LGA775 Socket

Mechanical Design Guide

February 2006

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Revision History

Revision Number.	Description	Revision Date
-001	• Initial public release	June 2004
-002	• Lead-free information added	May 2005
-003	• Added Vendor Information for LF sockets	February 2006

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1 Introduction

1.1 Document Goals and Scope

1.1.1 LGA775 Socket Overview

This document describes a surface mount, LGA (Land Grid Array) socket intended for performance and value desktop platforms based on future Intel microprocessors in the 775-land LGA package. The socket provides I/O, power and ground contacts. The socket contains 775 contacts arrayed about a cavity in the center of the socket with eutectic solder balls for surface mounting with the motherboard. The LF-LGA775 socket contains lead-free solder balls while the LGA775 socket contains eutectic solder balls. This design guide refers to the socket as LGA775 for simplicity, but its contents are applicable to both solder materials unless otherwise specified. The socket contacts have 1.09 mm X 1.17 mm pitch (X by Y) in a 33x30 grid array with 15x14 grid depopulation in the center of the array and selective depopulation for alignment keys. A matching LGA package will be mated with the socket.

1.1.2 Document Goals

The goals of this document are:

- To provide LGA775 socket information necessary for motherboard design to ensure the specified performance of the platform.
- To define the boundary conditions and design constraints within which the socket design must fit and perform.

1.1.3 Important Remarks

All LGA775 socket characteristics mentioned in this document may change.

LGA775 socket validation reports are available from socket vendors.

1.2 Terminology

Term	Description
LGA775 Socket	Processor in the 775-land package mates with the system board through a surface mount, 775-pin, LGA (land grid array) socket.
LGA775-Land LGA Package	Processors in the 775-Land LGA package uses Flip-Chip Land Grid Array package technology and consists in a processor core mounted on a substrate with an integrated heat spreader (IHS). This packaging technology employs a 1.09 mm x 1.17 mm pitch for the substrate lands. Refer to the processor datasheet for additional information.
IHS (Integrated Heat Spreader)	A component of the processor package used to enhance the thermal performance of the package. Component thermal solutions interface with the processor at the IHS surface.

1.3 Reference Documents

Document	Comment
Processor Datasheet	http://www.intel.com/products/processor/index.htm Note 1
Processor Thermal Design Guidelines	http://www.intel.com/products/processor/index.htm Note 2
LGA775 Socket Validation Report	Note 3
Boxed Intel® Pentium® 4 Processor in the 775-Land LGA Package - Integration Video	http://www.intel.com/go/integration

NOTES:

1. Select the appropriate processor and then go to the **technical documents** tab and locate the Processor Datasheet in the Datasheets section of the page.
2. Select the appropriate processor and then go to the **technical documents** tab and locate the Processor Thermal Design Guidelines in the Design Guides section of the page.
3. Socket validation reports are available from socket vendors.

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2 Assembled Component and Package Description

The LGA775 Socket dimensions and characteristics must be compatible with that of the processor package and related assembly components. The 775-land LGA package uses Flip-Chip Land Grid Array package technology. Processors in the 775-land LGA package are targeted to be used with the LGA775 socket.

The assembled component may consist of a cooling solution (heatsink, fan, clips, and retention mechanism), and processor package. The processor *Thermal Design Guidelines* provides information for designing components compliant with the Intel reference design.

Relevant processor 775-land LGA package and land information is given in the processor datasheet.

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3 Mechanical Requirements

3.1 Attachment

The socket will be tested against the mechanical shock and vibration requirements listed in Chapter 5 under the expected use conditions with a heatsink and retention mechanism attached under the loading conditions outlined in the processor datasheet. The socket will only be attached by the 775 contact solder balls to the motherboard. There are no additional external methods (i.e., screw, extra solder, adhesive, etc.) to attach the socket.

All relevant package mechanical load specifications are given in the processor datasheet.

Important Note: Heatsink Clip Preload

Heatsink clip preload is traditionally used for:

- Mechanical performance in mechanical shock and vibration.
- Thermal Interface Material (TIM) performance.
  - Required preload depends on selected thermal interface material.

In addition to mechanical performance in shock and vibration and TIM performance, LGA775 socket requires a minimum heatsink preload to protect against fatigue failure of socket solder joints.

Solder ball tensile stress is created by inserting a processor into the socket and actuating the LGA775 socket load plate. In addition, solder joint shear stress is caused by coefficient of thermal expansion (CTE) mismatch induced shear loading. The solder joint compressive axial force induced by the heatsink preload helps to reduce the combined joint tensile and shear stress.

Overall, the heatsink required preload is the minimum preload needed to meet all of the above requirements: Mechanical shock and vibration, TIM performance, and LGA775 socket protection against fatigue failure.

Refer to the processor *Thermal Design Guidelines* for detailed information for heatsink clip static preload and motherboard deflection guidelines for the LGA775 socket to ensure socket solder joint protection against fatigue in temperature cycling.

3.2 Socket Components

The socket is made of four main components: socket body, load plate, load lever, and socket body stiffener (refer to Appendix A, Figure 2).

The socket will be delivered as a single integral assembly.

3.2.1 Socket Body

3.2.1.1 Housing

The housing material must be a thermoplastic or equivalent, UL 94 V-0 flame rating, temperature rating and design capable of maintaining structural integrity following a temperature of 260 °C for 40 seconds which is typical of a reflow/rework profile for the solder used on the socket. The material must have a thermal coefficient of expansion in the XY plane capable of passing reliability tests rated for an expected high operating temperature, mounted on FR4-type motherboard material. The creep properties of the material must be such that the mechanical integrity of the socket is maintained for the use condition outlined in Chapter 5.

The color of the socket housing must be dark, as compared to the solder balls, to provide the contrast needed for surface-mount (SMT) equipment pick and place vision systems. Components of the socket may be different colors as long as they meet the above requirement.

3.2.1.2 Package Installation / Removal Access

Access is provided to facilitate the manual insertion and removal of the package.

To assist in package alignment and proper orientation during package installation into the socket:

- The package substrate has keying notches along two opposing edges of the package and offset from the package centerline (refer to the processor datasheet for further details).
- The socket uses two features designed to mate with the keying notches along the inside walls of the package seating cavity (refer to Appendix A).

3.2.1.3 Socket Standoffs

Standoffs must be provided on the bottom of the socket base to ensure the minimum socket height after solder reflow. The standoff locations and surface area are located as specified in Appendix A, Figure 3. A minimum gap between the solder ball seating plane and the standoff prior to reflow is required to prevent solder ball to motherboard land open joints.

3.2.1.4 Markings

All markings withstand a temperature of 260 °C for 40 seconds, which is typical of a reflow/rework profile for solder material used on the socket, as well as any environmental test procedure outlined in Chapter 5 without degrading.

3.2.1.4.1 Name

LF-LGA775 (Font type is Helvetica Bold – minimum 6 point (or 2.125 mm)).

Note: This mark shall be stamped or laser marked into the sidewall of the stiffener plate on the actuation lever side when lead-free solder are is used.

LGA775 (Font type is Helvetica Bold – minimum 6 point (or 2.125 mm)).

Note: This mark shall be stamped or laser marked into the sidewall of the stiffener plate on the actuation lever side when eutectic solder balls are used.

Manufacturer's insignia (font size at supplier's discretion).

- This mark will be molded or laser marked into the socket housing.

Both socket name and manufacturer's insignia must be visible when first seated on the motherboard.

3.2.1.4.2 Lot Traceability

Each socket must be marked with a lot identification code to allow traceability of all components, date of manufacture (year and week), and assembly location. The mark must be placed on a surface that is visible when mounted on the motherboard.

3.2.1.5 Contacts

The socket has a total of 775 contacts; with 1.09 mm X 1.17 mm pitch (X by Y) in a 33x30 grid array with 15x14 grid depopulation in the center of the array and selective depopulation for alignment features.

Base material for the contacts is a high strength copper alloy.

For the area on the socket contacts where processor lands will mate, there is a 0.381 μm [15 μinches] minimum gold plating over 1.27 μm [50 μinches] minimum nickel underplate.

No contamination by solder in the contact area is allowed during solder reflow.

3.2.1.6 Solder Balls

A total of 775 solder balls corresponding to the contacts are on the bottom of the socket for surface mounting with the motherboard.

Two versions of the socket, leaded and lead-free will be available, with the following materials for the solder balls:

- **Eutectic Solder**
  - — Sn63 Pb37 (+/-0.5% Sn).
  - — Socket marking will be LGA775 for sockets comprised of eutectic solder.
- **Lead-free Solder**
  - — Composition must be lead free and have a melting point temperature in the range of 217-220°C (for example: Sn Ag 3.0 Cu 0.5).
  - — Socket marking will be LF-LGA775 for sockets comprised of lead-free solder.

The co-planarity (profile) requirement for all solder balls on the underside of the socket is defined in Appendix A.

The solder ball pattern has a true position requirement with respect to applicable datum's in order to mate with the motherboard land pattern. Refer to Appendix A.

3.2.2 Socket Actuation Mechanism

The socket actuation mechanism is made of the load plate and the load lever. These components are made of stainless steel SUS 301. Both components need to be fully actuated to ensure electrical contact. When correctly actuated, the top surface of the processor IHS is above the load plate allowing proper installation of a heatsink. The post-actuated seating plane of the package is flush with the seating plane of the socket. Movement will be along the Z direction, perpendicular to the motherboard.

When combined with the socket body and load lever, the load plate distributes the force necessary to achieve the required resistance values. The load from the load plate is distributed across two sides of the package onto a step on each side of the IHS. It is then distributed by the package across all of the contacts.

The stiffener plate provides the interface to the load lever and the load plate and creates the primary stiffening element to react to the load generated by the load plate.

3.2.3 Pick and Place Cover

The pick and place cover is a dual purpose removable component of the LGA775 socket. The cover's primary purpose is to provide a planar surface at least 20-mm in diameter and compatible with SMT placement systems. As such, the cover retention must be sufficient to support the socket weight during lifting, translation, and placement. The cover material should be chosen such that it is able to withstand 260 °C for 40 seconds.

The secondary function of the Pick and Place Cover is to provide a physical barrier against contamination and un-desirable physical contact of the socket contact array during post-SMT handling environments in board assembly environments, shipping, and in system assembly environments. As such, cover retention is sufficient for the cover to remain in place through these environments. The cover should be able to be installed and removed without the use of tools.

There should be no surfaces or features above the pick surface. The Pick and Place cap should attach to the exterior of the Load Plate to maximize its distance from the socket contacts and be compatible with volumetric keep-ins as defined in the processor *Thermal Design Guidelines*. The cover should not have features that protrude below the Load Plate inner profile and into the socket cavity. Also, there should be no features that protrude above the pick and place surface. Further, any vent holes added to the Pick and Place Cover to aid in air circulation during reflow should be positioned to not allow fluid contaminants a direct path to the contacts (i.e., no socket contacts should be visible with the cover installed). Finally, a Pin 1 indicator, typically a triangular cutout, on the Pick and Place cover is highly desirable.

3.2.4 Socket Insertion / Actuation Forces

Any actuation should meet or exceed SEMI S8-95 Safety Guidelines for Ergonomics/Human Factors Engineering of Semiconductor Manufacturing Equipment, example Table R2-7 (Maximum Grip Forces).

The load lever actuation force must not exceed 3.9 kgf [8.6 lbf] in the vertical direction and 1 kgf [2.3 lbf] in the lateral direction.

The pick and place cover insertion and removal force must not exceed 1 kgf [2.3 lbf].

The socket is designed such that it requires no force to insert the package into the socket.

3.3 Socket Size

Socket information needed for motherboard design is provided in Appendix A, Figure 3.

This information should be used in conjunction with the reference motherboard keep-out drawings provided in the processor Thermal Design Guidelines to ensure compatibility with the reference thermal mechanical components.

3.4 Socket Weight

The LGA775 socket weighs about 35 g.

3.5 Socket Maximum Temperature

The power dissipated within the socket is a function of the current at the pin level and the effective pin resistance. The key temperature targets for the LGA775 socket are:

- Temperature of socket contact < 100 °C sustained.
- Temperature of socket solder ball < 91 °C sustained.

3.6 Manufacturing with LGA775 Socket

The *Boxed Intel® Pentium® 4 Processor in the 775-Land LGA Package - Integration Video* provides Best Known Methods for package and heatsink installation and removal for LGA775 socket based platforms and systems manufacturing. The video is available on the Web, from http://developer.intel.com.

For additional LGA775 manufacturing information, contact your Intel field sales representative.

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4 Electrical Requirements

Table 1 provides LGA775 Socket electrical requirements. These requirements are measured from the socket-seating plane of the processor to the component side of the PCB to which it is attached. All specifications are maximum values (unless otherwise stated) for a single socket contact, but includes effects of adjacent contacts where indicated.

Table 1. LGA775 Socket Electrical Requirements

Item	Parameter	Value	Comment
1	Mated loop inductance, Loop	1.17 mm < 3.9 nH 1.09 mm < 3.9 nH	• The inductance calculated for two conductors, considering one forward conductor and one return conductor. These values must be satisfied at the worse-case height of the socket.
2	Mated partial mutual inductance, L	NA	• The inductance on a conductor due to any single neighboring contact.
3	Maximum mutual capacitance, C	< 1 pF	• The capacitance between two contacts.
4	Socket Average Contact Resistance (End Of Life)	≤ 15.2 mΩ	• This value has to be satisfied at all times. The specification is listed at room temperature. • The socket average resistance is derived from average of every chain contact resistance, with a chain contact resistance defined as the resistance of each chain minus resistance of shorting bars divided by number of lands in the daisy chain. • **Socket Contact Resistance:** The resistance of the socket contact, including the interface resistance to the package land.
5	Maximum Chain Contact Resistance (End Of Life)	≤ 28 mΩ	• This value has to be satisfied at all times. The specification is listed at room temperature. • The maximum chain resistance is derived from maximum resistance of each chain minus resistance of shorting bars divided by number of lands in the daisy chain. • **Socket Contact Resistance:** The resistance of the socket contact, including the interface resistance to the package land.
6	Bulk Resistance Increase	≤ 3 mΩ	• The bulk resistance increase per contact from 24 ºC to 100 ºC.
7	Dielectric Withstand Voltage	360 Volts RMS	
8	Insulation Resistance	800 M Ohms	

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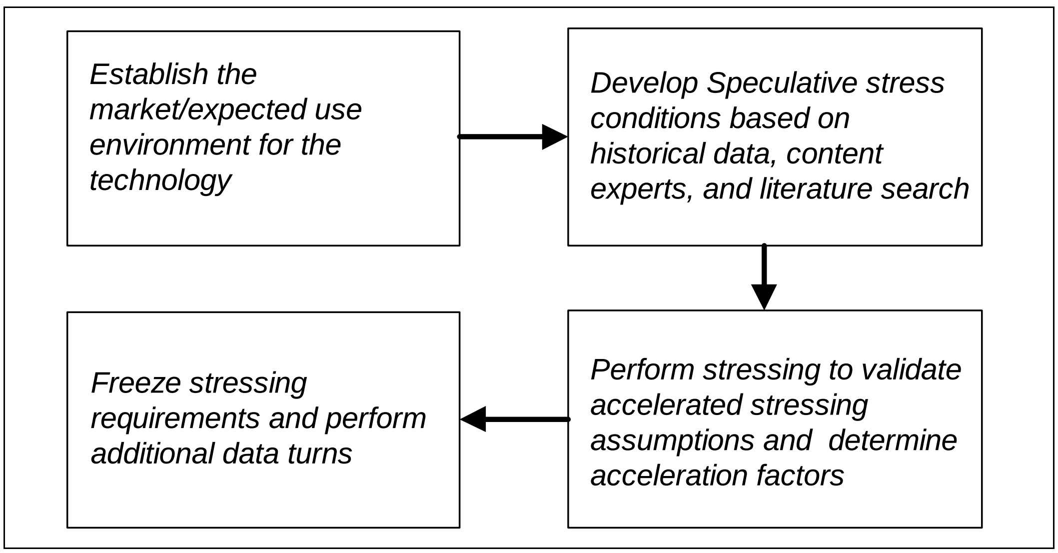
5 Environmental Requirements

Design, including materials, shall be consistent with the manufacture of units that meet the following environmental reference points.

The reliability targets in this section are based on the expected field use environment for a desktop product. The test sequence for new sockets will be developed using the knowledge-based reliability evaluation methodology, which is acceleration factor dependent. A simplified process flow of this methodology is provided in Figure 1.

Figure 1. Flowchart of Knowledge-Based Reliability Evaluation Methodology



A detailed description of this methodology can be found at:
http://developer.intel.com/design/packtech/245162.htm.

The use environment expectations assumed are for desktop processors, based on an expected life of 7 years, are listed in Table 2**.** The target failure rates are <1% at 7 years (and <3% at 10 years).

Table 2. Use Conditions Environment

Use Environment	Speculative Stress Condition	7 Year Life Expectation	10 Year Life Expectation
Slow small internal gradient changes due to external ambient (temperature cycle or externally heated)	Temperature Cycle	1500 cycles with a mean ΔT = 40 °C	2150 cycles with a mean ΔT = 40 °C
High ambient moisture during low-power state (operating voltage)	THB / HAST	62,000 hrs at 30 °C, 85%RH	89,000 hrs at 30 °C, 85%RH
High Operating temperature and short duration high temperature exposures	BAKE	62,000 hrs at 100 °C	89,000 hrs at 100 °C
Shipping and Handling	Mechanical Shock 50g trapezoidal profile; 170"/sec Velocity change; 11 msec duration pulse	Total of 18 drops: 3 drops per axis ± direction	
Shipping and Handling	Random Vibration 3.13 g RMS, random, 5 Hz – 20 Hz .01 g2/Hz sloping up to .02 g2/Hz 20 Hz – 500 Hz .02 g2/Hz	10 min / axis, 3 axis	

For additional information on mechanical shock and vibration testing conditions, refer to the processor *Thermal Design Guidelines*.

5.1 Solvent Resistance

Requirement: No damage to ink markings if applicable. EIA 364-11A

5.2 Durability

The LGA775 Socket must withstand at least 20 insertion cycles (i.e., the package is removed at the end of each de-actuation cycle and reinserted into the socket). Test is done per EIA-364, test procedure 09. Contact resistance is measured when mated in 1st and 20th cycles.

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Appendix A Mechanical Drawings

The following table lists the mechanical drawings included in this Section. These drawings refer to the LGA775 socket.

Note: *Intel reserves the right to make changes and modifications to the design as necessary.*

Drawing Description	Page Number
LGA775 Socket Assembly Drawing	22
LGA775 Socket Motherboard Footprint – 1	23
LGA775 Socket Motherboard Footprint – 2	24

Figure 2. LGA775 Socket Assembly Drawing

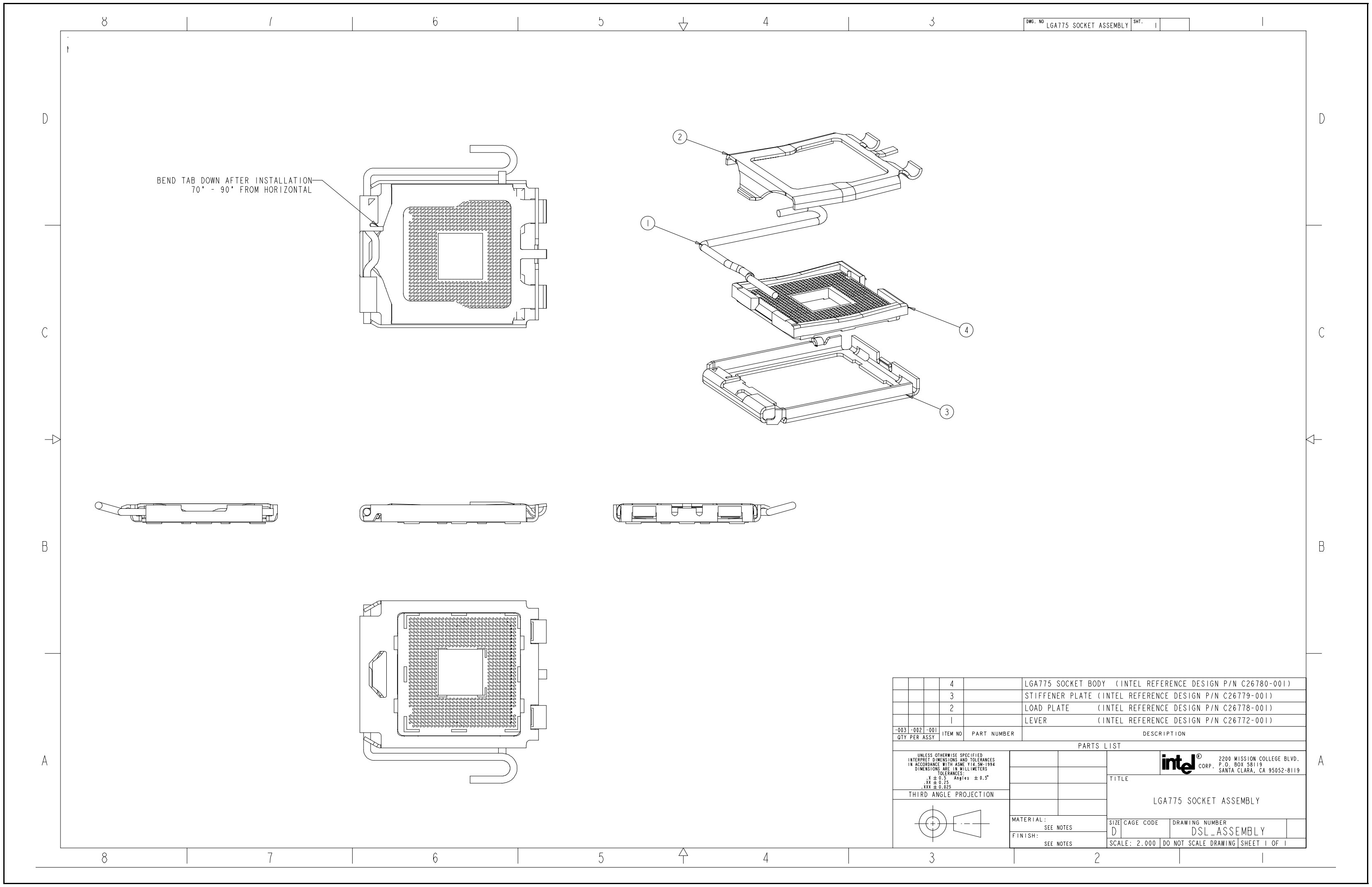


Figure 3. LGA775 Socket Motherboard Footprint – 1

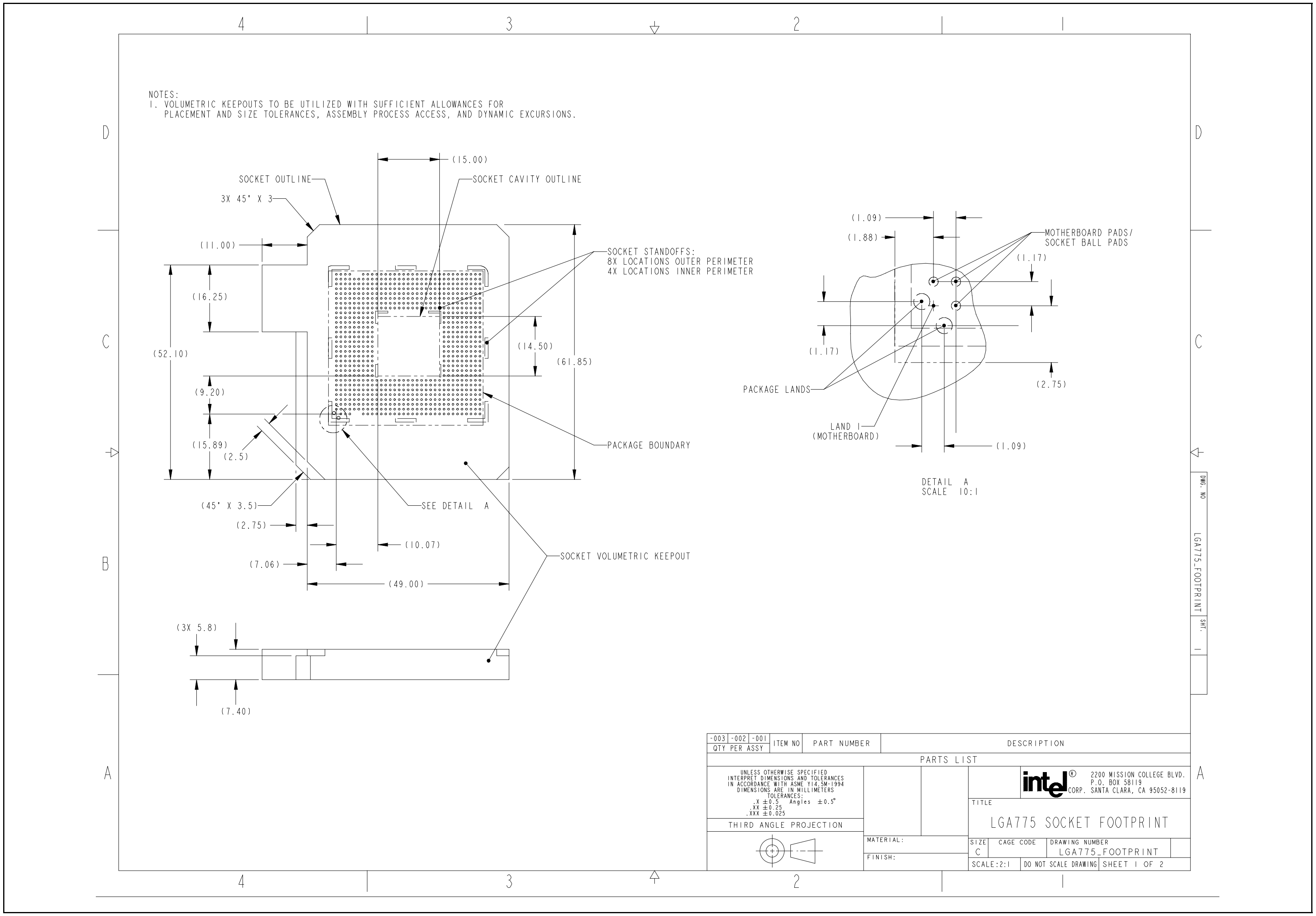
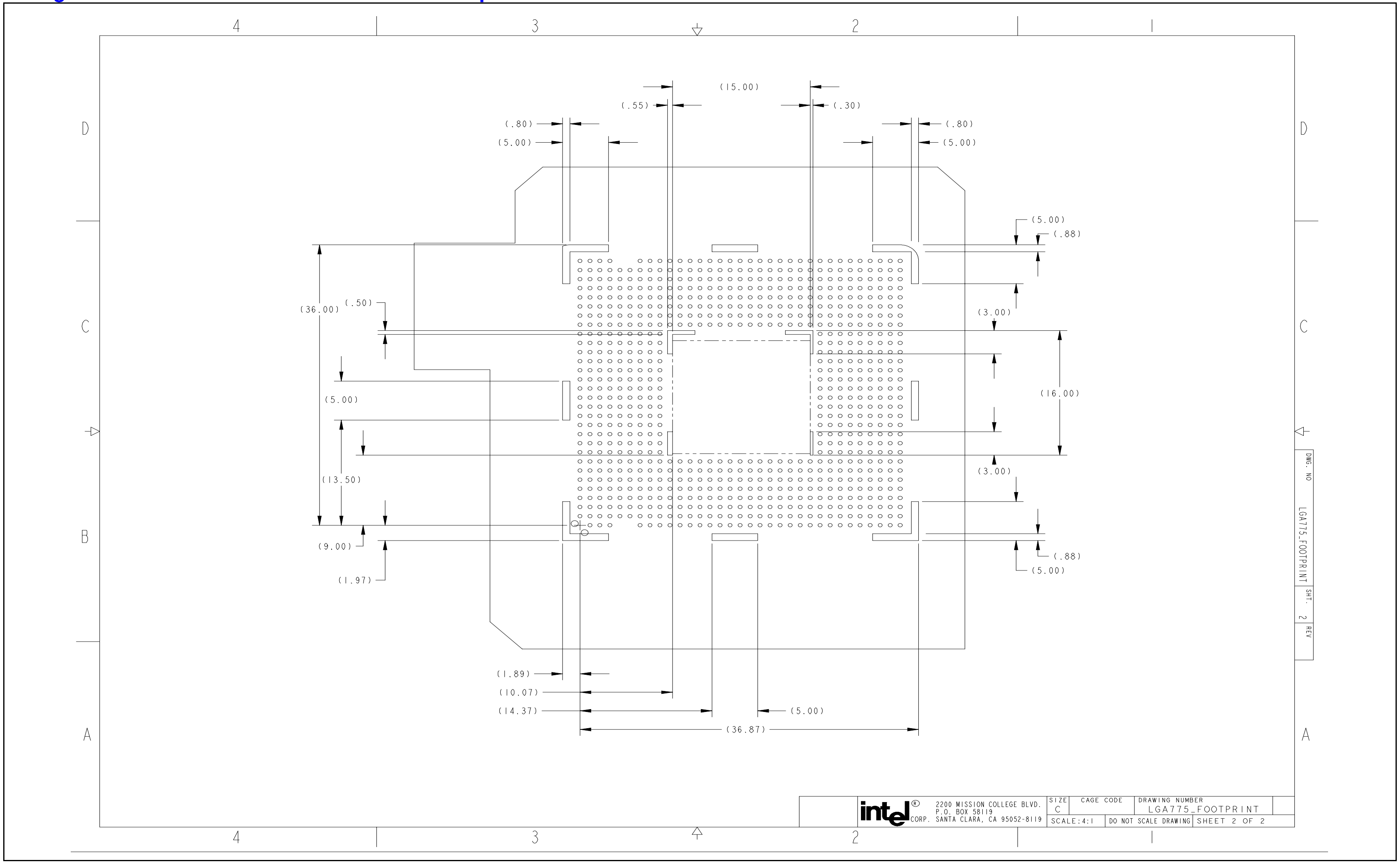


Figure 4. LGA775 Socket Motherboard Footprint – 2



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Appendix B Vendor Information

Table 3 lists suppliers that produce Intel enabled reference components. The part numbers listed below identifies these reference components. End-users are responsible for the verification of the Intel enabled component offerings with the supplier. Customers are responsible for thermal, mechanical, and environmental validation of these solutions.

Table 3. LGA775 Socket Vendors

Part Numbers (Intel equivalent PN)	Supplier	Contact	Phone	Email
LGA775 (leaded): **C28288** LF-LGA775 (lead-free): **C28289**	FCI	Asia Fred Gilbert US-EU Scott Kleinle	+86 769 88682108 x355 717-938-7509	fred.gilbert@fciconnect.com scott.kleinle@fciconnect.com
	Foxconn*	Julia Jiang	408-919-6178	juliaj@foxconn.com
	Molex	Far East USA	+886-2-2620-2300 800-786-6539	ProcessorSocket@molex.com
	Tyco*	Kevin Tsuchiya	+81 (44) 900-5015	ktsuchiy@tycoelectronics.com

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

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