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Plug connector assembly, receptacle connector assembly and connector assembly with improved data transmission speed

Abstract

A connector assembly includes a plug connector assembly and a receptacle connector assembly matched with each other. The plug connector assembly includes a metal shell and a plug connector. The plug connector includes a number of plug terminal modules. Each plug terminal module includes a first differential signal terminal, a first ground terminal, and a second ground terminal. The receptacle connector assembly includes a metal cage and a receptacle connector. The receptacle connector includes a number of receptacle terminal modules. Each receptacle terminal module includes a second differential signal terminal, a metal shield surrounding member surrounding a periphery of the second differential signal terminal, and a receptacle cable electrically connected to the second differential signal terminal.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

(1) This patent application claims priority of a Chinese Patent Application No. 202111281307. X, filed on Nov. 1, 2021 and titled “PLUG CONNECTOR ASSEMBLY, RECEPTACLE CONNECTOR ASSEMBLY AND CONNECTOR ASSEMBLY”, the entire content of which is incorporated herein by reference.

TECHNICAL FIELD

(2) The present disclosure relates to a plug connector assembly, a receptacle connector assembly and a connector assembly, which belongs to a technical field of connectors.

BACKGROUND

(3) An existing SFP (Small Form Factor Pluggable) connector assembly usually includes an SFP receptacle connector assembly and an SFP plug connector assembly. The SFP receptacle connector assembly usually includes a metal cage and an SFP receptacle connector located in the metal cage. The SFP receptacle connector includes an insulating body and a plurality of conductive terminal modules which are assembled to the insulating body and arranged at intervals. Each conductive terminal module includes an insulating bracket and a plurality of conductive terminals insert-molded with the insulating bracket. Among the plurality of conductive terminal modules, some conductive terminal modules are signal terminal modules, and some conductive terminal modules are ground terminal modules. After assembling, the plurality of conductive terminal modules are disposed next to each other. Two adjacent signal terminal modules form a differential pair. It should be noted that two signal terminals of the differential pair are located on different terminal modules.

(4) The SFP plug connector assembly usually includes a built-in circuit board, a cable connected to the built-in circuit board, and a shell enclosing the built-in circuit board. The built-in circuit board includes a tongue plate portion and a plurality of gold fingers provided on a surface of the tongue plate portion.

(5) When the SFP plug connector assembly is inserted into the SFP receptacle connector assembly and plugged in place, the gold fingers on the tongue plate portion contact the conductive terminals of the SFP receptacle connector so as to transmit data.

(6) However, with the continuous improvement of the data transmission requirements of the connector assembly, there is still room for improvement of the existing connector assembly.

SUMMARY

(7) An object of the present disclosure is to provide a plug connector assembly, a receptacle connector assembly, and a connector assembly which are compact in layout and easy to realize high-speed data transmission.

(8) In order to achieve the above object, the present disclosure adopts the following technical solution: a plug connector assembly, including: a metal shell, the metal shell including a first end surface and an installation space extending through the first end surface; and a plug connector, the plug connector being at least partially received in the installation space, the plug connector including a plug housing and a plurality of plug terminal modules, the plurality of plug terminal modules being arranged side by side and assembled to the plug housing; wherein at least one plug terminal module includes a plurality of plug conductive terminals, the plurality of plug conductive terminals include a first differential signal terminal, a first ground terminal and a second ground terminal, and the first differential signal terminal is located between the first ground terminal and the second ground terminal.

(9) In order to achieve the above object, the present disclosure adopts the following technical solution: a receptacle connector assembly, including: a metal cage, the metal cage including a second end surface and a mating space extending through the second end surface; and a receptacle

connector, the receptacle connector being located at a rear end of the mating space and communicating with the mating space, the receptacle connector including a receptacle housing and a plurality of receptacle terminal modules assembled to the receptacle housing; wherein at least one receptacle terminal module includes a second differential signal terminal, a grounding element, and a receptacle cable electrically connected to the second differential signal terminal.

(10) In order to achieve the above object, the present disclosure adopts the following technical solution: a connector assembly, including a plug connector assembly and a receptacle connector assembly which are matched with each other, the plug connector assembly including: a metal shell, the metal shell including an installation space; and a plug connector, the plug connector being at least partially received in the installation space, the plug connector including a plug housing and a plurality of plug terminal modules, the plurality of plug terminal modules being arranged side by side and assembled to the plug housing; wherein at least one plug terminal module includes an insulating bracket and a plurality of plug conductive terminals fixed to the insulating bracket, and the plurality of plug conductive terminals include a first differential signal terminal; the receptacle connector assembly including: a metal cage, the metal cage including a mating space; and a receptacle connector, the receptacle connector being located at a rear end of the mating space and communicating with the mating space, the receptacle connector including a receptacle housing and a plurality of receptacle terminal modules assembled to the receptacle housing; wherein at least one receptacle terminal module includes a second differential signal terminal and a receptacle cable electrically connected to the second differential signal terminal; and wherein the plug connector assembly is at least partially inserted into the mating space, so that the first differential signal terminal and the second differential signal terminal are in contact with each other.

(11) Compared with the prior art, at least one plug terminal module of the plug connector assembly of the present disclosure includes a first differential signal terminal, a first ground terminal, and a second ground terminal; and the first differential signal terminal is located between the first ground terminal and the second ground terminal. By arranging the first differential signal terminal, the first ground terminal, and the second ground terminal on a single plug terminal module, the arrangement of the first differential signal terminal, the first ground terminal and the second ground terminal becomes more compact, and it is beneficial to increase the speed of data transmission. Besides, at least one receptacle terminal module of the receptacle connector assembly of the present disclosure includes a second differential signal terminal, a metal shield surrounding member surrounding a periphery of the second differential signal terminal, and a receptacle cable electrically connected to the second differential signal terminal. By arranging the second differential signal terminal on the receptacle terminal module, the arrangement of the second differential signal terminal becomes more compact, and it is beneficial to increase the data transmission speed. In addition, by matching the plug connector assembly with the receptacle connector assembly, the data transmission speed is improved.

Description

BRIEF DESCRIPTION OF DRAWINGS

(1) FIG. **1** is a perspective schematic view of a connector assembly in accordance with an embodiment of the present disclosure, in which a plug connector assembly is inserted into a receptacle connector assembly;

(2) FIG. **2** is a right side view of FIG. **1**;

(3) FIG. **3** is a partially exploded perspective view of FIG. **1**;

(4) FIG. **4** is a front view of the plug connector assembly in FIG. **3**;

(5) FIG. **5** is a rear view of FIG. **4**;

(6) FIG. **6** is a right side view of the plug connector assembly in FIG. **3**;

(7) FIG. **7** is a partial perspective exploded view of FIG. **6**, in which a plug connector and a built-in circuit board are separated;
(8) FIG. **8** is a partial perspective exploded view of FIG. **7** from another angle;
(9) FIG. **9** is a perspective exploded view of the plug connector assembly in FIG. **3**;
(10) FIG. **10** is a perspective exploded view of FIG. **9** from another angle;
(11) FIG. **11** is a partial perspective exploded view of the plug connector in FIG. **10**;
(12) FIG. **12** is a partially exploded perspective view of FIG. **11** from another angle;
(13) FIG. **13** is a partial perspective exploded view of the plug connector of the present disclosure, in which one plug terminal module is separated;
(14) FIG. **14** is a partial perspective exploded view of the plug terminal module in FIG. **13**;
(15) FIG. **15** is a partial perspective exploded view of FIG. **14** from another angle;
(16) FIG. **16** is a side view of an insulating bracket and plug conductive terminals separated from the insulating bracket;
(17) FIG. **17** is a perspective schematic view of the plug connector in FIG. **3** from another angle;
(18) FIG. **18** is a partially exploded perspective view of FIG. **17**;
(19) FIG. **19** is a partially exploded perspective view of FIG. **18** from another angle;
(20) FIG. **20** is a schematic cross-sectional view taken along line A-A in FIG. **17**;
(21) FIG. **21** is a partial enlarged view of a frame part B in FIG. **20**;
(22) FIG. **22** is a schematic cross-sectional view taken along line C-C in FIG. **17**;
(23) FIG. **23** is a partial enlarged view of a frame part D in FIG. **22**;
(24) FIG. **24** is a side view of a first metal shield of the plug connector;
(25) FIG. **25** is a side view of a second metal shield of the plug connector;
(26) FIG. **26** is a front view of the plug terminal module in FIG. **11**;
(27) FIG. **27** is a partial enlarged view of a frame part E in FIG. **26**;
(28) FIG. **28** is a top view of the plug terminal module in FIG. **11**;
(29) FIG. **29** is a partial enlarged view of a frame part F in FIG. **28**;
(30) FIG. **30** is a front view of the receptacle connector assembly in FIG. **3**;
(31) FIG. **31** is a rear view of FIG. **30**;
(32) FIG. **32** is a right side view of the receptacle connector assembly in FIG. **3**;
(33) FIG. **33** is a partially exploded perspective view of the receptacle connector assembly in FIG. **3**;
(34) FIG. **34** is a perspective exploded view of a metal cage in FIG. **33**;
(35) FIG. **35** is a perspective exploded view of FIG. **34** from another angle;
(36) FIG. **36** is a partially exploded perspective view of a receptacle connector in FIG. **33**;
(37) FIG. **37** is a partially exploded perspective view of FIG. **36** from another angle;
(38) FIG. **38** is a partial perspective exploded view of a receptacle terminal module in FIG. **36**; and
(39) FIG. **39** is a schematic cross-sectional view taken along H-H in FIG. **3**.

DETAILED DESCRIPTION

(40) Exemplary embodiments will be described in detail here, examples of which are shown in drawings. When referring to the drawings below, unless otherwise indicated, same numerals in different drawings represent the same or similar elements. The examples described in the following exemplary embodiments do not represent all embodiments consistent with this application. Rather, they are merely examples of devices and methods consistent with some aspects of the application as detailed in the appended claims.
(41) The terminology used in this application is only for the purpose of describing particular embodiments, and is not intended to limit this application. The singular forms “a”, “said”, and “the” used in this application and the appended claims are also intended to include plural forms unless the context clearly indicates other meanings.
(42) It should be understood that the terms “first”, “second” and similar words used in the specification and claims of this application do not represent any order, quantity or importance, but

are only used to distinguish different components. Similarly, “an” or “a” and other similar words do not mean a quantity limit, but mean that there is at least one; “multiple” or “a plurality of” means two or more than two. Unless otherwise noted, “front”, “rear”, “lower” and/or “upper” and similar words are for ease of description only and are not limited to one location or one spatial orientation. Similar words such as “include” or “comprise” mean that elements or objects appear before “include” or “comprise” cover elements or objects listed after “include” or “comprise” and their equivalents, and do not exclude other elements or objects. The term “a plurality of” mentioned in the present disclosure includes two or more.

(43) Hereinafter, some embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. In the case of no conflict, the following embodiments and features in the embodiments can be combined with each other.

(44) Referring to FIGS. **1** to **3**, the present disclosure discloses a connector assembly **500** including a plug connector assembly **300** and a receptacle connector assembly **400**. The plug connector assembly **300** is adapted to be inserted into the receptacle connector assembly **400** so as to realize transmission of high-speed signals, control signals, and power, etc.

(45) Referring to FIGS. **4** to **10**, the plug connector assembly **300** includes a metal shell **5** and a plug connector **100** at least partially installed in the metal shell **5**. In the illustrated embodiment of the present disclosure, the plug connector **100** is a backplane connector. The plug connector **100** is located at a front end of the metal shell **5**. It is understandable to those skilled in the art that the backplane connector generally includes a plurality of terminal modules. Each terminal module includes multiple groups of differential signal terminals. By providing the differential signal terminals, the data transmission speed of the plug connector assembly **300**, the receptacle connector assembly **400** and the connector assembly **500** can be improved, and the miniaturization of the connector assemblies can be achieved.

(46) The metal shell **5** includes a first end surface **50** and an installation space **501** extending through the first end surface **50**. The plug connector **100** is at least partially received in the installation space **501**. In the illustrated embodiment of the present disclosure, the metal shell **5** includes a first top wall **51**, a first bottom wall **52**, a first side wall **53** and a second side wall **54**. The installation space **501** is at least jointly enclosed by the first top wall **51**, the first bottom wall **52**, the first side wall **53** and the second side wall **54**. Specifically, the metal shell **5** includes a first metal shell **55** and a second metal shell **56** assembled together. The first metal shell **55** includes the first top wall **51**, a first side wall portion **531** extending downwardly from one side of the first top wall **51**, and a second side wall portion **541** extending downwardly from the other side of the first top wall **51**. The second metal shell **56** includes the first bottom wall **52**, a third side wall portion **532** extending upwardly from one side of the first bottom wall **52**, and a fourth side wall portion **542** extending upwardly from the other side of the first bottom wall **52**. The first side wall portion **531** and the third side wall portion **532** are located on a same side of the metal shell **5**. The first side wall **53** includes the first side wall portion **531** and the third side wall portion **532**. Similarly, the second side wall portion **541** and the fourth side wall portion **542** are located on a same side of the metal shell **5**. The second side wall **54** includes the second side wall portion **541** and the fourth side wall portion **542**. In the illustrated embodiment of the present disclosure, a length of the metal shell **5** extending in a mating direction (i.e., a front-to-rear direction) is much longer than a length of the plug connector **100** after a plug cable **302** is removed, which is beneficial to improve the shielding effect of the plug connector **100**. When the plug connector assembly **300** is just inserted into the receptacle connector assembly **400**, static electricity can be discharged through the metal shell **5**, thereby avoiding adverse effects on the connection between plug conductive terminals and receptacle conductive terminals.

(47) In an embodiment of the present disclosure, both the first metal shell **55** and the second metal shell **56** are casted from metal materials, so as to facilitate manufacturing and improve the shielding performance of the first metal shell **55** and the second metal shell **56**. The first metal shell **55** and

the second metal shell **56** are fixed together by bolts **57**.
(48) In addition, the first metal shell **55** includes an opening **551** located between the first side wall portion **531** and the second side wall portion **541**. The metal shell **5** includes a plug heat sink **59** installed in the opening **551**. The plug heat sink **59** includes a plurality of heat dissipation channels **591** arranged at intervals.
(49) In the illustrated embodiment of the present disclosure, the plug connector assembly **300** further includes a built-in circuit board **301**, a plug cable **302**, an unlocking assembly **303** mounted on the metal shell **5**, and a pull strap **304** connected to the unlocking assembly **303**. The plug connector **100** is mounted on the built-in circuit board **301**. The plug cable **302** is electrically connected to the plug connector **100** through the built-in circuit board **301**. Of course, in other embodiments, the plug cable **302** can also be directly electrically connected to the plug connector **100**.
(50) The unlocking assembly **303** is substantially U-shaped, and includes a first locking side wall **3031**, a second locking side wall **3032**, and a connection bottom wall **3033** connecting the first locking side wall **3031** and the second locking side wall **3032**. The first locking side wall **3031** includes a first protrusion **3031***a* protruding backwardly from the connection bottom wall **3033**. The second locking side wall **3032** includes a second protrusion **3032***a* protruding backwardly from the connection bottom wall **3033**.
(51) The third side wall portion **532** of the second metal shell **56** is provided with a first slot **5321** for receiving the first locking side wall **3031**. The fourth side wall **542** of the second metal shell **56** is provided with a second slot **5421** for receiving the second locking side wall **3032**. In addition, the plug connector **100** further includes compression springs **58** received in the third side wall portion **532** and the fourth side wall portion **542**, and abutting against the first locking side wall **3031** and the second locking side wall **3032**.
(52) The pull strap **304** includes a first coupling portion **3041** fixed to the first protrusion **3031***a*, a second coupling portion **3042** fixed to the second protrusion **3032***a*, and a force applying portion **3043** connecting the first coupling portion **3041** and the second coupling portion **3042**. In an embodiment of the present disclosure, the first protrusion **3031***a* is insert-molded with the first coupling portion **3041**, and the second protrusion **3032***a* is insert-molded with the second coupling portion **3042**.
(53) The unlocking assembly **303** is slidable back and forth under the action of the pull strap **304**. When unlocking is required, a backward force is applied to the force applying portion **3043** of the pull strap **304**, the unlocking assembly **303** overcomes the elastic force of the compression springs **58**, so that the first locking side wall **3031** and the second locking side wall **3032** move backwardly so as to realize unlocking. When the force disappears, the compression springs **58** release part of the elastic force, so that the unlocking assembly **303** moves forwardly and resets.
(54) Referring to FIGS. **11** and **12**, the plug connector **100** includes a plug housing **1**, a plurality of plug terminal modules **2** at least partially assembled to the plug housing **1**, a spacer **3** held on the plurality of plug terminal modules **2**, and a mounting block **4** held at the bottom of the plurality of plug terminal modules **2**. The plurality of plug terminal modules **2** are disposed side by side along a left-right direction.
(55) The plug housing **1** includes a first base **11**, a first extension wall **12** extending rearwardly from a top end of the first base **11**, and a second extension wall **13** extending rearwardly from a bottom end of the first base **11**. The first base **11** includes a mating surface **111** and a plurality of terminal mating grooves **112** extending through the mating surface **111**. The terminal mating grooves **112** are arranged in multiple rows along a first direction (i.e., a left-right direction). Two adjacent rows of terminal mating grooves **112** are staggered and arranged in a second direction (i.e., a top-bottom direction) perpendicular to the first direction. That is, the terminal mating grooves **112** at corresponding positions in the two adjacent rows of terminal mating grooves **112** are not aligned in the left-right direction. This arrangement is beneficial to reduce the signal crosstalk between two

adjacent plug terminal modules **2**. The first extension wall **12** and the second extension wall **13** are provided with a plurality of first installation slots **14** for receiving the plurality of plug terminal modules **2**. The first extension wall **12** and the second extension wall **13** are respectively provided with positioning protrusions **15** protruding beyond the mating surface **111**. The first extension wall **12** is provided with a plurality of first locking grooves **121** extending upwardly through the first extension wall **12**.

(56) The second extension wall **13** is provided with a plurality of second locking grooves **131** extending downwardly through the second extension wall **13**. The first locking grooves **121** and the second locking grooves **131** are used to lock the plug terminal module **2** so as to prevent the plug terminal modules **2** from escaping from the plug housing **1**.

(57) Referring to FIGS. **13** to **16**, each plug terminal module **2** includes an insulating bracket **21** inserted into the first installation slot **14**, a plurality of plug conductive terminals **22** fixed to the insulating bracket **21**, and a metal shield located at least on one side of the insulating bracket **21**. In the illustrated embodiment of the present disclosure, the metal shield includes a first metal shield **23** fixed on one side (i.e., a left side) of the insulating bracket **21** and a second metal shield **24** fixed on the other side (i.e., a right side) of the insulating bracket **21**.

(58) Referring to FIG. **16**, the insulating bracket **21** is roughly frame-shaped. The insulating bracket **21** includes a rear wall **211**, a front wall **212** opposite to the rear wall **211**, a top wall **213** connecting one side of the rear wall **211** and one side of the front wall **212**, a bottom wall **214** connecting the other side of the rear wall **211** and the other side of the front wall **212**, and a plurality of connecting walls **215**. The connecting wall **215** is capable of enhancing the structural strength of the frame. The rear walls **211** of the insulating brackets **21** include a plurality of first protrusions **2111** protruding backwardly and spaced apart from each other in the left-right direction. The top walls **213** of the insulating brackets **21** includes a plurality of second protrusions **2130** protruding upwardly and spaced apart from each other in the left-right direction. Referring to FIG. **13**, in the illustrated embodiment of the present disclosure, each plug terminal module **2** includes two second protrusions **2130** which are spaced apart from each other along the front-rear direction. The second protrusions **2130** of two adjacent plug terminal modules **2** are staggered in the front-rear direction. That is, the second protrusions **2130** at the corresponding positions of two adjacent plug terminal modules **2** are not in alignment with each other in the left-right direction. An extending direction (i.e., the top-bottom direction) of the first protrusion **2111** is perpendicular to an extending direction (i.e., the front-rear direction) of the second protrusion **2130**.

(59) Besides, the insulating bracket **21** further includes a plurality of third protrusions **2112** disposed at intervals from the first protrusions **2111**. The first protrusions **2111** and the corresponding third protrusions **2112** are in alignment with each other along the top-bottom direction. The first protrusion **2111** includes a first constriction portion **2113**, and the third protrusion **2112** includes a second constriction portion **2114**. In the illustrated embodiment of the present disclosure, the insulating bracket **21** has a hollow portion **210**. The connecting walls **215** include a first connecting wall **2151** connecting the top wall **213** and the bottom wall **214**, and a second connecting wall **2152** connecting the rear wall **211** and the bottom wall **214**. The first connecting wall **2151** and the second connecting wall **2152** are disposed obliquely. One ends of the first connecting wall **2151** and the second connecting wall **2152** are adjacent to each other, and the other ends are spread out so as to form a radial shape. The connecting walls **215** further include a first reinforcing wall **2153** connecting the top wall **213** and the bottom wall **214**. The first reinforcing wall **2153** is parallel to the first front wall **212**. Referring to FIG. **16**, a width of the first reinforcing wall **2153** is smaller than a width of the first front wall **212**. The first connecting wall **2151** and the second connecting wall **2152** are exposed in the hollow portion **210**. The top wall **213** includes a first locking protrusion **2131** for being locked in the first locking groove **121**. The bottom wall **214** includes a second locking protrusion **2141** for being locked in the second locking groove **131**.

(60) Referring to FIGS. **14** to **16**, the insulating bracket **21** further includes a plurality of posts **216** for fixing the first metal shield **23** and the second metal shield **24**. In the illustrated embodiment of the present disclosure, the posts **216** are substantially cylindrical. In the illustrated embodiment of the present disclosure, the posts **216** are disposed on the bottom wall **214**, the first connecting wall **2151**, the second connecting wall **2152**, the first reinforcing wall **2153** and the front wall **212**. The first metal shield **23** and the second metal shield **24** are respectively located on opposite sides of the insulating bracket **21**. The posts **216** include a plurality of first posts **2161** and a plurality of second posts **2162**. The first posts **2161** and the second posts **2162** are respectively disposed on opposite sides of the insulating bracket **21** so as to be fixed and positioned with the first metal shield **23** and the second metal shield **24**, respectively.

(61) Referring to FIG. **16**, each group of plug conductive terminals **22** includes a mating portion **221**, a tail portion **222** and a first connection portion **223** connecting the mating portion **221** and the tail portion **222**. The mating portions **221** extend beyond the insulating bracket **21**. Some of the mating portions **221** are adapted to electrically connect with the receptacle connector assembly **400**. The tail portions **222** are used for being mounted to the circuit board **301**. In the illustrated embodiment of the present disclosure, the mating portion **221** is substantially perpendicular to the tail portion **222**. The first connection portion **223** is curved. Specifically, the first connection portion **223** includes a first section **223***a* parallel to the mating portion **221**, a second section **223***b* parallel to the tail portion **222**, and a third section **223***c* connecting the first section **223***a* and the second section **223***b*. Referring to FIG. **16**, the first section **223***a* extends horizontally, the second section **223***b* extends vertically, and the third section **223***c* extends obliquely.

(62) Each group of plug conductive terminals **22** include a plurality of first ground terminals G**1**, a plurality of second ground terminals G**2**, and a plurality of first signal terminals S**1**. In the illustrated embodiment of the present disclosure, two adjacent first signal terminals S**1** form a pair of first differential signal terminals. Each pair of first differential signal terminals are located between one first ground terminal G**1** and one second ground terminal G**2**. That is, each group of plug conductive terminals **22** are disposed in a manner of G**1**-S**1**-S**1**-G**2**, which is beneficial to improve the quality of signal transmission. The first differential signal terminals are narrow-side coupling or wide-side coupling. A width of the first ground terminal G**1** and a width the second ground terminal G**2** are greater than a width of each first signal terminal S**1** which is located between the first ground terminal G**1** and the second ground terminal G**2**. Therefore, it is beneficial to increase the shielding area and improve the shielding effect. The mating portion **221** of the first differential signal terminal is exposed in the corresponding terminal mating groove **112**. In some embodiments of the present disclosure, the plug cable **302** may also be directly electrically connected to the first differential signal terminal. Compared with a circuit board, by having the first differential signal terminal directly transmit data through the plug cable **302**, it is beneficial to improve the speed and quality of data transmission.

(63) In the illustrated embodiment of the present disclosure, the first connection portions **223** of the plug conductive terminals **22** are insert-molded with the insulating bracket **21**. The first connection portions **223** of the differential signal terminals, the first connection portion **223** of the first ground terminal G**1** and the first connection portion **223** of the second ground terminal G**2** are all exposed in the same hollow portion **210**. Each first connection portion **223** of the first signal terminals S**1** includes a narrowed portion **2230** insert-molded with the insulating bracket **21** so as to adjust the impedance of the first signal terminals S**1** for achieving impedance matching. In the illustrated embodiment of the present disclosure, the mating portions **221** of the first signal terminals S**1** are substantially needle-shaped. The mating portions **221** of the first ground terminal G**1** and the second ground terminal G**2** are substantially rectangular-shaped. The mating portions **221** of the first signal terminals S**1** and the first connection portions **223** of the plug conductive terminals **22** are coplanar, which means they are located in a first plane (i.e., a horizontal plane). It should be noted that the technical term “coplanar” used in the present disclosure is intended to indicate that

related components are substantially flush, which includes situations of incomplete coplanarity caused by manufacturing tolerances. However, in the illustrated embodiment of the present disclosure, the first ground terminal G**1** includes a first torsion portion **2241** connected between its mating portion **221** and its first section **223***a*, so that the mating portion **221** of the first ground terminal G**1** is located in a second plane (i.e., a vertical plane) perpendicular to the first plane. The second ground terminal G**2** includes a second torsion portion **2242** connected between its mating portion **221** and its first section **223***a*, so that the mating portion **221** of the second ground terminal G**2** is also located in the second plane (i.e., the vertical plane) perpendicular to the first plane. The mating portion **221** of the first ground terminal G**1** and the mating portion **221** of the second ground terminal G**2** are parallel to each other.

(64) As shown in FIG. **16**, each plug terminal module **2** includes multiple pairs of first differential signal terminals in order to increase the speed of signal transmission. Among the first differential signal terminals in different pairs, an average length of the first differential signal terminals located on an outer side is greater than an average length of the first differential signal terminals located on an inner side. Among the first differential signal terminals in a same pair, a length of the first signal terminal S**1** located on an outer side is greater than a length of the first signal terminal S**1** located on an inner side.

(65) Referring to FIGS. **12** to **16**, in the illustrated embodiment of the present disclosure, each plug terminal module **2** is located in a vertical plane as a whole. The first ground terminals G**1**, the first differential signal terminals, and the second ground terminals G**2** are stacked and separated by a certain distance in the vertical plane. The first differential signal terminals are divided into least three pairs. Each pair of the first differential signal terminals is located between one first ground terminal G**1** and one second ground terminal G**2**. In the illustrated embodiment of the present disclosure, the number of the plug terminal modules **2** is at least five and they are arranged side by side. Any two adjacent plug terminal modules **2** are arranged next to each other. That is, a front end (a mating end) of each plug terminal module **2** is close to the adjacent plug terminal module **2**.

(66) Referring to FIGS. **17** to **19**, in the illustrated embodiment of the present disclosure, the spacer **3** is made of a metal material or an insulating material. The spacer **3** is used to assemble the plurality of plug terminal modules **2** together. The spacer **3** includes a first body portion **31**, a second body portion **32**, a bending portion **33** connecting the first body portion **31** and the second body portion **32**, and a protruding piece **34** extending downwardly from the first body portion **31**. The first body portion **31** is perpendicular to the second body portion **32**. The first body portion **31** includes a plurality of first slots **311** for holding the first protrusions **2111**. The second body portion **32** includes a plurality of second slots **321** for holding the second protrusions **2130**. The protrusion piece **34** is provided with a plurality of slits **341** corresponding to the third protrusions **2112**, so that the protrusion piece **34** is substantially comb-shaped. Each first slot **311** is a closed slot, which means a periphery of the first slot **311** is surrounded by the first body portion **31**. Each slit **341** is a non-closed slit, which means one end (i.e., a bottom end) of the slit **341** is opened. The slits **341** and the corresponding first slots **311** are spaced apart and aligned along the top-bottom direction. The first slot **311** includes a first slit **3111** and a second slit **3112** having a width larger than the first slit **3111**. The first slit **3111** is located above the second slit **3112** and communicates with the second slit **3112**. The slit **341** is located below the second slit **3112**. The bending portion **33** includes with a plurality of openings **331** spaced apart along the left-right direction, so as to facilitate bending and control bending accuracy.

(67) When assembling the spacer **3** to the plurality of plug terminal modules **2**, firstly, the second slits **3112** of the spacer **3** correspond to the first protrusions **2111** along an extending direction of the mating portions **221**, and the first protrusions **2111** pass through the second slits **3112**. At this time, the second slots **321** are located above the second protrusions **2130**. The second slots **321** and the second protrusions **2130** are in alignment with each other in a vertical direction. Then, the spacer **3** is moved downwardly along an extending direction of the tail portions **222**, so that the

first constriction portions **2113** are tightly clamped in the first slits **3111**. At the same time, the second protrusions **2130** are positioned in the second slots **321**. The second constriction portions **2114** of the third protrusions **2112** are tightly clamped in the slits **341** so as to achieve multiple fixation and improve reliability. With this arrangement, all the plug terminal modules **2** can be combined into a whole by the spacer **3** in order to prevent loosening. In addition, the plug terminal modules **2** can be prevented from being separated from the spacer **3** along the extending direction of the mating portions **221**. At the same time, distances between the plug terminal modules **2** can be effectively controlled. Through the mating of the second protrusions **2130** and the second slots **321**, the retaining piece **3** can be prevented from falling off by an external force in a horizontal direction, thereby the structural reliability of the plug connector **100** is improved.

(68) Referring to FIGS. **18** and **19**, the mounting block **4** includes a plurality of through holes **41** for allowing the tail portions **222** of the plug conductive terminals **22** to pass through. Preferably, the mounting block **4** is made of electroplated plastic in order to further improve the shielding effect.

(69) Referring to FIGS. **20** and **23**, in the illustrated embodiment of the present disclosure, the mating portion **221** and the first connection portion **223** of the first ground terminal G**1** have a first wide surface **221***a* and a first narrow surface **221***b* perpendicular to the first wide surface **221***a*. The mating portion **221** and the first connection portion **223** of the second ground terminal G**2** have a second wide surface **221***c* and a second narrow surface **221***d* perpendicular to the second wide surface **221***c*. The first connection portions **223** of each pair of first differential signal terminals are located between the first narrow surface **221***b* of the first ground terminal G**1** and the second narrow surface **221***d* of the second ground terminal G**2** which are located on opposite sides of the first connection portions **223** of each pair of first differential signal terminals. The mating portions **221** of each pair of first differential signal terminals are located between the first wide surface **221***a* of the first ground terminal G**1** and the second wide surface **221***c* of the second ground terminal G**2** which are located on opposite sides of the mating portions **221** of each pair of first differential signal terminals. In the illustrated embodiment of the present disclosure, a width of the first wide surface **221***a* and a width of the second wide surface **221***c* are greater than a width of each mating portion **221** of the first signal terminals S**1**, thereby better shielding can be provided for the mating portions **221** of the first signal terminals S**1**.

(70) In the illustrated embodiment of the present disclosure, the first metal shield **23** and the second metal shield **24** are symmetrically disposed on opposite sides of the first insulating bracket **21**. Referring to FIG. **24**, the first metal shield **23** includes a first main body portion **231** and a first extension portion **232** extending from the first main body portion **231**. The first main body portion **231** is located on one side of the first connection portions **223** of the first plug conductive terminals **22**. The first extension portion **232** is located on one side of the mating portions **221** of the first plug conductive terminals **22**. In the illustrated embodiment of the present disclosure, the first extension portion **232** and the first main body portion **231** are located in different planes, in which the first extension portion **232** is farther away from the second metal shield **24** than the first main body portion **231**. The first main body portion **231** includes a plurality of first mounting holes **2311** for mating with the plurality of first posts **2161**. The first posts **2161** are fixed and positioned in the first mounting holes **2311** by soldering, thereby the fixing and positioning of the first metal shield **23** and the first insulating bracket **21** are realized. The first main body portion **231** includes a plurality of ribs **233**. The ribs **233** include a plurality of first ribs **2331** protruding toward the first ground terminals G**1** and a plurality of second ribs **2332** protruding toward the second ground terminals G**2**. The first ribs **2331** corresponding to the first ground terminal G**1** are disposed along an extending direction of the first connection portion **223** of the first ground terminal G**1**. The second ribs **2332** corresponding to the second ground terminal G**2** are disposed along an extending direction of the first connection portion **223** of the second ground terminal G**2**. In the illustrated embodiment of the present disclosure, the first ribs **2331** and the second ribs **2332** are formed by

stamping the first main body portion **231**. The first ribs **2331** and the second ribs **2332** protrude toward the second metal shield **24**. The first ribs **2331** and the second ribs **2332** are discontinuously disposed along the extending direction of the first connection portion **223** of the first ground terminal G**1** and the extending direction of the first connection portion **223** of the second ground terminal G**2**, respectively, so as to achieve multi-position contact. In order to improve the reliability of the contact between the first metal shield **23** and the first ground terminals G**1** and the second ground terminals G**2**, in the illustrated embodiment of the present disclosure, referring to FIG. **21**, a wall thickness of the first rib **2331**, a wall thickness of the second rib **2332**, and a wall thickness of a portion of the first main body portion **231** located between the first rib **2331** and the second rib **2332** are the same. Specifically, each of the first ribs **2331** and the second ribs **2332** includes a first rib section **233***a* parallel to the mating portion **221**, a second rib section **233***b* parallel to the tail portion **222**, and a third rib section **233***c* connecting the first rib section **233***a* and the second rib section **233***b*. Referring to FIG. **20**, the first rib section **233***a* extends horizontally, the second rib section **233***b* extends vertically, and the third rib section **233***c* extends obliquely. The first rib section **233***a*, the second rib section **233***b* and the third rib section **233***c* are in contact with the first section **223***a*, the second section **223***b* and the third section **223***c* of the first ground terminal G**1** and the second ground terminal G**2**, respectively.

(71) The first extension portion **232** includes a plurality of first bulges **2321** protruding toward the corresponding mating portions **221** of the first ground terminals G**1**, a plurality of second bulges **2322** protruding toward the corresponding mating portions **221** of the second ground terminals G**2**, and a plurality of first elastic pieces **2323** each of which is located between adjacent first bulge **2321** and second bulge **2322**. The first elastic pieces **2323** extend along directions toward the first main body portion **231**. Each first elastic piece **2323** has an arc-shaped contact portion **2324**. In the illustrated embodiment of the present disclosure, the first extension portion **232** further includes two first protruding tabs **2325** located at opposite sides of each first elastic piece **2323**. The first protruding tabs **2325** and the first elastic pieces **2323** extend along opposite directions. The first protruding tabs **2325** protrude sidewardly to contact the second metal shield **24** of the adjacent plug terminal module **2** so as to improve the shielding effect. In the illustrated embodiment of the present disclosure, referring to FIG. **23**, a wall thickness of the first bulge **2321**, a wall thickness of the second bulge **2322** and a wall thickness of a portion of the first extension portion **232** located between the first bulge **2321** and the second bulge **2322** are the same.

(72) Similarly, referring to FIG. **25**, the second metal shield **24** includes a second main body portion **241** and a second extension portion **242** extending from the second main body portion **241**. The second main body portion **241** is located on the other side of the first connection portions **223** of the plug conductive terminals **22**. The second extension portion **242** is located on the other side of the mating portions **221** of the plug conductive terminals **22**. In the illustrated embodiment of the present disclosure, the second extension portion **242** and the second main body portion **241** are located in different planes, in which the second extension portion **242** is farther away from the first metal shield **23** than the second main body portion **241**. The second main body portion **241** includes a plurality of second mounting holes **2411** for mating with the plurality of second posts **2162**. The second posts **2162** are fixed and positioned in the second mounting holes **2411** by soldering, so as to realize the fixing and positioning of the second metal shield **24** and the first insulating bracket **21**. The second main body portion **241** includes a plurality of ribs **243**. The ribs **243** include a plurality of third ribs **2431** protruding toward the first ground terminals G**1** and a plurality of fourth ribs **2432** protruding toward the second ground terminals G**2**. The third ribs **2431** are disposed along the extending direction of the first connection portion **223** of the first ground terminal G**1**. The fourth ribs **2432** are disposed along the extending direction of the first connection portion **223** of the second ground terminal G**2**. In the illustrated embodiment of the present disclosure, the third ribs **2431** and the fourth ribs **2432** are formed by stamping the second main body portion **241**. The third ribs **2431** and the fourth ribs **2432** protrude toward the first metal

shield **23**. The third ribs **2431** and the fourth ribs **2432** are discontinuously disposed along the extending direction of the first connection portion **223** of the first ground terminal G**1** and the extending direction of the first connection portion **223** of the second ground terminal G**2**, respectively, so as to achieve multi-position contact. As a result, the reliability of the contact between the second metal shield **24** and the first ground terminals G**1** and the second ground terminals G**2** is improved. In the illustrated embodiment of the present disclosure, a wall thickness of the third rib **2431**, a wall thickness of the fourth rib **2432** and a wall thickness of a portion of the second main body portion **241** located between the third rib **2431** and the fourth rib **2432** are the same. Specifically, each of the third rib **2431** and the fourth rib **2432** includes a first rib section **243***a* parallel to the mating portion **221**, a second rib section **243***b* parallel to the tail portion **222**, a third rib section **243***c* connecting the first rib section **243***a* and the second rib section **243***b*. Referring to FIG. **25**, the first rib section **243***a* extends horizontally, the second rib section **243***b* extends vertically, and the third rib section **243***c* extends obliquely. The first rib section **243***a*, the second rib section **243***b* and the third rib section **243***c* are in contact with the first section **223***a*, the second section **223***b* and the third section **223***c* of the first ground terminal G**1** and the second ground terminal G**2**, respectively. In an embodiment of the present disclosure, soldering is performed on the surfaces of the ribs **233** and the ribs **243** to solder the ribs **233** and the ribs **243** to the first ground terminals G**1** and the second ground terminals G**2**. I.e., soldering is performed on the surfaces of the first ribs **2331**, the second ribs **2332**, the third ribs **2431** and the fourth ribs **2432** in order to solder the first ribs **2331**, the second ribs **2332**, the third ribs **2431** and the fourth rib **2432** to the first ground terminals G**1** and the second ground terminals G**2**. The soldering method is at least one of spot soldering, laser soldering and ultrasonic soldering. Preferably, the first rib **2331**, the second rib **2332**, the third rib **2431** and the fourth rib **2432** include through holes to expose the corresponding first ground terminal G**1** and the corresponding second ground terminal G**2**, thereby facilitating soldering.

(73) The second extension portion **242** includes a plurality of third bulges **2421** protruding toward the mating portions **221** of the first ground terminals G**1**, a plurality of fourth bulges **2422** protruding toward the mating portions **221** of the second ground terminals G**2**, and a plurality of second elastic pieces **2423** each of which is located between adjacent third bulge **2421** and fourth bulge **2422**. The second elastic pieces **2423** extend along directions toward the second main body portion **241**. Each second elastic piece **2423** has an arc-shaped contact portion **2424**. In the illustrated embodiment of the present disclosure, the second extension portion **242** further includes two second protruding tabs **2425** located at opposite sides of each second elastic piece **2423**. The second protruding tabs **2425** and the second elastic pieces **2423** extend along opposite directions. The second protruding tabs **2425** protrude sidewardly to contact the first metal shield **23** of the adjacent plug terminal module **2** so as to improve the shielding effect. In the illustrated embodiment of the present disclosure, a wall thickness of the third bulge **2421**, a wall thickness of the fourth bulge **2422**, and a wall thickness of a portion of the second extension portion **242** located between the third bulge **2421** and the fourth bulge **2422** are the same.

(74) Referring to FIG. **21**, along a length of the first connection portion **223** of the plug conductive terminal **22**, the first rib **2331** of the first metal shield **23** and the third rib **2431** of the second metal shield **24** respectively contact two opposite sides of the first connection portion **223** of the first ground terminal G**1**, and the second rib **2332** of the first metal shield **23** and the fourth rib **2432** of the second metal shield **24** respectively contact two opposite sides of the first connection portion **223** of the second ground terminal G**2**, thereby forming the shielding cavity **26** surrounding the outer periphery of the first connection portions **223** of each pair of first differential signal terminals. In the illustrated embodiment of the present disclosure, the first rib **2331** and the third rib **2431** respectively contact the first wide surface **221***a* of the first connection portion **223** of the first ground terminal G**1**. The second rib **2332** and the fourth rib **2432** respectively contact the second wide surface **221***c* of the first connection portion **223** of the second ground terminal G**2**. In the

illustrated embodiment of the present disclosure, the shielding cavity **26** is jointly formed by the first main body portion **231**, the second main body portion **241**, the first ground terminal G**1** and the second ground terminal G**2**. The first connection portion **223** of the first ground terminal G**1** includes a first tab portion **2234** protruding into the shielding cavity **26**. The first connection portion **223** of the second ground terminal G**2** includes a second tab portion **2235** protruding into the shielding cavity **26**. The first connection portions **223** of the first differential signal terminals are located between the first tab portion **2234** and the second tab portion **2235**. In the illustrated embodiment of the present disclosure, there are a plurality of the shielding cavities **26** which are disposed along an arrangement direction of each group of the plug conductive terminals **22**. Two adjacent shielding cavities **26** share a single first ground terminal G**1** or a single second ground terminal G**2**. In addition, a part of the shared first ground terminal G**1** protrudes into one shielding cavity **26**, and another part of the shared first ground terminal G**1** protrudes into another shielding cavity **26**.

(75) Referring to FIG. **23**, in the length of the mating portion **221** of the plug conductive terminal **22**, the first bulge **2321** of the first metal shield **23** and the third bulge **2421** of the second metal shield **24** respectively contact two opposite side surfaces of the mating portion **221** of the first ground terminal G**1**, and the second bulge **2322** of the first metal shield **23** and the fourth bulge **2422** of the second metal shield **24** respectively contact two opposite side surfaces of the mating portion **221** of the second ground terminal G**2**. In the illustrated embodiment of the present disclosure, the first bulge **2321** of the first metal shield **23** and the third bulge **2421** of the second metal shield **24** respectively contact the first narrow surfaces **221***b* of the mating portion **221** of the first ground terminal G**1**. The second bulge **2322** of the first metal shield **23** and the fourth bulge **2422** of the second metal shield **24** respectively contact the second narrow surfaces **221***d* of the mating portion **221** of the second ground terminal G**2**. The first extension portion **232**, the second extension portion **242**, the first ground terminal G**1** and the second ground terminal G**2** jointly form a shielding space **27** for accommodating the corresponding mating portions **221** of the first differential signal terminals. The first elastic piece **2323** and the second elastic piece **2423** extend into the shielding space **27**. In the illustrated embodiment of the present disclosure, there are multiple shielding spaces **27** which are disposed along a stacking direction of each group of the plug conductive terminals **22**. Two adjacent shielding spaces **27** share a single first ground terminal G**1** or a single second ground terminal G**2**. One first wide surface **221***a* of the mating portion **221** of the shared first ground terminal G**1** is exposed to the shielding space **27**, and the other first wide surface **221***a* of the mating portion **221** of the shared first ground terminal G**1** is exposed to an adjacent shielding space **27**. Similarly, a first wide surface **221***c* of the mating portion **221** of the shared second ground terminal G**2** is exposed to the adjacent shielding space **27**, and the other wide surface **221***c* of the mating portion **221** of the shared second ground terminal G**2** is exposed to another adjacent shielding space **27**. The first protruding tabs **2325** and the second protruding tabs **2425** are inclined in a direction away from the shielding space **27** to facilitate contact with the adjacent plug terminal modules **2**.

(76) In the illustrated embodiment of the present disclosure, there are multiple first plug terminal modules **2** of the plug connector **100**, and the terminal arrangement of two adjacent plug terminal modules **2** are staggered. Correspondingly, the shielding cavities **26** at the same position of two adjacent plug terminal modules **2** are staggered (referring to FIG. **20**), and the shielding spaces **27** at the same position of two adjacent plug terminal modules **2** are staggered (referring to FIG. **22**).

(77) The first extension portion **232** and/or the second extension portion **242** include limiting structures which restrict the mating portions **221** of the first ground terminal G**1** and/or the mating portions **221** of the second ground terminal G**2** in the front-rear direction and/or the top-bottom direction.

(78) Specifically, as shown in FIGS. **14**, **15**, and **26** to **29**, the mating portion **221** of the first ground terminal G**1** includes a first limiting slot **2211** and a third limiting slot **2213** opposite to the first

limiting slot **2211**. The first limiting slot **2211** and the third limiting slot **2213** are symmetrically disposed on opposite sides of the mating portion **221** of the first ground terminal G**1**. The first limiting slot **2211** and the third limiting slot **2213** extend through the first narrow surfaces **221***b* of the first ground terminal G**1**, respectively. In the illustrated embodiment of the present disclosure, an angle between the first limiting slot **2211** and the front-rear direction, and an angle between the third limiting slot **2213** and the front-rear direction are approximately 45 degrees. Similarly, the mating portion **221** of the second ground terminal G**2** includes a second limiting slot **2212** and a fourth limiting slot **2214** opposite to the second limiting slot **2212**. The second limiting slot **2212** and the fourth limiting slot **2214** are symmetrically disposed on opposite sides of the mating portion **221** of the second ground terminal G**2**. The second limiting slot **2212** and the fourth limiting slot **2214** extend through the second narrow surfaces **221***d* of the second ground terminal G**2**, respectively. In the illustrated embodiment of the present disclosure, an angle between the second limiting slot **2212** and the front-rear direction, and an angle between the fourth limiting slot **2214** and the front-rear direction are approximately 45 degrees.

(79) The first extension portion **232** includes a first limiting protrusion **2326** locked in the first limiting slot **2211** and a second limiting protrusion **2327** locked in the second limiting slot **2212**. Each of the first limiting protrusion **2326** and the second limiting protrusion **2327** forms an angle of 45 degrees with respect to a vertical plane. Similarly, the second extension portion **242** includes a third limiting protrusion **2426** locked in the third limiting slot **2213** and a fourth limiting protrusion **2427** locked in the fourth limiting slot **2214**. Each of the third limiting protrusion **2426** and the fourth limiting protrusion **2427** forms an angle of 45 degrees with respect to the vertical plane. The first limiting protrusion **2326** and the third limiting protrusion **2426** are symmetrically disposed on opposite sides of the mating portion **221** of the first ground terminal G**1**. The first limiting protrusion **2326** and the third limiting protrusion **2426** are adapted to restrict the mating portion **221** of the first ground terminal G**1** in the front-rear direction to prevent it from moving backwardly. The second limiting protrusion **2327** and the fourth limiting protrusion **2427** are symmetrically disposed on opposite sides of the mating portion **221** of the second ground terminal G**2**. The second limiting protrusion **2327** and the fourth limiting protrusion **2427** are adapted to restrict the mating portion **221** of the second ground terminal G**2** in the front-rear direction.

(80) In the illustrated embodiment of the present disclosure, the first limiting protrusion **2326** is located at a front free end of the first bulge **2321** and is integrally stamped from the first bulge **2321**. The second limiting protrusion **2327** is located at a front free end of the second bulge **2322** and is integrally stamped from the second bulge **2322**. The third limiting protrusion **2426** is located at a front free end of the third bulge **2421** and is integrally stamped from the third bulge **2421**. The fourth limiting protrusion **2427** is located at a front free end of the fourth bulge **2422** and is integrally stamped from the fourth bulge **2422**.

(81) In addition, the first extension portion **232** further includes two first clamping blocks **2326***a* and two second clamping blocks **2327***a*. The two first clamping blocks **2326***a* include a first clamping groove **2326***b* for restricting the mating portion **221** of the first ground terminal G**1** in the vertical direction. The two second clamping blocks **2327***a* include a second clamping groove **2327***b* for restricting the mating portion **221** of the second ground terminal G**2** in the vertical direction. Similarly, the second extension portion **242** further includes two third clamping blocks **2426***a* and two fourth clamping blocks **2427***a*. The two third clamping blocks **2426***a* include a third clamping groove **2426***b* for restricting the mating portion **221** of the first ground terminal G**1** in the vertical direction. The two fourth clamping blocks **2427***a* include a fourth clamping groove **2427***b* for restricting the mating portion **221** of the second ground terminal G**2** in the vertical direction.

(82) Of course, in other embodiments, the first clamping block **2326***a*, the second clamping block **2327***a*, the third clamping block **2426***a* and the fourth clamping block **2427***a* can also be provided as one which is used to abut against the corresponding mating portions **221** of the first ground terminal G**1** and the second ground terminal G**2** in the vertical direction so as to achieve position

restriction. In the illustrated embodiment of the present disclosure, the first clamping block **2326***a* is located at a front end of the first limiting protrusion **2326**. The second clamping block **2327***a* is located at a front end of the second limiting protrusion **2327**. The third clamping block **2426***a* is located at a front end of the third limiting protrusion **2426**. The fourth clamping block **2427***a* is located at a front end of the fourth limiting protrusion **2427**.

(83) Referring to FIGS. **30** to **35**, the receptacle connector assembly **400** includes a metal cage **8** and a receptacle connector **200** at least partially located in the metal cage **8**. The metal cage **8** includes a second end surface **80** and a mating space **801** extending through the second end surface **80**. The receptacle connector **200** is located at a rear end of the mating space **801** and communicates with the mating space **801**. In an embodiment of the present disclosure, the receptacle connector **200** is a backplane connector.

(84) The metal cage **8** includes a second top wall **81**, a second bottom wall **82**, a third side wall **83**, a fourth side wall **84** and a rear wall **87**. The mating space **801** is enclosed by the second top wall **81**, the second bottom wall **82**, the third side wall **83** and the fourth side wall **84**. The third side wall **83** and the fourth side wall **84** are provided with abutting elastic arms **88** protruding into the mating space **801** to abut against the metal shell **5** of the plug connector **100**. The receptacle connector assembly **400** also includes grounding elastic arms **85** fixed to the second top wall **81**, the second bottom wall **82**, the third side wall **83**, and the fourth side wall **84**, respectively. The grounding elastic arms **85** are disposed adjacent to the second end surface **80**.

(85) The receptacle connector assembly **400** further includes a receptacle heat sink **86** fixed to the second top wall **81** and/or the second bottom wall **82** to improve the heat dissipation effect.

(86) Referring to FIGS. **36** to **38**, the receptacle electrical connector **200** includes a receptacle housing **7** and a plurality of receptacle terminal modules **6** mounted to the receptacle housing **7**. The reason why the plug connector **100** is such called is because it is a component of the plug connector assembly **300**. The reason why the receptacle connector **200** is such called is because it is a component of the receptacle connector assembly **400**. So, it does not necessarily mean that the plug connector **100** must have some unique features to be a plug connector, and it does not necessarily mean that the receptacle connector **200** must have some unique features to be a receptacle connector. It is understandable to those of ordinary skill in the art that the plug connector **100** and the receptacle electrical connector **200** are exchangeable. For example, when the receptacle connector **200** is applied in the plug connector assembly **300**, it is then called a plug connector; and when the plug connector **100** is applied in the receptacle connector assembly **400**, it is then called a receptacle connector.

(87) The receptacle housing **7** is made of insulating material, and includes a body portion **71**, a first extension wall **72** extending from the body portion **71** to one end, and a second extension wall **73** extending from the body portion **71** to the other end. The body portion **71** includes a plurality of terminal receiving grooves **711** extending along a front-rear direction. In the illustrated embodiment of the present disclosure, the terminal receiving grooves **711** are disposed in multiple rows along a left-right direction. Two adjacent rows of terminal receiving grooves **711** are staggered in a vertical direction. That is, the terminal receiving grooves **711** at corresponding positions in the two adjacent rows of terminal receiving grooves **711** are not aligned in the left-right direction. The first extension wall **72** includes a first extension wall portion **74** and a second extension wall portion **75** opposite to each other. The second extension wall **73** includes a receiving space **735** which is used for at least partially receiving the plug electrical connector **100**. The first extension wall portion **74** and the second extension wall portion **75** are provided with a plurality of second installation slots **76** for installing the receptacle terminal modules **6**. The first extension wall portion **74** and the second extension wall portion **75** further include positioning slots **77** for positioning the positioning protrusions **15**.

(88) Referring to FIG. **38**, each receptacle terminal module **6** includes a plurality of insulating blocks **65**, a plurality of terminal modules **60** mounted to the insulating blocks **65**, a grounding

element, a metal shielding plate **67** for cooperating with the grounding element, a plurality of receptacle cables **68** electrically connected to the terminal modules **60**, and an outer covering portion **69** partially covering the terminal modules **60**, the grounding element, the metal shielding plate **67** and the receptacle cables **68**. In the illustrated embodiment of the present disclosure, the grounding element includes a plurality of metal shield surrounding members **66** sleeved on the insulating blocks **65** and the terminal modules **60**. The receptacle cables **68** extend through the rear wall **87** of the metal cage **8**. In some other embodiments, the receptacle terminal module **6** may not include receptacle cables **68**. Under such condition, the receptacle electrical connector **200** is located at the rear of the mating space **801**, but in front of the rear wall **87**. It is understandable to those of ordinary skill in the art that the mating space **801** is configured to receive the plug connector **100** before the plug conductive terminals **22** of the plug connector **100** are electrically connected with receptacle conductive terminals **62** of the receptacle electrical connector **200**.

(89) The terminal module **60** includes an insulating member **61** and a plurality of receptacle conductive terminals **62** fixed to the insulating member **61**. In an embodiment of the present disclosure, the receptacle conductive terminals **62** are insert-molded with the insulating member **61**. Of course, in other embodiments, the receptacle conductive terminals **62** may also be fixed to the insulating member **61** by assembly. In a preferred embodiment of the present disclosure, each receptacle conductive terminal **62** is connected with a corresponding receptacle cable **68**. In other words, none of the receptacle conductive terminals **62** is directly connected to a circuit board. Compared to transmit signals through the circuit board, by transmitting signals, especially differential signals, through cables, it is more beneficial to reduce signal distortion and improve signal transmitting quality.

(90) From a structural point of view, each receptacle conductive terminal **62** includes a contact arm **621**, an end portion **622**, and a second connection portion **623** connecting the contact arm **621** and the end portion **622**. The second connection portion **623** is fixed to the insulating member **61**. The contact arm **621** extends forwardly and protrudes beyond the insulating member **61** so as to be electrically connected to the first signal terminal S**1** of the plug connector **100**. The end portion **622** extends backwardly and protrudes beyond the insulating member **61** to be electrically connected to the receptacle cable **68**. In the illustrated embodiment of the present disclosure, each receptacle conductive terminal **62** is substantially in a shape of a straight bar and extends in the front-to-rear direction.

(91) In an embodiment of the present disclosure, the receptacle conductive terminals **62** in each terminal module **60** form a pair of second differential signal terminals to increase the signal transmission rate. In other words, the plurality of receptacle conductive terminals **62** of each terminal module **60** include a first signal terminal and a second signal terminal. The first signal terminal and the second signal terminal form a differential pair and are fixed to the insulating member **61**.

(92) Each insulating block **65** is provided with two through holes **651** into which the contact arms **621** of the receptacle conductive terminals **62** are inserted, and a mating surface **652** at an end of the insulating block **65**. The through holes **651** extend through the mating surface **652**. In the illustrated embodiment of the present disclosure, the insulating block **65** has a substantially cuboid shape. Correspondingly, the metal shield surrounding member **66** has a substantially cuboid shape. In an embodiment of the present disclosure, the insulating block **65** is fixed in the metal shield surrounding member **66** by soldering. Of course, in other embodiments, the insulating block **65** may also be fixed in the metal shield surrounding member **66** in other ways, i.e., by mechanical fixation.

(93) Referring to FIG. **38**, the metal shield surrounding member **66** includes a cylindrical portion **661**, an extended portion **662** connected to the cylindrical portion **661**, and an abutting portion **663** connected to the extended portion **662**. The cylindrical portion **661** is provided with a shielding cavity **6610** for accommodating the insulating block **65** and the terminal module **60** in order to

improve the shielding effect. A cross section of the extended portion **662** is substantially U-shaped.
(94) The metal shielding plate **67** is arranged opposite to the extended portion **662**, and the metal shielding plate **67** is in contact with the metal shield surrounding member **66** so as to improve the grounding shielding effect.
(95) Referring to FIG. **38**, each receptacle cable **68** includes a core **681** electrically connected to the end portion **622** of the second differential signal terminal, an insulating layer **682** wrapped on the core **681**, a shielding layer **683** wrapped on the insulating layer **682**, an insulating outer layer **684** wrapped on part of the shielding layer **683**, and a grounding wire **685** located between the shielding layer **683** and the insulating outer layer **684**. In an embodiment of the present disclosure, the core **681** and the end portion **622** of the second differential signal terminal are fixed by soldering. In the illustrated embodiment of the present disclosure, the grounding wire **685** is bent and extends out of the insulating outer layer **684**.
(96) The metal shield surrounding member **66** surrounds a periphery of the second differential signal terminal to provide a better shielding effect on signal transmission. The metal shield surrounding member **66** is similar to the function of the first ground terminal G**1** and the second ground terminal G**2**. The metal shield surrounding member **66** is equivalent to connect the first ground terminal G**1** and the second ground terminal G**2** and forms a cylindrical shape wrapped around the periphery of the second differential signal terminal to further improve the ground shielding effect. The receptacle terminal module **6** further includes a connecting piece **64** connecting the grounding wire **685** and the metal shield surrounding member **66** so as to improve the ground shielding effect.
(97) In the illustrated embodiment of the present disclosure, there are a plurality of receptacle terminal modules **6** of the receptacle connector **200**, and an arrangement of each two adjacent receptacle terminal modules **6** is staggered. When the receptacle terminal modules **6** are assembled to the receptacle housing **7**, each metal shield surrounding member **66** of the receptacle terminal modules **6** passes through the corresponding terminal receiving groove **711** to extend into the receiving space **735**.
(98) Referring to FIG. **37**, in the illustrated embodiment of the present disclosure, the plurality of receptacle terminal modules **6** include a first receptacle terminal module **601**, a second receptacle terminal module **602**, and at least one non-differential signal terminal (not shown) located between the first receptacle terminal module **601** and the second receptacle terminal module **602**. The plurality of receptacle terminal modules **6** include a cable **686** electrically connected to the non-differential signal terminal. The at least one non-differential signal terminal is adapted to transmit control signals and/or power supplies.
(99) In the illustrated embodiment of the present disclosure, each of the first receptacle terminal modules **601** and each of the second receptacle terminal modules **602** are respectively located in a vertical plane as a whole. For each of the first receptacle terminal modules **601** and each of the second receptacle terminal modules **602**, a plurality of the metal shield surrounding members **66** and a plurality of pairs of the second differential signal terminals are stacked and separated by a certain distance in the vertical plane. The second differential signal terminals are divided into at least three pairs. Each pair of the second differential signal terminals is wrapped in the corresponding metal shield surrounding member **66**. The number of the first receptacle terminal modules **601** and the second receptacle terminal modules **602** is at least five and they are arranged side by side. Any two adjacent first receptacle terminal modules **601** are arranged next to each other. That is, a mating end of each first receptacle terminal module **601** is close to the adjacent first receptacle terminal module **601**. Any two adjacent second receptacle terminal modules **602** are arranged next to each other. That is, a mating end of each second receptacle terminal module **602** is close to the adjacent second receptacle terminal module **602**. The first receptacle terminal modules **601** are spaced a certain distance with respect to the second receptacle terminal modules **602** along a left-right direction as a whole in order to install the non-differential signal terminal.

(100) Referring to FIGS. **15**, **38** and **39**, when the plug connector assembly **300** is mated with the receptacle connector assembly **400**, the plug connector assembly **300** is at least partially inserted into the mating space **801**. The length of the metal cage **8** extending in the mating direction (i.e., the front-to-rear direction) is much greater than the length of the receptacle connector **200** after the receptacle cable **68** is removed. In this way, a relatively deep mating space **801** is formed at the front end of the receptacle connector **200**, which is beneficial to improve the shielding effect. In addition, the length of the metal shell **5** extending in the mating direction (i.e., the front-to-rear direction) is much greater than the length of the plug connector **100** after the plug cable **302** is removed. In this way, it is beneficial to improve the shielding effect of the plug connector **100**. By providing the metal cage **8** and the metal shell **5**, the shielding effect of the connector assembly **500** of the present disclosure is improved, which is beneficial to improve the quality of signal transmission. When the plug connector assembly **300** is inserted in place, the plug housing **1** of the plug connector **100** is inserted into the receiving space **735** of the receptacle housing **7** of the receptacle connector **200**. Moreover, at a rear end (a deep end) of the receiving space **735**, the mating portion **221** of the plug terminal module **2** is inserted into the corresponding contact arm **621** of the receptacle terminal module **6** so as to achieve contact. By mating the plug connector **100** and the receptacle connector **200** at the rear end (the deep end) of the receiving space **735**, the shielding effect of the metal shell **5** and the metal cage **8** at the front end can be fully utilized, thereby improving the quality of signal transmission. In addition, the present disclosure increases the speed of signal transmission by arranging multiple pairs of differential signal terminals.
(101) The above embodiments are only used to illustrate the present disclosure and not to limit the technical solutions described in the present disclosure. The understanding of this specification should be based on those skilled in the art. Descriptions of directions, such as “front”, “back”, “left”, “right”, “top” and “bottom”, although they have been described in detail in the above-mentioned embodiments of the present disclosure, those skilled in the art should understand that modifications or equivalent substitutions can still be made to the application, and all technical solutions and improvements that do not depart from the spirit and scope of the application should be covered by the claims of the application.

Claims

1. A first connector assembly, comprising: a metal shell, the metal shell comprising a first end surface and an installation space extending through the first end surface; and a first connector, the first connector being at least partially received in the installation space, the first connector comprising a first housing and a plurality of first terminal modules, the plurality of first terminal modules being arranged side by side and assembled to the first housing; wherein at least one first terminal module comprises a plurality of first conductive terminals, the plurality of first conductive terminals comprise a first differential signal terminal, a first ground terminal and a second ground terminal, and the first differential signal terminal is located between the first ground terminal and the second ground terminal; wherein each first conductive terminal comprises a first connection portion and a mating portion, the at least one first terminal module further comprises: an insulating bracket, the insulating bracket being fixed on the first connection portion, the mating portion protruding beyond the insulating bracket; a first metal shield, the first metal shield being located on one side of the insulating bracket; and a second metal shield, the second metal shield being located on the other side of the insulating bracket.
2. The first connector assembly according to claim 1, wherein the metal shell comprises a first top wall, a first bottom wall, a first side wall, and a second side wall; and wherein the installation space is enclosed by the first top wall, the first bottom wall, the first side wall and the second side wall.
3. The first connector assembly according to claim 2, wherein the metal shell comprises a first metal shell and a second metal shell assembled together; the first metal shell comprises the first top

wall, a first side wall portion extending from a first side of the first top wall, and a second side wall portion extending from a second side of the first top wall; the second metal shell comprises the first bottom wall, a third side wall portion extending from a first side of the first bottom wall, and a fourth side wall portion extending from a second side of the first bottom wall; the first side wall comprises the first side wall portion and the third side wall portion; and the second side wall comprises the second side wall portion and the fourth side wall portion.

4. The first connector assembly according to claim 3, wherein the first metal shell comprises an opening located between the first side wall portion and the second side wall portion; and wherein the metal shell comprises a first heat sink installed in the opening, and the first heat sink comprises a plurality of heat dissipation channels arranged at intervals.

5. The first connector assembly according to claim 1, further comprising a first cable which is electrically connected to the plurality of first conductive terminals, directly or indirectly.

6. The first connector assembly according to claim 5, further comprising a built-in circuit board, the plurality of first conductive terminals being electrically connected to the built-in circuit board, the first cable being electrically connected to the plurality of first conductive terminals through the built-in circuit board.

7. The first connector assembly according to claim 5, further comprising an unlocking assembly mounted on the metal shell and a pull strap connected to the unlocking assembly; wherein the unlocking assembly is slidable driven by the pull strap.

8. The first connector assembly according to claim 1, wherein the first metal shield comprises a first extension portion, the second metal shield comprises a second extension portion, the first extension portion, the second extension portion, the mating portion of the first ground terminal, and the mating portion of the second ground terminal are enclosed to form a shielding space, and the mating portion of the first differential signal terminal is located in the shielding space.

9. The first connector assembly according to claim 8, wherein the first extension portion comprises a first bulge protruding toward the first ground terminal and a second bulge protruding toward the second ground terminal; wherein the second extension portion comprises a third bulge protruding toward the first ground terminal and a fourth bulge protruding toward the second ground terminal; and wherein the first bulge and the third bulge are in contact with opposite side surfaces of the contact portion of the first ground terminal, respectively; the second bulge and the fourth bulge are in contact with opposite side surfaces of the contact portion of the second ground terminal, respectively; and the first extension portion, the second extension portion, the first ground terminal and the second ground terminal are jointly enclosed to form the shielding space.

10. The first connector assembly according to claim 1, wherein the first metal shield comprises a first main body portion located on one side of the first connection portions of the first conductive terminals, the first main body portion comprises a first rib protruding toward the first ground terminal and a second rib protruding toward the second ground terminal; wherein the second metal shield comprises a second main body portion located on the other side of the first connection portions of the first conductive terminals, the second main body portion comprises a third rib protruding toward the first ground terminal and a fourth rib protruding toward the second ground terminal; wherein the first rib and the third rib respectively contact opposite side surfaces of the first connection portion of the first ground terminal; the second rib and the fourth rib respectively contact opposite side surfaces of the first connection portion of the second ground terminal; and wherein the first main body portion, the second main body portion, the first ground terminal and the second ground terminal are enclosed to form a shielding cavity to accommodate the first connection portion of the first differential signal terminal.

11. A first connector assembly, comprising: a metal shell, the metal shell comprising a first end surface and an installation space extending through the first end surface; and a first connector, the first connector being at least partially received in the installation space, the first connector comprising a first housing and a plurality of first terminal modules, the plurality of first terminal

modules being arranged side by side and assembled to the first housing; wherein at least one first terminal module comprises a plurality of first conductive terminals, the plurality of first conductive terminals comprise a first differential signal terminal, a first ground terminal and a second ground terminal, and the first differential signal terminal is located between the first ground terminal and the second ground terminal; wherein there are a plurality of the first differential signal terminals, there are a plurality of the first ground terminals, and there are a plurality of second ground terminals; wherein the first terminal module is located in a plane; and wherein the plurality of first ground terminals, the plurality of first differential signal terminals, and the plurality of second ground terminals are stacked and separated by a distance in the plane; and wherein the first differential signal terminals are divided into at least three pairs, and each pair of first differential signal terminals are located between one said first ground terminal and one said second ground terminal.

12. The first connector assembly according to claim 1, wherein a structure of the mating portion of the first differential signal terminal is different from a structure of the mating portion of the first ground terminal and a structure of the mating portion of the second ground terminal; and wherein the mating portion of the first ground terminal and the mating portion of the second ground terminal are flat-shaped, and the mating portion of the first differential signal terminal is needle-shaped.

13. A second connector assembly, comprising: a metal cage, the metal cage comprising a second end surface and a mating space extending through the second end surface, the mating space being configured to receive a first connector along a first direction; and a second connector, the second connector being located at a rear end of the mating space and communicating with the mating space, the second connector comprising a second housing and a plurality of second terminal modules assembled to the second housing; wherein at least one second terminal module comprises a pair of second differential signal terminals, a grounding element located beside the pair of second differential signal terminals along a second direction perpendicular to the first direction, and a second cable electrically connected to the second differential signal terminals; wherein the at least one second terminal module comprises an insulating block and an insulating member fixed to the second differential signal terminals, the grounding element comprises a metal shield surrounding member surrounding a periphery of the second differential signal terminals, the insulating block defines a through hole, each second differential signal terminal comprises a contact arm located in the through hole, and the insulating block is received in the metal shield surrounding member.

14. The second connector assembly according to claim 13, wherein the metal cage comprises a second top wall, a second bottom wall, a third side wall, and a fourth side wall; the mating space is enclosed by the second top wall, the second bottom wall, the third side wall, and the fourth side wall; wherein the second connector assembly further comprises a plurality of grounding elastic pieces adjacent to the second end surface, the plurality of grounding elastic pieces are fixed to the second top wall, the second bottom wall, the third side wall, and the fourth side wall, respectively; wherein the second connector assembly comprises a second heat sink fixed to the second top wall and/or the second bottom wall.

15. The second connector assembly according to claim 13, wherein a plurality of second terminal modules are provided, each second terminal module comprises an insulating part and a grounding member, the second differential signal terminals comprise a first signal terminal and a second signal terminal, the first signal terminal and the second signal terminal form a differential pair and are fixed to the insulating part, and the grounding member is located adjacent to the second differential signal terminals along a third direction perpendicular to the first direction and the second direction.

16. The second connector assembly according to claim 13, wherein the second connector is a backplane connector.

17. The second connector assembly according to claim 13, wherein the at least one second terminal

module comprises a plurality of second conductive terminals which comprise the pair of second differential signal terminals, a plurality of the second cables are provided, and all the second conductive terminals are connected to corresponding second cables.

18. The second connector assembly according to claim 13, wherein at least one second terminal module comprises a second cable electrically connected to the pair of second differential signal terminals, the second cable comprises a core electrically connected to a corresponding second differential signal terminal and a grounding wire located outside the core, the at least one second terminal module further comprises a metal shield plate and a connecting piece connecting the grounding wire and the metal shield surrounding member, and the metal shield plate is in contact with the metal shield surrounding member.

19. The first connector assembly according to claim 1, wherein there are a plurality of the first differential signal terminals, there are a plurality of the first ground terminals, and there are a plurality of second ground terminals; wherein the first terminal module is located in a plane; and wherein the plurality of first ground terminals, the plurality of first differential signal terminals, and the plurality of second ground terminals are stacked and separated by a distance in the plane; and wherein the first differential signal terminals are divided into at least three pairs, and each pair of first differential signal terminals are located between one said first ground terminal and one said second ground terminal.

20. The second connector assembly according to claim 11, wherein each first conductive terminal comprises a first connection portion and a mating portion; the at least one first terminal module further comprises: an insulating bracket, the insulating bracket being secured to the first connection portion; a first metal shield, the first metal shield being located on one side of the insulating bracket; and a second metal shield, the second metal shield being located on another side of the insulating bracket.