

BOARD-TO-BOARD CONNECTOR

TECHNICAL FIELD

The present invention relates to board-to-board connectors, and more particularly to shielded electrical board-to-board connectors.

5 BACKGROUND

An electrical board-to-board interconnect system generally includes a pair of plug and socket connectors each mounted on a printed circuit board (PCB) and both adapted to mate with each other mechanically and electrically. Conventional board-to-board interconnect systems are generally used in low-speed electrical
10 transmission environments where signal noise and electromagnetic interference (EMI) are not very critical. Thus, the conventional systems generally have no specific shielding or grounding contacts for removing noise and EMI.

With the demand on higher speed electrical transmission as well as the miniaturisation of electronic devices resulting in the reduction in size of the
15 electrical connectors used, the conventional board-to-board interconnect systems need to be modified.

An example of such a modified interconnect system is disclosed in U.S. Pat. No. 5,915,976. Shields of a plug connector are attached on side walls of a housing of the plug connector and are selectively connected to some contacts of
20 the plug connector. Each shield has an engagement arm. Correspondingly, a number of grounding contacts are disposed in a housing of the socket connector. The grounding contacts engage the engagement arm of the shields and connect with corresponding contacts of the socket connector. Thus, EMI and noise are dissipated to ground through the shields and the grounding contacts.

However, since the shields are attached on outer sides of side walls of the housing of the plug connector and since the grounding contacts are inserted into the engagement arms of the shields, the shields are prone to separate from the side walls of the housing of the plug connector when the plug and socket
5 connectors are mated with each other. This is due to pushing force of the grounding contacts acting on the engagement arms of the shields. When such separation occurs, the grounding connections between the shields and the grounding contacts are rendered useless.

The present invention is directed to a plug and a socket connector with
10 minimised cross-talk and good EMI shielding.

SUMMARY

It would be desirable to provide a plug connector and a socket connector with minimised cross-talk and good EMI shielding.

In accordance with one embodiment of the present invention, there is
15 provided a plug connector comprising an insulative housing comprising an insulative longitudinal base with an insulative wall having a first face and a second face, the insulative wall extending from the longitudinal base and separating the longitudinal base into a first portion and a second portion; a first group and a second group of first passageways wherein the first group of the first
20 passageways extends from the first face of the insulative wall to the first portion of the longitudinal base and the second group of the first passageways extends from the second face of the insulative wall to the second portion of the longitudinal base; a set of second passageways configured alongside the first passageways wherein each second passageway has a first segment extending
25 from the first face of the insulative wall to the first portion of the longitudinal base and a second segment extending from the second face of the insulative wall to the second portion of the longitudinal base and a third segment connecting the

first segment to the second segment; and a plurality of signal contacts disposed in the first passageways wherein each signal contact comprises a mating portion, a terminal portion and an engaging portion connecting the mating portion to the terminal portion.

5 In accordance with another embodiment of the present invention, there is provided a socket connector comprising an insulative housing with a recess defined by a pair of side walls, each side wall having an inner face and an outer face, a first end wall and a second end wall; a plurality of signal passageways defined on the inner faces of the side walls; a plurality of signal contacts disposed
10 in the signal passageways; a plurality of retention devices on at least one end wall of the insulative housing configured to cooperate with a plurality of complementary retention devices on an optional supplementary shield plate; and a first housing extension configured in proximity to a first end of the side wall and a second housing extension configured in proximity to a second end of the
15 side wall, both first and second housing extensions configured to cooperate with the optional supplementary shield plate and retain the optional supplementary shield plate to the insulative housing when the optional supplementary shield plate is coupled to the socket connector.

 The invention further includes any alternative combination of parts or
20 features mentioned herein or shown in the accompanying drawings. Known equivalents of these parts or features which are not expressly set out are nevertheless deemed to be included.

BRIEF DESCRIPTION OF THE DRAWINGS

An exemplary form of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a perspective view of an exemplary plug connector and an
5 exemplary socket connector forming the interconnect system in accordance with one embodiment of the invention;

Figure 2 is an exploded, perspective view of the plug connector in Figure 1;

Figure 3 is an exploded, perspective view of the socket connector in
10 Figure 1;

Figure 4 is a cross-sectional view of the plug connector and the socket connector in Figure 1 in a mid-way mating position taken at a location where a set of signal contacts is located;

Figure 5 is a cross-sectional view of the plug connector and the socket
15 connector in Figure 1 in a mid-way mating position taken at a location where a grounding contact is located;

Figure 6 is a perspective view of an arrangement of a set of signal contacts, a set of grounding contacts and a plurality of shield plates in accordance with another embodiment of the invention;

Figure 7 is a sectional view of the socket connector in Figure 1 with a
20 complementary retention device on an optional supplementary shield plate coupled to a retention device on the socket connector;

Figure 8 is a perspective view of a socket connector in accordance with another embodiment of the invention; and

Figure 9 is a perspective view of the plug connector and the socket connector in Figure 1 in a mid-way mating position taken from one end of the interconnect system.

While the above-identified drawing figures set forth several embodiments
5 of the invention, other embodiments are also contemplated, as noted in the
discussion. In all cases, this disclosure presents the invention by way of
representation and not limitation. It should be understood that numerous other
modifications and embodiments can be devised by those skilled in the art, which
fall within the scope and spirit of the principles of the invention. The figures may
10 not be drawn to scale. Like reference numbers have been used throughout the
figures to denote like parts.

DETAILED DESCRIPTION

Referring to Figure 1, an electrical board-to-board interconnect system **1** in accordance to an embodiment of the present invention comprises a plug connector **1000** and a socket connector **2000**.

5 Figure 2 provides an exploded view of the exemplary plug connector **1000** shown in Figure 1. The plug connector **1000** comprises an insulative housing **1010** comprising an insulative longitudinal base **1100** with an insulative wall **1200** having a first face **1210** and a second face **1220**. In one embodiment, the insulative wall **1200** extends from the longitudinal base **1100** thereby separating
10 the longitudinal base **1100** into a first portion **1110** and a second portion **1120**.

 The plug connector **1000** further comprises a set of first passageways **1310** and a set of second passageways **1320**. Referring also to Figure 4 and Figure 5, in one embodiment of the present invention, the set of first passageways **1310** is divided into a first group **1311** and a second group **1312**
15 wherein the first group **1311** of the first passageways **1310** extends from the first face **1210** of the insulative wall **1200** to the first portion **1110** of the longitudinal base **1100** and the second group **1312** of the first passageways **1310** extends from the second face **1220** of the insulative wall **1200** to the second portion **1120** of the longitudinal base **1100**.

20 In one embodiment of the present invention, the set of second passageways **1320** is configured alongside the first passageways **1310** with each second passageway **1320** having a first segment **1321** extending from the first face **1210** of the insulative wall **1200** to the first portion **1110** of the longitudinal base **1100**, a second segment **1322** extending from the second face **1220** of the
25 insulative wall **1200** to the second portion **1120** of the longitudinal base **1100** and a third segment **1323** connecting the first segment **1321** to the second segment **1322**.

In one embodiment of the present invention, there is a signal contact **1400** disposed in each first passageway **1310** and there is a grounding contact **1500** disposed in each second passageway **1320**. Each signal contact **1400** comprises a mating portion **1410**, a terminal portion **1430** and an engaging portion **1420**
5 connecting the mating portion **1410** to the terminal portion **1430**. Each grounding contact **1500** comprises a first arm **1510**, a second arm **1520** and a contact body **1530**, wherein the first arm **1510** is disposed in the first segment **1321** of the second passageway **1320**, the second arm **1520** is disposed in the second segment **1322** of the second passageway **1320** and the contact body **1530** is disposed in
10 the third segment **1323** of the second passageway **1320**. Both the first arm **1510** and the second arm **1520** of the grounding contact **1500** each has a mating portion **1610**, a terminal portion **1630** and an engaging portion **1620** connecting the mating portion **1610** to the terminal portion **1630**.

In one embodiment of the present invention, the insulative wall **1200**
15 further comprises a longitudinal passageway **1700** extending from one end of the insulative wall **1200** to an opposite end of the insulative wall **1200**. In another embodiment of the present invention, the plug connector **1000** further comprises a shield plate **1710** disposed in the longitudinal passageway **1700**. The shield plate **1710** may further include a plurality of terminal legs **1720** configured on at
20 least one end of the shield plate **1710**.

With reference to Figure 6, when the terminal portion **1630** (not shown) of the grounding contact **1500** is connected to a grounding trace (not shown) of a printed circuit board (PCB) on which the plug connector **1000** is to be connected to, the grounding contact **1500** will minimise the cross-talk between a left signal
25 contact **1400l** disposed on one side of the grounding contact **1500** and a right signal contact **1400r** disposed on the other side of the grounding contact **1500**.

When the terminal legs **1720** of the shield plate **1710** is connected to a grounding trace (not shown) of a printed circuit board (PCB) on which the plug

connector **1000** is to be connected to, the shield plate **1710** will minimise the cross-talk between the signal contacts **1400f** disposed in the first group **1311** of the first passageway **1310** and the signal contacts **1400s** disposed in the second group **1312** of the first passageway **1310**.

5 Figure 3 provides an exploded view of the exemplary socket connector **2000** shown in Figure 1. The plug connector **2000** comprises an insulative housing **2010** with a recess **2020** defined by a pair of side walls **2100** wherein each side wall has an inner face **2110** and an outer face **2120**, a first end wall **2210** and a second end wall **2220**, a first housing extension **2510** configured in
10 proximity to a first end of the side wall and a second housing extension **2520** configured in proximity to a second end of the side wall, a plurality of signal passageways **2300** defined on the inner faces **2110** of the side walls **2100**, and a plurality of signal contacts **2310** disposed in the signal passageways **2300**.

 In one embodiment of the present invention, the socket connector **2000**
15 further comprises a plurality of retention devices **2320** on at least one end wall of the insulative housing **2010** configured to cooperate with a plurality of complementary retention devices **2600** on an optional supplementary shield plate **2400**. The optional supplementary shield plate **2400** provides additional EMI shielding from the external environment. Thus, for applications where it is not
20 critical to provide good EMI shielding from the external environment, the socket connector **2000** may not require the optional supplementary shield plate **2400**.

 In one embodiment of the present invention, the socket connector **2000** is coupled with at least one supplementary shield plate **2400** comprising at least one terminal leg **2620** and at least one end finger **2410** connected to a longitudinal
25 shield body **2420** extending from the first housing extension **2510** to the second housing extension **2520** wherein the end finger **2410** is configured with a plurality of complementary retention devices **2600**. The first housing extension **2510**, the second housing extension **2520** and together with the complementary

retention devices **2600** on the end finger **2410** of the supplementary shield plate **2400** which are designed to cooperate with the retention devices **2320** on the end wall of the insulative housing **2010**, retain the supplementary shield plate **2400** to the insulative housing **2010** when the supplementary shield plate **2400** is coupled
5 to the socket connector **2000**.

With reference to Figure 7, in one embodiment of the present invention, the retention device **2320** configured at the end wall of the insulative housing **2010** may be but not limited to, a groove **2330** extending inwardly into the end wall and the complementary retention device **2600** on the supplementary shield
10 plate **2400** may be but not limited to, a latch **2610** extending away from the end finger **2410** towards the end wall of the insulative housing **2010**.

To couple the supplementary shield plate **2400** with the socket connector **2000**, the supplementary shield plate **2400** is to be fitted from the top of the socket connector **2000**. As the supplementary shield plate **2400** moves vertically
15 down towards the socket connector **2000** (as shown by the arrow D), the end wall of the insulative housing **2010** deflects the latch **2610** on the supplementary shield plate **2400** towards the end finger **2410** as the latch **2610** traverse the end wall. As soon as the latch **2610** passes an edge **2340** before the groove **2330**, the latch **2610** immediately returns to its original position and thus engaging with the
20 groove **2330** in the end wall. The supplementary shield plate **2400** is now coupled and retained to the socket connector **2000** and the supplementary shield plate **2400** will not be accidentally dislodged from the socket connector **2000**.

With reference to Figure 8 and Figure 9, in one embodiment of the present invention, the socket connector **2000** further comprises a housing ledge **2530**
25 adjoining the first housing extension **2510** to the second housing extension **2520** thereby defining a corridor **2540** between the side wall **2100** of the insulative housing **2010** and the housing ledge **2530**. In another embodiment of the present invention, the housing ledge **2530** at least partially covers an optional

supplementary shield plate **2400** when the optional supplementary shield plate **2400** is coupled to the socket connector **2000**. The housing ledge **2530** serves to further retain the optional supplementary shield plate **2400** to the socket connector **2000** and prevents the optional supplementary shield plate **2400** from
5 being damaged by any external forces.

When the terminal legs **2620** of the optional supplementary shield plate **2400** is connected to a grounding trace (not shown) of a printed circuit board (PCB) on which the socket connector **2000** is to be connected to, the optional supplementary shield plate **2400** will provide EMI shielding from the external
10 environment for the socket connector **2000**.

The combination of the grounding contacts **1500** disposed alongside with the signal contacts **1400**, the shield plate **1710** disposed in the longitudinal passageway **1700** of the plug connector **1000** and the coupling of the optional supplementary shield plate **2400** to the socket connector **2000** confine each set of
15 signals within a designated area A as shown in Figure 6. It is therefore clear how the board-to-board interconnect system **1** is able to reduce the cross-talk between the signal contacts and lower the EMI shielding from the external environment when the plug connector **1000** is coupled to the socket connector **2000**.

The foregoing description of the preferred embodiment of the invention
20 has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed, since many modifications or variations thereof are possible in light of the above teaching. All such modifications and variations are within the scope of the invention. The embodiments described herein were chosen and described in order
25 to best explain the principles of the invention and its practical application, thereby to enable others skilled in the art to utilise the invention in various embodiments and with various modifications as are suited to the particular use contemplated thereof. It is intended that the scope of the invention be defined by

the claims appended hereto, when interpreted in accordance with the full breadth to which they are legally and equitably suited.

CLAIMS

1. A plug connector comprising an insulative housing comprising:

an insulative longitudinal base with an insulative wall having a first face and a second face, the insulative wall extending from the longitudinal base and
5 separating the longitudinal base into a first portion and a second portion;

a first group and a second group of first passageways wherein the first group of the first passageways extends from the first face of the insulative wall to the first portion of the longitudinal base and the second group of the first passageways extends from the second face of the insulative wall to the second
10 portion of the longitudinal base;

a set of second passageways configured alongside the first passageways wherein each second passageway has a first segment extending from the first face of the insulative wall to the first portion of the longitudinal base and a second segment extending from the second face of the insulative wall to the second
15 portion of the longitudinal base and a third segment connecting the first segment to the second segment; and

a plurality of signal contacts disposed in the first passageways wherein each signal contact comprises a mating portion, a terminal portion and an engaging portion connecting the mating portion to the terminal portion.

20 2. The plug connector of claim 1 further comprising a plurality of grounding contacts disposed in the second passageways, each grounding contact comprising a first arm, a second arm and a contact body, wherein the first arm is disposed in the first segment of the second passageway, the second arm is disposed in the second segment of the second passageway and the contact body is disposed in the third
25 segment of the second passageway.

3. The plug connector of claim 2 wherein both the first arm and the second arm of the grounding contact each comprise a mating portion, a terminal portion and an engaging portion connecting the mating portion to the terminal portion.

4. The plug connector of one of the preceding claims 1 to 3 wherein the
5 insulative wall further comprise a longitudinal passageway extending from one end of the insulative wall to an opposite end of the insulative wall.

5. The plug connector of claim 4 further comprising a shield plate disposed in the longitudinal passageway.

6. The plug connector of claim 5 further comprising a plurality of terminal
10 legs configured on at least one end of the shield plate.

7. A socket connector comprising:

an insulative housing with a recess defined by a pair of side walls, each side wall having an inner face and an outer face, a first end wall and a second end wall;

a plurality of signal passageways defined on the inner faces of the side
15 walls;

a plurality of signal contacts disposed in the signal passageways;

a plurality of retention devices on at least one end wall of the insulative housing configured to cooperate with a plurality of complementary retention devices on an optional supplementary shield plate; and

20 a first housing extension configured in proximity to a first end of the side wall and a second housing extension configured in proximity to a second end of the side wall, both first and second housing extensions configured to cooperate with the optional supplementary shield plate and retain the optional supplementary shield plate to the insulative housing when the optional supplementary shield plate
25 is coupled to the socket connector.

8. The socket connector of claim 7 further comprising a housing ledge adjoining the first housing extension to the second housing extension thereby

defining a corridor between the side wall of the insulative housing and the housing ledge such that the housing ledge at least partially covers an optional supplementary shield plate when the optional supplementary shield plate is coupled to the socket connector.

5 9. The socket connector of claim 7 or claim 8 further comprising at least one supplementary shield plate comprising at least one terminal leg and at least one end finger connected to a longitudinal shield body extending from the first housing extension to the second housing extension wherein the end finger is configured with a plurality of complementary retention devices designed to cooperate with the
10 retention devices on the end wall of the insulative housing and retain the supplementary shield plate to the insulative housing when the supplementary shield plate is coupled to the socket connector.

10. The socket connector of claim 9 wherein the retention device configured at the end wall of the insulative housing is a groove extending inwardly into the end
15 wall and the complementary retention device on the supplementary shield plate is a latch extending away from the end finger towards the end wall of the insulative housing such that the latch engages the groove and retain the supplementary shield plate to the insulative housing when the supplementary shield plate is coupled to the socket connector.

20 11. A board-to-board interconnect system comprising:
 a plug connector of any one of the claims 1 to 6; and
 a socket connector of any one of the claims 7 to 10.