

ZERO INSERTION FORCE PIN GRID ARRAY SOCKET**Field of the Invention**

5 The present invention relates to an electrical connector and, in particular, a zero insertion force, pin grid array socket.

10 Integrated circuits (ICs) have become the world's standard for electronic circuits. These range from basic transistor networks to complex memory, microprocessor and multi-chip module circuits. The common denominator to all such circuits is that they are produced en masse on a substrate such as silicon and then separated into individual units commonly known as chips. The majority of chips are then mounted in a carrier for subsequent incorporation into end products. The basic size, shape and construction of the carrier is commonly known as the package and many standard packages have emerged. Some examples are commonly known as DIP, SOJ, PLCC, QFP and PGA. Chip packages have developed to accommodate both circuit function, i.e., number and placement of leads, and assembly trends, i.e., through-board and surface mount solder assembly. While the majority of IC devices are hard soldered in place, several factors such as device availability, testing, upgrades, etc., have traditionally shown that there is a need to socket ICs regardless of their package. IC sockets are known in the art for receiving pin grid array (PGA) packages. Previous PGA sockets required a high insertion force or low insertion force. Such sockets resulted in lead damage due to the high insertion and withdrawal forces. 25 Presently, IC packages have increasingly larger pin counts due to the continued miniaturization of the ICs. Such increased pin counts require zero insertion force (ZIF) sockets. For example, Intel, Inc. OverDrive™

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Processor Sockets are known in the art. Generally, the contacts used in these sockets are referred to as normally closed contacts. Such ZIF PGA sockets are known in the art but include complex and expensive contact designs. Such contact designs are stressed greatly as the insertion forces increase. Also, such common contact designs have large plating areas which increase cost. Accordingly, there is desired a ZIF PGA socket design which overcomes the aforementioned shortcomings.

Summary of the Invention

It is, therefore, an object of the present invention to provide a socket which includes a contact design which is quickly and inexpensively manufactured.

It is another object of the present invention to provide a socket having a contact design which provides for a selective plating area.

It is a further object of the present invention to provide a socket having a contact design which provides for low stress-strain upon increase of normal force.

It is another object of the present invention to provide a contact design providing for great elastic range upon insertion.

It is a further object of the present invention to provide a contact which may be generated on a die having small centers to reduce material usage.

According to the above objects, a zero insertion force, pin grid array IC socket is provided comprising a cover slidably engaged to a base and the cover having an array of holes formed therethrough corresponding to an array of passages in the base for receiving a corresponding array of IC pins. The passages of the base include contacts having a tail portion and a single unidirectionally stamped beam. The contact tails are

mounted in the socket housing at a 60°-85° angle from a plane parallel to a first side of the socket. The contact includes a retention arm being bent at a 45°-90° angle to the plane of the tail. The contact includes a
5 wipe surface and shoulders. The wipe surface is at the stamped edge of the contact. The contact includes a continuous torsional beam having a surface area of at least forty percent of the surface area of the entire contact. The torsional beam provides for a low stress/
10 strain force ratio.

The contact includes a wipe surface along the stamped edge or first side of the open end of the contact. This arrangement provides for a reduced selective plating area. A selective plating area
15 includes an area less than an eightieth of the size of the entire contact.

These and other features of the invention are set forth below in the following detailed description of the presently preferred embodiments.

20 **Brief Description of the Drawings**

FIG. 1 is a plan view of the socket of the present invention;

FIG. 2 is a plan view of the socket of the present invention having the cover removed;

25 FIG. 3 is an enlarged plan view of Area A of the socket of FIG. 2;

FIG. 4 is a perspective view of the socket of FIG. 3, partially cut-away; and

30 FIG. 5 is a plan view of the contact of the present invention prior to insertion.

Detailed Description of the Preferred Embodiments

An embodiment of the zero insertion force, pin grid array socket of the present invention is best understood

by FIGS. 1-5. Turning to FIG. 1, socket 10 is shown having base 20 and cover 40. The cover includes an array of holes 42 for receiving pins of an IC package. The holes 42 generally are beveled in order to assist in the insertion of the pins of the IC package. The socket 10 includes actuator 60 for sliding the cover 40. By moving the actuator 60, the cover 40 will be slid in direction of arrow 41 to move the cover across the top surface of the base 20. The IC package is mounted to the socket 10 via insertion of the IC package pins through the corresponding array of holes 42 of the cover 40. The array of pins of the IC package are inserted through the array of holes 42 of the cover 40 and into the corresponding array of passages of the base 20. Due to the design of the contacts and the passages of the base 20, the insertion of the pins requires a zero insertion force. Following full insertion of the pins into the holes 42 and passages of the base 20, the actuator 60 is moved causing the cover 40 to slide, forcing the pins into their fully mated position with the contacts mounted in the passage of the base 20.

The cover 40 is mounted to the base 20 via outer latches 51 which engage hooks 53 of the base 20. As well, the cover 40 includes inner latches 52 which engage inner hooks 54. In a preferred embodiment, the latches 51,52 are integrally molded with the cover 42, and the hooks 53,54 are integrally molded with the base 20. While the latches 51,52 act to retain the cover 40 onto the base 20, they also provide a means for limiting warpage of the cover 40. The IC packages which are mounted to the socket 10 can undergo great changes in heat dissipation. Such heat may cause the warpage of the socket 10. To avoid such warpage in a preferred

embodiment, four outer latches 51 are oriented in each corner of the socket 10 and a pair of inner latches 52 are oriented on either side of the inner portion of the socket 10. The actuator 60 is mounted in channel 67 of the base 20. The channel 67 has an open end 68 and a closed end 69. At the closed end 69, a retaining wall 70 extends from the edge of the base 20 and is perpendicular to the channel 67. A retaining wall 70 retains the actuator 60 within the channels 67 upon attachment of the cover 40 over the actuator 60 and onto the base 20.

FIG. 2 is a plan view of the socket 10 having the cover 40 removed. The base 20 is shown having an array of passages 22. The base 20 includes a first side 33 which is perpendicular to the channel 67 and a second side 34 which is parallel to the channel 67. The contacts 30 are mounted in the passages 22. It can be seen that while the passages 22 are generally parallel to the first side 33 of the base 20, the tails 38 are mounted at a 60°-85° angle to the first side 33. The channel 67 is shown having the actuator removed. In a preferred embodiment, the socket 10 houses approximately three hundred and twenty (320) contacts being interstitially spaced on a .100 inch x .100 inch grid. Generally, the socket 10 has an overall dimension of 2 inches x 2.420 inches x 5/16 inches. In a preferred embodiment, the housing of the cover and base are injection molded from a polymeric material.

Turning to FIG. 3, an enlarged plan view of Section A of FIG. 2 is shown. The base 20 includes the passages 22 having the contacts 30 mounted therein. Upon initial insertion of the pins of an IC package, the pins are inserted through the cover 40 and are received in the zero insertion force pocket 25. The zero insertion force

pocket 25 has dimensions greater than the diameter of the pin of the IC package. The pin is then slid in the direction of arrow 24 and is moved from the zero insertion force pocket 25 into the portion of the passage 22 adjacent the contact 30 via the movement of the cover. The pin first contacts shoulder 31 of the retention arm 35 of contacts 30. The pin then continues past shoulder 31 to arrive in its fully mated position against wipe area 32. The base 20 includes a first side 33 and a second side 34. While the passages 22 have walls which are generally perpendicular and parallel to first and second sides 33,34, the contacts 30 are mounted within the passages 22 at a skewed angle θ . Generally, angle θ is an angle between 60° - 85° from the first side 33. The mounting of the contacts 30 at an angle allow for the high density arrangement of the passages 22 and the contacts 30 of the present invention.

Turning to FIG. 4, a perspective view of an enlarged section of the base 20 is shown having a cut-away section exposing the passages 22 and the contacts 30. A first side 33 and second side 34 of the base 20 are shown. The cut-away was taken forming a first wall 11 and a second wall 12. The first wall 11 is parallel with first side 33. The second wall 12 is parallel with the mounting angle of the tail 38 of the contacts 30. First wall 11 and second wall 12 form angle θ . Generally, angle θ is between 60° - 85° . In a preferred embodiment, the contacts 30 are mounted having tail 38 at an angle of 75° to the first side 33. A pin 85 of an IC package is inserted in zero insertion pocket 25. As shown, the diameter of the pin 85 is less than the dimensions of the zero insertion force pocket 25 and therefore requires zero insertion force. The pin 85 is moved in the

direction of arrow 24, parallel to the first side 33, when the cover 40 is slid due to the movement of the actuator (as shown in FIG. 1). The pin 85 slides along the stamped edge 13 and engages the shoulder 31 of the contacts 30. The pin 85 then is slid past to the wiping area 32. The pin 85 reaches its fully mated position, as shown by pin 85'.

The contacts 30 include tail 38 and the torsional beam 27. The tail 38 and torsional beam 27 are formed in a unitary plane. The contacts 30 are mounted in the base 20 at an angle θ to the first side 33. The unitary plane of the tail 38 and the torsional beam 27 is at an angle θ which is generally 60° - 85° from the first side 33. However, the angle θ may be any skewed angle or an angle which is not parallel or perpendicular to the first side 33 which allows for a high density arrangement of the passages 22 and the contacts 30. In a preferred embodiment, the contacts 30 are mounted at an angle of 75° to the first side 33. The contacts 30 include the retention arm 35. The retention arm 35 is bent at approximately a 45° - 90° angle to the plane of the tail 38 and torsional beam 27. The positioning of the retention arm 35 at other than a 90° angle may allow for overlapping mounting of the contacts 30 for even tighter spacing than shown in FIG. 4. As mentioned earlier, the contacts 30 include the wiping area 32 along the stamped edge 13 of the retention arm 35. Opposite the wiping area 32 is a nonwiping side 37 of the contacts 30. The nonwiping side 37 is also offset at an angle to the first side 33 of the base 20 (also see FIG. 3). As the retention arm 35 is bent at approximately a 45° - 90° angle to the plane of the tail 38 and torsional beam 27, the nonwiping side 37 will be offset approximately 90° from

the angle θ at which the tail 38 is mounted within the base 20. As the wiping surface 32 is not parallel with the nonwiping side 37, the angle of the wiping surface 32 is skewed from all other stamped edges 13. The present design of the contacts 30 and their placement at an angle within the base 20 allows for the dense spacing which is required for the present interstitial footprint of the base 20 and the high pin count of the IC package which is received therein. The contacts 30 also include wings 26 for providing a friction fit of the contacts within the passages 22.

Generally, the contacts 30 are a stamped contact of a copper alloy. The contact 30 is stamped on a die in a unitary plane. The unitary plane is that of the tail 38 and the torsional beam 27. The stock that the contacts 30 are stamped from, in a preferred embodiment, has a stamped edge 13 which generally has a thickness of .006 inch and a wipe area 32 which is approximately .030 inches long, providing a total wiping surface area of .00018 square inches compared to the total contact surface area which is .0082 square inches or approximately forty-five times the wiping surface area. This small wiping area allows for selective plating of a small area of the contacts 30. Prior to the forming of the retention arm 35 at approximately a 45°-90° angle, the contact 30 in its unitary plane is plated at this selective wiping area 32 or target area. A method of forming the socket includes preparing a plurality of contacts in a unitary plane plated generally at the selective wiping area 33. It can be seen that the overall design of this contact allows for a great reduction in the plating materials required for the contacts 30. In a preferred embodiment, gold plating is

adhered to the wipe areas 32 and due to the small area, the plating costs are greatly reduced. Such plating techniques may include mask plating or controlled depth plating. Such plating techniques may be applied either before or after bending of the retention arm 35. As well, the contact design of the present invention allows for the contacts to be spaced on the die on .100 inch spacing so that they may be quickly and easily inserted into the passages 22 of the base 20 and providing for minimal material usage.

The IC package pin 85 is initially inserted into the zero insertion force pocket 25 and is then slid in direction of arrow 24, sliding past the shoulder 31. At this point of insertion, the greatest amount of force is received by the contacts 30. Because the retention arm 35 is a unitary member with the entire torsional beam 27, the entire force received at the shoulder 31 is spread along the entire length of the torsional beam 27. The force of the pin 85 against the shoulder 31 causes the torsional beam 27 including the retention arm 35 to deflect in a torsional manner in direction of arrow 39. The torsional beam 27 of the contacts 30 receives this torsional deflection upon insertion of the pin 85.

The present contact design provides for the contact being stamped from a sheet of material having a narrow Z dimension or thickness or stamped edge 13. The rolled surface of the material is of sufficient width and length for the X-Y dimensions of the contact to define a second side 14 and a third side 15. The retention arm 35 is bent at an angle to the second side 14 or the third side 15 of the contacts 30. Such bending along a relatively lengthy crease 75, as compared to the thickness of the first side 13, provides for a large

surface area of the contacts 30 for the torsional motion 39 induced by the normal force of pin 85 to be transferred beyond the retention arm 35 and to the entire torsional beam 27. Such torsional beam 27 provides for the advantages of the present invention of a low stress/strain force ratio and a great elastic range, as compared to the straight cantilever designs of the prior art. Due to the dispersion of the normal force of the pin 85 of the present invention along the entire torsional beam 27 length, the stress-strain measurement is lessened for this contact design. Thus, the torsional beam 27 having a surface area of at least forty percent of the entire contact surface area, provides for greater elastic range than the contacts of the prior art, while maintaining sufficient normal forces.

After the pin 85 is slid past the shoulder 31 of the retention arm 35, it attains its final mating position against the wiping area 32. Pin 85' is shown in a final mated position between the wiping area 32 of the retention arm 35 of the contacts 30 and a partition 18 of the passages 22 which provide a sufficient normal force to hold the pin 85 therein. Prior art contacts do not have the advantage of the contact of the present invention in that insertion forces are not deflected throughout the majority of the contact surfaces and selective plating of small areas cannot be undertaken.

Turning to FIG. 5, the contacts 30 are shown after stamping prior to insertion in the base 20 of the socket. The contacts 30 include the tail 38 and the torsional beam 27. Wings 26,26 help retain the contacts 30 via press-fit within the base 20. It can be observed that the present contact design allows for the quick stamping and insertion of the contacts within the

base 20.

5 It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications may be made without departing from the spirit and scope of the present invention and without diminishing its attendant advantages. It is, therefore, intended that such changes and modifications be covered by the appended claims.



CLAIMS:

1. A zero insertion force pin grid array socket comprising:

5 a cover having an array of holes formed therethrough
slidably engaged to a base, said base having a first side
and a corresponding array of passages to said holes, said
holes and corresponding passages for receiving pins of an
IC package; and

10 contacts mounted in said passages including a tail
at a first end and a torsional beam at the opposite end,
said contacts mounted within said base having said tail
mounted at an angle of 60°-85° to said first side of said
base.

15 2. The socket of Claim 1 wherein said contact
receives plating at a wiping area and the entire surface
area of said contact being at least forty times the
surface area of said wiping area.

20 3. The socket of Claim 1 wherein said torsional
beam has a total surface area of at least thirty percent
of the entire surface area of said contact.

4. The socket of Claim 1 wherein said wiping area
is at a stamped edge of said contacts.

5. The socket of Claim 1 wherein a shoulder of
said contact is at a stamped edge of said contacts.

25 6. The socket of Claim 1 including zero insertion
force pockets adjacent to said passages.

7. The socket of Claim 1 wherein the insertion
path of said pins is parallel to said retention arm.

30 8. The socket of Claim 1 wherein said retention
arm is at a 45°-90° angle to the plane of said torsional
beam and contact tail.

9. A zero insertion force, pin grid array socket
comprising:



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a cover slidably engaged to a base and having an array of holes formed therethrough, said base having a corresponding array of passages to said holes, said holes and corresponding passages for receiving pins of an IC package; and

contacts mounted in said passages including a tail at a first end and a torsional beam at the opposite end being mounted within said base at a skewed angle.

10. The socket of Claim 9 wherein said contact is mounted at an angle of 60°-85° to a first side of said base.

11. The socket of Claim 9 wherein said torsional beam includes a retention arm at an angle of 45°-90° to the plane of said contact tail.

12. The socket of Claim 9 wherein said torsional beam includes a retention arm having a wiping area, the entire surface area of said contacts being at least forty times of the surface area of said wiping area.

13. The socket of Claim 9 wherein said bent retention arm forms a crease having a length greater than the thickness of said contact.

14. A method of forming a zero insertion force, pin grid array socket including the steps of:

molding a cover slidably engagable to a base and having an array of holes formed therethrough;

molding said base having a corresponding array of passages to said holes;

stamping a plurality of contacts on .100 inch spacing including torsional beams having a wiping area; plating said wiping area; and

inserting said contacts in said passages at a skewed angle.

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15. The method of Claim 14 wherein the wiping area has a surface area of less than a fiftieth of the surface area of said contact.

5 16. The method of Claim 14 wherein said torsional beam has a surface area of at least thirty percent of said contact surface area.

17. The method of Claim 14 wherein said contacts create a normal force through torsional movement of said torsional beam.

10 18. The method of Claim 14 wherein said plating step includes selective plating of said wiping area.

19. The method of Claim 14 wherein said plating step includes spot plating of said wiping area.

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