

PLUG CONNECTOR, RECEPTACLE CONNECTOR AND ELECTRICAL CONNECTOR ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 The present invention relates to a plug and receptacle connector assembly, and more particularly, to a composite plug and receptacle connector assembly for coupling radio frequency signals.

2. Description of the Related Art

10 Coaxial radio frequency (RF) connector assemblies are used with coaxial cables for transmitting radio frequency signals with shielding. Current technology includes a coaxial RF connector and an electrical connector including a plurality of arrayed terminals combined within the same housing as a composite electrical connector. For example, a composite electrical connector assembly 12, as shown in FIG. 1, includes a
15 plug connector 13 having a pair of coaxial plugs 131 and a pin receptacle 132 between the pair of coaxial plugs 131, a receptacle connector 14 having a pair of coaxial receptacles 141 for receiving the respective coaxial plugs 131, and a pin plug 142 between the pair of coaxial receptacles 141. Each coaxial receptacle 141 may include a pin-shaped male contact 1411, and
20 each coaxial plug 131 may include a cylindrical female contact (not shown) for receiving the male contact 1411. Generally, each cylindrical female contact is surrounded by a tubular insulating layer (not shown) typically of a material with a high dielectric constant, all of which are enclosed by a conductive layer (not shown). Normally, the coaxial plug 131 and the
25 coaxial receptacle 141 have the same predetermined impedance as the attached cable so that their dimensions cannot easily be changed.

Due to the determined dimension of the coaxial plug 131, the size reduction of the composite electrical connector assembly 12 cannot be easily reduced. Although some approaches, such as making cutouts on each

coaxial receptacle 141 as shown in FIG. 1, have been attempted for size reduction, such thickness reduction is not significant and cannot satisfy the requirements of slim electronic apparatuses. Further, inserting the coaxial plug 131 to the coaxial receptacle 141 requires high insertion force, and such high insertion force makes the composite electrical connector assembly 12 inconvenient to use. Moreover, the coaxial plug 131 and the coaxial receptacle 141 use tools and manufacture molds different from those for the pin plug 142 and the pin receptacle 132 so that the manufacturing cost of the composite electrical connector assembly 12 is high. Furthermore, the coaxial plug 131 and the coaxial receptacle 141 have to be assembled in assembly steps different from those in which the assembly of the pin plug 142 and the pin receptacle 132 is performed, complicating the entire assembly process of the composite connector.

Therefore, a traditional composite connector including a coaxial connector still has many issues, and requires further improvement.

SUMMARY OF THE INVENTION

An objective of the present invention is to provide an electrical connector assembly, which can be used for transmission of a radio frequency signal and is of compact size.

In order to achieve the above objective, the present invention proposes a plug connector configured to be coupled to an electronic device having a printed circuit board, which includes a radio frequency contact pad and a plurality of signal pads. The plug connector comprises a plug housing, a first plug terminal and a pair of second plug terminals. The plug housing includes a support plate. The first plug terminal, configured to be coupled to the radio frequency contact pad for transmission of radio frequency signals, includes a first plug contact portion disposed on the support plate. The pair of second plug terminals are configured to be grounded to confine the electromagnetic field produced by the radio frequency signals. Each second plug terminal includes a second plug contact portion, and the two

second plug contact portions are disposed on the support plate and on opposite sides of the first plug contact portion and extend parallel thereto.

The present invention also proposes a receptacle connector configured to be coupled to an electronic device having a printed circuit board, which includes a radio frequency contact pad and a plurality of signal pads. The
5 receptacle connector includes a receptacle housing, a first receptacle terminal, and a pair of second receptacle terminals. The first receptacle terminal is disposed within the receptacle housing and is coupled to the radio frequency contact pad for transmission of radio frequency signals.
10 The two second receptacle terminals, configured to be grounded to confine the electromagnetic field produced by the radio frequency signal, are disposed on opposite sides of the first receptacle terminal and are arranged parallel thereto.

The present invention further proposes an electrical connector assembly comprising the above-mentioned plug connector and the above-mentioned plug connector.
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BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described according to the appended drawings in which:

20 FIG. 1 is a traditional coaxial radio frequency connector assembly;

FIG. 2 is a top perspective exploded view showing an electrical connector assembly according to one embodiment of the present invention;

FIG. 3 is a bottom perspective exploded view showing an electrical connector assembly according to one embodiment of the present invention;

25 FIG. 4 is an exploded perspective view showing a plug connector according to one embodiment of the present invention;

FIG. 5 is an exploded perspective view showing a receptacle connector

according to one embodiment of the present invention;

FIG. 6 is a top view showing a plug connector according to one embodiment of the present invention;

FIG. 7 is a cross-sectional view along the line A-A of FIG. 6;

5 FIG. 8 is a top view showing a receptacle connector according to one embodiment of the present invention; and

FIG. 9 is a cross-sectional view along the line B-B of FIG. 8 according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

10 Embodiments of the present invention will be described in detail with reference to attached drawings.

As illustrated in FIGS. 2 and 3, an electrical connector assembly 1, comprising a plug connector 2 connected to a receptacle connector 3, is provided. The plug connector 2 can comprise an insulative plug housing 21
15 having a pair of oppositely disposed parallel arm portions 211, between which an accommodation space is formed for receiving the plug-in portion 311 of the receptacle connector 3. The receptacle connector 3 can include a receptacle housing 31 having a stepped shape.

Referring to FIGS. 2 and 4, the plug housing 21 may comprise a
20 support plate 212, on which a plurality of parallel recesses 213 are formed as shown in FIG. 4. The plug connector 2 may include a plurality of plug terminals 4-7 each having a plug contact portion 41, 51, 61 and 71. The plug contact portions 41, 51, 61 and 71 are respectively received within the plurality of recesses 213 when the plurality of plug terminals 4-7 are
25 inserted into the plug connector 2. Correspondingly, the plug-in portion 311 of the receptacle connector 3, as shown in FIG. 5, comprises a receiving slot 3111 for receiving the support plate 212 of the plug connector 2. A plurality of parallel grooves 3112 are provided within the receptacle

connector 3 with respect to the recesses 213 on the support plate 212. The receptacle connector 3 also comprises a plurality of arrayed receptacle terminals 8-11 each having a receptacle contact portion 81, 91, 101 and 111 movable in a cantilevered manner and configured for operatively coupling
5 to the corresponding plug contact portion 41, 51, 61 or 71. Each of the receptacle terminals 8-11 is received in the respective groove 3112 with the respective receptacle contact portion (81, 91, 101 or 111) residing in the plug-in portion for engagement with the respective one of the plug contact portions (41, 51, 61 and 71).

10 As shown in FIGS. 2 to 5, the plug connector 2 comprises two groups of plug terminals 4-6, which are respectively disposed on opposite sides of the plurality of plug terminals 7 and properly configured for transmission of radio frequency signals. Specifically, each of the plug terminals 5 is configured to transmit a radio frequency signal, and each pair of plug
15 terminals 4 and 6 are disposed on the opposite sides of the respective plug terminal 5 and configured to be connected to ground so as to confine the electromagnetic field produced by the radio frequency signal carried by the respective plug terminal 5 to the area along the transmission path of the radio frequency signal and to protect the plug terminal 5 from
20 electromagnetic interference from the surrounding environment. In particular, the plug connector 2 can, as shown in FIG. 2, be electrically connected to an electronic device 500, which includes a printed circuit board 501 having a plurality of contact pads 502 correspondingly connected to radio frequency transmission lines (not shown), ground pads 503, and a
25 plurality of signal pads 504. The plug terminals 5 are correspondingly coupled to the radio frequency contact pads 502 and the plug terminals 4 and 6 are coupled to the ground pads 503.

Because the plug terminals 4-6 can be blade type terminals, the plug connector 2 can be of compact size. In addition, each group of plug
30 terminals 4-6 for transmission of radio frequency signals can be similar to the group of plug terminals 7, which can be adapted for power transmission,

or for non-radio frequency signals or digital data signals. Therefore, all terminals 4-7 can be manufactured using the same tools or manufacturing molds, and can be assembled in the same process step. Consequently, the assembly procedure of the plug connector 2 is simple and its manufacture cost is low.

The receptacle connector 3 can also comprise two groups of the receptacle terminals 8-10, which are respectively disposed on opposite sides of the plurality of receptacle terminals 11, as shown in FIGS. 2 and 5. Each group of the receptacle terminals 8-10 of the receptacle connector 3 can be correspondingly adapted for transmission of radio frequency signals such that each receptacle terminal 9 is for transmission of radio frequency signals and each pair of the receptacle terminals 8 and 10 are grounded. In particular, the receptacle connector 3 can, as shown in FIG. 3, also be electrically connected to a communication device 400, which includes a printed circuit board 401 having a plurality of contact pads 402 correspondingly connected to radio frequency transmission lines (not shown), a plurality of ground pads 403, and a plurality of signal pads 404. The receptacle terminals 9 are correspondingly coupled to the radio frequency contact pads 402 and the receptacle terminals 8 and 10 are respectively coupled to the ground pads 403. Similarly, all terminals 8-11 can be similar so that they can be manufactured using the same tools or manufacturing molds, and can be assembled in the same process step. Compared to the connection of a traditional coaxial plug and receptacle, the plug connector 2 and the receptacle connector 3 of the present invention require less force for insertion.

Referring to FIGS. 4 and 6, each of the plug contact portions (41, 51, 61 and 71) can have a plurality of lateral protruding parts (411, 511, 611 or 711) and each recess 213 is defined by inward stepped side walls 214. Thus, when the plug terminals 4-7 are inserted, each of the plug contact portions (41, 51, 61 and 71) can be secured due to the interference fit between the respective one of the protruding parts (411, 511, 611 and 711) and the

respective stepped side walls 214, as shown in FIG. 6.

Referring to FIGS. 4 and 7, each of the plurality of plug terminals 4-7 includes a resilient contact portion (42, 52, 62 or 72) and a locking portion (43, 53, 63 or 73) connecting the respective resilient contact portion (42, 52, 62 or 72) and the respective plug contact portion (41, 51, 61 or 71). Each locking portion (43, 53, 63 or 73) includes a plurality of laterally extending barbs (431, 531, 631 or 731) for engaging the side walls 2151 of a respective through channel 215. The through channels 215 respectively connect to the respective recesses 213 and penetrate through the plug connector 2 so that the plug contact portions (41, 51, 61 and 71) can be inserted through the respective through channels 215 from the backside of the plug connector 2 and be placed within the respective recesses 213. Each resilient contact portion (42, 52, 62 or 72), disposed opposite to the respective plug contact portion (41, 51, 61 or 71), can have, for example, a wave-like shape. The resilient contact portions (42, 52, 62 and 72) can partially protrude outside of the plug housing 21 when the plug terminals 4-7 are inserted as shown in FIG. 3.

Referring to FIG. 5, each of the receptacle terminals 8-11 can further include a tail portion (82, 92, 102 or 112) and a locking portion (83, 93, 103 or 113) connecting the respective tail portion (82, 92, 102 or 112) and the respective receptacle contact portion (81, 91, 101 or 111). Referring to FIGS. 8 and 9, each of the locking portions (83, 93, 103 and 113) is dimensioned to form an interference fit with the respective opposite side walls 3121 partially defining the respective groove 3112. Each of the receptacle contact portions (81, 91, 101 and 111) can be checkmark-shaped such that it can rotate about the angular part 1012 as the bow-like part 1011 is engaging the respective plug contact portion (41, 51, 61 or 71). Each tail portion (82, 92, 102 or 112), disposed opposite to the respective receptacle contact portions (81, 91, 101 or 111), can be, for example, formed to have a configuration adapted for surface mount soldering.

In summary, the present invention proposes an electrical connector

assembly comprising a plug connector and a receptacle connector. The plug connector comprises a plurality of plug terminals, wherein at least one plug terminal is configured to transmit a radio frequency signal with a pair of plug terminals disposed on opposite sides thereof, connected to ground.

5 The plug connector comprises a support plate configured to support the plug contact portions of the plug terminals. Correspondingly, the receptacle connector comprises a plurality of receptacle terminals, wherein at least one receptacle terminal is configured to transmit a radio frequency signal with a pair of receptacle terminals disposed on opposite sides thereof, connected to

10 ground. The plug terminals can be similar such that they can be manufactured using the same tools or manufacturing molds, and can be assembled in a single process step. The receptacle terminals can be also similar such that they can also be manufactured using the same tools or manufacturing molds, and can be assembled in a single process step.

15 Consequently, the assemblies of the plug connector and the receptacle connector are simple and their manufacture cost is low.

The above-described embodiments of the present invention are intended to be illustrative only. Numerous alternative embodiments may be devised by persons skilled in the art without departing from the scope of the

20 following claims.

What is claimed is:

1. A plug connector configured to be coupled to an electronic device having a printed circuit board, which includes a first radio frequency contact pad and a plurality of signal pads, the plug connector comprising:

5 a plug housing having a support plate;

a first plug terminal having a first plug contact portion disposed on the support plate, the first plug terminal configured to be coupled to the first radio frequency contact pad for transmission of first radio frequency signals; and

10 a pair of second plug terminals each having a second plug contact portion disposed on the support plate, the pair of second plug terminals configured to be grounded to confine electromagnetic field produced by the first radio frequency signals, wherein the second plug contact portions are disposed on opposite sides of the first plug contact portion and extend
15 parallel thereto.

2. The plug connector of Claim 1, further comprising a plurality of third plug terminals each having a third plug contact portion disposed on the support plate, the third plug terminals configured to be connected to the respective signal pads.

20 3. The plug connector of Claim 2, further comprising:

a fourth plug terminal having a fourth plug contact portion disposed on the support plate, wherein the printed circuit board includes a second radio frequency contact pad and the fourth plug terminal is configured to be coupled to the second radio frequency contact pad for transmission of
25 second radio frequency signals; and

a pair of fifth plug terminals each having a fifth plug contact portion disposed on the support plate, the pair of fifth plug terminals configured to be grounded to confine the electromagnetic field produced by the second radio frequency signals, wherein the fifth plug contact portions are disposed

on opposite sides of the fourth plug contact portion and extend parallel thereto, wherein a group of the first plug terminal and the second plug terminals and a group of the fourth plug terminal and the fifth plug terminals are disposed on opposite sides of the plurality of third plug terminals.

4. The plug connector of Claim 3, wherein the plug housing comprises a plurality of recesses disposed on the support plate, the recesses configured for receiving the respective first, second, third, fourth, and fifth plug contact portions.

10 5. The plug connector of Claim 4, wherein the plug housing comprises a plurality of through channels respectively connected to the recesses, wherein each through channel holds a respective one of the first, second, third, fourth, and fifth plug terminals.

15 6. The plug connector of Claim 5, wherein each of the first, second, third, fourth, and fifth plug terminals comprises a locking portion having a barb, wherein each locking portion is configured to be received in the respective through channel and the barb is configured to form an interference fit with a side wall partially defining the respective through channel.

20 7. The plug connector of Claim 6, wherein each of the first, second, third, fourth, and fifth plug terminals comprises a resilient contact portion connected to the respective locking portion.

25 8. The plug connector of Claim 7, wherein each recess is defined by inward stepped side walls and each of the first, second, third, fourth, and fifth plug contact portions includes a lateral protruding part configured to form an interference fit with the respective inward stepped side wall.

9. A receptacle connector configured to be coupled to an

electronic device having a printed circuit board, which includes a first radio frequency contact pad and a plurality of signal pads, the receptacle connector comprising:

a receptacle housing;

5 a first receptacle terminal disposed within the receptacle housing, the first receptacle terminal configured to be coupled to the first radio frequency contact pad for transmission of first radio frequency signals; and

a pair of second receptacle terminals disposed on opposite sides of the first receptacle terminal and arranged parallel thereto, the pair of second
10 receptacle terminals configured to be grounded to confine the electromagnetic field produced by the first radio frequency signals.

10. The receptacle connector of Claim 9, wherein the receptacle housing comprises a plug-in portion, the first receptacle terminal comprises a first receptacle contact portion disposed within the plug-in portion, and
15 each second receptacle terminal comprises a second receptacle contact portion disposed within the plug-in portion.

11. The receptacle connector of Claim 10, further comprising a plurality of third receptacle terminals each having a third receptacle contact portion disposed within the plug-in portion, the third receptacle terminals
20 configured to be connected to the respective signal pads.

12. The receptacle connector of Claim 11, further comprising:

a fourth receptacle terminal disposed within the receptacle housing, wherein the printed circuit board comprises a second radio frequency contact pad and the fourth receptacle terminal is configured to be coupled to
25 the second radio frequency contact pad for transmission of second radio frequency signals; and

a pair of fifth receptacle terminals disposed on opposite sides of the fourth receptacle terminal and arranged parallel thereto, the pair of fifth

receptacle terminals configured to be grounded to confine the electromagnetic field produced by the second radio frequency signals, wherein a group of the first receptacle terminal and the second receptacle terminals and a group of the fourth receptacle terminal and the fifth receptacle terminals are disposed on opposite sides of the plurality of third receptacle terminals.

13. The receptacle connector of Claim 12, wherein the fourth receptacle terminal comprises a fourth receptacle contact portion disposed within the plug-in portion, and each fifth receptacle terminal comprises a fifth receptacle contact portion disposed within the plug-in portion.

14. The receptacle connector of Claim 13, wherein each of the first, second, third, fourth, and fifth receptacle contact portions is movable in a cantilevered manner.

15. The receptacle connector of Claim 14, wherein the receptacle housing comprises a plurality of grooves for receiving the respective first, second third, fourth, and fifth receptacle terminals.

16. The receptacle connector of Claim 15, wherein each of the first, second, third, fourth, and fifth receptacle terminals comprises a locking portion configured to form an interference fit with the respective groove.

17. The receptacle connector of Claim 16, wherein each of the first, second, third, fourth, and fifth receptacle terminals comprises a surface mount tail portion connected to the respective locking portion.

18. An electrical connector assembly for coupling radio frequency signals from an electronic device to an external device, the electronic device including a printed circuit board, which includes a first radio frequency contact pad and a plurality of signal pads, comprising:

a receptacle connector, comprising:

a receptacle housing having a plug-in portion;

5 a first receptacle terminal having a first receptacle contact portion disposed within the plug-in portion, the first receptacle terminal configured to be coupled to the first radio frequency contact pad for transmission of first radio frequency signals; and

10 a pair of second receptacle terminals each having a second receptacle contact portion disposed within the plug-in portion; the pair of second receptacle terminals, disposed on opposite sides of the first receptacle terminal and arranged parallel thereto, configured to be grounded to confine the electromagnetic field produced by the first radio frequency signals; and

a plug connector, comprising:

15 a plug housing having a support plate configured to be received by the plug-in portion;

a first plug terminal having a first plug contact portion disposed on the support plate, wherein the first plug contact portion is configured for operatively coupling to the first receptacle contact portion; and

20 a pair of second plug terminals each having a second plug contact portion disposed on the support plate, wherein the second plug contact portions are disposed on opposite sides of the first plug contact portion and extend parallel thereto, and the second receptacle contact portion of each second receptacle terminal is configured for
25 operatively coupling to the respective second plug contact portion.

19. The electrical connector assembly of Claim 18, wherein the receptacle connector further comprises a plurality of third receptacle terminals each having a third receptacle contact portion disposed within the plug-in portion, and the third receptacle terminals are configured to be
30 connected to the respective signal pads.

20. The electrical connector assembly of Claim 19, wherein the plug connector further comprises a plurality of third plug terminals each having a third plug contact portion disposed on the support plate, and each third plug contact portion is configured for operatively coupling to the
5 respective third receptacle contact portion.

21. The electrical connector assembly of Claim 20, further comprising:

a fourth receptacle terminal having a fourth receptacle contact portion disposed within the plug-in portion, wherein the printed circuit
10 board comprises a second radio frequency contact pad and the fourth receptacle terminal is configured to be coupled to the second radio frequency contact pad for transmission of second radio frequency signals;

a pair of fifth receptacle terminals each having a fifth receptacle contact portion disposed within the plug-in portion; the pair of fifth
15 receptacle terminals, disposed on opposite sides of the fourth receptacle terminal and arranged parallel thereto, configured to be grounded to confine the electromagnetic field produced by the second radio frequency signals;

wherein a group of the first receptacle terminal and the second receptacle terminals and a group of the fourth receptacle terminal and the
20 fifth receptacle terminals are disposed on opposite sides of the plurality of third receptacle terminals;

a fourth plug terminal having a fourth plug contact portion disposed on the support plate, wherein the fourth receptacle contact portion of the fourth receptacle terminal is configured for operatively coupling to the
25 fourth plug contact portion; and

a pair of fifth plug terminals each having a fifth plug contact portion disposed on the support plate, wherein the fifth plug contact portions are disposed on opposite sides of the fourth plug contact portion and extend parallel thereto, and the fifth receptacle contact portion of each fifth
30 receptacle terminal is configured for operatively coupling to the respective

fifth plug contact portion;

wherein a group of the first plug terminal and the second plug terminals and a group of the fourth plug terminal and the fifth plug terminals are disposed on opposite sides of the plurality of third plug terminals.

22. The electrical connector assembly of Claim 21, wherein the plug housing comprises a plurality of recesses disposed on the support plate and a plurality of through channels respectively connected to the recesses, wherein each through channel holds a respective one of the first, second, third, fourth, and fifth plug terminals and the recesses are configured for receiving the respective first, second, third, fourth, and fifth plug contact portions.

23. The electrical connector assembly of Claim 22, wherein the receptacle housing comprises a plurality of grooves for receiving the respective first, second, third, fourth, and fifth receptacle terminals.

24. The electrical connector assembly of Claim 23, wherein each of the first, second, third, fourth, and fifth plug terminals comprises a first locking portion having a barb, and each of the first, second, third, fourth, and fifth receptacle terminals comprises a second locking portion configured to form an interference fit with the respective groove, wherein each first locking portion is configured to be received in the respective through channel and the barb is configured to form an interference fit with a side wall partially defining the respective through channel.

25. The electrical connector assembly of Claim 24, wherein each of the first, second, third, fourth, and fifth plug terminals comprises a resilient contact portion connected to the respective first locking portion, and each of the first, second, third, fourth, and fifth receptacle terminals comprises a surface mount tail portion connected to the respective second locking portion.

26. The electrical connector assembly of Claim 25, wherein each recess is defined by inward stepped side walls, and each of the first, second, third, fourth, and fifth plug contact portions includes a lateral protruding part configured to form an interference fit with the respective inward
5 stepped side wall.