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METHOD AND APPARATUS FOR RETENTION OF A FRAGILE CONDUCTIVE TRACE WITH A PROTECTIVE CLAMP

Field Of The Invention

The present invention relates to a method and apparatus for retaining a conductive trace on a unitary clamp. More particularly to an interconnect system designed to mount, secure, and protect a conductive trace having a multi-lead integrated circuit. A clamp, when assembled with a conductive trace having an integrated circuit permits safe storage of the device, mounting of the device for testing of the electronic components, and safe and accurate mounting of the assembly on a printed circuit board during production of the latter.

Background Art

The density of integrated circuits continues to increase and as a result, the number of delicate leads between the integrated circuit and a printed circuit board continues to increase. A difficult problem still confronting engineers in the electronics industry is an efficient and reliable way to secure an integrated circuit to a board while maintaining electrical connection and mechanical protection of the leads.

A fabrication process known in the electronics packaging art is tape automated bonding (TAB). A continuous tape of fragile conductive traces, similar to, but far more fragile than photographic film provides a basis for mountirig integrated circuits on each frame of the tape.

A metal pattern is formed on each frame of the conductive trace. These metal patterns radiate from the center of the trace where an integrated circuit is mounted to the peripheral edges of the frame to form leads. The circuit is mounted such that the contacts of the chip are mated with the corresponding metal pads in the central portion of the frame. These fragile conductive traces provide for electrical connection between the integrated circuit and the circuit board.

The manufacture of electronic components, sub-assemblies and assemblies requires a number of functionally different manufacturing operations.

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Manufacturing the fragile components is one operation. Testing the component is another and final assembly is the last of these different operations. The complex and additive nature of these operations makes cost effective manufacture difficult. Each operation requires unique and complicated equipment at the manufacturing location. To perform these operations is not only expensive, but there is also a relatively high possibility for defective items.

United States Patent 5,099,392, entitled Tape-Automated Bonding Frame Adapter System issued to the Hewlett--Packard company on March 24, 1992 and illustrates an adapter system for mounting an integrated circuit and conductive trace to a circuit board.

The adapter system comprises three separate components to mount the frame to a circuit board by building a sandwich of parts. An adapter ring is positioned on a circuit board. A plurality of conductive elements are wrapped around members of the adapter ring to provide electrical connection between the circuit board and conductive trace. The conductive trace is mounted over the adapter ring. A seal is mounted over the conductive trace and finally a lid is provided over the entire assembly to protect the conductive trace. The entire assembly is secured in place by a number of fasteners such as nuts and bolts.

United States Patent 4,696,526, entitled Carrier for Tape Automated Bonded Semiconductor Device issued to the Intel Corporation on September 29, 1987 and illustrates a device for mounting an integrated circuit and conductive trace to a base for electrical test of the integrated circuit.

The device comprises two separate and complicated components to mount a conductive trace by building a sandwich of parts. A base is provided with a socket for receiving a conductive trace. The conductive trace is positioned within the base by a plurality of lugs. A cover is placed over the conductive trace and locked in place with the base by a number of complimentary locking members.

United State Patent 5,005,070, entitled Soldering Interconnect Method and Apparatus For Semiconductor Packages issued to the Hewlett-Packard company on April 2

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1991 and illustrates a device for attaching the outer leads of a semiconductor package to lands on a circuit board.

The device comprises a frame structure that urges the edges of a semiconductor package to the board. The frame structure is secured in position either adhesively, or by thermally deformation of stakes.

IBM technical Disclosure Bulletin entitled, Method of Bonding Tape Automated Bonding Packages Using Conventional Surface Mount Technologies, Vol. 34 No. 11 of April of 1992 and illustrates a temporary fixture that may be used in the assembly of a circuit module with a printed circuit board.

A fixture temporarily grips the module in order to transport, place the module on a printed circuit board. After a solder process, the fixture releases the module and is removed for recycling leaving the unprotected module behind. The circuit module is relatively thick and durable compared to the circuit trace contemplated herein.

The prior art references have a number of significant deficiencies. Most systems have multiple components which are costly to manufacture. Aligning a sandwich of components on a circuit board is difficult, costly and time consuming. It is also prone to error.

Retention of a fragile conductive trace having an integrated circuit and retention on a circuit board in a unitary protective structure is not disclosed. Conductive traces having integrated circuits are stored and shipped separately from the mounting devices. Separate storing of the unprotected conductive traces is difficult due to the fragile nature of the traces and integrated circuits. This typically requires additional protective packaging for storage and shipping of components.

Summary Of The Invention

It is a primary advantage of the invention to provide, a unitary structure which permits retention of a very thin, fragile conductive trace having an integrated circuit and retention on the circuit board. In another advantage of the invention, the clamp assembly is useful for safe storage, placement in a circuit test apparatus, and mounting on a printed circuit board.

In a broad aspect of the invention, the invention

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consists of a clamp having a base member for providing rigid support to a conductive trace, a plurality of retention means extending downwardly from said base, each of said plurality of retention means having a retention section adapted for retaining engagement with a plurality of corresponding apertures in said conductive trace and each of said plurality of retention means adapted for fastening engagement with a plurality of corresponding apertures in said substrate.

In another broad aspect of the invention, the invention consists of a conductive trace, a clamp, said clamp having a base member, said base member having a plurality of retention means extending downwardly from said base, each of said plurality of retention means having retention section adapted for retaining engagement with a plurality of corresponding apertures in said conductive trace and each of said plurality of retention means adapted for fastening engagement with a plurality of corresponding apertures in said substrate wherein said trace is retained with said clamp.

In another broad aspect of the invention, the invention consists of a conductive trace, a substrate, a clamp, said clamp having a base member, said base member having a plurality of retention means extending downwardly Erom said base, each of said plurality or retention means having retention section adapted for retaining engagement with a plurality of corresponding apertures in said conductive trace and each of said plurality of retention means adapted for fastening engagement with a plurality of corresponding apertures in said substrate wherein said trace is retained with said clamp and said clamp is fastened to said substrate.

The invention may include a standoff means to space a lower surface of the base member a predetermined distance above a circuit board.

The invention may also include a locator such as an indentation trace formed in an upper surface of the base member to permit centering of a material cutter for removal of the clamp.

In an embodiment of the invention, the base member is formed by the upper surface, sidewall and lower surface of

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the clamp structure. The substrate is a printed circuit board. The retention means is a cylindrical post formed in plastic having a diameter that press fits with an opening of the conductive trace. The standoff means is a plurality of downwardly extending members disposed at the peripheral edge of the base member or alternatively, a rim formed in the posts.

It is another primary advantage of the invention to provide a method to assemble a clamp with a fragile conductive trace having an integrated circuit wherein the trace is retained in the clamp.

In another broad aspect of the invention, the invention consists of a method of assembling a clamp with a conductive trace having an integrated circuit comprising the steps of acquiring a clamp from a clamp feeder and pressing the clamp onto a conductive trace, retaining the conductive trace and integrated circuit within the clamp.

In the drawings which illustrate embodiments of the invention,

Figure 1 is a axonometric view of a conductive trace retained in a clamp mounted on a printed circuit board,

Figure 2 is a top view of the clamp,

Figure 3 is a side view of the clamp illustrating the posts and the standoff,

Figure 4 is a bottom view of the clamp,

Figure 5 is another side view of the clamp illustrating the posts and the standoffs,

Figure 6a is an expanded sectional view of the clamp taken along line CC of Figure 2 illustrating the profile of a lower surface of a clamp in an embodiment,

Figure 6b is an expanded sectional view of the clamp taken along line CC of Figure 2 illustrating another embodiment of the profile of a lower surface of the clamp,

Figure 6c is an expanded sectional view of the clamp taken along line AA of Figure 2 illustrating one embodiment of the posts,

Figure 6d is an expanded sectional view of the clamp taken along line AA of Figure 2 illustrating another embodiment of the posts,

Figure 6e is an expanded sectional view of the clamp

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taken along line AA of Figure 2 illustrating another embodiment of the posts,

Figure 7 is a top view of a tape with a plurality of conductive traces,

Figure 8 is a single conductive trace excised from the tape, Figure 9 is a top view of a conductive trace retained in the clamp,

Figure 10a is a bottom view of a conductive trace retained in the clamp,

Figure 10b is an expanded sectional view of the cleimp illustrating an embodiment of the post cooperating with the trace,

Figure 11 is a top view of a printed circuit board illustrating the apertures which communicate with the posts of the clamp to permit alignment of the clamp and the conductive trace with the layout on the circuit board,

Figure 12 is a flow chart of the method to assembly a clamp with a integrated circuit and a conductive trace,

Figure 13 is a schematic view of a die and plurality of conductive traces having integrated circuits before excise of a single trace,

Figure 14 is a schematic view of a die with a separated single trace,

Figure 15 is a schematic view of acquiring a clamp from a feeder by a vacuum nozzle for placement on a single trace,

Figure 16 is a schematic view of the clamp placed on a single conductive trace for retaining the trace,

Figure 17 is a schematic view of removal of the completed assembly of the clamp and conductive trace,

Figure 18 is a schematic view of the completed assembly located in a test apparatus,

Figure 19 is a schematic view of the completed assembly located in a shipping tube,

Figure 20a is a schematic view illustrating placement of the completed assembly onto a printed circuit board, and

Figure 20b is a schematic view illustrating the completed assembly located on a printed circuit board.

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Detailed Description of the Preferred Embodiment

Referring to Figure 1, a clamp assembly is generally illustrated at 10. An integrated circuit 14 located on a conductive trace (not visible) is retained in the clamp 12. The clamp 12 is mounted on a printed circuit board 16. The plurality of leads 18 of the conductive trace communicate with the plurality of pads 20 on the printed circuit board 16 for mechanical and electrical contact. In final form, the leads are soldered to the pads.

Those skilled in the art will understand the clamp is formed of plastic from an injection molding process. The plastic must be suitable for withstanding high temperatures during a soldering process and must have mechanical stability to protect the fragile conductive trace and integrated circuit 14 from damage when assembled as shown in Figure 1.

Referring now to Figure 2, features of the upper surface 30 of the clamp 12 are shown. An aperture 24 is formed in the center of the clamp 12. Location and size of the aperture 24 may be varied as long as the aperture 24 permits visual inspection of information located on a upper surface of the integrated circuit (not shown).

For example, the information may be a part number, or lot number, or some other related technical markings.

During the assembly process or diagnostics after assembly, an integrated circuit must be readily identifiable. The aperture 24 permits identification without having to add equivalent information to the top surface of the clamp.

A plurality of recesses 22 are formed at the peripheral edges of the clamp 12. These recesses 22 permit a visual inspection of the leads 18 before assembly. After assembly, the recesses 22 permit a visual inspection of the solder joint between the leads 18 of the conductive trace 80 and the pads 20 of the printed circuit board 16 (refer to Figure 1.)

In the preferred embodiment, the clamp 12 is substiantially square having a recess 22 at the peripheral edge of each side to permit inspection for each group of leads 18 (four groups not shown).

A bevel 26 is formed on one side of the upper

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surface 30. The bevel 26 permits orientation of the clamp assembly for correct positional placement of the assembly on a printed circuit board 16 as the assembly must be electrically aligned with the board. The bevel 26 also provides clamp orientation in a storage tube (not shown). The bevel 26 also facilitates the use of vibratory feeders during the assembly process.

A plurality of indentations 28 are formed in the upper surface 30 of the clamp. These indentations 28 are formed directly over the downwardly extending posts 40 (not shown, see Figure 3). The diameter and depth of an indentation is selected to loosely receive an end of a post to permit tight stacking of the clamps 12. The indentations also provide a visual indication from the upper surface 30 of the clamp 12 to locate the posts 40 for removal of the clamp 12 from a printed circuit board 16. A drill may be located over the indentation to drill down through the upper surface 30 of the clamp 12 and effectively remove the post material or tape component without damage to the printed circuit board 16. This permits easy accurate removal of a clamp assembly, for example upon electrical failure of the integrated circuit 14, once assembled for non-destructive failure analysis.

Referring now to figure 3 and 5 side views of the clamp 12 are shown. The clamp 12 has a sidewall 46 formed of a suitable thickness to provide mechanical rigidity of the structure and protection of the fragile conductive trace and integrated circuit.

The clamp 12 is formed with an upper surface 30 and a lower surface 44. A plurality of posts 40 extend downwardly from the lower surface 44. The posts 40 engage apertures in the conductive trace (not shown) for retention of the conductive trace within the clamp 12. The posts 40 also engage apertures in the printed circuit board 16 (not shown) to retain the clamp 12 on the printed circuit board 16.

The sidewall 46 has a plurality of standoffs 42 extending downwardly at each corner of the clamp 12. The standoffs 42 are of a length to control the height of the clamp 12 in a predetermined spaced relationship with the printed circuit board 16.

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The clamp assembly is effectively located on a printed circuit board and pressed downwardly onto the board until the standoffs engage the upper surface of the board providing the spaced relationship. The function of the spaced relationship will be discussed later with reference to Figure 20b.

Referring now to figure 4, a bottom view of the clamp 12 is shown. From the lower surface 44, the downwardly extending posts 40 and standoffs 42 are shown. The cooperation between the posts 40 and the standoffs 42 permit retainment of the clamp assembly with the printed circuit board 16 at a predetermined height above the board.

While the preferred embodiment illustrates four posts and four standoffs, those skilled in the art will appreciate the number and placement of the posts 40 and standoffs 42 may vary without departing from the scope and spirit of the invention.

Referring now to Figure 4 and Figures 6a and 6b which are a cross sectional view taken along line CC of Figure 2, a profile of the lower surface 44 is illustrated. The profile of the lower surface 44 depresses the leads 18 of the conductive trace (not shown) downwardly, effectively forcing the leads 18 of the conductive trace down for engagement with pads 20 on a printed circuit board 16 (refer to Figure 1.).

In one embodiment of the invention, a rectangular ridge 50 is formed on the lower surface 44 of the clamp 12 as shown in Figure 6b. This ridge forms a rectangular shape around the lower surface 44 of the clamp 12 as shown in Figure 4. In another embodiment of the invention, the lower surface 44 slopes downwardly and outwardly from the center of the clamp 12 to depress the leads of the conductive trace. The posts 40 retain a conductive trace 80 in a plane beneath the lower surface of the clamp 12. This plane is slightly above the lowest point of the lower surface or ridge in order to create the downward force on the leads 18.

Sufficient downward force on the leads 18 will only occur if the leads 12 lie below the plane of the integrated circuits 14 solderable surface as will be

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later described with reference to Figure 20b.

Referring now to Figure 6c, 6d, and 6e, a sectional view taken along line AA of Figure 2 illustrates the posts 40 extending downwardly from the lower surface 44 of the clamp 12. As previously described, the posts provide retainment of the conductive trace in a spaced relationship with the clamp 12 and retainment of the clamp 12 with a printed circuit board 16.

In one embodiment, shown in Figure 6c, the posts 40 are substantially cylindrical for engagement with apertures in the conductive trace 80 (not shown) and apertures in the printed circuit board 16 (not shown). A chamfer 60 located in a distant end of the post 40 aids engagement of the respective apertures.

In another embodiment, shown in Figure 6d, the posts 40 are substantially cylindrical, having a slot 62 extending from the distant end of the post 40 inwardly to form two flexible post members. The slot 62 permits inward flexation of these post members to aid with engagement of the respective apertures and to provide a tight press fit with the apertures of the printed circuit board for retention of the clamp assembly 10.

In another embodiment, shown in Figure 6e, integral standoffs are formed in the posts 40. In this embodiment, the clamp 12 does not require the standoffs 42 to provide the spaced relationship between the clamp 12 and the printed circuit board 16. The post 40 forms an upper cylindrical surface 41 and a lower cylindrical surface 45. The upper surface 41 communicates with the aperture 76 of the conductive trace 80 as previously described. The lower surface 45 communicates with the apertures 90 of the printed circuit board as previously described. The apertures 90 and lower surface 45 are of a different diameter, being smaller than the upper surface 41. The smaller diameter again must provide a tight press fit. A lip 43 is formed at the junction of the upper and lower surfaces. The lip 43 provides the function of a standoff by resting on the upper surface of the printed circuit board 16. The lip 43 is positioned on the post to provide the predetermined spaced relationship between the clamp 12 and the printed circuit board 16.

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Referring now to Figure 7, a tape 70 of conductive traces 80 is shown. A plurality of sprocket holes 72 are provided at the respective edges of the tape 70 to control movement of the tape during the manufacturing process.

Electrical connection between the integrated circuit and a printed circuit board is achieved by a single conductive trace 80. A plurality of leads 18 is shown on each conductive trace 80. The leads 18 are for electrical engagement with pads 20 on the printed circuit board 16. A plurality of contacts 78 secure and electrically engage an integrated circuit (not shown). A plurality of lands 74 electrically connect the leads 18 with the contacts 78.

Formed in each conductive trace 80 are a plurality of apertures 76. The apertures 76 engage the posts 40 (not shown) for retention of the conductive trace 80 with the clamp 12.

In one embodiment, four circular apertures 76 are provided to engage four cylindrical posts 40 on the clamp 12. The diameter of the posts 40 and the diameter of the apertures 76 are such that a press fit occurs between them providing retention of the fragile trace without damage during the assembly process. The apertures formed in the fragile film of the conductive trace 80 are surrounded by metal patterns to strengthen the area for engagement with the posts. The strengthened area resists tearing of the film when engaged by the posts 40. It is appreciated by those skilled in the art that minor changes to the number of, and shape of, posts/apertures may be made without departing from the scope and spirit of the invention.

Referring now to Figure 8, a single conductive trace 80 has been excised and lead formed from the tape 70. The leads 18 are formed in the shape of an S, as shown in Figure 14. The leads could assume other shapes such as a gull wing.

Referring now to Figures 9, and 10a, a clamp assembly 10 is shown. The conductive trace 80 is retained in the clamp 12 by the engagement and cooperation between the plurality of apertures 76 in the conductive trace 80

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and the plurality of posts 40 of the clamp. This assembly 10 may be stored in a shipping tube, or temporarily placed in a test apparatus and then removed, or retained by a printed circuit board. An integrated circuit is not shown in Figures 9 and 10a.

Referring now to Figure 10b, a sectional view of a post is shown cooperating with a conductive trace 80. The aperture formed in the conductive trace 80 includes a plastic layer 81 having a diameter slightly larger than the diameter of the post, and a copper layer 83 having diameter slightly smaller that the diameter of the post. A peripheral edge of the copper layer 83 deflects downward when a post is inserted into the aperture. The edge provides a biting engagement with the post retaining the conductive trace 80 with the post.

Referring now to Figure 11, a printed circuit board 16 is shown as configured to receive a clamp assembly 10. A plurality of pads 20 are arranged to engage the leads 18 of a conductive trace (not shown). The engagement is both mechanical, to secure contact by application of solder, and electrical. The pads 20 are electrically connected to other parts of the printed circuit board 16 by lands 92 etched on the board.

A plurality of apertures 90 are arranged in a predetermined spaced relationship on the board 16 for receiving a plurality of posts 40 of the clamp 12 (not shown). Those skilled in the art will appreciate that the arrangement of pads 20 and apertures 90 may be modified without departing the scope and spirit of the invention.

Referring now to Figure 12, the method to assemble a clamp with a conductive trace will be described. The method starts at 110. A single conductive trace having an integrated circuit is removed from a tape by application of a die to excise the trace. The leads are formed by the complimentary surfaces of the die pressing the leads into an S shape (111), or other suitable shapes such as a gull wing shape

This single excised and lead formed trace is presented to a placement machine (112). A clamp is then acquired from a clamp feeder, for example by a vacuum nozzle (113).

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The clamp is placed onto the single excised and lead formed trace where the posts engage apertures. A downward force moves the posts through the apertures a predetermined distance, without damage to the conductive trace. This operation retains the conductive trace with the clamp (114). The completed assembly is acquired for placement at (115).

The completed assembly of a clamp and trace may be placed in a storage package for shipping (117), or may be temporally placed in a test apparatus to electrically test the component (116), or may be mounted on a printed circuit board (118).

Referring now to Figures 13 through 17, a schematic cross section of the apparatus and components for the method to assemble a clamp 12 and conductive trace 80 is shown.

In Figure 13, a tape of conductive traces 70 having integrated circuits 14 is fed to an excise and lead form die, generally indicated at 100. The die has an upper member 102 and a lower member 104. The upper member 102 is operable to communicate with the lower member 104 where a single conductive trace may be excised from the tape 70 and the leads 18 may be formed during the same operation. The leads are formed into a shape by the contour 106 of the upper member 102 cooperating with the complimentary contour 108 of the lower member 104 pressing the leads into shape. The result is a single conductive trace 80 as shown in Figure 14.

A clamp is obtained from a clamp feeder 122 as shown in Figure 15 by a vacuum nozzle 120 and transported for engagement with a conductive trace located in the lower member 104 of the die. The vacuum nozzle 120 has a baffle over the aperture in the clamp to permit suction to effectively grip the upper surface 30 of the clamp 12.

As shown in Figure 16, the clamp is aligned over the conductive trace 80. This alignment operation centers the posts 40 directly over the apertures 76 of the conductive trace 70. The lower member 104 of the die has a plurality of openings 124 directly under the apertures 76 of the conductive trace 80. The size of the openings must be large enough to loosely receive the posts 40 of the clamp

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12 and small enough to support the surrounding area of the conductive trace 70 as placed in the die. A downward force drives the posts 40 through the apertures 76 a predetermined distance to retain the conductive trace 70 in the clamp 12. The posts 40 on the clamp 12 effectively press fit into apertures 76 on the conductive trace 70 without tearing or damaging the fragile conductive trace 70.

The lower member 104 of the die is contoured so that the standoffs 42 of the clamp 12 do not touch or engage the die surface. This permits the clamp 12 to be pressed downward to unrestrictively receive the conductive trace 80 in a predetermined spaced relationship without interference by the standoffs 42.

A completed assembly of a conductive trace 80 having an integrated circuit retained in a clamp 12 is removed from the die as shown in Figure 17. This assembly may be placed in a test cell, a storage container, or provided for final assembly on a printed circuit board.

Referring now to Figure 18, a completed assembly is shown in a test apparatus 130. The test apparatus 130 is soldered directly in place to a printed circuit board 16 in place of a completed clamp assembly 10. The test apparatus 130 acts as an interposer between the clamp assembly 10 under electrical test and the printed circuit board 16.

The test apparatus 130 is substantially a square box with an operable lid 151. A plastic gate 132 pushes leads 18 onto its the contact pads 134 for electrical engagement. The upper surface of the integrated circuit 14 is also pressed against a copper slug 136 by a protruding member 150 formed on the lower surface of a lid 151. A surface of the integrated circuit 14 communicates with a surface of the slug 136 in order to dissipate heat generated by the integrated circuit 14 under electrical test.

Thus the test apparatus provides both electrical and thermal contact of the integrated circuit 14 for burn-in testing of the integrated circuit 14 as retained within the clamp assembly 10.

The lid 151 is pivotally connected at one end 152 to

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the side of the test apparatus and releasably connected at another end 153. These connections permit the lid 151 to operate from a closed position for testing to an open position for insertion and removal of a clamp assembly 10. The lid 151 is releasably locked in the closed position in order to provide a downward force on the integrated circuit 14 by the protruding member 150.

A plurality of copper posts 134 are soldered to pads on the printed circuit board 16. The copper posts 134 extend upwardly through the bottom 155 of the test apparatus 130 to form exposed pads 154. The leads 18 of the conductive trace 80 contact the exposed pads 154 for electrical connection during test of the integrated circuit 14. The height of the copper posts 134 and slug 136 are such that the posts 60 of the clamp 12 do not engage the apertures 90 of the printed circuit board 16 in order to permit removal of the clamp 12 after the burn-in test. The bottom 155 has a plurality of openings to loosely receive the posts 60.

The test apparatus 130 and gate 132 are designed so that the leads 18 of the conductive trace 80 are not deformed. This allows the clamp assembly 10 to be removed from the test apparatus 130 after burn-in for later use in the production of printed circuit boards.

Referring to Figure 19, a completed assembly 10 is shown in a tube container 140 for storage and shipping. The overall shape of the clamp 12 cooperates with the overall shape of the tube container 140 to provide a single orientation of the clamp 12 within the container 140. The chamfer 26 of the clamp 12 communicates with a chamfer 142 of the container wherein these chamfers must aline before inserting the clamp 12 into the tube 140. The inside dimensions of the tube are such that the clamp assembly 10 may be slidably received and removed from the tube 140. A single tube 140 may contain a plurality of clamp assemblies 10.

The clamp 12 protects the fragile conductive trace 80 from damage that may occur from the top or sides of the clamp 12 by combination of the upper surface, sidewalls, and standoffs of the clamp. The four corners of the clamp extend beyond the ends of the outer leads of

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the conductive trace 80 to protect the ends of the leads 18 from handling damage.

In addition, the four posts 40 protect the outer leads 18 from below. These posts 40 partially prevent damage of the trace 80 from underneath by raising the trace above a smooth or level contacting surface.

When the clamp assembly is placed in the tube 140, the trace 80 is completely protected from damage that may occur from underneath the trace 80.

Tubes 140 containing these clamp assemblies 10 may be shipped without damage to the printed circuit board assembly plant. The tube 140 may be used in a manufacturing process and provides the machinery with the capability to determine the orientation of clamps for placement on printed circuit boards.

Referring to Figure 20a and 20b, a completed clamp assembly 10 is shown on a printed circuit board 16. A placement machine acquires an assembly from a feeder and locates the assembly over a printed circuit board 16. The posts 40 of the clamp 12 are aligned over apertures 90 in the printed circuit board. The machine pushes the clamp 12 down onto the printed circuit board 16. The clamp 12 and conductive trace 80 are retained on the board by the posts 40 press fitting into the apertures 90 on the board. The clamp 12 is eased down onto the board. The chamfers 60 on the posts 40 assist with engagement between the posts 40 and apertures 90. The clamp 12 is then pushed down until the standoffs 42 engage the upper surface of the board to engage the outer leads 18 of the trace 80 into solder paste which have been previously screened onto the printed circuit board 16.

The ridge 50 (not shown) depresses the leads 18 of the conductive trace 80 downwardly, effectively forcing the leads 18 of the conductive trace into engagement with the pads 20 of the printed circuit board 16, prior to a soldering process.

The posts 40 engage the apertures 94 of the printed circuit board 16 for retention of the clamp 12 on the printed circuit board 16. The length and diameter of the posts 40 and length diameter of the apertures 94 are such

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that a tight press fit occurs between the sidewall of the post 40 and the sidewall of the aperture 94 preventing removal of the clamp 12 from the printed circuit board.

The posts 40 provide retention with the fragile conductive trace 80 and retention with the apertures 90 of the printed circuit board 16, once assembled to the printed circuit board 16.

The standoffs 42 rest on the upper surface of the printed circuit board 16 to provide a predetermined spaced relationship between the clamp 12 and the upper surface of the printed circuit board 16. This spaced relationship must permit forced engagement of the contacts 18 with the pads 20 and retain the printed circuit 14 at a distance above the printed circuit board 16.

Once a clamp assembly 10 is mounted on a printed circuit board 16, it provides mechanical protection to the delicate structure.

The printed circuit card assembly is then passed through a surface mount technology reflow oven to form the various solder joints. The clamp 12 remains in place on the printed circuit board 16 to provide mechanical protection to the fragile conductive trace 80 and integrated circuit 14. A surface of the integrated circuit may be soldered to the printed circuit board 16 to provide for cooling of the circuit. Optionally, an adhesive may be applied to the back bond of the integrated circuit to provide for cooling.

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CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a module having a conductive trace and a substrate, a clamp for protectively retaining said trace in said clamp on said substrate, said clamp comprising,
a base member,
a plurality of retention means extending downwardly from said base,
each of said retention means having a retention section adapted for retaining engagement with corresponding apertures in said conductive trace and said retention means being adapted for fastening engagement with at least one corresponding aperture in said substrate.

2. In a module having a conductive trace and a substrate, a clamp for protectively retaining said trace in said clamp on said substrate, said clamp comprising,
a base member,
a plurality of retention means extending downwardly from said base having a first retention section adapted for retaining engagement with corresponding apertures in said conductive trace; and second retention section adapted for fastening engagement with corresponding apertures in said substrate.

3. The clamp of claim 1 or 2 wherein said retention means are located in a predetermined relationship with said trace apertures and said substrate apertures to align said trace in a desired location on said substrate when said clamp is mounted on said substrate.

4. The clamp of claim 3 wherein said retention means is a post member, said post member having a first trace retaining section and a second substrate fastening section, said second section extending downwardly from said first section.

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5. The clamp of claim 4 wherein said base member includes a standoff means to space a lower surface of said base member at a predetermined distance above said substrate.

6. The clamp of claim 5 wherein said standoff means comprises a plurality of downwardly extending members from said base member.

7. The clamp of claim 1, 2, 4, 5, or 6 wherein said base member has a plurality of recesses for exposing leads on said trace.

8. The clamp of claim 1, 2, 4, 5, or 6 wherein said base member has an opening disposed over an integrated circuit mounted on the conductive trace..

9. The clamp of claim 1, 2, 4, 5, or 6 wherein said base member has a plurality of indentations formed on an upper surface of said base member and directly over said means for retaining.

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10. A module comprising,

a conductive trace,

a clamp, said clamp having a base member,

said base member having a plurality of retention means extending downwardly from said base,

each of said retention means having a retention section adapted for retaining engagement with corresponding apertures in said conductive trace and each of said retention means adapted for fastening engagement with corresponding apertures in said substrate wherein said trace is retained with said clamp.



11. A module comprising,

a conductive trace,

a clamp, said clamp having a base member,

said base member having a plurality of retention means extending downwardly from said base, having a first retention section adapted for retaining engagement with a plurality of corresponding apertures in said conductive trace; and second retention section adapted for fastening

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engagement with a plurality of corresponding apertures in said substrate wherein said trace is retained with said clamp.

12. The clamp of claim 10 or 11 wherein said retention means are located in a predetermined relationship with said trace apertures and said substrate apertures to align said trace in a desired location on said substrate when said clamp is mounted on said substrate.

13. The clamp of claim 12 wherein said retention means is a post member, said post member having a first trace retaining section and a second substrate fastening section, said second section extending downwardly from said first section.

14. The clamp of claim 13 wherein said base member includes a standoff means to space a lower surface of said base member at a predetermined distance above said substrate.

15. The clamp of claim 14 wherein said standoff means comprises a plurality of downwardly extending members from said base member.

16. The clamp of claim 10, 11, 13, 14, or 15 wherein said base member has a plurality of recesses for exposing leads on said trace.

17. The clamp of claim 10, 11, 13, 14, or 15 wherein said base member has an opening disposed over an integrated circuit mounted on the conductive trace.

18. The clamp of claim 10, 11, 13, 14, or 15 wherein said base member has a plurality of indentations formed on an upper surface of said base member and directly over said means for retaining.

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19. A module comprising,

a conductive trace,

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a substrate,

a clamp, said clamp having a base member,

said base member having a plurality of retention means extending downwardly from said base,

each of said plurality of retention means having retention section adapted for retaining engagement with a plurality of corresponding apertures in said conductive trace and each of said plurality of retention means adapted for fastening engagement with a plurality of corresponding apertures in said substrate wherein said trace is retained with said clamp and said clamp is fastened to said substrate.

20. A module comprising,

a conductive trace,

a substrate,

a clamp, said clamp having a base member;

said base member having a plurality of retention means extending downwardly from said base having a first retention section adapted for retaining engagement with a plurality of corresponding apertures in said conductive trace; and

second retention section adapted for fastening engagement with a plurality of corresponding apertures in said substrate wherein said trace is retained with said clamp and said clamp is fastened to said substrate.

21. The clamp of claim 19 or 20 wherein said retention means are located in a predetermined relationship with said trace apertures and said substrate apertures to align said trace in a desired location on said substrate when said clamp is mounted on said substrate.

22. The clamp of claim 21 wherein said retention means is a post member, said post member having a first trace retaining section and a second substrate fastening section, said second section extending downwardly from said first section.

23. The clamp of claim 22 wherein said base member includes a standoff means to space a lower surface of

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said base member at a predetermined distance above said substrate.

24. The clamp of claim 23 wherein said standoff means comprises a plurality of downwardly extending members from said base member.

25. The clamp of claim 19, 20, 22, 23, or 24 wherein said base member has a plurality of recesses for exposing leads on said trace.

26. The clamp of claim 19, 20, 22, 23, or 24 wherein said base member has an opening disposed over an integrated circuit mounted on the conductive trace.

27. The clamp of claim 19, 20, 22, 23, or 24 wherein said base member has a plurality of indentations formed on an upper surface of said base member and directly over said means for retaining.

28. A method of assembling a clamp with conductive trace having an integrated circuit comprising the steps of, acquiring a clamp from a clamp feeder, and placing the clamp onto a conductive trace retaining the conductive trace and integrated circuit within the clamp.

29. A method as in claim 28 comprising, prior to the step of acquiring a clamp, presenting a singulated conductive trace having a integrated circuit to a placement machine.

30. A method as in claim 29 comprising,

prior to the step of presenting, removing a single conductive trace having an integrated circuit from a tape by application of a cutting die.

31. A method as in claim 28, 29, or 30 comprising,

temporary placement of the clamp and retained conductive trace and integrated circuit in a test cell for electrically testing the completed assembly.

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32. A method as in claim 28, 29, or 30 comprising, temporary placement of the clamp and retained conductive trace and integrated circuit in a storage package.

33. A method as in claim 28, 29, or 30 comprising, placement of the clamp and retained conductive treace and integrated circuit on a printed circuit board.

34. A method of assembling a clamp with conductive trace having an integrated circuit comprising the steps of, acquiring a clamp from a clamp feeder, and loading said clamp with said conductive trace to retain the conductive trace and integrated circuit within the clamp.

35. For use in a module having a conductive trace and a substrate, a clamp for protectively retaining said trace on said substrate, said clamp comprising:

a base member,

a plurality of retention means extending from said base,

said retention means having retention sections adapted for retaining engagement with corresponding apertures in said conductive trace and said retention means being adapted for fastening engagement with at least one corresponding aperture in said substrate.

36. A clamp for protectively retaining a circuit module on a substrate comprising:

a base member,

a plurality of retention means extending from said base member,

said retention means being adapted for (a) retaining engagement with corresponding apertures in said circuit module and (b) fastening engagement with at least one corresponding aperture in said substrate.

37. The clamp of claim 36 wherein each of said retention means is adapted for retaining engagement with said circuit module and fastening engagement with said substrate.

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38. A clamp for protectively retaining a circuit module on a substrate comprising:

a base member,

a plurality of retention means extending from said base member said retention means having (a) retention sections adapted for retaining engagement with corresponding apertures in said circuit module and (b) engagement sections adapted for fastening engagement with at least one corresponding aperture in said substrate.

39. The clamp of claim 38 wherein said retention means extend downwardly from said base member.

40. The clamp of claim 38 wherein each of said retention means has a retention section and an engagement section.

41. The clamp of claim 38 wherein said clamp is adapted to protectively retain a circuit module comprising a fragile lamina including a conductive trace and wherein said base member is adapted to shelter said circuit module.

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