



Multi-Position Patch Antenna and Method Therefor

Field of the Invention

5 The present invention pertains to antennas for communication apparatus.

Background of the Invention

10 Radio communication devices include a transmitter and/or receiver coupled to an antenna which emits and/or detects radio frequency signals. The device may include a microphone for inputting audio signals to a transmitter or a speaker for outputting signals received by a receiver. Examples of such radio communication
15 devices include one way radios, two way radios, radio telephones, personal communication devices, and a variety of other equipment. These communication devices often have a standby configuration, wherein the device is collapsed for storage, and an active communication configuration, wherein the antennae is extended for
20 optimum performance.

 For radio telephones and two-way radios, it is typically desirable that these devices have a small size during a standby mode to facilitate storage and transport thereof. For example, users
25 prefer that the radio telephones are small enough in the standby mode to permit storage in a shirt or jacket pocket. In the active communication state, it is desirable for the device to be sufficiently long to position the speaker adjacent to the user's ear, the microphone near the user's mouth, and the antenna away from the
30 user's body. It is desirable for the antenna to be positioned away from the user's body since the user's body is a ground plane that interferes with radio frequency signal reception. One particularly effective way of positioning the antenna away from the user's body is to extend the antenna away from the device body during use. By
35 providing an antenna which collapses for storage and extends for



active communication, an antenna with optimum active mode operation is provided in a readily storable device.

5 A difficulty encountered with such reconfigurable communication devices is providing a high performance antenna in the standby mode. For example, radio telephones are known that receive paging signals, electronic mail, and call alerting signals in the standby mode. However, the body of the device, including the internal electronic circuitry within the body, is typically in the
10 reactive near-field of the antenna in the storage position. This mass in the reactive near-field degrades performance of the antenna, which is detrimental to signal reception in the standby mode.

15 Accordingly, it is desirable to provide an antenna system having high performance characteristics when the communication device is extended in an active communication mode and when the communication device is collapsed in a standby mode of operation.

Brief Description of the Drawings

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FIG. 1 is a front perspective view illustrating an extended radio telephone including an antenna system according to the invention;

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FIG. 2 is a front perspective view illustrating a collapsed radio telephone according to FIG. 1 which is in the standby configuration;

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FIG. 3 is an exploded top perspective view illustrating the front housing, the radio frequency (RF) printed circuit board, the logic printed circuit board, and the rear housing section;

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FIG. 4 is a fragmentary view illustrating the inside of the radio telephone housing according to FIG. 1 and schematically showing a transceiver;



FIG. 5 is a plan view of a cover of the radio telephone according to FIG. 1 with the cover front housing section removed and illustrating a first antenna;

5 FIG. 6 is a side elevational view of the cover antenna;

FIG. 7 is a top exploded perspective view illustrating the cover;

10 FIG. 8 is a bottom exploded perspective view illustrating the cover;

FIG. 9 is a top plan illustrating a patch antenna;

15 FIG. 10 is a top plan view illustrating a patch antenna;

FIG. 11 is a side elevational view illustrating schematically a radio telephone cover antenna in the open position; and

20 FIG. 12 is a cross sectional view illustrating the cover taken along plane XII-XII in FIG. 11.

Detailed Description of the Drawings

25 A radio communication device radio frequency circuitry positioned in the first housing portion. A second housing portion is movably supported on the first housing portion to move between an extended open position and a collapsed position, the second housing portion projecting outwardly from the first housing portion in the open position. An antenna assembly is positioned in the second
30 housing portion. The antenna assembly includes an antenna conductor and a ground member, the ground member positioned between the antenna conductor and the radio frequency circuitry when the first and second housing portions are in the collapsed position.

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The antenna system according to the invention is illustrated in a radio telephone 100 including a cover 103 (FIG. 1), wherein the immediate invention is particularly advantageous. However, the invention may also be advantageously employed in other devices, such as one way and two way radios, or any other communication device employing an antenna. Accordingly, "device" as used herein refers to all such equipment and their equivalents.

A radio telephone 100 is illustrated in FIG. 1. The radio telephone includes a housing 102 including a first housing portion 101 and a second housing portion 103. In the illustrated embodiment, the first housing portion 101 is a radio telephone body and the second housing portion 103 is a cover pivotably connected to the body. The cover housing portion 103 moves between an extended, or open, position illustrated in FIG. 1 during an active communication mode and a collapsed, or closed position, illustrated in FIG. 2, in a standby mode.

The radio telephone body 101 includes a back body housing section 104 and a front body housing section 105 which are interconnected to define an interior volume housing electronic circuitry including an RF printed circuit board 315 (FIG. 3) and a logic printed circuit board 314. A key pad 106 includes keys 109 (only some of which are numbered) associated with the keypad. Keys 109 are accessible for manual actuation by the user to selectively close popple switches 322 (only some of which are numbered). The illustrated cover housing portion 103 at least partially covers key pad 106 when closed. The cover housing portion may be longer to cover all the keys. The cover housing portion prevents actuation of the keys 109 thereby when the cover is closed. Additionally, the cover housing portion may place the telephone in a standby mode when closed.

The cover housing portion 103 includes an antenna 107, which is referred to herein as a cover antenna. The cover antenna is



positioned between a front cover housing 111 (FIGs. 7 and 8) and a back cover housing section 112, and thus is illustrated in phantom in FIG. 1. The front cover and back cover housing sections 111 and 112 are generally planar members. The back cover housing section 112 includes a recess 439 for receipt of antenna 107 and front housing portion 111. The cover housing sections are manufactured of a suitable dielectric material, such as an organic polymer. The cover antenna 107 is sandwiched between these members. The cover antenna 107 is in an extended position illustrated in FIG. 1 when the cover 103 is open. The cover antenna is in a collapsed, or retracted, position when cover 103 is closed (FIG. 2).

Transceiver circuitry 415 is schematically illustrated in FIG. 4. The transceiver circuitry is mounted on RF circuit board 315 (FIG. 3). The transceiver circuitry may be implemented using any suitable conventional transceiver. The transceiver circuitry 415 is positioned in first housing portion 101 by conventional means, such as by assembling printed circuit board 315 to the front housing section 105. The transceiver circuitry is connected to an elastomeric connector 319 or other means, which connects to a flex conductor 320. The flex conductor 320 extends into a hinge assembly 418. Hinge assembly 418 includes a knuckle 419

As illustrated in FIG. 5, the hinge assembly 418 also includes a knuckle 420 on cover housing portion 103 to engage knuckle 419. The flex conductor, or transmission line, 320 is connected to the cover antenna 107 through the hinge assembly 318 when the cover 103 is connected to the body 102. The transmission line and hinge assembly 418 providing the connection between the cover antenna 107 and the transceiver circuitry 415 may have any suitable construction, such as the hinge disclosed in United States patent application Serial No. 08/148, 718, filed on 08 November 1993 in the name of Tanya Rush et al., the disclosure of which is incorporated herein by reference thereto.



The cover antenna 107 is a patch antenna which will be described with reference to FIGs. 6, 9 and 10. The antenna includes a patch conductor 542, a dielectric layer 544, and a ground layer 446. The patch conductor 542 is microstrip patch. The conductor 542 (FIG. 9) is illustrated as a half wavelength, generally rectangular conductor applied as a thin film to the dielectric layer 544. Alternately, the patch conductor 542 can be a quarter wavelength conductor with the edge remote from feed line 440 connected to ground layer 546 by conducting connectors 550. It will be recognized by those skilled in the art, that the configuration of the patch conductor can be a circle, an oval, a square, or any other suitable configuration. The conductor may be manufactured of any suitable electrically conductive material, such as copper, a copper alloy, an aluminum alloy, or any other suitable material which can be applied in a thin layer to the dielectric by spraying the material in a liquid state or attaching the material in a solid state using an adhesive. The patch conductor is connected to transceiver circuitry 415 via feedline conductor 440, strip 320, and conductor 319. Conductor 440 is connected to patch conductor 542, by any suitable means such as soldering, direct connection of the two conductors using tape, or any other suitable means.

The dielectric layer 544 is preferably a high dielectric constant material. Those skilled in the art will recognize that the higher the dielectric constant of the material utilized for the dielectric layer, the smaller the pattern of conductor 542 can be. The dielectric may alternately be a loaded dielectric. The dielectric is preferably a stronger material which can withstand forces exerted on the device if it is dropped or otherwise mishandled. Accordingly, Duroid 6010, having a dielectric value of 10, is a preferred dielectric material because it will not break if the radio telephone 100 is dropped. Ceramics having higher dielectric values can be used instead of Duroid 6010.



The ground layer 446 is provided by any suitable electrical conductor. For example, the ground layer is a copper alloy, rectangular plate. The ground layer, or member, 446 is connected to ground through conductor 441, flex strip 420, and a conductor 338. Ground conductor 338 is connected to ground circuit, which includes a metalized layer applied to the interior radio telephone housing 105. Conductor 441 is connected to ground member 446, by any suitable means such as soldiering direct contact of the two conductors with tape over the contact point, or any other suitable means.

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To assemble the cover, the cover antenna 107 is inserted into recess 439 (FIG. 7) with ground layer 446 facing upwardly. In this orientation, the patch conductor 542 faces downwardly and abuts with the interior surface 760 in back cover housing section 112. The front cover housing 111 is then placed into recess 439 over the patch antenna 107. The front and rear housings may be attached by suitable adhesives, fasteners, or the like.

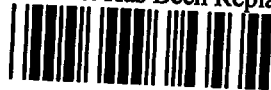
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Flex strips 440 and 441 extend outwardly from the cover housing portion. These conductors are merged into flex strip 320. Flex strip 320 is inserted to extend through the hinge 418 and into the body housing section 105. The conductors in the flex strip are separated for connection to ground conductor 338 and transceiver circuitry 415.

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In operation, in the open position illustrated in FIG. 11, the user's face (not shown) is positioned such that the user's ear is pressed against ear piece 160 (FIG. 1) and the user's cheek is located adjacent to keypad 106. The patch antenna 107 is positioned in the cover such that the ground member abuts front housing section 111 facing the user. Consequently, the patch conductor 542 (FIGs. 11 and 12) faces away from the user, and into free space. Thus, the ground member 446 is positioned between the patch conductor and the user and operates as a shield between the user and the patch. The user's

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body will not interfere with the tuning of patch conductor 542 in the active position.

5 In the closed position illustrated in FIG. 2, back housing
section 112 faces away from the internal electronic circuit boards 314
and 315 within radio telephone body 102. The ground layer 446
positioned against front cover section 111 (FIG. 12), which abuts with
the keypad 106. Thus, the ground layer 446 is positioned between
the patch conductor and electronic circuits in housing 102. The
10 ground layer provides a shield between the radio frequency circuitry
within the radio telephone body housing portion 102 and the
conductive patch layer 542. This grounded shield limits the effect of
the transceiver circuitry on the tuning of the patch antenna in the
closed position. The patch antenna thus has substantially the same
15 tuning characteristics in both the collapsed storage position and the
extended active position. Consequently, operation constancy of the
antenna in the collapsed and stored positions is significantly
improved.

20 In practice, it is envisioned that a flexible dielectric layer, such
as Duroid 6010 commercially available from Rogers Corporation in
Chandler Arizona will be employed. For such a dielectric, a half wave
length for an 800 MHz operating frequency of the transceiver
requires approximately 5.92 cm and the quarter wavelength requires
25 approximately 3 cm. For 1500 MHz, the half wavelength
implementation requires approximately 3.2 cm and the quarter
wavelength embodiment requires approximately 1.6 cm. The
dielectric and ground members preferably have outer dimensions
larger than the patch conductor, as illustrated in FIGs. 9 and 10.



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CLAIMS

What is claimed is:

- 5 1. A portable radio communication device (100),
comprising:
 a first housing portion (101)
 radio frequency circuitry (415) positioned in the first housing
 portion;
10 a second housing portion (103) movably supported on the first
housing portion to move between an extended open position and a
collapsed position, the second housing portion projecting outwardly
from the first housing portion in the open position;
 an antenna assembly (107) positioned in the second housing
15 portion, the antenna assembly including
 an antenna conductor (542),
 a flexible dielectric layer (544), the antenna conductor
 mounted to the flexible dielectric layer,
 a ground conductor (446) attached to the flexible
20 dielectric layer, the ground conductor positioned between the
antenna conductor and the radio frequency circuitry when the
first and second housing portions are in the collapsed position;
 and
 a feedline strip (440) coupled between the antenna conductor
25 and the radio frequency circuitry.
2. The portable radio communication device as defined in
claim 1, wherein the ground conductor (446) is a planar member
having a perimeter dimension larger than a perimeter dimension of
30 the antenna conductor (542).
3. The portable radio communication device as defined in
claim 2, wherein the flexible dielectric layer (542) is a high dielectric
constant materiel.

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4. The portable radio communication device as defined in claim 3, wherein the second housing portion is a cover including dielectric sections (111, 112) and the antenna assembly (107) is sandwiched between the dielectric sections.

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5. The portable radio communication device as defined in claim 4, wherein the housing portions are connected by a hinge assembly (418) and the feedline strip includes a flexible conductor extending through the hinge assembly.

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