# Land Grid Array (LGA) Socket and Package Technology

## Handling, Inspection, & Integration Module

### Sept. 2009

# Disclaimer

# Introduction

In this document, Intel has integrated customer feedback and developed a reference process to serve as a manufacturing enabling solution.

This recommendation focuses on the key learning's from Intel reference process development

- **This document provides a baseline for customer manufacturing solution development. Manufacturing processes are unique, and may require unique solutions to ensure an acceptable level of quality, reliability, and manufacturing yield. Due to differences in equipment and materials, process parameter modifications may be required**

- **The differences between Intel's reference process and industry equipment capability must be considered for high volume manufacturing.**

- **While this document applies to LGA socket processing in general, Intel Manufacturing Advantage Service (MAS) documents for individual products should also be consulted, for potential product-specific process information. MAS documents for products take precedence over this document.**

Customers are responsible for

- **Developing and characterizing their manufacturing processes to ensure acceptable solder joint quality and reliability.**

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# Agenda

## Component Level

### LGA Socket Technology Overview
### LGA Package Technology Overview
### LGA Technology: LGA771 vs. LGA775

## Handling & System Integration

### Socket Handling Overview & Recommendations
### Socket Preparation, Package Insertion, Package Removal
### TIM Application & Removal
### Visual Inspection: Contact Damage & Inspection Flow

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# LGA Socket Technology Overview:
## LGA Socket Features

Contact Array
- **Metal contacts**
- **Susceptible to mechanical damage**

Load Plate
- **Distributes uniform load to LGA, ensuring electrical connection between package pads and socket contacts**
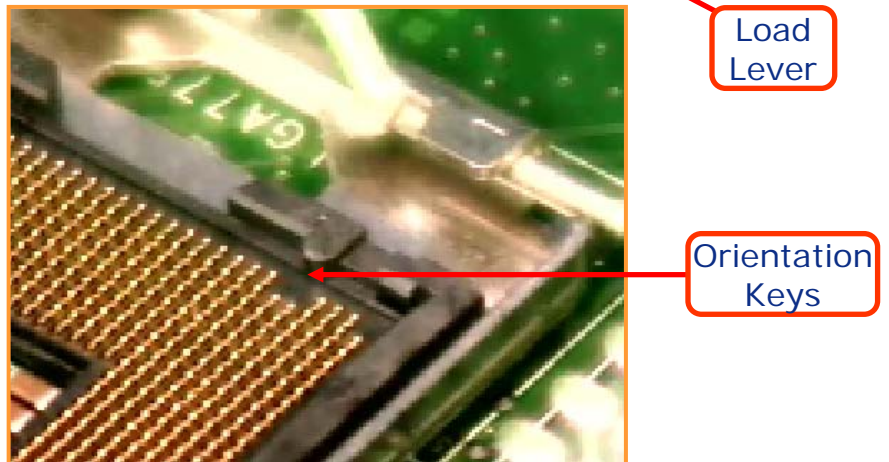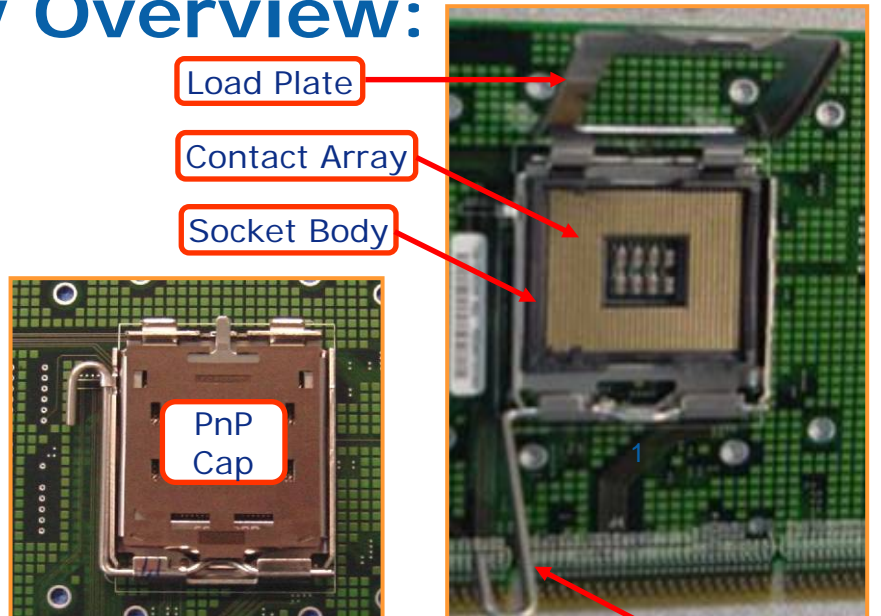
Load Lever

Socket Body
- **Integral to the DSL mechanism**
- **Contains package orientation keys**
- **Not removable**
- **Aligns the package**
- **Finger cutouts**

Pick and Place (PnP) Cap
- **Protects socket contacts**
- **Varies according to supplier**



Load Plate

Contact Array

Socket Body

PnP Cap

Load Lever

Orientation Keys

**Pictures for illustration only**

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# LGA Package Technology Overview:

## LGA Package & Shipping Media

### Key Attributes

- **37.5 x 37.5-mm package**

- **Stepped Integrated Heat Sink (IHS) for socket Load Plate interface**

- **Land Grid Array (no pins, exposed land pads), gold pads**

- **Notched substrate for orientation control**

- **Shipping Media: Thermoformed trays**

- **Land Side Cover (LSC) to protect LGA package land pads from scratches and contamination when handled with vacuum wand hand**

**Note:** LGA packages dropped with or without the land side cover should be scrapped.



Substrate

Stepped IHS



Orientation Notch

Capacitors

Gold Pads

**Avoid touching gold pads!**
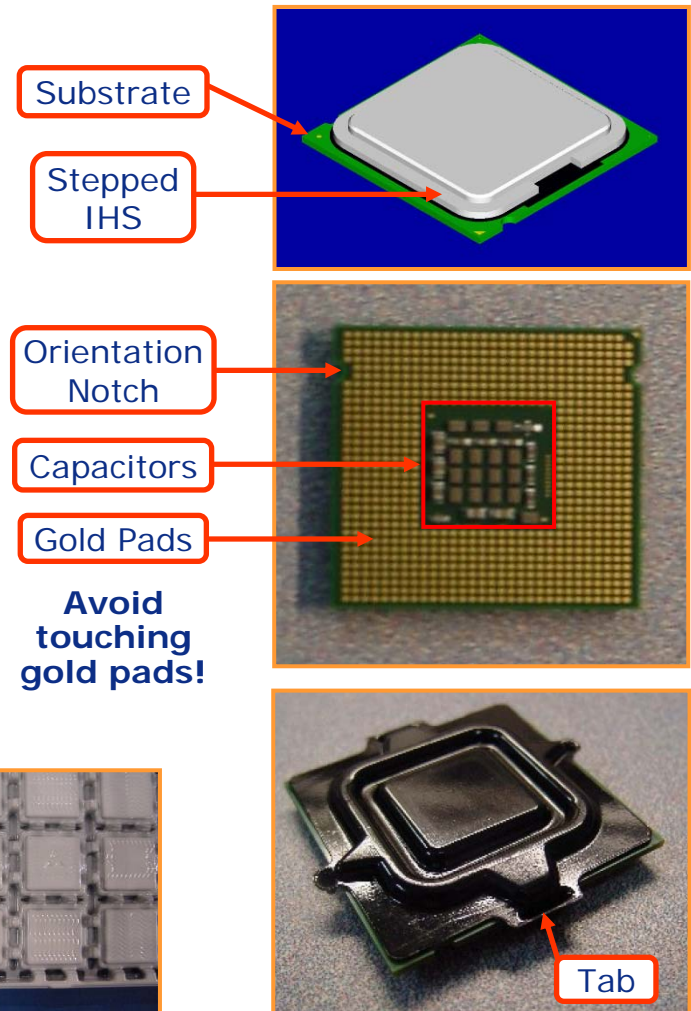


**LGA Package in Thermoformed Tray**



Tab

**Land Side Cover**

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# Comparison of LGA775 vs. LGA771

|  | LGA 771 | LGA775 | Manufacturing Considerations |
|---|---|---|---|
| **Package Lands** | 771 | 775 | **Different Intel enabling components solution** |
| **Keying Feature** | **2 cut outs on upper X axis** | **2 cut outs on left y axis** | **Design for orientation control** |
| **Typical Product Segment** | **Server** | **Desktop** | **Differentiate between Server and Desktop solutions** |

## Key emphasis areas

- **Packages are nearly identical, but uniquely keyed**
- **Differences are difficult to see to the untrained eye- potential for misidentification**
- **Inventory can easily be mixed on lines that build with both LGA771 & LGA775 based products**
- **Understand package labeling and keying relative to pin 1 to avoid misidentification.**

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# Comparison of LGA775 Vs LGA771



Orientation Notches

LGA775

LGA771

Orientation Notches

LGA775

LGA771

Pin 1 Triangle Markings

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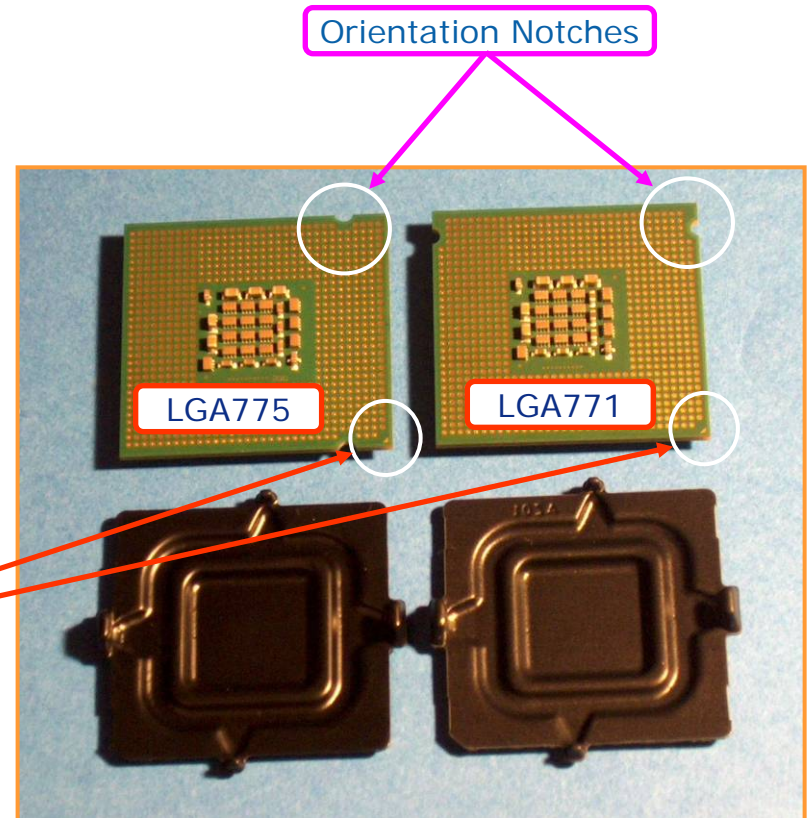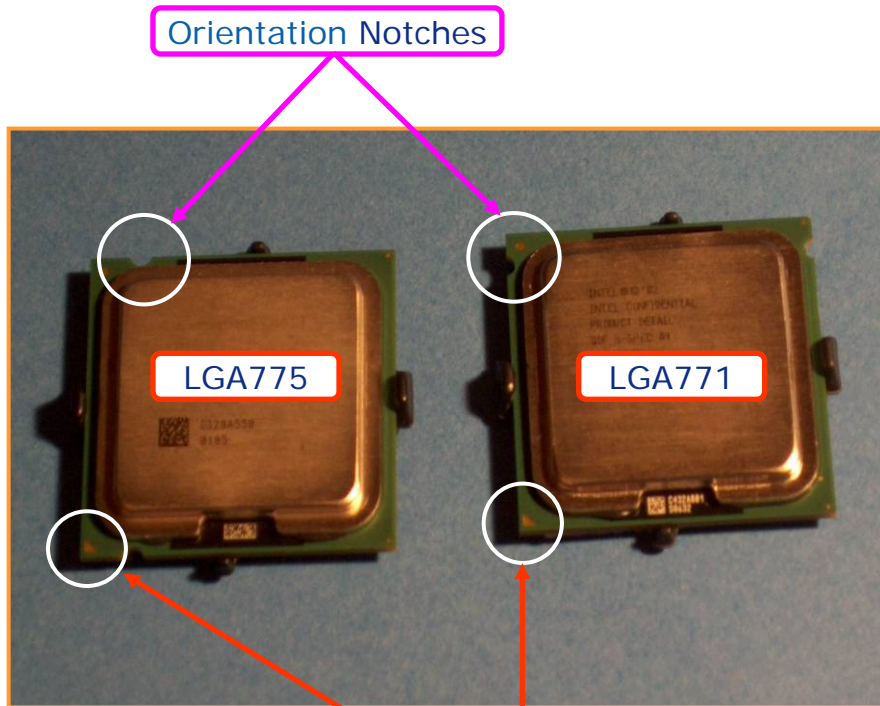
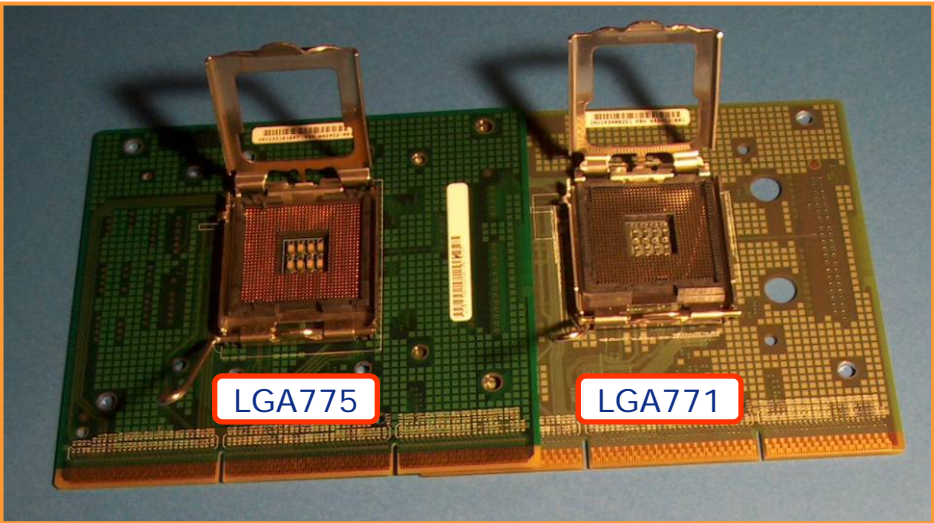# Comparison of LGA775 vs. LGA771
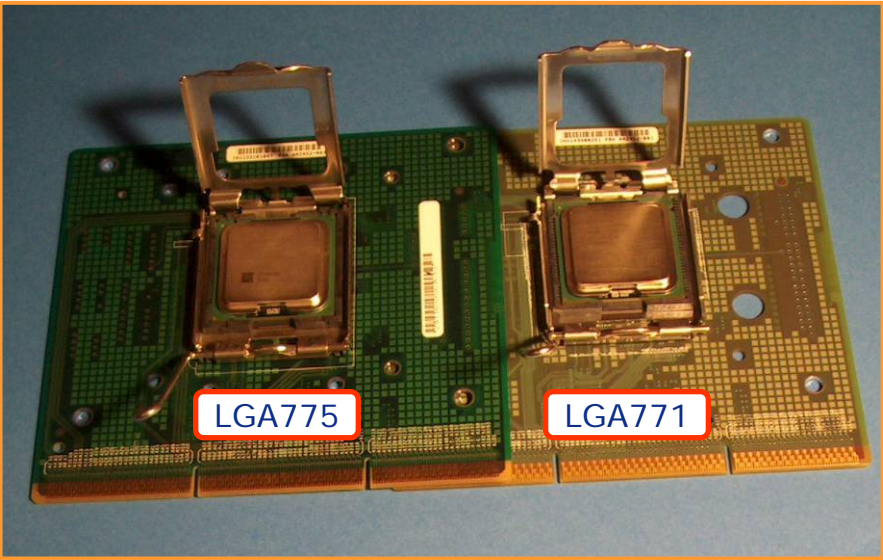


Sockets with Processor

Sockets without Processor

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# LGA771 Package & Socket



Orientation Notches

Pin 1 Triangle Markings

**Pin 1 referenced to package notch**

Socket Keying Feature

No Notch!

Pin 1 Locator
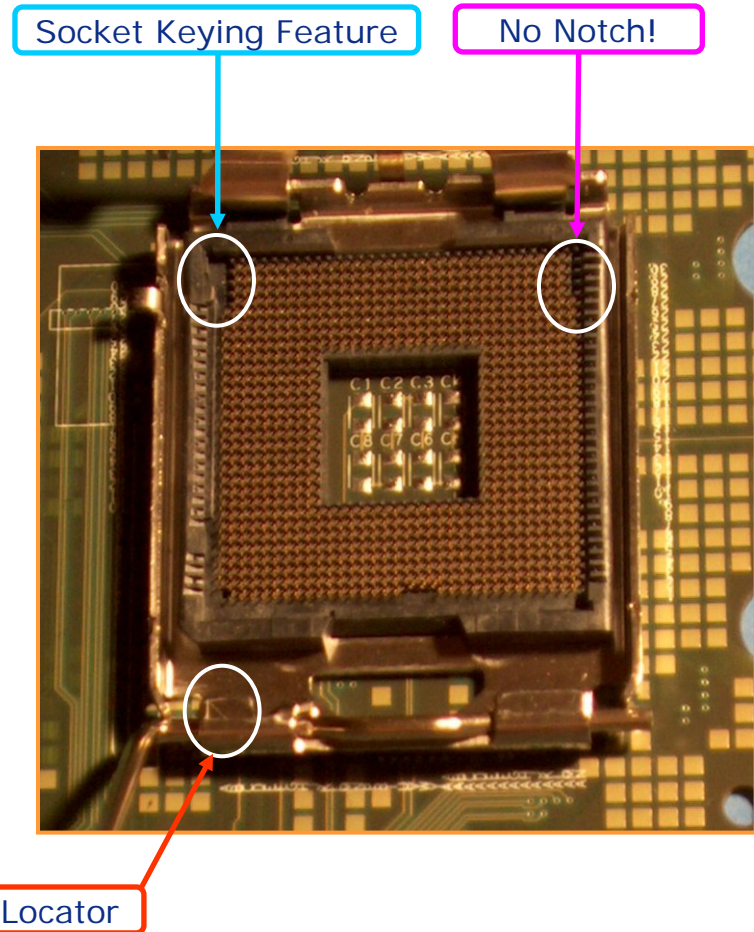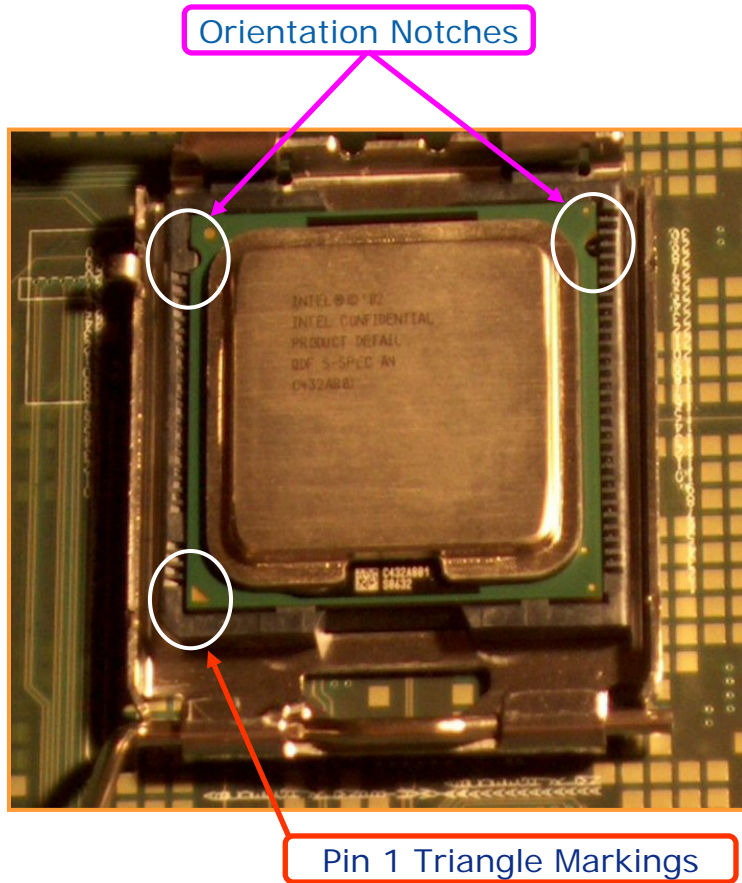
# LGA775 Package & Socket

**Pin 1 referenced to package notch**
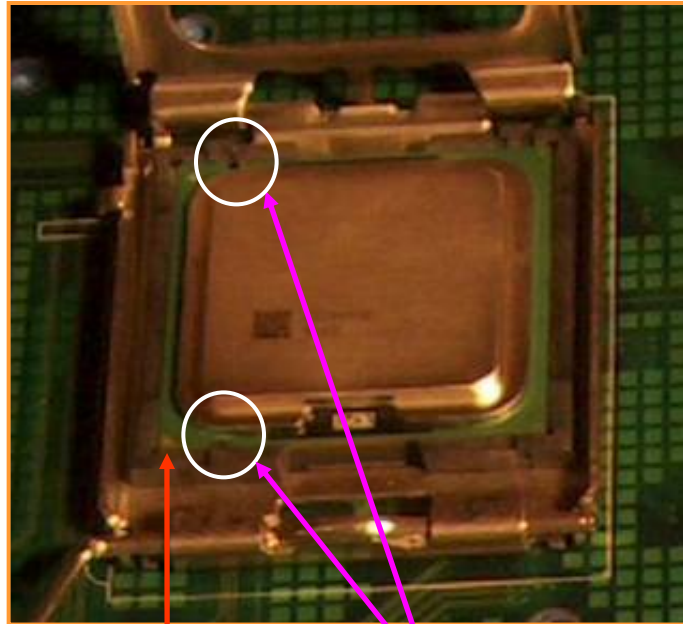


Orientation Notches

Pin 1 Triangle Markings

Socket Keying Features

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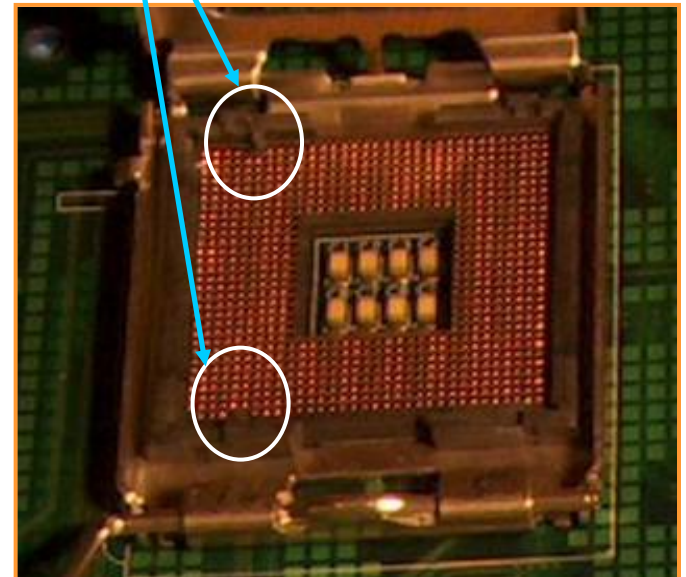
# Socket Platform Handling:
## ESD Sensitivity

Standard ESD handling practices should be used.

Processors should only be unpacked from boxes at ESD workstations
- **All persons handling processors should be properly grounded.**
- **All work and storage surfaces for processors should be properly grounded.**
- **All tools and equipment used to install or rework processors should be properly grounded.**

Use proper storage and material transfer
- **Transfer material using ESD safe trays, not by hand**
- **Remove processors from trays when they are ready to be used**
- **Units should be handled by the substrate edge**

For more information on ESD, visit Intel's website at:

**http://resource.intel.com/telecom/support/install/config/esd/esd.pdf**

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# Socket Handling Recommendations

Non-Recommended Manufacturing Practices: The following are examples of activities known to cause damage or quality failures

**Do not touch socket contacts or processor land pads**
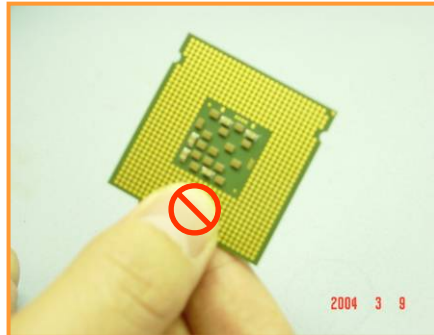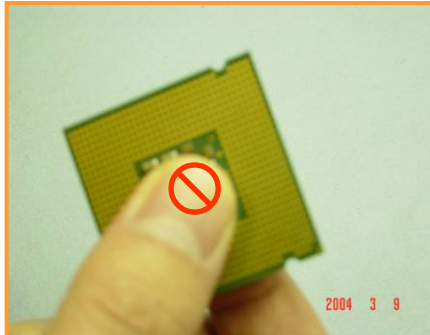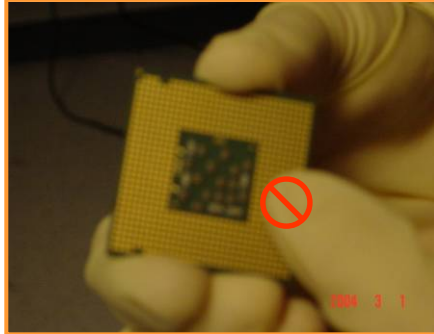


**Do not push on center of PnP cap to remove- instead, use the cap tab to handle**
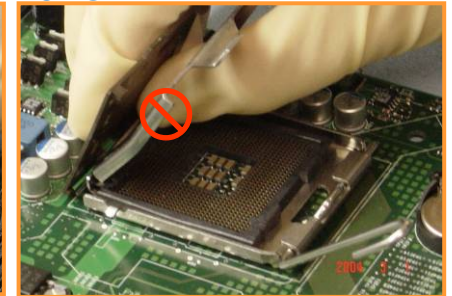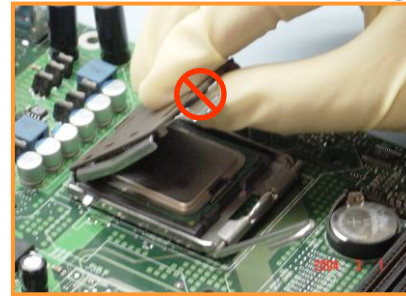


**Avoid incorrect CPU orientation**

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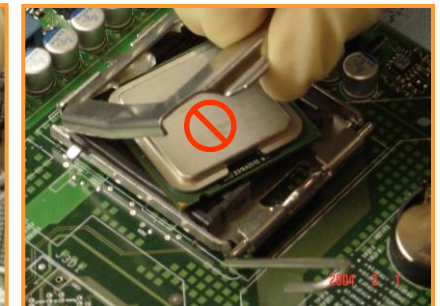
# Socket Handling Recommendations

Non-Recommended Manufacturing Practices (cont):

**Do not insert CPU in a tilted fashion**



**Do NOT close lever without DSL tab engaged during assembly**



**Do NOT remove PnP cap before opening the load plate**

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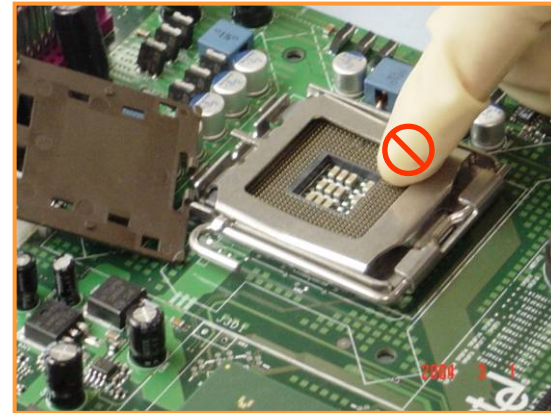
# Foreign Material (FM) Removal

## From CPU

1. Grasp and hold CPU by substrate edge
2. Lint and other loose particulates can be removed using oil-free, low pressure compressed air (follow local safety regulations)
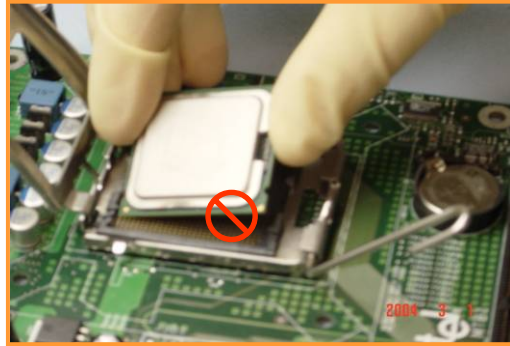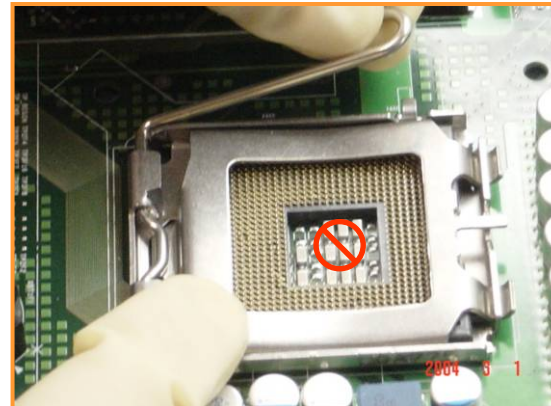3. Wet lint-free cloth with IPA and wipe package land pads lightly to remove FM
   - **Limit contact to contaminated area only**
   - **Use a daubing motion to minimize scoring and avoid spreading FM**
   **Note:  All operations using IPA should be accomplished with latex gloves**
4. Repeat with a clean cloth each time until no FM is visible (w/out magnification)
   - **If cleaning is unsuccessful, CPU must be scrapped**
5. If FM is Thermal Interface Material (G751) or Flux:
   - **Allow package to sit for 5-10-minutes after Step 3**
   - **Inspect under 10x magnification**
   - **Presence of FM under magnification is unacceptable, except per below condition, repeat step 1 – 4.**
   **Note: Presence of FM in micro-vias is ok. Attempt to remove FM from micro-vias by using any sharp implement is not recommended.  This could result in non-repairable CPU damage**

## From Socket

Oil-free low pressure air can be used to blow off loose particles (Follow local safety regulations) on socket contacts.

**Note: IPA may be dripped onto the socket to remove or dissolve FM.  Avoid brushing or swabbing IPA onto contacts as this will result in damage to the socket.**

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# System Integration:
## Motherboard Handling

1. Remove motherboard from ESD bag (if applicable)

2. Visually inspect the socket(s) to ensure load lever and load plate are secured

   **Caution:** **Opening the socket is not recommended**

3. Visually inspect the socket(s) to ensure PnP cap is present and properly secured

   **Caution:** **Removing the PnP cap is not recommended**

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# Socket Platform Handling:
## Board Flexure

Reference Intel board flexure guideline for M/B handling recommendation

- Always handle board by the edges with both hands to avoid excessive tensile force on the solder joint or flexing the board

- Avoid applying excessive downward force to the board during system assembly and test

- Ensure that the board has adequate support from the bottom / sides while all cards, cables, and devices are inserted in order to meet minimum flexure guideline

- Design ICT fixture to induce the lowest amount of flexure possible. Off-spec board warping can cause mechanical overstress

- Ensure that the fixture provides uniform support to the board, with extra attention to the areas around BGA and socket.

- If fixture design requires top side push downs, their surface area should be maximized to minimize localized board flexure. Use large contact surfaces, such as frames around BGA devices

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# System Integration:
## Socket Preparation

1. Open the socket:

   a) Disengage Load Lever by <u>depressing down and out</u> on the hook to clear retention tab

   b) Rotate Load Lever to fully open position at approximately 135 degrees

   c) Rotate Load Plate (DSL) to fully open position at approximately 100 degrees

Note: Apply pressure to the corner with right hand thumb while opening/closing the load lever, otherwise lever can bounce back like a "mouse trap" and WILL cause bent contacts (when loaded)

3. Socket Load Plate (DSL) open

2. Socket Load Lever open
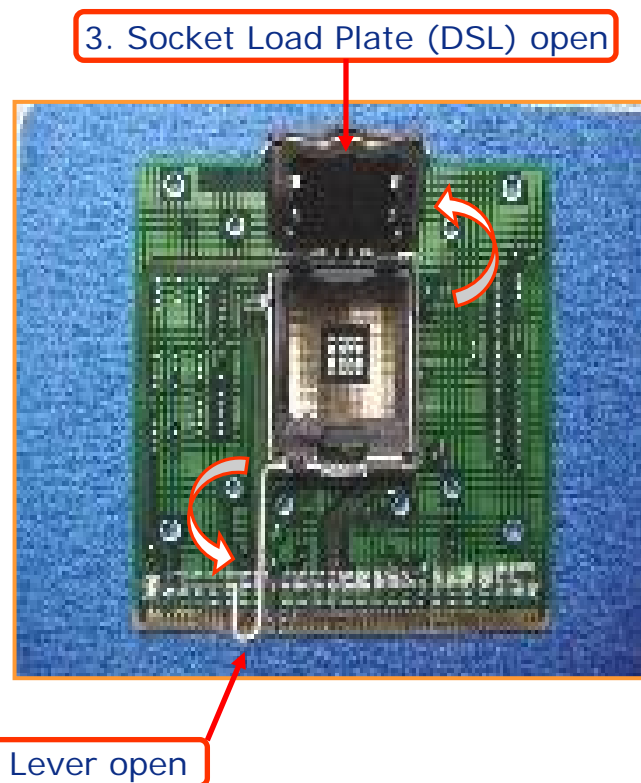
Note: Typical LGA on test board

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# System Integration:
## Socket Preparation (cont)

2. Remove PnP cap
   a) With left hand index finger and thumb to support the load plate edge, engage PnP cap with right hand thumb and peel the cap from LGA socket while pressing on center of PnP cap to assist in removal.
   b) Set PnP cap aside. Always reinstall PnP cap if the processor is removed from the socket.
   c) Visually inspect PnP cap for damage.  If damage is observed, replace the PnP cap.

**Note: After PnP cap removal, make sure socket load plate and contacts are free of foreign material; Refer to *Overview Module* for FM cleaning.**

**Note: Optionally, remove PnP cap after CPU insertion. This will compromise the ability to visually inspect socket.**

3. Visually inspect for bent contacts (Recommend at least 1st pass visual inspection)

**Note: Refer to the *Handling and Inspection* section for 1st and 2nd pass inspection details.**



2. Lift Here: PnP Cap

**Representative single CPU style board**

**Note: Glove images are for illustrative purposes only. Please consult local safety guidelines for specific requirements**

**Note: Do not hold the load plate as a lever, instead hold at tab with left hand, removing the PnP cap with right hand**

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# System Integration:
## LGA Package Insertion

1. Lift processor package from shipping media by grasping the substrate edges ONLY.

   **Note:** **Orient processor package such that the Pin 1 triangle mark is on bottom left**

2. Visually inspect the package gold pads
   - Scan the processor package gold pad array for presence of foreign material.
   - Refer to *Overview Module* for FM cleaning recommendations

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# System Integration:
## LGA Package Insertion (cont)


Pin 1 Indicator

3. Orient the package with IHS up. Locate Pin1 and the two orientation key notches

4. Carefully place the package into the socket body using a purely vertical motion
   **Caution: Using a vacuum pen for installation is not recommended**

– Verify that package is within the socket body and properly mated to the orient keys

5. Close the socket by
   a) **Rotating the Load Plate onto the package IHS**
   b) **While pressing down lightly on Load Plate, engage the Load Lever.**
   c) **Securing Load Lever with Load Plate tab under retention tab of Load Lever**

6. Repeat the process on the second processor for a 2P system

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# System Integration:
## LGA Package Removal

1. Open the Load Plate/Lever (using both hands)

2. Pick up LGA package:

    - **Option 1: Vacuum Pen- Place a minimum 9mm cup at approximately the center of IHS.**

        **Note: Do not to place the vacuum pen on IHS edge due to risk of dropping and causing bent contact.**

        **Note: Do not use a vacuum pen for inserting CPU**

    - **Option 2: By Hand- Use thumb to hold load plate hinge side and index finger to hold load lever side**

3. Lift the package straight up and away.

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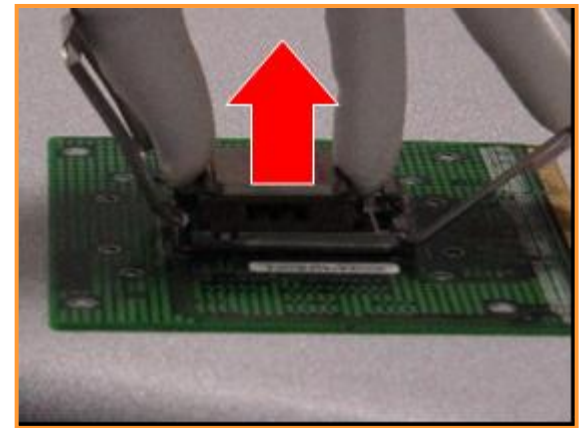
# System Integration:
## LGA Package Removal (cont)

4. Visually inspect socket contact array
   a) **First Pass Inspection**
      i. *Scan socket contact array at varying angles noting the presence of any foreign material*
      ii. *Reject the motherboard for further evaluation or socket replacement if-*
         *1) Foreign material is found and can't be removed using compressed air*
         *2) Mechanical damage (Mode1 or 4) is observed,*
   b) **Second Pass Inspection**
      i. *Repeat 2 more times to sight down the rows and columns from each of the 4 sides of the socket to ensure all contacts within the array are inspected*
      ii. *Inspect for Mode2, Mode3, and Mode5 failures*

   **Note: Refer to the *Test* section for detailed visual inspection criteria. Inspect both sockets in sequential fashion when more than one is used**

5. Assemble LGA socket PnP cap
   a) **Secure/Hook the back side of PnP cap.**
   b) **Snap down the front side to fully secure**
6. Close the Socket

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# System Integration
## Thermal Interface Material (TIM) and Grease Removal from CPU

**Notes:** Load Lever must stay engaged during this process or damage to the socket contacts will result!

TIM and grease removal process:

1. **Remove the heatsink from the socket**
2. **Gently push loose thermal interface material (TIM) to center of processor (Figures 2 and 3)**
3. **Remove pieces with dry cloth (Figure 4)**
4. **Wipe with dry, lint-free cloth to remove most of the material (Figure 5)**
5. **Wet another lint-free cloth with isopropyl alcohol (IPA) and wipe to clean remaining material (Figure 6)**
6. **Be careful to remove material from gaps between processor and load plate**
7. **For thermal grease removal use Steps 4-6**
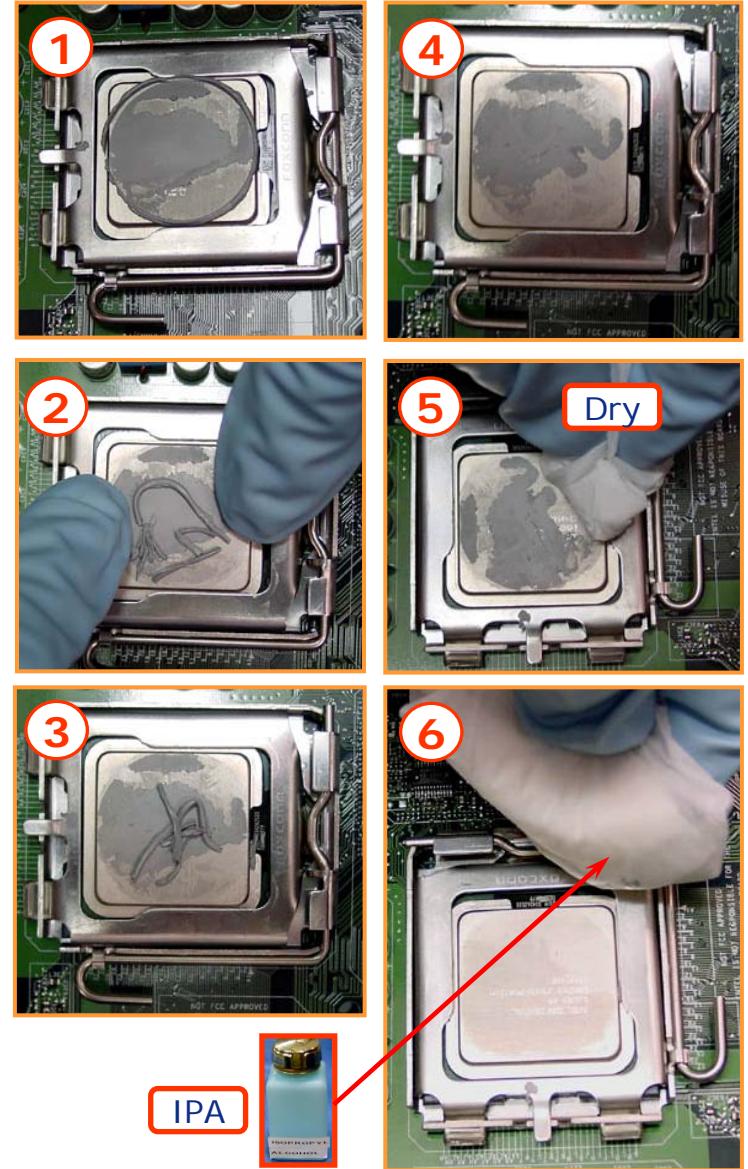
# System Integration
## TIM and Grease Removal from Heat Sink

Note: Remove and replace the TIM from the heatsink if you are re-using the heatsink on a new processor

1. Use dry, lint-free cloth and wipe package to remove most of the material (Figure 1)

2. Wet another lint-free cloth with isopropyl alcohol (IPA) and wipe heatsink to clean remaining material (Figure 2)
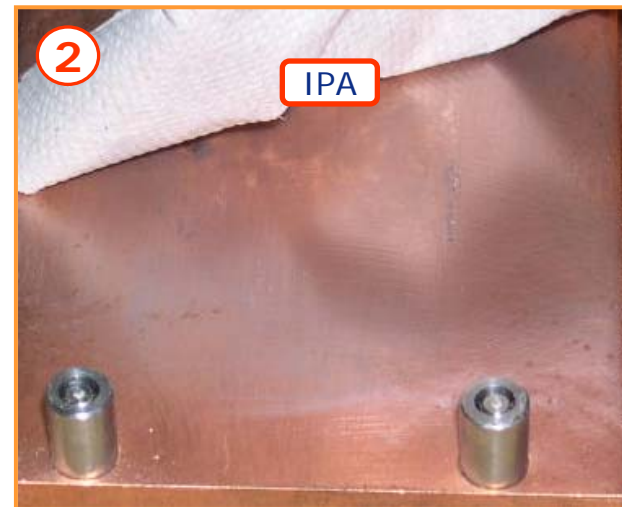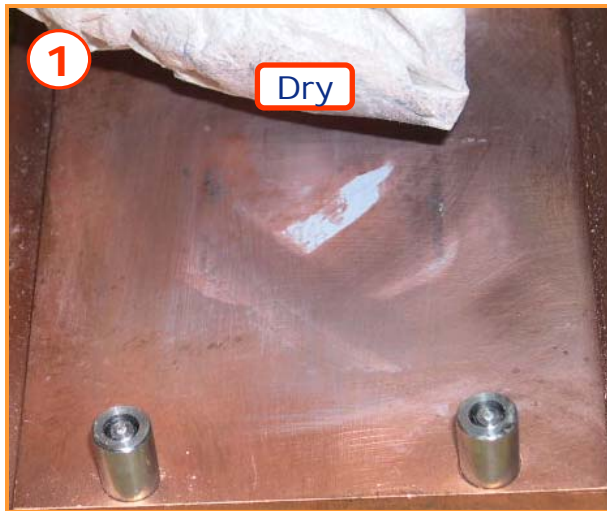
# System Integration
## Boxed Processor TIM Application

Thermal Interface Material (TIM) application process:

1. Remove smaller, square liner from one side (Figure 1)
2. Apply pad to top of the processor while CPU is in the socket (Figure 2)
3. Gently tap the corners, middle, and edges of the liner (Figure 3)
4. Use tweezers to carefully pull the liner off the TIM (Figure 4)
5. TIM should remain intact (Figure 5)

**Note:** It is acceptable for the TIM to be broken. Under high temperatures, the material will flow and fill any voids or gaps (Figure 6)

Order a single unit thermal pad from Shop Intel:

- http://www.shop-intel.com
- Part Number C53879-001
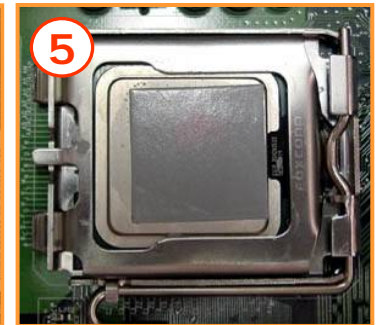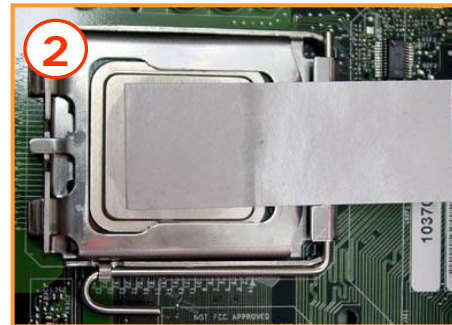
# Visual Inspection
## LGA Package Inspection Overview

Lighting:
- **General lighting**
- **No special requirements**
- **Task lighting optional**

Visual Acuity:
- **Vision corrected to 20/20**
- **Magnification optional**

LGA Package
- **Foreign Material (FM) in sufficient quantities to be detected with un-aided vision should be cleaned**
- **Reference**: **Cleaning procedure in *Overview* section**

**Note:** **Occasional orange discoloration of package lands due to oxidation was assessed and confirmed to have no impact on electrical performance, quality or reliability.**





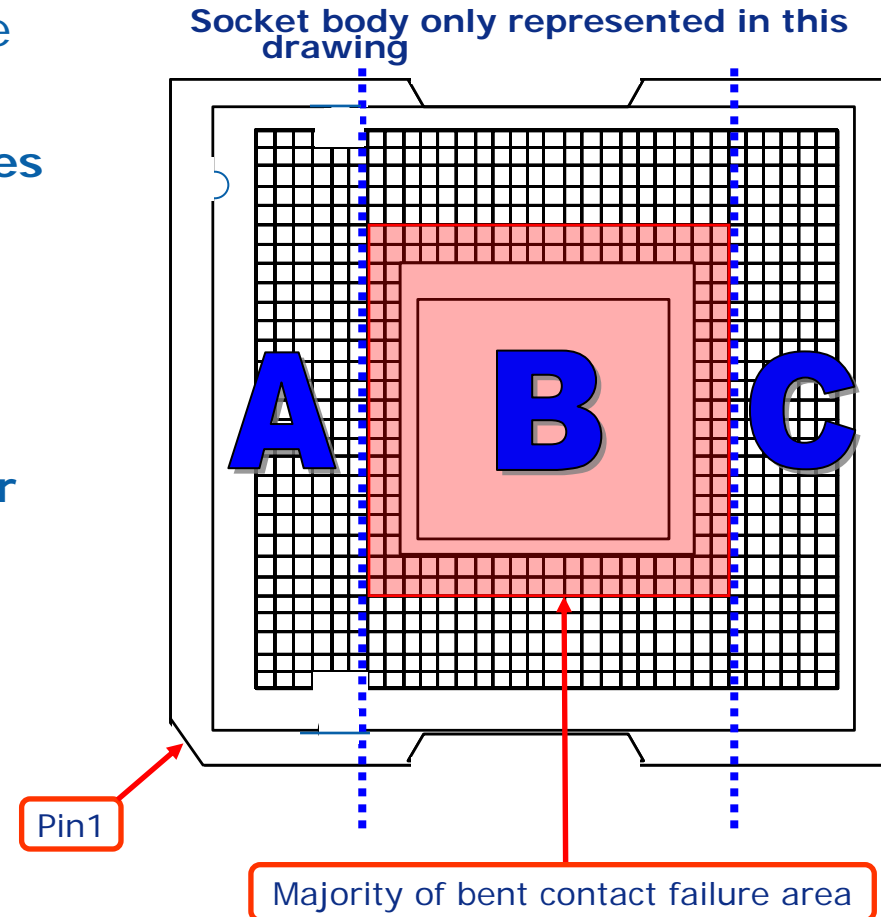**Discoloration**

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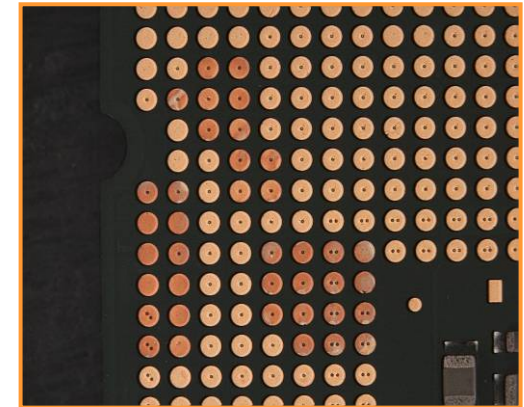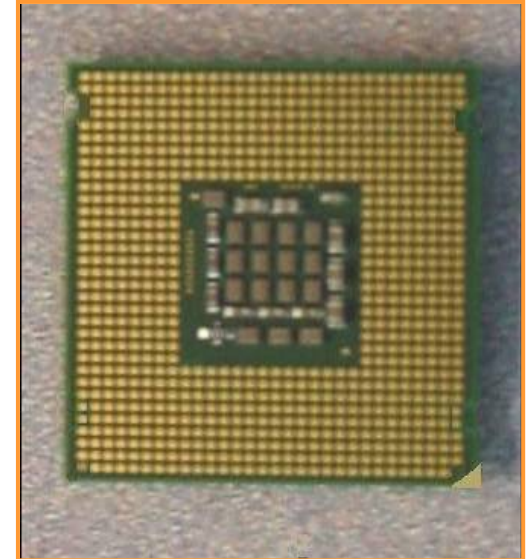
# Visual Inspection
## Data Analysis & Key Learning

Approximately 60% of contact damage occurs in the inner 2 rows of Zone B

- **Back row higher frequency of failures**

Most frequent causes of bent contact

- **Install/removal of CPU by tilting**
- **Improper handling**
- **Thick (cotton) gloves have a greater tendency to induce contact damage**



**Socket body only represented in this drawing**

A    B    C

Pin1

Majority of bent contact failure area

# Contact failure Type 1: Upward Bent

- **Contact is bent backward upon itself**

- **Inspection criteria:**
  *Contact tips must fall within 0.2mm (+/- 0.1mm or **+/- 1 contact thickness**) of the plane defined by the contact tips.*

- **Most common in in the first 2 rows and columns around the center cavity**

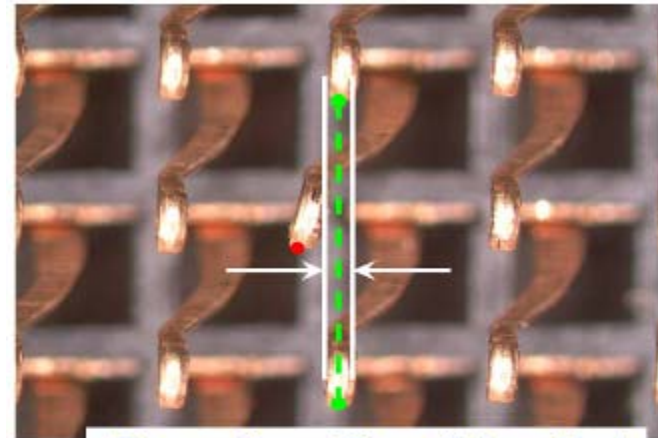- **Reject <u>ALL</u> Type 1 failures**
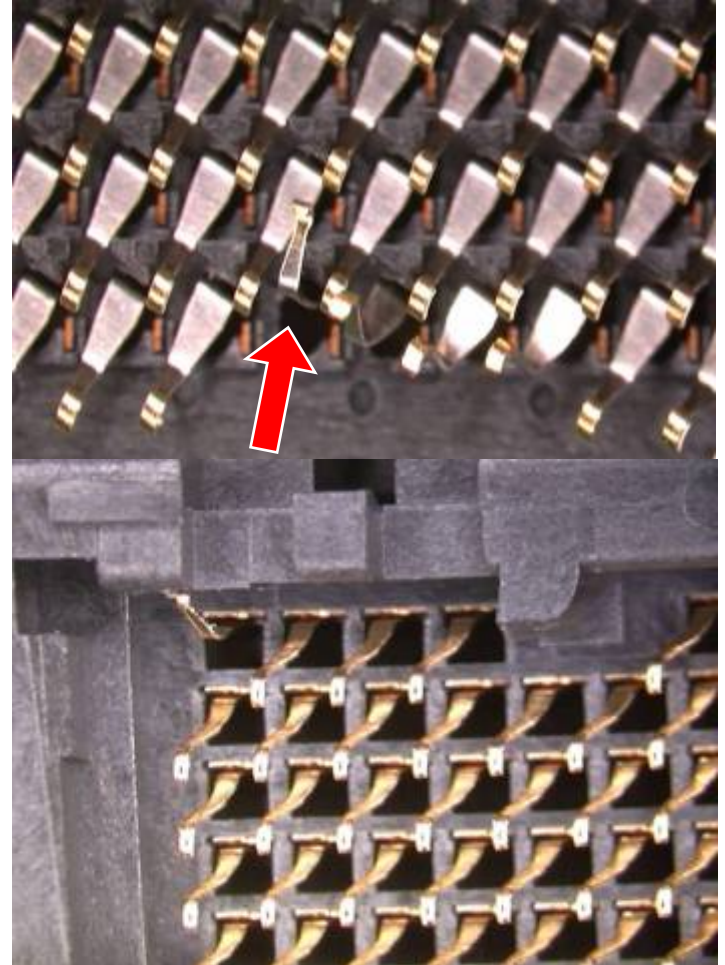
# Contact failure Type 2 (Upward / downward Shift)

- **Contact tip position is shifted (up or down) more than one contact thickness**

- **Inspection criteria:**
  *Contact tips must fall within 0.2mm (+/- 0.1mm or __+/- 1 contact thickness__) of the plane defined by the contact tips.*
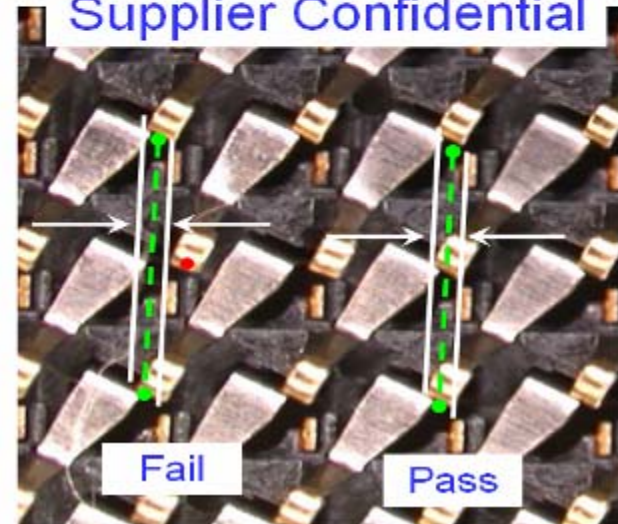
- **Reject __ALL__ Type 2 failures**

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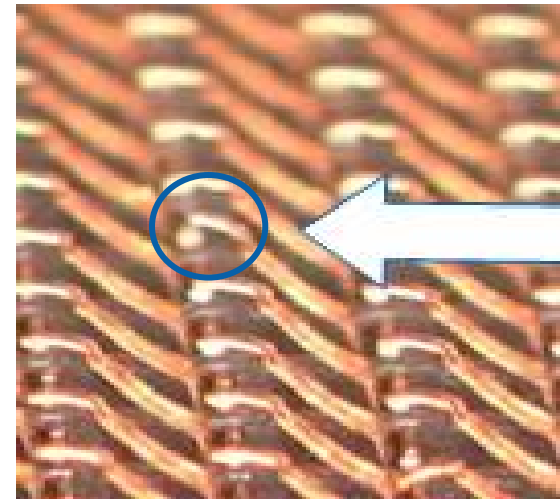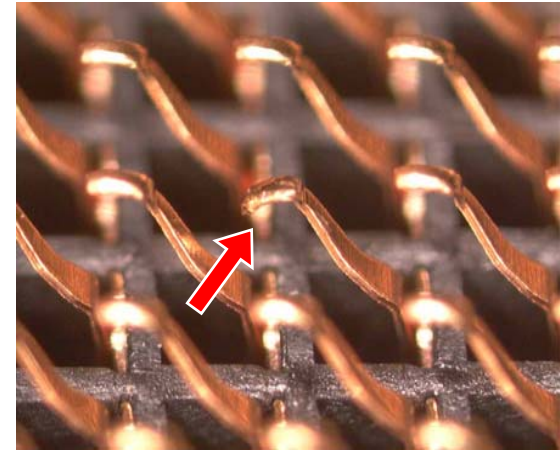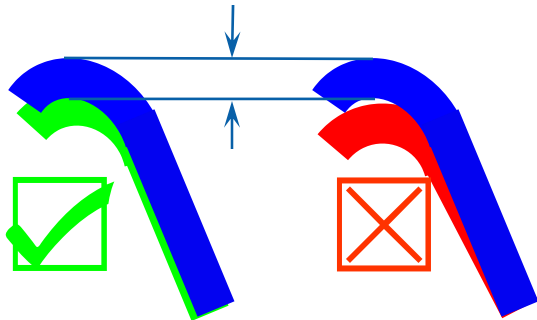
# Contact failure Type 3: x axis shift

- **Contact is shifted sideways (X direction)**

- **Reject contacts when the tip is shifted <u>more than ¾ of the width</u> of the contact**

- **Reject <u>ALL</u> Type 3 failures**

  - *Note: Red circle indicates contact out of alignment*



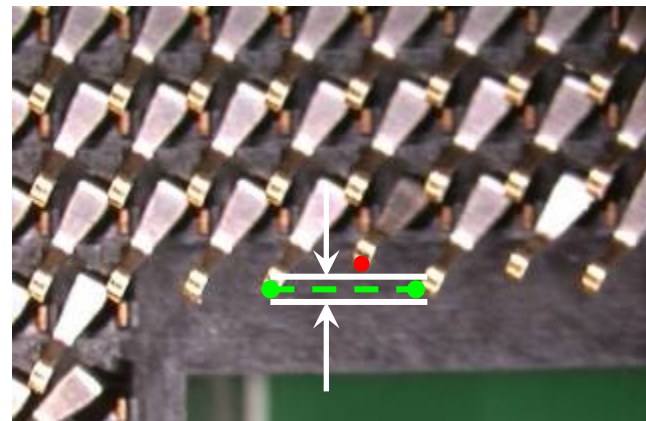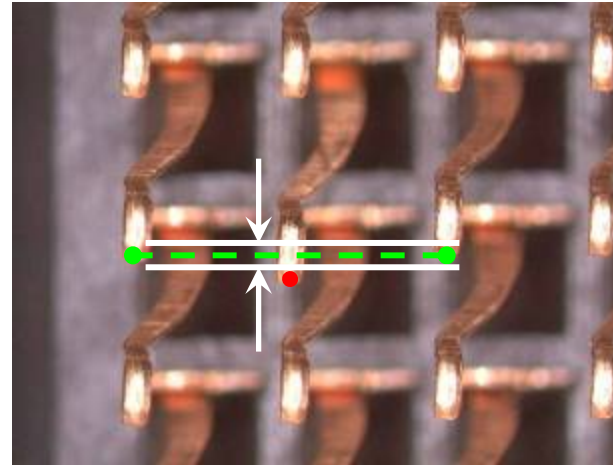Supplier Confidential

Fail    Pass

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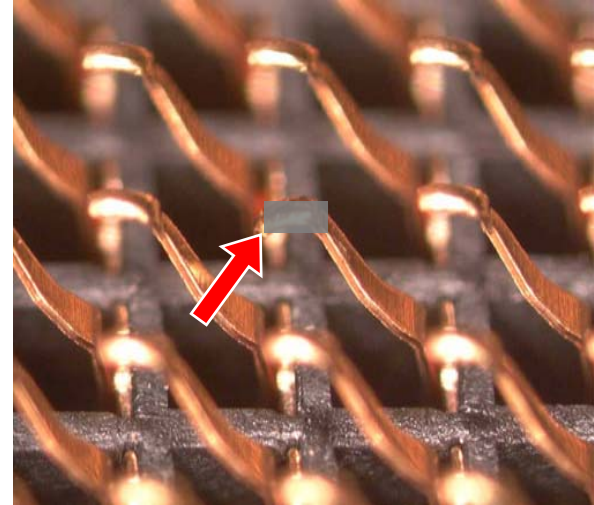# Contact failure Type 3: y axis shift

## Type 3 (continued)

- **Contact is shifted sideways (Y direction)**

- **Reject contacts when the tip is shifted <u>more than ¾ of the width</u> of the contact**

- **Reject <u>ALL</u> Type 3 failures**

  - *Note: Red circles indicate contact out of alignment*

# Contact failure

**Type 4**

- **Contact tip is missing**

- **Reject <u>ALL</u> Type 4 failures**
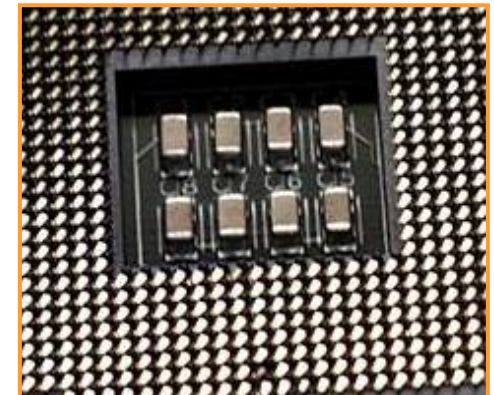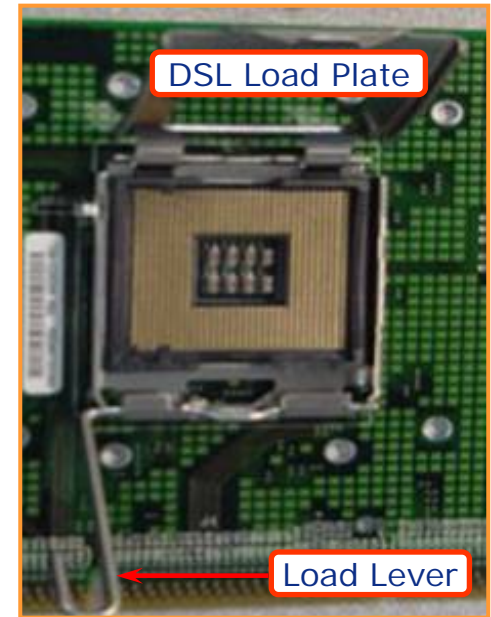
# Visual Inspection
## LGA Socket 1st Pass Inspection

Optional supplies

- **Microscope, min 10x magnification**
- **Magnification task light (ESD compliant)**

First Pass Inspection Process

- **Orient the load lever on the left side and the hinge to the load plate on the top.**
- **Hold the load plate open with your thumb as you hold both sides of the board.**
- **Hold board 6-12" away from face perpendicular to your viewing angle**
  - *Scan the contacts while tilting away approximately 15-45° and rotating about 15-45° from perpendicular to change the viewing angle several times.*
  - *Light should create a reflection moving back and forth across the contacts*
  - *Changes in the light pattern are indications of shifted or damaged contacts*
- **If no failures are found, proceed with a detailed inspection**



DSL Load Plate

Load Lever



Bent Contact

(intel)

# Visual Inspection
## LGA Socket 2nd Pass Inspection

Detailed Inspection (2nd Pass Inspection)

- **Hold the DSL load plate open with your thumb, while grasping both sides of the board.**
- **With the open DSL load plate on the opposite side of the socket, bring the board into visual focus at a 15° angle (almost flat)**

<u>Step 1</u>

– *Sight down the columns of Zone A, B, and C*

– *Inspect for Mode 2, 3, and 5 with one eye only*

<u>Step 2</u>

– *Turn the board 90° clockwise and sight down the rows across all three zones*

– *Inspect for Mode 2, Mode 3, and Mode 5*

<u>Step 3 and Step 4</u>

– *Repeat twice more to sight down the rows and columns from the remaining sides of the socket to ensure all contacts within the array are inspected*

- **If amount of contact shift cannot be determined, a more detailed inspection can be completed under magnification**
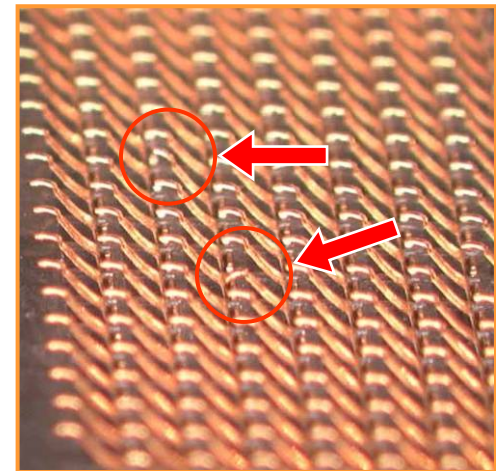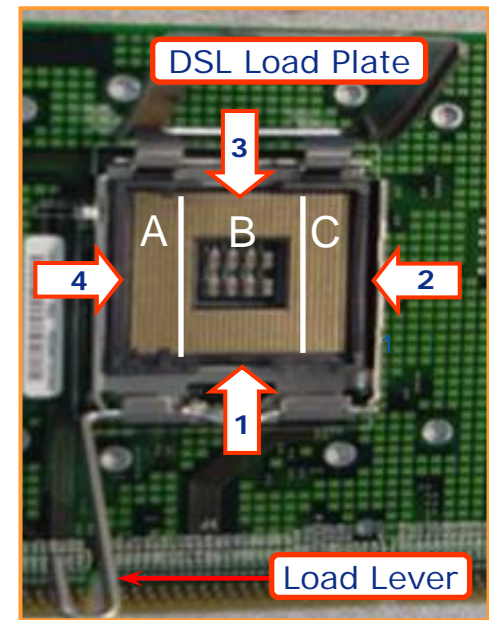
# Reference Documents

- **Processor technical document downloads**
  - **http://www.intel.com/products/processor/index.htm**
- **Processor Electrical, Mechanical, and Thermal Specification**
- **Processor Thermal Mechanical Design Guideline**
- **LGA Socket Mechanical Design Guide**
  - **http://www.intel.com/design/pentium4/guides/302666.htm**
- **MAS: LGA Socket Handling, Inspection, Integration Module**
- **MAS: Intel® SMT Profile Board Information**
- **MAS: Manufacturing with Intel® Components Using Lead-free Technology**
- **MAS: Board Flexure Control Methodology**

**Note:**

  *1) Contact your Intel field sales representatives for latest revision and order number for these documents.*
  *2) Some documents may not be released at the time of publication of this document.*