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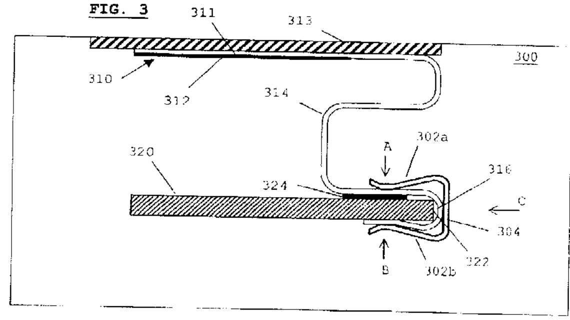
(54) Abstract Title: **Mechanism for connecting an antenna to a PCB and a connector there for**

(57) A connector 314 providing electrical and mechanical connection between an antenna 310 and a printed circuit board (PCB) 320. The transmit/receive element 312 of the antenna may be a patch antenna and the connector may be constructed using a flexible circuit board and provides spatial separation between the antenna and the PCB.

FIG. 3



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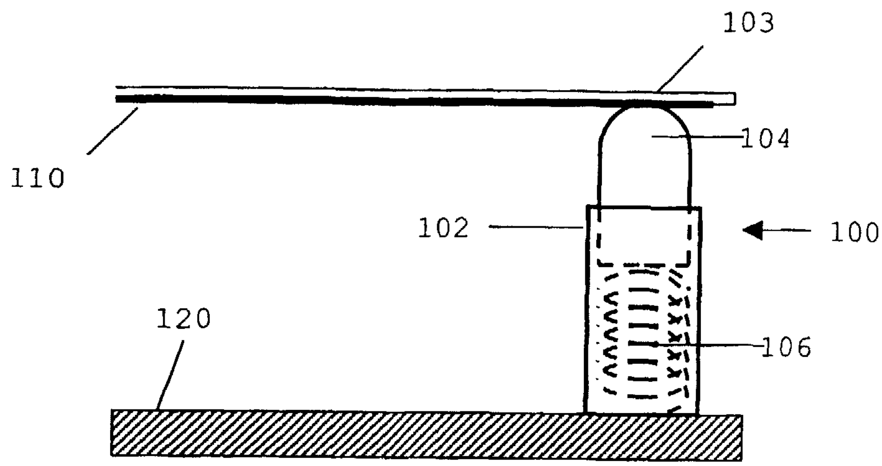


FIG. 1 Prior Art

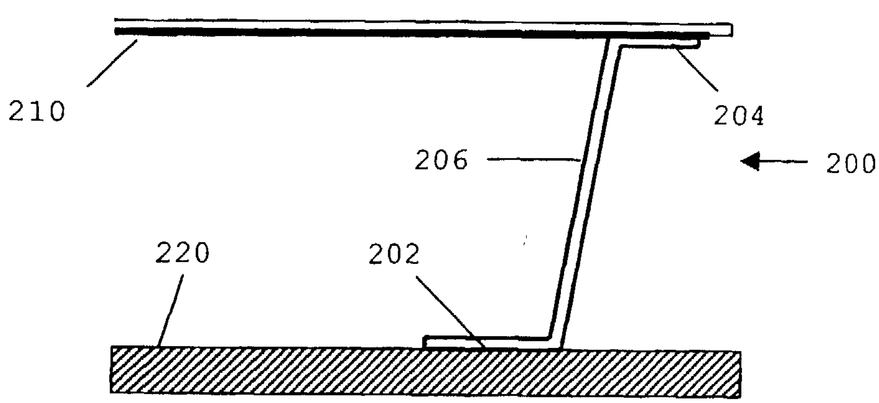


FIG. 2 Prior Art

FIG. 3

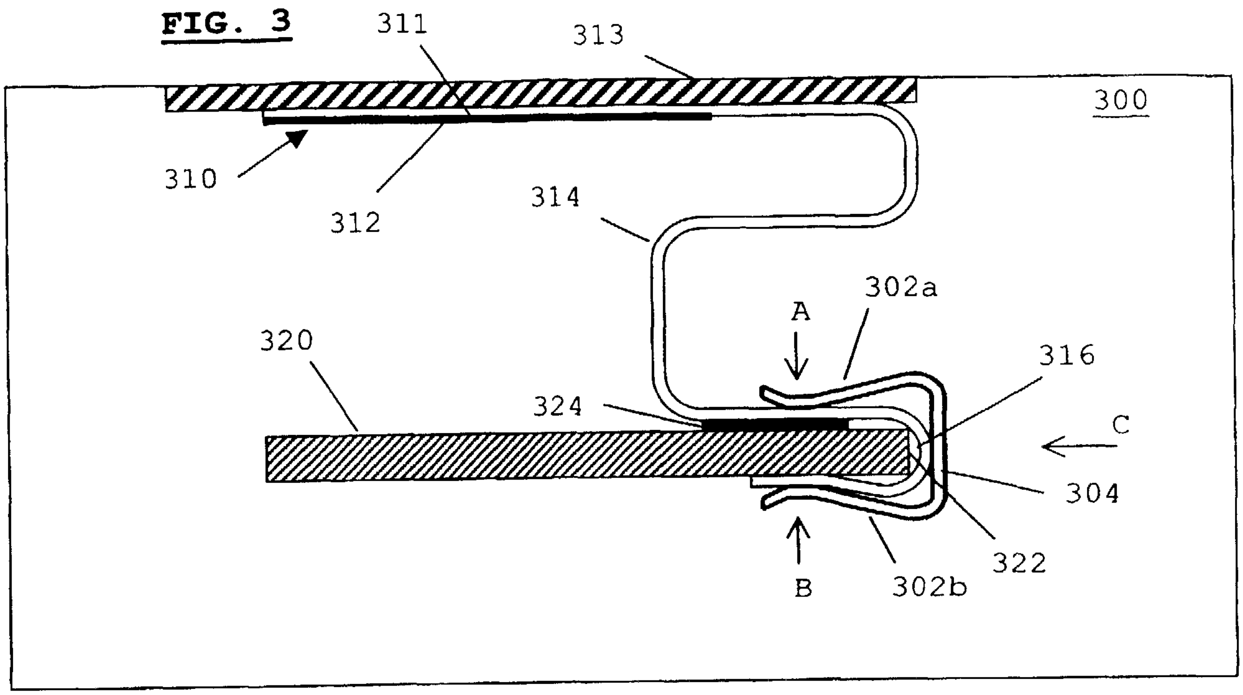
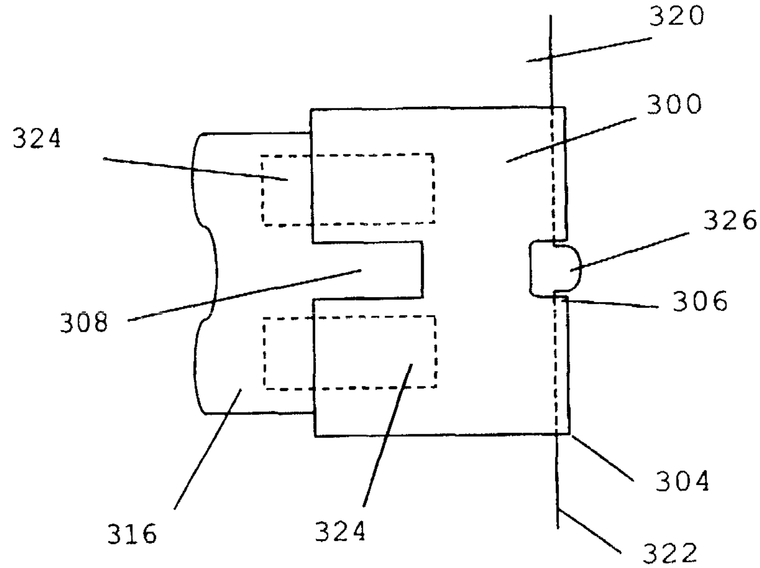

311
313
300
310
312
314
302a
A
316
320
324
C
304
322
B
302b

FIG. 4


320
300
324
326
306
308
304
316
324
322

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MECHANISM FOR CONNECTING AN ANTENNA TO A PCB AND CONNECTOR THERE FOR

Field of the Invention

The present invention relates to a mechanism for connecting an antenna to a printed circuit board and a connector there for.

Background of the Invention

Patch antennae are becoming more popular for use in radio communications devices. The popularity of such antennae emanates from the fact that they are particularly suited to being located within the housing of a device. This removes the need for the antenna to extend from the main body of the device, using for example a helical coil antenna, in what many users find an un-aesthetic manner. A typical patch antenna is constructed using a piece of printed circuit board (PCB). The 'transmission/reception element' of the antenna is provided by tracking, for example of copper, etched or otherwise provided onto/into the surface of a base material such as fiberglass. Alternative base materials used for flexible PCBs are polyamide, polyester or polythene napthalate.

However, a known problem with such antennae is in connecting them to a printed circuit board (PCB) on which radio circuitry is located. In devices such as radio communications devices, for example mobile cellular telephones, it is desirable for the overall size of the device to be kept to a minimum. Therefore, extending the PCB in order to provide a region on which the antenna can be provided is not desirable, since this would increase the length and/or width of the device.

In order to overcome this, the antenna is generally located above or below the PCB, substantially adjacent the radio circuitry.

FIG. 1 illustrates a known connector 100 used for electrically connecting an antenna 110 to a PCB 120. The connector 100, often referred to as a 'pogo pin', comprises a base 102, which in use is affixed to the PCB 120, for example by soldering. The connector 100 further comprises an electrical contact element 104 and a spring element 106. The spring element 106 is located within the base 102, with the contact element 104 located partially within the base 102 and extending there from in a direction toward the antenna 110. A surface 103 of the contact element 104 distant from the PCB 120 comes into electrical contact with a contact region (not illustrated) of the antenna 110.

In use, the spring element 106 is under compression such that the contact element 104 is forced into engagement with the contact region of the antenna 110. The contact element 104 and the spring element 106 and/or base 102 provide an electrical connection between the PCB 120 and the antenna 110.

A problem experienced by the connector 100 of FIG. 1 is that of the inductance of the spring element 106. The inductance of the spring element 106 affects the radio signals to be transmitted and that are received by the antenna. Hence, the antenna design is made much more complex, and variations in mechanical tolerances have a significant impact on the antenna's performance at different frequencies.

FIG. 2 illustrates another known connector 200 used for electrically connecting an antenna 210 to a PCB 220. The connector 200 comprises a base 202, which in use is affixed to the PCB 220, for example by soldering. The connector 200 further comprises a contact element 204 and an intermediate element 206, which extends transversely between the base 202 and contact element 204.

In use, the contact element 204 is forced into engagement with a contact region (not illustrated) of the antenna 210, by the resilient nature of the material and form of the connector 200.

The inventor of the present invention has recognised a major deficiency in the aforementioned known antenna connector mechanisms. The deficiency emanates from movement of the antenna relative to the PCB. Such relative movement is common in cellular phone devices due to vibrations, forces acting on the housing of the device, for example when gripped by a user, and sharp jolts caused, for example, by the device being dropped. With the aforementioned known antenna connectors, any such movement is constantly flexing the connector. This causes the connectors to wear out much faster, and also wears out the contacts on the antenna.

In particular, for the known antenna connector 200 of FIG. 2, this movement also causes horizontal movement at the point of contact with the antenna. Therefore, in order to ensure that an electrical contact is always maintained, the contacts 204 to the antenna 210 must be larger to account for such horizontal movement.

A yet further problem of the aforementioned known antenna connectors is that their design requires consideration of a large number of tolerances, for example the distance between the PCB and antenna. The distance between the PCB and antenna is affected by many factors, such as:

(i) Width of antenna,

(ii) Width of PCB,

(iii) Fixing of PCB relative to housing, both in terms of the accuracy of the housing manufacturing and the assembling of the housing,

(iv) Fixing of antenna relative to housing, again both in terms of the accuracy of the housing manufacturing and the assembling of the housing, and

(v) Accuracy of manufacturing the connector itself.

Furthermore, the aforementioned known antenna connector/clips all provide electrical paths. Therefore, not only do their physical/mechanical properties have to be carefully designed, their electrical properties also have to be carefully designed. This is critical for the efficient radiation of radio frequency (RF) signals.

Generally, such antenna connectors are used to allow a non-permanent connection between the antenna and PCB, to assist in the assembly, servicing and maintenance of radio communication devices.

Both of the connectors 100, 200 illustrated in FIG. 1 and FIG. 2 rely on their resilient elements, namely the spring element 106 of connector 100 and the material and form of the connector 200, for maintaining a good electrical connection with the antenna 110, 210. The use of such resilience suffers from the problem that a consistent electrical contact is difficult to achieve. In particular, the electrical contact is easily affected by external influences such as vibrations and movement, of, say, the cellular phone. Thus, the antenna receives a poor electrical contact and operates inefficiently.

In order to improve the electrical contact for such connections, it would be necessary to increase the force exerted by the resilient elements. However, in order for the electrical contact to be improved sufficiently, the force would be such that the PCB and antenna would experience excessive stress, potentially causing damage thereto, and would require a sufficient opposing force to maintain the antenna and PCB in position relative to one another.

Another problem experienced is that the resilience of the connectors is likely to decrease with time, reducing the force with which the contact element of each connector is urged into engagement with the antenna. Thus, even if a satisfactory electrical contact could be provided initially, it would be expected that over time the electrical contact would degrade as the resilience of the connector degraded.

The unreliability of the contact between the connector and the antenna results in poor performance of the antenna, with received signals transferred to the PCB being of poor quality.

Furthermore, in order to overcome the problem from the transmission side, a more powerful RF amplified signal is required to be transmitted than would otherwise be required. In order to ensure a consistent radiated RF transmit power from the antenna, the RF power amplifier needs to provide a much larger RF output signal, to compensate for the signal losses that result from having an inefficient antenna connection. This results in an increase in power consumption of the radio communications device, which is clearly undesirable.

Therefore, there is a need for a wireless communication device with an improved antenna connector, which provides a more reliable electrical connection between the antenna and the PCB.

A still further problem encountered by these prior art connectors is that they are affixed, for example by soldering, to the PCB. This not only requires a further manufacturing step, but also hinders servicing and maintenance, for example when the connector becomes worn or damaged, since they are not easily removed and replaced.

Therefore, there is a further need for a wireless communication device with an improved antenna connector, which provides a more reliable electrical connection and facilitates the assembling and disassembling of the connector to/from the antenna and PCB.

Statement of Invention

According to a first aspect of the present invention, there is provided a wireless communication device, according to Claim 1.

According to a second aspect of the present invention, there is provided a wireless communication device, according to Claim 2.

According to a third aspect of the present invention, there is provided an antenna connector, according to Claim 10.

Brief Description of the Drawings

FIG. 1 and FIG. 2 illustrate examples of known antenna connectors.

FIG. 3 is a cross-sectional illustration of an antenna connector and a mechanism for connecting an antenna to a printed circuit board according to the present invention.

FIG. 4 is a side view illustration of an arm of the antenna connector of FIG. 3, connecting the antenna to the printed circuit board.

Description of Preferred Embodiments

Referring to FIG.3 there is illustrated an arrangement according to the present invention, comprising a connector 300 for connecting an antenna 310 to a printed circuit board (PCB) 320. Such an arrangement is particularly suited for use in devices such as radio communications devices, for example mobile cellular telephones, or the like.

The antenna 310, which for the illustrated embodiment is a patch antenna, comprises a radio, or wireless, transmission/reception element 312, which in use transmits and receives radio frequency (RF) signals. The antenna 310 is connected to a flexible PCB 311, which is preferably attached to a cellular phone housing 313. The flexible PCB 311 further comprises a PCB engaging element 316, which in use is located about an edge 322 of the PCB 320. It will be appreciated that the mechanism for connecting an antenna to a PCB in the present invention is not limited to use with patch antennae, but may alternatively be applied for any form of antenna to be electrically connected to a PCB. For example, a helical coil arrangement could be affixed to the flexible PCB 311.

For the illustrated embodiment, the antenna 310 comprises a flexible PCB 311, on a region of which the transmission/reception element 312 of the antenna 310 is provided. The transmission/reception element 312 may be provided by any suitable means, such as by printing/etching conductive tracking onto/into the surface of the flexible PCB.

The flexible PCB 311 preferably comprises a flexible intermediate part 314, extending from the region on which the transmission/reception element 312 is provided. In this regard, the flexible PCB includes a first portion 311 that attaches to the radiating element 312, second portion 314 providing a flexible distance between the (fixed) PCB 320 and the antenna 310 and a third PCB engaging portion 316 for attaching to the PCB 320. Preferably the region on which the transmission/reception element 312 is provided is affixed, for example by way of adhesive, to a substantially rigid structure 313, for example an inner surface of a cover of the radio communications device in which the antenna 310 is used, in order to maintain the general configuration (structure) of the transmission/reception element 312. Preferably the transmission/reception element 312 is provided on an opposing face of the antenna to that which is affixed to the rigid structure. However, the present invention is not limited to the transmission/reception element 312 being on a surface of the antenna 310 facing the PCB, as illustrated in FIG. 3.

Thus, for the illustrated embodiment, the PCB engaging part 316 of the antenna 310 is located about the edge 322 of the PCB 320 preferably by folding thereof, as is illustrated in FIG. 3.

The PCB 320 comprises at least one electrical contact part 324, located proximate to the edge 322 thereof. The antenna 310 also comprises at least one electrical contact part (not shown), which is preferably located on the PCB engaging part 316.

In use, the electrical contact parts 324 of the PCB 320 and the PCB engaging element 316 of the antenna 310 electrically engage one another.

Although in the illustrated embodiment the electrical contact parts in use are located on a surface of the PCB 320 facing the region of the antenna 310 on which the transmission/reception element 312 is provided, they may alternatively/additionally be provided on the opposing surface of the PCB 320.

The electrical contact part 324 of the PCB 320 is preferably provided by an area of conductive tracking printed or etched onto/into the surface of the PCB 320. The electrical contact part 324 is electrically coupled to RF circuitry (not shown), such as a front-end switch, which in turn is coupled to an RF transmit chain and an RF receive chain of the radio communications device. RF circuitry, such as is commonly used in mobile radio or cellular telephones or the like, is well known in the art, and so will not be described further.

The electrical contact part of the PCB engaging part 316 of the antenna 310 is preferably also printed onto the surface of the flexible PCB. In this manner, the PCB engaging part 316 is electrically coupled to the transmission/reception element 312 via, for example, further conductive tracking or the like provided in/on the flexible PCB.

In accordance with the preferred embodiment of the present invention, a connector 300 is applied to the PCB engaging part 316 to facilitate a gripping action of the PCB engaging part 316 with the (fixed) PCB 320. In use the connector 300 has two distal ends that are forcibly separated from their natural state in order that they can be coupled to the PCB engaging part 316.

When positioned as described above, the connector 300 applies a first force 'A' at a first point substantially adjacent the electrical contact parts 324 of the PCB 320 and PCB engaging part 316 of the antenna 310. Advantageously, this force improves the electrical contact with the PCB engaging element 316 and the electrical contact part 324 of the PCB 320. The connector 300 also applies a second force 'B' at a second point, preferably on an opposing side of the PCB 320, and in an opposing direction to the force 'A' applied to the first point.

A skilled artisan will appreciate that the aforementioned opposing force relationship, around the electrical contact points are the preferred positions. In other configurations, other locations of the applied force could be used within the contemplation of the present invention.

In this way, the connector 300 retains the PCB 320 and the PCB engaging element 316 of the antenna 310 in place relative to one another such that the at least one electrical contact part 324 of the antenna 310 and PCB 320 remain in electrical contact with one another.

Preferably the PCB engaging part 316 of the antenna 310 is located, i.e. folded, about the edge of the PCB 320 such that it doubles back under the PCB 320 as illustrated in FIG. 3. In this way, it is acted upon by both forces 'A' and 'B', being retained in position relative to the PCB 320 more securely by the connector 300.

In the illustrated embodiment, the connector 300 is substantially 'U' shaped, comprising two opposing arms 302a, 302b, which in use are located one either side of the PCB 320, and which apply the forces 'A' and 'B' respectively. The two arms 302a, 302b extend transversely from each side of a central part 304 of the connector

300, which in use is located substantially adjacent the edge 322 of the PCB 320.

The arms 302a, 302b preferably extend at an acute angle to one another, being closer to one another at ends distant from the central part 304. When the connector 300 is not in use, and is in a relaxed state, i.e. with no object (PCB) between the two arms 302a, 302b, the distance between the ends of the arms 302a, 302b distant from the central part 304 is preferably less than the combined thickness of the PCB 320, electrical contact part 324 of the PCB 320 and the PCB engaging part 316 of the antenna. Note that, in the preferred embodiment, this distance includes twice the thickness of the PCB engaging part 316, which is doubled back under the PCB 320 as illustrated.

In this way, when the connector 300 is located in position, as illustrated in FIG. 3, the arms 302a, 302b are pushed away from one another in order for the PCB 320 and PCB engaging part 316 of the antenna 310 to fit there between. The connector 300 is preferably made from a material having a resilient nature such that this resilient nature combined with the form of the connector 300 provides the forces 'A' and 'B' in reaction to the arms 302a, 302b being pushed apart.

Preferably the ends of the arms 302a, 302b are angled away from one another, as illustrated, in order to facilitate the insertion of the connector over the PCB engaging part 316 and the edge 322 of the PCB 320.

The use of such antenna connectors allows a non-permanent connection between the antenna and PCB, which is particularly desirable in the assembly, servicing and maintenance of radio communication devices. Also, since the connector 300 is preferably not affixed, for example by soldering or the like, to either the antenna 310 or the PCB 320, the assembly, servicing and maintenance of the radio communications device is further facilitated due to the ease of assembling and disassembling the connection between the antenna and PCB.

Furthermore, since the forces 'A' and 'B', applied by the connector 300 to maintain the PCB engaging part 316 of the antenna 310 and the PCB 320 in position relative to one another, act against each other in a compressive manner relative to the PCB engaging part 316 of the antenna 310 and the PCB 320, neither the PCB 320 nor the antenna 310 experience excessive stress, allowing a greater force to be exerted than by the prior art connectors previously described. In this way, a more consistent and reliable electrical connection between the electrical engagement parts of the antenna 310 and PCB 320 can be achieved, improving the performance of the antenna 310. This in turn improves the performance of the radio communication device, in which the present invention is applied.

The form of the connector 300 illustrated in FIG. 3 is also more durable than those of the prior art connectors described. Thus, the resilience of the connector 300 is less likely to degrade, and so the connector is less likely to require replacing during the lifetime of the radio communications device in which it is used.

Another advantage that the connector 300 of the present invention has over the prior art connector of FIG. 1 is that it does not suffer from the affect of inductance of a spring element.

It is within the contemplation of the present invention that the inventive concepts herein described are not limited to the use of a flexible PCB for the antenna 310. Any suitable alternative may be used, for example the antenna may comprise a substantially rigid PCB on which the transmission/reception element 312 is printed or etched.

Where the transmission/reception element 312 is printed/etched on a substantially rigid substrate, preferably the antenna 310 comprises a substantially flexible element to provide the intermediate part 314 between the regions on which the transmission/reception element 312 is provided and the PCB engaging part 316. This allows relative movement between the antenna 310 and the PCB 320, thereby facilitating manufacture, servicing and maintenance of the cellular phone/antenna. Furthermore, the structure reduces the effects of vibrations or knocks experienced by the radio communications device on the antenna/PCB connection.

The PCB engaging part 316 of the antenna 310 is also not limited to being provided by flexible PCB, but may alternatively be provided by any other suitable material or part capable of being located about the edge of the PCB 320 in a pliable or flexible manner.

The connector 300 is not limited to the preferred, substantially 'U' shaped element, as illustrated in FIG. 3. The connector 300, in other configurations, may comprise any other suitable form or configuration whereby a first force would be applied at a point substantially adjacent the electrical contact parts of the PCB 320 and PCB engagement part 316 of the antenna 310, urging the PCB engaging part 316 of the antenna 310 generally toward the PCB 320. A second force would be applied, generally opposing the first force, retaining the PCB 320 and PCB engagement part 316 of the antenna 310 in position relative to one another.

Preferably the connector 300 is retained in position solely by virtue of friction provided by the opposing forces on the PCB 320 and PCB engagement part 316 of the antenna 310. Furthermore, the connector 300 is preferably located in position by simply being slid over both the edge 322 of the PCB 320 and PCB engagement part 316 of the antenna 310 in a direction 'C', substantially perpendicular to the opposing forces provided thereby.

Advantageously, the mechanical operable coupling of the connector 300 with the PCB engagement part 316, and the mechanical and electrical coupling of the PCB engagement part 316 and PCB 320 are hardly affected by movement of the antenna relative to the PCB. As mentioned earlier, such relative movement is a common problem with antenna connectors in current portable wireless communications such as phones due to vibrations, forces acting on the housing of the device, for example when gripped by a user, and sharp jolts caused, for example, by the device being dropped.

A yet further advantage of the above coupling mechanisms of the present invention is that the only relevant tolerances to be considered in the design are the width of the PCB (and PCB engaging part of antenna) and the accuracy of manufacturing the connector. Therefore the 'tolerance stack up' is greatly reduced, aiding in both design of the assembly and the reliability of the assembly.

Furthermore, the above coupling mechanisms do not suffer from their physical, mechanical and electrical properties having to be as carefully designed as known antenna connector arrangements.

Referring now to FIG. 4, further preferred features of the connector 300, antenna 310 and PCB 320 are illustrated.

As can be seen, the PCB 320 preferably comprises two electrical contact parts 324, with the PCB engaging part 316 of the antenna 310 comprising two corresponding electrical contact parts (not shown). In this way, an electrical connection can be provided for a ground line and a signal line, or two differential signal lines.

The PCB 320 preferably further comprises a protrusion 326 extending from the edge 322 thereof. The connector 300 also comprises an aperture or slot 306 generally corresponding to the protrusion 326 of the PCB 320. The PCB engaging part 316 of the antenna 310 also comprises an aperture or slot (not shown) generally corresponding to the protrusion 326 of the PCB 320.

Thus, in use, the apertures or slots of the connector 300 and PCB engaging part 316 of the antenna 310 receive the protrusion 326 of the PCB 320, facilitating the correct alignment and location of the connector 300, PCB 320 and PCB engaging part 316 of the antenna 310 relative to one another. This ensures that the electrical contact parts of the PCB 320 and PCB engaging part 316 of the antenna 310 engage one another.

Finally, the connector 300 may have one or more cut away sections 308 on each of the arms 302a, 302b, proximate the ends of the arms 302a, 302b and distant from the central part 304. In this way, the ends of the arms 302a, 302b distant from the central part 304 are more flexible, facilitating easier and more accurately locating of the connector 300.

Thus, a wireless communication device with an improved antenna connector and mechanism for connecting an antenna to a PCB have been described, which provide a more reliable electrical connection between the antenna and the PCB. Furthermore, the improved antenna connector facilitates easier assembling and disassembling of the connector to/from the antenna and PCB.

Whilst the specific and preferred implementations of the embodiments of the present invention are described above, it is clear that one skilled in the art could readily apply variations and modifications of such inventive concepts.

Claims

1. A wireless communication device comprising:

an antenna for radiating and/or receiving radiated signals,

a printed circuit board operably coupled to said antenna for routing electrical signals to said antenna; and

a connector mechanism for connecting said antenna to said printed circuit board;

wherein said wireless communication device is characterised by said antenna providing an electrical connection to said printed circuit board and said connector mechanism facilitating a mechanical connection of said antenna to said printed circuit board.

2. A wireless communication device, for example the wireless communication device according to Claim 1, comprising:

an antenna for radiating and/or receiving radiated signals,

a printed circuit board operably coupled to said antenna for routing electrical signals to said antenna; and

a connector mechanism for connecting said antenna to said printed circuit board;

wherein said wireless communication device is characterised by said antenna being attached to a flexible printed circuit board, which, in combination provides both an electrical connection and a spatial separation to said printed circuit board.

3. The wireless communication device according to Claim 1 or Claim 2, said wireless communication device further characterised by said connector mechanism being configured to apply a force on said printed circuit and said antenna, in use, substantially adjacent complimentary electrical parts of said antenna and said printed circuit board to bring said complimentary electrical parts into electrical contact.

4. The wireless communication device according to any preceding Claim, wherein said antenna is operably coupled to a flexible printed circuit board and configured to fold around a part of said printed circuit board to provide both electrical and mechanical coupling.

5. The wireless communication device according to any preceding Claim, wherein said antenna is a patch antenna for use in a cellular phone.

6. The wireless communication device according to any preceding Claim, wherein said connector mechanism is substantially 'U' shaped including two substantially opposing arms arranged to provide a gripping action on said antenna and said printed circuit board to effect an electrical contact.

7. The wireless communication device according to Claim 6, wherein said two substantially opposing arms extend at an acute angle to one another.

8. The wireless communication device according to Claim 6 or Claim 7, wherein said two substantially opposing arms, when not in use, have has a distance therebetween less than a depth of said printed circuit board and said antenna portion(s), such that in use, a mechanical force is applied by separating said arms from their natural state.

9. The wireless communication device according to Claim 6 or Claim 7 or Claim 8, wherein at least one of said two substantially opposing arms includes an open end that extends away from said opposing arm to facilitate easier insertion and disassembly of the connector mechanism around said printed circuit board and said antenna portion(s).

10. The wireless communication device according to any preceding Claim, wherein said printed circuit board includes a protrusion extending from an edge of said printed circuit board, and said antenna portion includes a complementary aperture for slotting over said protrusion to affix said antenna portion to said printed circuit board.

11. An antenna connector for use in the wireless communication device according to any preceding Claim.

12. A wireless communication device having an antenna connector arrangement substantially as hereinbefore described with reference to, and/or as illustrated by, FIG.3 or FIG. 4 of the accompanying drawings.

Application No:	GB 0214104.2	**Examiner:**	Alastair Kelly
Claims searched:	1 to 12	**Date of search:**	26 November 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): H2E EEKD, EEKE, EHC

Int Cl (Ed.7): H01R 12/32, H04Q 1/24

Other: On-line: EPODOC, WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	US6426724	(GUNEE) fig 4,5 and 6	1,3,5,11
X	US2001/0008839	(CHO) fig 9 and 10	1,5,11
X	WO02/078123	(BOLIN) figure 5	1,5,11

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application
&	Member of the same patent family		