

US Patent & Trademark Office

Patent Public Search | Text View

United States Patent Application Publication

20250266647

Kind Code

A1

Publication Date

August 21, 2025

Inventor(s)

ZI; HAOZHE et al.

ELECTRICAL CONNECTOR WITH IMPROVED GROUNDING STRUCTURE

Abstract

An electrical connector assembly includes: a plug connector including: a row of contacts, a ground lead-frame, and an insulator retaining the row of contacts and the ground lead-frame, the ground lead-frame having plural ground contacts interposed among and aligned with the row of contacts; and plural cable wires terminating to the row of contacts and the ground contacts of the ground lead-frame; and a receptacle connector including: an insulative housing having a tongue extending toward one side thereof and a cavity opening to an opposite side thereof; a row of terminals exposing to the tongue, the row of terminals including plural signal terminals and plural ground terminals, the plurality of ground terminals being exposed to the cavity; and a ground bar disposed in the cavity to connect with the plurality of ground terminals, wherein the ground bar has a beam for making an electrical connection to the ground lead-frame.

Inventors: ZI; HAOZHE (Irvine, CA), LI; JESSE (Anaheim, CA), LITTLE; TERRANCE F. (Fullerton, CA), YANG; AN-JEN (Irvine, CA)

Applicant: FOXCONN (KUNSHAN) COMPUTER CONNECTOR CO., LTD. (Kunshan, CN); FOXCONN INTERCONNECT TECHNOLOGY LIMITED (Grand Cayman, KY)

Family ID: 1000008460857

Appl. No.: 19/057591

Filed: February 19, 2025

Related U.S. Application Data

us-provisional-application US 63555659 20240220

Publication Classification

Int. Cl.: H01R13/6581 (20110101); H01R12/71 (20110101); H01R13/6474 (20110101)

U.S. Cl.:

CPC H01R13/6581 (20130101); H01R12/716 (20130101); H01R13/6474 (20130101)

Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application claims the benefit of, and priority to, U.S. Provisional Patent Application No. 63/555,659, filed Feb. 20, 2024, the contents of which are incorporated entirely herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to an electrical connector with improved grounding structures.

2. Description of Related Arts

[0003] U.S. Pat. No. 9,692,183 discloses an electrical connector comprising signal contacts, ground contacts, and a ground bus that electrically commons the ground contacts with each other. The ground contacts are arranged in approximately the same plane as the signal contacts. Two or more ground contacts and the ground bus are integrally fabricated as a single, unitary, continuous structure. The signal contacts have jogs that offset the signal contacts from the ground bus.

[0004] U.S. Pat. No. 10,944,214 discloses an electrical connector comprising a terminal group having a signal terminal pair, a ground plate configured to provide a ground terminal on each of both sides of the signal terminal pair, a shield plate configured to be connected to the ground plate, and a twin-ax cable having a pair of conductors which extend through the shield plate and connect to the signal terminal pair and a ground portion which electrically connects to at least one of the shield plate and the ground plate.

[0005] Therefore, an improved electrical connector is desired.

SUMMARY OF THE INVENTION

[0006] An object of the present invention is to provide an electrical connector with an improved grounding structure.

[0007] To achieve the above-mentioned object, an electrical connector assembly comprises: a plug connector including: a row of contacts, a ground lead-frame, and an insulator retaining the row of contacts and the ground lead-frame, the ground lead-frame having a plurality of ground contacts interposed among and aligned with the row of contacts; and a plurality of cable wires terminating to the row of contacts and the ground contacts of the ground lead-frame; and a receptacle connector including: an insulating housing having a tongue extending toward one side thereof and a cavity opening to an opposite side thereof; a row of terminals secured to the insulating housing and exposing to the tongue, the row of terminals including a plurality of signal terminals and a plurality of ground terminals, the plurality of ground terminals being exposed to the cavity; and a ground bar disposed in the cavity to connect with the plurality of ground terminals, wherein the ground bar has a beam for making an electrical connection to the ground lead-frame.

[0008] Other advantages and novel features of the invention will become more apparent from the following detailed description of the present embodiment when taken in conjunction with the accompanying drawings.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0009] FIG. **1** is a perspective view of a receptacle connector in accordance with the present invention mounted on a printed circuit board;

[0010] FIG. **2** is an exploded view of the receptacle connector in FIG. **1**;

[0011] FIG. **3** is a further exploded view of a part of the receptacle connector in FIG. **2**;

[0012] FIG. **4** is a still further exploded view of a part of FIG. **3**;

[0013] FIG. **5** shows a bottom assembled view of FIG. **3**;

[0014] FIG. **6** shows a bottom exploded view of FIG. **3**;

[0015] FIG. **7** is a side view of FIG. **6**;

[0016] FIG. **8** is a view similar to FIG. **7** but showing a subsequent state;

[0017] FIG. **9** is a perspective view of an electrical connector assembly in accordance with the present invention mounted on a printed circuit board, including a varied receptacle connector and a plug connector;

[0018] FIG. **10** is an exploded view of the electrical connector assembly;

[0019] FIG. **11** is a view similar to FIG. **10** but from another perspective;

[0020] FIG. **12** is an exploded view of the varied receptacle connector in FIG. **10**;

[0021] FIG. **13** is a further exploded view of a part of the varied receptacle connector in FIG. **12**;

[0022] FIG. **14** is a still further exploded view of a part of the varied receptacle connector in FIG. **12**;

[0023] FIG. **15** is a perspective view of a ground bar in FIG. **14**;

[0024] FIG. **16** is a cross-sectional view of the varied receptacle connector taken along lines A-A in FIG. **12**;

[0025] FIG. **17** is a cross-sectional view of the varied receptacle connector taken along lines B-B in FIG. **12**;

[0026] FIG. **18** is an exploded view of a plug connector of the electrical connector assembly in FIG. **10**;

[0027] FIG. **19** is a view similar to FIG. **18** but from another perspective;

[0028] FIG. **20** is a further exploded view of a part of FIG. **19**;

[0029] FIG. **21** is a view similar to FIG. **20** but from another perspective;

[0030] FIG. **22** is a cross-sectional view of the electrical connector assembly taken along lines C-C in FIG. **17**;

[0031] FIG. **23** is another cross-sectional view of the electrical connector assembly taken along lines C-C in FIG. **17**;

[0032] FIG. **24** is a perspective view of a varied ground lead-frame of the plug connector in accordance with the present invention;

[0033] FIG. **25** is a front view of the varied ground lead-frame;

[0034] FIG. **26** is a side view of varied ground lead-frame;

[0035] FIG. **27** is an exploded view of FIG. **24**;

[0036] FIG. **28** is a further exploded view of FIG. **27**;

[0037] FIG. **29** shows the ground lead-frame in an intermediate state;

[0038] FIG. **30** is a view similar to FIG. **1** but showing a varied ground lead-frame of the plug connector;

[0039] FIG. **31** is a front view of FIG. **30**;

[0040] FIG. **32** is a side view of FIG. **30**;

[0041] FIG. **33** is a perspective view of a part of a varied plug connector;

[0042] FIG. **34** is an exploded view of FIG. **33**;

[0043] FIG. **35** is a further exploded view of one part of FIG. **34**;

[0044] FIG. **36** is a view similar to FIG. **35** but from another perspective;

[0046] FIG. **37** is a further exploded view of another part of FIG. **34**;
[0047] FIG. **38** is a view similar to FIG. **37** but from another perspective;
[0048] FIG. **39** is a side view of FIG. **33**;
[0049] FIG. **40** is a top view of the receptacle connector;
[0050] FIG. **41** is a cross-sectional side view of FIG. **40**;
[0051] FIG. **42** is a top view of the varied receptacle connector; and
[0052] FIG. **43** is a cross-sectional side view of FIG. **42**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0053] Reference will now be made to the drawing figures to describe the preferred embodiment of the present invention in detail.

[0054] FIGS. **1-8** illustrate a receptacle connector **20** mounted on a circuit board **200**, which is adapted for mating with a plug connector **10** as shown in FIGS. **14** and **15**. Seen in FIGS. **11**, an electrical connector assembly **100** comprises a cable plug connector **10** and a mating receptacle connector **20A** mounted on a printed circuit board (PCB) **200**.

[0055] Referring to FIGS. **1-8**, the receptacle connector **20** may include an insulating housing **22**, one or more rows of terminals **24**, and a ground bar **26**. The insulating housing **22** have a tongue **222** extending toward one side thereof and a cavity **224** opening to an opposite side thereof. The rows of terminals **24** are secured to the insulating housing **22** while exposing to the tongue **222**. The row of terminals **24** includes a plurality of signal terminals **242** and a plurality of ground terminals **244**, the plurality of ground terminals **244** is exposed to the cavity **224**. The ground bar **26** is disposed in the cavity **224** and has a plurality of beams **262**, **263** or grounding beams to connect with the plurality of ground terminals **244**. The receptacle connector **20** may further include a shroud **28** made from insulating material and enclosing the insulating housing **22** and a receptacle shell **29** made from a metal plate and enclosing the shroud **28**. The shroud **28** may have features for retaining the insulating housing **22** and the shell **29** may have retention features for retaining to the shroud **28**.

[0056] In this embodiment, two rows of the terminals **24** are provided to be disposed in the insulating housing **22** and exposed upon opposite side faces of the tongue **222**. Two grounding bars **26** are attached in a back to back form, the beams **262**, **263** are attached to corresponding the grounding terminals **244**. The beams **262** of a downward type extend downwards each with a lower arc, the beams **263** of an upward type extend upwards each with an upper arc, the upper arcs are located higher than the lower arcs. The grounding terminals **244** of the two rows of terminals **24** are located aligned with each other in a transverse direction perpendicular to a longitudinal direction along which the row of terminals **24** is arranged, so the beams of one grounding bar are opposite to corresponding beams of another grounding bar in the transverse direction. As shown in FIGS. **8-10**, the two grounding bars **26** connected with strips **260** are attached together and then inserted in to the cavity **224**, the beams **262**, **263** elastically attach corresponding grounding terminals **244**. Combination with FIG. **5**, the row of terminals **24** are retained in an insulator by a first injection process, and then an insulating material are injected around the terminals with the cavity **224** by a second injection process. And then the two grounding bars are inserted in the cavity **224**. Last, the strip is cut off.

[0057] FIGS. **2-3** feature an outline of the receptacle connector **20**. In conjunction with FIG. **4**, the shroud **28** is generally elongate and may include a pair of end walls **282** and respective notches **284** on the pair of end walls **282**. The two notches **284** align with each other along the longitudinal direction while being offsetting from the tongue **222** in the transverse direction. A bottom interior face **2842** of the notch **284** is leveled higher than an interior face **226** of the tongue **222**. The pair of end walls **282** protrudes upward beyond the shell **29**.

[0058] FIGS. **11-30** illustrate an electrical connector assembly **100** includes a varied receptacle connector **20A** and a plug connector **50**. Referring to the FIGS. **18-23**, the varied receptacle connector **20A** is similar to the electrical connector **20** with a varied grounding bar **26A**. The

ground bar **26A** has a plurality of first/grounding beams **264** and a plurality of second/engaging beams **266**. In this embodiment, each of the first beams **264** includes upward beams **2641** and downward beams **2642** aligned with corresponding upward beams **2641**, so that each grounding terminal **244** are attached with two points of the beams **264**. The second beam **266** may make an electrical connection to the ground lead-frame **14'** as best shown in FIGS. **12-13**. The second beams **266** extend upwards beyond the first beams **264**, and beyond a top/mating face **2221** of the tongue **222**, the second beam **266** has an arc portion **2661** protruding the mating face **2221** to engage with a grounding plane defined on the plug connector **10** which will be described hereinafter.

[0059] Referring to the FIGS. **24-25**, the plug connector **50** including a plug contact assembly **60** with a plurality of cable wires **90** terminated thereto. The plug connector **50** may further include an upper cover **72** and a lower cover **74** cooperating to contain the contact assembly **60** and a latch **76**. The contact assembly **60** may include a front contact unit **62** and a rear contact unit **64**. Other suitable insulator may be further employed to retain the front and rear contact units **62** and **64**. Each of the contact units includes a row of contact and a grounding lead frame with a plurality of grounding contacts, and an insulator **16** united the row of contact and the grounding lead frame together.

[0060] Firstly referring to FIGS. **31-43**, a varied plug contact assembly **60B** is illustrated, which is similar to the plug contact assembly **60**. The varied plug contact assembly **60B** includes a row of contacts **12**, a ground lead-frame **14**, an insulator (such as insulator **16** seen in FIGS. **25-26**) retaining the row of contacts **12** and the ground lead-frame **14**, and a plurality of cable wires **900** terminating to the row of contacts **12** and the ground lead-frame **14**. The ground lead-frame **14** has a plurality of ground contacts **142** interposed among and aligned with the row of contacts **12**. The terminating portions **121** of the row of contacts **12** may be suitably thinned relative to remaining portions as clearly seen in FIG. **43** for impedance matching consideration.

[0061] The ground lead-frame **14** is unitary and has a plurality of first/joining bars **144** located at one side of the row of contacts **12** and a plurality of second/engaging bars **146** located at an opposite side of the row of contacts **12**. Each of the plurality of first bars **144** and the plurality of second bars **146** is connected between two adjacent ground contacts **142**. A pair of the contacts **12** goes across the first bar **144**. The plug contact assembly **60B** is clearly shown in this embodiment. The first bars **144** are joined the grounding contact **142** together to be the unitary grounding lead frame **14**. The second bars **146** are joined the grounding contacts **142** together, and the second bar **146** extend to and is adapted for make a connection with the grounding bar of the receptacle connector **20A**.

[0062] Back to FIGS. **26-30**, the grounding lead frame **14'** is similar the grounding lead frame **14** of the varied plug contact assembly **60B**. Specifically, the ground lead-frame **14'** may include one or more engaging ends **1422** protruding outwards the insulator **16**. A ground plate **18** may include one or more slits **182** each receiving and being retained with a corresponding engaging end **1422**. As shown, the arc portions **2661** of the second beams **266** touch the grounding plate **18** to get an electric connector between the grounding lead frame **14'** and the grounding bars **26A** when the plug connector is inserted into the receptacle connector **20**. That means, the grounding lead-frame is electrically connected with the grounding bars **26** via the grounding plate, the engaging ends **1422** is functioned as the second beams, the first beams **148** are connected with every adjacent grounding contacts **142**. As shown in FIGS. **12** and **13** and **15**, the grounding plate **18** exposes upon an inner bottom **501** of a mating cavity **501** of the plug connector **10** to make an engagement with the second beams **266**. The lower cover **74** defines an insulating base **502** which defines said mating cavity **501**. Back to FIG. **33**, the second beams **142** extend into the mating cavity **501** and the exposes upon the inner bottom of the mating cavity **501** of the plug connector when the two connectors are mated together, the second beams **266** also are engaged with the second bars **146** of the receptacle connector. FIGS. **28-29** further show that each of the row of contacts **12** has a concave end face **122** and each of the plurality of cable wires **90** extends across and is terminated to

the concave end face **122**.

[0063] In summary, an electrical connector assembly of the invention comprises a plug connector and a receptacle connector. The receptacle connector includes a ground bar that is stamped and formed of copper. When two ground bars are assembled back-to-back, the touch fingers thereof represent a spider-shape. The receptacle connector also includes a pair of contact arrays each consisting of ground contacts and signal contacts that is first shot insert molded as an insert molded lead-frame assembly (IMLA). Two IMLAs are then addressed to a mold for second shot molding of main strip. Underside of the main strip has channels cored out for spider-shape ground bar touch fingers to make contact with ground contacts at assembly. The spider-shape ground bars make intimate contact with the ground contacts, thus creating a common ground with touch points at staggered locations. The plug connector includes integrated ground contacts blanked in one continuous lead-frame with common ground bar to form a ground lead-frame. The ground lead-frame has upper and lower ground bars and coined areas. The coined area at cable termination will raise impedance prior to hot melt glue; after applying the hot melt glue for strength, the impedance will fall into the desired range. Another wire termination design is that wire is attached onto a half-moon structure at the tip of lead frame and drain wires are soldered on an upper level compared to signal pairs for building a common GND for signal integrity (SI) purpose. A further common ground (GND) bar design is that on the bottom there is an elastic beam for common GND bar to only touch the GND lead frame while on the top the common GND bar is laser welded onto GND lead frame. This design can achieve different touching positions by adjusting length of the elastic beam, even on moving area of the lead frame, which will benefit SI performance. Also, for better impedance control design at termination, open air pocket under the wire termination area may be provided to increase the impedance at this area and may be made thinner. The main housing may have features to better locating the common GND bar elastic beam for tolerance control.

[0064] FIGS. **37-43** show a varied plug contact assembly **60C** with a plurality of cable wires **90** terminated thereto. The plug connector may further include an upper cover **72** and a lower cover **74** (such as those shown in FIGS. **24** and **28**) cooperating to contain the plug contact assembly **60** and a latch **76**. The contact assembly **60C** may include a front contact unit **62** and a rear contact unit **64**. Other suitable insulator may be further employed to retain the front and rear contact units **62** and **64**. The front contact unit **62** may include a row of contacts **622**, an insulator **624** retaining the row of contacts **622**, and a ground bar **66**. The rear contact unit **64** may include a row of contacts **642**, an insulator **644** retaining the row of contacts **642**, and a ground bar **68**. Each of the front and rear ground bars **66** and **68** may be suitably secured to securing features disposed on the associated insulator **624** or **644**. The cable wire **90** may be twin-ax raw cable wires directly attached to the contacts **622** or **642** in a well-known manner. The front ground bar **66** may include a plurality of first fingers **662** each engaging a securing portion of a corresponding ground contact **622** and a plurality of second fingers **664** each resiliently engaging a contacting portion of the corresponding ground contact **622**. The rear ground bar **68** may include a plurality of first fingers **682** each engaging a securing portion of a corresponding ground contact **642** and a plurality of second fingers **684** each resiliently engaging a contacting portion of the corresponding ground contact **642**. The second fingers **664** and **684** are designed as elastic beams which may be easily adjusted, even on moving portions of the ground contacts **622** and **642**, as to lengths in order to improve SI performance.

[0065] The above-mentioned embodiments are only preferred embodiments of the present invention, and should not limit the scope of the present invention, any simple equivalent changes and modifications made according to the claims of the present invention and the contents of the description should still belong to the present invention.

Claims

- 1.** An electrical connector assembly comprising: a plug connector comprising: a row of contacts, a ground lead-frame, and an insulator retaining the row of contacts and the ground lead-frame, the ground lead-frame having a plurality of ground contacts interposed among and aligned with the row of contacts; and a plurality of cable wires terminating to the row of contacts and the ground contacts of the ground lead-frame; and a receptacle connector comprising: an insulating housing having a tongue; a row of terminals secured to the insulating housing and exposing to the tongue, the row of terminals comprising a plurality of signal terminals and a plurality of ground terminals; and a ground bar disposed in the insulating housing and electrically connect with the plurality of ground terminals; wherein the ground bar has at least one beam for making an electrical connection to the ground lead-frame when the plug connected is inserted in the receptacle connector.
- 2.** The electrical connector assembly as claimed in claim 1, wherein the grounding lead-frame has a plurality of bars connected with every adjacent two grounding contacts for contacting the grounding bar.
- 3.** The electrical connector assembly as claimed in claim 1, wherein the plug connector comprises a ground plate engaging the ground lead-frame, and the ground plate is for contacting the at least one beam of the grounding bar of the receptacle connector.
- 4.** The electrical connector assembly as claimed in claim 1, wherein the at least one beam of the grounding bar protrudes upward beyond a mating face of the tongue.
- 5.** A plug connector comprising: an insulating base having a mating cavity with two opposite inner face and an inner bottom; a row of contacts, a ground lead-frame, and an insulator retaining the row of contacts and the ground lead-frame, the ground lead-frame having a plurality of ground contacts interposed among and aligned with the row of contacts; and a plurality of cable wires terminating to the row of contacts and the ground contacts of the ground lead-frame; wherein the row of contacts and the plurality of grounding contacts are arrange along the inner side, the ground lead-frame has a plurality of engaging bars each connected between two adjacent ground contacts, and the engaging bars expose upon the inner bottom of the mating cavity.
- 6.** The plug connector as claimed in claim 5, wherein each of the row of contacts has a concave end face and each of the plurality of cable wires extends across and is terminated to the concave end face.
- 7.** The plug connector as claimed in claim 5, wherein the connecting bars bend from the grounding lead-frame and disposed parallel to the inner bottom.
- 8.** The plug connector as claimed in claim 5, wherein the engaging bars bend from the grounding lead-frame and are attached to a grounding plate disposed on the inner bottom of the mating cavity.
- 9.** The plug connector as claimed in claim 5, wherein the grounding lead-frame has a plurality of joining bars each connected between every two adjacent ground contacts, every two contacts go across the joining bar, the joining bars and the engaging bars are located on opposite sides of the row of the contacts.
- 10.** A receptacle connector comprising: an insulating housing having a tongue; a row of terminals secured to the insulating housing and exposing to a side face of the tongue, the row of terminals comprising a plurality of signal terminals and a plurality of ground terminals; and a ground bar disposed in insulating housing and connected with the plurality of ground terminals; wherein the ground bar has at least one engaging beam exposing upon a mating face of the tongue intersected with the side face.
- 11.** The receptacle connector as claimed in claim 10, wherein the at least one engaging beam has an arc portion extending beyond the mating face.
- 12.** The receptacle connector as claimed in claim 10, wherein the at least one connecting beam has a plurality of grounding beams contacting the plurality of grounding terminals respectively.
- 13.** The receptacle connector as claimed in claim 10, wherein the grounding bar has a plurality of grounding beams punched from the grounding bar, and two engaging beams extend from a top

edge of the grounding plate.

14. The receptacle connector as claimed in claim 10, wherein another row of terminals is secured to the insulating housing and expose to another side face of the tongue, and an another grounding bar is attached to the grounding bar in a back to back form.
