



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.04.2010 Bulletin 2010/14

(51) Int Cl.:
H01Q 1/24 (2006.01) **H01Q 9/04** (2006.01)
H01Q 9/42 (2006.01) **H01Q 23/00** (2006.01)

(21) Application number: **08165821.3**

(22) Date of filing: **03.10.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

• **Östervall, Torsten**
114 21 Stockholm (SE)
• **Erlandsson, Per**
117 34 Stockholm (SE)

(71) Applicant: **Laird Technologies AB**
164 22 Kista (SE)

(74) Representative: **Dahnér, Christer et al**
Kransell & Wennborg AB
P.O. Box 27834
115 93 Stockholm (SE)

(72) Inventors:
• **Braun, Christian**
186 47 Vallentuna (SE)

(54) **Multi-band antenna device and portable radio communication device comprising such an antenna device**

(57) A multi-band antenna device (10) for a portable radio communication device comprises a parasitic element (14) and a radiating element (12) including a feeding section (16), a length varying section (18) and first and second dual band sections (20, 22). The feeding section (16) stretches along the parasitic element (12). The length varying section (18) is further distanced from the

parasitic element (14) than the feeding section (16) and includes a first and a second parallel branch (24, 26) as well as a switch (SW). The first branch (24) is shorter than the second branch (26) for providing resonance in a first frequency band while the second branch provides resonance in a second frequency band. The first and second dual-band sections (20, 22) together provide resonance in a third frequency band.

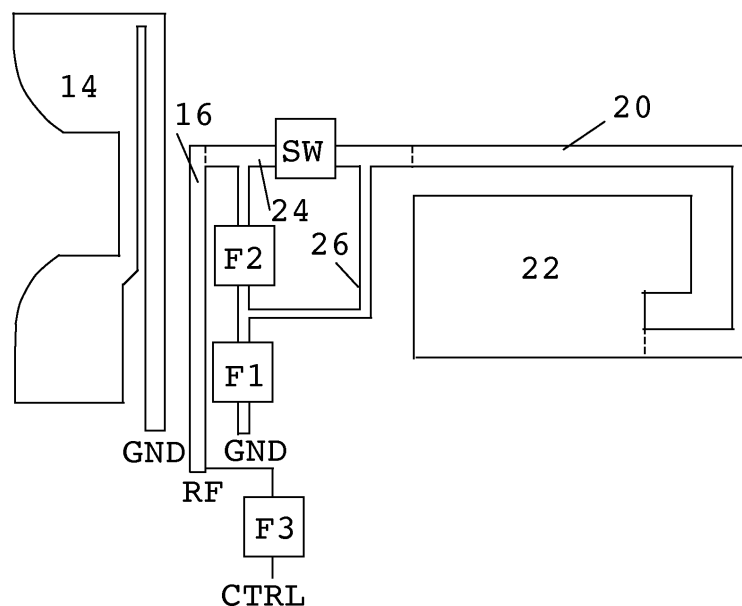


FIG. 4

Description

FIELD OF INVENTION

[0001] The present invention relates generally to antenna devices and more particularly to an antenna device for a portable radio communication device operable in at least four different frequency bands, such as in mobile phones. The invention also relates to a portable radio communication device comprising such an antenna device.

BACKGROUND

[0002] 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 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.

[0003] Such portable radio communication devices do furthermore often need to operate in several frequency bands. An example of this in for instance GSM is the 850 MHz band, the 900 MHz bands and the 1800 and 1900 MHz bands. This is also often combined with higher frequency bands such as around 2100 MHz for UMTS. With the limitations regarding cost and size of antenna devices this multi-band operation is difficult to achieve, especially if the antenna is to be provided in the interior of the device.

[0004] One type of multi-band antenna used for several frequency bands in the interior of a portable radio communication device is described in EP 1858115. In this document one embodiment describes a multi-band antenna including two monopole element sections having two different lengths and being connected in parallel to a length varying section. The length varying section here includes two branches or conductors of varying lengths, where a switch is provided in the shortest branch and where there is a parasitic element provided in parallel with a part of the longest branch of the varying length section. This provides a switchable antenna where it is possible to switch between two high bands and two low bands and where the parasitic element may provide a further band. In another embodiment in the document the parasitic element is omitted and the monopole elements are replaced by a branched PIFA element.

[0005] WO 200414464 in turn describes a PIFA antenna that provides multiple bands through the use of two sections that are connected in series with each other and where there is a slit between these two sections. This slit is dimensioned for giving the antenna two resonance frequency bands arranged at a desired distance to each other.

[0006] It is in some cases of interest to provide an alternative to the quad-band antenna solution in EP 1858115 that provides switching of two frequency bands while keeping two other frequency bands essentially un-

affected by a switching action.

[0007] The present invention is directed towards providing such an alternative.

SUMMARY OF THE INVENTION

[0008] An object of the present invention is to provide a multi-band antenna device that provides switching of two frequency bands while keeping two other frequency bands essentially unaffected by a switching action.

[0009] The invention is based on the realization that the provision of switching of two frequency bands while keeping two other frequency bands essentially unaffected by a switching action is obtained in an antenna device having a feeding section of a radiating element placed adjacent a parasitic element, while a varying length section of the radiating element that includes two parallel branches of different lengths is further distanced from the parasitic element than the feeding section.

[0010] According to a first aspect of the present invention there is provided an antenna device as defined in claim 1.

[0011] According to a second aspect of the present invention there is provided portable radio communication device as defined in claim 18.

[0012] Further preferred embodiments are defined in the dependent claims.

[0013] The invention provides an antenna device and a portable radio communication device wherein the problem of providing switching of two frequency bands while keeping two other frequency bands essentially unaffected by a switching action is solved through having a feeding section of a radiating element of the antenna device placed adjacent a parasitic element, while a varying length section of the radiating element that includes two parallel branches of different lengths is further distanced from the parasitic element than the feeding section.

[0014] This has the advantage of simplifying the design of the antenna device for operation in the frequency bands that are of interest. Another advantage is that a simpler switching signal can be used.

BRIEF DESCRIPTION OF DRAWINGS

[0015] The invention is now described, by way of example, with reference to the accompanying drawings, in which:

fig. 1 is an overall view of a portable radio communication device comprising an antenna device according to the invention;

fig. 2 shows a schematic diagram of a conductive material structure used for providing various elements of the antenna device according to the present invention, where these elements include a radiating element and a parasitic element;

fig. 3 shows a schematic diagram of the radiating element for use in an antenna device according to a first embodiment of the present invention;

fig. 4 shows a schematic diagram of the antenna device according to a second embodiment of the present invention;

fig. 5 shows a return loss diagram of an antenna device acting as a reference for the antenna device of the present invention;

fig. 6 shows a return loss diagram of an antenna device according to the first embodiment of the present invention; and

fig. 7 shows a schematic diagram of a radiating element for an antenna device according to a third embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0016] In the following, a detailed description of preferred 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 embodiments that depart from these specific details. In other instances, detailed descriptions of well-known apparatuses, and circuits are omitted so as not to obscure the description of the present invention with unnecessary details.

[0017] Fig. 1 shows the outlines of a portable radio communication device 1, such as a mobile phone. An antenna device 10 is arranged at the top of the communication device, adjacent to a printed circuit board (PCB) 2, and being connected to RF feeding and grounding devices (not shown). As an alternative it should be realised that the antenna device may be provided for instance also at the bottom of the communication device. The present invention is in fact not limited to the specific location of the antenna device in such a portable radio communication device.

[0018] In fig. 2, there is shown a general outline of a conductive material structure that may be used for providing an antenna device according to the present invention. The structure may be provided through traces or conductors made of an electrically conductive material, such as copper, as is conventional. This material may furthermore be provided on a flex film, which may in turn be bent or folded in order to fit within a portable radio communication device. As can be seen in fig. 2 the conductive material structure here provides two elements 12 and 14, where the element 14 to the left is to be connected to ground and is a passive parasitic elongated element,

while the element 12 to the right is an active radiating element and is to be connected to a feed point for receiving and/or emitting a radio signal. Generally the radiating element 12 is dimensioned for resonating at a first, second and third frequency band, while the parasitic element is designed for providing resonance in a fourth frequency band.

[0019] Fig. 3 shows a schematic diagram of the radiating element 12 according to a first embodiment of the present invention. It should here be realized that this radiating element 12 is to be provided together with a parasitic element like the one in fig. 2. However, here this parasitic element has been omitted from the figure in order to provide a clearer description of the radiating element 12.

[0020] The radiating element 12 includes a set of sections that are joined together. The set here includes a single feeding section 16, which is arranged to be connected to the above-mentioned feed point RF. This feeding section 16 may be provided as a single conductor and then as a single straight elongated conductor (which may be folded if being provided on a folded flex film).

[0021] To the feeding section 16 there is in this embodiment connected a length varying section 18. The length varying section 18 stretches in a direction away from the feeding section 16 and here it is essentially placed perpendicular to the feeding section 16. This direction is here also in a direction away from the parasitic element (not shown). When the parasitic element is placed adjacent the feeding section 16, it is thus clear that the length varying section 18 is further distanced from the parasitic element than the feeding section. It is also clear that the feeding section 16 in this particular case is provided between the parasitic element and the length varying section 18.

[0022] The length varying section 18 here includes a first and a second branch 24, 26 of electrically conducting material, which may be provided as conductors. These branches 24 and 26 are electrically connected in parallel with each other. This means that both branches 24 and 26 are connected to the feeding section 16 as well as to a further section 20 with which the length varying section 18 is joined. This means that the feeding section 16 is common for both the branches 24 and 26. The further section is in the present embodiment a first dual-band section 20. The first branch 24 has an electrical length that is shorter than the electrical length of the second branch 26. The varying length section 18 also includes a switch SW for selecting in which branch essentially the whole antenna current is to run. In this first embodiment the switch SW is placed in the first branch 24 and when the switch SW is open the whole antenna current runs in the second branch 26, while when it is closed essentially the whole antenna current runs in the first branch 24. As an alternative it is possible to place the switch between the two branches for selectively connecting either the first 24 or the second branch 26 to the other sections of the radiating element, i.e. for connecting either the first

or the second branch to the feeding section 16 and to the first dual-band section 20. There may as an alternative be one switch in each branch for achieving the same result. The switch SW may be of an on/off nature, such as a single pole, single throw (SPST) switch. In the first embodiment the switch SW is a transistor, which may with advantage be a GaAs switching transistor. For this reason it may receive a switching signal CTRL (shown as a dotted line) on a control input, which may be a gate or a base of such a transistor.

[0023] The radiating element 12 may also have a connection to ground GND that is provided between the feeding section 16 and the first dual-band section 20. In this first embodiment the connection to ground is provided via the second branch 26 of the length varying section 18. Here the connection to ground furthermore includes a first low pass filter block F1, which may include an inductor and in this embodiment only includes an inductor. The low pass filter block F1 is here arranged in the antenna device itself. As an alternative it may be provided in electronic circuitry arranged on the above-mentioned PCB.

[0024] The length varying section 18 is, as has been described previously, at the opposite end of the connection to the feeding section 16 connected to a first dual-band section 20, which first dual-band section 20 is further connected to a second dual-band section 22. In fig. 3 the borders between the various sections are indicated with dashed lines in the conductive material structure. The joined sections may furthermore be provided in one piece. There are in this case no joints between them.

[0025] The second dual-band section 22 is electrically connected in series with the first dual-band section 20. It is at the same time provided side by side with the first dual-band section 20. This means that the first dual-band section 20 has a certain extension and that the second dual-band section 22 then stretches back along the first dual-band section displaced a distance from it, where this displacement provides a gap G between the first and second dual-band sections 20 and 22.

[0026] In more detail the first dual-band section 20 of the first embodiment includes a first part that is straight and preferably has a bar shape. This first part of the first dual-band section 20 is thus at a first end joined to the length varying section 18 and may furthermore be provided at right angles to the feeding section 16. In the first embodiment the first dual-band section 20 has a second opposite end where it is joined to a first end of a second straight bar-shaped part. This second part is perpendicular to the first part and stretches from the first part in parallel with the feeding section 16. Also the second part has a second opposite end, which is joined to a first end of a third straight bar-shaped part stretching back in a direction towards the feeding section 16 in parallel with the first part.

[0027] The third straight bar shaped part of the first section 20 has a second opposite end that is joined to the second dual-band section 22. The second dual-band

22 in this first embodiment has a rectangular shape and is placed with a first long side provided in parallel with and distanced from the first part of the first dual-band section 20. The corner of the rectangle between a first short side that faces the second part of the first dual-band section 20 and a second opposite long side has furthermore been cut away. The third part of the first dual-band section 20 is here joined to the second dual-band section at this cut-way corner and is aligned with a second opposite long side of the rectangle. The cut out area is here also rectangular. The width of the third part of the first dual-band section 20 is furthermore smaller than the width of the cut.

[0028] The first dual-band section 20 here has a first side 28 that is made up of each side of the three parts of the first dual-band section 20 facing the second dual-band section 22, while the second dual-band section 22 has a second side 30 made up of the first long rectangle side facing the first dual-band section, what remains of the first short side, the length of the cut and the width of the cut minus the width of the third part of the first dual-band section 20. Thus the second side 30 of the second dual-band section faces, is displaced a distance from and stretches along the first side 28 of the first dual-band section, thereby forming the gap G between the first and second dual-band sections.

[0029] From fig. 3 it can also be seen that a part of the second branch 26 of the length varying section 18 stretches along a side of the second dual-band section 22, and here along a second short side of the rectangular second dual-band section 22. There is therefore a capacitive coupling between this second branch 26 and the second dual-band section 22.

[0030] The length of the first branch 24 of the length varying section 18 is according to the present invention selected for making the radiating element 12 resonate in a first frequency band B1. This is done through providing a resonating element length made up of the length of the feeding section 16, the length of the first branch 24 of the length varying section 18, the length of the first dual-band section 20 and the length of the second dual-band section 22. These together form a length for which the radiating element resonates in the first desired frequency band B1, which total length typically corresponds to a quarter of a wavelength. In the same manner the length of the second branch 26 of the length varying section 18 is selected for making the radiating element 12 resonate in a second frequency band B2. This is done through providing a resonating element length made up of the length of the feeding section 16, the length of the second branch 26 of the length varying section 18, the length of the first dual-band section 20 and the length of the second dual-band section 22. These together form a length for which the radiating element 12 resonates in the second desired frequency band B2, which total length typically also corresponds to a quarter of a wavelength.

[0031] The dimensions of the gap G between the first and the second dual-band sections 20 and 24 are on the

other hand selected to provide resonance of the radiating element in a third frequency band B3. This means that the length and the width of the gap G are selected to provide resonance of the radiating element in the third band B3.

[0032] When the parasitic element is provided adjacent the radiating element 12 and here adjacent the feeding section 16 of the radiating element, the antenna device provides a fourth frequency band B4.

[0033] The first and second frequency bands are because of this typically low frequency bands and here in the region of 900 or 850 MHz, while the third and the fourth frequency bands are high frequency bands for instance in the region of 2100 and 1800 - 1900 MHz. Here the first band B1 would be 900 MHz, the second band B2 the 850 MHz band, while the third and the fourth bands B3 and B4 together cover the cellular system bands of 1800, 1900 and 2100 MHz. The third and fourth band B3 and B4 may for instance together cover a range of 1710 - 2170 MHz.

[0034] The first filter block F1 here provides a matching of the antenna device to an impedance of 50 Ω and may for this reason include an inductance that may also be variable. As the radiating element is connected to both feeding and ground it is clear that it is in fact an IFA antenna.

[0035] In operation the antenna device provides operation in the first, third and fourth bands with the switch closed, while it provides operation in the second, third and fourth bands with the switch open.

[0036] Fig. 4 shows a second embodiment of the antenna device according to the present invention. The main difference here is that the switch SW is different. It is here controllable by a current flowing through it. This switch may be provided through a PIN diode.

[0037] In the second embodiment there is furthermore a high pass filter F2 provided between the first and second branches 24 and 26 of the length varying section 18, the function of which will be explained below. This high pass filter F2 may be implemented through a capacitance. The main purpose of the second high pass filter block is to block DC signals. It therefore blocks signals having frequencies below the second frequency band.

[0038] A DC control input, designated CTRL in the figure, for controlling the operation of the switch SW is connected to the RF input via a further filter block F3 in order to not affect the RF characteristics of the antenna device. This means that the filter characteristic of this filter block F3 is designed so as to block all radio frequency signals. In the embodiment in fig. 4, the filter block comprises a low pass filter. The control signal CTRL is used for opening and closing the switch SW.

[0039] The above-mentioned filter block F3 may also be arranged in electronic circuitry arranged on the PCB.

[0040] The switching of the antenna device according to the second embodiment then functions as follows. The RF source and other electronic circuits of the communication device operate at a given voltage level, such as

1.5 Volts. The criterion is that the voltage level is high enough to create the necessary voltage drop across the PIN diode, i.e. about 1 Volt. This means that the control signal CTRL is a voltage being switched between the two voltages "high" and "low", such as 1.5 and 0 Volts, respectively. When CTRL is high, there is a DC current flowing through the third filter block F3, the feeding section 16, the first branch 18 and switch SW and part of the second branch 26, and finally through the low pass filter F1 and to ground. This DC current creates a voltage drop across the switch SW and a corresponding current there through of about 5-15 mA. This voltage drop makes the diode SW conductive, effectively making the first branch 24 conductive with respect to RF signals. The second high pass filter F2 here blocks the current so that it cannot go to ground without passing the diode SW. With the control signal CTRL "low", there is an insufficient voltage drop across the PIN diode SW to make it conductive, i.e. it is "open", effectively blocking any RF signals in the first branch 24. As an alternative it should be known that the switch may be a transistor, like a GaAs transistor, also in this second embodiment.

[0041] The provision of the first and second multi-band sections together with a length varying section allows the provision of good bandwidth in both low and high bands.

[0042] Traditionally the length varying section is placed as close to the feeding as possible. This means that normally the parasitic element would be provided adjacent the length varying section. Since the two branches would have to be provided on different distances to the parasitic element it is then clear that the parasitic element would influence the currents running through them differently based on which branch is conducting current..

[0043] Fig. 5 shows a return loss diagram for an antenna device having a varying length section provided adjacent the parasitic element and being connected to a first and second dual-band section designed like in the first and the second embodiments. The return loss in dB in relation to frequency in MHz is here shown. Here a curve 32 of the return loss with the switch closed, i.e. when the short first branch is conducting, is shown with a solid line, while a curve 34 of the return loss with the switch open, i.e. with the second longer branch conducting, is shown with a dashed line. As can be seen the operation of the switch provides a shifting of the low bands from the first low band B1 to the second low band B2. It can also be seen that also the high bands B3 and B4 are shifted to bands B3' and B4'.

[0044] It is however of interest to keep the high bands as much as possible unaffected by the switching. Then it can be possible to better design the antenna device for operation in the bands of interest, i.e. it would be easier to design the gap and the passive element. This means that it is of interest that the covered high-frequency bands are affected as little as possible by the switching.

[0045] The present invention solves this problem through the alternative placing of the length varying sec-

tion, i.e. where the length varying section is further distanced from the parasitic element than a feeding section that runs in parallel with the parasitic element.

[0046] Fig. 6 shows a return loss diagram for the antenna device according to the first and second embodiments.

[0047] Here a curve 36 of the return loss with the switch closed, i.e. when the short first branch is conducting, is shown with a solid line, while a curve 38 of the return loss with the switch open, i.e. with the second longer branch conducting, is shown with a dashed line. As can be seen the high frequency bands B3 and B4 are more or less unaffected by the switching operation.

[0048] This means that it is easier to design the antenna device for covering these bands than with the above-described placing of the length varying section beside the parasitic element. As these bands remain unaffected it is also possible to use a simpler switching signal, since the signal only has to consider the switching between the first and the second band and does not have to consider any switching between the third and the fourth band.

[0049] The antenna device of the present invention is also small in size, simple to produce as well as advantageous to use in multi-mode portable radio communication devices, i.e. devices that can be used in several different types of wireless communication networks.

[0050] The present invention can be varied in a number of different ways. It should for instance be realised that as long as the required electrical length of the radiating element is obtained, the shape of the first and second dual-band sections can be varied in a multitude of ways. They do for instance not have to include straight parts or have a general rectangular shape. It is for instance possible that one or both of these sections have meandering shape. The width of a section can thus be variable. One example of an alternative design is shown in fig. 7. Here an L-shaped first dual-band section is provided adjacent two sides of an essentially rectangular shaped second dual-band section. Instead of a cut out area at the above-mentioned corner, this second dual-band section is provided with a bar like protrusion, which is joined to the L-shaped first dual-band section.

[0051] It is likewise possible that the height of the cut out area in the radiating element of fig. 3 is prolonged so that the third part of the first dual-band section stretches longer towards the feeding section.

[0052] For the purpose of matching ground may be connected to the antenna device via an inductor or a capacitor. These may furthermore be variable. In the case of an inductor, this may furthermore be provided as a part of the first filter block.

[0053] Preferred embodiments of an antenna device according to the invention have been described. However, it will be appreciated that these can be varied within the scope of the appended claims. The placing of the length varying section may for instance be varied. It can be provided as a part of the first or second dual-band sections or be provided between them. It is also possible

that the ground connection provided between the feeding section and the first dual-band section does not include the first filter block or that the ground connection is omitted completely. It is furthermore possible to include more sections in the radiating element than what has been described so far, for instance between the length varying section and the first dual-band section and/or between the feeding section and the length varying section. Furthermore, a GaAs switch or a PIN diode switch have been described. It will be appreciated that other kinds of switches can be used as well. The placing of the switch may furthermore be made in a multitude of ways. The important thing is that it connects the radiating element with one of the conductors based on which frequency range that is to be covered. Finally other types of first and second dual-band sections may be provided, for instance an ordinary branched IFA structure as in EP 1858115.

[0054] Consequently the present invention is only to be limited by the following claims.

Claims

1. An antenna device (10) for a portable radio communication device (1) operable in at least four different frequency bands (B1, B2, B3, B4), the antenna device (10) comprising:

- a set of sections (16, 18, 20, 22) of electrically conductive material joined to each other for forming a radiating element (12); and
- a parasitic element (14) provided at least partly along a part of the radiating element;
- said set of sections including

- o a feeding section (16) for connection to a feed point;
- o a length varying section (18) including a first and a second branch (24, 26) connected in parallel with each other, where the first branch (24) has an electrical length that is shorter than the electrical length of the second branch (26), the length of the first branch is selected for making the radiating element resonate in a first frequency band (B1) and the length of the second branch is selected for making the radiating element resonate in a second frequency band (B2), and a switch (SW) for selecting in which branch essentially the whole antenna current is to run; and
- o a first and a second dual-band section (20, 22) together providing resonance in a third frequency band (B3);

- characterised in that

- the part of the parasitic element (14) that is provided adjacent the radiating element only

- stretches along the feeding section (16) of this radiating element; and
 - the length varying section (18) is further distanced from the parasitic element (14) than the feeding section (16).
2. The antenna device (10) according to claim 1, wherein the second dual-band section (22) is electrically connected in series with the first dual-band section (20) and the first and second dual-band sections (20, 22) are separated by a gap (G), the dimensions of which are selected to provide resonance of the electrically conductive radiating element in said third frequency band (B3).
 3. The antenna device (10) according to claim 1 or 2, wherein the feeding section (16) is provided between the parasitic element (14) and the length varying section (18).
 4. The antenna device (10) according to any previous claim, wherein the length varying section (18) connects the feeding section (16) with the first dual-band section (20) and stretches in a direction away from the parasitic element (14) and feeding section (16).
 5. The antenna device according to claim 4, wherein the length varying section (18) is placed perpendicular to the feeding section.
 6. The antenna device according to any previous claim, wherein the second branch (26) of the length varying section (18) includes a part that at least partly stretches along a side of the second dual-band section (22).
 7. The antenna device according to claim 6, wherein said part of the second branch (26) of the length varying section (18) has a capacitive coupling to the second dual-band section (22).
 8. The antenna device (10) according to any previous claim, wherein the second dual-band section (22) is the last section in the electrical path of the radiating element (12).
 9. The antenna device (10) according to any previous claim, wherein the radiating element has a connection to ground provided between the feeding point and the first dual-band section.
 10. The antenna device (10) according to claim 9, wherein the connection to ground is provided via the second branch (26) of the length varying section (18).
 11. The antenna device (10) according to claim 9 or 10, wherein the connection to ground includes a first low pass filter block (F1), which may include an inductor.
 12. The antenna device (10) according to any previous claim, wherein said first dual-band section has a first side (28) and the second dual-band section has a second side (30) facing, displaced a distance from and stretching along said first side (22) of the first dual-band section (20), thereby forming said gap (G) between the first and second dual-band sections, where the length and the width of the gap are selected to provide resonance of the radiating element in the third band.
 13. The antenna device (10) according to any previous claim, wherein said switch is controllable by a current flowing through it.
 14. The antenna device (10) according to claim 13, further comprising a second filter (F2) provided between the first and second branches (24, 26) of the length varying section (18), said second filter block being arranged to block signals with a frequency lower than the frequencies of the different frequency bands.
 15. The antenna device (10) according to any previous claim, further comprising a further filter block (F3) arranged between the feeding section (16) and a control voltage input (CTRL) for the switch (SW).
 16. The antenna device (10) according to any of claims 13 - 15, wherein the switch (SW) comprises a PIN diode.
 17. The antenna device (10) according to any of claims 1 - 15, wherein the switch (SW) comprises a GaAs switch.
 18. The antenna device (10) according to any previous claim, wherein the radiating element (12) is an inverted F antenna.
 19. A portable radio communication device (1) comprising an antenna device (10) including an antenna device according to any previous claim.

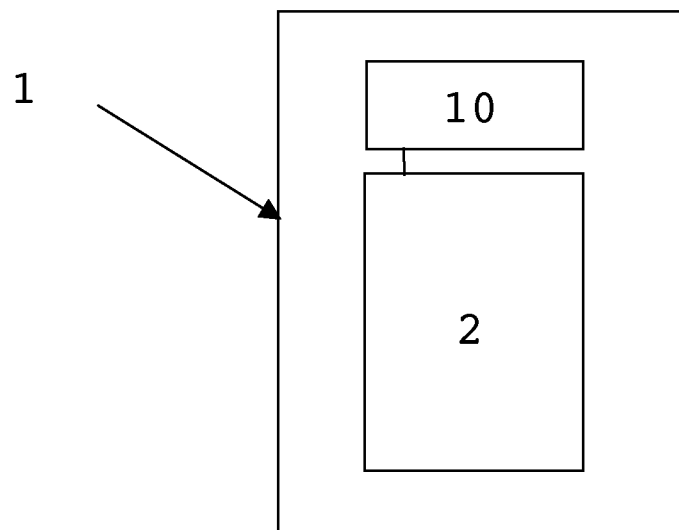


FIG. 1

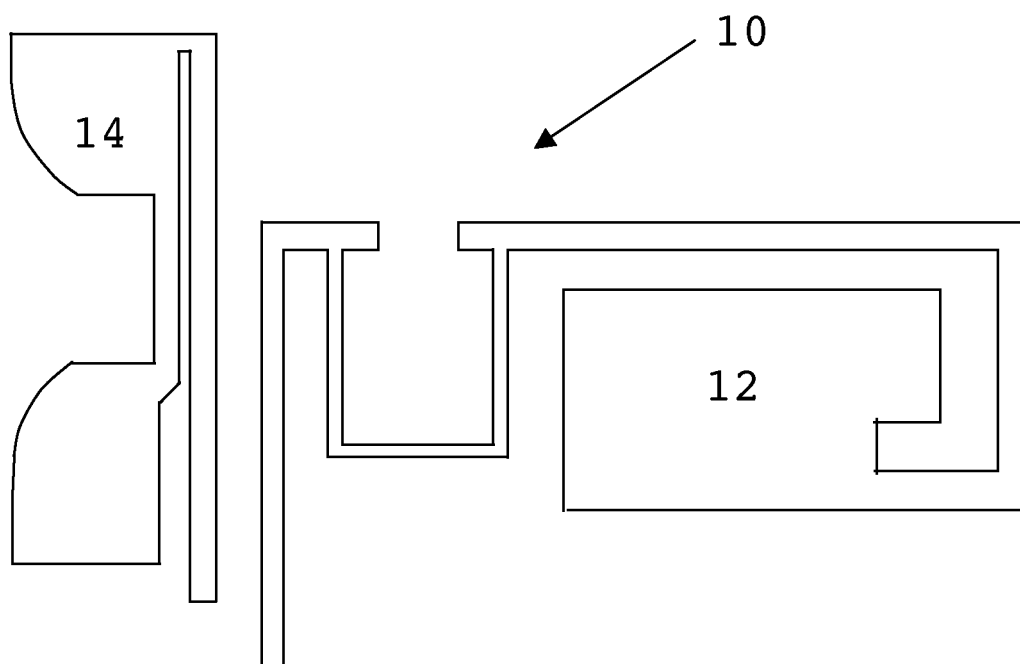


FIG. 2

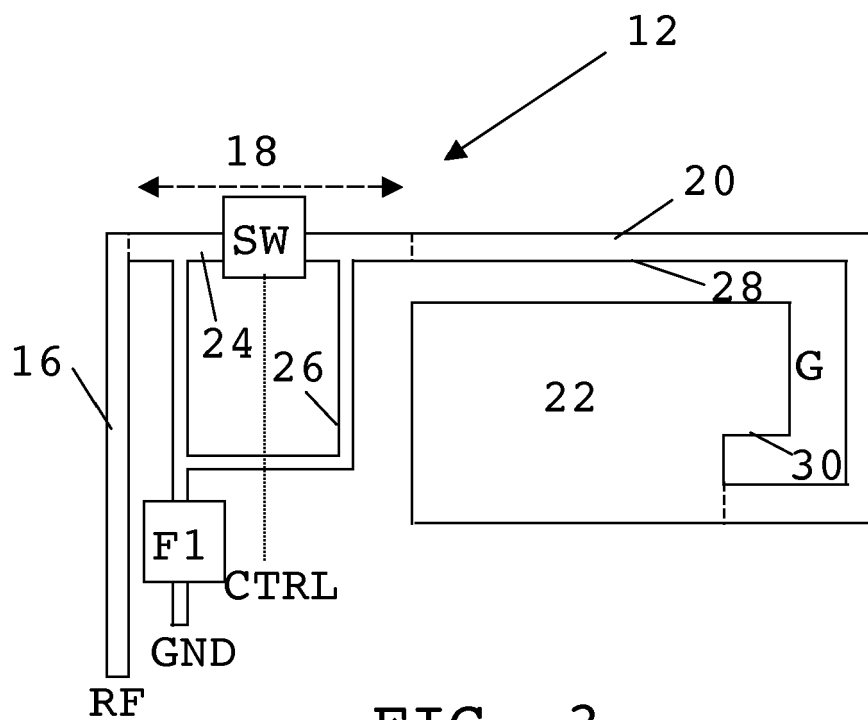


FIG. 3

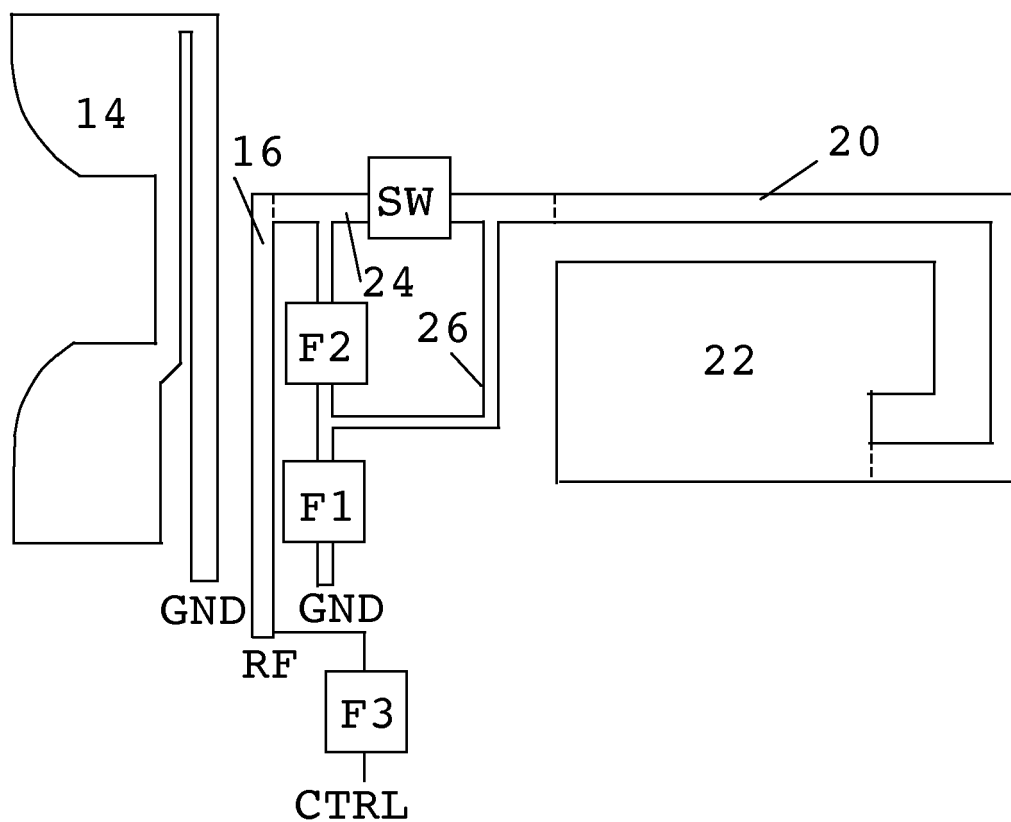


FIG. 4

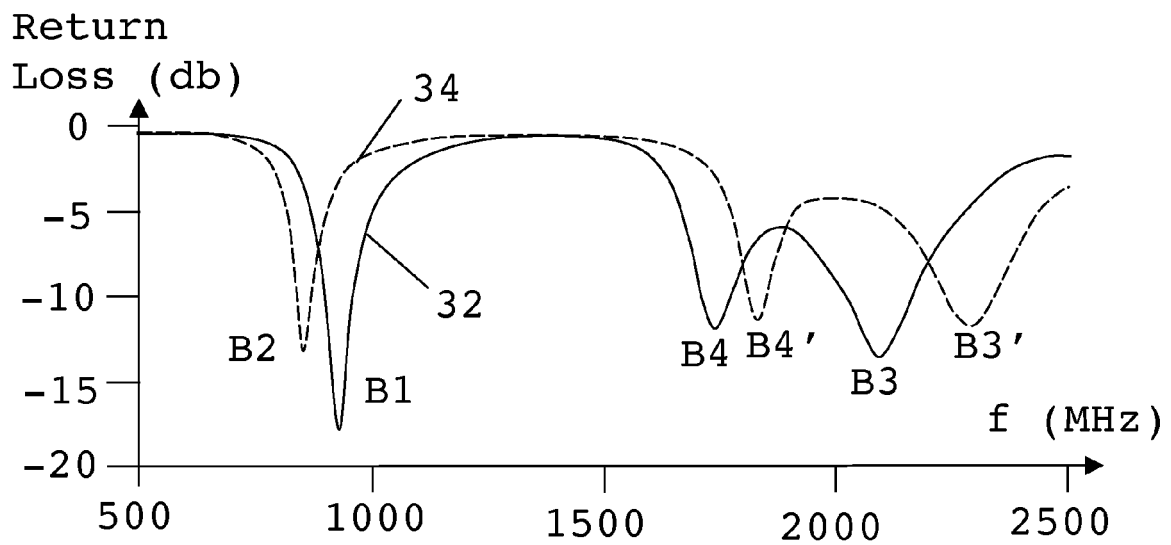


FIG. 5

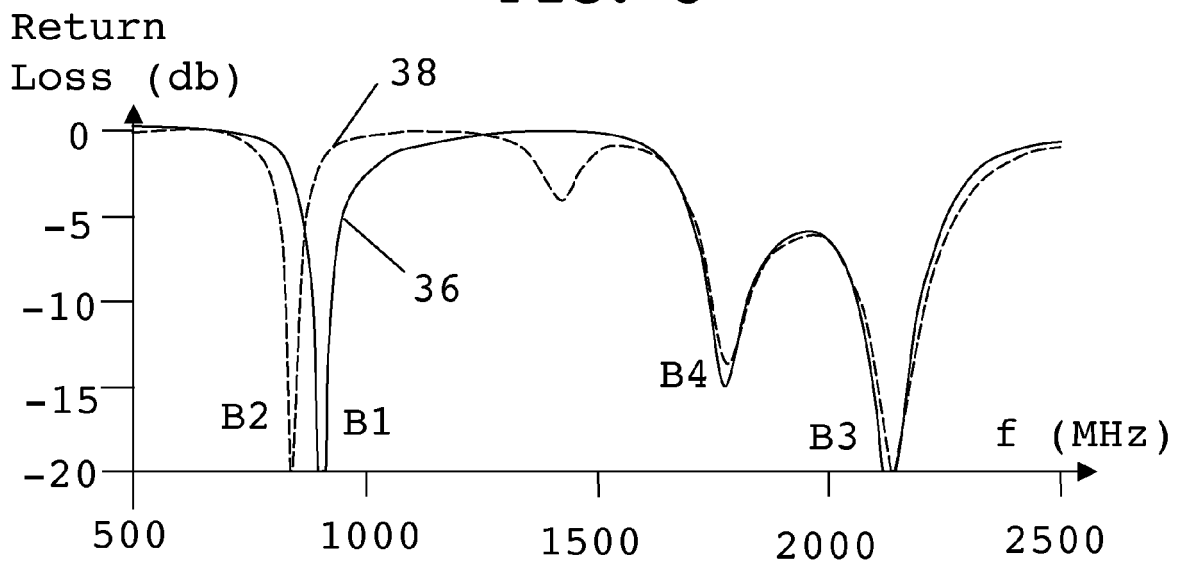


FIG. 6

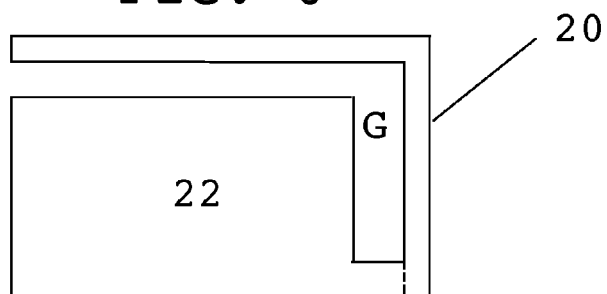


FIG. 7



EUROPEAN SEARCH REPORT

Application Number
EP 08 16 5821

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
D,A	EP 1 858 115 A (AMC CENTURION AB [SE]) 21 November 2007 (2007-11-21) * paragraphs [0015] - [0037] * * figures 1-7 *	1-19	INV. H01Q1/24 H01Q9/04 H01Q9/42 H01Q23/00
A	WO 2006/062215 A (YOKOWO SEISAKUSHO KK [JP]; MITSUGI KENICHI [JP]; HORIE RYO [JP]; SEKIG) 15 June 2006 (2006-06-15) * figures 1-3,15-19 *	1-19	
A	JP 11 163620 A (SHARP KK) 18 June 1999 (1999-06-18) * figures 1,2 *	1	
A	US 2002/021248 A1 (YING ZHINONG [SE] ET AL) 21 February 2002 (2002-02-21) * paragraphs [0011] - [0026] * * figures 1,2 *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01Q
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 19 March 2009	Examiner Kruck, Peter
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			

1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 16 5821

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

19-03-2009

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 1858115	A	21-11-2007	WO 2007136330 A2	29-11-2007
WO 2006062215	A	15-06-2006	JP 2006165834 A	22-06-2006
JP 11163620	A	18-06-1999	NONE	
US 2002021248	A1	21-02-2002	NONE	

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 1858115 A [0004] [0006] [0053]
- WO 200414464 A [0005]