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(54) **REDUCED FOOTPRINT TEST SOCKET SYSTEM**

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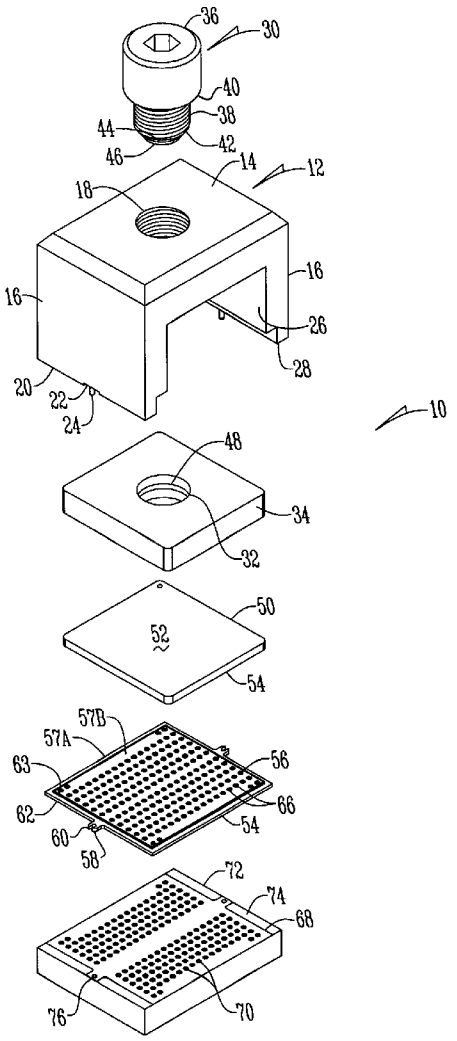
(57) **ABSTRACT**

A test socket system has a housing with a screw that extends through central openings in the housing and a pusher block. Positioned below the pusher block is an integrated circuit and positioned below the integrated circuit is a contact set. The contact set is slidably received within slots on the inner surface of side walls of the housing. Positioned below the contact set is a PC adapter which is connected to a motherboard. The PC adapter has holes that receive dowels that extend downwardly from the bottom edge of the side walls of the housing. This system allows for easy and quick attachment of integrated circuits to a motherboard for testing purposes.



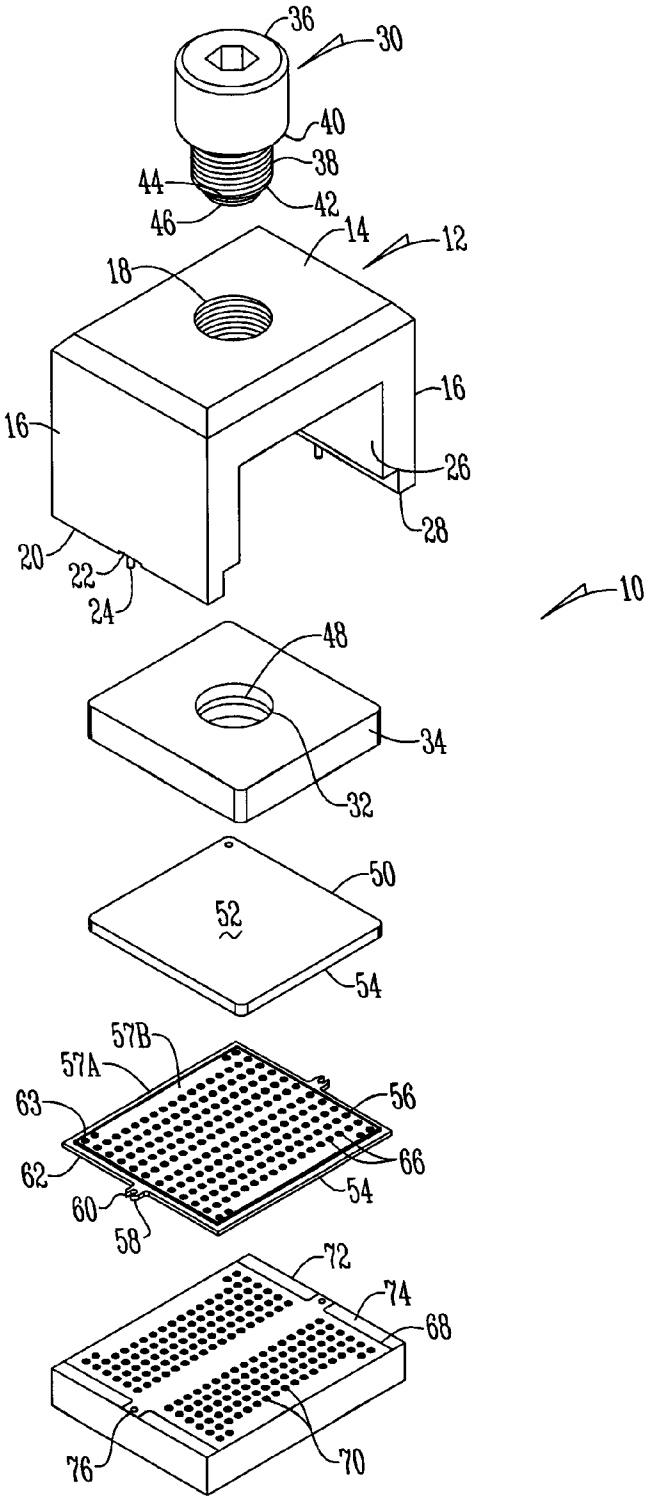

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Fig. 1

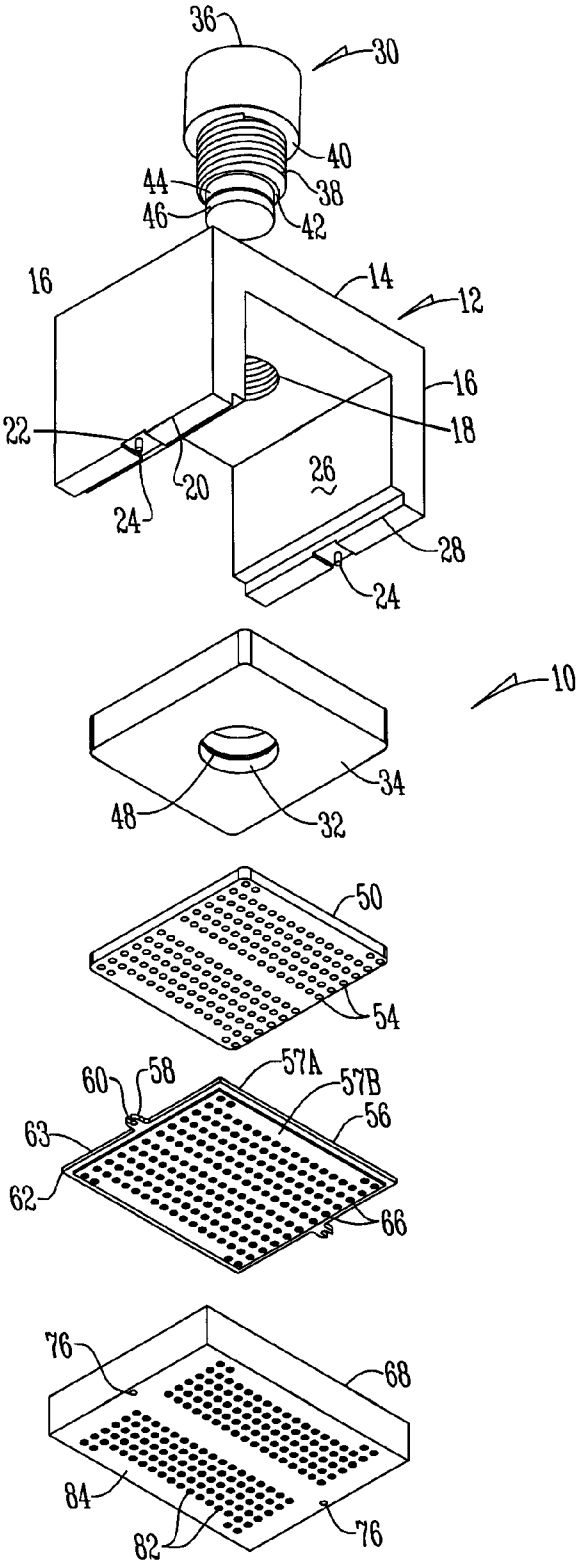
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Fig. 2

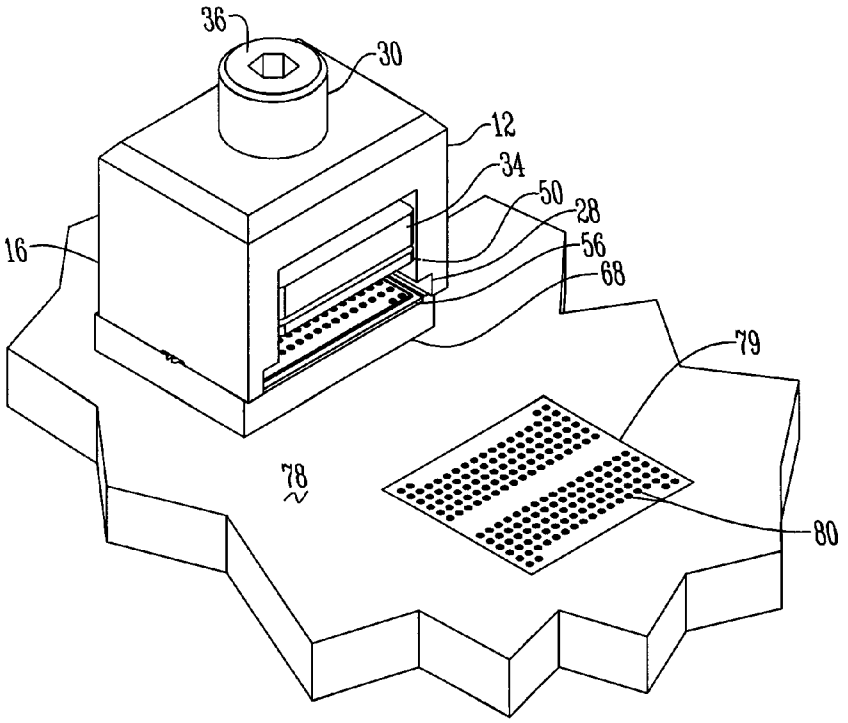

Fig. 3

REDUCED FOOTPRINT TEST SOCKET SYSTEM

BACKGROUND OF THE INVENTION

[0001] This invention is related to a test socket system and more particularly a test socket system that does not require mounting features on the motherboard.

[0002] Test sockets are well-known in the art and are used to make an electro-mechanical connection between a packaged integrated circuit (IC) and a printed circuit board (PCB) for testing the functionality and/or performance of the IC. Typically, the test socket employs different electrical interconnect systems such as spring loaded pins, ridged metal contacts, conductive elastomers and other structures that pass current and electrical signals between terminals on the IC and PCB. The test socket normally has mounting holes with screws and alignment pins that mate with corresponding holes in the PCB.

[0003] When a PCB is designed for end use as a motherboard, test sockets are not used and the IC is directly attached to the board, usually by soldering. There are situations where an end user wishes to test one or more devices on the board without having the device under test (DUT) soldered. In these, and other situations, a test socket that does not require mounting features is desired. In addition, due to space constraint on the PCB, additional active and passive components are near the DUT and must be accommodated.

[0004] Therefore, an objective of the invention is to provide a test socket system that does not require mounting features on the motherboard.

[0005] A further objective of the invention is to provide a test socket system that accommodates passive components near active components.

[0006] Yet another object of the invention is to provide a test socket system that is inexpensive.

[0007] Another object of the invention is to provide a test socket system that is fast and easy to use.

[0008] Yet another object of the invention is to provide a test socket system that compensates for variation of the coplanarity between the DUT/IC and the motherboard.

[0009] Another object of the invention is to provide a test socket system that has a zero footprint.

[0010] These and other objectives will be apparent to one of ordinary skill in the art based upon the following written description.

SUMMARY OF THE INVENTION

[0011] A test socket system has a housing with a screw that extends through central openings in the housing and a pusher block. Positioned below the pusher block is an integrated circuit and positioned below the integrated circuit is a contact set. The contact set is slidably received within slots on the inner surface of side walls of the housing.

[0012] Positioned below the contact set is a PCB adapter which is connected to a motherboard. The PC adapter has holes that receive dowels that extend downwardly from the bottom edge of the side walls of the housing. This system allows for easy and quick attachment of integrated circuits to a motherboard for testing purposes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. **1** is an exploded perspective view of a test socket system;

[0014] FIG. **2** is an exploded perspective view of a test socket system; and

[0015] FIG. **3** is a perspective view of a test socket system attached to a motherboard.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] Referring to the Figures, the test socket system **10** includes a housing **12** having a top wall **14** and multiple side walls **16** that extend downwardly from the top wall **14**. In the arrangement shown, a pair of opposing side walls **16** are shown, however any number of side walls **16** are contemplated such as 3, 4, 5, 6, or more. The top wall **14** has a centrally located opening **18**. Along the bottom edge **20** of the side walls **16** is a cut-out section **22** from which one or multiple dowels **24** extend in a downward direction. Adjacent the bottom edge **20**, extending lengthwise along the interior of the inner surface **26** of the side walls **16** are slots **28**. Slots **28** may be grooves, recesses, or any other alignment feature positioned on or in or connected to the interior of inner surface **26** and can extend any distance up the inner surface **26** to provide alignment for the other components of the system **10** as is discussed herein.

[0017] A screw **30** is formed to extend through opening **18**. In one example, screw **30** is a pusher screw received in a central opening **32** of a pusher block **34**, by a snap fit connection. Alternatively, screw **30** threadably engages opening **18**. In one arrangement, the screw **30** has a head **36** with a shaft **38** having a diameter smaller than the head **36** to form a shoulder **40**. Extending from the shaft **38** and having a diameter smaller than the diameter of shaft **38** to form shoulder **42** is a connecting extension **44**. The connecting extension **44** has a ridge **46** that extends around the outer surface of the extension **44** which is formed to be received in a groove **48** which extends around the wall of opening **32**. The description of pusher screw **30** is not meant to be limiting. Any other type of screw is hereby contemplated such as a straight screw, a shoulder screw, a stepped screw, a tapered screw, a bolt screw or the like or any other type of connecting member may be used, such as a snap fit arrangement, a press arrangement or the like to connect pusher screw **30** to pusher block **34**.

[0018] The pusher block **34** has a width that fits within side walls **16** and a length no greater than the length of top wall **14**. In this arrangement, pusher block **34** fits within and is aligned by sidewalls **16** and is vertically positional by rotating pusher screw **30**.

[0019] Positioned below the pusher block **34** is a packaged integrated circuit (PIC) device under test (DUT) **50** (DUT for short). In one arrangement, the DUT **50** is smooth on the top surface **52** and has downwardly extending leads **54**. In one arrangement, the downwardly extending leads **54** are merely electrical contact points which are flush with a generally flat and planar bottom surface of the DUT **50**. In another arrangement, the downwardly extending leads **54** protrude a distance from the flat and planar bottom surface of the DUT **50**. In one arrangement, the downwardly extending leads **54** take on the form of a ball grid array (BGA).

[0020] A ball grid array (BGA) is a type of surface-mount packaging used for integrated circuits. BGA packages are used to permanently mount devices, such as microprocessors, to other components, such as motherboards. A BGA can provide more interconnection pins than can be put on a dual in-line or flat package. The whole bottom surface of the device can be used, instead of just the perimeter. The leads are

also on average shorter than with a perimeter-only type, leading to better performance at high speeds.

[0021] The BGA is descended from the pin grid array (PGA), which is a package with one face covered (or partly covered) with pins in a grid pattern which, in operation, conduct electrical signals between the integrated circuit and the motherboard or printed circuit board (PCB) on which it is placed. In a BGA the pins are replaced by pads on the bottom of the package, each initially with a tiny ball of solder stuck to it. These solder spheres can be placed manually or by automated equipment, and are held in place with a tacky flux. [1] The device is placed on a PCB with copper pads in a pattern that matches the solder balls. The assembly is then heated, either in a reflow oven or by an infrared heater, melting the balls. Surface tension causes the molten solder to hold the package in alignment with the circuit board, at the correct separation distance, while the solder cools and solidifies, forming soldered connections between the device and the PCB.

[0022] BGA is a solution to the problem of producing a miniature package for an integrated circuit with many hundreds of pins. Pin grid arrays and dual-in-line surface mount packages were being produced with more and more pins, and with decreasing spacing between the pins, but this was causing difficulties for the soldering process. As package pins got closer together, the danger of accidentally bridging adjacent pins with solder grew. BGAs resolve many of these problems.

[0023] Like the pusher block **34**, the DUT **50** is sized and shaped to fit within and is aligned by sidewalls **16** of housing **12**. Or, said another way, the size, shape and dimensions of the housing **12** are designed such that the housing **12** fits over the DUT **50** within close tolerances such that the housing **12** holds and aligns the DUT **50**. Like pusher block **34**, the DUT **50** and is vertically positional within the housing **12** by rotating pusher screw **30**.

[0024] Positioned below the IC **50** is contact set **56**. Contact set **56** serves to connect the downwardly extending leads **54** of the DUT **50** to the leads electrical interconnects **70** on the PCB adapter **68**. In one arrangement, contact set **56** is formed of a plurality of spring pins.

[0025] In another arrangement, contact set **56** includes a frame **57**A which holds and surrounds a flexible member **57**B. In one arrangement frame **57**A is a rigid or semi-rigid member which provides support for and holds the flexible member **57**B so as to maintain its dimensional size and shape within needed tolerances.

[0026] In one arrangement, flexible member **57**B is an elastomeric interconnect. In this arrangement, the elastomeric interconnect of flexible member **57**B is formed of a sheet of flexible and compressible silicon rubber which is non-conductive in nature, or said another way, is an electrical insulator. Any other flexible and/or compressible material is hereby contemplated for use. The elastomeric interconnect of flexible member **57**B has a plurality of electrical interconnects **66** therein that align with the leads **54** of the DUT **50** and receive leads **54** of the DUT **50** on its top surface. In one arrangement, these electrical interconnects **66** are formed of columns of particles of electrically conductive material suspended within the elastomeric interconnect, or silicon rubber. In one arrangement, these columns of conductive material extend from the top surface to the bottom surface of the flexible member **57**B so as to provide an electrical passageway through the insulating elastomeric interconnect or flexible member **57**B.

[0027] The electrically conductive material can include any conductive material such as copper, silver, gold, iron, metal, alloy, aluminum, any alloy or any combination thereof or the like. In one arrangement gold powder, gold particles, gold coated particles, gold dust or gold beads are suspended in columns within the silicon rubber. In one arrangement, when not compressed, these columns of conductive material are not-conductive or non-conductive; in contrast, when compressed, these columns of conductive material are conductive.

[0028] Connected to the exterior edge of frame **57**A are one or multiple tabs **58** which include slots **60** which are in vertical alignment with dowels **24** of the housing **12**. The tabs **58** permit installation and/or replacement as well as alignment of the contact set **56** with housing **12**, pusher block **34** and DUT **50** after assembly. In one arrangement, the bottom edge **62** and/or the top edge **63** of frame **57**A of the contact set **56** extends upwardly and/or downwardly thereby providing a shoulder, step, recess or protrusion at the intersection of frame **57**A and flexible member **57**B that aids in aligning the contact set **56** with the other components described herein such as DUT **50**. In another arrangement, the frame **57**A is vertically narrower or thinner than the flexible member **57**B, such that the frame does not prevent compression of the flexible member between the DUT **50** and the printed circuit board adapter **68**. The exterior edge of frame **57**A is sized and shaped to be held by and slidably received within slots **28** on the inner surface **26** of the housing **12** when the dowels **24** are received within slots **60** of tabs **58**.

[0029] Positioned below the contact set **56** is a printed circuit board adapter **68** (PCB adapter). The PCB adapter **68** has a plurality of electrical interconnects **70**, also known as pads, that align with leads **54** of the DUT **50** and/or electrical interconnects **66** of the contact set **56**. The PCB adapter **68** also has elongated top edges **72** that extend along the top surface of the sides of the PCB adapter **68**. The top edges **72** include multiple mounting surfaces **74** and at least one if not multiple openings **76** that align with and receive dowels **24** from the housing **12**. When fully assembled, the mounting surfaces **74** abut the bottom edge **20** of the side walls **16** of housing **12**.

[0030] In one arrangement electrical interconnects **70** of PC adapter **68** extend through the PC adapter **68** and therefore are exposed at the top surface and the bottom surface of PC adapter **68**

[0031] The PCB adapter **68** is connected to a motherboard or system board **78**. The motherboard **78** has a footprint **79** thereon which is sized and shaped to receive the DUT **50** in a commercial embodiment of the motherboard **78**. This footprint **79** includes a plurality of electrical interconnects **80**, also known as pads, that are aligned to receive solder balls, leads or contacts **82** that extend from the bottom surface **84** of the PCB adapter **68**. In one arrangement, the electrical interconnects or pads **70** of the PCB adapter **68** are designed to replicate the electrical interconnects or pads **80** of the footprint **79** of motherboard **78**. In this arrangement, the PCB adapter **68** is merely a pass-through.

[0032] In another arrangement, the electrical interconnects or pads **70** of the PCB adapter **68** are different from the electrical interconnects or pads **80** of the footprint **79** of motherboard **78**. Rerouting the electrical interconnects or pads **70** of the PCB adapter **68** allows the user to test different DUTs **50**. In addition additional components or functionality can be placed in the PCB adapter. This allows the signals,

powers, grounds and/or traces to be rerouted. In addition, this allows improved or different DUTs **50** to be tested. This also allows the user to test DUTs **50** with different footprints on the motherboard **78**. In addition, the modified PCB adapter **68** can provide various test-points for further testing purposes.

[0033] In one arrangement, the solder balls, leads or contacts **82** shown on the bottom surface **84** of the PC adapter **68** are electrically connected to the electrical interconnects **70** shown on the top surface of the PC adapter **68**. In one arrangement BGA is used to connect the PCB adapter **68** to the motherboard **78**. Alternatively the adapter **68** is soldered to the motherboard **78** and/or any other method or means of connecting the PCB adapter **68** to the motherboard **78** is used.

[0034] To assemble the system **10**, the pusher block **34** is positioned within sidewalls **16** of the housing **12** such that opening **32** of block **34** aligns with opening **18** of housing **12**. Pusher screw **30** is inserted through opening **18** and into opening **32** such that ridge **46** is received within groove **48** of pusher block **34**.

[0035] DUT **50** is placed on top of contact set **56** and aligned such that the downwardly extending leads **54** of the DUT **50** are positioned over and engage the electrical interconnects **66** on the top surface of the contact set **56**. Once aligned, the frame **57**A is aligned with and held within the slot **28** in the bottom edge **20** of the housing **12**. In this position, the dowels **24** of housing **12** are received in slots **60** of tabs **58** assuring proper alignment and hold.

[0036] The PCB adapter **68** is connected to the motherboard **78**. This is accomplished by either starting with a motherboard **78** that does not include a chip or packaged integrated circuit connected to footprint **79**; or alternatively, if a chip or packaged integrated circuit is connected to footprint **79** by removing the chip or packaged integrated circuit. The chip or packaged integrated circuit may be removed by any conventional means such as melting the solder that connects the chip or packaged integrated circuit to the motherboard **78**, grinding the chip or packaged integrated circuit off of the motherboard **78**, or by any other means or methods. Once the footprint **79** is clear and the electrical interconnects **80** of the footprint **79** are exposed, the PCB adapter **68** is aligned with and connected to the motherboard **78** by any conventional means such as soldering, BGA or the like. This connects the solder balls, lead or electrical contact **82** of the PCB adapter to the electrical interconnects **80** of the footprint **79** of the motherboard **78**.

[0037] Once the PCB adapter **68** is rigidly, permanently or non-removably connected to the motherboard **78**, the housing **12** is then placed on the PCB adapter **68** such that the dowels **24** are received in openings **76** of the PCB adapter **68**. In this arrangement, the bottom edge **20** of the housing **12** is connected to or adhered to the mounting surfaces **74** of the PCB adapter **68**. In this arrangement the system **10** is then connected to the motherboard **78** for testing.

[0038] Once assembled, the screw **30** is rotated or adjusted which moves the pusher block **34** towards and away from the PCB adapter **68**. When this movement is towards the PCB adapter **68**, the pusher block **34** forces downward on the DUT **50** which forces downward on the contact set **56** which is sandwiched between the pusher block **34**/DUT **50** combination and the non-movable PC adapter **68** which is connected to the motherboard **78**. This downward motion squeezes or compresses flexible member **57**B which is held within rigid frame **57**A. This compression causes the plurality of electrical interconnects **66** therein to similarly compress. As the flexible member **57**B compresses, the columns of particles of electrically conductive material suspended within the elastomeric interconnect that form electrical interconnects **66** similarly compress thereby forming an electrically conductive column through the flexible member **57**B.

[0039] By the elastomeric interconnect being flexible, this allows the flexible member **57**B and the individual electrical interconnects **66** therein to compensate for variation of coplanarity between the DUT **50** and the PCB adapter. This reduces the number of shorts or connection failures between the downwardly extending leads **54** of the DUT **50** and the electrical interconnects **70** of the PC adapter **68**. In addition, the columns of compressible conductive particles provide a high quality electrical connection between the DUT **50** and the PCB adapter **68** which provides excellent electrical performance, high contact area (with more contact points), high bandwidth (~39~25 GHz@−1 dB (S21)) minimal solder ball deformation, no load board damage, missing ball detection, fast & easy maintenance, lower cost of ownership, among other improvements and advantages.

[0040] In operation, this system can be easily used to test a plurality of different Packaged Integrated Circuits (such as DUT **50**) on a motherboard **78** when no mounting or alignment features or test features are positioned on motherboard **78**.

[0041] In another arrangement, to provide additional strength of connection between PCB adapter **68** and housing **12**, conventional screws connect housing **12** to PCB adapter **68**. Alternatively, the housing **12** is connected to PCB adapter **68** by adhering, gluing, welding, soldering, snapping, or any other manner or method of connecting or binding two components together. This allows additional pressure to be applied to the DUT **50** without the housing separating from the PCB adapter **68**. Accordingly, a test socket system **10** has been disclosed in the art that, at the very least, meets the stated objectives. That is, the system and method described herein improves upon the state of the art; it provide a test socket system that does not require mounting or alignment features on the motherboard; it provides a test socket system that accommodates passive components near active components; it is inexpensive; it is easy to use; it compensates for variation of the coplanarity between the device under test and the motherboard or the PCB adapter; and it has a zero footprint, among other features and advantages.

[0042] It will be appreciated by those skilled in the art that other various modifications could be made to the device without parting from the spirit and scope of this invention. All such modifications and changes fall within the scope of the claims and are intended to be covered thereby.

What is claimed:

1. A test socket system, comprising:

a housing;

a pusher block positioned within the housing;

an integrated circuit positioned below the pusher block;

a contact set positioned below the integrated circuit and aligned by the housing; and

a printed circuit board adapter positioned below the contact set;

wherein the pusher block applies pressure to the integrated circuit.

2. The system of claim **1** wherein the housing has side walls with dowels that extend downwardly along a bottom edge of the side walls.

3. The system of claim **1** wherein the printed circuit board adapter is connected to a motherboard.

4. The system of claim **1** wherein the contact set has tabs on its sides that are in vertical alignment with dowels of the housing.

5. The system of claim **1** wherein the contact set is received within the side walls of the housing.

6. The system of claim **1** wherein the printed circuit board adapter has holes that align with and receive dowels of the housing.

7. The system of claim **1** wherein the contact set includes a rigid frame which surrounds a flexible member having a plurality of electrical interconnects.

8. The system of claim **1** wherein the contact set includes a plurality of electrical interconnects which are formed of columns of conductive material held by a flexible member.

9. The system of claim **1** wherein the contact set includes a plurality of columns of suspended gold.

10. The system of claim **1** wherein the contact set includes a flexible silicon rubber having a plurality of columns of conductive material.

11. A test socket system, comprising:

a housing;

a pusher block held by the housing,

the pusher block being vertically adjustable;

an integrated circuit positioned below the pusher block;

a contact set positioned below the integrated circuit;

a printed circuit board adapter positioned below the contact set;

the printed circuit board adapter connected to a motherboard;

wherein the contact set includes a plurality of electrical interconnects which connect the integrated circuit to the printed circuit board adapter.

12. The system of claim **11** wherein the contact set has a flexible material having a plurality of columns of conductive material therein.

13. The system of claim **11** wherein when the pusher block applies pressure to the integrated circuit the contact set creates an electrical connection between integrated circuit and the printed circuit board adapter.

14. The system of claim **11** wherein the electrical interconnects are formed of gold particles.

15. The system of claim **11** wherein the electrical interconnects are formed of particles suspended in a flexible material.

16. The system of claim **11** wherein the electrical interconnects are non-conductive when not compressed, and conductive when compressed.

17. The system of claim **11** wherein the electrical interconnects are held within silicon rubber.

18. A test socket system, comprising:

a housing;

a pusher block held by the housing,

the pusher block being vertically adjustable;

an integrated circuit positioned below the pusher block;

a contact set positioned below the integrated circuit;

the contact set having a flexible material which holds a plurality of electrical interconnects;

a printed circuit board adapter positioned below the contact set;

the printed circuit board adapter connected to a motherboard;

wherein when the pusher block applies pressure to the system, the contact set electrically connects the integrated circuit to the printed circuit board adapter.

* * * * *