(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 February 2001 (08.02.2001)

PCT

(10) International Publication Number
WO 01/09978 A1

(51) International Patent Classification[7]: H01Q 1/52, 1/24, 11/08, 1/36, 9/30

(21) International Application Number: PCT/EP00/07180

(22) International Filing Date: 24 July 2000 (24.07.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
99202551.0 3 August 1999 (03.08.1999) EP

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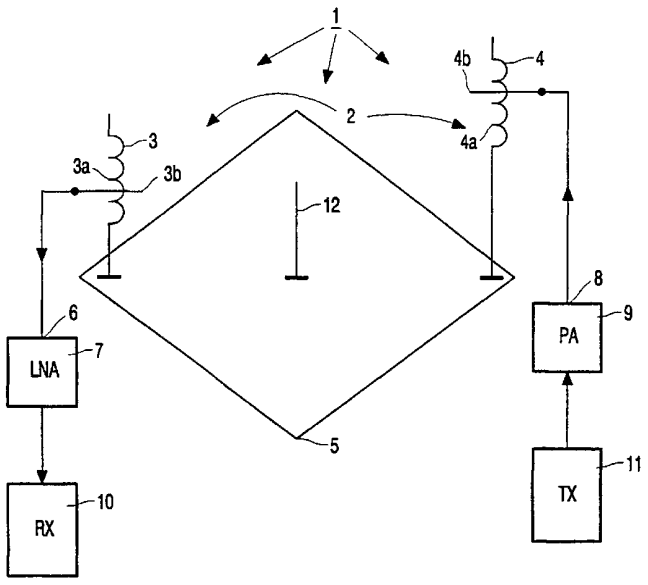
(81) Designated States *(national)*: CN, JP, KR.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published:
— *With international search report.*
— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: DUAL ANTENNA AND RADIO DEVICE PROVIDED THEREWITH



(57) Abstract: A radio device comprises a receiving circuit and/or a transmitting circuit, and an antenna assembly including a receiving antenna coupled to the receiving circuit and/or a transmitting antenna coupled to the transmitting circuit. The antenna assembly comprises at least one additional antenna part, which additional antenna part is electromagnetically coupled to the receiving antenna and/or the transmitting antenna respectively. By means of inserting the additional antenna part between windings of the receiving and/or transmitting antenna, independent antenna impedances adjustment is feasible, which broadens the design flexibility of designers of transmitters and receivers, and makes duplexors, as well as impedance matching circuits superfluous.

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Dual antenna and radio device provided therewith.

The present invention relates to a radio device comprising a receiving circuit and/or a transmitting circuit, and an antenna assembly including a receiving antenna coupled to the receiving circuit and/or a transmitting antenna coupled to the transmitting circuit.

The present invention also relates to an antenna which is suited for application in the radio device, which antenna comprises an antenna assembly including a receiving antenna and/or a transmitting antenna.

Such a radio device and antenna are known from EP-A-0 767 508. The known radio device comprises an antenna assembly in the form of a helical antenna assembly including a receiving antenna and a transmitting antenna. The radio device further comprises a receiving circuit having a receiving/matching filter and a transmitting circuit having a similar transmitting filter. Furthermore the radio device is provided with a transmit/receive switch or with a duplexor. Obviously the construction of the known radio device and antenna is complex and its impedance matching is troublesome and comprehensive.

Therefore it is an object of the present invention to provide an improved radio device and antenna, both comprising fewer components and providing possibilities for reduced impedance matching handling and hardware.

Thereto the radio device according to the invention is characterized in that the antenna assembly comprises at least one additional antenna part, which additional antenna part is electromagnetically coupled to the receiving antenna and/or the transmitting antenna respectively.

Similarly the antenna according to the present invention is characterized in that the antenna comprises at least one additional antenna part, which additional antenna part is electromagnetically coupled to the receiving antenna and/or the transmitting antenna respectively.

It is an advantage of the radio device and antenna according to the invention that the additional antenna part makes an impedance matching circuit or filter superfluous because the impedances of the receiving antenna and/or transmitting antenna each including said additional antenna part can easily be adapted directly to the input-impedance of the receiving circuit and/or to the output-impedance of the transmitting circuit respectively. As both these input and output impedances are mutually different, each of them can now be matched individually and thus better to the respective receiving and transmitting antennas. This decreases the impedance losses and increases the sensitivity of in particular the receiving circuit. In general the design flexibility for receivers and transmitters is broadened, because designers are no longer bound to input and output impedance specifications, which used to lie within very strict limits, because of the narrow impedance ranges of known antennas.

Furthermore, if both the receiving antenna and the transmitting antenna are being used in a transceiver radio device the structures with additional antenna parts provide a very good isolation between the receive path and the transmit path. The isolation is generally better than 30 dB for a frequency band in the range of 850 MHz or higher, which can even be achieved without any transmit/receive switch or duplexor at all. For example an antenna assembly, which is helically shaped, or has any other form, which can be electromagnetically coupled to the additional antenna part of any form is suitable for the purpose.

An embodiment of the radio device according to the invention providing a flat base structure is characterized in that, the antenna assembly comprises at least one grounded plate. If in particular one grounded plate is coupled, either to at least one of said receiving antenna and transmitting antenna, or vice versa to the at least one additional antenna part, a variety of possible embodiments come within reach.

A further embodiment of the radio device according to the invention is characterized in that the antenna assembly has a patch structure. This way the structure of the antenna assembly can be integrated in a layer structure, which reduces the amount of necessary space taken up by the antenna according to the invention. Antennas including ceramic structures have an even more reduced proportion.

A still further embodiment of the radio device according to the invention is characterized in that the radio device is provided with a shielding element positioned approximately midway between the receiving antenna with its associated additional antenna part and the transmitting antenna with its associated additional antenna part. This embodiment is particularly advantageous for mobile equipment applications, such as with mobile telephone, because the mutual distance between both the receiving and transmitting antennas

can be reduced to approximately several to maximally 10-15 centimeter, again without duplexor or impedance matching circuitry being necessary. Preferably the shielding element is a cost effective and small sized rod antenna.

In particular the above mentioned matching is easily achieved in another embodiment of the antenna according to the invention, which is characterized in that the receiving antenna and/or the transmitting antenna are/is each provided with windings, and that the additional antenna part is inserted between the windings of the receiving antenna and/or the transmitting antenna respectively. Matching now takes place by simply inserting the additional antenna part between a first and a second, or a second and a third winding etcetera of an antenna, and/or by angular rotation said part between the windings, and/or by influencing the insertion depth or spacial form of said part between or outside the windings.

At present the radio device and antenna according to the invention will be elucidated further together with their additional advantages, while reference is being made to the appended drawing. In the drawing:

Fig. 1 shows an embodiment of a radio device according to the invention provided with two dual helical antennas according to the invention; and

Fig. 2 shows an impedance versus frequency curve of the antenna of fig. 1.

Fig.1 shows an schematic embodiment of a radio device 1. The radio device 1 may only comprise the left receiver part of fig. 1, or it may only comprise the right transmitter part thereof, or may comprise both parts, such that in the latter case the radio device 1 is arranged as a transmitter-receiver, also called transceiver. The radio device 1 also comprises a antenna assembly 2 of any suitable form. In this case the antenna assembly 2 is built up as two dual helical antennas 3 and 4, which are here shown to be similar, but which generally will not be identical. Each antenna 3, 4 comprises in this case several windings 3a, 4a, and additional antenna parts 3b, 4b. Each antenna part 3b, 4b is electromagnetically coupled to its associated windings 3a, 4a, respectively. Such antenna parts 3b, 4b may have any suitable curved, helical or even straight form, while the parts 3b, 4b are each inserted between the spatial structure, winding or windings 3a, 4a. The antenna 3a and its associated antenna part 3b are electrically separated from one another, but electromagnetically coupled to one another. The same holds for the windings 4a and its associated antenna part 4b.

As a consequence antenna impedance adjustment can take place individually for every pair 3a, 3b and 4a, 4b by influencing the inserting position of the additional antenna part between a first and a second, or a second and a third winding etcetera, and/or by individual angular rotation of the respective antenna parts 3b, 4b between the windings, and/or by individually influencing the insertion depth or spacial form of said part 3b, 4b between or outside the windings 3a, 4a respectively. In the embodiment as shown the radio device 1 is provided with a grounded plate 5 serving in this case as a common base for the antenna assembly as a whole.

In the embodiment as shown the windings 3a forming the receiving antenna, and the windings 4a forming the transmitting antenna are each electrically connected to the grounded plate 5. The antenna part 3b of the receiving antenna is in this case connected to an input 6 of an amplifier 7, which generally is of the low noise (LNA) type, whereas the antenna part 4b of the transmitting antenna is connected to an output 8 of a power (PA) amplifier 9. No specific impedance matching circuitry is present between input 6 and LNA 7, and output 8 and PA 9 respectively. LNA 7 is connected to a receiving (RX) circuit 10, and PA 9 is connected to a transmitting (TX) circuit 11 of the radio device 1. The radio device 1 is thus particularly suited for bi-directional voice and/or data transmission, such as with mobile communication apparatus, in particular mobile telephone, without a duplexor being necessary therefor.

It appeared in practise that both above receiving and transmitting antennas 3a, 3b and 4a, 4b respectively showed a sufficient isolation of more than 30 dB at a mutual distance of around 10 cm. Both antennas can easily be integrated on a patch or layered structure possibly including a ceramic structure for very small sized integration, distance and isolation. Application of a probe or shielding element 12 preferably a rod connected to the grounded plate 5 and to be positioned approximately midway between the receiving antenna 3a, 3b, and the transmitting antenna 4a, 4b provided adequate isolation of the respective antennas. Adding the respective antenna parts changed the antenna impedance from approximately 19Ω to approximately 50Ω. The measured bandwidth (at -10 dB return loss at 50Ω) was around 17,3 MHz at a resonance impedance of 58Ω. This is roughly as shown in fig. 2, which shows impedance versus frequency curves for the real impedance part (upper curve) and the reactive impedance part (lower curve).

CLAIMS:

1. A radio device comprising a receiving circuit and/or a transmitting circuit, and an antenna assembly including a receiving antenna coupled to the receiving circuit and/or a transmitting antenna coupled to the transmitting circuit, characterized in that the antenna assembly comprises at least one additional antenna part, which additional antenna part is electromagnetically coupled to the receiving antenna and/or the transmitting antenna respectively.

2. The radio device according to claim 1, characterized in that the antenna assembly is a helical antenna assembly.

3. The radio device according to claim 1 or 2, characterized in that the antenna assembly comprises at least one grounded plate.

4. The radio device according to claim 3, characterized in that the grounded plate is coupled, either to at least one of said receiving antenna and transmitting antenna, or to the at least one additional antenna part.

5. The radio device according to one of the claims 1-4, characterized in that the antenna assembly has a patch structure.

6. The radio device according to one of the claims 1-5, characterized in that the antenna assembly has a ceramic structure.

7. The radio device according to one of the claims 1-6, characterized in that the radio device is provided with a shielding element positioned approximately midway between the receiving antenna with its associated additional antenna part and the transmitting antenna with its associated additional antenna part.

8. The radio device according to claim 7, characterized in that the shielding element is a rod antenna.

9. An antenna suited for application in the radio device according to one of the claims 1-8, the antenna comprising an antenna assembly including a receiving antenna and/or a transmitting antenna, characterized in that the antenna assembly comprises at least one additional antenna part, which additional antenna part is electromagnetically coupled to the receiving antenna and/or the transmitting antenna respectively.

10. The antenna assembly according to claim 9, characterized in that the antenna assembly is a helical antenna assembly.

11. The antenna according to claim 9 or 10, characterized in that the receiving antenna and/or the transmitting antenna are/is each provided with one or more windings, and that the additional antenna part is inserted between the on or more windings of the receiving antenna and/or the transmitting antenna respectively.

12. The antenna according to claim 11, characterized in that the antenna assembly comprises a grounded plate, which grounded plate is coupled to said windings of the receiving antenna and/or the transmitting antenna.

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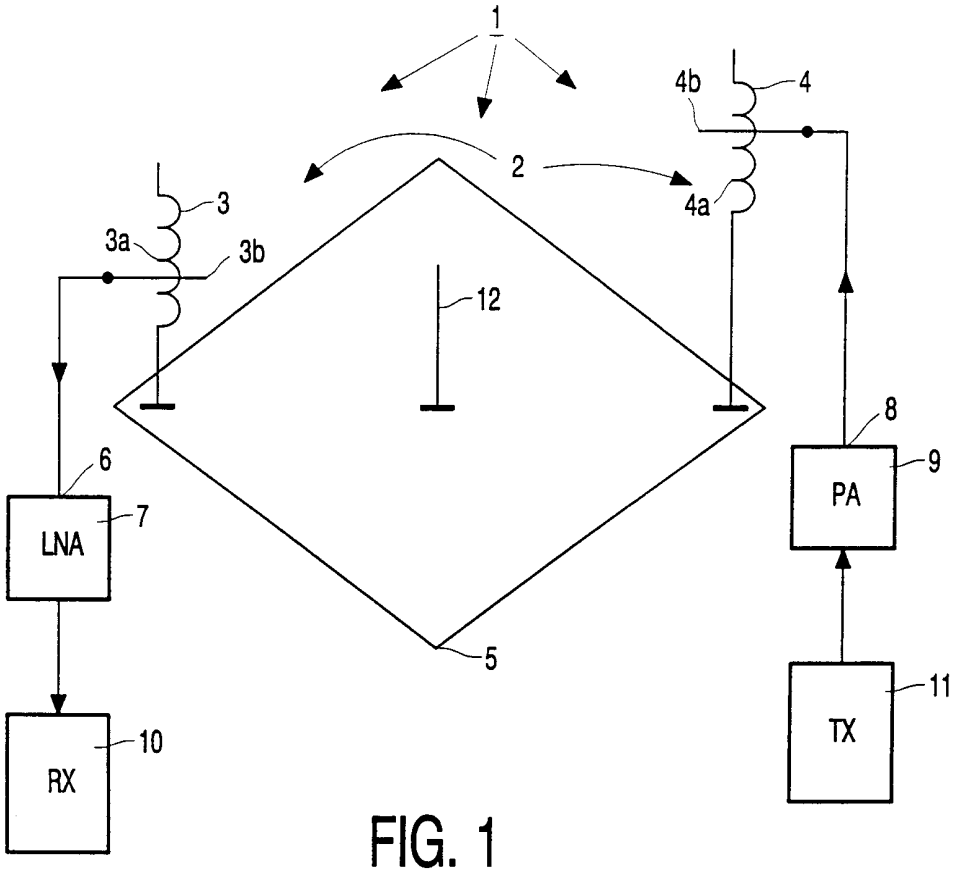
1
2
3
3a
3b
4
4a
4b
5
6
7
8
9
10
11
12
LNA
PA
RX
TX

FIG. 1

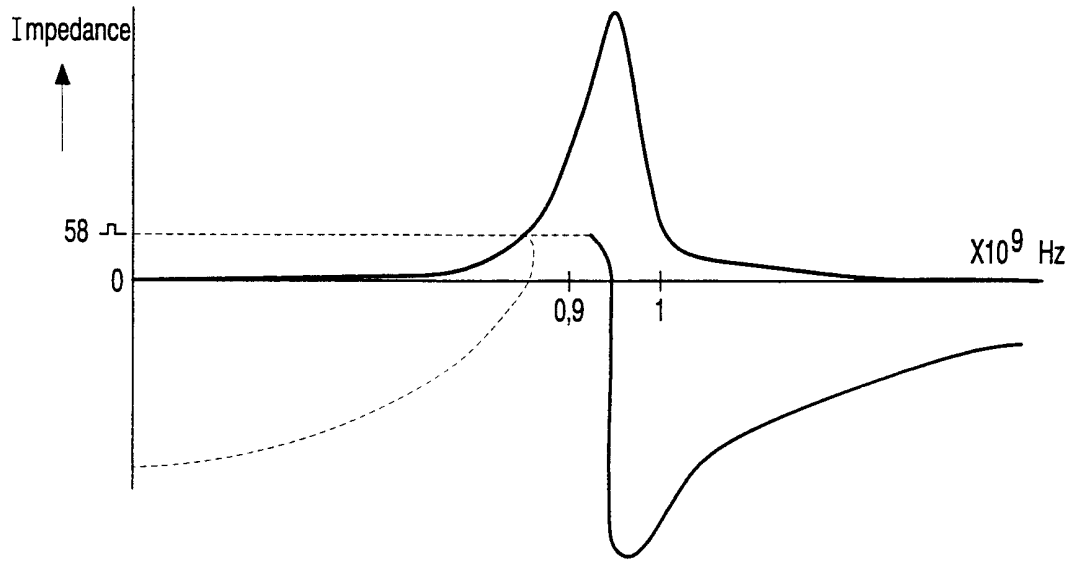
Impedance
58
0
0,9
1
X10⁹ Hz

FIG. 2

INTERNATIONAL SEARCH REPORT

Internat. .l Application No
PCT/EP 00/07180

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01Q1/52 H01Q1/24 H01Q11/08 H01Q1/36 H01Q9/30

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)
IPC 7 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, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	EP 0 526 643 A (MITSUBISHI ELECTRIC CORP ;NIPPON TELEGRAPH & TELEPHONE (JP)) 10 February 1993 (1993-02-10) figure 1 ---	1,3-5,9
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 November 2000	07/12/2000

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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