

APPARATUS AND METHOD OF SELF-CLEANING TEST SOCKETS

Field of the Invention

[0001] The present invention relates to test sockets capable of self-cleaning and preventing debris from depositing on pogo probes. The self-cleaning sockets are applicable to testing general electronic assemblies, particularly high-pin-count semiconductor IC devices.

Background of the Invention

[0002] High performance test sockets for semiconductor devices, general electronic components and modules are essential to design, testing and production applications. Typically, a test socket **100** comprises a plurality of spring probes or pogo pins housed in an electrically insulating block **20**. **Figure 1a** illustrates the cross-sectional side view of such pogo pin configuration in a typical test socket available commercially. The pogo pins **10** are good electrical conductors and each of which primarily comprises one (single-ended) or two (double-ended) plungers **11** resting on a spring (not shown) housed in a barrel **13**. When test socket **100** is closed, the downward force **14** applied on the device under test (DUT) **15** compresses the solder balls or leads **21** of the DUT on the pogo pins **10**, which in turn compress on the circuit board **16** and thereby completing the paths for electrical connection. **Figure 1b** shows the top view of pogo pins **10** housed in said insulating block **20**.

[0003] Test sockets are prone to performance degradation if contaminants are not removed from the pogo pins. Common contaminants include debris from the device substrate, solder and its oxides from device leads, and ambient dust. These materials not only block contact with the device leads and could lead to poor electrical conductivity for the internal contact surfaces, but also obstruct the movement of plungers **11** when they are trapped around the internal springs of pogo pins. This results in intermittent or permanent contact failures and elevated resistance. Test sockets must therefore be maintained clean. In a mass production assembly line, the requirement for regular cleaning of the pogo pins and test sockets is stringent as failure to maintain clean test sockets could lead to significantly poor test and production yields.

[0004] Presently, cleaning procedures typically involve manual brushing and directing compressed air at probe tips. JP03270246A and JP01248072A teach the use of single or a small number of fixed compressed air nozzles positioned in the proximity of test pins to blow metal and resin dust off the socket. The disclosed methods fail to address problems associated with the pogo spring probes widely used in today's test sockets, particularly those for high-pin-count devices with fine pitches: Firstly, test sockets designed for high-pin-count components such as ball grid array semiconductor chips employ high-density miniature pogo probes, whose plungers and tips are very fragile and are not designed to withstand excessive air flow and pressure; secondly, said air nozzle configuration potentially drives contaminants into the internal working parts of the pogo probes and they cause a serious damage to the probes. Therefore, high performance socket and probe suppliers discourage direct use of compressed air and heavy brushing.

[0005] Thus, there is an imperative need for a safe and effective apparatus and means of cleaning test sockets applicable to a wide range of devices and test applications. The system and method of the present invention satisfy the need. Other advantages of this invention are apparent with reference to the detailed description provided herewith.

Summary of the Invention

[0006] The present invention provides a system and means of supplying fluid streams to individual pogo probe in a test socket, and said fluid streams travel in parallel with the longitudinal axis of the tips of said probe and in the directions away from the tips. Gases such as air, nitrogen and inert gases may be used as suitable fluid. The configuration employed in the present invention has overcome the difficulties and shortfalls of prior disclosures: Firstly, there is minimum compressed fluid traveling in transverse of the pogo plungers and in the directions that compresses the pogo pins and their internal springs, which potentially cause significant damages to the fragile probe tips; secondly, contaminants are blown or kept away from the gaps between the pogo plungers and flanges; and thirdly, the present invention comprises a programmable controller which regulates the pressure of said fluid streams with respect to time, and said controller enables regular cleaning using fluid streams of higher pressure, and continuous prevention of collection of debris with diffused fluid streams of moderate pressure.

[0007] Accordingly, in one aspect, the present invention provides a self-cleaning test socket comprising pogo probes mounted in an electrical insulator block with embedded network of fluid ducts for leading fluid flow from an external source to pogo plungers on a scheduled or continuous basis. In another aspect, the present invention provides a method of self cleaning test sockets, comprising steps of mounting pogo probes in an electrical insulator block and embedding a network of fluid ducts in said insulator block for distributing diffused fluid streams from an external source to individual pogo plungers on a scheduled or continuous basis.

Brief Description of the Drawings

[0008] Preferred embodiments according to the present invention are described with reference to the figures, wherein like reference numerals denote like elements:

[0009] **Figures 1a & 1b** illustrate respectively the cross-sectional side and top views of a typical test socket available commercially;

[0010] **Figure 2** shows the cross sectional view of the probe portion of the self-cleaning test socket;

[0011] **Figure 3** shows the cross sectional view of the probe portion of an alternative embodiment of the self-cleaning test socket;

[0012] **Figure 4** shows the cross sectional view of the probe portion of yet another alternative embodiment of the self-cleaning test socket;

[0013] **Figure 5** depicts a typical embedded fluid duct network in communication with an external fluid controller.

Detailed Description of the Invention

[0014] The present invention may be understood more readily by reference to the following detailed description of certain embodiments of the invention.

[0015] **Figure 2** shows the cross sectional view of the probe portion of the self-cleaning test socket, which comprises one top block **21** and one bottom block **22**. The socket blocks are electrical insulator machined from Polysulfone or Torlon or any other suitable insulating material. The pogo pins **10** are sandwiched and kept in place by the top **21** and bottom **22** blocks with typically two-level matching drilled holes **23**. The pogo

probes 10 are made from gold-plated beryllium copper or any other suitable electrically conducting material. The pogo probes 10 have two end plungers 11 or they could be single ended (not shown). The plunger tips 11 could be shaped in a variety of ways for different mechanical and electrical requirements. Said tip shape includes but is not limited to flat, round-edged, convex, concave and faceted. The distribution of pogo probes in the socket is determined by the pin or test pad configuration of the device under test (DUT) (15 in **Figure 1**). Said distribution includes is but not limited to linear, dual-in-line, circular, concentric, square array, rectangular array and their variations and combinations.

[0016] In **Figure 2**, the drilled holes 23 house the probes 10 and serve as vertical branch ducts 23 to distribute fluid stream from the horizontal branch duct 24 to the fluid outlets 25 beside or encircling individual plungers 11. It should be understood by one skilled in the art that gases such as air, nitrogen and other inert gases may be used as suitable fluid to clean the test sockets. The pogo probes 10 are further kept in place by the spacer or collar rings 31 attached to the neck of the flanges 17 where the plungers 11 emerge. Each of the collar rings 31 has an outer diameter 32 larger than the diameter 26 of the fluid outlet 25 against which the ring is placed, whereas the inner diameter 33 of each ring is large enough for the ring to slip and rest on the flange neck 17. Horizontal branch duct 24 is in communication with a plurality of vertical branch ducts 23. Part of the fluid stream traveling along horizontal branch duct 24 flows through individual vertical branch duct 23 in the directions 27. Each collar ring 31 comprises at least one or preferably a plurality of through holes or apertures 34 through which fluid stream from vertical branch duct 23 is delivered to fluid outlets 25 in the directions 28. Collar rings 31 are preferably made from electrical insulator which can either be rigid or semi-rigid.

[0017] The design of the overall fluid duct network is by no means restricted to the design depicted in **Figure 2**. **Figure 3** illustrates another configuration wherein the interconnections between the horizontal 24 and vertical 23 branch ducts are characterized by smoothed cavity walls 41 for improved fluid distribution. D-shaped structures 42 are disposed across the walls at the intersection of the horizontal 24 and vertical 23 branch ducts, with their longitudinal axes perpendicular to those of pogo pins 10. Said structures 42 provide additional mechanical support to pogo probes 10 and assist in distributing fluid flow to vertical branch ducts 23 in the directions 43. **Figure 4** shows yet another configuration wherein horizontal branch ducts 24 do not intersect with the center portion of

the barrels 13 of pogo probes 10 for improved fluid distribution. Connecting ducts 51 are used to lead fluid stream from horizontal branch ducts 24 to vertical branch ducts 23 in the directions 52.

[0018] Figure 5 shows a typical fluid duct network embedded in the top and bottom insulator blocks (21 & 22 in Figure 2) which are used to support the pogo probes (not shown) inserted in vertical branch ducts 23. Fluid inlet 62 is located at a convenient position on the insulator block, wherein pogo probes are housed, such that it does not cause obstruction to any probe and socket movement. Main fluid duct 61 is part of the embedded fluid duct network and it distributes fluid flow from fluid inlet 62 to all the horizontal branch ducts 24, which in turn lead the fluid streams to vertical branch ducts 23 and subsequently fluid outlets encircling the pogo probes (not shown). Fluid inlet 62 is connected to a fluid controller 72 via external fluid tubing 71. Fluid controller 72 is user programmable to activate and deactivate fluid supply to fluid inlet 62 with respect to time settings. In addition, fluid controller 72 is programmable to supply fluid at pre-determined fluid pressure levels with respect to time settings. Programming fluid controller 72 is achieved by entering options and values by way of the dedicated keypad 73 and / or any external means such as a computer 75 which interfaces with the fluid controller 72 via the input-output connector interface 74. Interface port 74 supports common data transfer protocols such as USB, RS-232, IEEE-1284 and their variant standards.

[0019] As a summary, the present invention provides an apparatus of self cleaning the pogo spring probes of test sockets, and capable of preventing contaminants from depositing on the external and internal contact areas of said probes by means of diffused fluid streams which blow in the directions away from the probe tips. For scheduled self-cleaning, the optimum fluid pressure levels and time interval are deduced by registering any decline in test yield, and altering said settings for the best improvement. As for the latter application of debris prevention, the fluid controller is programmed to continuously feed lowly to moderately pressurized fluid stream to the pogo probes.

[0020] While the present invention has been described with reference to particular embodiments, it will be understood that the embodiments are illustrative and that the invention scope is not so limited. Alternative embodiments of the present invention will become apparent to those having ordinary skill in the art to which the present invention pertains. Such alternate embodiments are considered to be encompassed within the spirit

and scope of the present invention. Accordingly, the scope of the present invention is described by the appended claims and is supported by the foregoing description.

CLAIMS

What is claimed is:

1. A self-cleaning test socket comprising:

a plurality of spring probes or pogo pins as conducting paths for electrical signals between the solder balls or leads of a device under test and a circuit board; and

said spring probes or pogo pins are mounted in a single or plurality of stacked electrically insulating blocks wherein an embedded network of main and branch fluid ducts or cavities is employed to lead and distribute fluid stream from an external source to fluid outlets beside or encircling individual pogo plungers and in the directions away from the end tips of said pogo pins.

2. The test socket of claim 1, wherein the suitable fluid employed includes air, purified air, nitrogen, inert gases and any other suitable gases which do not cause adverse chemical reactions, such as corrosion and excessive oxidation, with the test sockets and in particular the pogo probes.

3. The test socket of claim 1, wherein said device under test includes general circuit boards, modules, electronic components, semiconductor IC devices in all commercially available packaging configurations such as ball grid array, flip chip and chip scale package.

4. The test socket of claim 1, wherein the geometrical distribution of said pogo probes is in alignment with the pin or test pad configuration of said device under test.

5. The test socket of claim 1, wherein said pogo probes are made from good electrical conductors and the probes could be double ended with two end plungers or single ended.

6. The test socket of claim 1, wherein said pogo probes are held in place in their respective housing cavities, which also serve as vertical branch fluid ducts, by means of

spacer or collar rings attached to the flange necks where the plungers of said pogo probes emerge.

7. The test socket of claim 6, wherein said collar rings have outer diameter larger than the diameter of fluid outlets against which the collar rings are disposed, and inner diameter large enough for the rings to slip and rest on the flange necks of said pogo probes.

8. The test socket of claim 6, wherein said collar rings have holes or apertures through which fluid stream from vertical branch ducts is delivered to fluid outlets where the tips of said pogo probes emerge.

9. The test socket of claim 1, wherein said network of fluid ducts comprises a main duct drawing fluid flow from an external source via a fluid inlet, and horizontal branch ducts leading said fluid flow from said main duct to vertical branch ducts wherein pogo probes are housed, and said fluid flow travels out of fluid outlets where said pogo probe tips emerge.

10. The test socket of claim 1, wherein the interconnections between said horizontal and vertical branch ducts are characterized by rounded smooth cavity walls for improved fluid distribution, and D-shaped or any suitable supporting structures may be placed near the middle portion of said pogo probes to provide additional mechanical support to the pogo probes and assist in distributing fluid flow to said vertical branch ducts.

11. The test socket of claim 1, wherein said horizontal branch ducts do not intersect with the center portion of the barrels of said pogo probes for improved fluid distribution, and additional connecting ducts are employed to lead fluid stream from said horizontal branch ducts to said vertical branch ducts before reaching fluid outlets where said pogo probe tips emerge.

12. The test socket of claim 1, wherein said fluid inlet is in communication with a fluid controller via an external fluid tubing, and said fluid controller is user programmable to activate and deactivate fluid supply to said fluid inlet with respect to time settings, and said

fluid controller is programmable to supply fluid at pre-determined fluid pressure levels with respect to time settings.

13. The test socket of claim 12, wherein said fluid controller has a dedicated keypad and / or input-out connector interface for appropriate external means such as a computer to enter control options and parametric values, and said communication interface supports common data transfer protocols.

14. A method for self-cleaning and preventing contaminants from depositing on the pogo probes of test sockets, comprising the steps of:

employing a plurality of spring probes or pogo pins as conducting paths for electrical signals between the solder balls or leads of a device under test and a circuit board;

mounting said pogo probes in a single or plurality of stacked electrically insulating blocks;

embedding a network of main and branch fluid ducts or cavities in said insulating blocks to lead and distribute fluid stream from an external source to the fluid outlets beside or encircling individual pogo plungers and in the directions away from the pogo tips, thereby generating diffused fluid streams;

the diffused fluid streams may automatically be activated at pre-determined pressure levels at regular intervals for scheduled self cleaning; and

said diffused fluid streams may be activated at pre-determined pressure levels on a continuous basis for prevention of debris collection on, around and inside the internal contact areas of said pogo probes.

15. The method of claim 14, wherein the suitable fluid employed includes air, purified air, nitrogen, inert gases and any other suitable gases that do not cause adverse chemical reactions, such as corrosion and excessive oxidation, with the test sockets and in particular the pogo probes.

16. The method of claim 14, wherein the device under test includes general circuit boards, modules, electronic components, semiconductor IC devices in all commercially available packaging configurations.

17. The method of claim 14, wherein the geometrical distribution of said pogo probes is in alignment with the pin or test pad configuration of said device under test.

18. The method of claim 14, wherein said pogo probes are made from good electrical conductors and the probes could be double ended with two end plungers or single ended.

19. The method of claim 14, wherein said pogo probes are held in place in their respective housing cavities, which also serve as vertical branch fluid ducts, by means of spacer or collar rings attached to the flange necks where the plungers of said pogo probes emerge.

20. The method of claim 19, wherein said collar rings have outer diameter larger than the diameter of fluid outlets against which the collar rings are disposed, and inner diameter large enough for the rings to slip and rest on the flange necks of said pogo probes.

21. The method of claim 19, wherein said collar rings have holes or apertures through which fluid stream from vertical branch ducts is delivered to fluid outlets where the tips of said pogo probes emerge.

22. The method of claim 14, wherein said network of fluid ducts comprises a main duct drawing fluid flow from an external source via an fluid inlet, and horizontal branch ducts leading said fluid flow from said main duct to vertical branch ducts wherein pogo probes are housed, and said fluid flow travels out of fluid outlets where said pogo probe tips emerge.

23. The method of claim 14, wherein the interconnections between said horizontal and vertical branch ducts are characterized by rounded smooth cavity walls for improved fluid distribution, and D-shaped structures may be placed near the middle portion of said pogo

probes to provide additional mechanical support to the pogo probes and assist in distributing fluid flow to said vertical branch ducts.

24. The method of claim 14, wherein said horizontal branch ducts do not intersect with the center portion of the barrels of said pogo probes for improved fluid distribution, and additional connecting ducts are employed to lead fluid stream from said horizontal branch ducts to said vertical branch ducts before reaching fluid outlets where said pogo probe tips emerge.

25. The method of claim 14, wherein said fluid inlet is in communication with a fluid controller via an external fluid tubing, and said fluid controller is user programmable to activate and deactivate fluid supply to said fluid inlet with respect to time settings, and said fluid controller is programmable to supply fluid at pre-determined fluid pressure levels with respect to time settings, thereby capable of providing scheduled self cleaning and continuous prevention of debris collection.

26. The method of claim 25, wherein said fluid controller has a dedicated keypad and / or input-out connector interface for appropriate external means such as a computer to enter control options and parametric values, and said communication interface supports common data transfer protocols.