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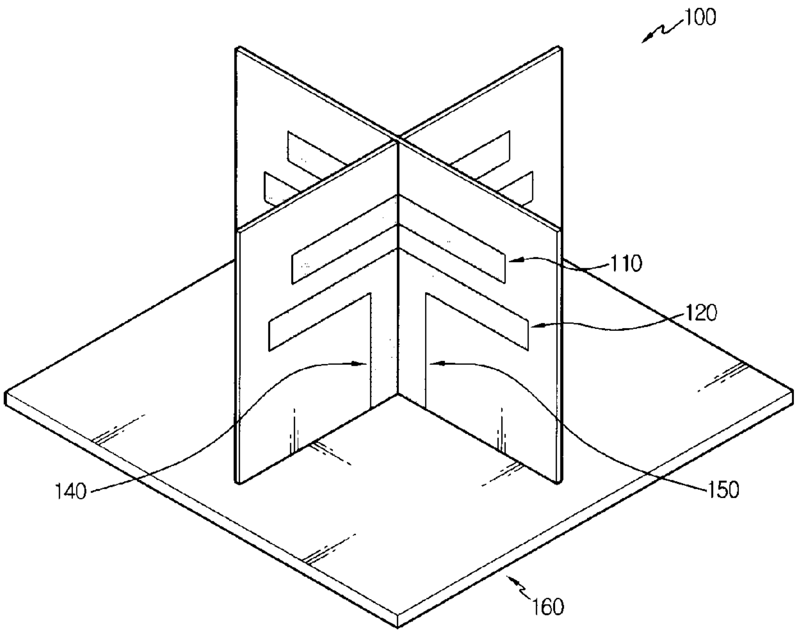
(54) **Title:** BROAD-BAND DUAL POLARIZATION DIPOLE ANTENNA AND ANTENNA ARRAY

[Fig. 1]



(57) **Abstract: A** broad-band dual polarization dipole antenna includes first and second antenna substrates installed to extend perpendicular to a reference surface and coupled to cross each other at right angles at a center thereof. Each of the first second antenna substrate includes a dipole radiating element serving as a medium for transmitting/receiving communication signals, and at least one parasitic element arranged separated in parallel from the dipole radiating element and having a length different from the length of the dipole radiating element.

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Description

Title of Invention: BROAD-BAND DUAL POLARIZATION DIPOLE ANTENNA AND ANTENNA ARRAY

Technical Field

[1] The present disclosure relates to a dual polarization dipole antenna, and more particularly, to a substrate-type broad-band dual polarization dipole antenna, which may transmit and receive further extended broad-band signals by forming a radiating element for transmitting/receiving signals and at least one parasitic element at the front of the radiating element on the same PCB board.

[2]

[3] Cross-Reference to Related Application

[4] This application claims priority to Korean Patent Application No. 10-2011-0008127 filed in the Republic of Korea on January 27, 2011, the entire contents of which are incorporated herein by reference.

Background Art

[5] Generally, an antenna serves as a medium which irradiates electric waves to a predetermined region or receives electric waves in wireless communication. The antenna plays a role of converting the electric signal input from a signal transmission line (feed line) into electric wave energy and irradiating the electric wave energy as an electric wave beam in free space. The functions of an antenna are receiving electric wave energy existing in the outside by means of half-wave rectification, converting the electric wave energy into power and outputting the power to the signal receiving line (feed line).

[6] The antenna is classified into various product categories depending on implementations and specifications. Among them, a dipole antenna distributes an electric flux symmetrically based on an axis when DC is applied to an open-type conducting wire, and the length is configured to be a half-wave length of the receiving wavelength.

[7] The dipole antenna is mostly used as transmission signals of base stations in a mobile or wireless communication system, and the dipole antenna is implemented in various ways as the communication technology makes great strides.

[8] In addition, a dual polarization antenna has two polarizations of a certain angle (+45 degrees), compared with a general single polarization antenna having only vertical or horizontal polarization, and is used for dualizing a receiving (Rx) path of a base station in a mobile communication system or for implementing transmission (Tx) and receiving (Rx) with one dual polarization antenna.

[9] In a case where a receiving (Rx) path is dualized, both the vertical polarization and

horizontal polarization of a dual polarization antenna are utilized for receiving signals and each signal is separated and received to compose, compare and analyze the signals. This may greatly reduce the communication deterioration caused by the fading phenomenon occurring at a general space diversity antenna.

[10] In addition, in cases where transmission and receiving are respectively allocated to vertical and horizontal polarizations, two existing antennas may be implemented with a single dual polarization antenna, which greatly increases space utilization and therefore remarkably reduces costs.

[11] Moreover, the dual polarization dipole antenna may have a dipole square structure where four individual dipoles are arranged symmetrically by twos, or a cross dipole structure where two pairs of dipoles extending in a line are arranged to cross each other. The dual polarization antenna dipole pairs are arranged to be perpendicular to each other and used to transmit (or receive) two linear polarization signals which may be arranged vertically or horizontally. Therefore, the antenna has horizontal polarization and vertical polarization simultaneously, and the polarization direction may have an angle of ±45 degrees.

[12] Meanwhile, with 2G and 3G mobile communication networks under commercialization, the highly anticipated next-generation 4G mobile communication network system is being introduced. To keep up, there are many communication systems, communication service providers, and various mobile communication service frequency bands that exist in many countries. To reduce base station installation/operation costs, a broad-band dual polarization dipole antenna technique which may provide the service of a communication base station using various frequencies by installing only one antenna is spotlighted.

[13] However, even though a general dual polarization dipole antenna is utilized to dualize a signal system or dualize transmitted or received signals, since the band of transmitted or received signals is limited, the general dual polarization dipole antenna is not optimized to a communication environment which is directed to a multiplied communication signal system as described above.

[14] For example, a dual polarization dipole antenna which optimizes impedance matching by adjusting a gap between antenna strip lines is disclosed. Even though the dual polarization dipole antenna is somewhat advantageous in comparison to the Balun method since it may adjust impedance, its communication band is narrow and thus still limited to a specific signal band.

[15] In addition, another dual polarization dipole antenna disclosed in the art is very inefficient in installation and implementation since its structure is complicated and it may be operated only when additional equipment or device is installed. Further, the physical structure of the antenna is not suitable for mass production since its parts

should be individually fabricated and assembled. Therefore, its price competition is also very low.

Disclosure of Invention

Technical Problem

[16] The present disclosure is designed to solve the problems of the prior art, and therefore it is an object of the present disclosure to provide a broad-band dual polarization dipole antenna implemented in a PCB form, which has an improved antenna structure optimized to a broad-band communication environment and ensures better productivity and utilization.

[17] Objects and advantages according to the present disclosure will be described below and understood by embodiments. In addition, objects and advantages of the present disclosure may be implemented by combinations of components defined in the claims.

Solution to Problem

[18] In one aspect, the broad-band dual polarization dipole antenna according to the present disclosure includes first and second antenna substrates installed to extend perpendicular to a reference surface and coupled to cross each other at right angles at a center thereof. Each of the first second antenna substrate includes a dipole radiating element serving as a medium for transmitting/receiving communication signals; and at least one parasitic element arranged to be separated parallel from the dipole radiating element and having a length different from the length of the dipole radiating element.

[19] A reflecting plate may be further disposed at the reference surface to reflect communication signals, and the reflecting plate may be coupled perpendicular to the first and second antenna substrates.

[20] In another aspect, the broad-band dual polarization dipole antenna array according to the present disclosure includes first and second antenna substrates, each of which has a dipole radiating element serving as a medium for transmitting/receiving communication signals, and at least one parasitic element arranged to be separated parallel from the dipole radiating element and having a length different from the length of the dipole radiating element; and a reflecting plate for reflecting the communication signals, wherein at least two antenna modules, where the first and second antenna substrates are installed to extend perpendicular to the reflecting plate and coupled to cross each other at right angles at a center thereof, are arranged on the reflecting plate to be separated from each other.

[21] At least one low frequency antenna module and at least one high frequency antenna module may be disposed at the reflecting plate.

[22] In addition, the first and second antenna substrates may be PCB substrates, and the dipole irradiation element and the at least one parasitic element may be patterned on

the PCB substrates.

[23] A feed line and a ground line electrically connected to the dipole radiating element may be further patterned on the first and second antenna substrates.

[24] The at least one parasitic element may have a shorter length than the dipole ir-radiation element.

Advantageous Effects of Invention

[25] According to the present disclosure, an antenna having existing dual polarization characteristics and more excellent broad-band characteristics may be provided only by using a simple structure, and a dual polarization dipole antenna configured suitably for mass production may be implemented. Therefore, it is possible to provide an antenna having improved price competition and more excellent durability.

[26] In addition, it is possible to provide an antenna with a more improved and optimized space suitability and utilization by using the structure of the present disclosure. Therefore, a basic infrastructure of a dual polarization dipole antenna optimized for various communication environments may be provided.

Brief Description of Drawings

[27] Other objects and aspects of the present disclosure will become apparent from the following descriptions of the embodiments with reference to the accompanying drawings in which:

[28] Fig. 1 isdual polarization dipole antenna according to a preferred embodiment of the present disclosure;

[29] Fig. 2 isdual polarization dipole antenna according to the preferred embodiment of the present disclosure;

[30] Fig. 3 isdual polarization dipole antenna according to a preferred embodiment of the present disclosure;

[3 1] Fig. 4 isdual polarization dipole antenna according to another embodiment of the present disclosure;

[32] Fig. 5 isdual polarization dipole antenna shown in Fig. 4;

[33] Fig. 6 isdual polarization dipole antenna according to another embodiment of the present disclosure;

[34] Fig. 7 isdual polarization dipole antenna shown in Fig. 6;

[35] Fig. 8 is a table showing frequency relations or the lik& of the dual polarization dipole antenna shown in Fig. 6; and

[36] Fig. 9 is a perspective view showing a dual polarization dipole antenna array according to another embodiment of the present disclosure.

Best Mode for Carrying out the Invention

[37] Hereinafter, preferred embodiments of the present disclosure will be described in

detail with reference to the accompanying drawings. Prior to the description, it should be understood that the terms used in the specification and the appended claims should not be construed as limited to general and dictionary meanings, but interpreted based on the meanings and concepts corresponding to technical aspects of the present disclosure on the basis of the principle that the inventor is allowed to define terms appropriately for the best explanation.

[38] Therefore, the description proposed herein is just a preferable example for the purpose of illustrations only, not intended to limit the scope of the disclosure, so it should be understood that other equivalents and modifications could be made thereto without departing from the spirit and scope of the disclosure.

[39J Fig. 1 isdual polarization dipole antenna according to a preferred embodiment of the present disclosure, and Fig. 2 isdual polarization dipole antenna according to the preferred embodiment of the present disclosure. As shown in Figs. 1 and 2, a dual polarization dipole antenna 100 according to the present disclosure may be configured to include a parasitic element 110, a dipole radiating element 120, PCB (Printed Circuit Board) substrate 130, a feed line 140, a ground line 150 and a reflecting plate 160.

[40] The dipole radiating element 120 is a component serving as a medium for transmitting/receiving communication signals, and the dipole radiating element 120 have functions of irradiating the signal transmitted through the feed line 140 to the outer space as an electric wave beam, receiving the electric wave energy existing in the outer space by means of half-wave rectification, converting the electric wave energy into power, and outputting the power to the feed line 140. Though not shown in the figures, it is obvious that the feed line 140 is connected to a predetermined terminal, module, system or the like for communication.

[41] In the present disclosure, in order to further improve the efficiency in fabrication and utilization while maintaining the structure of the dual polarization dipole antenna, the dipole radiating element 120 is implemented in a form of being patterned on the PCB substrate 130. The dipole radiating element 120 is electrically connected to the ground line 150 corresponding to the feed line 140, thereby configuring a kind of loop structure.

[42] The feed line 140 and the ground line 150 may be patterned on the PCB substrate 130 and may also be electrically connected to the dipole radiating element 120 in various ways useable by a user, such as cable wiring or combination of PCB patterning and cable connection. In addition, in the present disclosure, the feed line and the ground line shown in the figures are relative to each other, and so it is obvious that the feed line and the ground line are not limited in location relations such as right and left directions as long as they have a mutually corresponding relationship.

[43] The parasitic element 110 of the present disclosure is patterned on the PCB substrate

130 and arranged in parallel to the dipole radiating element 120 and separated from the dipole radiating element 120 by a predetermined distance. As described later, the parasitic element 110 is made of metallic material in order to give a coupling effect.

[44] As described above, the dipole radiating element 120 and the parasitic element 110 according to the present disclosure are arranged in parallel on the same PCB substrate 130, and this structure may give a parasitic coupling effect.

[45] If a metallic element is provided at a location adjacent to a dipole radiating element to which a signal is applied, a radiating signal is excited to the metallic element, and an additional resonance is generated at a frequency corresponding to the length ($\lambda/2$) of the metallic element. This phenomenon is the parasitic coupling effect. For example, if a metallic element having a length corresponding to f_2 is disposed near a dipole radiating element (radiating element) having a resonance frequency of f,, double resonance of f, and f_2 is generated.

[46] In order to form the structure of the dual polarization dipole antenna, the PCB substrate 130 of the present disclosure is implemented in a crossing pattern. As shown in Fig. 1, the PCB substrates 130 cross at a central portion at right angles and is installed perpendicularly based on the ground, namely a horizontal surface (reference surface). The ground or horizontal surface (reference surface) is a relative concept of a surface portion of the place where the antenna of the present disclosure is installed, and the antenna of the present disclosure stands erect based on the direction in which communication signals are radiated or irradiated.

[47] Preferably, the dual polarization dipole antenna 100 according to the present disclosure may be implemented like the first antenna substrate 131 and second antenna substrate 132 as shown in Fig. 3. The first antenna substrate 132 and the second antenna substrate 132 are respectively configured with a PCB substrate. Each of the PCB substrates 131 and 132 has a groove 20 at its central portion for fitting the PCB substrates 131 and 132, the grooves 20 are coupled with each other perpendicularly so that the PCB substrates 131 and 132 cross each other at right angles as described above.

[48] In addition, as shown in Fig. 4, the dual polarization dipole antenna 100 of the present disclosure may be configured by forming a corresponding dual dipole structure at four individual PCB substrates 133, 134, 135, 136 and coupling the PCB substrates 133, 134, 135, 136 with each other at right angles. At this time, the PCB substrates 133 and 134 are defined as the first antenna substrate, and the PCB substrates 135 and 136 are defined as the second antenna substrate.

[49] In a case of the embodiment shown in Fig. 4, at the A portion of Fig. 4, the PCB substrates 133, 134, 135, 136 have guiding grooves corresponding to each other such as concave and convex structures so that the PCB substrates 133, 134, 135, 136 may be

easily attached and detached.

[50] The dual polarization dipole antenna 100 according to the present disclosure may be configured with the above structure, and it may also be implemented with a combined structure of the embodiments shown in Figs. 3 and 4.

[51] Meanwhile, the reflecting plate 160 of the present disclosure is installed perpendicular to the first and second antenna substrates. The reflecting plate 160 has a function of reflecting communication signals to improve the efficiency in signal transmission/receiving and the directivity or directionality of signals.

[52] In the case where the dipole radiating element 120 and the parasitic element 110 are implemented at the same PCB substrate 130 as described above, as shown in Fig. 5, resonance is generated at fi and f_2 corresponding to each element by the dipole radiating element 120 and the parasitic element 110.

[53] In this case, in order to generate valid and effective parasitic coupling effect, a distance between the dipole radiating element 120 and the parasitic element 110 may be an important parameter. If the distance is too small, an impedance component by capacitance increases. If the distance is too great, the space utilization is deteriorated and an effective parasitic coupling effect is not generated, as revealed experimentally.

[54] In consideration of the relationship and experimental results, the distance between the dipole radiating element 120 and the parasitic element 110 is most preferably 14% to 68% of the thickness (Wl or W2) of the dipole radiating element or the parasitic element.

[55] Meanwhile, as shown in Fig. 5, in a case where resonance frequencies of fi and f_2 are formed as shown in Fig. 5, a gap may be generated between bandwidths. In order to implement a broad-band antenna characteristic of a greater range, an additional parasitic element which may make resonance at a frequency corresponding to a central portion of the bandwidth gap of Fig. 5 is more preferably provided.

[56] In other words, as shown in Fig. 6, a plurality of parasitic elements 111 and 113 are provided at the front end of the dipole radiating element 120 in the signal transmitting/receiving direction as shown in Fig. 6, so that resonance may be generated at a frequency corresponding to the dipole radiating element 120 and a frequency band corresponding to the plurality of parasitic elements 111 and 113.

[57] Compared with the former embodiment shown in Fig. 5, the resonance frequency corresponding to fi is a frequency corresponding to the dipole radiating element 120, and the resonance frequency corresponding to f_2 is a frequency corresponding to a shortest parasitic element 111 among the plurality of parasitic elements. For better explanation, the parasitic element by a reference numeral 111 is called a first parasitic element 111, and the parasitic element by a reference numeral 113 is called a second parasitic element 113.

[58J In the embodiment shown in Fig. 6, the second parasitic element 113 is added. The frequency f_3 corresponding to the second parasitic element 113 corresponds to a frequency greater than the frequency f, by the dipole radiating element 120 and smaller than the frequency f_2 by the first parasitic element 111.

[59J As described above, the parasitic elements 110 of the subject invention are composed of a plurality of parasitic elements having different lengths and arranged in parallel to be separated from each other, and the parasitic elements 110 are patterned on the same PCB substrate 130 together with the dipole radiating element 120 as described above, thereby implementing a dual polarization dipole antenna with broad-band antenna characteristics more effectively.

[60J The location relations of the parasitic element 110 and the dipole radiating element 120 according to the present disclosure may be changed. However, it is more preferred that the dipole radiating element 120 takes charge of a signal corresponding to the frequency which will be the main, the parasitic element 110 for implementing an additional resonance frequency and resultant broad-band antenna characteristics is provided at the front end in the signal transmitting/receiving direction, and particularly the parasitic element having a shorter length is provided at a relatively front side because of the nature of antenna signals.

[61] In a case where the dipole radiating element 120 and two first and second parasitic elements 111 and 113 having different lengths are provided as shown in Fig. 6, the signal applied from the feed line 140 is applied to the dipole radiating element 120 to cause resonance and radiation of fi frequency, and the radiated signal is also excited to the first and second parasitic elements 111 and 113 provided at the front end so that resonance is generated in f_1, f_2, f3 frequency bands as shown in Fig. 7. Therefore, the broad-band characteristics may be implemented identical to a single dipole radiating element.

[62] The length and frequency of the dipole radiating element 120 and the parasitic elements 111 and 113 shown in Fig. 6 are shown in Fig. 8.

[63] As briefly described above, since the parasitic element 110 and the dipole radiating element 120 are made of metallic material, the gap gi, g_2 between them and the height h of the dipole radiating element 120 from the ground are preferably suitably matched with the coupling capacitance.

[64] Parameters of the gap g_1, g_2, the height h or the like may vary according to the bandwidth to be implemented and may be variously set depending on implementation status, communication environments, environmental factors for the installation of the antenna, or the like. By means of the gap adjustment, a parasitic coupling effect is generated by the parasitic element, and the capacitance to be coupled is minimized to be optimized for the broad-bandwidth to be implemented.

[65] Meanwhile, Fig. 9 is a perspective view showing a dual polarization dipole antenna array according to another embodiment of the present disclosure. The antenna array 200 of the present disclosure includes at least one antenna module 210, 220, where the first antenna substrate and the second antenna substrate shown in Figs. 3 and 4 are coupled with each other, is disposed on the reflecting plate to be separated from each other.

[66] The antenna module 210, 220 includes at least one low frequency antenna module 210 and at least one high frequency antenna module 220 so that the band having broad-band characteristics may be dualized or multiplied.

[67] The present disclosure has been described in detail. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the disclosure, are given by way of illustration only, since various changes and modifications within the spirit and scope of the disclosure will become apparent to those skilled in the art from this detailed description.

[68] In addition, it is obvious that terms or expressions representing directions such as first, second, up, down, front, rear or the like are just used for relatively distinguishing components, and they are not used for distinguishing components based on absolute basis to define specific orders, significances, priorities or the like.

Industrial Applicability

[69] The PCB-type broad-band dual polarization dipole antenna according to the present disclosure is generally used for transmitting/receiving signals at a base station of a mobile or wireless communication system.

Claims

[Claim 1] A broad-band dual polarization dipole antenna, comprising first and second antenna substrates installed to extend perpendicular to a reference surface and coupled to cross each other at right angles at a center thereof,
wherein each of the first second antenna substrate includes:
a dipole radiating element serving as a medium for transmitting/receiving communication signals; and
at least one parasitic element arranged to be separated parallel from the dipole radiating element and having a length different from the length of the dipole radiating element.

[Claim 2] The broad-band dual polarization dipole antenna according to claim 1, wherein a reflecting plate is further disposed at the reference surface to reflect communication signals, and the reflecting plate is coupled perpendicular to the first and second antenna substrates.

[Claim 3] The broad-band dual polarization dipole antenna according to claim 2, wherein the first and second antenna substrates are PCB (Printed Circuit Board) substrates, and the dipole irradiation element and the at least one parasitic element are patterned on the PCB substrates.

[Claim 4] The broad-band dual polarization dipole antenna according to claim 3, wherein a feed line and a ground line electrically connected to the dipole radiating element are further patterned on the first and second antenna substrates.

[Claim 5] The broad-band dual polarization dipole antenna according to claim 3, wherein the at least one parasitic element has a shorter length than the dipole irradiation element.

[Claim 6] The broad-band dual polarization dipole antenna according to claim 5, wherein the at least one parasitic element includes at least two parasitic elements separated in parallel and having different lengths.

[Claim 7] The broad-band dual polarization dipole antenna according to claim 6, wherein the at least two parasitic elements have a shorter length than the dipole radiating element, and the at least two parasitic elements are disposed to have a shorter length as farther from the dipole radiating element.

[Claim 8] The broad-band dual polarization dipole antenna according to claim 5, wherein a gap between the dipole radiating element and a parasitic element closest to the dipole radiating element is 14% to 68% of the thickness of the dipole radiating element.

[Claim 9] A broad-band dual polarization dipole antenna array, comprising:
first and second antenna substrates, each including:
a dipole radiating element serving as a medium for transmitting/receiving communication signals; and
at least one parasitic element arranged to be separated parallel from the dipole radiating element and having a length different from the length of the dipole radiating element; and
a reflecting plate for reflecting the communication signals,
wherein at least two antenna modules, where the first and second antenna substrates are installed to extend perpendicular to the reflecting plate and coupled to cross each other at right angles at a center thereof, are arranged on the reflecting plate to be separated from each other.

[Claim 10] The broad-band dual polarization dipole antenna array according to claim 9, wherein at least one low frequency antenna module and at least one high frequency antenna module are disposed at the reflecting plate.

[Claim 11] The broad-band dual polarization dipole antenna array according to claim 10, wherein the first and second antenna substrates are PCB substrates, and the dipole irradiation element and the at least one parasitic element are patterned on the PCB substrates.

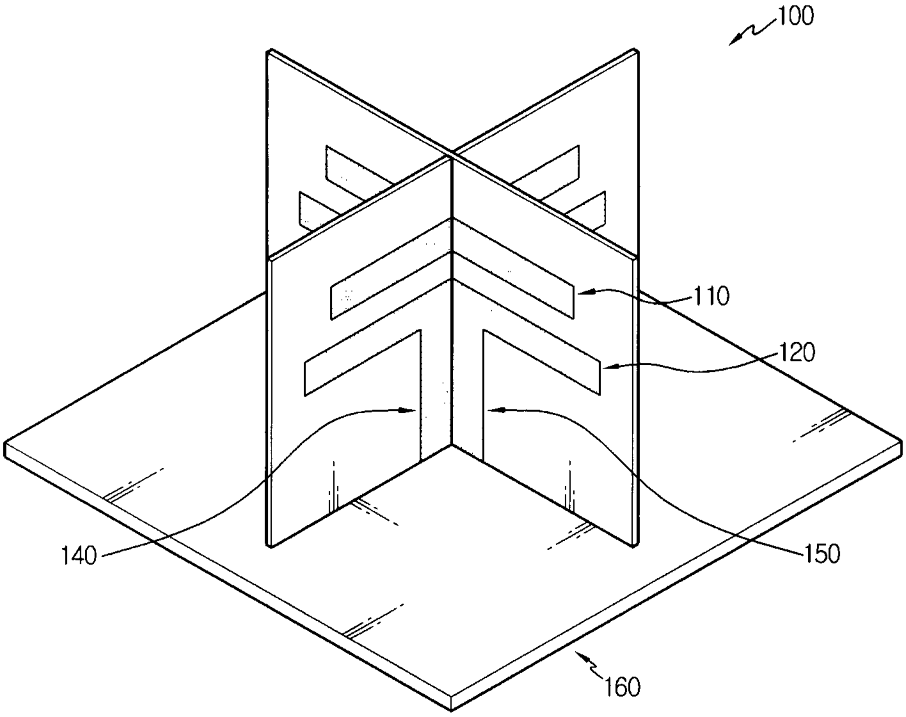
[Claim 12] The broad-band dual polarization dipole antenna array according to claim 11, wherein a feed line and a ground line electrically connected to the dipole radiating element are further patterned on the first and second antenna substrates.

[Claim 13] The broad-band dual polarization dipole antenna array according to claim 11, wherein the at least one parasitic element has a shorter length than the dipole irradiation element.

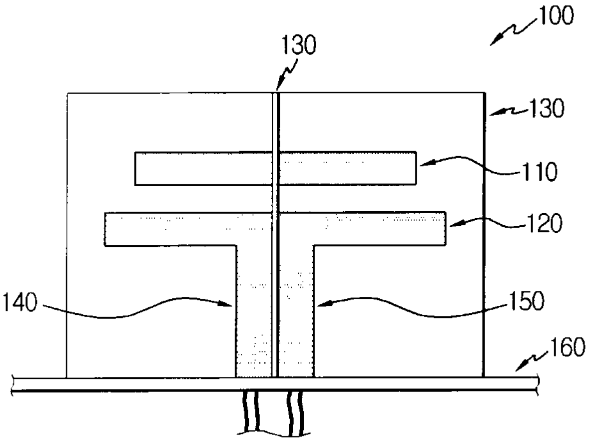
[Claim 14] The broad-band dual polarization dipole antenna array according to claim 13, wherein the at least one parasitic element includes at least two parasitic elements separated parallel and having different lengths.

[Claim 15] The broad-band dual polarization dipole antenna array according to claim 14, wherein the at least two parasitic elements have a shorter length than the dipole radiating element, and the at least two parasitic elements are disposed to have a shorter length as farther from the dipole radiating element.

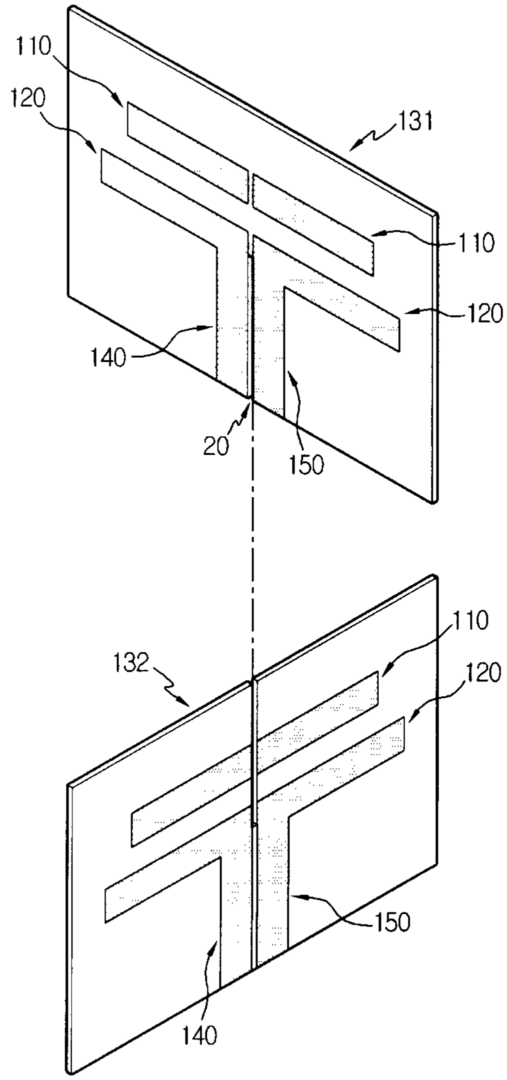
[Fig. 1]



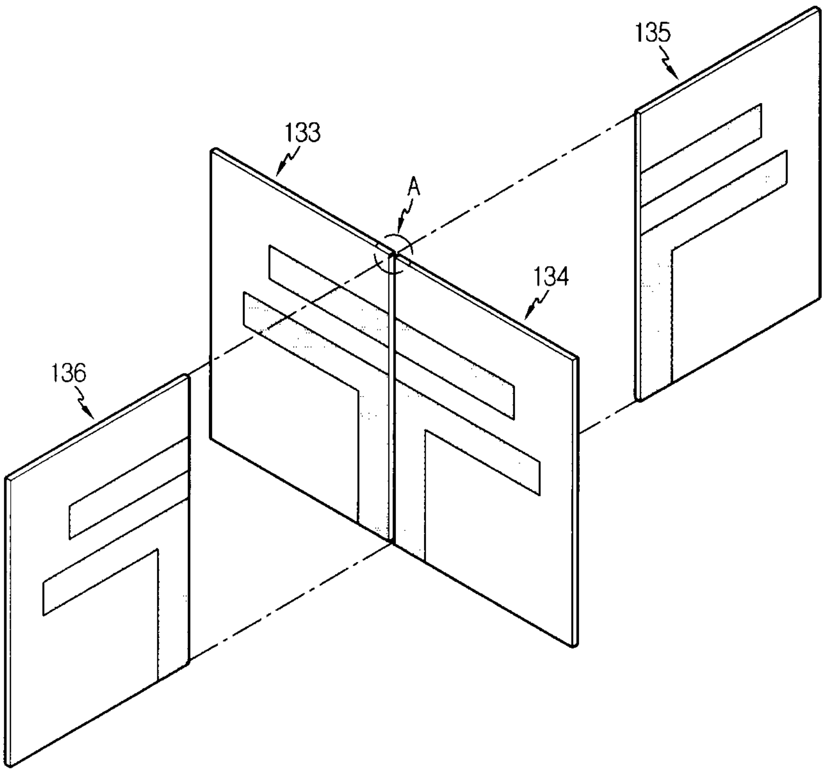
[Fig. 2]



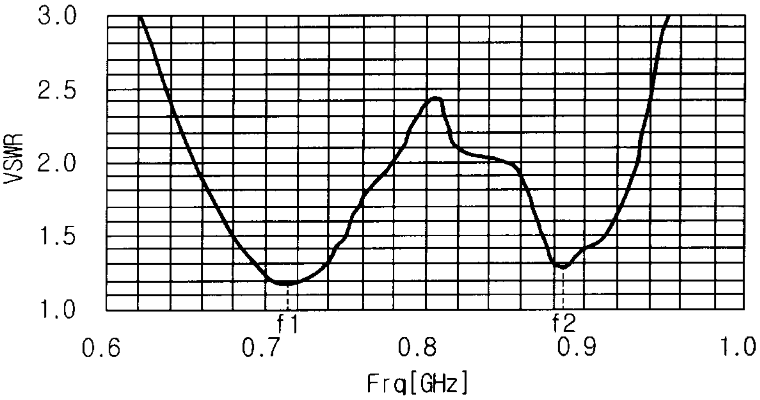
[Fig. 3]



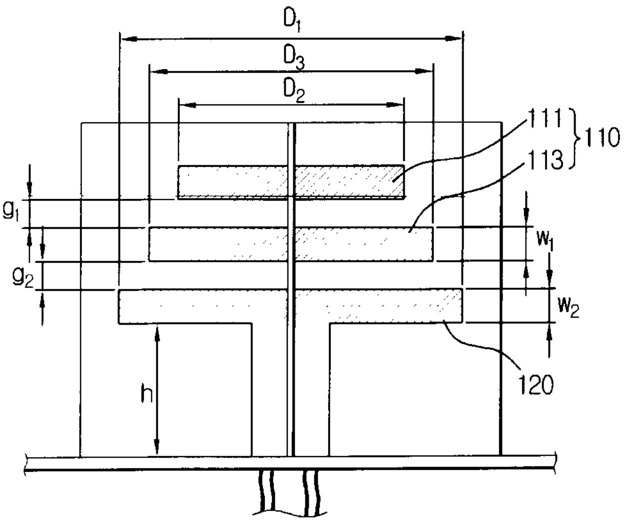
[Fig. 4]



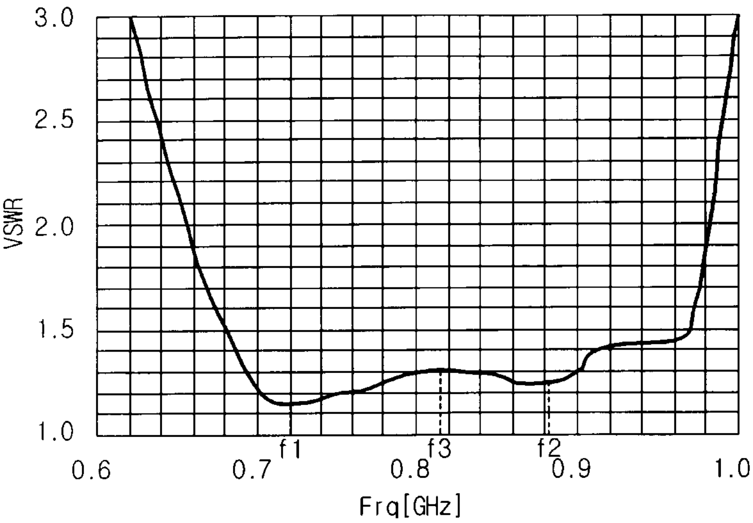
[Fig. 5]



[Fig. 6]



[Fig. 7]



[Fig. 8]

	DIPOLE RADIATING ELEMENT (120)	FIRST PARASITIC ELEMENT (111)	SECOND PARASITIC ELEMENT (113)	RELATIONSHIP
LENGTH	D1	D2	D3	D1 > D2 > D3
RESONANCE FREQUENCY	f1	f2	f3	f1 < f2 < f3

[Fig. 9]