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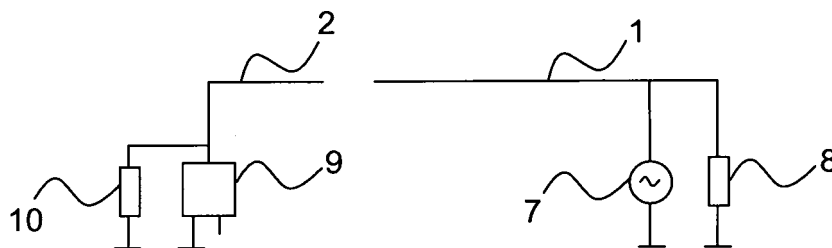
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AL BA HR MK RS(71) Applicant: **Laird Technologies AB****184 25 Åkersberga (SE)**(72) Inventor: **Braun, Christian****183 77 Täby (SE)**(74) Representative: **Estreen, Lars J.F. et al****Kransell & Wennborg KB****P.O. Box 27834****115 93 Stockholm (SE)**(54) **A multi-band antenna for a portable radio communication device**

(57) The present invention relates to a multi-band antenna arranged to provide a high frequency band and a low frequency band for a portable radio communication device, the multi-band antenna comprising a main antenna element (1) and a parasitic antenna element (2), wherein the main antenna element (1) is arranged to provide resonance in the high frequency band and the low frequency band, wherein the multi-band antenna com-

prises controllable switching means (9) arranged to tune the parasitic antenna element (2) to a first parasitic resonance center frequency (IIa) above a first main resonance center frequency (Ia) of the main antenna element (1) in a first state of the switching means (9) and to tune the parasitic antenna element (2) to a second parasitic resonance center frequency (IIb) below a second main resonance center frequency (Ib) in a second state of the switching means (9).

**Fig. 2****EP 1 962 375 A1**

Description

FIELD OF INVENTION

[0001] The present invention relates generally to antennas, and particularly to a multi-band antenna for a portable radio communication device.

BACKGROUND

[0002] The market for portable radio communication devices, such as mobile phones, PDA, portable computers and similar devices, is today very competitive, which puts tough economical demands on the manufacturers. Furthermore, antennas of such devices many times only have access to limited space of different shapes.

[0003] It is many times of interest to provide portable radio communication devices which can be used for a multitude of radio frequency bands, such as GSM850, GSM900, GSM1800, GSM1900 and WCDMA2100. This puts a further demand on antennas for such portable radio communication devices. Yet further, many antennas are today off-ground antennas, i.e. positioned outside a printed wiring board of the portable radio communication device, with even more space restrictions.

SUMMARY OF THE INVENTION

[0004] An object of the present invention is to provide an antenna for a portable radio communication device that provides broad frequency band coverage.

[0005] This object, among others, is according to the present invention attained by a multi-band antenna and a portable radio communication device, respectively, as defined by the appended claims.

[0006] A multi-band antenna, comprising a main antenna element, a parasitic antenna element and controllable switching means, which parasitic antenna element is arranged to provide resonance above and below a main antenna element resonance with the controllable switching means changing tuning of the parasitic antenna element, provides broad frequency band coverage.

[0007] Advantageously the main antenna element and the parasitic antenna element are off-ground antenna elements to be fitted in recent designs of portable radio communication devices.

[0008] Preferably the switching means comprises a switch connecting the parasitic antenna element to ground in a first state and the parasitic antenna element to open in a second state. Alternatively the switching means preferably comprises a switch connecting the parasitic antenna element to inducting means connected to ground in the first state and the parasitic antenna element to open in the second state.

[0009] For tuning the parasitic antenna element the multi-band antenna preferably comprises inducting means between the parasitic antenna element and ground. Preferably the inducting means comprises an

inductor.

[0010] Further features and advantages of the present invention will be evident from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] 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 shows a main antenna element and a parasitic antenna element positioned adjacent each other according to a first embodiment of the present invention;

Fig. 2 schematically shows a switching means connected to a parasitic antenna element according to the first embodiment of the present invention;

Fig. 3 is a return loss chart for a multi-band antenna according to the first embodiment of the present invention;

Fig. 4 schematically shows a multi-band antenna according to the present invention in a portable radio communication device; and

Fig. 5 schematically shows a switching means connected to a parasitic antenna element according to a second embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0012] 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.

[0013] A first embodiment of the present invention will now be described with reference to Figs. 1-4.

[0014] A multi-band antenna providing a high frequency band and a low frequency band for a portable radio communication device 12, such as a mobile phone, a PDA, a portable computer or similar devices, comprises a main antenna element 1 and a parasitic antenna element 2. The high frequency band preferably covers GSM1800, GSM1900 and WCDMA2100, and the low frequency band preferably covers GSM850 and GSM900.

[0015] The main antenna element 1 is designed to provide resonance both in the high frequency band and the

low frequency band of the multi-band antenna. The main antenna element 1 preferably comprises an IFA type of radiator with a feeding 3 and grounding portion 4. Alternatively the main antenna element 1 e.g. comprises a monopole type of radiator with a feeding portion 3 and no grounding portion 4. The main antenna element 1 is e.g. fed by RF circuits 7 and grounded through inducting means 8, such as an inductor 8. The inductor can in some cases be omitted and replaced by a direct short-circuit to ground. The parasitic antenna element 2 is designed to provide resonance in the high frequency band of the multi-band antenna, as desired coverage of such frequency band requires the broadest frequency band coverage. The parasitic antenna element 2 is preferably a radiator with a grounding portion 5, 6. The grounding portion 6 of the parasitic antenna element 2 is e.g. grounded through reactive means 10, such as inductive means 10, e.g. a discrete inductor or a transmission line, but could also be grounded through capacitive means or a combination thereof. The grounding portion 5 of the parasitic antenna element 2 is e.g. connected to controllable switching means 9.

[0016] The controllable switching means 9 tunes the parasitic antenna element 2 to a first parasitic resonance center frequency IIa above a first main resonance center frequency Ia of the main antenna element 1 in a first state of the switching means 9, e.g. by connecting the grounding portion 5 to ground. The controllable switching means 9 tunes the parasitic antenna element 2 to a second parasitic resonance center frequency IIb below a second main resonance center frequency Ib of the main antenna element 1 in a second state of the switching means 9, e.g. by connecting the grounding portion 5 to an open connection. The controllable switching means 2 is preferably a switch, such as a SPDT (Single Pole, Double Throw) switch, but could be provided by other means. The first and second main resonance center frequencies Ia and Ib are essentially the same resonance center frequency of the main antenna element 1 but it is slightly shifted with major tuning changes of the parasitic antenna element 2. By switching the resonance center frequency of the parasitic antenna element 2 above and below of the resonance center frequency of the main antenna element 1 a very broad frequency band coverage is attained for the multi-band antenna with use of only little space of the portable radio communication device, thus allowing little clearance utilization for the multi-band antenna in the portable radio communication device. By clearance is meant the spacing between an end of the printed wiring board and the casing of the portable radio communication device. With the expression that the switching means tunes the parasitic antenna element to first and second parasitic center frequencies is included that the parasitic antenna element is designed for one parasitic center frequency and is retuned by the switching means to another parasitic center frequency.

[0017] The reactive means 10 is largely used to determine the amount of frequency switching of the parasitic

radiator resonance between the switch states.

[0018] A multi-band antenna having a main antenna element 1 and a parasitic antenna element 2, which resonance center frequency of the parasitic antenna element 2 is switched above and below a resonance center frequency of the main antenna element 1, provides for small clearance in the portable radio communication device, which is particularly advantageous for off-ground antennas. An off-ground antenna is positioned outside of a printed wiring board 11 in the portable radio communication device 12, such as a mobile phone, which is illustrated in Fig. 4.

[0019] The switching means may be provided with more than two switching states, up to essentially continuous variation of tuning. Essentially continuous variation of tuning may e.g. be provided by means of a variable capacitor. Also, the main antenna element may be provided with switching means and/or tuning means to adjust its different resonance center frequencies.

[0020] Although this embodiment has been described with a parasitic antenna element providing resonances in the high frequency band the same principle is applicable for a parasitic antenna element providing resonances in the low frequency band instead.

[0021] A second embodiment of the present invention is next described with reference to Fig. 5. This second embodiment is identical with the first embodiment described above apart from the following. The switch 9 connects the parasitic antenna element 2 to open or to ground through inductive means, such as an inductor, to provide fine tuning for the grounded as well as open state of the switch. Alternatively the switch 9 connects the parasitic antenna element 2 to a first inductive means in the first state and a second inductive means in the second state, in which case the inductive means 10 could be omitted.

[0022] A third embodiment of the present invention will next be described. This third embodiment is identical with the first embodiment described above apart from the following. The parasitic resonance center frequency of the parasitic antenna element is in the first state of the switching means 9 tuned to the high frequency band of the multi-band antenna and in the second state of the switching means 9 tuned to the low frequency band of the multi-band antenna, or vice versa. This is e.g. achieved by use of a large inductance 10.

[0023] 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 as defined by the appended claims. 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. A multi-band antenna arranged to provide a high fre-

- quency band and a low frequency band for a portable radio communication device, said multi-band antenna comprising a main antenna element (1) and a parasitic antenna element (2), wherein said main antenna element (1) is arranged to provide resonance in said high frequency band and said low frequency band, **characterized in that** said multi-band antenna comprises controllable switching means (9) arranged to tune said parasitic antenna element (2) to a first parasitic resonance center frequency (IIa) above a first main resonance center frequency (Ia) of said main antenna element (1) in a first state of said switching means (9) and to tune said parasitic antenna element (2) to a second parasitic resonance center frequency (IIb) below a second main resonance center frequency (Ib) in a second state of said switching means (9).
2. The multi-band antenna according to claim 1, wherein said first and second main resonance center frequencies are in said high frequency band.
3. The multi-band antenna according to claim 1 or 2, wherein said main antenna element (1) and said parasitic antenna element (2) are off-ground antenna elements.
4. The multi-band antenna according to any of claims 1-3, wherein said switching means (9) comprises a switch (9) connecting said parasitic antenna element (2) to ground in said first state and said parasitic antenna element (2) to open in said second state.
5. The multi-band antenna according to any of claims 1-3, wherein said switching means (9) comprises a switch (9) connecting said parasitic antenna element (2) to reactive means (13) connected to ground in said first state and said parasitic antenna element (2) to open in said second state.
6. The multi-band antenna according to any of claims 1-5, comprising reactive means (10) between said parasitic antenna element (2) and ground.
7. The multi-band antenna according to claim 5 or 6, wherein said reactive means (10; 13) comprises an inductor (10; 13).
8. A multi-band antenna arranged to provide a high frequency band and a low frequency band for a portable radio communication device, said multi-band antenna comprising a main antenna element (1) and a parasitic antenna element (2), wherein said main antenna element (1) is arranged to provide resonance in said high frequency band and said low frequency band, **characterized in that** said multi-band antenna comprises controllable switching means (9) arranged to tune said parasitic antenna element (2) to a first parasitic resonance center frequency in said high frequency band in a first state of said switching means (9) and to tune said parasitic antenna element (2) to a second parasitic resonance center frequency in said low frequency band in a second state of said switching means (9).
9. A portable radio communication device comprising a multi-band antenna according to any previous claim.

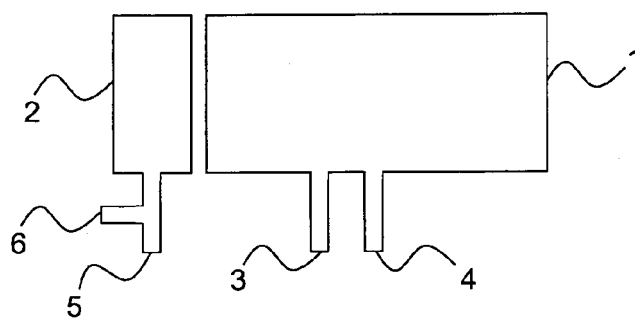


Fig. 1

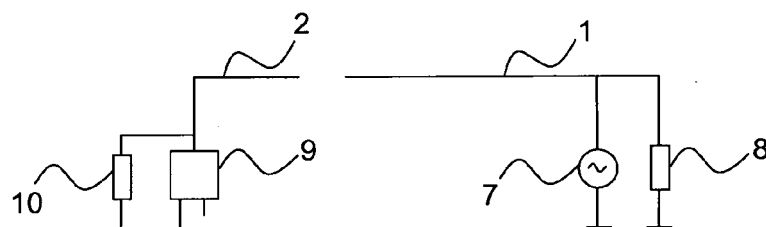


Fig. 2

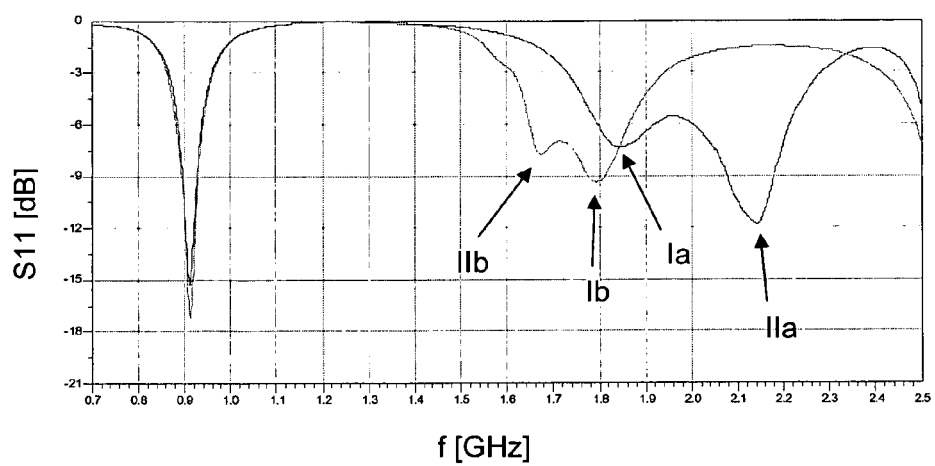


Fig. 3

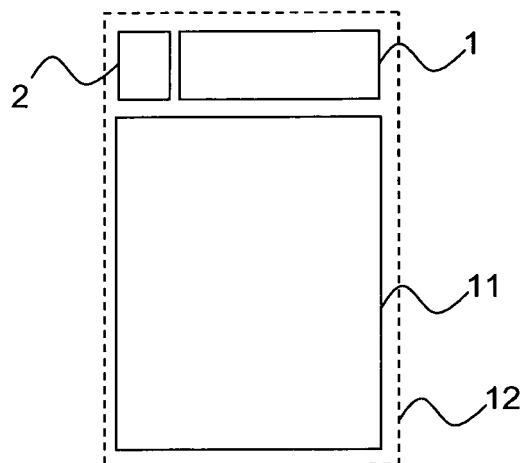


Fig. 4

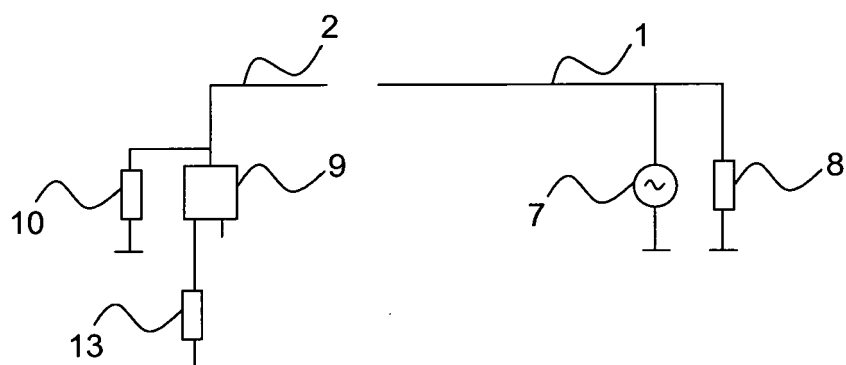


Fig. 5



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 44 5005

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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
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CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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