push-pin assembly, otherwise it may be difficult to insert the assembly into the motherboard hole. Next install the RM's onto the motherboard at both ends of the Slot 1 connector. Using the push-end of the insertion/removal tool apply a slight down ward force until the white plastic component of the push-pin is seated all the way down against the assembly (as shown in Figure 38). Repeat this process for all four of the pins.

Figure 38. Manual Installation of Plastic Fastener



5.2.5 Insertion of S.E.P. Package

Align the notch of the processor substrate with the notch on the Slot 1 connector. Insert the heatsink and substrate into the guide rails along the retention mechanism making sure to install the heatsink into the retention mechanism and the processor substrate into the Slot 1 connector. Press firmly (but not with excessive force) on the top of the heatsink until you hear a click as the retention mechanism pops back, firmly locking the processor into the Slot 1 connector. Do not bend the processor package.

5.2.6 Other System and Motherboard Assembly Issues

For some chassis designs (e.g., ATX), the S.E.P. package may need to be inserted into the Slot 1 connector before the motherboard is assembled into the chassis. Also, the power supply unit (PSU) may need to be installed after the motherboard in placed into the chassis. It is important to ensure adequate distance is allowed between the S.E.P. package and the PSU during installation, removal and shock/vibration environmental testing. Also, the memory modules (SIMMs or DIMMs) may need to be inserted before the S.E.P. package; the spacing between the heatsink support base and memory modules should be evaluated. These types of issues should be addressed as the S.E.P. package processor is evaluated for introduction to the manufacturing flow.

5.3 Removal of S.E.P. Package and Mechanical Support Pieces

Once installed, it is possible to disassemble the processor and retention components. It is recommended to follow the correct procedure as outlined in this section. Improper use of force or effort can damage the processor, enabling components or motherboard. Pushing on the motherboard or components during processor removal can cause damage.

The first step is to remove the S.E.P. package and heatsink assembly. The second and last step of disassembly is to remove the RM posts. How these posts are removed is determined by which type of post is used—captive fastener type or plastic fastener type.

5.3.1 Removal of the S.E.P. Package

To remove the S.E.P. package grasp the processor substrate/heatsink assembly by the heatsink. Apply pressure on the tab of one RM post while pulling up on one end of the S.E.P. package and heatsink assembly (See Figure 39). It is very important to only work on one end of the processor. With sufficient force the RM post should release the S.E.P. package assembly (see Figure 40). Once one end of the processor is free from the RM it will be possible to rotate that end up and out of the connector and RM.

Note: The retention mechanisms provide firm mechanical support for the processor. If you find that considerable force is required to remove the processor, consider wearing gloves to protect your hands and take care to keep your hands away from any metal edges on the chassis and processor package when de-installing the processor from the retention mechanisms. Loosening or removing one of the retention mechanisms greatly reduces the force required to remove the processor. See Section 5.3.2 and Section 5.3.3 for removal instructions.

Figure 39. Removing S.E.P. Package from RM

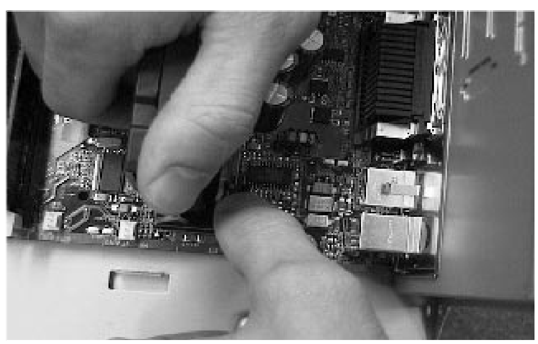
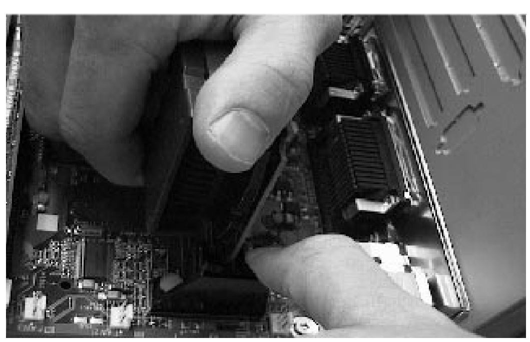


Figure 40. Rotate the S.E.P. Package Out of the Slot 1 Connector



5.3.2 Removal of the Captive Fastener Retention Mechanism

The removal of the Captive Fastener RM is the exact reverse of the installation process. Simply use a Phillips screw driver in a counter-clockwise direction on each of the four captive nuts. See the assembly section for details.

5.3.3 Removal of the Plastic Fastener Retention Mechanism

To increase the ease of disassembly, a tool has been developed to assist in the manual removal, as well as insertion, of the plastic pin fasteners. This tool is shown in Figure 41. Simply slide the forked head under the pin, pull up gently, and rotate the pin up as show in through Figure 42. Avoid touching the motherboard with the extraction tool so as not to damage any components or traces. Once the pins are raised, the RM can be removed (see Figure 45). The push pins and plastic fastener sleeve are not meant to be reused.

If no tool is available, removal of the motherboard from the chassis may be required. Once the motherboard is removed and while viewing the underside of the motherboard, use the tip of a ballpoint pen or other tool to carefully push the bottom of the white pin insert out of the black plastic fastener sleeve. Once the white insert pins are removed, carefully push the black sleeve portion of the fastener out of the motherboard to free the retention mechanism

Figure 41. Plastic Fastener Installation/Extraction Tool

Figure 42. Slide Head Under Pin

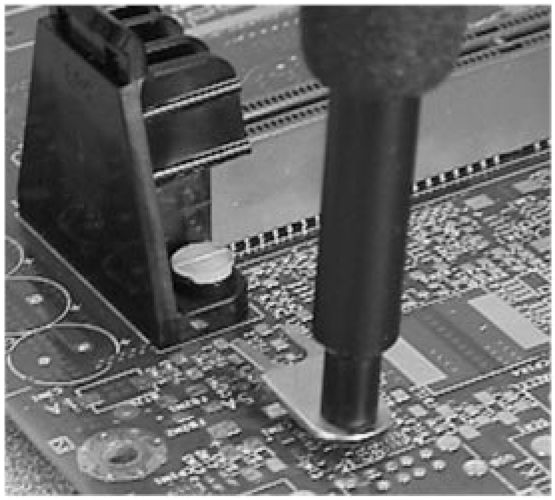


Figure 43. Pull Up Gently

Figure 44. Rotate Up

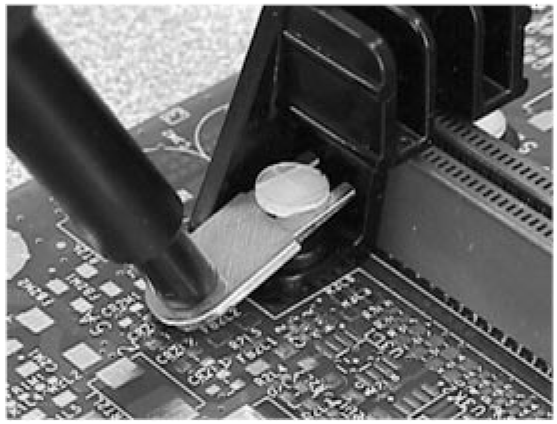
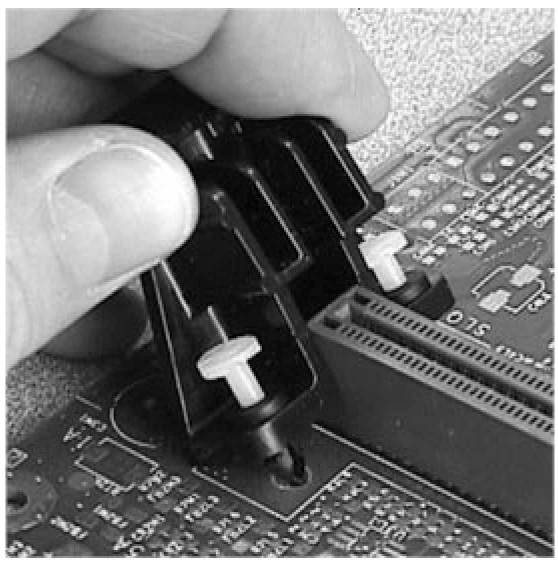


Figure 45. Removing RM with Plastic Fasteners



5.4 Reuse of Processor and Enabling Components

The processor and mechanical support pieces are robust components, meant for use in PC OEM manufacturing and system environments. The processor is “reusable” within the specification limits defined in the Intel Celeron™ processor at 266 MHz and 300 MHz datasheet (order number 243658). The mechanical support pieces can be removed from the motherboard as described above. Removal, though, is NOT recommended for the Slot 1 connector and RMAM. Each of these pieces interacts with the motherboard material and could damage the board if removed incorrectly. Also, if removed and intended to be reused within specification limits, each mechanical piece should receive a thorough inspection to ensure mechanical integrity.

6.0 Boxed Intel® Celeron™ Processor Integration Guidelines

The Intel Celeron processor is also offered as a boxed processor. The term “boxed processor” refers to processors specifically designed and packaged for system integrators, who use off-the-shelf system components to assemble personal computer systems. System integrators use varied combinations of chassis, power supplies, motherboard form factors, and peripherals. This provides for a wide variety of thermal environments in which the processor must operate within thermal specifications. For this reason, boxed processors include an appropriate cooling solution. The boxed Intel Celeron processor includes an attached active fan heatsink. Boxed processors also come with installation instructions and any necessary hardware.

6.1 Boxed Processor Fan Heatsink

For the boxed Intel Celeron processor, the fan heatsink is already attached to the processor before the unit is shipped, using a high quality thermal grease and a metal clip. Specifications for the boxed Intel Celeron processor can be found in the *Intel® Celeron™ Processor at 266MHz and 300MHz Datasheet*.

The fan heatsink consists of two pieces: an extruded aluminum heatsink base and a plastic fan-shroud that attaches to the base. The shroud is made of a molded high grade plastic.

The fan heatsink requires clearance around the unit for proper airflow and cooling efficiency. The fan heatsink also requires the air-intake temperature to not exceed a specified limit, in order to keep the processor case below its maximum temperature. Clearance requirements and air-intake temperature requirements are defined in the *Intel® Celeron™ Processor at 266 MHz and 300 MHz Datasheet*.

6.2 Boxed Processor Fan Power Cable

The fan heatsink also requires power to drive the integrated fan to provide needed airflow. A fan power cable is included with the boxed Intel Celeron processor and connects the fan power connector to a power header on the motherboard. Specifications and location of the fan power header on the motherboard are defined in the *Intel® Celeron™ Processor at 266 MHz and 300 MHz Datasheet*.

6.3 Boxed Processor System Integration Manufacturing Guidelines

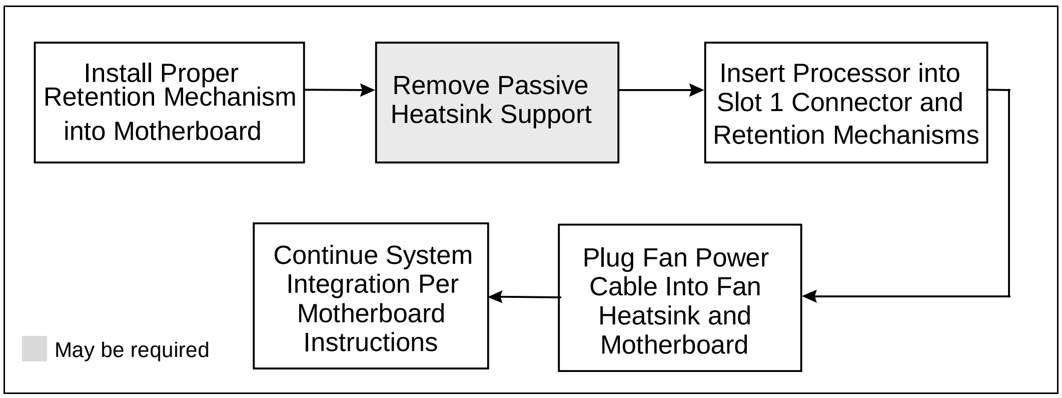
Table 4 and Figure 46 provide the overall list of materials and manufacturing flow for the integration of the boxed Intel Celeron processor and support pieces into the system manufacturing flow.

Table 4. Boxed Intel® Celeron™ Processor System Assembly and Material List

Assembly Type	Quantity Per System
System Assembly	
Processor with Attached Fan Heatsink	1
Fan Power Cable	1
Retention Mechanisms[1]	2 (Symmetrical)
Slot 1 Motherboard	1

NOTES:
1. Retention Mechanisms are not included with the boxed processor, and are supplied to system integrators by motherboard vendors with the motherboard products intended for system integrator use.

Figure 46. Suggested System Integration Manufacturing Flow



6.3.1 Pre-Installation Preparation

1. Be sure that the motherboard kit includes retention mechanisms that specifically support the Intel Celeron processor. Retention mechanisms designed only for the Pentium® II processor should not be used with the Intel Celeron processor as damage to the processor and motherboard may occur. Make sure that the motherboard kit includes instructions for installing the retention mechanisms.
2. Be sure that the boxed Intel Celeron processor kit includes:
   - One processor with fan heatsink attached
   - One power cable
3. Place the motherboard on an ESD workbench (not in a chassis). Be sure that the motherboard is bare (that is, no system memory, cables, or cards are installed). If the motherboard has an installed passive heatsink support, it may be left in the motherboard or removed if necessary, following the manufacturer's removal instructions.

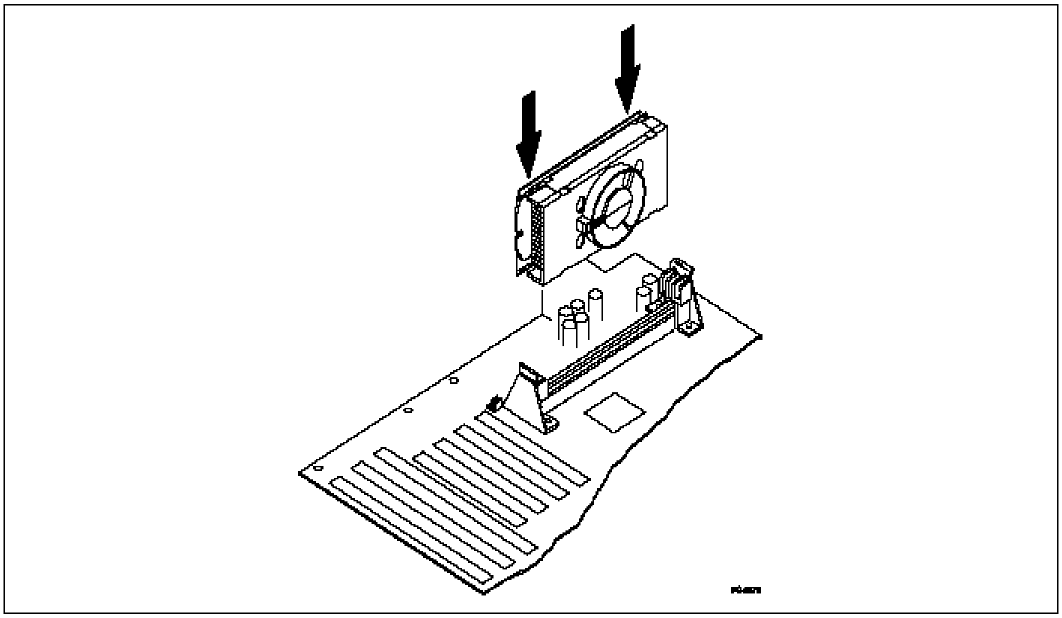
6.3.2 Motherboard Preparation – Installation of the Retention Mechanisms

Motherboards for system integrators should be shipped with retention mechanisms and include instructions on installing the retention mechanisms. Some Slot 1 motherboards may include retention mechanisms that support the Pentium II processor also. Make sure that the retention mechanisms being installed specifically support the Intel Celeron processor. Without proper mechanical support, the boxed Intel Celeron processor may be damaged, and the boxed processor warranty is void.

Follow the motherboard instructions for installation of the Intel Celeron processor retention mechanisms.

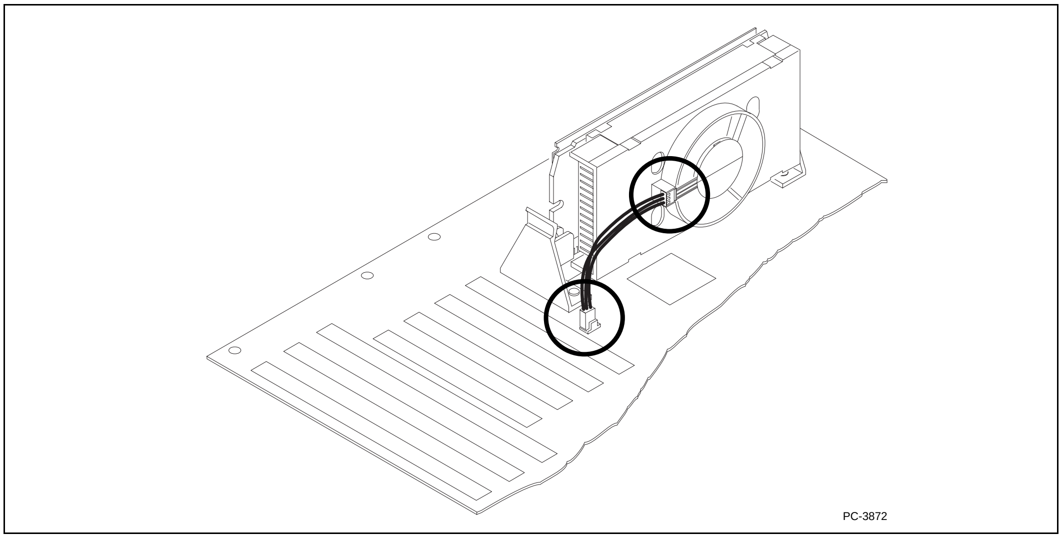
6.3.3 Installing the Boxed Processor

Figure 47. Inserting the Boxed Processor



1. Align the notch of the processor substrate with the notch on the Slot 1 connector. Install the processor into the Slot 1 processor connector by pressing firmly (but not with excessive force) on the top of the processor substrate and heatsink (See Figure 47). Make sure to install the heatsink into the retention mechanism and the processor substrate into the Slot 1 connector. Do not bend the processor package.

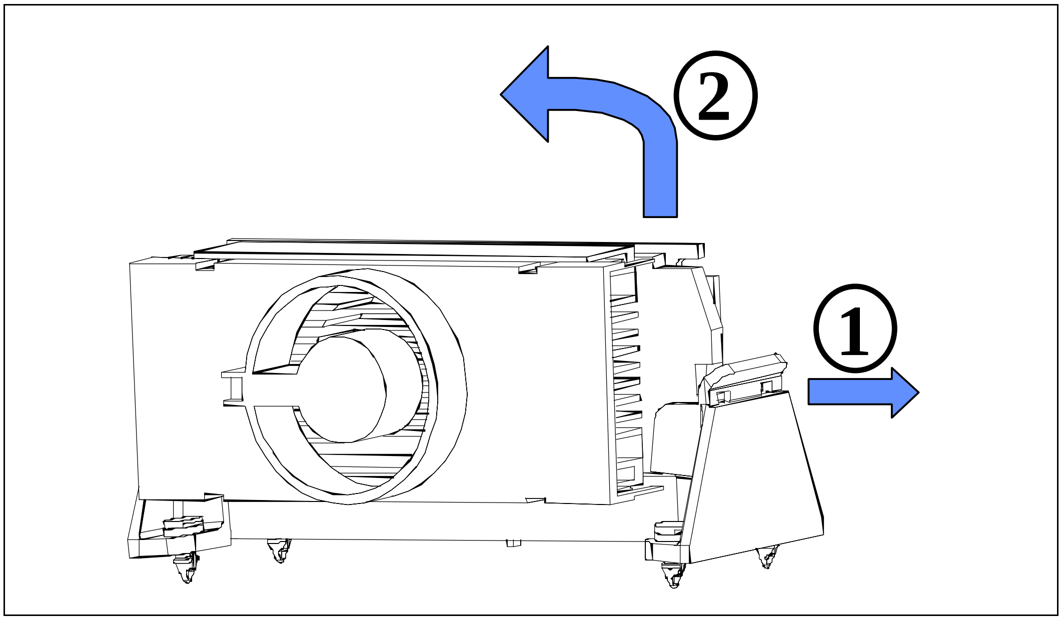
Figure 48. Connecting the Boxed Processor Fan Power Cable



2. Attach the small end of the fan power cable to the three-pin connector on the processor, and then attach the large end to the three-pin power header on the motherboard. Consult the motherboard documentation to determine the connector location.

6.3.4 Removing the Boxed Processor

Figure 49. Removing the Boxed Intel® Celeron™ Processor



Pull one retention mechanism away from the processor with one hand while rotating the processor out of the Slot 1 connector with the other (See Figure 49). The retention mechanisms provide firm mechanical support for the processor.

Note: If considerable force is required to remove the processor, consider wearing gloves for protection and take care to keep hands away from any metal edges on the chassis and processor package when de-installing the processor from the retention mechanisms. Loosening or removing one of the retention mechanisms greatly reduces the force required to remove the processor. To loosen retention mechanisms with brass captive fasteners, simply unscrew the nuts with a screwdriver. Removing retention mechanisms with plastic fasteners requires the removal of the motherboard from the chassis. Once the motherboard is removed and while viewing the underside of the motherboard, use the tip of a ballpoint pen or other tool to carefully push the bottom of the white pin insert out of the black plastic fastener sleeve. Once the white insert pins are removed, carefully push the black sleeve portion of the fastener out of the motherboard to free the retention mechanism. Do not reuse the push pins.

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