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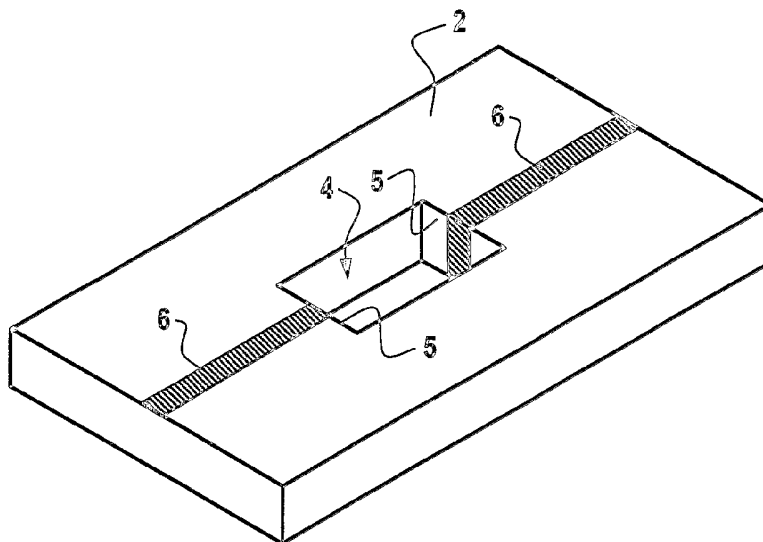
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ning of each regular issue of the PCT Gazette.

(54) Title: **SOLDERLESS COMPONENT PACKAGING AND MOUNTING**



(57) **Abstract:** An apparatus and method for providing three-dimensional carrier mounting of one or more electronic components. In accordance with one embodiment, the device mounting apparatus of the present invention includes an elastically resilient plastic substrate having component mounting surfaces in at least two dimensions. At least one press-fit component insertion cavity is disposed within the component mounting surfaces to provide compressive retention of the electronic component when press-fit into the cavity. Preferably, the cavity has a depth such that when the component is press-fit, it does not extend above the surface plane of the cavity. The insertion cavity is further characterized as including at least one conductive trace disposed on an inner surface of said insertion cavity and positioned on the insertion cavity surface such that the conductive trace contacts at least one lead of the electronic device retained within the insertion cavity.



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SOLDERLESS COMPONENT PACKAGING AND MOUNTING

TECHNICAL FIELD

5 [001] Embodiments are generally related to electronics device packaging and mounting techniques, and more particularly to a component mounting apparatus suitable for hostile sensor mounting applications. More particularly, embodiments are related to a specialized electronics packaging and corresponding component mounting apparatus that are structurally and
10 functionally superior to traditional surface-mounted and press-fit technologies.

BACKGROUND OF THE INVENTION

15 [002] Electronics packaging and mounting reliability issues are almost always associated with thermal-mechanical stresses. These issues are compounded by the industry's ongoing revolution in which the market demands smaller packages and higher density devices delivering more power and greater functionality. One of the weakest links in the hostile
20 environment of a sensor package, for example, is the soldered joint utilized to attach the sensor components to a printed circuit board (PCB).

[003] Several types of solder-based techniques have been used for attaching integrated circuit modules and/or discrete components to a suitable interconnecting forum, typically a PCB. One such traditional mounting
25 technique involves positioning a component encased in a plastic material and having metal leads extending therefrom onto a PCB such that the leads extend into holes in the PCB. A solder joint is utilized to rigidly couple the leads to the PCB holes. Another solder-based mounting method, commonly known as surface mount technology (SMT), involves mounting the electronic
30 components such that the leads are soldered onto the surface of a PCB rather than inserted into holes in the board.

[004] Solder molding compounds have several significant

performance characteristics that must be considered by a manufacturer for a given application. These items include temperature of glass transition, coefficient of thermal expansion (CTE), moisture absorption characteristics, flexural modulus and strength, and thermal conductivity.

5 [005] These and other characteristics may contribute to problems associated with soldered mounting of electronic components including moisture sensitivity, cracked packages, open bond wires, intermittent electrical continuity failures, etc. Particularly when deployed in high-temperature environments, such as many automotive sensor applications,
10 CTE mismatch strains can significantly compromise the strength and reliability of the solder joints in an electronics package. Most of these problems are not present in the devices prior to assembly onto PCBs but are the result of thermally induced stressing during assembly soldering or rework de-soldering.

15 [006] An alternative approach to soldering PCB components on a common circuit substrate to form a functional unit such as an electronic sensor package is generally known as press-fit technology. A press-fit connection is made, as the name implies, through the pressing in of a contact pin into a PCB through hole. The important consideration here is
20 that the cross-section diameter of the pin is greater than the diameter of the PCB hole. This difference in pin cross section and hole diameter results in deformation of either the PCB hole or the cross section of the pin during the insertion process of pin into a PCB through hole.

 [007] The two major press-fit techniques include a solid pin that does
25 not deform in the insertion process and a compliant pin that compresses as a result of insertion into the PCB through hole. The compliant pin approach has proven more popular for achieving a reliable press fit contact for several reasons. First, the reduction in the size of press-fit section exerts less potentially damaging forces on the PCB through hole and greater tolerances
30 can be accepted for the plated through hole. Furthermore, compliant pins

result in lower required insertion forces, resulting in fewer logistical complications. Finally, compliant pins enable multiple press cycles into the same through holes.

[008] In addition to being used for connecting components to a PCB, press fit technology is also commonly utilized in multilayer PCB applications in which press fit connector adapters are installed as effective plug-in adapters onto a PCB.

[009] In view of the aforementioned problems with soldered PCB connection techniques, such press-fit technologies are rapidly emerging as a more attractive alternative for connecting multiple components to a common platform. Press-fit compliant solutions offer several advantages over soldering including providing simple, clean, robust and highly reliable interconnections, even in high-vibration and thermal cycling environments. Press-fit connectivity further eliminates the need for special features for PCB ground plane layers to minimize their heat sink effects when soldering. Use of press fit PCB connectivity eliminates the need to solder and consequently eliminates package exposure to the high temperatures associated with conventional soldering and wave soldering applications. The elimination of solder joints enhances long-term reliability by providing a more shock resistant connection. Furthermore, the use of press fit connections eliminates the need to wash the PCB as is required for removing flux and other soldering board residue.

[0010] While alleviating problems associated with soldering connectivity, conventional press-fit technologies pose several significant problems. Many of the drawbacks to conventional press-fit relate to the fine tolerances involved in positioning and pressing multiple pins into the very small press-fit holes. For example, the connector pins often protrude through the PCB when pressed thereon, requiring clearance holes or slots be provided at all connector sites. Furthermore, high precision press positioning equipment including tooling pins is required to pre-align the PCB holes with

the fixture. Furthermore, the aforementioned compliant pin approach results reduced component re-usability due to the deformation of component leads.

[0011] It can therefore be appreciated that a need exists for an improved apparatus and method for packaging and mounting electronic components to a substrate forum that alleviates some or all of the foregoing problems with soldering and conventional press-fit technologies. The present invention addresses such a need.

BRIEF SUMMARY OF THE INVENTION

[0012] The following summary of the invention is provided to facilitate
5 an understanding of some of the innovative features unique to the present
invention and is not intended to be a full description. A full appreciation of
the various aspects of the invention can be gained by taking the entire
specification, claims, drawings, and abstract as a whole.

[0013] An apparatus and method for providing three-dimensional
10 carrier mounting of one or more electronic components are disclosed herein.
In accordance with one embodiment, the device mounting apparatus of the
present invention includes an elastically resilient plastic substrate having
component mounting surfaces in at least two dimensions. At least one
press-fit component insertion cavity is disposed within the component
15 mounting surfaces to provide compressive retention of the electronic
component when press-fit into the cavity.

[0014] Preferably, the cavity has a depth such that when the
component is press-fit, it does not extend above the surface plane of the
cavity. The insertion cavity is further characterized as including at least one
20 conductive trace disposed on an inner surface of said insertion cavity and
positioned on the insertion cavity surface such that the conductive trace
contacts at least one lead of the electronic device retained within the
insertion cavity.

All objects, features, and advantages of the present invention will
25 become apparent in the following detailed written description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The accompanying figures, in which like reference numerals
5 refer to identical or functionally-similar elements throughout the separate
views and which are incorporated in and form a part of the specification,
further illustrate the present invention and, together with the detailed
description of the invention, serve to explain the principles of the present
invention.

10 [0016] FIG. 1 depicts an apparatus for mounting an electronic
component in accordance with one embodiment of the present invention;

[0017] FIG. 2 illustrates an apparatus for providing multi-dimensional
carrier device mounting in accordance with an alternate embodiment of the
present invention;

15 [0018] FIG. 3 depicts an alternate embodiment of the device mounting
apparatus of the present invention utilizing a component snap-in feature;

[0019] FIG. 4 illustrates an electronic device mounting apparatus
utilizing an alternative snap-in mechanism in accordance with the present
invention; and

20 [0020] FIG. 5 depicts an electronic device mounting apparatus utilizing
a covered and clip design in an alternate embodiment of the present
invention.

DETAILED DESCRIPTION OF THE INVENTION

5 [0021] The present invention is described in a preferred embodiment in the following description with reference to the figures. While this invention is described in terms of the best mode for achieving this invention's objectives, it will be appreciated by those skilled in the art that variations may be accomplished in view of these teachings without deviating from the spirit or scope of the present invention.

10 [0022] The present invention is directed to an apparatus and method for collectively mounting electronic devices, such as for a sensor or other electronics packages that eliminates many of the disadvantages of conventional printed circuit board (PCB) and press-fit technologies. More specifically, as and explained in further detail below with reference to the
15 figures, the device mounting apparatus of the present invention employs a compliant/flexible substrate material that simultaneously serves as the multi-component frame, analogous to a PCB, and has material properties enabling it to be used to mechanically retain the components without the need for soldering or other mechanical or adhesive component coupling.

20 [0023] As utilized herein, "elastic," "elastomeric," and similar terms used to described the retention properties of a substrate are intended to refer to the mechanical property of an object material characterized in that a material is "elastic" if it changes shape due to an applied load, but that when the load is removed, recovers its original shape.

25 [0024] With reference now to the figures, wherein like reference numerals refer to like and corresponding parts throughout, and in particular with reference to FIG. 1, there is depicted an apparatus for mounting an electronic device in accordance with one embodiment of the present invention. As shown in FIG. 1, the device mounting apparatus generally
30 comprises a substrate member 2 having an open cavity insertion zone 4 in which an electronic device (not depicted) may be compressively retained.

Although depicted as rectangular in the depicted embodiment, insertion zone 4 may be formed to have any of a variety of inner contours and dimensions to accommodate the shape and size of the particular electronic device or component for which insertion zone 4 is designed.

5 [0025] As further illustrated in FIG. 1, the device mounting apparatus further includes conductive traces 6 disposed in at least two planar dimensions on the surface of substrate member 2, from the upper surface plane and extending to the inside lateral surfaces 5 of the open cavity insertion zone 4. Assuming substrate member 2 comprises a plastic
10 material, conductive traces 6 are preferably gold or a gold alloy. In alternative embodiments, conductive traces 6 may comprise other suitable metals or alloys including one or more of copper, nickel, gold, tin, aluminum and chrome.

 [0026] Conductive traces 6 are positioned on the surfaces of the cavity
15 insertion zone portion of substrate member 2 such that the traces contact the respective ends of an electronic device or component installed therein. Specifically, the depicted mounting apparatus is designed such that when an electronic component is press-fit into insertion zone 4, a pair of opposing inside lateral surfaces 5 of insertion zone 4 exerts an elastic compressive
20 force to compressively retain the device within insertion zone 4 without the need for further coupling or fastening means such as soldering. To this end, and in an important feature of the depicted embodiment, substrate member 2 comprises an elastically resilient material, such as one of many well-known polymer composites. The portions of conductive traces 6 extending into
25 insertion zone 4 on lateral surfaces 5 provide reliable electrical contact with corresponding device leads (depicted in FIG. 2) contacting the respective elastic surfaces.

 [0027] Referring to FIG. 2, there is illustrated an apparatus for providing multi-dimensional device mounting in accordance with an alternate
30 embodiment of the present invention. As shown in FIG. 2, the alternate

embodiment apparatus, like that depicted in FIG. 1, generally includes a substrate material member 22 providing the device mounting framework and at least one press-fit component insertion cavity for press-fitting components onto the substrate. In particular, substrate member 22 includes multiple mounting surfaces 21, 23, and 27 disposed in at least two different mounting planes. Furthermore, mounting surfaces 21, 23, and 27 include, respectively, press-fit cavities 13, 17, and 18 that are formed similarly in principle to the press-fit cavity 4 explained with reference to FIG. 1. Specifically, the cross-section depiction provided by FIG. 2 reveals a conductive trace 24 disposed on the surface of substrate 22 and extending onto the inner surfaces of opposing lateral sidewalls of the insertion cavities such that conductive trace 24 contacts at least one device lead of an electronic device retained therein. As with the previously depicted embodiment, the conductive traces illustrated in FIG. 2 are preferably gold or a gold alloy, but may also comprise other suitable metals or alloys.

[0028] FIG. 2 further illustrates the manner in which an electronic component 16 is mounted within press-fit cavity 13. Specifically, electronic component 16 is mounted onto the apparatus by press-fitting the component into press-fit cavity 13 that is sized to accommodate component 16 while inside lateral walls 26 provide a sufficient compressive elastic force against a corresponding set of component leads (not depicted) disposed at the depicted lengthwise ends of component 16 to mechanically and electrically couple and retain the component to substrate 22. In this manner, component 16 may be hand- or machine-installed without the need for further bonding or adhesive coupling, thereby providing for convenient uninstallation and/or reinstallation of a previously installed component.

[0029] A significant advantage provided by the apparatus of the invention, and depicted in the side cross-section view of FIG. 2, is that it eliminates the need for soldering in a manner providing significant logistical advantages relating to the configuration and placement of the apparatus within another system. In particular, and with continued reference to FIG. 2,

press-fit cavity 13 is preferably formed to have a depth at least sufficient such when an electronic component is press-fit therein, the component does not extend above the surface plane of mounting surface 21 from which the open cavity extends. By effectively embedding the components to maintain
5 a flat or otherwise flush substrate surface contour, the mounting apparatus of the present invention provides a device framework that can be more flexibly and compactly deployed in a variety of systems having contouring and sizing limitations.

[0030] With reference to FIG. 3, there is depicted an alternate
10 embodiment of the device mounting apparatus of the present invention utilizing a component snap-in feature. Specifically, the embodiment shown in FIG. 3 is an apparatus for mounting one or more electronic devices or components generally comprising a substrate member 45 having an upper surface boundary 42 below which a snap-in insertion zone 48 is disposed.
15 Snap-in zone preferably 48 is designed to accommodate an electronic component having specified dimensions and lead structures. As shown in the depicted embodiment, snap-in zone 48 is characterized as including a pair of opposing flexible component retention members 44 extending beneath the substrate boundary surface 42 and compressively retaining an
20 electronic component 34 within a snap-in surface contouring of the retention members 44.

[0031] As with the embodiments depicted in FIGS. 1 and 2, substrate 45 preferably comprises an elastic/resilient plastic material. Furthermore, the snap-in device mounting apparatus shown in FIG. 3 includes conductive
25 traces 38 disposed on the surface of substrate member 45 and extending to the inside surfaces of component retention members 44. In this manner, a corresponding set of one or more device leads 36 are maintained in compressive contact with the respective opposing portions of conductive traces 38 with electronic component 34 mounted on the apparatus.

30 [0032] FIG. 4 illustrates a variation of the snap-in embodiment of FIG.

3 in accordance with an alternate embodiment. The mounting apparatus of FIG. 4 generally comprises a substrate 52 having conductive traces 58 extending into a snap-in insertion zone 56. In contrast to the embodiment shown in FIG. 3, the insertion zone 56 is characterized as comprising a pair
5 of dual-set component retention arms 54 that provide additionally secure mechanical coupling to the apparatus.

[0033] With reference to FIG. 5, there is depicted an electronic device mounting apparatus employing a "sandwich" type snap-in design. Similar to the previously described embodiments, the mounting apparatus shown in
10 FIG. 5 generally comprises a plastic substrate 68 having a conductive trace 72. As with the previous embodiments, conductive trace 72 is disposed on the surface of the elastic insertion zone formed by the depicted well in substrate 68 such that conductive trace 72 contacts the respective leads of as electronic device 66 retained therein.

15 [0034] In addition, the mounting apparatus depicted in FIG. 5 includes a lid member 64 that is disposed over the open cavity insertion zone formed in substrate 68 to compressively retain electronic device 66 securely within the insertion zone. Such compressive retention may be particularly useful for applications, such as electronic vehicle sensors wherein the device
20 packaging is subjected to considerable dynamic forces, acceleration, and other dynamic stresses. As further depicted in FIG. 5, the mounting apparatus may include a clip 62 that applies a compressive force between substrate 68 and lid member 64 to securely retain the lid member in position. Under severe thermal conditions, clip 62 may be utilized to maintain a
25 sufficient structural retention force thus ensuring component 66 remains securely seated within the insertion zone.

[0035] The embodiments and examples set forth herein are presented to best explain the present invention and its practical application and to thereby enable those skilled in the art to make and utilize the invention.
30 Those skilled in the art, however, will recognize that the foregoing description

and examples have been presented for the purpose of illustration and example only. Other variations and modifications of the present invention will be apparent to those of skill in the art, and it is the intent of the appended claims that such variations and modifications be covered.

5 [0036] The description as set forth is not intended to be exhaustive or to limit the scope of the invention. Many modifications and variations are possible in light of the above teaching without departing from the scope of the following claims. It is contemplated that the use of the present invention can involve components having different characteristics. It is intended that
10 the scope of the present invention be defined by the claims appended hereto, giving full cognizance to equivalents in all respects.

CLAIMS

Having thus described the invention what is claimed is:

- 5 1. An apparatus for mounting one or more electronic devices, said apparatus comprising:
- a substrate member having an elastic insertion zone in which an electronic device may be compressively retained; and
- at least one conductive trace disposed on the surface of said elastic
- 10 insertion zone, wherein said conductive trace is positioned on the insertion zone surface such that the conductive trace contacts at least one lead of the electronic device retained within the insertion zone.
2. The apparatus of claim 1, wherein said substrate member comprises a
- 15 plastic material.
3. The apparatus of claim 1, wherein said at least one conductive trace comprises a metal pattern applied in at least two dimensions on the surface of said substrate member.
- 20 4. The apparatus of claim 1, wherein said at least one conductive trace comprises a metal or metallic alloy comprising one or more of copper, nickel, gold, tin, aluminum and chrome.
- 25 5. The apparatus of claim 1, wherein said elastic insertion zone comprises at least two opposing lateral surfaces, at least one of said opposing lateral surfaces comprising a substantially elastic plastic.
- 30 6. The apparatus of claim 1, wherein said elastic insertion zone is formed as an open cavity within said substrate member.

7. The apparatus of claim 6, wherein said elastic insertion zone is designed to mechanically engage and retain the electronic component, said open cavity characterized as having a depth at least sufficient such that when the electronic component is press-fit therein, the electronic component does not
5 extend above the surface plane of said open cavity.

8. The apparatus of claim 1, further comprising:

a lid member disposed over said elastic insertion zone, wherein said lid member provides a cover for retaining said electronic device; and

10 a clip that applies a compressive force between said substrate member and said lid member to securely retain said lid member in position.

9. An apparatus for providing three-dimensional carrier mounting of one or more electronic components, said apparatus comprising:

15 a plastic substrate having component mounting surfaces in at least two dimensions; and

at least one press-fit component insertion cavity disposed within the component mounting surfaces, said insertion cavity characterized as including at least one conductive trace disposed on an inner surface of said
20 insertion cavity, wherein said conductive trace is positioned on the insertion cavity surface such that the conductive trace contacts at least one lead of the electronic device retained within the insertion cavity.

10. The apparatus of claim 9, wherein said plastic substrate comprises an
25 elastic polymer material.

11. The apparatus of claim 9, wherein said at least one conductive trace comprises a metal pattern disposed on the mounting surfaces of said plastic substrate.

30

12. The apparatus of claim 9, wherein said at least one conductive trace comprises a metal or metallic alloy comprising one or more of copper, nickel,

gold, tin, aluminum and chrome.

13. The apparatus of claim 9, wherein said insertion cavity comprises at least two opposing lateral surfaces, at least one of said opposing lateral
5 surfaces comprising a substantially elastic plastic.

14. The apparatus of claim 13, wherein said insertion cavity is designed to mechanically engage and retain an electronic component, said insertion cavity characterized as having a depth at least sufficient such that when the
10 electronic component is press-fit therein, the electronic component does not extend above the surface plane of said open cavity.

15. A method for mechanically and electrically interconnecting at least two electronic devices, said method comprising:
15 providing a plastic substrate having component mounting surfaces in at least two dimensions; and

press-fitting an electronic component into at least one press-fit component insertion cavity disposed within the component mounting surfaces, said insertion cavity characterized as including at least one
20 conductive trace disposed on an inner surface of said insertion cavity, wherein said conductive trace is positioned on the insertion cavity surface such that the conductive trace contacts at least one lead of the electronic device retained within the insertion zone.

25 16. An apparatus for mounting one or more electronic devices, said apparatus comprising:

a substrate member having an upper surface boundary and including a snap-in insertion zone characterized as comprising at least one pair of opposing flexible component retention members extending beneath the
30 surface of said substrate member and mutually disposed to compressively retain an electronic device installed therein; and

at least one conductive trace disposed on the respective inner

surfaces of the component retention members such that the conductive trace contacts at least one lead of the electronic device retained within the snap-in insertion zone.

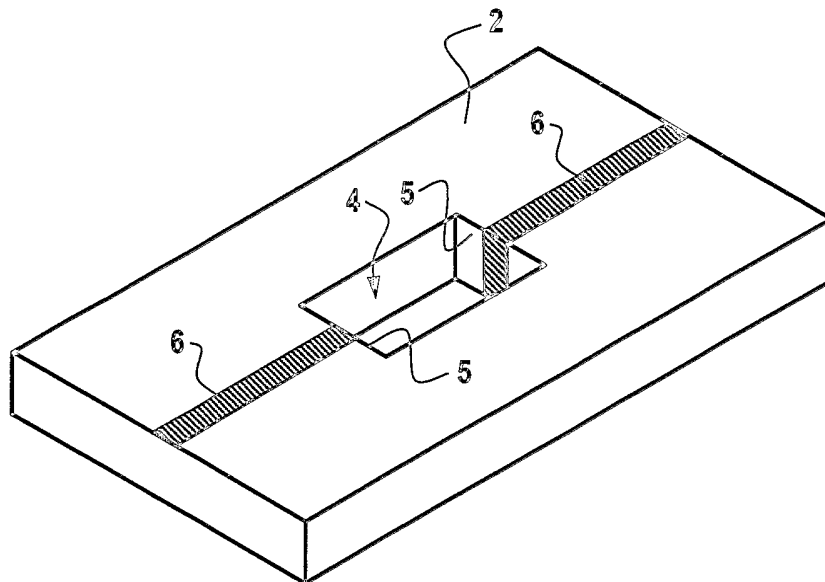
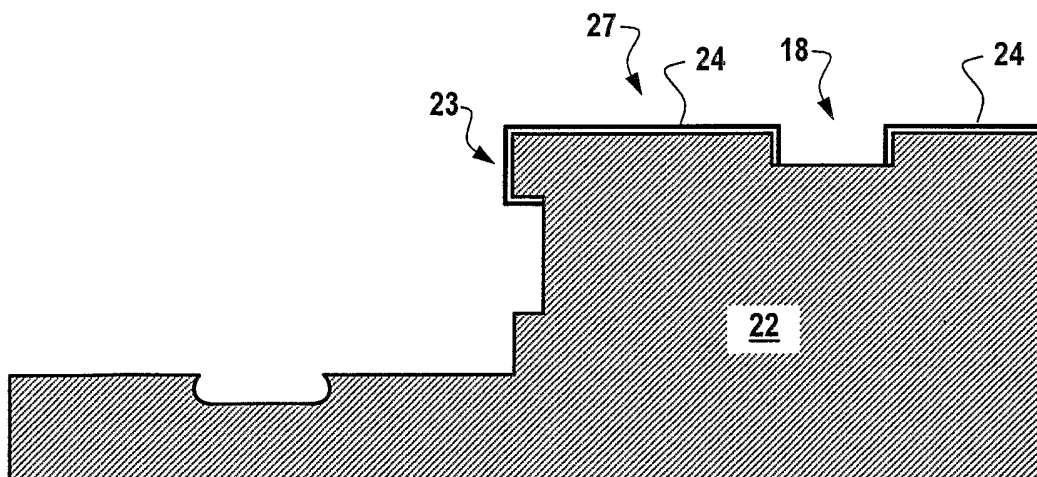
5 17. The apparatus of claim 16, wherein said substrate member comprises a plastic material.

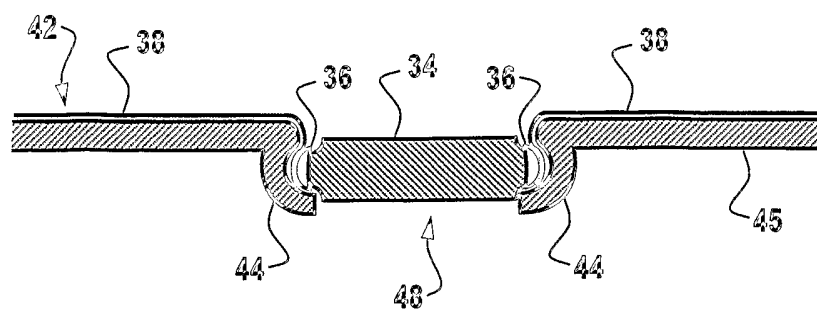
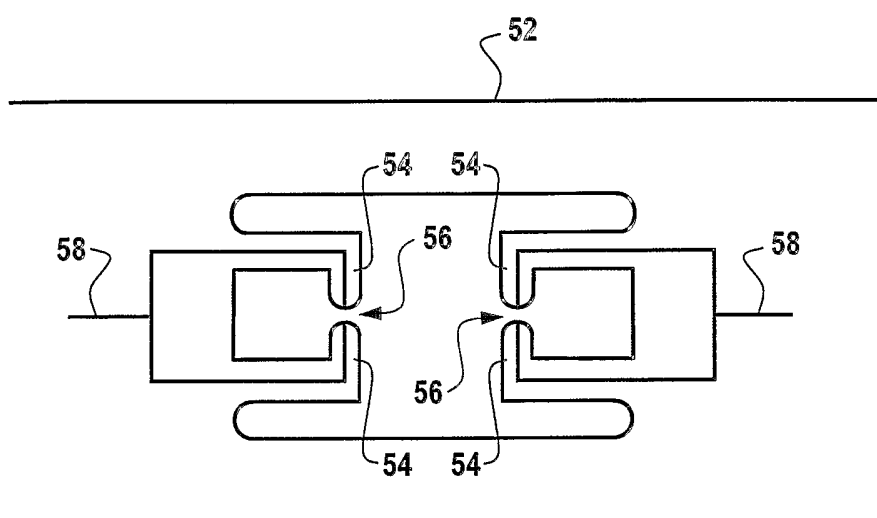
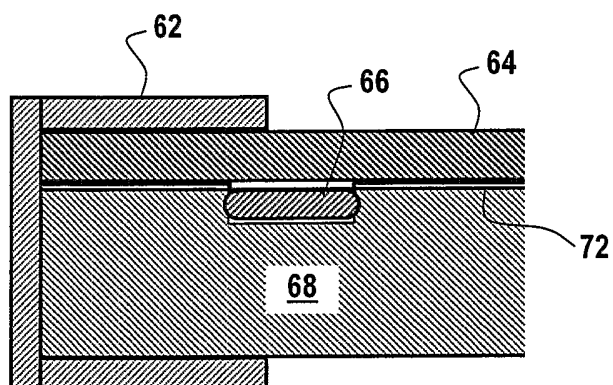
18. The apparatus of claim 16, wherein said at least one conductive trace comprises a metal pattern applied in at least two dimensions on the surface
10 of said substrate member.

19. The apparatus of claim 16, wherein said at least one conductive trace comprises a metal or metallic alloy comprising one or more of copper, nickel, gold, tin, aluminum and chrome.

15

20. The apparatus of claim 16, wherein said snap-in insertion zone is characterized as having a depth at least sufficient such that when the electronic component is snap-fit therein, the electronic component does not extend above the upper surface boundary of said substrate member.

*Fig. 1**Fig. 2*

*Fig. 3**Fig. 4**Fig. 5*

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
H05K1/18 H05K3/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, IBM-TDB, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 03, 31 March 1999 (1999-03-31) & JP 10 321987 A (SONY CORP), 4 December 1998 (1998-12-04) abstract	1-20
X	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 12, 25 December 1997 (1997-12-25) & JP 09 205264 A (OMRON CORP), 5 August 1997 (1997-08-05) abstract	1-15
X	US 5 994 648 A (GLOVATSKY ET AL) 30 November 1999 (1999-11-30) column 3, line 56 - column 4, line 35; figures 2a-2c	1-15
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Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

° Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
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- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search

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Date of mailing of the international search report

12/12/2005

Name and mailing address of the ISA

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
X	<p>PATENT ABSTRACTS OF JAPAN vol. 1999, no. 08, 30 June 1999 (1999-06-30) & JP 11 087876 A (TEIKOKU TSUSHIN KOGYO CO LTD), 30 March 1999 (1999-03-30) abstract -----</p>	<p>1-4, 7-12,14, 16-20</p>

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PCT/US2005/028765

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