Title: CENTER OFFSET FED MULTIBAND MONOPOLE ANTENNA AND PORTABLE RADIO COMMUNICATION DEVICE COMPRISING SUCH AN ANTENNA

Abstract: The present invention relates to an antenna device for a portable radio communication device (2), wherein the antenna device comprises a monopole radiating element (3) to be positioned along one end of the portable radio communication device, for operation of a plurality of complementary frequency bands including the FM frequency band. The antenna device further comprises a feed (4) offset positioned on the monopole radiating element dividing the monopole radiating element in a first part (5) and a second part (6) to provide at least one complementary frequency band additional to the FM frequency band, which FM frequency band and the at least two additional complementary frequency bands are fed through the feed.
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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.

BACKGROUND

In portable radio communication devices, such as mobile phones, cellular antennas are often positioned in the lower end of the mobile phone to be positioned as much away from a user talking in the phone as possible. Complementary antennas, such as FM, BT, or GPS antennas are in such phones often positioned in the opposite upper end, where available space exists for such complementary antennas.

The available space for a plurality of complementary antennas is thus limited, which makes it difficult to provide adequate function for a plurality of complementary antennas in a portable radio communication device such as a mobile phone.

SUMMARY OF THE INVENTION

An object of the present invention is thus to provide an antenna device for a portable radio communication device, which allows the portable radio communication device to be provided with a plurality of complementary antennas.
A monopole FM antenna can be provided in a portable radio communication device, such as a mobile phone, e.g. along an edge of the mobile phone. The monopole FM antenna is typically positioned oppositely of a cellular antenna in the mobile phone. By having the monopole FM antenna covering an edge of the mobile phone and wherein the monopole FM antenna is being fed in a corner of the mobile phone, optimal performance is expected by to utilize maximum length of a ground plane of the mobile phone along the diagonal of the ground plane. Such a monopole FM antenna utilizes much of the available space of a portable radio communication device, such as a mobile phone. Other useful complementary antennas in a mobile phone are e.g. Bluetooth (BT), GPS, and WLAN antennas.

A possible solution for adding e.g. BT/GPS function to the FM antenna is to add BT/GPS branches to the FM antenna, but this would take up more space in the mobile phone, which is undesirable, and also risk causing unwanted resonances which degrade antenna isolation to cellular antennas in the mobile phone. In mobile phones today an upper edge of the mobile phone is many times 50 mm long or even 60 mm long. Such lengths are not suitable for BT and GPS frequencies, but if the monopole FM antenna would be shortened to not cover an edge of the mobile phone, FM performance would be degenerated in an undesirable way.

By feeding the monopole FM antenna offset from the corner of the mobile phone it has surprisingly been found that the FM performance is not noticeably degraded, and it is then possible to feed the monopole
FM antenna with at least one, and preferably two, complementary frequency bands apart from the FM frequency band, without risking e.g. degraded antenna isolation to cellular bands.

According to the present invention there is provided an antenna device for a portable radio communication device, comprising a monopole radiating element to be positioned along one end of the portable radio communication device, for operation of a plurality of complementary frequency bands including the FM frequency band, and comprising a feed offset positioned on the monopole radiating element dividing the monopole radiating element in a first part and a second part to provide at least one complementary frequency band additional to the FM frequency band, which FM frequency band and the at least one additional complementary frequency band are fed through the feed.

For good FM performance the monopole radiating element preferably covers the whole length of one end of the portable radio communication device.

For e.g. a mobile phone having width of about 50 mm, two preferably additional complementary frequency bands are BT and GPS.

For good isolation between the complementary bands and the cellular frequency bands of the portable radio communication device the portable radio communication device preferably comprises a separate radiating element for cellular frequency bands positioned along another end of the portable radio communication device.
opposite the one end wherein the complementary radiating element is positioned.

For implementation of three complementary antennas on a single monopole radiating element the antenna device preferably comprising a diplexer connected to the feed through matching means for the at least two additional complementary frequency bands, and an LNA connected to the feed through matching means for the FM frequency band.

The monopole radiating element is preferably positioned at most 5 mm from the one end for optimal FM performance.

Further features and advantages of the present invention will be evident from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description of embodiments given below and the accompanying figures, which are given by way of illustration only, and thus, are not limitative of the present invention, wherein:

Fig. 1 schematically illustrates an antenna device in a portable radio communication device according to a first embodiment of the present invention.

Fig. 2 illustrates a detailed implementation of an antenna device in a portable radio communication device.
DETAILED DESCRIPTION OF THE INVENTION

In the following description, for purpose of explanation and not limitation, specific details are set forth, such as particular techniques and applications in order to provide a thorough understanding of the present invention. However, it will be apparent for a person skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details.

In other instances, detailed description of well-known methods and apparatuses are omitted so as not to obscure the description of the present invention with unnecessary details.

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 and 2.

The antenna device comprises a monopole radiating element 3 to be positioned along one end of the portable radio communication device, for operation of a plurality of complementary frequency bands including the FM frequency band. The antenna device further comprises a feed 4 offset positioned on the monopole radiating element 3 dividing it in a first part 5 and a second part 6, in order to provide at least one, preferably two, complementary frequency bands additional to the FM frequency band. The FM frequency band and the at least one, preferably two, additional complementary frequency bands are fed through the common feed 4.
In this way the FM frequency band is offset fed for the whole monopole radiating element 3, which preferably covers the whole end of the portable radio communication device, in the following exemplified as mobile phone 2. By preferably having the monopole radiating element covering the whole end of the phone FM performance is optimized. The feed 4 is preferably positioned such that the first part 5 is about $\lambda/4$ long for a first additional complementary frequency band, such as BT. The second part 6 would for a 50 mm wide mobile phone then be about $\lambda/4$ long for a second additional complementary frequency band, GPS. By having both additional complementary frequency bands radiated from the monopole FM radiating element in the basic resonances, minimal coupling to cellular frequency bands in a radiating element 1, in an opposite end of the mobile phone 2, is achieved.

For further optimization of FM performance, the monopole FM radiating element is preferably positioned close to the edge of the mobile phone, preferably less than 5 mm inward from the edge of a ground plane of the mobile phone. It may also protrude out from that edge.

For feeding of the monopole radiating element 3 by three simultaneous complementary frequency bands, preferably FM, BT and GPS, the following configuration is preferably used.

The feed 4 of the radiating element 3 is connected to a diplexer 9 through matching means 12 and 13 for the BT and GPS frequency bands. The matching means 12 and
13 is preferably dimensioned to comprise a capacitor 12 of about 1 pF, in order to block FM frequencies from reaching BT and/or GPS receivers. The diplexer 9 is in turn connected 7 to a BT transceiver and connected 8 to a GPS receiver. The feed 4 is also connected to an LNA 11 through matching means 14 for the FM frequency band. The LNA 11 is in turn connected 10 to an FM receiver/transceiver. The matching net preferably also comprises an Electrostatic Discharge (ESD) protection, Radiated Spurious Emission (RSE) filtering and low-pass filter for cellular cross-talk reduction components.

It will be obvious that the present invention may be varied in a plurality of ways. Such variations are not to be regarded as departure from the scope of the present invention. All such variations as would be obvious for a person skilled in the art are intended to be included within the scope of the present invention as defined by the appended claims.
CLAIMS

1. An antenna device for a portable radio communication device (2), characterized in that said antenna device comprises a monopole radiating element (3) to be positioned along one end of said portable radio communication device, for operation of a plurality of complementary frequency bands including the FM frequency band, and comprising a feed (4) offset positioned on said monopole radiating element dividing said monopole radiating element in a first part (5) and a second part (6) to provide at least one complementary frequency band additional to said FM frequency band, which FM frequency band and the at least two additional complementary frequency bands are fed through said feed.

2. The antenna device according to claim 1, wherein said monopole radiating element covers the whole length of said one end.

3. The antenna device according to claim 1 or 2, wherein said at least one additional complementary frequency band comprises two additional complementary frequency bands, BT and GPS.

4. The antenna device according to any of claims 1-3, wherein said portable radio communication device comprises a separate radiating element (1) for cellular frequency bands positioned along another end of said portable radio communication device opposite said one end.
5. The antenna device according to any of claims 1-4, comprising a diplexer (9) connected to said feed through matching means (12, 13) for said at least one additional complementary frequency band, and an LNA (11) connected to said feed through matching means (14) for said FM frequency band.

6. The antenna device according to any of claims 1-5, wherein said monopole radiating element is positioned at most 5 mm inward from said one end.

7. A portable radio communication device comprising an antenna device according to any previous claim.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. H01Q9/46 H01Q5/00 H01Q1/24
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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

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"Z" document member of the same patent family

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Form PCT/ISA/210 (second sheet) (April 2005)
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