

SPECIFICATIONBOARD-TO-BOARD ELECTRICAL CONNECTORField of the Invention

5 This invention generally relates to the art of electrical connectors and, particularly, to an electrical connector for interconnecting a pair of printed circuit boards.

Background of the Invention

10 A wide variety of electrical connectors for interconnecting printed circuit boards, such as a mother board and a daughter board, are well known in the art. These electrical connectors generally include an insulating or dielectric housing mounting a plurality of conductive metal terminals. The connector is mounted on one of the
15 printed circuit boards, such as the mother board, by soldering tail portions of the terminals to respective circuit traces on the printed circuit board. An edge of the other printed circuit board, such as the daughter board, is inserted into the connector to engage contact
20 portions of the metal terminals with respective circuit traces on one or both sides of the daughter board, thereby electrically interconnecting the two circuit boards. Many problems have been encountered with such connectors, including but not limited to the fact that the connector is
25 permanently soldered to one of the printed circuit boards and cannot be easily replaced.

30 Other electrical connectors form a type of splice connection between a pair of printed circuit boards. In other words, the edges of two circuit boards are inserted into a single electrical connector wherein conductive metal terminals are used to span the circuit boards and engage circuit traces on one or both sides thereof, thereby electrically interconnecting the two boards. Problems also continue to be encountered with these types of connectors



primarily involving the cost, assembly and unreliability of the metal terminals which interconnect the circuit board. This is particularly problematic with the ever-increasing miniaturization and density of electrical connectors, resulting in extremely tiny metal terminals.

The present invention is directed to solving these various problems with the prior art connectors by providing a unique electrical connector which utilizes a flat flexible circuit to electrically interconnect at least two printed circuit boards.

Summary of the Invention

An object, therefore, of the invention is to provide a new and improved electrical connector for interconnecting a pair of printed circuit boards.

In the exemplary embodiment of the invention, the connector includes a housing defining a first elongated opening for receiving a connecting end of a first printed circuit board and a second elongated opening for receiving a connecting end of a second printed circuit board. A flat circuit overlies the connecting ends of the two printed circuit boards. Actuator means are mounted on the housing for movement between a first position allowing insertion of the printed circuit boards into their respective openings and a second position biasing appropriate conductors of the flat circuit against appropriate circuits of the printed circuit boards.

As disclosed herein, the flat circuit comprises a flat flexible circuit fixed to and movable with the actuator means. The actuator means include first and second levers pivotally mounted on the housing at the first and second openings, respectively. The levers bias different portions of the flat flexible circuit toward the first and second printed circuit boards. First and second pressure plates are disposed beneath and engageable by the first and second levers, respectively. The pressure plates engage the different portions of the flat flexible circuit



in response to pivoting of the levers. Resilient engaging layers may be provided on the pressure plates between the pressure plates and the flat flexible circuit.

5 Other objects, features and advantages of the invention will be apparent from the following detailed description taken in connection with the accompanying drawings.



Brief Description of the Drawings

The features of this invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with its objects and the advantages thereof, may be best understood by reference to the following description taken in conjunction with the accompanying drawings, in which like reference numerals identify like elements in the figures and in which:

FIGURE 1 is a perspective view of an electrical connector according to the invention, mounted to one of a pair of printed circuit boards;

FIGURE 2 is an enlarged side elevational view of the connector, interconnecting a pair of printed circuit boards;

FIGURE 3 is a view similar to that of Figure 1, with a second printed circuit board being inserted into the connector;

FIGURE 4 is a top plan view of the connector;

FIGURE 5 is a front elevational view of the connector;

FIGURE 6 is a side elevational view of the connector;

FIGURE 7 is a perspective view of one of the pressure plates fixed to one-half of the flat flexible circuit;

FIGURE 8 is a fragmented perspective view of a corner of the flat flexible circuit and a portion of the resilient backing layer;

FIGURE 9 is a bottom plan view of the flat flexible circuit;

FIGURE 10 is a fragmented top plan view of the first or mother printed circuit board; and

FIGURE 11 is a top plan view of the second or daughter printed circuit board.

Detailed Description of the Preferred Embodiment

Referring to the drawings in greater detail, and first to Figures 1-6, the invention is embodied in an electrical connector, generally designated 1, which is designed to electrically interconnect first and second printed circuit boards 2 and 3, respectively. First circuit board 2 can be considered a "mother board", and second circuit board 3 can be considered a "daughter board".

Connector 1 includes a metallic shell or housing, generally designated 4, which includes a bottom plate 4a and a pair of side plates 4b upstanding generally perpendicularly from opposite edges of bottom plate 4a. The housing defines a first elongated opening 6 for receiving a connecting end 5 of mother board 2 and a second elongated opening 8 for receiving a connecting end 7 of daughter board 3. A base member 9 of insulating or dielectric material, such as plastic or the like, is mounted on bottom plate 4a inside housing 4 to provide a bottom support beneath printed circuit boards 2 and 3.

Connector 1 includes first and second pressure plates 10 and 11, respectively, mounted inside first and second openings 6 and 8, respectively. Each pressure plate 10 and 11 is stamped and formed of sheet metal material. First and second actuating levers 12 and 13 also are mounted at first and second openings 6 and 8, respectively, above pressure plates 10 and 11, respectively. Each lever 12 and 13 is stamped and formed of sheet metal material.

Pressure plates 10 and 11 include flat plate portions 10a and 11a, respectively. Each pressure plate 10 and 11 includes a curve portion 10b and 11b, respectively, connected integrally to one end of the respective flat plate portion. Pressure plate 10 is pivotally mounted within the housing by means of pivot pins 14 projecting into holes 16 in side plates 4b of the housing. A curved actuator end 15 is bent back over the top of flat plate portion 10a of pressure plate 10. Similarly, pressure plate 11 is pivotally mounted within the housing by means



of pivot pins 17 projecting into holes 19 in side plates 4b of the housing. A curved actuator end 18 is bent back over the top of flat plate portion 11a of pressure plate 11.

5 First and second actuating levers 12 and 13, respectively, include flat plate portions 12a and 13a, respectively. Lever 12 has an oblique leg 12b at an inner end thereof, with pivot projections 20 extending into holes 22 in side plates 4b of the housing to pivotally mount the lever above pressure plate 10. An edge 12c of oblique leg 10 12b is positioned for engaging curved actuator end 15 of pressure plate 10. Similarly, second lever 13 has an oblique leg 13b with projections 21 extending into holes 23 in side plates 4b of the housing to pivotally mount the lever. An edge 13c of oblique leg 13b is engageable with 15 curved actuator end 18 of pressure plate 11.

An elastic or resilient backing layer or pad 24 is disposed beneath each pressure plate 10 and 11. Specifically, one of the resilient backing pads is fixed, as by adhesive or the like, to the underside of each flat 20 plate portion 10a and 11a of the two pressure plates.

The invention contemplates that a sheet of flat flexible circuitry 25 be mounted beneath pressure plates 10 and 11 and spanning connecting ends 5 and 7 of printed circuit boards 2 and 3, respectively. The top surface of 25 flat flexible circuit 25 is adhered to the undersides of resilient backing pads 24. As will be seen hereinafter, the flat flexible circuit has conductors for engaging conductors on the printed circuit boards to electrically interconnect or splice the boards within connector 1.

30 Generally, the above description of the operative components of connector 1 shows that the connector has actuator means mounted on housing 4 for movement between a first position allowing insertion of printed circuit boards 2 and 3 into their respective openings 6 and 8, and a 35 second position biasing appropriate conductors of flat circuit 25 against appropriate circuits of the printed circuit boards. Specifically, a first actuator assembly is



provided by pressure plate 10 and lever 12, and a second actuator assembly is provided by pressure plate 11 and lever 13. Each lever is movable between a first position shown in phantom by lever 13 in Figure 2, as well as lever 13 in Figure 3. In this first position of lever 13, connecting end 7 of printed circuit board 3 can be inserted into opening 8 in the direction of arrow "A" (Fig. 3). The same would be true for printed circuit board 2 when lever 12 is lifted to the position shown for lever 13 in Figures 2 and 3. Once printed circuit board 3 is fully inserted into opening 8, lever 13 is pivoted downwardly in the direction of arrows "B" (Figs. 2 and 3) to the position shown in Figures 1, 4 and 5 as well as in full lines in Figure 2. Of course, lever 12 already has been pivoted downwardly in all of Figures 1-5.

When actuating levers 12 and 13 are pivoted downwardly in the direction of arrows "B", edges 12c and 13c of oblique legs 12b and 13b engage curved actuator ends 15 and 18 of pressure plates 10 and 11, respectively. This is effective to pivot the pressure plates about pivot pins 14 and 17 and bias plate portions 10a and 11a of the pressure plates downwardly toward the printed circuit boards. With flat flexible circuit 25 adhered to resilient backing pads 24, and with the resilient backing pads adhered to pressure plate portions 10a and 11a, it can be understood that pivoting of levers 12 and 13 is effective to bias opposite ends of flat flexible circuit 12 against the tops of printed circuit boards 2 and 3. Resilient backing pads 24 are effective to uniformly spread the biasing forces over the area of the flat flexible circuit.

Figure 7 shows how one of the resilient backing pads 24 is sandwiched between flat plate portion 11a of one of the pressure plates 11 and one end 25a of flat flexible circuit 25. Of course, the opposite end 25b of the flat flexible circuit will be adhered to the underside of the resilient backing pad 24 adhered to the underside of flat plate portion 10a of pressure plate 10.



Figures 7-9 show that flat flexible circuit 25 includes a plurality of conductive metal bumps 26 provided on one or both sides of the circuit. These metal bumps are in a predetermined circuit pattern and are electrically connected to conductors within the substrate of the circuit. As is known, the substrate of the circuit is a multi-layer construction, and metal bumps 26 extend therethrough in conductivity with the inner conductors of the circuit. Resilient backing pad 24 may be fabricated of silicon material and may include a pattern of slits 27 (Fig. 8) corresponding to the pattern of conductive bumps 26 of the flat flexible circuit. The pattern of conductive bumps are in an arrangement corresponding to conductive lands or circuit traces 28 (Fig. 10) on connecting end 5 of mother board 2 and circuit traces or conductive lands 29 (Fig. 11) on connecting end 7 of daughter board 3. Therefore, the conductive bumps and conductors of flat flexible circuit 25 are effective to electrically interconnect circuit traces 28 and 29 of the two printed circuit boards 2 and 3, respectively.

Figure 10 shows that the first or mother printed circuit board 2 has slits 30 defining a cut-out portion 31 within which connecting end 5 is disposed. When inserting connecting end 5 into its opening 6 in connector 1, side plates 4b of metallic housing 4 move into slits 30. When levers 12 and 13 are pivoted upwardly as shown by lever 13 in Figures 2 and 3, pressure on plates 10 and 11 is released, and the connecting ends 5 and 7 of printed circuit boards 2 and 3, respectively, can be easily inserted into their respective openings 6 and 8 beneath flat flexible circuit 25. With flat circuit 25 being flexible, either lever and its respective pressure plate can be actuated independently, with the flat circuit flexing as shown in Figure 7. With printed circuit board 2 being a "mother" board, this printed circuit board most likely would be mounted to the connector before daughter board 13 is inserted into its opening 8. In fact, daughter



board 3 more likely will be interchangeable once mother board 2 is mounted in the connector. The connector has mounting flanges or tabs 32 (Figs. 1 and 3), for fixing the connector to an appropriate framework.

5 It will be understood that the invention may be embodied in other specific forms without departing from the spirit or central characteristics thereof. The present examples and embodiments, therefore, are to be considered
10 in all respects as illustrative and not restrictive, and the invention is not to be limited to the details given herein.



CLAIMS

1. An electrical connector (1) for interconnecting a pair of printed circuit boards (2,3), comprising:

5 a housing (4) defining a first elongated opening (6) for receiving a connecting end (5) of a first printed circuit board (2) and a second elongated opening (8) for receiving a connecting end (7) of a second printed circuit board (3);

10 a flat circuit (25) overlying said connecting ends (5,7) of the first and second printed circuit boards (2,3); and

15 actuator means (10-13) mounted on the housing for movement between a first position allowing insertion of the printed circuit boards (2,3) into their respective openings (6,8) and a second position biasing appropriate conductors (26) of the flat circuit (25) against appropriate circuits (28,29) of the printed circuit boards (2,3).

20 2. The electrical connector of claim 1 wherein said flat circuit comprises a flat flexible circuit (25) movable with said actuator means.

3. The electrical connector of claim 1 wherein said actuator means comprise lever means (12,13) pivotally mounted on the housing (4).

25 4. The electrical connector of claim 3 wherein said lever means comprise first and second actuating levers (12,13) pivotally mounted at the first and second openings (6,8), respectively, for biasing different portions (25a,25b) of the flat circuit (25) toward the first and second printed circuit boards (2,3), respectively.

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5. The electrical connector of claim 4, including first and second pressure plates (10,11) disposed beneath and engageable by the first and second levers (12,13), respectively, for engaging said different portions (25a,25b) of the flat circuit (25) in response to pivoting of the levers (12,13).

6. The electrical connector of claim 5, including resilient engaging layers (24) on the pressure plates (10,11) between the pressure plates and the flat circuit (25).

7. The electrical connector of claim 5 wherein said pressure plates (10,11) are pivotally mounted on the housing.

8. The electrical connector of claim 1 wherein said actuator means comprise first and second actuators (10,11) for biasing different portions (25a,25b) of the flat circuit (25) toward the first and second printed circuit boards (2,3), respectively.

9. The electrical connector of claim 1 wherein said flat circuit (25) includes a plurality of conductive bumps (26) for engaging the circuits (28,29) on the printed circuit boards (2,3).

10. The electrical connector of claim 9 wherein said flat circuit comprises a flat flexible circuit (25).

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11. An electrical connector (1) for interconnecting a pair of printed circuit boards (2,3), comprising:

5 a housing (4) defining a first elongated opening (6) for receiving a connecting end (5) of a first printed circuit board (2) and a second elongated opening (8) for receiving a connecting end (7) of a second printed circuit board (3);

10 a flat flexible circuit (25) overlying said connecting ends (5,7) of the first and second printed circuit boards (2,3); and

15 first and second actuator assemblies (10-13) mounted on the housing for movement between first positions allowing insertion of the printed circuit boards (2,3) into their respective openings (6,8) and second positions biasing appropriate conductors (26) of different portions (25a,25b) of the flat circuit (25) against appropriate circuits (28,29) of the printed circuit boards (2,3), each actuator assembly including

20 a pressure plate (10,11) pivotally mounted on the housing (4) and including a flat plate portion (10a,11a) for engaging a portion of the flat flexible circuit (25), and

25 an actuating lever (12,13) pivotally mounted on the housing (4) and engageable with the pressure plate (10,11) to move the flat plate portion (10a,11a) of the pressure plate and, in turn, said portion (25a,25b) of the flat flexible circuit (25) against a respective one of the printed circuit boards (2,3).

30 12. The electrical connector of claim 11, including resilient backing pads (24) between the flat plate portions (10a,11a) of the pressure plates (10,11) and the flat flexible circuit (25).

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13. The electrical connector of claim 11 wherein said flat flexible circuit (25) includes a plurality of conductive bumps (26) for engaging the circuits (28,29) on the printed circuit boards (2,3).

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