Socket AM3 Design Specification

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Issue Date: **April 2010**	

Advanced Micro Devices

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Revision History

Date	Revision	Description
April 2010	1.06	Initial Public Release.
April 2008	1.05	Revised Figure 4, Section 3.4.2, Section 5.5, and included heatsink part number information.
November 2007	1.04	Second NDA release.
November 2007	1.03	Revised the package inner supports requirements.
October 2007	1.02	Replaced Figure 2 on page 9 and Figure 3 on page 10.
September 2007	1.01	Updated socket keying locations, package keying pins, and step height requirements.
April 2006	1.00	Initial NDA release.

Chapter 1 Introduction

This design specification defines the requirements for a 941-pin, 1.27-mm pitch, surface mount technology (SMT), zero insertion force (ZIF) socket (herein referred to as Socket AM3) for use with the AMD 938-pin or 940-pin, organic, micro pin grid array (µPGA) package. Socket AM3, shown in Figure 1, is designed to provide a reliable electrical interconnect between the printed circuit board (PCB) and the 938 pins or 940 pins of the organic µPGA package throughout the life of the product.

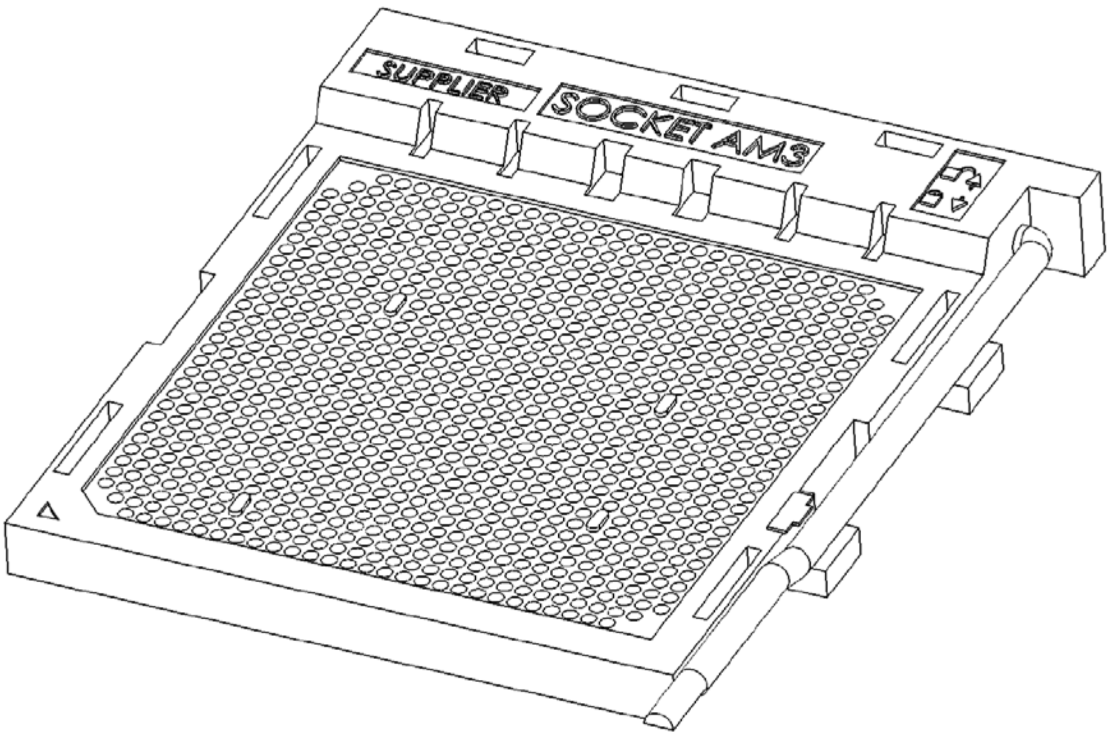


Figure 1. A 3-D View of Socket AM3

1.1 Purpose

This design specification specifies the dimensional, mechanical, electrical, and reliability requirements for the Socket AM3 that are necessary to meet the performance requirements of AMD microprocessor products.

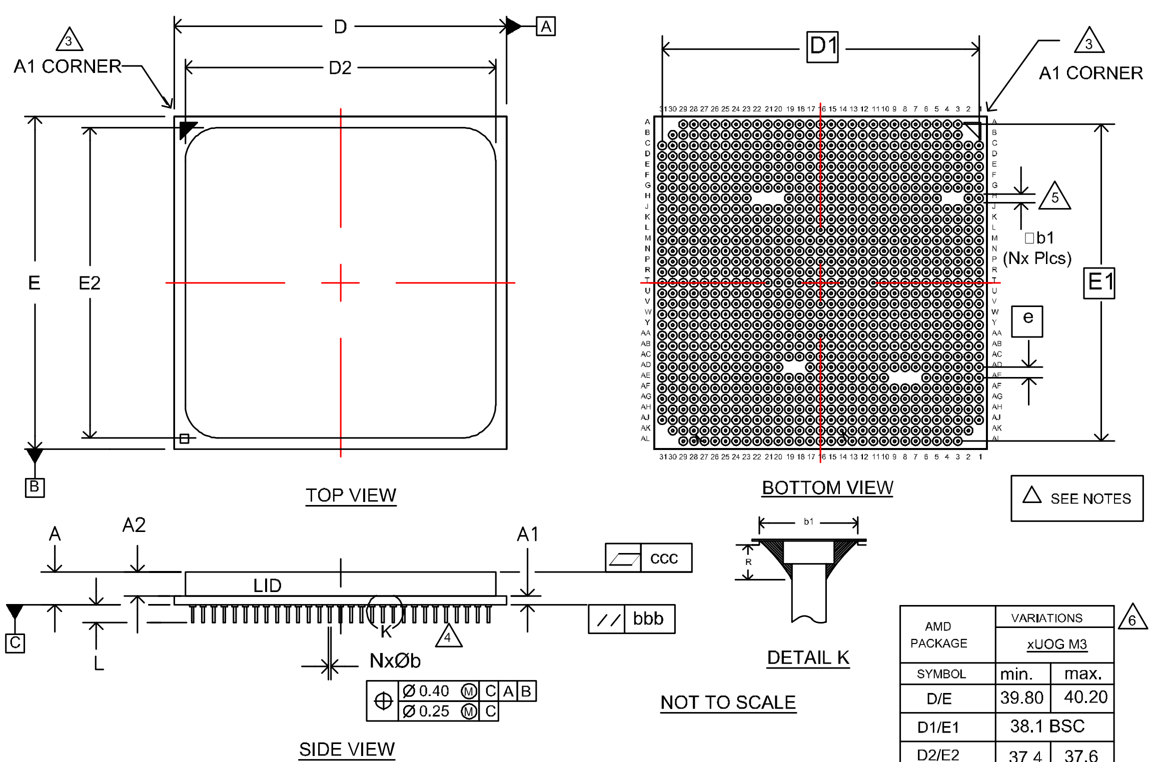
1.2 Supplier Requirements

To become a qualified supplier for the Socket AM3, the potential socket supplier must demonstrate that their product meets the requirements listed in this document and must conduct qualification testing on their production run sockets in accordance with the *Socket AM3 Qualification Plan*, order# 40524.

Chapter 2 Microprocessor Package Description

Figure 2 and Figure 3, on page 10, provides dimensional information for the 938-pin and 940-pin organic µPGA package that mates with the Socket AM3.

Socket AM3 is designed to be functional with the lidded, as well as with the lidless, package configuration.

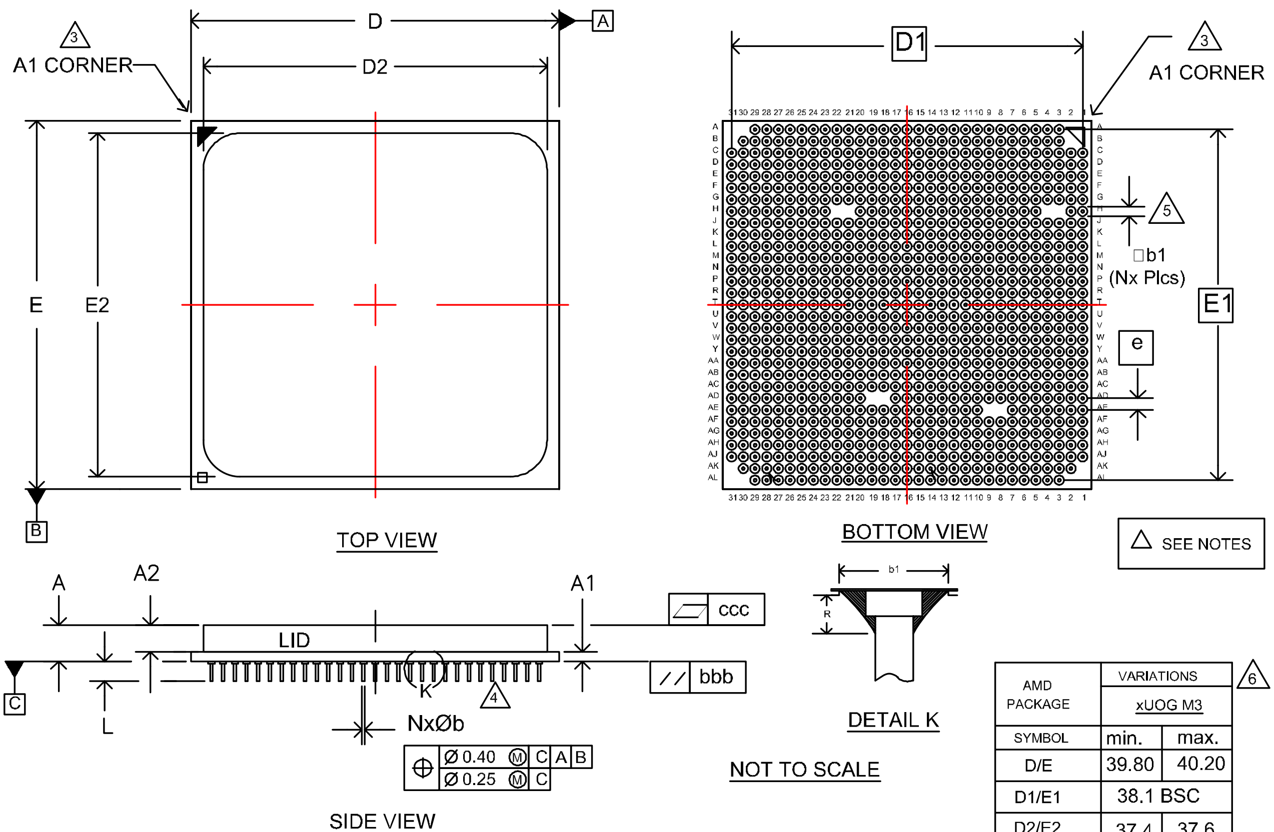


GENERAL NOTES

1. All dimensions are specified in millimeters (mm).
2. Dimensioning and tolerancing per ASME-Y14.5M-1994.
3. This corner is marked with a triangle on both sides of the package, identifying pin A1 corner, and can be used for handling and orientation purposes.
4. Pin tips should have radius 0.13.
5. Symbol "M" determines pin matrix size and "N" is number of pins.
6. "x" in front of package variation denotes non-qualified package per AMD 01-002.3.

AMD PACKAGE	VARIATIONS (6) xUOG M3	
SYMBOL	min.	max.
D/E	39.80	40.20
D1/E1	38.1 BSC	
D2/E2	37.4	37.6
A	4.12	4.86
A1	1.02	1.46
A2	3.10	3.40
e	1.27 BSC	
b	0.275	0.325
b1	0.98	1.08
L	1.95	2.11
M	31	
N	938	
R	0.30 MAX	
bbb	0.10	
ccc	0.125	
WT (gms)	39.275 REF	

Figure 2. AMD 938-Pin Organic µPGA Package Drawing



GENERAL NOTES

1. All dimensions are specified in millimeters (mm).
2. Dimensioning and tolerancing per ASME-Y14.5M-1994.
3. (△) This corner is marked with a triangle on both sides of the package, identifying pin A1 corner, and can be used for handling and orientation purposes.
4. (△) Pin tips should have radius 0.13.
5. (△) Symbol "M" determines pin matrix size and "N" is number of pins.
6. (△) "x" in front of package variation denotes non-qualified package per AMD 01-002.3.

AMD PACKAGE	VARIATIONS (△6)	
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A2	3.10	3.40
e	1.27 BSC	
b	0.275	0.325
b1	0.98	1.08
L	1.95	2.11
M	31	
N	940	
R	0.30 MAX	
bbb	0.10	
ccc	0.125	
WT (gms)	39.275 REF	

Figure 3. AMD 940-Pin Organic µPGA Package Drawing

Chapter 3 Socket Mechanical Requirements

This chapter describes the socket outline and mechanical requirements for the Socket AM3.

3.1 Socket Outline

Figure 4 shows the maximum allowable outline for the Socket AM3.

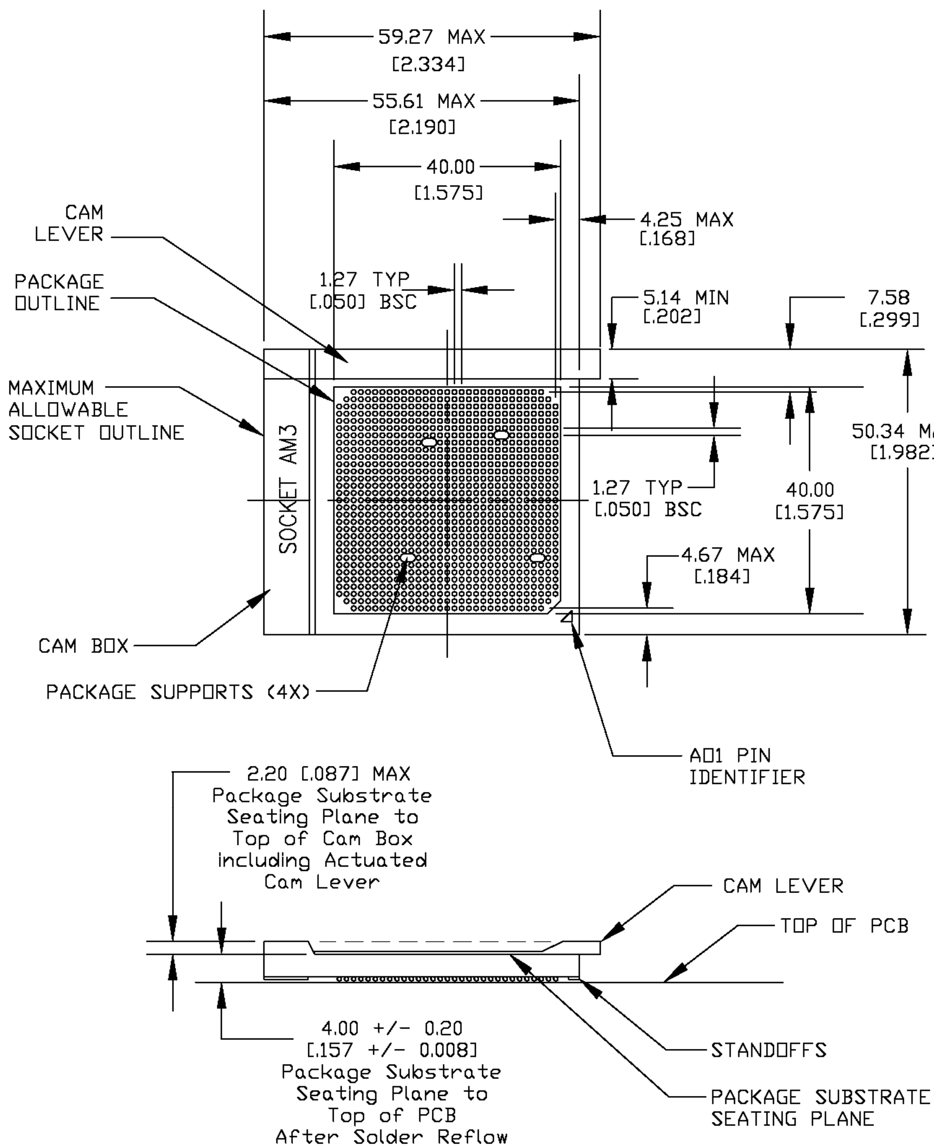

Figure 4. Socket AM3 Outline

3.2 Package Seating Plane

The cover for the Socket AM3 is designed to accommodate the package pin shoulder and braze/solder fillet as shown by the 938-pin or 940-pin organic µPGA package drawings in Figure 2 and Figure 3 on pages 9 and 10 respectively. Package support structures are incorporated into the socket cover to provide sufficient mechanical support (seating plane) for the package substrate without causing damage to the package pins at any time.

The package-seating plane on the socket cover has a surface flatness better than 0.25 mm when unmated, as well as when mated, with a package. After the socket is mounted to the PCB, the package-seating plane on the socket cover is 4.00 mm ± 0.20 mm from the mounting surface of the PCB.

3.2.1 Package Supports and Seating Plane Dimensional Requirements

To ensure proper support of the processor package while it is situated in the socket, the outer region of the socket seating plane that supports the outer portion of the processor package and the inner processor package supports, (indicated in Figure 4 on page 11), must meet the following dimensional requirements:

Table 1. Package Supports and Seating Plane Dimensional Requirements

Item No.	Requirement
1.	The outer support region step height is 0.30 mm ± 0.05 mm.
2.	The flatness of the outer support region must not exceed 0.25 mm.
3.	The inner supports are + 0.04 mm ± 0.05 mm above the least mean squares defined plane of the outer support region.

Refer to measurement requirements in Section 3.2.2.

3.2.2 Measurement Method for Package Supports and Seating Plane

The features in Section 3.2.1 must be measured using the methodologies shown in Sections 3.2.2.1 through 3.2.2.4, on pages 12 through 14, respectively.

3.2.2.1 Measurement Conditions

The socket to be measured must be reflowed to a PCB using the recommended reflow process for the socket for the particular solder ball composition.

Note: *A fixture that maintains the cover plate in contact with the base plate at the inner seating plane supports must be used for the socket measurement.*

3.2.2.2 Outer Support Region Step Height Measurement

Measure the outer step height at 24 evenly-spaced points (6 per side) around the outer support using a local point-to-point method as shown in Figure 5.

The step height is the difference in height between a point on the outer support region and an adjacent point on the recessed plane of the socket. See Figure 6, on page 14, for the definition of step height.

Note: *The step height must conform to the dimensional requirements of item 1, in Table 1, on page 12.*

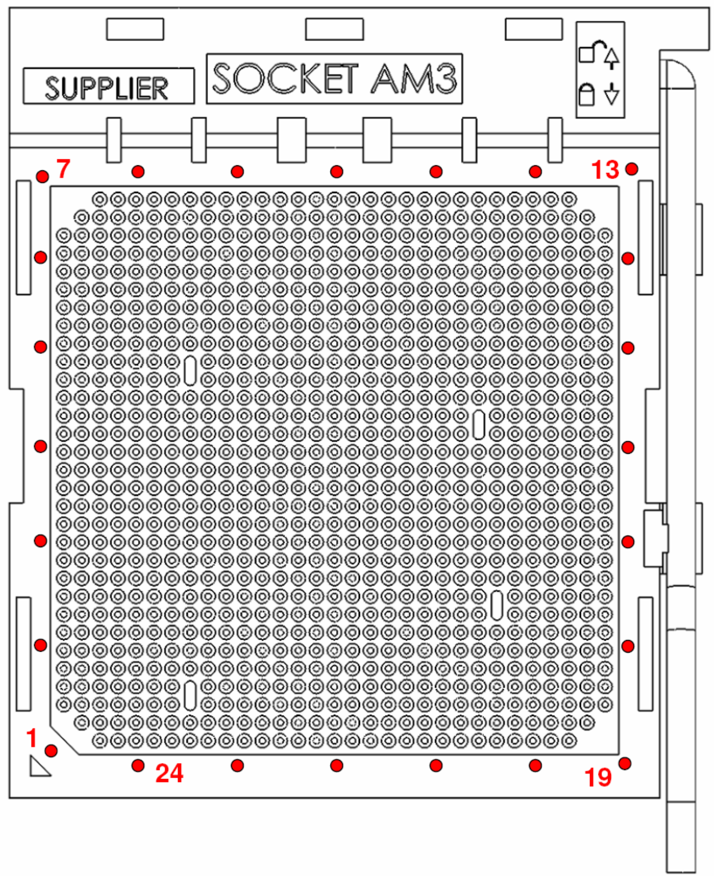

Figure 5. Illustration of Outer Region Measurement Points

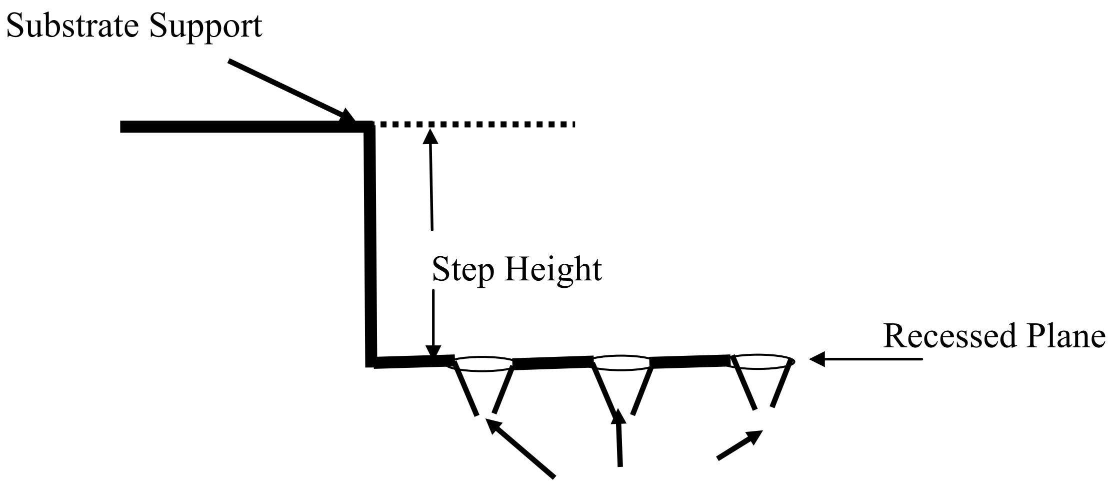

Figure 6. Definition of Step Height

3.2.2.3 Outer Support Region Flatness Measurement

Determine the best fit plane, least mean squares (LMS) method, to the 24 points measured on outer support region used in the step height measurement in section 3.2.2.2 on page 13.

Calculate the normal distance from each point to the LMS plane. Outer support region flatness equals the maximum normal distance of all points above the LMS plane minus the maximum normal distance of all points beneath the LMS plane (the distance of all points beneath the LMS plane is a negative number). Refer to Figure 7 for more detail.

Note: *The outer support region flatness must meet the criteria in item 2, of Table 1, on page 12.*

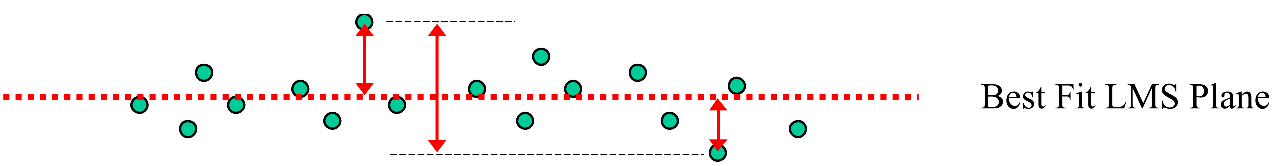

Figure 7. Illustration of Best Fit Plane and Outer Support Region Flatness

3.2.2.4 Inner Support Region Measurement

Measure the distance between four support posts and the defined plane, (the outer support region LMS plane defined in section 3.2.2.3), using a point-to-plane method. Refer to Figure 8, on page 15, for an illustration of the measurement method and Figure 9, on page 15, for an illustration of the measurement locations.

Note: *All four support posts measured must meet the dimension requirements of item 3, in Table 1, on page 12.*

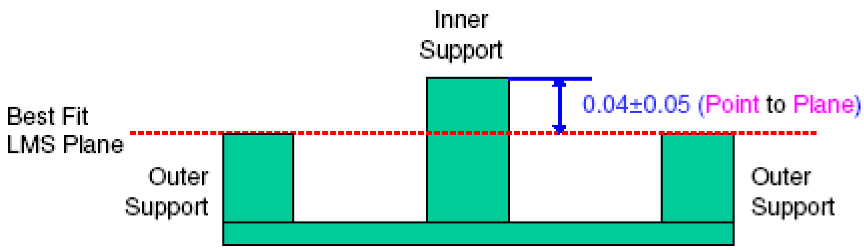

Figure 8. Illustration of Inner Support Measurement Method

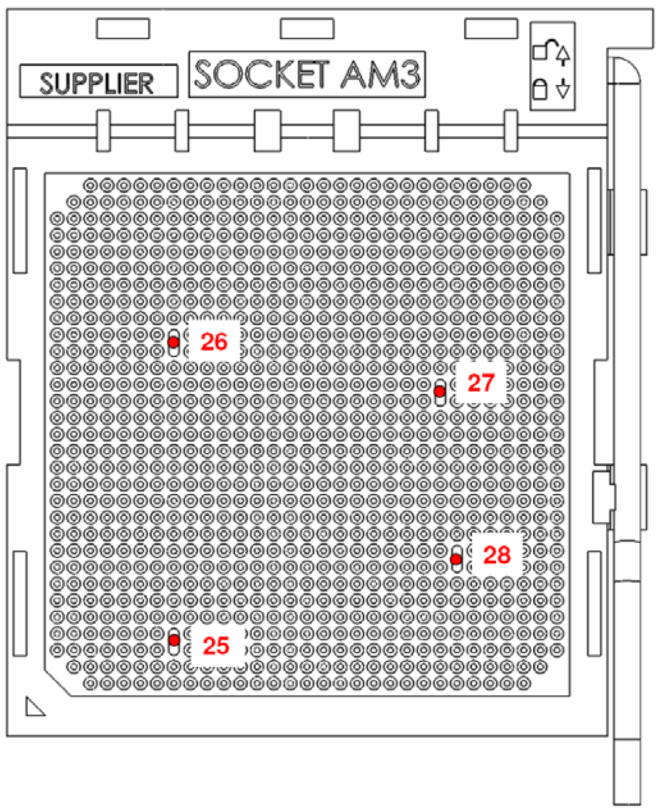

Figure 9. Illustration of Inner Support Measurement Locations

3.3 Socket Base and Socket Cover

The socket base and socket cover are made from liquid crystal polymer (LCP) with a UL flammability rating of 94 V-0. The colors for the socket base and cover are as follows:

- Socket base color — black
- Socket cover color — natural or ivory

The thickness of the socket cover (including the 0.30-mm pocket recess) must not exceed 1.17 mm. The socket cover flatness is less than 0.25 mm before and after the SMT reflow to the

PCB. The flatness measurement must remain less than 0.25 mm after environmental and mechanical testing.

Either a removable tape or plastic cover acts as an overlay for the pinholes in the top of the socket cover. The overlay facilitates socket pick-and-place operation with a vacuum nozzle during board assembly. The overlay must not outgas during the solder reflow processes or leave any residue upon removal prior to package pins insertion.

3.3.1 Socket Markings

The requirements for socket markings are as follows:

- The socket identifier marking "SOCKET AM3" must be molded into the top surface of the socket cover cam box region. See Figure 1 on page 8.
- A locked and unlocked directional designator is molded into the top surface of the cam box in close proximity to the actuation lever. See Figure 1 on page 8.
- A triangular shape symbol must be molded into the top of the socket cover for proper package pin A01 orientation. This orientation symbol is located to remain visible after the package is mated to the socket as shown in Figure 1, on page 8, and Figure 4, on page 11.
- The supplier's trademark symbol must be molded on the socket cover. Locate this marking to allow visibility and readability after the socket is solder mounted onto the PCB.
- The lot traceability number can be ink, laser, or impact marked on the socket cover. Locate the marking to be visible and readable after the socket is solder mounted onto the PCB.

3.4 Socket Contact

This section describes the contact material and solder balls for socket attachment to the PCB.

Note: *No lubricants can be present on the contact mating areas of fully assembled sockets that are shipped to customers by the supplier.*

3.4.1 Contact Base Metal

The contact base metal is made of high-strength copper alloy.

3.4.2 Contact Plating

The specifications for the contact plating are as follows:

- The entire contact is plated with 1.27-µm minimum thickness of nickel.
- The contact mating area is plated with 0.25-µm minimum thickness of gold over the 1.27 µm minimum thickness of nickel underplating. Gold porosity in the contact mating areas must be monitored and the number of pores must be recorded during qualification testing. This pore count should be maintained as a production quality control indicator.

3.4.3 Surface Mount Technology (SMT) Solder Balls

The specifications for the surface mount technology (SMT) solder balls are as follows:

- The socket is mounted to the PCB by SMT. The PCB solder pad diameter is 0.64 mm.
- The solder balls on the socket have a diameter of 0.76 ± 0.15 mm and are either leaded or lead-free in composition.
- Leaded solder ball composition is tin/lead (63/37 ± 5%).
- Lead-free solder ball composition can be Sn4.0Ag0.5Cu (SAC405), Sn3.0Ag0.5Cu (SAC305), or Sn3.5Ag.
- The contact must include a solder barrier feature to prevent solder from wicking up into the contact mating area during solder reflow.
- The Socket AM3 solder ball field must meet the co-planarity requirement of 0.20 mm.
- The force required to shear off the solder ball from the contact must be a minimum of 0.75 kgf.

3.5 Socket Actuation Lever

The socket incorporates a lever to the right side of the cam box for actuating and deactuating the socket contacts with the package pins. This actuation lever provides the mechanical advantage to easily actuate the socket in an OEM high-volume manufacturing environment and also facilitates tool-less socket actuation and deactuation operations by the end-user.

3.5.1 Lever Material

The recommended material for the actuation lever is stainless steel.

3.5.2 Package Insertion and Extraction Force

With the actuation lever in the open position, the package insertion and extraction forces, conceptually, are zero. These insertion and extraction forces must not exceed 2 kgf in actual applications.

3.5.3 Socket Retention Force

With the actuation lever in the closed position, the force required to extract the package pins out of the socket contacts must be a minimum of 0.013 kgf per pin.

3.5.4 Locking Latch

The socket cover incorporates a latch mechanism to lock the lever in the closed position after the socket contacts are mated with the package pins. Support tab(s) are added to the socket cover to cradle the actuation lever in the closed position. The tab(s) prevent the actuation lever from contacting the PCB.

3.5.5 Lever Actuation and Deactuation Force

The force required to actuate or deactuate the lever must be less than 3.6 kgf.

3.5.6 Pin Field Actuation Displacement

The package pins must be displaced less than 1.0 mm during socket actuation or deactuation.

3.6 Socket Durability

The socket must maintain electrical and mechanical integrity after 50 actuation and deactuation cycles with each mating package used no more than 5 mating cycles.

3.7 Visual Inspection

All visual inspections must be at 1X magnification, except for solder balls that must be inspected at 5X magnification.

3.7.1 Solder Balls

No missing, malformed, damaged, or misaligned solder balls attached to the contacts are allowed.

3.7.2 Contacts

No missing or damaged contacts that prevent the socket from functioning properly are allowed. Contact mating surface must not be missing gold plating.

3.7.3 Cover and Base

No cracks or flashing visible on the socket cover and base are allowed. All tabs that secure the socket cover to the base must not be damaged or missing. The socket cover must fit properly on the socket base with no visible gap between them. The lever latch cannot be damaged or malformed.

3.7.4 Actuation Lever

The actuation lever cannot be damaged, malformed, or missing.

Chapter 4 Socket Electrical Requirements

This chapter describes the contact current rating, inductance, capacitance, differential impedance, propagation delay, cross talk, dielectric withstanding voltage, and insulation resistance of the Socket AM3.

4.1 Contact Current Rating

The contact must be rated at a current rating of 1.5 A per contact with less than 30°C temperature rise and with a minimum of ten rows of mated contacts and pins energized.

4.2 Low Level Circuit Resistance (LLCR)

Contact resistance applies to the mounted socket with actuated package pin and includes the bulk resistance of the contact, solder ball, package pin, and the interface resistance between the contact and the package pin, but does not include the package internal trace resistance.

4.2.1 Initial Resistance

Initial contact resistance must be measured immediately after the first mating of the package pins to the socket contacts. The 200 daisy-chained pairs (400 contact locations) must be measured per socket sample. Initial LLCR must not exceed 20 mΩ per contact when mated with Cu Alloy-194 pins, based on measurements made on a daisy-chained pair of contacts.

4.2.2 Final Resistance

Final contact resistance must be measured after the mechanical and environmental testing of the mated package and socket is complete. The same 200 daisy-chained pairs (400 contact locations) must be measured per socket sample. Final LLCR must not exceed 20 mΩ per contact when mated with Cu Alloy-194 pins, based on measurements made on a daisy-chained pair of contacts.

4.3 Inductance

The inductance specifications for the Socket AM3 are as follows:

- The mated, partial self-inductance of a single pin must be less than 4 nH.
- The mated-loop inductance of two nearest pins must be less than 3.3 nH.
- The mated partial-loop inductance matrix of three neighboring pins must be less than 3.3 nH for the diagonal entries, and must be less than 2.2 nH for the off-diagonal entries.

Note: *Measurements are made at frequencies of 500 MHz and 2 GHz.*

4.4 Capacitance

The capacitance specifications for the Socket AM3 are as follows:

- The mated capacitance between two nearest pins must be less than 1 pF.
- The mated capacitance matrix of three neighboring pins must be less than 1 pF.

Note: *Measurements are made at frequencies of 500 MHz and 2 GHz.*

4.5 Differential Impedance

The differential (or odd mode) impedance for three, mated-pins configuration (one pin as the voltage/current reference—S1, S2, and G) must be 100 Ω ± 10% between the two nearest pins (with an additional ± 2-Ω measurement error). If the Time Domain Method is used, the signal must have a rise time of 150 ps for the signal amplitude to go from 10% to 90%.

4.6 Propagation Delay

The propagation delay specifications for the Socket AM3 are as follows:

- The propagation delay skew among single-ended signals must be less than 10 ps, plus a maximum measurement error of 3 ps.
- The propagation delay skew among differential signal pairs must be less than 10 ps, plus a maximum measurement error of 3 ps.

4.7 Cross Talk

Cross talk between the nearest single-ended and differential signals must be measured and compared to results from the measured partial-loop inductance and the Maxwell capacitance matrices.

4.8 Dielectric Withstanding Voltage (DWV)

The contact-to-contact dielectric withstanding voltage between randomly selected adjacent lateral, diagonal, and vertical contacts must be a minimum of 650 VAC.

4.9 Insulation Resistance (IR)

The contact-to-contact insulation resistance between randomly selected adjacent lateral, diagonal, and vertical contacts must be a minimum of 1000 MΩ.

Chapter 5 Socket Environmental Requirements

This section describes the socket design required to meet reliability requirements for the end-user field-use environment, OEM high volume manufacturing environment, and shipping and handling conditions of desktop computers.

5.1 Thermal Shock

Sockets must meet LLCR and visual inspection requirements after being subjected to 10 thermal shock cycles with the cold temperature extreme at –55°C and the hot temperature extreme at +110°C. The dwell at each temperature extreme is 30 minutes with less than 15 seconds transition time. The test should be conducted with the associated heatsink assembly (AMD part number 91B0000090) attached to the processor package.

5.2 Cyclic Humidity

Sockets must meet low-level circuit resistance (LLCR), dielectric withstanding voltage (DWV), insulation resistance (IR), and visual inspection requirements after being subjected to 1000 hours of cyclic humidity tests with a cycle time of eight hours. Temperature range is 25°C to 85°C with relative humidity maintained between 90% to 95%. This test should be conducted with the associated heatsink assembly (AMD part number 91B0000090) attached to the processor package.

5.3 Thermal Cycling

Sockets must meet LLCR and visual inspection requirements after being subjected to a minimum of 1000 cycles of thermal cycles with testing continued until 60% of the sockets fail or 3000 cycles are completed. Cold temperature extreme is –55°C with a dwell time of 20 minutes, and hot temperature extreme is +110°C with a dwell time of 15 minutes. The average rate of temperature change between the hot and cold temperature extremes must not exceed 10°C per minute. This test should be conducted with the associated heatsink assembly (AMD part number 91B0000090) attached to the processor package.

5.4 Temperature Life

Sockets must meet LLCR and visual inspection requirements after being subjected to 500 hours of temperature life testing at 115°C. This test should be conducted with the associated heatsink assembly (AMD part number 91B0000090) attached to the processor package.

5.5 Industrial Mixed Flowing Gas

Sockets must meet LLCR and visual inspection requirements after being subjected to mixed flowing gas testing with half the samples mated and the other half samples unmated for the first five days, and then all samples mated for the final five days. The test temperature is 30°C with a relative humidity of 70%. Mixed flowing gas constituents are 10-ppb chlorine, 10-ppb hydrogen sulfide, 200-ppb nitrogen dioxide, and 100-ppb sulfur dioxide.

5.6 Mechanical Shock

Sockets must meet LLCR, continuity intermittency of less than 1-µs duration, and visual inspection requirements after being subjected to mechanical shock testing at 50 g, 11-ms duration, half-sine waveform with three shocks per positive and negative directions on all three axes — totaling 18 shocks. This test should be conducted with the associated heatsink assembly (AMD part number 91B0000090) attached to the processor package.

5.7 Random Vibration

Sockets must meet LLCR, continuity intermittency of less than 1-µs duration, and visual inspection requirements after being subjected to random vibration testing at 3.1 g rms between 20 Hz to 500 Hz for a duration of 45 minutes per axis for each of the three axes. This test should be conducted with the associated heatsink assembly (AMD part number 91B0000090) attached to the processor package.

5.8 Resistance to Solder Heat

Sockets must meet LLCR, cover flatness, and visual inspection requirements after being subjected to four convection-solder-reflow processes for mounting the socket to the PCB. No deterioration of the markings on the socket is allowed.

5.9 Resistance to Solvents

Sockets must meet visual inspection requirements after being subjected to the Four Solutions test. No deterioration of the markings on the socket is allowed.

5.10 Heatsink Assembly

The associated heatsink assembly (AMD part number 91B0000090) attached to the processor package in the environmental testing can weigh up to 450 grams.