An electrical connector for surface mounting and solder anchoring on a circuit board. The electrical connector has a plurality of contact elements that engage respective contact pads on the circuit board. The contact elements are self-adjusting to compensate for co-planarity variations on the circuit board or on the electrical connector.
ABSTRACT

An electrical connector for surface mounting and solder anchoring on a circuit board. The electrical connector has a plurality of contact elements that engage respective contact pads on the circuit board. The contact elements are self-adjusting to compensate for coplanarity variations on the circuit board or on the electrical connector.
TITLE: Electrical connector with self-adjusting contact elements

FIELD OF THE INVENTION

The invention relates to electric terminals, in particular to an electrical connector with a plurality of contact elements mounted in a body of insulating material. The electrical connector is suitable for surface mounting on a circuit board having electrical contact pads designed to receive respective electrical connectors. The contact elements are characterized by the ability to move in the body of insulating material, which allows them to acquire the proper relationship to the contact pads on the circuit board.

BACKGROUND OF THE INVENTION

Traditional electrical connectors that are surface mounted and solder anchored on a circuit board have a body of insulating material that supports a plurality of contact elements. When the electrical connector is mounted on the circuit board, the contact elements rest on the respective contact pads formed on the circuit board. For a permanent connection, the electrical connectors are soldered to the respective contact pads.

During the assembly operation, the contact pads on the circuit board are coated with solder paste. Subsequently, the electrical connector is deposited on the
circuit board at a position such that the contact elements register with the respective contact pads. The contact pads are then heated to cause the solder paste to melt and permanently join the contact elements to the contact pads.

Electrical connectors for surface mounting on a circuit board must be manufactured with a high level of precision such that the contact elements are all co-planar. Failure to realize this co-planar relationship will result in a situation where, during the assembly operation one or more of the contact elements will not be in firm contact with the respective contact pads, which may result in faulty contact elements/contact pads joints.

To compensate for improper manufacturing tolerances it is known to apply pressure on the electrical connector such that the body of insulating material is distorted sufficiently to bring all the contact elements in firm contact with the respective contact pads. The pressure between the electrical connector and the circuit board is maintained until the soldering operation is completed. However, this technique has several drawbacks. First, the application of pressure requires an additional step and necessitates additional equipment during the assembly operation, in particular if the assembly operation is fully automated. Second, after the contact elements/contact pads join has cooled, the electrical connector is likely to remain under strain, which may result in an overstressed join likely to fail prematurely.

Accordingly, there is a need in the industry to develop improved electrical connectors that do not require
application of pressure to be adequately surface mounted on a circuit board.

**SUMMARY OF THE INVENTION**

According to a broad aspect the invention provides an electrical connector suitable for surface mounting to a circuit board having a plurality of electrical contact pads. The electrical connector has a body of insulating material including a circuit board facing side. A plurality of contact elements are mounted in the body of insulating material, each contact element being movable in the body of insulating material relative to the circuit board facing side.

In a specific non-limiting example of implementation of the invention, the body of insulating material defines a plurality of individual cages that hold captive respective contact elements. Each contact element has a contact portion and a contact element body portion. The contact portion is the part of the contact element that engages a contact pad on the circuit board when the electrical connector is mounted on it.

Each contact element is free to move in its respective cage under the effect of gravity between two extreme positions. In the first position, the contact portion projects from the circuit board facing side. In the second position the contact portion is flush or slightly recessed relative to the circuit board facing side. During the placement of the electrical connector on the circuit board, gravity causes the contact elements
to move in their respective cages such that the contact portions project from the circuit board facing side. When the electrical connector is deposited on the circuit board, the contact portions are the first components of the electrical connector to contact the circuit board. As the deposition movement continues, the contact elements start to progressively retract in their cages until the circuit board facing side touches the circuit board. In this position, heat is applied to melt the solder paste on the contact pads and thus solder anchor the contact elements to the circuit board.

The reader will appreciate that under the above specific and non-limiting example of implementation, the floating contact elements can compensate for irregularities on the circuit board or the electrical connector itself that render either one of them or both non-planar.

Under a second broad aspect, the invention provides an electrical connector suitable for surface mounting to a circuit board having a plurality of electrical contact pads. The electrical connector has a body of insulating material including a circuit board facing side and a plurality of contact elements mounted in the body of insulating material. Each contact element has a contact portion suitable for engaging a corresponding electrical contact pad when the electrical connector is mounted on the circuit board. Each contact element is free to move in the body of insulating material relative to the circuit board facing side under the effect of gravity
between two positions, namely a first position and a second position. In the first position, the contact portion projects from the circuit board facing side. In the second position, the contact portion is recessed relative to the circuit board facing side.

Under another broad aspect, the invention provides an electrical connector suitable for surface mounting and solder anchoring to a circuit board having a plurality of electrical contact pads. The electrical connector has a body of insulating material including a circuit board facing side and a plurality of contact elements mounted in the body of insulating material. Each contact element has a contact portion suitable for engaging a corresponding electrical contact pad when the electrical connector is mounted on the circuit board. The contact portion projects from the circuit board facing side and when the electrical connector is deposited on the circuit board the contact portions of the contact elements engage the circuit board and they are retractable at least partially relative to the circuit board facing side.

**BRIEF DESCRIPTION OF THE DRAWINGS**

A detailed description of examples of implementation of the present invention is provided hereinbelow with reference to the following drawings, in which:

Figure 1 is a perspective view from above of an electrical connector constructed in accordance with an example of implementation of the present invention;
Figure 2 is a perspective view of the contact elements in the electrical connector shown in Figure 1;

Figure 3 is a perspective view from below of the electrical connector shown in Figure 1;

Figure 4 is a magnified fragmentary cross-sectional view of the electrical connector mounted on a circuit board;

Figure 5 illustrates alternative examples of implementation for the contact elements of the electrical connector shown in Figure 1; and

Figure 6 is a perspective view from above of a variant of the electrical connector shown in Figure 1.

In the drawings, embodiments of the invention are illustrated by way of example. It is to be expressly understood that the description and drawings are only for purposes of illustration and as an aid to understanding, and are not intended to be a definition of the limits of the invention.

DETAILED DESCRIPTION

Figure 1 illustrates an electrical connector 10 constructed in accordance with a non-limiting example of implementation of the present invention. The electrical connector 10 includes two main components, namely a body
of insulating material 12 and a plurality of contact elements 14 mounted in the body of insulating material.

The body of insulating material 12 is made of any suitable synthetic material that has the requisite dielectric strength and mechanical resistance characteristics. The body of insulating material 12 includes a top side 16 and a bottom side 18 that constitutes a circuit board facing side. The circuit board facing side 18, which is best shown in Figure 3 is flat.

The body of insulating material 12 defines a plurality of cages 20 designed to receive respective ones of the contact elements 14. Each cage 20 is generally rectangular in shape and includes a bottom wall provided with an aperture 22 that opens on the circuit board facing side 18. Both sidewalls 24 (only one being shown in Figure 1) are open to allow access to the contact elements 14 mounted in the cages 20. Each cage also has a cylindrical extension 26 at its top, opening on the topside 16.

With reference to Figure 2, each contact element 14 is made of metallic material such as brass, copper or aluminum. The contact element 14 has a contact element body portion 28 having generally a rectangular shape and defining a recess 30 in which the conductor portion of a wire (not shown in the drawings) can be inserted. The top of the contact element body portion 28 is provided with a threaded aperture 32 to receive a screw 34 (shown
in Figure 1). As it will be plain to a person skilled in
the art, the screw 34 is used to secure in place the
conductor of the wire inserted in the recess 30.
Optionally, a L-shaped strip 36 (best shown in Figures 1
and 3) is placed in the recess 30 to more uniformly
spread the pressure applied on the conductor of the wire
by the screw 34.

From the contact element body portion 28 projects
downwardly a contact portion 38. In this example, the
contact portion 38 extends the entire length of the
contact element but it has a transverse dimension that is
reduced relative to the transverse dimension of the
contact element 14. Note however that the contact
portion 38 is not limited to any one particular shape or
dimension. Rather, the contact portion 38 may assume
various shapes and dimensions, a few examples of which
are shown in Figure 5.

The cages 20 receiving the contact elements 14 are
dimensioned such as to allow the contact elements to
freely float therein along a vertical direction. Each
contact element 14 can move in its respective cage 20
between two extreme positions. The first extreme
position is shown in Figures 1 and 3, where the contact
portion 38 is received in the aperture 22 and projects
therefrom. The second extreme position (not shown in the
drawings) is a position in which the contact portions 38
are generally flush with the circuit board facing side
18. Alternatively, the contact portions 38 could be
slightly recessed relative to the circuit board facing
The contact elements can move from one extreme position to the other under the effect of gravity. In the position shown in Figures 1 and 3, the contact elements 14 engage the bottom walls of the respective cages and are held in place there. It will be appreciated that the contact element body portions have transverse dimensions exceeding the transverse dimensions of the apertures 22, accordingly only the contact portions 38, smaller than the apertures 22, can pass through the apertures 22.

The electrical connector 10 is installed on the circuit board in the following manner. The electrical connector is picked-up by automated equipment and deposited on the circuit board such that the contact portions 38 of the contact elements 14 register with respective contact pads on the circuit board. Before the contact portions 38 touch the contact pads, they are extended, as shown in Figure 1. In other words the contact portions 38 project from the circuit board facing side 18. When the contact portions 38 touch the contact pads on the circuit board, the contact portions 38 start to retract under the effect of the weight of the electrical connector 10 and also under the effect of the slight pressure created by the automated equipment that handles the electrical connector 10. The contact portions 38 continue retracting until the circuit board facing side 18 engages the circuit board surface.
The position of the electrical connector 10 on the circuit board is shown in Figure 4. The circuit board 40 carries on its upper surface a contact pad 42 that is engaged by the contact portion 38 of the contact element 14. The contact pad 42 is coated with solder paste. When heat is applied, the solder paste melts and effects a permanent joint between the contact pad 42 and the contact element 14.

Advantageously, the range of movement of the contact element 14 within the cage 20 is such as to accommodate possible co-planarity variations that may arise on the circuit board 40 or on the electrical connector 10. In the example of implementation depicted in Figure 4, the contact portion 38 moves from a position that is extended relative to the circuit board facing side 18 to a position in which the contact portion 38 is flush with the circuit board facing side 18. If the contact pad 42 slightly projects above the surface of the circuit board 40, the contact portion 38 may even be slightly recessed relative to the circuit board facing side 18, if the contact pad 42 fits within the boundary of the aperture 22.

After the installation of the electrical connector 10 on the circuit board 40 is completed, the conductors of wires are inserted in the respective contact elements 14. The screws 34 are then tightened by inserting a screwdriver or any other suitable tool in the cylindrical bores 26, to engage and then turn the screws 34.
It is not essential that the circuit board facing side 18 engages the circuit board 40. It is possible to design the electrical connector 10 such that the contact portions 38 project from the circuit board facing side 18 and after the electrical connector 10 has been placed on the circuit board 40 the contact portions 38 retract only partially in the body 12. In this position, the circuit board facing side 18 will remain at a certain distance from the circuit board 40.

Another possible variant is to insert resilient members, such as coil springs in the cages 20 to urge the contact elements 14 toward their extended positions.

In yet another possible variant, the electrical connector 10 is provided with a removable gripping handle 44 as shown in the example of Figure 6, by which the automated equipment can more easily pick-up, transport and generally handle the electrical connector 10 during installation of the electrical connector on the circuit board 40. The gripping handle 44 may be removed once the electrical connector 10 has been soldered to the circuit board 40.

Although various embodiments have been illustrated, this was for the purpose of describing, but not limiting, the invention. Various modifications will become apparent to those skilled in the art and are within the scope of this invention, which is defined more particularly by the attached claims.
CLAIMS:

1. An electrical connector suitable for surface mounting to a circuit board having a plurality of electrical contact pads, said electrical connector, comprising;
   a) a body of insulating material including a circuit board facing side;
   b) a plurality of contact elements mounted in said body, each contact element being free to move in said body relative to said circuit board facing side.

2. An electrical connector as defined in claim 1, wherein said board facing side is generally planar.

3. An electrical connector as defined in claim 2, wherein each contact element includes a contact portion suitable for engaging a corresponding electrical contact pad when said electrical connector is mounted on the circuit board, each contact element being movable in said body under the effect of gravity to acquire a position in which the respective contact portion projects from said circuit board facing side.

4. An electrical connector as defined in claim 3, wherein during placement of said electrical connector on the circuit board, the contact portions of said contact elements are operative to engage the electrical contact pads and then progressively
retract in said body.

5. An electrical connector as defined in claim 4, wherein said body defines an individual cage for holding each contact element, said cage having a geometrical configuration allowing the respective contact element to move therein freely.

6. An electrical connector as defined in claim 5, wherein each cage includes an aperture that opens on said circuit board facing side.

7. An electrical connector as defined in claim 6, wherein each contact element includes a contact element body portion from which projects the contact portion of the contact element, the aperture of the cage receiving the contact element and the contact portion of the contact element having relative dimensions allowing the contact element to pass through the aperture.

8. An electrical connector as defined in claim 7, wherein the contact element body portion has a transverse dimension exceeding a transverse dimension of the aperture such that the contact element body portion is unable to pass through the aperture.

9. An electrical connector as defined in claim 8, wherein each contact element includes a recess for receiving a conductor of a wire.
10. An electrical connector as defined in claim 9, wherein each contact element has a screw for fastening the conductor of the wire to the contact element.

11. An electrical connector as defined in claim 10, wherein each individual cage of said body of insulating material includes a generally circular bore that receives the screw of a respective contact element.

12. An electrical connector as defined in claim 11, wherein said contact elements are disposed along an imaginary straight line.

13. An electrical connector suitable for surface mounting to a circuit board having a plurality of electrical contact pads, said electrical connector, comprising;
   a) a body of insulating material including a circuit board facing side;
   b) a plurality of contact elements mounted in said body, each contact element including a contact portion suitable for engaging a corresponding electrical contact pad when said electrical connector is mounted on the circuit board, each contact element being free to move in said body relative to said circuit board facing side under the effect of gravity between two positions, namely a first position and a second
position, in said first position the contact portion projecting from said circuit board facing side in said second position the contact portion being recessed relative to said circuit board facing side.

14. An electrical connector suitable for surface mounting and solder anchoring to a circuit board having a plurality of electrical contact pads, said electrical connector comprising:
   a) a body of insulating material including a circuit board facing side;
   b) a plurality of contact elements mounted in said body, each contact element including a contact portion suitable for engaging a corresponding electrical contact pad when said electrical connector is mounted on the circuit board, said contact portion projecting from said circuit board facing side, when said electrical connector is deposited on the circuit board the contact portions of said contact elements engaging the circuit board and being retractable at least partially relative to said circuit board facing side.

15. An electrical connector as defined in claim 14, wherein said board facing side is generally planar.

16. An electrical connector as defined in claim 15, wherein each contact element is movable in said body relative to said circuit board facing side between position A and a position B under the effect of
gravity, in said position B each contact element projects relative to said circuit board facing side to greater degree than in said position A.

17. An electrical connector as defined in claim 16, wherein during placement of said electrical connector on the circuit board, the contact portions of said contact elements are operative to engage the electrical contact pads and then progressively retract in said body until said circuit board facing side contacts the circuit board.

18. An electrical connector as defined in claim 17, wherein said body defines an individual cage for holding each contact element, said cage having a geometrical configuration allowing the respective contact element to move therein.

19. An electrical connector as defined in claim 18, wherein each cage includes an aperture that opens on said circuit board facing side.

20. An electrical connector as defined in claim 19, wherein each contact element includes a contact element body portion from which projects the contact portion of the contact element, the aperture of the cage receiving the contact element and the contact portion of the contact element having relative dimensions allowing the contact element to pass through the aperture.
21. An electrical connector as defined in claim 20, wherein the contact element body portion has a transverse dimension exceeding a transverse dimension of the aperture such that the contact element body portion is unable to pass through the aperture.

22. An electrical connector as defined in claim 21, wherein each contact element includes a recess for receiving a conductor of a wire.

23. An electrical connector as defined in claim 22, wherein each contact element has a screw for fastening the conductor of the wire to the contact element.

24. An electrical connector as defined in claim 23, wherein each individual cage of said body of insulating material includes a generally circular bore that receives the screw of a respective contact element.

25. An electrical connector as defined in claim 24, wherein said contact elements are disposed along an imaginary straight line.