(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 973 197 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
16.06.2010 Bulletin 2010/24

(51) Int Cl.:
H01Q 9/04 *(2006.01)* *H01Q 1/38* *(2006.01)*
H01Q 5/00 *(2006.01)* *H01Q 1/24* *(2006.01)*

(21) Application number: **07104442.4**

(22) Date of filing: **19.03.2007**

(54) Multi-band slot-strip antenna

Mehrband-Antenne mit Schlitzstreifen

Antenne à fente à barrette multibande

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

(43) Date of publication of application:
24.09.2008 Bulletin 2008/39

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EP 1 973 197 B1

Description

[0001] The invention described herein relates generally to a multi-band antenna for a handheld wireless communications device. In particular, the invention relates to a multi-band slot-strip antenna.

[0002] Slot antennas typically comprise a slot cut into a metal sheet or printed circuit board. Since some modem communication devices are required to operate in multiple frequency bands, multi-band slot antennas have been developed for use in such devices.

[0003] For instance, Chang (US 7,006,048) describes a dual-band slot antenna for satellite and/or RFID communication systems. The slot antenna comprises two interconnected L-shaped slot antenna structures, and a printed circuit feed line that is coupled to both of the L-shaped slot antenna structures. Sun (US 6,677,909) describes dual-band slot antenna that comprises a pair of meandering slots, and a coaxial feed cable that is connected to the meandering slots.

[0004] Planar inverted-F antennas (PIFA) are becoming increasingly common in wireless handheld communication devices due to their reduced size in comparison to conventional microstrip antenna designs. Therefore, PIFA antennas have been developed which include multiple resonant sections, each having a respective resonant frequency. However, since conventional PIFA antennas have a very limited bandwidth, broadband technologies, such as parasitic elements and/or multi-layer structures, have been used to modify the conventional PIFA antenna for multi-band and broadband applications.

[0005] These approaches increase the size of the antenna, making the resulting designs unattractive for modem handheld communication devices. Also, the additional resonant branches introduced by these approaches make the operational frequencies of the antennas difficult to tune. Further, the additional branches can introduce significant electromagnetic compatibility (EMC) and electromagnetic interference (EMI) problems.

[0006] EP-A1-0923156 discloses a multi-band slot-strip antenna comprising conductive and non-conductive regions defining first to third slot structures together with a signal feed portion and a signal grounding portion.

[0007] US 2004/085244 A1 discloses a PIFA comprising first to third radiating slots together with a feed strip, a shorting strip and a capacitive tuning stub.

GENERAL

[0008] According to the invention described herein, a multi-band antenna may comprise at least three slot-strip structures configured with multiple ground pins.

[0009] In accordance with a first aspect of the invention, there may be provided a multi-band slot-strip antenna as claimed in claim 1.

[0010] In accordance with a second aspect of the invention, there may be provided a wireless communication device as claimed in claim 9.

[0011] As will become apparent, in addition to a higher frequency band around 5 GHz for WLAN 802.11 j/a applications, the multi-band antenna offers enhanced low frequency bandwidth around 2 GHz for 3G communications, from a structure whose size is suitable for incorporation into small handheld communications devices.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a front plan view of a handheld communications device according to the invention;
Fig. 2 is a schematic diagram depicting certain functional details of the handheld communications device;
Fig. 3 is a top plan view of a multi-band slot-strip antenna of the handheld communications device, suitable for use with a wireless network;
Fig. 4 to 6 are computer simulations of the return loss for the multi-band slot-strip antenna;
Fig. 7 is a computer simulation of the return loss for a preferred implementation of the multi-band slot-strip antenna; and
Fig. 8 depicts the computer simulated and actual return loss for the preferred implementation of the multi-band slot-strip antenna.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0013] Turning to Fig. 1, there is shown a sample handheld communications device 200 in accordance with the invention. Preferably, the handheld communications device 200 is a two-way wireless communications device having at least voice and data communication capabilities, and is configured to operate within a wireless cellular network. Depending on the exact functionality provided, the wireless handheld communications device 200 may be referred to as a data messaging device, a two-way pager, a wireless e-mail device, a cellular telephone with data messaging capabilities, a wireless Internet appliance, or a data communication device, as examples.

[0014] As shown, the handheld communications device 200 includes a display 222, a function key 246, and data processing means (not shown) disposed within a common housing 201. The display 222 comprises a backlit LCD display. The data processing means is in communication with the display 222 and the function key 246. In one implementation, the backlit display 222 comprises a transmissive LCD display, and the function key 246 operates as a power on/off switch. Alternately, in another implementation, the backlit display 222 comprises a reflective or trans-reflective LCD display, and the function key 246 operates as a backlight switch.

[0015] In addition to the display 222 and the function key 246, the handheld communications device 200 includes user data input means for inputting data to the data processing means. As shown, preferably the user data input means includes a keyboard 232, a thumbwheel 248 and an escape key 260. The keyboard 232 includes alphabetic and numerical keys, and preferably also includes a "Send" key and an "End" key to respectively initiate and terminate voice communication. However, the data input means is not limited to these forms of data input. For instance, the data input means may include a trackball or other pointing device instead of (or in addition to) the thumbwheel 248.

[0016] Fig. 2 depicts functional details of the handheld communications device 200. As shown, the handheld communications device 200 incorporates a motherboard that includes a communication subsystem 211, and a microprocessor 238. The communication subsystem 211 performs communication functions, such as data and voice communications, and includes a primary transmitter/receiver 212, a secondary transmitter/receiver 214, a primary internal antenna 216 for the primary transmitter/receiver 212, a secondary internal antenna 300 for the secondary transmitter/receiver 214, and local oscillators (LOs) 213 and one or more digital signal processors (DSP) 220 coupled to the transmitter/receivers 212, 214.

[0017] Typically, the communication subsystem 211 sends and receives wireless communication signals over a wireless cellular network via the primary transmitter/receiver 212 and the primary internal antenna 216. Further, typically the communication subsystem 211 sends and receives wireless communication signals over a local area wireless network via the secondary transmitter/receiver 214 and the secondary internal antenna 300.

[0018] Preferably, the primary internal antenna 216 is configured for use within a Global System for Mobile Communications (GSM) cellular network or a Code Division Multiple Access (CDMA) cellular network. Further, preferably the secondary internal antenna 300 is configured for use within a Universal Mobile Telecommunications Service (UMTS) or WLAN WiFi (IEEE 802.1 1x) network. More preferably, the secondary internal antenna 300 is a multi-band slot-strip antenna that is configured for use with networks whose operational frequencies are at/near 2GHz and 5 GHz, and whose low frequency bandwidth is suitable for 3G communications and high frequcny band for WLAN 802.11 j/a applications. Although the handheld communications device 200 is depicted in Fig. 2 with two antennas, it should be understood that the handheld communications device 200 may instead comprise only a single antenna, with the multi-band slot-strip antenna 300 being connected to both the primary transmitter/receiver 212 and the secondary transmitter/receiver 214. Further, although Fig. 2 depicts the multi-band antenna 300 incorporated into the handheld communications device 200, the multi-band antenna 300 is not limited to mobile applications, but may instead by used with a stationary communications device. The preferred structure of the multi-band antenna 300 will be discussed in detail below, with reference to Figs. 3 to 8.

[0019] Signals received by the primary internal antenna 216 from the wireless cellular network are input to the receiver section of the primary transmitter/receiver 212, which performs common receiver functions such as frequency down conversion, and analog to digital (A/D) conversion, in preparation for more complex communication functions performed by the DSP 220. Signals to be transmitted over the wireless cellular network are processed by the DSP 220 and input to transmitter section of the primary transmitter/receiver 212 for digital to analog conversion, frequency up conversion, and transmission over the wireless cellular network via the primary internal antenna 216.

[0020] Similarly, signals received by the secondary internal antenna 300 from the local area wireless network are input to the receiver section of the secondary transmitter/receiver 214, which performs common receiver functions such as frequency down conversion, and analog to digital (A/D) conversion, in preparation for more complex communication functions performed by the DSP 220. Signals to be transmitted over the local area wireless network are processed by the DSP 220 and input to transmitter section of the secondary transmitter/receiver 214 for digital to analog conversion, frequency up conversion, and transmission over the local area wireless network via the secondary internal antenna 300. If the communication subsystem 211 includes more than one DSP 220, the signals transmitted and received by the secondary transmitter/receiver 214 would preferably be processed by a different DSP than the primary transmitter/receiver 212.

[0021] The communications device 200 also includes a SIM interface 244 if the handheld communications device 200 is configured for use within a GSM network, and/or a RUIM interface 244 if the handheld communications device 200 is configured for use within a CDMA network. The SIM/RUIM interface 244 is similar to a card-slot into which a SIM/RUIM card can be inserted and ejected like a diskette or PCMCIA card. The SIM/RUIM card holds many key configurations 251, and other information 253 including subscriber identification information, such as the International Mobile Subscriber Identity (IMSI) that is associated with the handheld communications device 200, and subscriber-related information.

[0022] The microprocessor 238, in conjunction with the flash memory 224 and the RAM 226, comprises the aforementioned data processing means and controls the overall operation of the device. The data processing means interacts with device subsystems such as the display 222, flash memory 224, RAM 226, auxiliary input/output (I/O) subsystems 228, data port 230, keyboard 232, speaker 234, microphone 236, short-range communications subsystem 240, and device subsystems 242. The data port 230 may comprise a RS-232 port, a Universal Serial Bus (USB) port or other wired data communication port.

[0023] As shown, the flash memory 224 includes both computer program storage 258 and program data storage 250, 252, 254 and 256. Computer processing instructions are preferably also stored in the flash memory 224 or other similar non-volatile storage. Other computer processing instructions may also be loaded into a volatile memory such as RAM 226. The computer processing instructions, when accessed from the memory 224, 226 and executed by the microprocessor 238 define an operating system, computer programs, operating system specific applications. The computer processing instructions may be installed onto the handheld communications device 200 upon manufacture, or may be loaded through the cellular wireless network, the auxiliary I/O subsystem 228, the data port 230, the short-range communications subsystem 240, or the device subsystem 242.

[0024] The operating system allows the handheld communications device 200 to operate the display 222, the auxiliary input/output (I/O) subsystems 228, data port 230, keyboard 232, speaker 234, microphone 236, short-range communications subsystem 240, and device subsystems 242. Typically, the computer programs include communication software that configures the handheld communications device 200 to receive one or more communication services. For instance, preferably the communication software includes internet browser software, e-mail software and telephone software that respectively allow the handheld communications device 200 to communicate with various computer servers over the internet, send and receive e-mail, and initiate and receive telephone calls.

[0025] Fig. 3 depicts the preferred structure for the multi-band slot-strip antenna 300. The secondary antenna 300 comprises a planar conductive layer 302. Preferably, the planar conductive layer 302 is disposed on a substrate layer (not shown). As shown, the conductive layer 302 has a substantially rectangular shape having two opposing pairs of substantially parallel edges. Preferably, the multi-band slot-strip antenna 300 is implemented as a printed circuit board, with the planar conductive layer 302 comprising copper or other suitable conductive metal.

[0026] The conductive layer 302 comprises a conductive region 308 and three non-conductive regions (discussed below). In contrast to the conductive region 308, the non-conductive region is devoid of conductive metal. Typically, the non-conductive region is implemented via suitable printed circuit board etching techniques. As shown, the non-conductive regions, together with the surrounding conductive region 308, define a first slot-strip structure 312, a second slot-strip structure 314 that is electrically coupled to the first slot-strip structure 312, and a third slot-strip structure 316 that is electrically coupled to the second slot-strip structure 314.

[0027] The conductive-region 308 comprises a first L-shaped arm 318 (comprising a first linear (straight) minor arm portion 318a and a first linear (straight) major arm portion 318b); a second L-shaped arm 320 (comprising a second linear (straight) minor arm portion 320a and a second linear (straight) major arm portion 320b); a first linear (straight) arm 322 and a second linear (straight) arm 324. The conductive-region 308 also comprises a first rectangular base portion 326 that extends substantially perpendicularly between the first major arm portion 318 and the second major arm portion 320b of the L-shaped arms 318, 320; a second rectangular base portion 328 that extends substantially perpendicularly between the second major arm portion 320b and the first linear arm 322; and a third rectangular base portion 330 that extends substantially perpendicularly between the first and second linear arms 322, 324.

[0028] The non-conductive region comprises a first non-conductive slot 332 (comprising first minor slot portion 332a and first major slot portion 332b), a second non-conductive slot 334 (comprising second minor slot portion 334a and second major slot portion 334b), and a third non-conductive slot 336.

[0029] The first non-conductive slot 332 has a substantially L-shape, and extends between the first and second L-shaped arms 318, 320, terminating at the first base portion 326. The second non-conductive slot 334 also has a substantially L-shape, and extends between the second L-shaped arm 320, the third base portion 330 and the first linear arm 322, terminating at the second base portion 332. The third non-conductive slot 336 has a substantially linear (straight) shape, and extends between the first and second linear arms 322, 324, terminating at the third base portion 330.

[0030] The first slot-strip structure 312 comprises the first L-shaped arm 318, the first base portion 326, the second base portion 328 and the first non-conductive slot 332. The second slot-strip structure 314 comprises the second L-shaped arm 320, the second base portion 328, the first linear arm 322, and the second non-conductive slot 334. The third slot-strip structure 316 comprises the first linear arm 322, the third base portion 330, the second linear arm 324, and the third non-conductive slot 336.

[0031] With this configuration, the first and second slot-strip structures 312, 314 are commonly coupled by the second L-shaped arm 320. Also, the second and third slot-strip structures 314, 316 are commonly coupled by the first linear arm 322. Further, the first, second and third slot-strip structures 312, 314, 316 are substantially U-shaped.

[0032] As shown, the multi-band slot-strip antenna 300 also includes a signal feed pin 304, and first and second signal grounding pins 306a, 306b. The signal feed pin 304 is connected to the first minor arm portion 318a of the first slot-strip structure 312, 314, in close proximity to the open end of the first non-conductive slot 332. The first signal ground pin 306a is connected to the second minor arm portion 320a of the first and second slot-strip structures 312, 314, in close proximity to the signal feed pin 304 and the open end of the first non-conductive slot 332. The first signal ground pin 306a is also proximate the third base portion 330 of the third slot-strip structure 316.

[0033] The second signal ground pin 306b is connected to the second linear arm 324 of the third slot-strip structure 316, in close proximity to the open end of the third non-conductive slot 336. As will become apparent, this second signal ground pin 306b extends the bandwidth of the lower frequency band of the multi-band slot-strip antenna 300 to cover most of the application bands at/near 2 GHz.

[0034] Preferably, the first minor arm portion 318a is substantially parallel to the second minor arm portion 320a; and the first major arm portion 318b is substantially parallel to the second major arm portion 320b. Further, preferably the first linear arm 322 is substantially parallel to the second major arm portion 320b, and the second linear arm 324 is substantially parallel to the first linear arm 322.

[0035] Similarly, the first minor slot portion 332a is substantially parallel to the second minor slot portion 334a. Similarly, preferably the first major slot portion 332b is substantially parallel to the second major slot portion 334b. Further, the second non-conductive slot 334 opens in substantially the same direction as the first non-conductive slot 332.

[0036] The third non-conductive slot 336 is preferably substantially parallel to the second major slot portion 334b of the second non-conductive slot 334. However, the third non-conductive slot 336 opens in a direction that is substantially opposite to that of the second non-conductive slot 334.

[0037] Further, preferably the first and second minor arm portions 318a, 320a, the first and second minor slot portions 332a, 334a, and the rectangular base portions 326, 328, 330 are parallel to one pair of opposing edges of the conductive layer 302. In addition, preferably the first and second major arm portions 318b, 320b, the first and second linear arms 322, 324 and the rectangular base portions 326, 328, 330 are parallel to the other pair of opposing edges of the conductive layer 302.

[0038] Fig. 4 to 8 are computer simulations of the return loss for the multi-band slot-strip antenna 300. In these simulations:

L_a is the length of the first major slot portion 332b
L_b is the length of the second major slot portion 334b
L_c is the length of the third non-conductive slot 336
h_a is the width of the first major slot portion 332b
h_b is the width of the second major slot portion 334b
h_c is the width of the third non-conductive slot 336

[0039] Fig. 4 depicts the variation in return loss of the multi-band slot-strip antenna 300 with length L_a. In this simulation, L_b = 28.5mm; L_c = 6.5mm; h_a = 1mm; h_b = 2mm; h_c = 2mm; and La3 > La2 > La1 . This simulation reveals that the length of the first major slot portion 332b has a preferential impact on the centre frequency and impedance of the lower frequency band, in comparison to the higher frequency band. This result is advantageous since it reveals that the frequency and impedance of the lower frequency band can be adjusted by varying the length of the first slot-strip structure 312, without significantly impacting the characteristics of the upper frequency band.

[0040] Fig. 5 depicts the variation in return loss with length L_b. In this simulation, L_a = 13.5mm; L_c = 6.5mm; h_a = 1mm; h_b = 2mm; h_c = 2mm; and Lb4 > Lb3 > Lb2 > Lb1. This simulation reveals that the centre frequency, impedance and bandwidth of the upper and lower frequency bands are sensitive to variations in the length of the second major slot portion 334b.

[0041] Fig. 6 depicts the variation in return loss with L_c. In this simulation, L_a = 13.5mm; L_b = 28.5mm; h_a = 1mm; h_b = 2mm; h_c = 2mm; and Lc1 > Lc2 > Lc3 > Lc4. This simulation reveals that the impedance of the upper and lower frequency bands is sensitive to variations in the length of the third non-conductive slot 336. This result is advantageous since it reveals that the impedance of both bands can be adjusted independently of the centre frequency and bandwidth of the upper and lower frequency bands.

[0042] Fig. 7 is a computer simulation of the return loss for a preferred implementation of the multi-band slot-strip antenna 300, in comparison to a structure which has the same shape and dimensions but lacks the second signal grounding pin 306b. In this simulation, L_a = 13.5mm; L_b = 28.5mm; L_c = 6.5mm; h_a = 1mm; h_b = 2mm; h_c = 2mm. This simulation reveals that the second signal grounding pin 306b adds two closely-spaced resonant frequencies to the simulated spectrum around 2GHz, which significantly increases the bandwidth of the low frequency range from about 250MHz to about 500MHz.

[0043] Fig. 8 depicts the computer simulated and actual performance of a secondary multi-band slot-strip antenna 300 having the following dimensions: L_a = 13.5mm; L_b = 28.5mm; L_c = 6.5mm; h_a =1mm; h_b = 2mm; h_c = 2mm. This graph reveals that the multi-band slot-strip antenna 300 has an actual low frequency range that extends from 1.67 GHz to 2.34 GHz. Since the GSM1800 band (1710-1880MHz), the GSM1900 band (1850-1990MHz), the DCS band (1710-1880MHz), the PCS band (1880-1990MHz), and the UMTS band (1900-2200MHz) all fall within this enhanced low frequency range of the multi-band slot-strip antenna 300, the introduction of the second signal grounding pin 306b significantly enhances the multi-band performance of the multi-band slot-strip antenna 300. The graph also reveals that the multi-band slot-strip antenna 300 has a higher frequency (5GHz) range that is suitable for WLAN 802.11 a/j applications.

[0044] As will be appreciated from the foregoing discussion, the multi-band antenna 300 offers enhanced low frequency bandwidth around 2 GHz suitable for 3G communications. This result is obtained in a structure whose size is suitable for incorporation into small handheld communications devices.

Claims

1. A multi-band slot-strip antenna (300) comprising:

    a planar conductive layer (302) comprising a conductive region (308) and a non-conductive region, the conductive region (308) and the non-conductive region together defining:

        a first slot-strip structure (312) comprising a signal feed portion (304);
        a second slot-strip structure (314) coupled to the first slot-strip structure (312), the second slot-strip structure (314) comprising a first signal grounding portion (306a); and
        a third slot-strip structure (316) coupled to the second slot-strip structure (314), the third slot-strip structure (316) comprising a second signal grounding portion (306b), the second signal grounding portion (306b) being distinct from the first signal grounding portion (306a),
        wherein the slot-strip structures each have a substantially U-shape, each said U-shaped slot-strip structure comprises a pair of substantially parallel arms, a base portion joining together the arms, and a slot (332, 334, 336) extending between the arms, the signal feed portion (304) and the grounding portions (306a, 306b) are each disposed proximate one end of one arm (318, 320, 324) of the respective slot-strip structures (312, 314, 316), **characterised in that** the other arm of the first slot-strip structure (312) is common with said one arm (320) of the second slot-strip structure (314), and the other arm (322) of the second slot-strip structure (314) is common with the other arm (322) of the third slot-strip structure (316).

2. The multi-band antenna (300) according to Claim 1, wherein the slot (336) of the third slot-strip structure (316) opens in a direction opposite to that of the second slot-strip structure (314).

3. The multi-band antenna (300) according to Claim 1 or Claim 2, wherein the slot (334) of the second slot-strip structure (314) opens in a direction substantially the same as the first slot-strip structure (312).

4. The multi-band antenna (300) according to any one of Claims 1 to 3, wherein the first grounding portion (306a) is disposed proximate the signal feed portion (304).

5. The multi-band antenna (300) according to any one of Claims 1 to 4, wherein the first grounding portion (306a) is disposed proximate the base portion (330) of the third slot-strip structure (316).

6. The multi-band antenna (300) according to any one of Claims 1 to 5, wherein the arms (318) of the first slot-strip structure (312) have a substantially L-shape.

7. The multi-band antenna (300) according to Claim 6, wherein one arm (320) of the second slot-strip structure (314) has a substantially L-shape, and the other arm (322) of the second slot-strip structure (314) has a substantially linear shape.

8. The multi-band antenna (300) according to any one of Claims 1 to 7, wherein the signal feed portion (304) and the signal ground portions (306) are provided proximate an end of the respective arms (318, 320, 324) opposite the respective base portions (326, 328, 330).

9. A wireless communications device (200) comprising:

    a radio transceiver section (214); and
    a multi-band slot-strip antenna (300) according to any one of Claims 1 to 8, the multi-band slot-strip antenna (300) being coupled to the radio transceiver section (214).

Patentansprüche

1. Mehrband-Antenne mit Schlitzstreifen (300), die aufweist:

    eine ebene leitfähige Schicht (302), die einen leitfähigen Bereich (308) und einen nicht-leitfähigen Bereich aufweist, wobei der leitfähige Bereich (308) und der nicht-leitfähige Bereich zusammen definieren:

        eine erste Schlitzstreifen-Struktur (312), die einen Signalzufuhr-Teil (304) aufweist;
        eine zweite Schlitzstreifen-Struktur (314), die mit der ersten Schlitzstreifen-Struktur (312) gekoppelt ist, wobei die zweite Schlitzstreifen-Struktur (314) einen ersten Signal-Erdungs-Teil (306a) aufweist; und
        eine dritte Schlitzstreifen-Struktur (316), die mit der zweiten Schlitzstreifen-Struktur (314) gekoppelt ist, wobei die dritte Schlitzstreifen-Struktur (316) einen zweiten Signal-Erdungs-Teil (306b) aufweist, wobei der zweite Signal-Erdungs-Teil (306b) verschieden von dem ersten Signal-Erdungs-Teil (306a) ist,
        wobei die Schlitzstreifen-Strukturen jeweils im Wesentlichen U-förmig sind,

wobei jede U-förmige Schlitzstreifen-Struktur ein Paar von im Wesentlichen parallelen Armen, einen Basisteil, der die Arme miteinander verbindet und einen Schlitz (332, 334, 336) aufweist, der sich zwischen den Armen erstreckt, wobei der Signalzufuhr-Teil (304) und die Erdungs-Teile (306a, 306b) jeweils in der Nähe zu einem Ende eines Arms (318, 320, 324) der jeweiligen Schlitzstreifen-Strukturen (312, 314, 316) angeordnet sind,

dadurch gekennzeichnet, dass der andere Arm der ersten Schlitzstreifen-Struktur (312) gemeinsam ist mit dem einen Arm (320) der zweiten Schlitzstreifen-Struktur (314), und der andere Arm (322) der zweiten Schlitzstreifen-Struktur (314) gemeinsam ist mit dem anderen Arm (322) der dritten Schlitzstreifen-Struktur (316).

2. Mehrband-Antenne (300) gemäß Anspruch 1, wobei sich der Schlitz (336) der dritten Schlitzstreifen-Struktur (316) in eine Richtung öffnet, die entgegengesetzt ist zu der der zweiten Schlitzstreifen-Struktur (314).

3. Mehrband-Antenne (300) gemäß Anspruch 1 oder Anspruch 2, wobei sich der Schlitz (334) der zweiten Schlitzstreifen-Struktur (314) in eine Richtung öffnet, die im Wesentlichen dieselbe ist wie die erste Schlitzstreifen-Struktur (312).

4. Mehrband-Antenne (300) gemäß einem der Ansprüche 1 bis 3, wobei der erste Erdungs-Teil (306a) in der Nähe des Signalzufuhr-Teils (304) angeordnet ist.

5. Mehrband-Antenne (300) gemäß einem der Ansprüche 1 bis 4, wobei der erste Erdungs-Teil (306a) in der Nähe des Basisteils (330) der dritten Schlitzstreifen-Struktur (316) angeordnet ist.

6. Mehrband-Antenne (300) gemäß einem der Ansprüche 1 bis 5, wobei die Arme (318) der ersten Schlitzstreifen-Struktur (312) eine im Wesentlichen L-Form haben.

7. Mehrband-Antenne (300) gemäß Anspruch 6, wobei ein Arm (320) der zweiten Schlitzstreifen-Struktur (314) eine im Wesentlichen L-Form hat und der andere Arm (322) der zweiten Schlitzstreifen-Struktur (314) eine im Wesentlichen lineare Form hat.

8. Mehrband-Antenne (300) gemäß einem der Ansprüche 1 bis 7, wobei der Signalzufuhr-Teil (304) und die Signal-Erdungs-Teile (306) in der Nähe zu einem Ende der jeweiligen Arme (318, 320, 324) gegenüberliegend der jeweiligen Basisteile (326, 328, 330) vorgesehen sind.

9. Drahtlose Kommunikationsvorrichtung (200), die aufweist:

einen Funk-Transceiver-Abschnitt (214); und eine Mehrband-Antenne mit Schlitzstreifen (300) gemäß einem der Ansprüche 1 bis 8, wobei die Mehrband-Antenne mit Schlitzstreifen (300) mit dem Funk-Transceiver-Abschnitt (214) verbunden ist.

Revendications

1. Antenne (300) à fente/ruban multi-bande comprenant :

une couche conductrice planaire (302) comprenant une région conductrice (308) et une région non conductrice, la région conductrice (308) et la région non conductrice définissant ensemble :

une première structure à fente/ruban (312) comprenant une partie d'alimentation de signal (304) ;

une deuxième structure à fente/ruban (314) couplée à la première structure à fente/ruban (312), la deuxième structure à fente/ruban (314) comprenant une première partie de masse de signal (306a) ; et

une troisième structure à fente/ruban (316) couplée à la deuxième structure à fente/ruban (314), la troisième structure à fente/ruban (316) comprenant une deuxième partie (306b) de masse de signal, la deuxième partie (306b) de masse de signal étant différente de la première partie (306a) de masse de signal,

où les structures à fente/ruban ont chacune une forme essentiellement en U, chacune desdites structures à fente/ruban en forme de U comprend une paire de bras essentiellement parallèles, une partie de base reliant les deux bras entre eux, et une fente (332, 334, 336) s'étendant entre les bras, la partie d'alimentation de signal (304) et les parties de masse (306a, 306b) sont disposées chacune à proximité d'une extrémité d'un bras (318, 320, 324) des structures à fente/ruban respectives (312, 314, 316),

caractérisée en ce que, l'autre bras de la première structure à fente/ruban (312) est commun avec ledit un bras (320) de la deuxième structure à fente/ruban (314) et l'autre bras (322) de la deuxième structure à fente/ruban (314) est commun à l'autre bras (322) de la troisième structure à fente/ ruban (316).

2. Antenne multi-bande (300) selon la revendication 1, dans laquelle la fente (336) de la troisième structure à fente/ruban (316) s'ouvre dans une direction opposée à celle de la deuxième structure à fente/ruban (314).

3. Antenne multi-bande (300) selon la revendication 1 ou la revendication 2, dans laquelle la fente (334) de la deuxième structure à fente/ruban (314) s'ouvre dans une direction essentiellement la même que la première structure à fente/ruban (312).

4. Antenne multi-bande (300) selon l'une quelconque des revendications 1 à 3, dans laquelle la première partie de masse (306a) est disposée à proximité de la partie d'alimentation de signal (304).

5. Antenne multi-bande (300) selon l'une quelconque des revendications 1 à 4, dans laquelle la première partie de masse (306a) est disposée à proximité de la partie de base (330) de la troisième structure à fente/ruban (316).

6. Antenne multi-bande (300) selon l'une quelconque des revendications 1 à 5, dans laquelle les bras (318) de la première structure à fente/ruban (312) ont une forme essentiellement en L.

7. Antenne multi-bande (300) selon la revendication 6, dans laquelle un bras (320) de la deuxième structure à fente/ruban (314) a une forme essentiellement en L, et l'autre bras (322) de la deuxième structure à fente/ruban (314) a une forme essentiellement linéaire.

8. Antenne multi-bande (300) selon l'une quelconque des revendications 1 à 7, dans laquelle la partie d'alimentation de signal (304) et les parties de masse signal (306) sont pourvues à proximité d'une extrémité des bras respectifs (318, 320, 324) à l'opposé des parties de base respectives (326, 328, 330).

9. Dispositif de communications sans fil (200) comprenant :

une section d'émetteur-récepteur radio (214) ; et
une antenne (300) à fente/ruban multi-bande selon l'une quelconque des revendications 1 à 8, l'antenne (300) à fente/ruban multi-bande étant couplée à la section d'émetteur-récepteur radio (214).

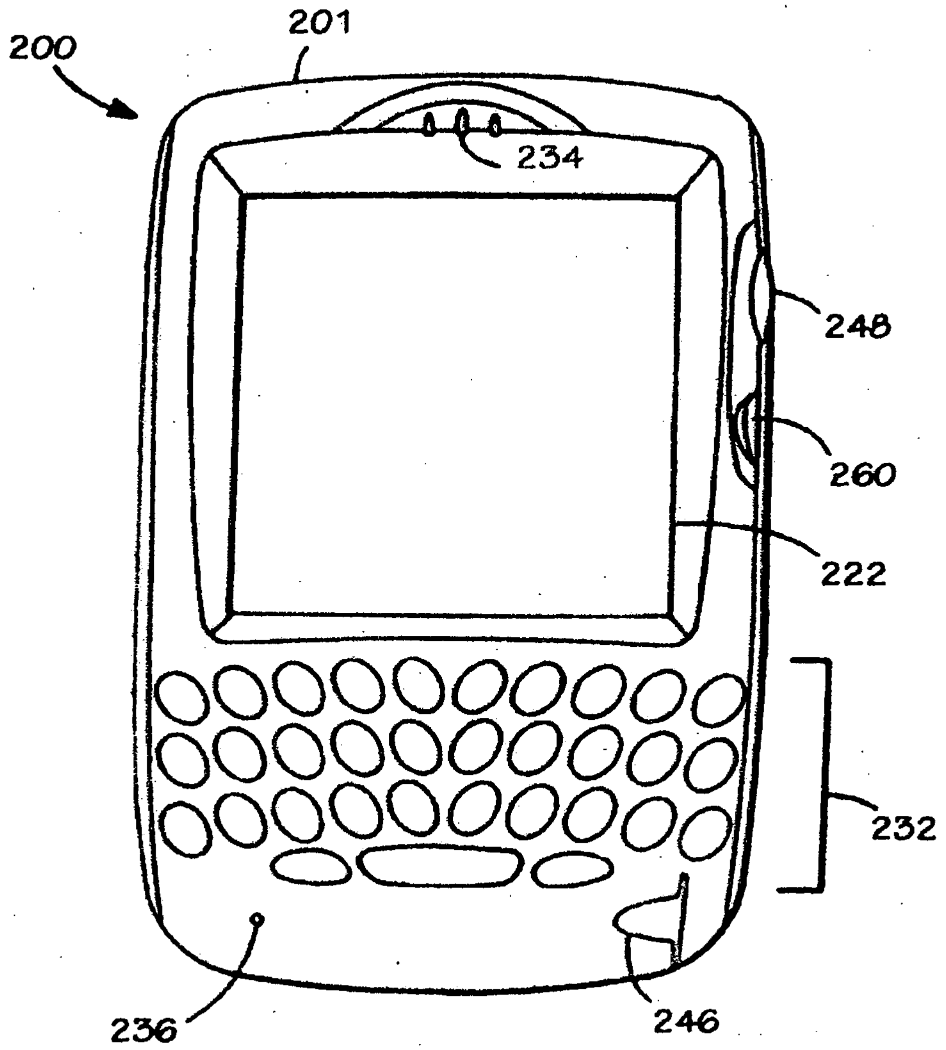

FIG. 1

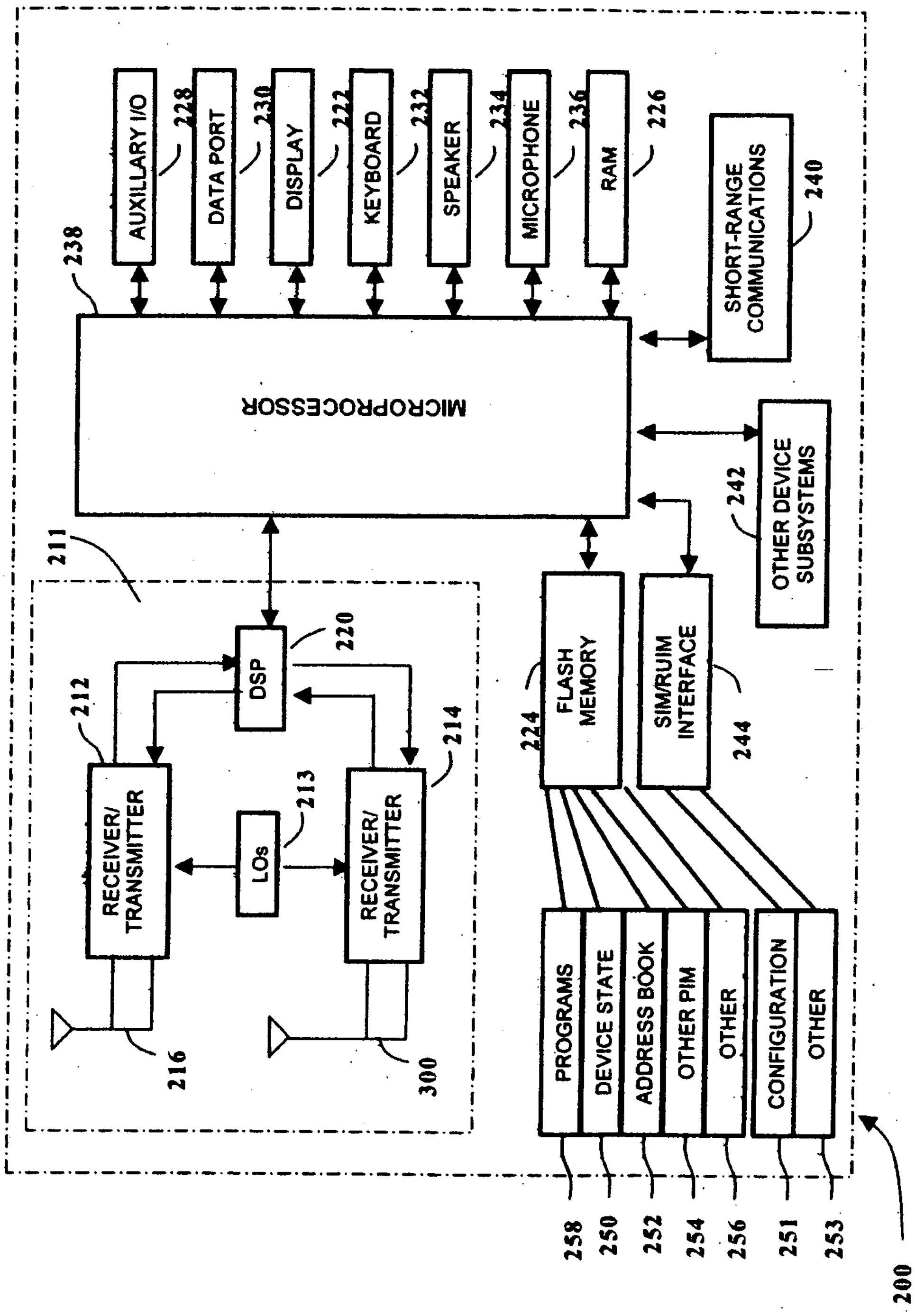
AUXILIARY I/O
228
DATA PORT
230
DISPLAY
222
KEYBOARD
232
SPEAKER
234
MICROPHONE
236
RAM
226
238
MICROPROCESSOR
SHORT-RANGE COMMUNICATIONS
240
OTHER DEVICE SUBSYSTEMS
242
211
DSP
220
212
214
RECEIVER/ TRANSMITTER
LOs
213
RECEIVER/ TRANSMITTER
216
300
FLASH MEMORY
224
SIM/RUIM INTERFACE
244
PROGRAMS
DEVICE STATE
ADDRESS BOOK
OTHER PIM
OTHER
CONFIGURATION
OTHER
258
250
252
254
256
251
253
200

FIG. 2

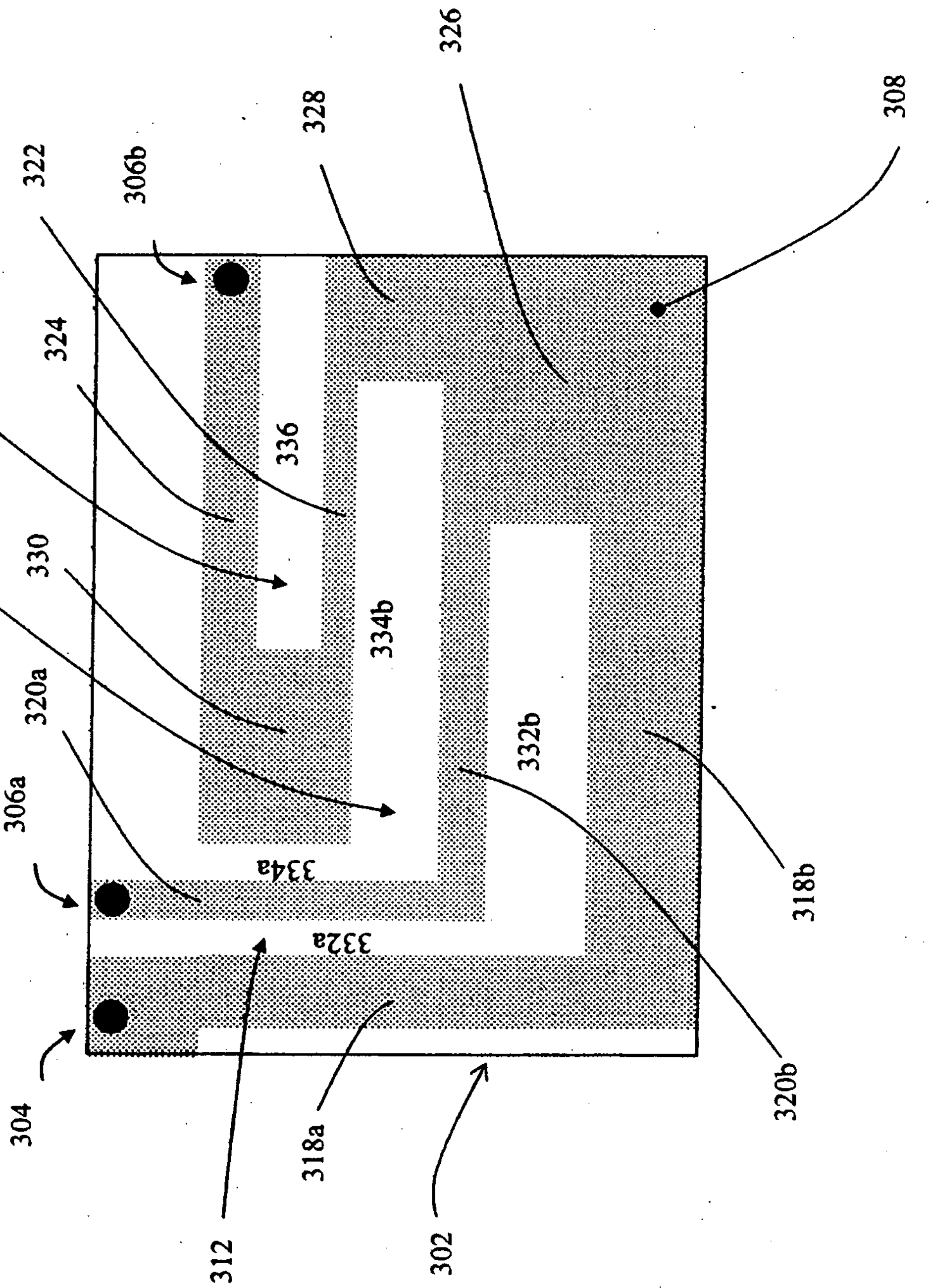
322
306b
328
326
308
316
324
336
314
330
320a
334b
332b
306a
334a
332a
318b
304
318a
312
302
320b

FIG. 3

300

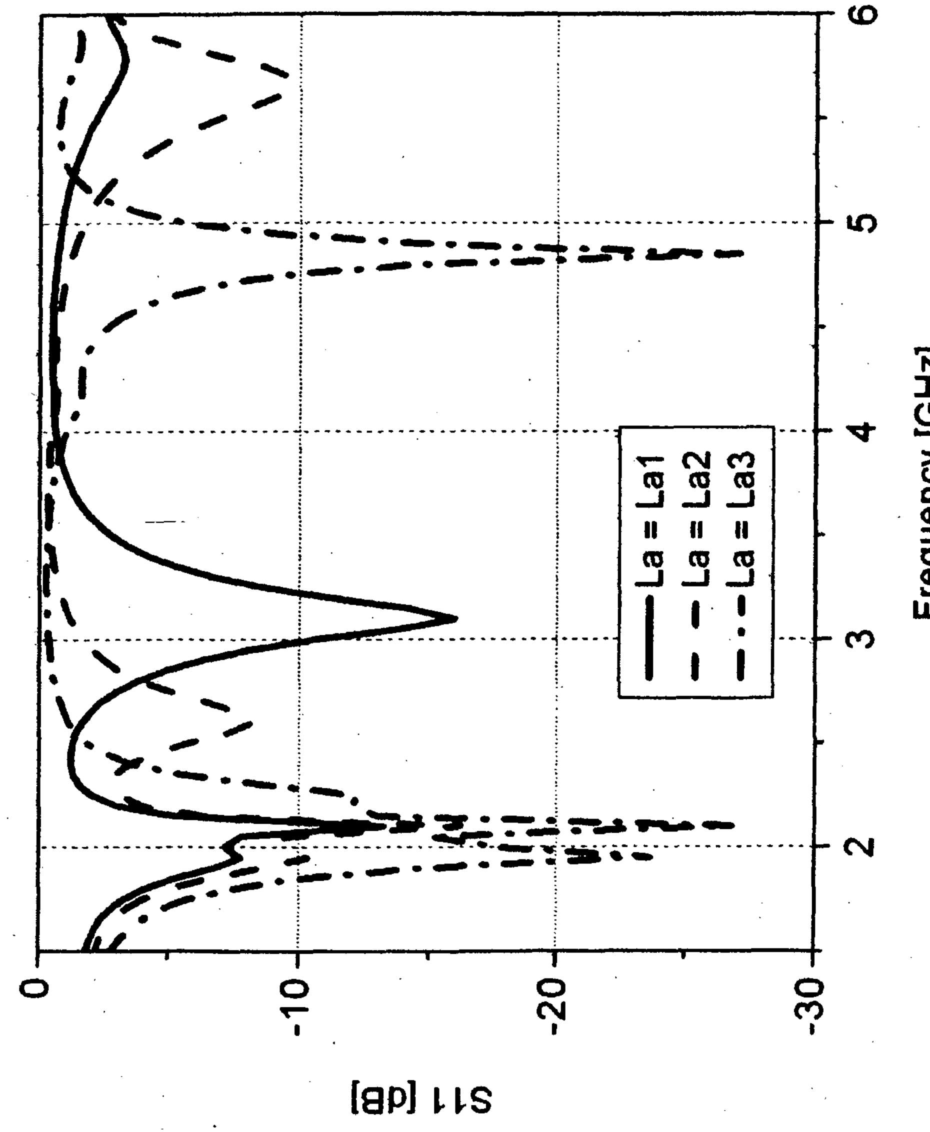

FIG. 4

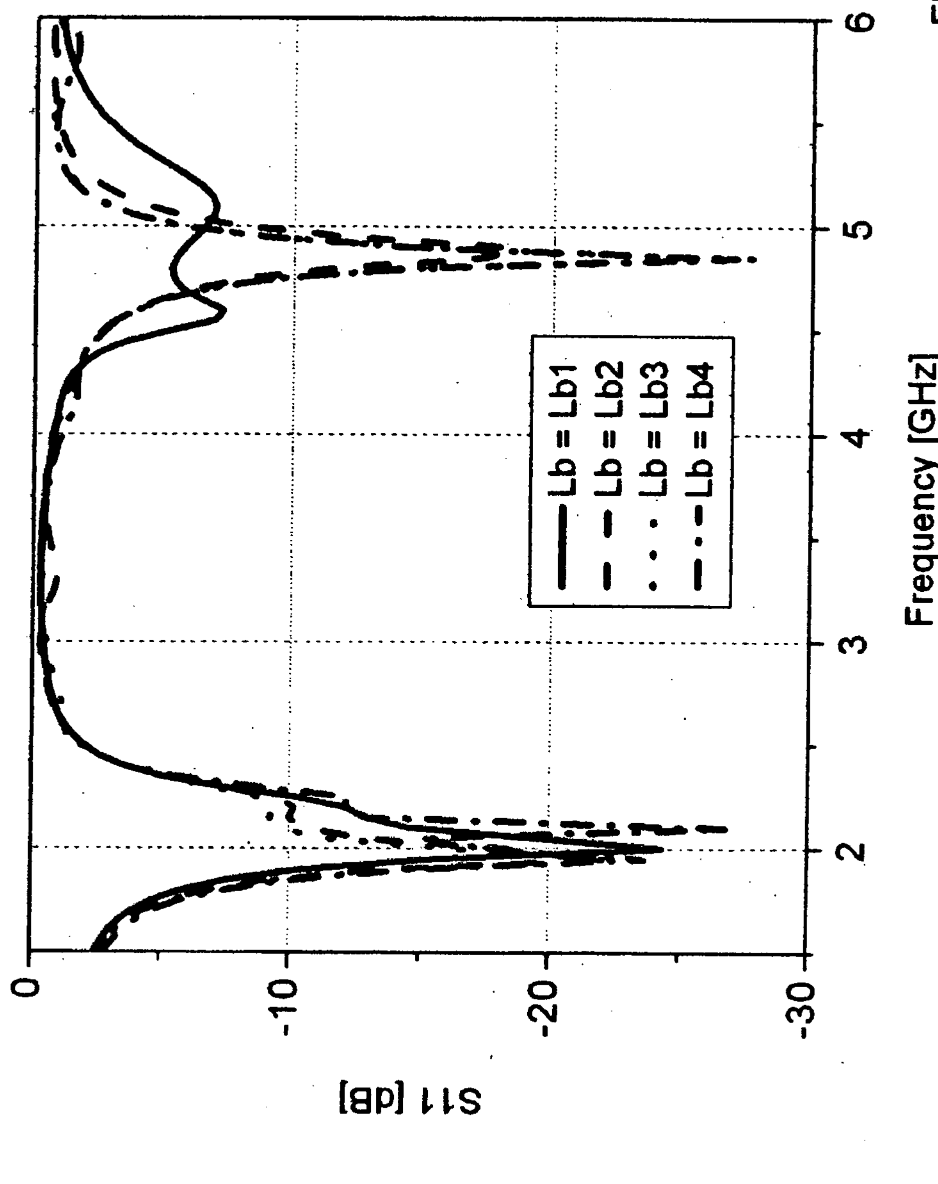

FIG. 5

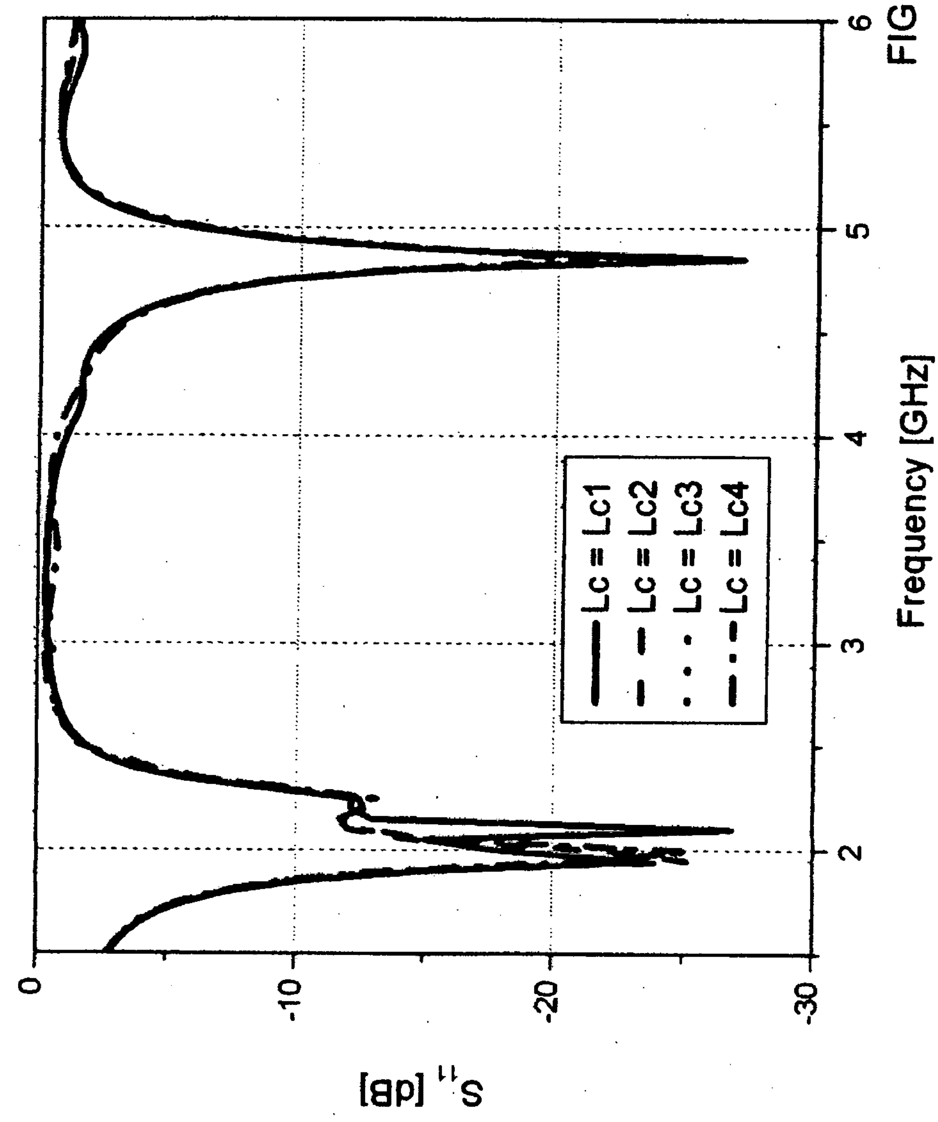

FIG. 6

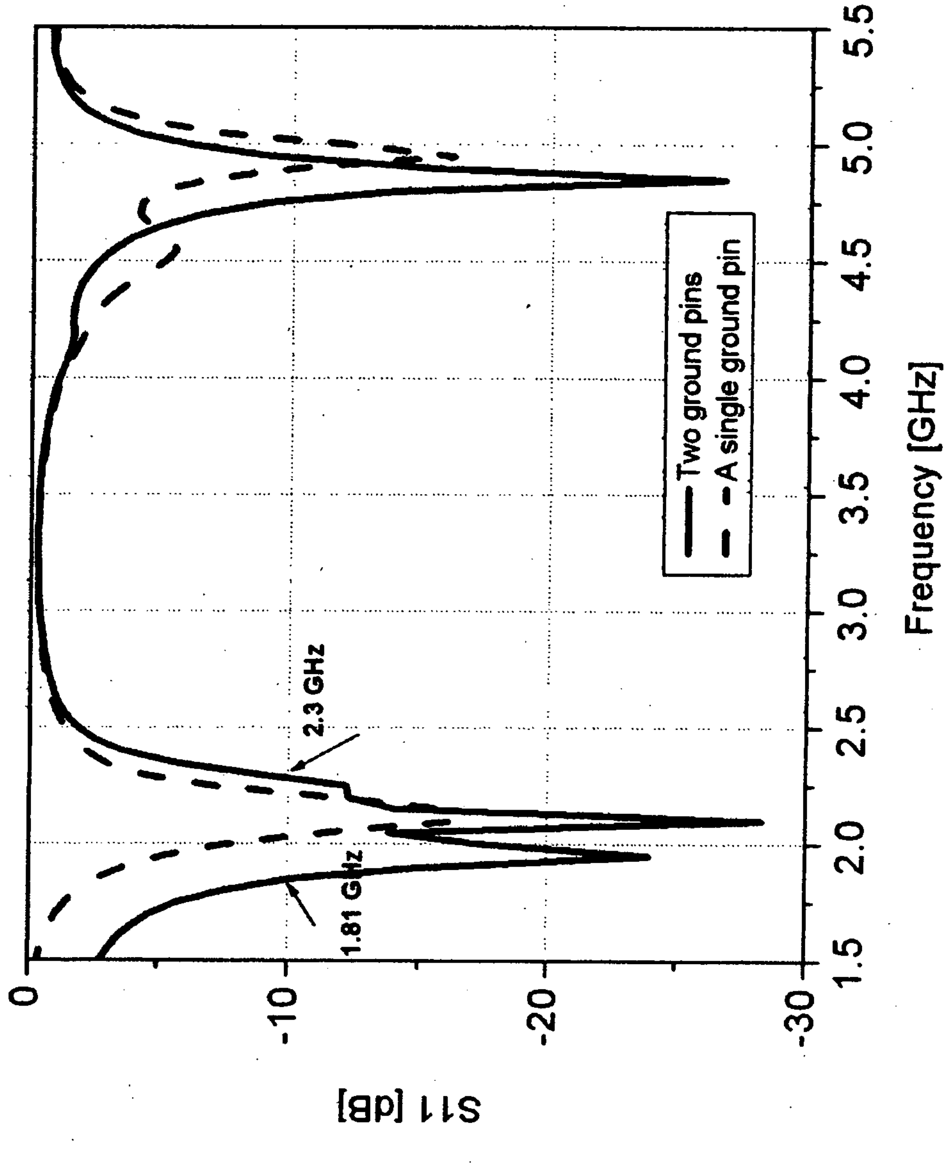
0
-10
-20
-30
S11 [dB]
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
Frequency [GHz]
1.81 GHz
2.3 GHz
Two ground pins
A single ground pin

FIG. 7

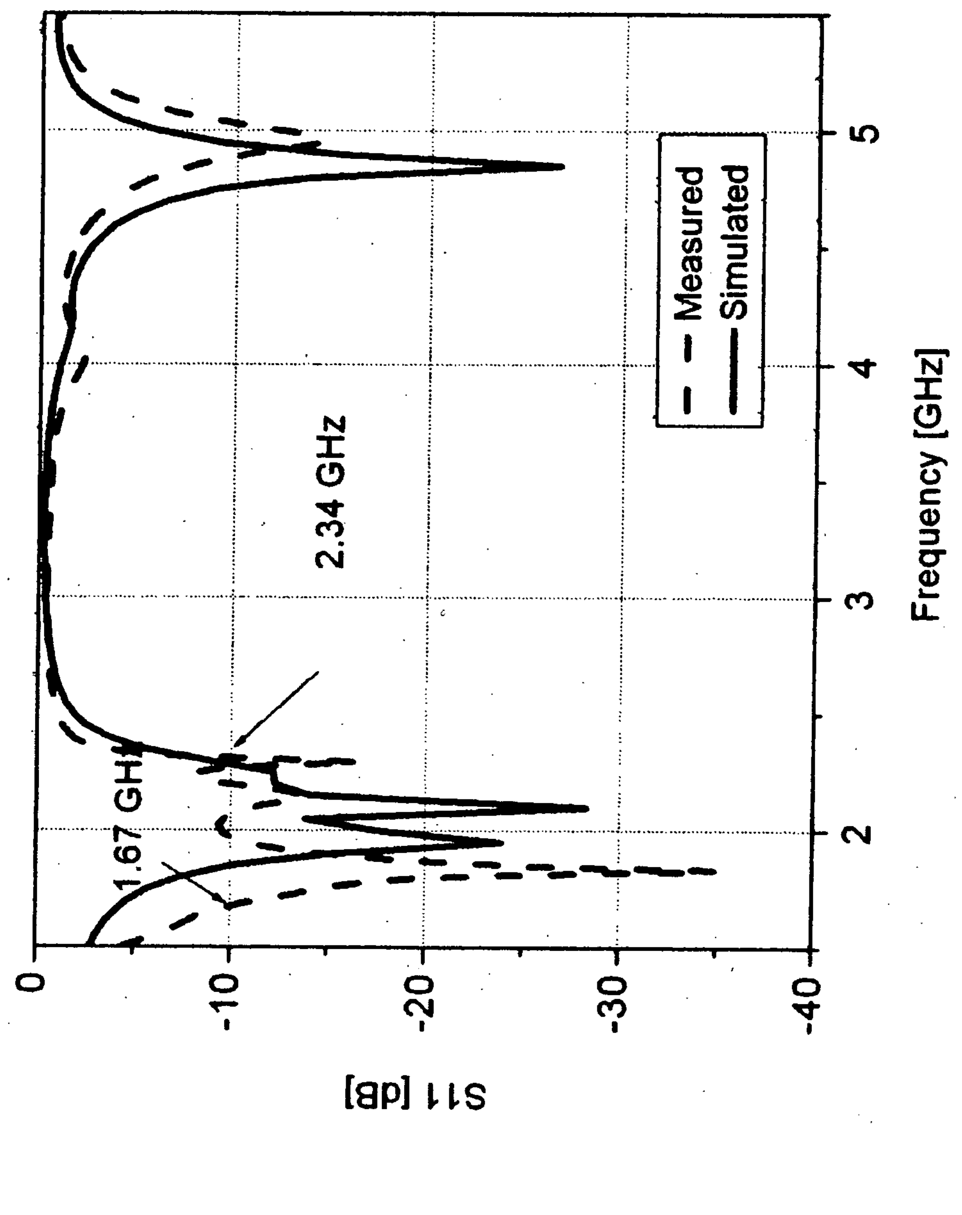
1.67 GHz
2.34 GHz
Measured
Simulated
0
-10
-20
-30
-40
S11 [dB]
2
3
4
5
Frequency [GHz]

FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 7006048 B **[0003]**
- US 6677909 B **[0003]**
- EP 0923156 A1 **[0006]**
- US 2004085244 A1 **[0007]**