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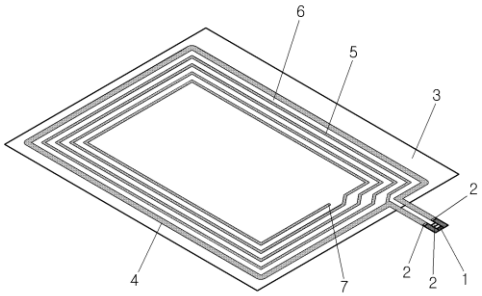
(54) Title of Invention **NFC ANTENNA HAVING SINGLE-LAYER STRUCTURE**

(57) Abstract

The present invention relates to an NFC antenna having a single-layer structure, and comprises a 13.56 MHz NFC antenna in the form of a FPCB (flexible PCB) for providing near field wireless communication within 10 cm composed of an antenna feed portion (1) to which the signal of the antenna is applied; an impedance matching portion (2) for matching the inductance value (L) and the capacitance value (C) to resonate at the resonance frequency ($f = 1/(2\pi\sqrt{LC})$, $c = f\lambda$, provided that, $c = 3 \times 10^8$ m/sec) of the 13.56 MHz NFC antenna; a dielectric substrate (3) used as a substrate (cover polymide [sic], $\varepsilon_r = 3.5$, 30) for covering the pattern of the antenna; an outer 1 turn line portion (4) arranged in the form of a loop at the outer edge of the 13.56 MHz NFC antenna; an internal branched line portion (5) constituting a branched metal line inside the 13.56 MHz NFC antenna; a clearance (6) indicating a gap portion of the empty space between the metal lines; and a branched line end portion (7), which is the end point of the branched line for controlling the number of turns of the branched metal line, and is composed of a battery (8) for attaching the 13.56 MHz NFC antenna to the battery of a smartphone. In the same manner as a conventional loop antenna having a double-layered structure, the 13.56 MHz NFC antenna having a single-layer structure forms a magnetic field in a state in which the impedance has been matched with respect to an antenna having an internal branched metal line capable of being adjusted to 2 turns to 5 turns in a basic 1 turn loop antenna to generate and operate a magnetic field having the same overall performance compared to a conventional NFC antenna having a double-layered structure, and the 13.56 MHz NFC antenna having a single-layer structure in the form of an FPCB (Flexible PCB) is applied to the battery (8) of a mobile communication terminal (smartphone) or applied to back cases, POS terminals, and other electronic devices to reduce the overall thickness of the mobile communication terminal.

Representative figure - Fig. 17



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National research and development project supporting this invention

Identification No.	C0015229
Name of department	Small- and Medium-sized Enterprise Administration
Name of research project	Industry-Academic-Research Joint Technology Development Project
Name of research	Development of NFC antenna and material for mobile terminals to secure a stable recognition region
Contribution ratio	1/1
Host institution	Kwangwoon University Industry-Academic Collaboration Foundation
Period of research	June 1, 2012 to May 31, 2014

Scope of claims

Claim 1

An NFC antenna having a single-layer structure, wherein the NFC antenna having a single-layer structure comprises

an antenna feed portion (1) to which the signal of the antenna is applied;

an impedance matching portion (2) for matching the inductance value (L) and the capacitance value (C) to resonate at the resonance frequency ($f = 1/(2\pi\sqrt{LC})$, $c = f\lambda$, provided that, $c = 3 \times 10^8$ m/sec) of the 13.56 MHz NFC antenna;

a dielectric substrate (3) used as a substrate (cover polymide [sic], $\varepsilon_r = 3.5$, 30) for covering the pattern of the antenna;

an outer 1 turn line portion (4) arranged in the form of a loop at the outer edge of the 13.56 MHz NFC antenna;

an internal branched line portion (5) constituting a branched metal line inside the 13.56 MHz NFC antenna;

a clearance (6) indicating a gap portion of the empty space between the metal lines; and

a branched line end portion (7), which is the end point of the branched line for controlling the number of turns of the branched metal line,

wherein a 13.56 MHz NFC loop antenna having a single-layer structure is designed and the branched metal line capable of controlling the number of turns wound inside the loop having a single-layer structure is inserted to eliminate the jump line present in a conventional antenna having a double-layered structure, thereby reducing the thickness of the NFC antenna to mitigate the disadvantages of a conventional NFC loop antenna having a double-layered structure.

Claim 2

The NFC antenna having a single-layer structure of claim 1,

wherein the 13.56 MHz NFC antenna having a single-layer structure is capable of changing the inductance value while having a constant resistance value through a branched metal line wound inside the basic loop antenna, and forms a magnetic field in a state in which the impedance has been matched with respect to the resistance value, inductance value, and quality factor of the antenna to be identical to that of the conventional loop antenna having a double-layered structure to generate and operate a magnetic field having the same overall performance compared to the conventional NFC antenna having a double-layered structure.

Claim 3

Deleted

Claim 4

Deleted

Specification

Technological field

[0001] The present invention relates to a 13.56 MHz NFC (Near Field Communication) antenna having a single-layer structure, and an NFC loop antenna having a single-layer structure is designed and a branched metal line capable of controlling the number of turns wound inside the loop having a single-layer structure is inserted to eliminate the jump line present in the conventional antenna having a double-layered structure, thereby reducing the thickness of the antenna to mitigate the disadvantages of the conventional NFC loop antenna having a double-layered structure, and it can be installed on back cases, battery packs, POS terminals, electronic devices. It can also be used for non-contact near field wireless communication as an antenna having a structure capable of providing reliability and reduced costs for mass production.

Background art

[0002] NFC is a non-contact, shot-range wireless technology standard that uses 13.56 MHz frequency allowing wireless communication between electronic devices with low power at a distance within 10 cm. It was jointly developed in 2002 by NXP Semiconductors (based in the Netherlands) and Sony (based in Japan). The speed of transmission is up to 424 kbps. It provides excellent security thanks to its proximity characteristics and encryption technology, and terminals can recognize each other in less than a tenth of a second without any complicated pairing procedures. NFC is a smart card RFID technology enabling contactless wireless communication and it provides bi-directionality compared to other smart cards. Moreover, it has a large storage memory space, and a wide range of applicable services. NFC not only provides data communication between terminals through convergence with mobile devices, especially smartphones, but it also maintains interoperability with conventional non-contact smart card technology and radio frequency identification (RFID).

[0003] Standards related to NFC (ISO/IEC 18092 and ISO/IEC 21481) were established at the NFC Forum. The NFC Forum was formed in 2004 with NXP and Sony as key members. The NFC standard is an extension of the ISO/IEC 14443' non-contact card standard, and data communication is possible with NFC devices and ISO/IEC 14443 readers or smart cards. Recently, a new movement has emerged to introduce NFC technology to smartphones.

[0004] Currently, there is a service model that introduces NFC technology in smartphones using the iOS (Apple) or Android (Google) operating systems. The NFC technology is used as a mobile credit card, RFID reader or tag, and data communication device. Major credit card companies such as VISA and Mastercard are active supporters of NFC technology. NFC support in other smartphone OSs (Google's Android OS and Nokia's Symbian OS) is on the rise.

[0005] NFC provides 13.56 MHz band non-contact near field wireless communication technology that allows it to provide both data communication between terminals through convergence with mobile devices and interoperability with conventional non-contact smart card technology and RFID. It was only after the establishment of the international standard for NFC communication (ISO/IEC 18092) in 2003 foundation of the NFC Forum in 2004 that the term "NFC" began to be used officially. In the past, most 13.56 MHz wireless communication technologies were included in the category of non-contact smart card technology. Conventional non-contact smart card technology is commonly used in credit cards and in transportation cards to pay subway and bus fares. NFC technology is used in RFID tags in the fields of distribution and logistics. However, efforts continue to be made to break away from fixed-type services like dedicated readers and IC cards and install non-contact wireless communication technology in mobile phones. Nokia, the world's top mobile phone manufacturer, has released some of their NFC-equipped mobile phone models. However, NFC's market expansion was limited because of insufficient service connections caused by limited wireless Internet access, limited use of general mobile phones, and the lack of NFC-equipped mobile devices.

[0006] It was only after the establishment of the international standard for NFC communication (ISO/IEC 18092) in 2003 and the foundation of the NFC Forum in 2004 that the term "NFC" began to be used officially. In the past, most 13.56 MHz wireless communication technologies were included in the category of non-contact smart card technology. NFC was established as an ISO/IEC 18092 non-contact near field wireless communication standard for the first time in 2004 and defines a communication interface and protocol between devices using a magnetic coupling method in the 13.56 MHz band. In Japan, the popular technology of FeliCa was partially reflected in the content of ISO/IEC 18092, but FeliCa (FeliCa^{TM}) is Sony's own wireless communication technology for smart cards and was included in the content of a new technological standard called NFC when they failed to add the ISO/IEC 14443 type C standardization.

[0007] The NFC standard is an extension of the ISO/IEC 14443' non-contact card standard and can communicate not only with NFC devices but also with ISO/IEC 14443 readers or smart cards. NFC is widely used for payment, transmitting product information at general stores, travel information to visitors, and transportation and access control lock information. The NFC market, which is expected to significantly increase from 2011, is expected to be applied to media-content industries in addition to the current industries of finance, transportation, and distribution.

[0008] NFC technology has existed for more than 10 years, and pilot projects continue to be executed to explore future NFC technology possibilities. NFC can read and write tag information and is technologically superior to conventional RFID technology, which can only read tag information using a reader. Although the data transmission speed is slower than Bluetooth transmission speeds, there are advantages to using NFC technology over Bluetooth or infrared technology, which are similar technologies, in that the communication setup time is very short at 0.1 seconds and there are fewer recognition errors caused by the direction of the sensor. Despite such advantages, the NFC market has quickly grown thanks to global supply pushes to integrate this technology. It started to emerge rapidly after Nokia announced in July 2010 that all Nokia smartphones would be equipped with NFC from 2011. In November, Verizon, AT&T, and T-Mobile USA (major US mobile carriers), announced the establishment of a JV called Isis. Google announced NFC technology as a major function in Gingerbread (Android 2.3 version unveiled in December), and formed a strategic alliance with the leader of NFC chips, NXP. In February of 2011, it was revealed that GSMA, the representative body for mobile carriers, was preparing NFC technology standards for 16 global mobile carriers (including SKT and KT). They later announced in March that Verifone, the world's second largest POS company, would introduce NFC into all future POS terminals.

[0009] NFC is a non-contact near field wireless communication method using the 13.56 MHz band. It is a technology capable of transmitting data between terminals with lower power at a distance of about 10 cm, and it can be said to be a type of RFID technology. The difference from a conventional mobile RFID is that it can read and write.

[0010] Under NFC protocol, the NFC device can either be in target or initiator mode. Passive devices are always in target mode. For NFC devices, the default mode is the target mode. NFC devices can be switched to initiator mode through an application program. When the NFC device is in target mode, the device must wait for the arrival of the RF field generated from another initiator. When the device operates in initiator mode, collision avoidance must be performed by detecting an external RF field before generating an RF field. The application program decides whether to operate the NFC device in active communication mode or in passive communication mode. If the NFC devices operates in passive communication mode, the application program performs a single device search before starting data transmission.

[0011] **1.1 Physical layer (RF)**

[0012] The communication mode between devices was defined as ISO/IEC 14443 A and FeliCa, the reader/tag mode was defined as ISO/IEC 14443 A/B and FeliCa, and the card emulation mode was defined as ISO/IEC 14443 A and FeliCa.

[0013] In terms of RF specification, all NFC communication carrier frequencies use 13.56 MHz and the bandwidth of the system is 13.56 MHz 7 kHz [sic: missing -]. The maximum/minimum value of the RF field is H_{max} = 7.5 A/m and H_{min} = 1.5 A/m (rms value), and all transponders operate when the strength of the H field is between the maximum and the minimum. All readers and active transponders must be capable of generating at least an RF field or more. To avoid a collision, all devices must be able to detect RF fields at the minimum field strength or higher.

[0014] **1.2 Link layer**

[0015] LLCP (Logical Link Control Protocol) defines a protocol for supporting high-level message data exchange in P2P mode and highly reliable bi-directional data transmission for the operation of OBEX and TCP/IP.

[0016] **1.3 Message format**

[0017] NDEF (NFC Data Exchange Format) defines the format of data stored in NFC tags. RTD (Record Type Definition) additionally defines detailed data for various application fields so that NDEF can be applied to actual applications.

[0018] **1.4 Reader/tag operation**

[0019] To support four tag types defined by the NFC Forum, the instruction set for each type is defined separately. Table 1 shows the classification of NFC tag types.

[0020]

Table 1

Classification	Type 1	Type 2	Type 3	Type 4
RF interface	ISO 14443 A	ISO 14443 A	ISO 18092	ISO 14443
Speed	106 kbps	212 kbps	106 kbps to 424 kbps	
Protocol	Its own command	Its own command	FeliCa protocol	ISO 14443-4 ISO 7816-4
Memory size	1 KB or less	2 KB or less	1 MB or less	64 KB or less
Application field	Low-capacity tag for single application service		High-capacity tag for multiple application service	
Related product	Broadcom Topaz™	Sony FeliCa™	NXP MAFARE™	ISO/IEC 14443 A/B compatible product

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