

REPLACED SHEETS		SG
☐	Description : paged ...1... to paged ...10.....	
☐	Claim(s) : paged ...11... to paged ...12.....	
☒	Drawing(s) : paged ...13... to paged ...14.....	
☒	Abstract : paged ...15... to paged ...16.....	
DATE OF RECEIPT		

This Sheet Has Been Replaced



- 1 -

SOLDERABLE CONNECTOR FOR HIGH DENSITY ELECTRONIC ASSEMBLIES

BACKGROUND OF THE INVENTION

Field of the Invention

5 This invention relates to an improved surface mount connector for connecting an electronic module or package, such as a multi-chip module, to a printed circuit board.

Description of the Prior Art

10 An important trend in the electronics industry has been the increasing utilization of integrated circuits as individual components due to their relatively inexpensive cost, miniature size, and electrical dependability. Today it is common for hundreds of complex integrated circuits to be treated as discrete components by the design engineer, with
15 such integrated circuits being appropriately packaged and electrically connected to their associated printed circuit boards. However, the small dimensions and tight tolerances of miniaturized electrical connectors preclude the use of holes in printed circuit boards for establishing mechanical, as well as
20 electrical, connection between an electronic module and a printed circuit board.

Thus, in order to connect the densely packaged integrated circuit modules to an associated printed circuit board, very high density connectors utilizing surface mount
25 technology ("SMT") have become prevalent in the industry. Such connectors comprise a plurality of small electronic terminals disposed within a housing and soldered to a printed circuit board or the like. The densely packed leads or contact pins of an electronic module are disposed into contacting engagement



- 5 -

views, and referring in particular to FIGURE 1, an improved connector 10 is constructed and arranged to be attached to a motherboard or substrate 12 that has contacts 14, preferably comprising copper, thereon. Substrate 12 can be a printed circuit board or the like having electronic circuitry printed thereon for carrying out specific functions in a known manner.

Connector 10 is adapted to receive an electronic module 16 that is of the type that has a plurality of leads 18 positioned on an underside thereof adjacent to one or more edges 20 of the electronic module 16. Leads 18 can be substantially flat contact pads that are flush against the underside of module 16, or leads 18 can be contact pins that are bent downwardly orthogonally to the plane of the underside of module 16. Electronic module 16 is, for example, a multichip module of the type that includes several semiconductor chips interconnected with a high-density substrate into a single package.

As is best shown in FIGURES 1 and 2, connector 10 preferably includes a housing that has an outer housing portion 22 and an inner housing portion 24. Housing portions 22 and 24 are preferably fabricated from a non-conductive, non-metallic material, such as hard plastic. A plurality of connector terminals 26 are positioned between and securely mounted in outer housing portion 22 and inner housing portion 24. Terminals 26 preferably comprise a material having a high electrical conductivity and high elastic modulus, such as phosphorous bronze or beryllium bronze, and can be formed by any known manufacturing method, such as stamping or etching.

As shown in FIGURES 2 and 3, a terminal 26 includes a foot portion 28 mounted on pad 14 by any known solder method such that foot portion 28 is in electrical contact with the conductive pad 14 on substrate 12. A solder composition having silver as a constituent provides for reliable electrical connection between the connector terminal and the printed circuit board.

- 6 -

- Terminal 26 further includes a contact portion 30 and a middle portion 32 located between foot portion 28 and contact portion 30. A deep slot 34 is formed in terminal 26 for receiving contact pin 38 formed as part of lead 18 of module 16. Pin 38 makes contact with contact portion 30 of terminal 26 at contact surfaces 40 such that module 16 is electrically connected to terminal 26. Terminal 26 can be coated over its entire surface with an electrically conductive material for preventing corrosion, such as nickel, and contact portion 30 can be plated with gold, palladium or other materials for establishing reliable electrical connection with the leads of module 16.

Terminal 26 interconnects module 16 to the printed circuitry (not shown) on substrate 12. Terminal 26 is a resilient, cantilevered beam member for mechanically securing edge 20 of module 16 into mechanical engagement with connector 10 in a known manner. Contact portion 30 of terminal 26 can be in contact with conductive traces (not shown) on housing portion 24 for connecting certain of the terminals 26 to ground.

It should be noted that the embodiment of terminal 26 shown in FIGURES 2 and 3 is only illustrative of an example of a surface mount terminal in accordance with the present invention and many other terminal configurations are within the scope of the invention in accordance with the features of the invention set forth in greater detail below. For example, terminal 26 can be configured for connection with leads 18 which are substantially flat contact pads or which are contact pins.

Referring to FIGURE 3, terminal 26 is shown as having first longitudinal side 42 and second longitudinal side 44, as well as first lateral side 43 and second lateral side 45. The dimension along the lateral side of the terminal is herein referred to as the width of the terminal and the dimension along the longitudinal side is referred to as the length of the

This Sheet Has Been Replaced

- 7 -

terminal. As shown, the height of the terminal 26 is substantially greater than the width of the terminal.

The surface of foot portion 28 along longitudinal side 42 is coated with a layer of non-solderable material to form coating 46 such that solder does not adhere to longitudinal side 42 when terminal 26 is soldered to pad 14. Referring to FIGURE 2, the surface of foot portion 28 along the other longitudinal side 44 does not have any such non-solderable coating. Thus, in accordance with the present invention, only one longitudinal side of the foot portion of each connector terminal 26 is coated with a layer of non-solderable material. When terminal 26 is soldered to pad 14 solder flows and adheres only onto the longitudinal side of the foot portion of the terminal which does not have a non-solderable coating, as well as onto the two lateral sides 43, 45 which form the width of the terminal in the foot portion area.

Terminals 26 are positioned on pads 14 such that the longitudinal side 42 of one terminal, having a non-solderable coating 46 thereon in the area of foot portion 28, is adjacent longitudinal side 44 of an adjacent terminal, wherein the longitudinal side 44 of the adjacent terminal does not have any such non-solderable material coating in the area of the foot portion. Thus, as shown in FIGURE 4, solder 48 adheres only to one longitudinal side and along the two lateral sides of each terminal 26 such that an undesirable solder bridge does not form between adjacent terminals. In a preferred embodiment of the present invention, a surface mount connector 10 comprises a plurality of terminals 26 disposed in a housing 22, 24 for solderable engagement with a printed circuit board wherein the pitch distance between adjacent terminals is about 0.1 mm (0.004 inches). The pitch distance is herein referred to as the distance between the centerline of adjacent terminals.

Referring once again to FIGURES 2 and 3, a layer of non-solderable material is coated on all four sides of middle portion 32 of terminal 26 such that a non-solderable ring 50 is formed around the middle portion 32 of the terminal 26. Ring



- 8 -

50 prevents solder from flowing up terminal 26 and contaminating the contact surfaces 40 of contact portion 30. The location, or height, of ring 50 can be predetermined to provide that solder forms on longitudinal side 44 and lateral 5 sides 43, 45 only to a desired height on the terminal. Terminal 26 is a cantilevered beam and the solder which adheres to the beam along the height of the terminal changes the cross-section, and thus the mechanical characteristics, of the beam. Thus, by placing ring 50 at a predetermined height to prevent 10 the flow of solder up the terminal beyond the location of the ring, the height of the solder joint on the non-coated sides of the foot portion can be controlled to prevent changes in the mechanical characteristics of the beam which would cause it to break when an electronic module or the like is secured into the 15 connector terminals.

In a preferred embodiment of the present invention, the non-solderable material used to provide the non-solderable coatings for a surface mount connector terminal comprises an electrically conductive material, such as aluminum. In another 20 preferred embodiment, the non-solderable material comprises a nonconductive electrically insulating material, such as polyimide or epoxy. In yet another embodiment, the non-solderable coating comprises a passivated electroplating of material of 10 to 200 micrometers thickness comprising, by 25 content, nickel at 60-90%, iron at 3-7%, and the balance of copper.

As shown in FIGURES 2 and 3, terminal 26 has a bottom surface 51 which is in contacting engagement with the top surface 55 of pad 14. Channel surface 52 is formed between 30 points p on bottom surface 51 such that a capillary nest 54 is formed between the channel surface 51 and the top surface 55 of pad 14 when the terminal is positioned on pad 14. In a preferred embodiment, channel surface 52 is a convex curved surface.

35 During the soldering process, when terminal 26 is soldered into contacting engagement with substrate 12,

This Sheet Has Been Replaced



capillary nest 54 allows molten solder to flow through the nest and along pad 14 under the influence of capillary forces. Thus, at the initiation of soldering the solder which is disposed on the top surface 55 of pad 14 begins to flow. The
5 solder in the vicinity of the longitudinal side 42 of foot portion 28 flows through the capillary nest 54 since the solder does not flow onto the foot portion in this area due to the influence of the non-solderable coating 46. The solder in this region flows through the capillary nest under the influence of
10 capillary forces in a known manner and onto the other side of the terminal for engagement with longitudinal side 44 of foot portion 28. Accordingly, a solder joint is formed on foot portion 28 only on longitudinal side 44 and lateral sides 43, 45 and the height of the solder joint is limited by non-
15 solderable ring 50.

In a preferred embodiment of the present invention for a terminal having a total length along the longitudinal sides of 0.08 inches (80 mils), the height of the capillary nest 54, from top surface 55 to the top of channel surface 52, is 0.02
20 inches (20 mils) and the length of the capillary nest, the distance between points p-p, is 0.06 inches (60 mils). In another embodiment where the total length of the terminal is 0.04 (40 mils) inches, the height of the capillary nest is 0.01 inches (10 mils) and the length is 0.03 inches (30 mils). The
25 height of the capillary nest should not be large enough to provide an attachment area on the channel surface 52 for the solder captured by capillary tension. Alternatively, the height of the capillary nest should not be small enough to prevent a flow of solder through the capillary nest such that
30 solder is trapped on the unsolderable side of the terminal.

It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the
35 invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size and



- 10 -

arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

This Sheet Has Been Replaced





WHAT IS CLAIMED IS:

1. An electrical connector, comprising:
a housing;
a plurality of terminals for solderable engagement
5 with a printed circuit board, said terminals disposed in said housing, each of said terminals having:
a foot portion having first and second longitudinal sides and further having first and second bottom surfaces for contacting engagement with the printed circuit
10 board, of said first and second longitudinal sides only said first longitudinal side has a layer of non-solderable material coated thereon, said foot portion further having a channel surface located between said first and second bottom surfaces;
a middle portion, said middle portion having a
15 layer of non-solderable material coated thereon; and
a contact portion for receiving and establishing electrical connection with an electronic module, whereby said non-solderable coating prevents solder from adhering to said first longitudinal side and on said middle portion when said
20 terminal is soldered to the printed circuit board and solder flows under the channel surface between the foot portion and the printed circuit board.
2. An electrical connector according to claim 1, wherein said non-solderable material comprises an electrically
25 conductive material.
3. An electrical connector according to claim 1, wherein said non-solderable material comprises a nonconductive electrically insulating material.
4. An electrical connector according to claim 1,
30 wherein said non-solderable material comprises polyimide.
5. An electrical connector according to claim 1, wherein said non-solderable material comprises, by content,





- 12 -

nickel ranging from 60-90%, iron ranging from 3-7% and the balance nickel, said layer comprising a passivated electroplating having a thickness ranging from 10-200 micrometers.

5 6. An electrical connector according to claim 1, wherein said channel surface is a convex curve.

7. [CANCELLED]

8. A circuit assembly, comprising:
a printed circuit board having a plurality of
10 conductive pads thereon, each said conductive pad having a top surface;
an electrical connector having:
a housing;
a plurality of terminals disposed in said
15 housing, each of said terminals disposed on and solderably connected to a corresponding pad on said printed circuit board, each of said terminals having:
four external surfaces;
a channel surface formed in said terminal
20 such that a capillary nest is formed between said channel surface and said top surface of said conductive pad; and
a layer of non-solderable material coated on a portion of one of said external surfaces in an area immediately adjacent to the top surface of the conductive
25 pad.

AMENDED SHEET

This Sheet Has Been Replaced





* C L M S *

947:751
IPEA/US 2 JUN 1995

- 13 -

9 An electrical connector according to claim 8,
wherein the height of said capillary nest is 0.02 inches and
the length is 0.06 inches.

10 10. An electrical connector according to claim 8,
5 wherein the height of said capillary nest is 0.01 inches and
the length is 0.03 inches.

11. A surface mount connector comprising a
plurality of terminals for solderable engagement with a
printed circuit board, said terminals being arranged
10 adjacently and having a predetermined pitch distance
therebetween, each terminal comprising a foot portion having
first and second longitudinal sides at least one of which is
disposed in facing relation to the longitudinal side of an
adjacent terminal, a same one of said first and second
15 longitudinal sides of the foot portion of each terminal
having a layer of non-solderable material coated thereon,
whereby the longitudinal side of each terminal having a non-
solderable coating faces the longitudinal side of an adjacent
terminal that does not have a non-solderable coating.

20 12. The surface mount connector of claim 11,
wherein the foot portion of each terminal contacts a
corresponding conductive pad on said printed circuit board,
and wherein said layer of non-solderable material is coated
on said one longitudinal side of the foot portion of each
25 terminal in an area immediately adjacent a top surface of the
corresponding conductive pad.

13. The surface mount connector of claim 11,
wherein the predetermined pitch distance between adjacent
terminals is about 0.1 mm.

30 14. The surface mount connector of claim 11,
wherein the foot portion of each of said terminals further
has first and second bottom surfaces for contacting

AMENDED SHEET

This Sheet Has Been Replaced





PCT/US 94/13051
IPER/US 95

- 13/1 -

engagement with the printed circuit board, and a channel surface located between said first and second bottom surfaces, whereby solder flows under said channel surface between the foot portion and the printed circuit board when
5 said terminals are soldered to the printed circuit board.

15. The surface mount connector of claim 14, wherein said channel surface is a convex surface.

16. The surface mount connector of claim 11, wherein said non-solderable material comprises an
10 electrically conductive material.

17. The surface mount connector of claim 11, wherein said non-solderable material comprises a non-conductive, electrically insulating material.

18. The surface mount connector of claim 11, wherein said non-solderable material comprises polyimide.
15

19. The surface mount connector of claim 11, wherein said non-solderable material comprises, by content, nickel ranging from 60-90%, iron ranging from 3-7% and the balance copper.

20. The surface mount connector of claim 11, wherein said layer of non-solderable material comprises a passivated electroplating of a non-solderable material having a thickness ranging from 10-200 micrometers.
20

21. The surface mount connector of claim 11, wherein each terminal further has a ring of non-solderable material formed around a middle portion thereof, between the foot portion and a contacting surface of said terminal.
25

22. A surface mount connector comprising a plurality of terminals for solderable engagement with a

This Sheet Has Been Replaced





- 13/2 -

printed circuit board, said terminals being arranged adjacently and having a predetermined pitch distance of about 0.1 mm therebetween, each terminal comprising a foot portion having first and second longitudinal sides at least one of which is disposed in facing relation to the longitudinal side of an adjacent terminal, a same one of said first and second longitudinal sides of the foot portion of each terminal having a layer of non-solderable material coated thereon, whereby the longitudinal side of each terminal having a non-solderable coating faces the longitudinal side of an adjacent terminal that does not have a non-solderable coating.

23. [CANCELLED]

24. The surface mount connector of claim 22, wherein the foot portion of each terminal contacts a corresponding conductive pad on said printed circuit board, and wherein said layer of non-solderable material is coated on said one longitudinal side of the foot portion of each terminal in an area immediately adjacent a top surface of the corresponding conductive pad.

25. The surface mount connector of claim 22 wherein the foot portion of each of said terminals further has first and second bottom surfaces for contacting engagement with the printed circuit board, and a channel surface located between said first and second bottom surfaces, whereby solder flows under said channel surface between the foot portion and the printed circuit board when said terminals are soldered to the printed circuit board.

26. The surface mount connector of claim 25 wherein said channel surface is a convex surface.

This Sheet Has Been Replaced



AMENDED SHEET



- 13/3 -

- 27. The surface mount connector of claim 22 wherein said non-solderable material comprises an electrically conductive material.

28. The surface mount connector of claim 22
5 wherein said non-solderable material comprises a nonconductive electrically insulating material.

29. The surface mount connector of claim 22, wherein said non-solderable material comprises polyimide.

30. The surface mount connector of claim 22,
10 wherein said non-solderable material comprises, by content, nickel ranging from 60-90%, iron ranging from 3-7% and the balance copper.

31. The surface mount connector of claim 22, wherein said layer of non-solderable material comprises a
15 passivated electroplating of a non-solderable material having a thickness ranging from 10-200 micrometers.

32. The surface mount connector of claim 22, wherein each terminal has a ring of non-solderable material formed around a middle portion thereof, between the foot
20 portion and a contacting surface of said terminal.

This Sheet Has Been Replaced

