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High Density Edge Card Connector

Cross-Reference to Related Applications

This application claims the benefit of U.S. Provisional Patent Application number 60/068,664, filed on December 23, 1997 and herein
5 incorporated by reference.

Background of the Invention

1. Field of the Invention

The present invention relates to electrical connectors. More specifically, the present invention relates to high density edge card
10 connectors.

2. Brief Description of Earlier Developments

Edge card connectors have been used for a substantial period of time. As with many other connector types, there has been a continual evolution of these connectors in terms of size reduction, terminal pitch, and
15 electrical performance. In order to reduce the size of the connector and in many cases increase the signal density, it is necessary to decrease the terminal pitch.

The decrease in terminal pitch necessitates a decrease in the amount of insulative material between terminals, thereby resulting in very thin
20 walls between terminals. The insertion of terminals into the terminal cavities can result in rupturing these thin walls between terminal cavities. Also an accumulation of stress along the lengthwise dimension of the connector can occur. However, the decreased wall thicknesses in the connector housing render the housing less able to resist the stress
25 accumulation. As a result, the connector tends to bow. This adversely affects conformance of the connector to the circuit board on which it is mounted and creates alignment difficulties, particularly in surface mount

connectors, with contact pads on the printed circuit board.

In addition, many prior designs employ relatively long length contact arms in order to develop sufficient deflection to accommodate daughter board thickness tolerances and to obtain good contact normal forces between the contacts and the terminals of the connector. This increases the impedance of the connector and can unduly increase skew.

Summary of the Invention

It is an object of the present invention to minimize the accumulation of stresses in the connector housing.

10 It is a further object of the present invention to employ relatively light retention forces when inserting terminals into the housing.

It is a further object of the present invention to utilize an element secured to the housing after terminal insertion to hold the terminals in place within the housing.

15 It is a further object of the present invention to provide terminals having features to help retain the terminal within the insulative housing during handling.

It is a further object of the present invention to provide terminals that are movable with respect to the housing to accommodate differences in the coefficient of thermal expansion (CTE) of the connector body and the printed circuit board upon which the connector mounts.

20 It is a further object of the present invention to employ deformable elements, such as solder balls, to secure the terminals to the housing.

It is a further object of the present invention to provide a connector that can be closely stacked in an end-to-end configuration with another connector.

25 These and other objects of the present invention are achieved in one

aspect of the present invention by an electrical connector comprising: an insulative housing having at least one cavity; a retaining member removably securable to the insulative housing and occluding at least a portion of the cavity, the retaining member having at least one aperture in communication with the cavity; a conductive terminal having a first portion disposed in the cavity and a second portion disposed in the aperture; and a surface mount element mounted on the second portion of the terminal. The member retains the terminal within the insulative housing.

10 These and other objects of the present invention are achieved in another aspect of the present invention by a card edge connector, comprising: an insulative housing, a conductive terminal, a retaining member and a surface mount element. The insulative housing has: a slot for receiving an edge of a card; a cavity in communication with the slot and a pair of posts, each having channels in communication with the slot for receiving the card. The conductive terminal has a mating portion residing within the cavity for engaging the card edge and a mounting portion extending from the cavity. The retaining member secures to the insulative housing and has an aperture in communication with the cavity that receives the mounting portion of the terminal. The retaining member preventing the terminal from exiting the cavity. The surface mount element attaches to the mounting portion of the terminal.

25 These and other objects of the present invention are achieved in another aspect of the present invention by a method of making an electrical connector, comprising the steps of: providing an insulative housing having a cavity; providing a conductive terminal having a mounting portion; providing a retaining member having an aperture;

providing a surface mount element; inserting the terminal into the cavity;
attaching the retaining member to the insulative housing, wherein the
mounting portion of the terminal resides within the aperture; and
securing the surface mount element to the mounting portion of the
5 terminal. The retaining member keeps the terminal within the cavity.

Brief Description of the Drawings

Other uses and advantages of the present invention will become
apparent to those skilled in the art upon reference to the specification and
the drawings, in which:

10 Figure 1 is a side elevation of a connector embodying the invention;

Figure 1a is a detailed view of a portion of Figure 1;

Figure 2 is an end view of the connector in Figure 1;

Figure 3 is a top view of the connector in Figure 1;

Figure 3a is a cross-sectional view taken along line IIIA-IIIA in Figure 3
15 showing the terminals inserted into a main portion of the connector
housing;

Figure 3b is a cross-sectional view taken along IIIB-IIIB in Figure 3
showing the terminals secured within the connector housing with a
terminal retention element;

20 Figure 4a is a detailed view of a portion of Figure 3a showing a
terminal retained within the connector;

Figure 4b is a detailed view of a portion of Figure 3a showing a
terminal partially retracted from the connector housing;

Figure 5 is a detailed view of a portion of Figure 3b showing a feature
25 of the terminal retention element;

Figure 6 is a detailed view of a portion of Figure 3b showing another
feature of the terminal retention element;

Figure 7 shows the connector of Figure 1 together with a mating daughter board;

Figure 8 is a detailed view of a portion of Figure 7; and

Figure 9 is a side view of two connectors according to the invention
5 arranged end-to-end.

Detailed Description of the Preferred Embodiments

Figures 1-3 show various views of a connector 10 of the present invention. Connector 10 consists of three main components, a main body 11, terminals 13 and a terminal retention member 15. Generally
10 speaking, assembly of connector 10 proceeds by inserting terminals 13 into main body 11, then securing terminal retention member 15 to main body 11 which retains terminals 13 within main body 11. Each component will now be described in detail.

Main body 11 is formed of a suitable dielectric material. Body 11 can
15 have a generally planar base with two parallel, longitudinally oriented slots 17 (see Figure 3) that receive daughter boards B (see Figure 7) in an edge-wise configuration.

Body 11 includes upstanding, split guide posts 19 at one end. Guide posts 19 include a latch member 21 pivotally mounted via a pivot pin 23
20 in each guide post 19. Latch member 21 can pivot between a substantially vertical position (shown in solid lines in Figure 1) and an ejecting position (shown in phantom in Figure 1). Latch member 21 includes an ejecting foot 25 at a bottom end and a pair of opposed cam tabs 27 for urging the portions of guide post 19 together against surfaces
25 of inserted daughter board B. International publication number WO 97/08782, herein incorporated by reference, describes in more detail the aforementioned structure for retaining daughter board B in connector 10.

Guide posts 29 oppose guide posts 19 on main body 11. Guide posts 29 include a slot 31 aligned with slot 17 in body 11 to receive side edges of inserted daughter board B. As seen in Figure 8, guide posts 29 have a surface 33 extending generally perpendicular to bottom surface 35 of main body 11 and an angled surface 37. Angled surface 37 acts as a lead-in for inserting daughter board B into connector 10. As will be described in more detail below, surface 33 helps retain daughter board B within connector 10.

Preferably, the upper end of each guide post 29 is relieved to form a canted surface 39. This allows end-to-end placement of several connectors 10 as seen in Figure 9 and as will be described in more detail below.

Referring to Figures 1 and 3, a plurality of terminal cavities 41 flank each slot 17 in body 11. Cavities 41 receive a respective terminal 13 that engage contact pads (not shown) disposed along the edge of daughter boards B inserted into slots 17.

Cavities 41 includes side surfaces 43, 45 and upper surfaces 47, 49 that abut against corresponding portions of terminals 13 when terminals 13 reside within main body 11. Surfaces 43, 47, 49 of cavities 41 form datum surfaces for the location of terminals 13 within main body 11. This feature will be described in more detail below.

Main body 11 also includes a plurality of flanges 51 formed on opposed outer surfaces along bottom surface 35. Flanges 51, along with openings 53 in a central portion of main body 11, help secure terminal retention member 15 to main body 11. For example, terminal retention member 15 secures to main body 11 by positioning along bottom surface 35 and securing latch members with flanges 51 and openings 53.

Figures 3a, 3b, 4a and 4b display terminals 13 positioned within main body 11. Each terminal 13 includes a tapered cantilever beam 55 extending from a base portion 57. Cantilevered beam 55 includes a contact surface 59 at a distal end opposite base portion 57.

5 Base portion 57 includes side surfaces 61, 63; upper surfaces 65, 67; and lower surface 69 that interact with surfaces 43, 45, 47, 49 of cavities 41 and a mating surface of terminal retention member 15. Interaction of the various surfaces help align and retain terminal 13 within main body 11.

10 Side surface 61 has a retention barb 71 extending therefrom. Barb 71 pierces side surface 43 of cavity 41 to retain terminal 13 within main body 11 until terminal retention member 15 can secure to main body 11.

Figure 4a displays terminal 13 properly seated within main body 11.

15 Retention barb 71 is located towards a lower end of side surface 61 to prevent rotation of terminal 13 out of main body 11. By locating barb 71 at a lower end of side surface 61, an upper portion 97 of side surface 63 cannot exit main body 11. As seen in Figure 4b, when terminal 13 rotates, upper portion 97 interferes with side surface 45 of cavity 41. This feature additionally retains terminal 13 within main body 11 until
20 terminal retention member 15 can secure to main body 11.

Base portion 57 also includes a terminal tab 73 to receive, for example, a fusible element 75 such as a solder ball for surface mounting connector 10 to a substrate (not shown). Fusible elements 75 typically have a slightly greater transverse extent than the transverse extent of the
25 openings 79 in terminal retention member 15. Thus, fusible elements 75 also serve a retention function for securing terminals 13 in proper position and for holding terminal retention member 15 onto main body

11. Fusible elements 75 form a connection between the terminals 13 and contact pads on the circuit substrate by conventional reflow techniques.

Fusible elements 75 secure to tabs 73 by applying a solder paste (not shown) into the openings 79, then by placing individual fusible elements
5 75 over openings 79. After placement of fusible elements 75 in openings 79, connector 10 then undergoes a first reflow operation to melt the solder paste and to fuse the fusible element 75 to tab 73 of terminal 13. A second reflow step attaches connector 10 to substrate S.

Figures 1 and 3b display terminal retention member 15. Preferably,
10 retention member 15 is made from a molded dielectric material.

Retention member 15 includes a mating surface 77 that abuts bottom surface 35 of main body 11 and surfaces 69, 71 of terminal 13. Retention member 15 includes a plurality of apertures 79 sized to receive terminal tab 73 of terminal 13 and at least a portion of fusible element 75.

15 Apertures 79 are preferably larger than tabs 73 to allow longitudinal movement of tab 73 without interference by the walls forming apertures 79.

Terminal retention member 15 includes latches 81 located at opposite ends thereof to engage flanges 43 of main body 11 and centrally located
20 latches 83 to engage openings 53 of main body 11. Latches 81, 83 are preferably cantilevered members integrally molded with terminal retention member 15.

Latches 81 include a flexible arm 85 and a catch 87 that engages flange 43. Latches 83 comprise two pieces 89a, 89b in an opposed
25 relationship. Each opposed portion 89a, 89b has a flexible arm 91a, 91b and a catch 93a, 93b. Slightly different than catch 87 of latch 81, catches 93a, 93b each include surfaces 95a, 95b angled opposite to that of

conventional latches. Canted surfaces 95a, 95b engage opposite edges of opening 53 to retain member 15 in main body 11.

The canting of surfaces 95a, 95b helps accommodate tolerance variations between main body 11 and terminal retention member 15. The amount of potential tolerance absorption is represented by the dimension T, a dimension that is defined by the difference in elevation between the inside edge of surface 95a and the outside edge of surface 95b. In essence, surfaces 95a, 95b serve as a camming surface, under the spring force generated by latches 83 to draw terminal retention member 15 against bottom surface 35 of main body 11. Stated differently, the securing system for the terminal retention member 15 can absorb vertical tolerances between main body 11 and terminal retention member 15 and also the vertical dimension of the base 57 of terminal 13. Preferably, surfaces 95a, 95b extends approximately 27° from the lateral axis of latch 83.

The assembly of connector 10 will now be described. Initially, main body 11, terminals 13 and terminal retention member 15 are separate elements. The first assembly step inserts terminals 13 into cavities 41 of main body 11. Figure 4a displays terminal 13 properly inserted into cavity 41. When seated within cavity 41, side wall 63 of terminal 13 abuts side surface 43 of cavity 41 and upper surfaces 65, 67 of terminal 13 abut upper surfaces 47, 49 of cavity 41.

The points of contact between cavity 41 and terminal 13 constitute datum points, designated by arrows Z_1 , Z_2 and L_3 . The datum points help locate terminals 13 within main body 11. Specifically, datum points Z_1 and Z_2 help position terminals 13 longitudinally within main body 11 (i.e. in the direction extending from the bottom to the top of Figure 3b). Also,

datum point L₃ helps position terminals 13 laterally within main body 11 (i.e. the direction extending from the left side to the right side of Figure 3a).

As seen in Figure 4a, a clearance exists between side wall 61 (excluding barb 71) of terminal 13 and side surface 43 of cavity 41 when side wall 63 of terminal 13 abuts side surface 45 of cavity 41. The length of barb 71, however, is greater than the clearance between side wall 61 of terminal 13 and side surface 43 of cavity 41. As a result, a portion of barb 71 pierces side surface 43 of cavity 41. Barb 71 allows terminals 13 to move slightly in the longitudinal direction within main body 11 while still engaging side surface 43 of cavity 41. This helps alleviate any stresses that might result from any mismatch in the coefficients of thermal expansion (CTE) between the materials of main body 11 and the substrate, such as a printed circuit board (not shown) on which the connector 10 is mounted.

Barb 71 creates a light retentive force sufficient to hold terminals 13 in housing 11 for subsequent handling prior to the attachment of terminal retention member 15, but not for full retention under conditions of use. The light retentive force applies a relatively light stress to main body 11 at locations S₁, S₂ than with conventional connectors. The light retentive force does not urge the main body to bow or cause the webs between adjacent cavities to crack as sometimes found with conventional connectors. The contact of surface 63 along surface 43 and the point contact of barb 71 with surface 45 allows for the movement of terminal 13 independent of housing 11.

After terminals 13 are inserted within main body 11, terminal retention portion 15 is secured to main body 11. Specifically, terminal retention

portion 15 is positioned to abut lower surface 35 of main body 11.

Latches 81, 83 on terminal retention portion engage corresponding flanges 51 and openings 53 on main body 11.

When properly fastened to main body 11, mating surface 77 of
5 terminal retention member 15 abuts lower surface 69 of terminal 13. The point of contact between cavity 41 and terminal 13 constitutes another datum point, designated by arrow Z_3 to help locate terminals 13 longitudinally within main body 11.

The assembly of connector 10 is now complete. After assembly,
10 connector 10 is attached to a substrate (not shown) using known surface mount techniques (SMT). Once attached to a substrate, connector 10 can receive daughter boards B as shown in Figure 7.

Generally perpendicular surface 33 helps retain daughter board B in slot 17. In a manner similar to the arrangement of cavity 41,
15 perpendicular surface 33 inhibits rotation of daughter board B out of slot 17. Upon rotation of daughter board B, the corner of daughter board B would interfere with perpendicular surface 33 as shown by the phantom line in Figure 8. Only upon actuation of lever 21 can daughter board B pass by perpendicular surface 33.

20 As seen in Figure 9, connectors 10 of the present invention can be closely stacked end-to-end. Canted surfaces 39 allow close end-to-end stacking because since they allow sufficient space for the outward swinging of the latch 21 to effect removal of daughter board B.

The advantages of the invention disclosed are many. A high density,
25 fine-pitch connector can be achieved which maintains a reliable and repeatable terminal to insulator interface. Propagation delay through the connector is minimized by employing short electrical paths that have low

inductance. The fine pitch connector of the present invention utilizes minimum printed circuit board space. The connector also has higher reliability in severe shock and vibration environments.

The structure as disclosed also allows the terminal to move
5 longitudinally with the printed circuit board under conditions of thermal expansion, without being impeded by CTE differential. The terminal is retained at the ends of its base only and the terminal leg is allowed to follow the expansion and contraction of the printed circuit board relative to the housing, without resistance. This prevents the accumulation of
10 terminal-to-housing stresses and subsequent forces on the solder ball-to-terminal and/or solder ball-to-printed circuit board interface. Manufacturing economies are realized by providing tolerance absorbing securing structures between assembled parts of the housing.

While the present invention has been described in connection with the
15 preferred embodiments of the various figures, it is to be understood that other similar embodiments may be used or modifications and additions may be made to the described embodiment for performing the same function of the present invention without deviating therefrom. Therefore, the present invention should not be limited to any single embodiment, but
20 rather construed in breadth and scope in accordance with the recitation of the appended claims.

Claims**WHAT IS CLAIMED IS:**

1. An electrical connector comprising:
 - an insulative housing having at least one cavity;
 - 5 a retaining member removably securable to said insulative housing and occluding at least a portion of said cavity, said member having at least one aperture in communication with said cavity;
 - a conductive terminal having a first portion disposed in said cavity and a second portion disposed in said aperture; and
 - 10 a surface mount element mounted on said second portion of said terminal;
 - whereby said member retains said terminal within said insulative housing.
- 15 2. The electrical connector as recited in claim 1, wherein said surface mount element is heat deformable.
3. The electrical connector as recited in claim 2, wherein said heat deformable element is a solder mass.
- 20 4. The electrical connector as recited in claim 1, wherein said retaining member further comprises a latch for securing to said insulative housing.
5. The electrical connector as recited in claim 4, wherein said latch
25 comprises:
 - at least one arm having a distal end; and
 - a catch at said distal end adapted to absorb assembly tolerances

between said insulative housing and said retaining member.

6. The electrical connector as recited in claim 5, wherein said catch includes a mating surface angled relative to said arm.

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7. The electrical connector as recited in claim 1, wherein said insulative housing extends in a longitudinal direction and said terminal is disposed transverse to said longitudinal direction.

10 8. The electrical connector as recited in claim 1, wherein the position of said terminal is fixed in at least one direction by surfaces on said insulative housing and said retaining member.

15 9. The electrical connector as recited in claim 8, wherein said one direction is other than a longitudinal direction of said insulative housing.

10. The electrical connector as recited in claim 8, wherein said one direction is every direction but a longitudinal direction of said insulative housing.

20

11. The electrical connector as recited in claim 1, wherein said terminal comprises a projection adapted to engage a surface of said cavity for retaining said terminal within said cavity.

25 12. The electrical connector as recited in claim 11, wherein said projection is located at a lower portion of said terminal to prevent said terminal from exiting said cavity.

13. A card edge connector, comprising:

an insulative housing, having:

a slot for receiving an edge of a card;

5 a cavity in communication with said slot; and

a pair of posts, each having channels in communication with said slot for receiving the card;

a conductive terminal, comprising:

a mating portion residing within said cavity for engaging the card

10 edge; and

a mounting portion extending from said cavity;

a retaining member securable to said insulative housing and having an aperture in communication with said cavity and receiving said mounting portion of said terminal, said retaining member preventing said terminal
15 from exiting said cavity; and

a surface mount element attached to said mounting portion of said terminal.

14. The card edge connector as recited in claim 13, wherein said

20 channel of one of said posts has a card retention surface at a proximal end thereof that extends generally perpendicular from said insulative housing and a lead-in surface at a distal end that is angled relative to said card retention surface.

25 15. The card edge connector as recited in claim 13, wherein said surface mount element is heat deformable.

16. The card edge connector as recited in claim 15, wherein said heat deformable element is a solder mass.

17. The card edge connector as recited in claim 13, wherein said
5 retaining member further comprises a latch for securing to said insulative housing.

18. The card edge connector as recited in claim 17, wherein said latch comprises:

10 at least one arm having a distal end; and
a catch at said distal end adapted to absorb assembly tolerances
between said insulative housing and said retaining member.

19. The card edge connector as recited in claim 18, wherein said catch
15 includes a mating surface angled relative to said arm.

20. The card edge connector as recited in claim 13, wherein said
insulative housing extends in a longitudinal direction and said terminal is
disposed transverse to said longitudinal direction.

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21. The card edge connector as recited in claim 13, wherein one of said
pair of posts has a lever for ejecting the card from the connector, and the
other of said pair of posts has an angled surface adapted to adjoin a lever
from a second connector disposed in an end-to-end relationship.

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22. A method of making an electrical connector, comprising the steps
of:

providing an insulative housing having a cavity;
providing a conductive terminal having a mounting portion;
providing a retaining member having an aperture;
providing a surface mount element;

5 inserting said terminal into said cavity;

attaching said retaining member to said insulative housing, wherein
said mounting portion of said terminal resides within said aperture; and
securing said surface mount element to said mounting portion of said
terminal;

10 whereby said retaining member keeps said terminal within said cavity.

23. The method of making an electrical connector as recited in claim
22, wherein the terminal providing step comprises the step of providing a
terminal having a projection and the terminal insertion step includes the
15 step of engaging said projection with a wall of said cavity.

24. The method of making an electrical connector as recited in claim
23, wherein the engaging step produces a force sufficient to keep said
terminal in said cavity until the retaining member attaching step.

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25. The method of making an electrical connector as recited in claim
24, wherein said force is less than a force required to keep said terminal
in said cavity during use of said connector.

25 26. The method of making an electrical connector as recited in claim
23, wherein the terminal providing step comprises the step of providing a
terminal having a projection at a lower end thereof.