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(54) Title: AN ANTENNA DEVICE AND A PORTABLE RADIO COMMUNICATION DEVICE COMPRISING SUCH AN ANTENNA DEVICE

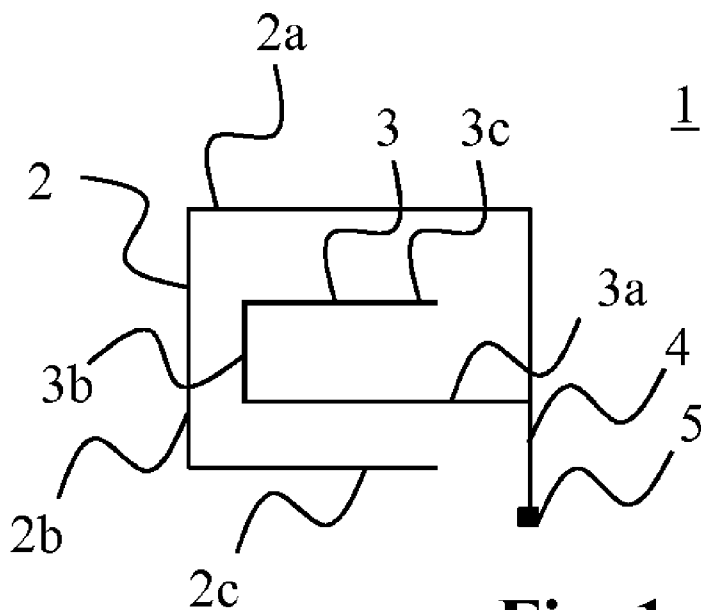


Fig. 1

(57) Abstract: The present invention relates to an antenna device (1) for a portable radio communication device (6) adapted for receiving radio signals in at least one frequency band, said antenna device (1; 10) comprising a radiating element having a first branch (2; 12) and a second branch (3; 13) connected to a common elongated feeding section (4; 14), being configurable to receiving right-hand side circularly polarized and left-hand side circularly polarized signals.

AN ANTENNA DEVICE AND A PORTABLE RADIO COMMUNICATION
DEVICE COMPRISING SUCH AN ANTENNA DEVICE

5 FIELD OF INVENTION

The present invention relates generally to antenna devices and more particularly to an antenna device for a portable radio communication device, such as a mobile phone, comprising a radiating element having two
10 branches.

BACKGROUND

Internal antennas have been used for some time in portable radio communication devices. There are a number of advantages connected with using internal antennas, of
15 which can be mentioned that they are small and light, making them suitable for applications wherein size and weight are of importance, such as in mobile phones.

However, the application of internal antennas in a mobile phone puts some constraints on the configuration
20 of the antenna device. In particular, in a portable radio communication device the space for an internal antenna device is limited. These constraints may make it difficult to find a configuration of the antenna that provides for desired operating band coverage.

25 Further, a portable radio communication device is today many times required to be provided with multiple frequency band coverage for a plurality of cellular operational frequency bands, such as GSM850, GSM900, GSM1800, GSM1900, and WCDMA, as well as a plurality of
30 non-cellular operational frequency bands, such as GPS, BT and FM. A portable radio communication device has

limited space and it is thus desirable to add multiple frequency band coverage to an antenna device.

For GPS operation in e.g. a mobile phone there exist requirements for the mobile phone to receive right-hand
5 circularly polarized signals as well as left-hand circularly polarized signals and a quota there between. It is thus desirable for an antenna device in a mobile phone to provide functionality fulfilling such requirements.

10 SUMMARY OF THE INVENTION

An object of the present invention is to provide an antenna device for a portable radio communication device, which can be configured to facilitate reception of circularly polarized signals, as well as be
15 configured to facilitate reception of at least two separate operation frequency bands.

According to the present invention there is provided an antenna device for a portable radio communication device adapted for receiving radio signals in at least
20 one frequency band, the antenna device comprising a radiating element having a first branch and a second branch connected to a common elongated feeding section, wherein the first branch comprises a first elongated section in a first end connected to a first end of the
25 common elongated feeding section, a second elongated section in a first end connected to a second end, opposite the first end, of the first section of the first branch, and a third elongated section in a first end connected to a second end, opposite the first end,
30 of the second section of the first branch and in a second end, opposite the first end, of the third

section of the first branch being open ended, wherein the first and third sections of the first branch being essentially parallel, the second branch comprises a first elongated section in a first end connected to a mid portion of the common elongated feeding section, a second elongated section in a first end connected to a second end, opposite the first end, of the first section of the second branch, and a third elongated section in a first end connected to a second end, opposite the first end, of the second section of the second branch and in a second end, opposite the first end, of the third section of the second branch being open ended, wherein the first and third sections of the second branch being essentially parallel, the first section of the second branch is between the third section of the second branch and the third section of the first branch, and the first branch at least partly surrounds the second branch. Such an antenna device can easily be configured to receive both GPS frequencies as well as BT frequencies, and can

easily be configured to receive both right-hand side circularly polarized signals as well as suppress left-hand side circularly polarized signals in the upper hemisphere.

The first section of the first branch is preferably arranged essentially perpendicularly to the feeding section, and the first section of the second branch is preferably arranged essentially perpendicularly to the feeding section, to further facilitate reception of circularly polarized signals.

The antenna device is advantageously arranged off-ground in the portable radio communication device, to facilitate broad band coverage. When available off-ground space is particularly sparse, the antenna device
5 is preferably arranged on-ground in the portable radio communication device.

A portable radio communication device comprising an antenna device having two branches is also provided.

Further preferred embodiments are defined in the
10 dependent claims.

BRIEF DESCRIPTION OF DRAWINGS

The invention is now described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a schematic illustration showing an antenna
15 device according to a first embodiment of the present invention.

FIG. 2 is a schematic illustration showing a first position of an antenna device in a portable radio communication device.

20 FIG. 3 is a schematic illustration showing a second position of an antenna device in a portable radio communication device.

DETAILED DESCRIPTION OF THE INVENTION

In the following, a detailed description of preferred
25 embodiments of an antenna device according to the invention will be given. In the description, for purposes of explanation and not limitation, specific details are set forth, such as particular hardware,

applications, techniques etc. in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be utilized in other
5 embodiments that depart from these specific details. In other instances, detailed descriptions of well-known methods, apparatuses, and circuits are omitted so as not to obscure the description of the present invention with unnecessary details.

10 In the following description and claims, the term radiating element is used. It is to be understood that this term is intended to cover electrically conductive elements arranged for receiving and/or transmitting radio signals.

15 An antenna device for a portable radio communication device according to a first embodiment of the present invention will now be described with reference to Figs. 1-3.

The portable radio communication device 6 may e.g. be a
20 mobile phone, a smart phone, a PDA, a portable computer or similar device, and will in this embodiment be described as a mobile phone. The antenna device 1 is arranged in a mobile phone 6 adapted for receiving radio signals in at least one frequency band, the
25 antenna device 1 comprising a radiating element having a first branch 2 and a second branch 3 connected to a common elongated feeding section 4.

The first branch 2 comprises a first elongated section 2a in a first end connected to a first end of the
30 common elongated feeding section 4, a second elongated

section 2b in a first end connected to a second end, opposite the first end, of the first section 2a of the first branch 2, and a third elongated section 2c in a first end connected to a second end, opposite the first end, of the second section 2b of the first branch 2 and in a second end, opposite the first end, of the third section 2c of the first branch 2 being open ended, wherein the first 2a and third 2c sections of the first branch 2 being essentially parallel. This first branch 2 can be seen as a C connected to the feeding section 4.

The second branch 3 comprises a first elongated section 3a in a first end connected to a mid portion of the common elongated feeding section 4, a second elongated section 3b in a first end connected to a second end, opposite the first end, of the first section 3a of the second branch 3, and a third elongated section 3c in a first end connected to a second end, opposite the first end, of the second section 3b of the second branch 3 and in a second end, opposite the first end, of the third section 3c of the second branch 3 being open ended, wherein the first 3a and third 3c sections of the second branch 3 being essentially parallel. This second branch 3 can also be seen as a C connected to the feeding section 4. By the term mid portion of the feeding section 4 is merely meant a portion between the respective ends of the feeding section.

The first branch 2 at least partly surrounds the second branch 3, and the antenna device can be seen as a double C radiator.

The first section 3a of the second branch 3 is between the third section 3c of the second branch 3 and the third section 2c of the first branch 2. The antenna device 1 can with this configuration be seen as
5 antiparallel C radiators combined into a single radiator. By antiparallel is meant that the currents in the first branch 2 are essentially in anti-phase with the currents in the second branch 3.

The feeding point 5 of the antenna device is in a
10 second end, opposite the first end of the feeding section 4. A fictitious extension of the third section 2c of the second branch preferably crosses the feeding section 4.

The first section 2a of the first branch 2 is arranged
15 essentially perpendicularly to the feeding section 4, and the first section 3a of the second branch 3 is arranged essentially perpendicularly to the feeding section 4.

In a typical user configuration for a mobile phone the
20 antenna device is configured for receiving right-hand side circularly polarized signals in the upper hemisphere, and to suppress left-hand side circularly polarized signals in the upper hemisphere, by the first branch 2 being open-ended in a anti-clockwise circular
25 direction and the second branch 3 being open-ended in a clockwise circular direction.

The antenna device is configured to, in the at least one frequency band, include a GPS operating frequency band, by the first branch 2 having a size of about $14 \times 7 \text{ mm}^2$,
30 and a volume of about 0.27 cm^3 . The length of the

first branch 2 is preferably predefined for tuning of the center frequency for the at least one frequency band GPS.

The antenna device is preferably also adapted for
5 receiving radio signals in a second separate frequency band, including a BT operating frequency band, by the second branch 3 having a size of about $12 \times 5 \text{ mm}^2$, and a volume of about 0.27 cm^3 . The length of the second branch 3 is preferably predefined for tuning of the
10 center frequency for the second frequency band BT.

The distance between the first branch 2 and the second branch 3 is preferably predefined to tune the separating frequency between the center frequency of the at least one frequency band and the second separate
15 frequency band

The antenna device is advantageously arranged off-ground in the mobile phone 6. The mobile phone 6 often has a large display having a shielding device 7 covering most of the back side part of the mobile phone
20 6. The antenna device 1 is advantageously arranged in the top left corner of the mobile phone 6, as seen from its back-side, which position is illustrated in Fig. 2. In this way hand and finger position of a user of the mobile phone is likely not to cover the GPS antenna.

25 In a further advantageous position, illustrated in Fig. 3, the antenna device 1 is positioned in the top most part of the left side of a mobile phone 6. The view of Fig. 3 is from the left-hand side of a mobile phone, having its top side to the left in the drawing.

Alternatively, if the available off-ground space of a mobile phone is not enough for the antenna device it is instead arranged on-ground in the portable radio communication device (not illustrated).

- 5 Preferred embodiments of an antenna device according to the present invention have been described. However, the person skilled in the art realizes that these can be varied within the scope of the appended claims without departing from the inventive idea.
- 10 It is realized that the shape and size of the antenna device according to the invention can be varied within the scope defined by the appended claims. Thus, the exact antenna configurations can be varied so as to correspond to the shape of the radio communication
- 15 device, desired performance etc.

CLAIMS

1. An antenna device (1; 10) for a portable radio communication device (6) adapted for receiving radio signals in at least one frequency band, said antenna device (1; 10) comprising a radiating element having a first branch (2; 12) and a second branch (3; 13) connected to a common elongated feeding section (4; 14), wherein

said first branch (2; 12) comprises a first elongated section (2a; 12a) in a first end connected to a first end of said common elongated feeding section (4; 14), a second elongated section (2b; 12b) in a first end connected to a second end, opposite said first end, of said first section (2a; 12a) of said first branch (2; 12), and a third elongated section (2c; 12c) in a first end connected to a second end, opposite said first end, of said second section (2b; 12b) of said first branch (2; 12) and in a second end, opposite said first end, of said third section (2c; 12c) of said first branch (2; 12) being open ended, wherein said first (2a; 12a) and third (2c; 12c) sections of said first branch (2; 12) being essentially parallel,

said second branch (3; 13) comprises a first elongated section (3a; 13a) in a first end connected to a mid portion of said common elongated feeding section (4; 14), a second elongated section (3b) in a first end connected to a second end, opposite said first end, of said first section (3a; 13a) of said second branch (3; 13), and a third elongated section (3c; 13c) in a first end connected to a second end, opposite said first end, of said second section (3b; 13b) of said second branch

(3; 13) and in a second end, opposite said first end, of said third section (3c; 13c) of said second branch (3; 13) being open ended, wherein said first (3a; 13a) and third (3c; 13c) sections of said second branch (3; 13) being essentially parallel,

said first section (3a) of said second branch (3) is between said third section (3c) of said second branch (3) and said third section (2c) of said first branch (2), and

said first branch (2; 12) at least partly surrounds said second branch (3; 13).

2. The antenna device as claimed in claim 1, comprising a feeding point (5; 15) in a second end, opposite said first end of said feeding section (4; 14).

3. The antenna device according to any of claims 1-2, wherein said first section (2a; 12a) of said first branch (2; 12) is arranged essentially perpendicularly to said feeding section (4; 14), and said first section (3a; 13a) of said second branch (3; 13) is arranged essentially perpendicularly to said feeding section (4; 14).

4. The antenna device according to any of claims 1-3, wherein said antenna device is configured for receiving right-hand side circularly polarized signals and suppressing left-hand side circularly polarized signals in the upper hemisphere.

5. The antenna device as claimed in any of claims 1-4, wherein said at least one frequency band includes a GPS operating frequency band.

6. The antenna device as claimed in any of claims 1-5, adapted for additionally receiving radio signals in a second separate frequency band, preferably including a BT operating frequency band.

5 7. The antenna device as claimed in any of claims 1-6, wherein said antenna device is arranged off-ground in said portable radio communication device.

8. The antenna device as claimed in any of claims 1-6, wherein said antenna device is arranged on-ground in
10 said portable radio communication device.

9. A portable radio communication device comprising an antenna device according to any previous claim.

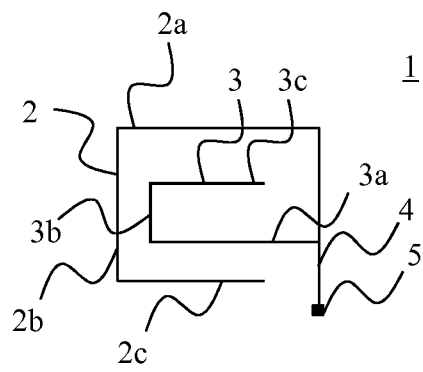


Fig. 1

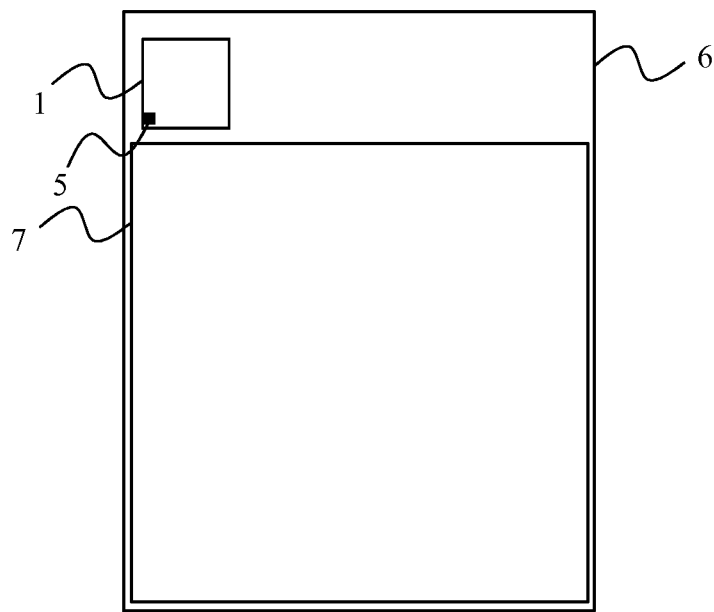


Fig. 2

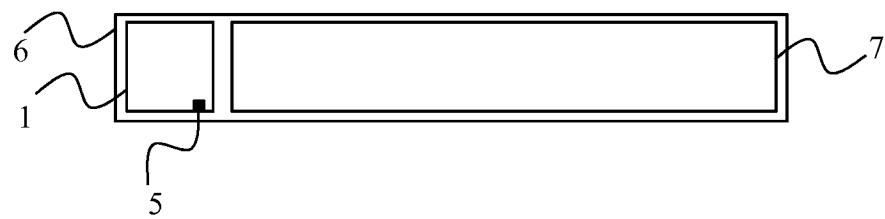


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/053849

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01Q21/30 H01Q1/24 H01Q9/42 H01Q5/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2005/062422 A1 (UNIV MACQUARIE [AU]; ESSELLE KARUNANAYAKE PATHIRANN [AU]; GE YUEHE [AU] 7 July 2005 (2005-07-07) page 30, line 1 - line 11; figure 6 -----	1-9
A	US 2004/119651 A1 (LECLERC DANIEL [FR] ET AL) 24 June 2004 (2004-06-24) abstract -----	1-9
A	US 2009/140931 A1 (CHO WON-WOO [KR] ET AL) 4 June 2009 (2009-06-04) paragraph [0024] - paragraph [0033]; figures 1-4 -----	1-9



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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