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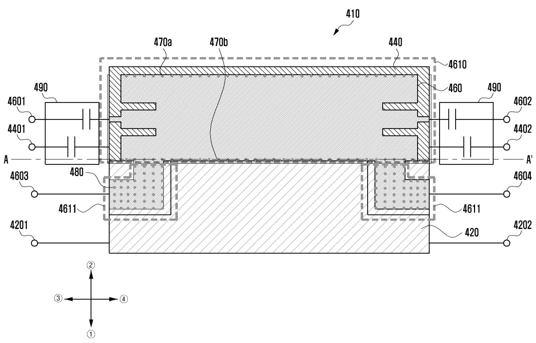
(54) WIRING STRUCTURE FOR TRANSMISSION OF MILLIMETERWAVE BAND SIGNAL AND POWER

(57) A wiring structure included in an electronic device according to various embodiments is a power and transmission line for transmitting a millimeter wave signal and power, and the power and transmission line is formed as a stack structure including: a first conductive layer connected to a negative wiring of a direct current (DC) signal; a first dielectric layer stacked on the first conductive layer; a second conductive layer stacked on the first dielectric layer and grounded to a ground of an alternating current (AC) signal; a second dielectric layer stacked on the second conductive layer; and a third conductive layer stacked on the second dielectric layer and connected to an input/output port of the AC signal and a positive wiring of the DC signal, wherein the third conductive layer may include a waveguide region in which a waveguide for transmitting the millimeter wave signal is formed, a transition region which extends from both ends of the waveguide region in a first direction, and forms a portion of a millimeter wave signal transmission line, and an isolation region which extends in a second direction of the waveguide region and is for blocking the DC signal and the AC signal from each other.

FIG. 4A



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Description

[Technical Field]

[0001] Various embodiments related to a wiring structure for transmission of a millimeter wave band signal and power.

[Background Art]

[0002] The next-generation communication systems require various structural improvements to enable various services with different requirements to be performed in a single system. Electronic devices supporting 5G communication systems require a structure for supplying power (e.g., a direct current {DC} signal) to internal components as well as multi-band signals such as RF signals and millimeter wave (mmWave) signals (e.g., alternating current {AC} signals).

[Disclosure of Invention]

[Technical Problem]

[0003] Electronic devices implementing 5G communication systems may require a wiring structure including a signal transmission line and a power transmission line that transmit ultrahigh frequency band (e.g., 30 GHz to 300 GHz) signals.

[0004] However, there is a structural problem in which the narrow-width signal transmission line needs to be implemented to suppress transmission losses for millimeter wave signals while the wide-width or multi-layered power transmission line needs to be implemented to supply power. For this reason, when the power transmission line is implemented separately from the signal transmission line to improve the performance of the signal transmission line and the power transmission line, it may be difficult to miniaturize the electronic device.

[0005] Various embodiments may provide a wiring structure that may improve transmission losses for millimeter wave signals while simultaneously enabling more stable power transmission.

[Solution to Problem]

[0006] A wiring structure included in an electronic device according to various embodiments is a power and transmission line for transmitting a millimeter wave signal and power, and the power and transmission line is formed as a stack structure including: a first conductive layer connected to a negative wiring of a direct current (DC) signal; a first dielectric layer stacked on the first conductive layer; a second conductive layer stacked on the first dielectric layer and grounded to a ground of an alternating current (AC) signal; a second dielectric layer stacked on the second conductive layer; and a third conductive layer stacked on the second dielectric layer and connected to an input/output port of the AC signal and a positive wiring of the DC signal, wherein the third conductive layer may include a waveguide region in which a waveguide for transmitting the millimeter wave signal is formed, a transition region which extends from both ends of the waveguide region in a first direction, and forms a portion of a millimeter wave signal transmission line, and an isolation region which extends in a second direction of the waveguide region and is for blocking the DC signal and the AC signal from each other.

[0007] A wiring structure included in an electronic device according to various embodiments and configured to function as a power and transmission line for transmitting a millimeter wave signal and power, the wiring structure comprising a ground panel connected to a ground of a DC signal; and a multi-layer comprising a substrate-integrated waveguide line that is isolated from the ground panel with a dielectric layer interposed therebetween and is connected to an input/output terminal of an AC signal and a positive wire of the DC signal, wherein the substrate-integrated waveguide line comprises: a waveguide region in which a waveguide for transmitting the millimeter wave signal is formed, a transition region that extends from both ends of the waveguide region in a first direction and transforms the millimeter wave signal and an isolation region that extends in a second direction of the waveguide region and blocks between the DC signal and the AC signal.

[Advantageous Effects of Invention]

[0008] According to various embodiments, by implementing a wiring structure in which a conductive layer to be used as a ground plane of a DC signal is additionally stacked on a stacked structure of a substrate-integrated waveguide, the wiring structure may be used as a power transmission line while being used as a signal transmission line in a millimeter wave band.

[0009] According to various embodiments, in a wiring structure for a millimeter wave band, an AC capacitor to block the inflow of a DC signal may be arranged in a millimeter wave input/output terminal and a via hole group to block the inflow of an AC signal may be arranged in at least a portion of a stacked structure of a substrate-integrated waveguide, thereby enabling simultaneous millimeter wave signal transmission and power transmission through isolation of the AC signal and the DC signal. In addition, by reducing the amount of metal and the number of layers for a power transmission structure implemented separately from a millimeter wave transmission line structure, it is possible to miniaturize a wiring structure or a cable.

[Brief Description of Drawings]

[0010]

FIG. 1 is a block diagram illustrating an example electronic device in a network environment according to various embodiments.

FIG. 2 is a block diagram illustrating the electronic device for supporting legacy network communication and 5G network communication according to various embodiments.

FIGS. 3A, 3B, and 3C illustrate an embodiment of, for example, the structure of the third antenna module described with reference to FIG. 2.

FIGS. 4A and 4B illustrate a wiring structure for a millimeter wave band according to an embodiment.

FIGS. 5A and 5B illustrate plan views illustrating a third conductive layer and a second conductive layer.

FIG. 6 illustrates a configuration of a wiring structure for a millimeter wave band according to an embodiment.

FIG. 7 illustrates results of testing performance of a wiring structure of an electronic device according to various embodiments.

FIG. 8 illustrates results of testing performance of a wiring structure of an electronic device according to various embodiments.

[Mode for the Invention]

[0011] The electronic device according to various embodiments may be one of various types of electronic devices. The electronic devices may include, for example, a portable communication device (e.g., a smartphone), a computer device, a portable multimedia device, a portable medical device, a camera, a wearable device, a home appliance, or the like. According to an embodiment of the disclosure, the electronic devices are not limited to those described above.

[0012] FIG. 1 is a block diagram illustrating an example electronic device in a network environment according to various embodiments.

[0013] Referring to FIG. 1, an electronic device 101 in a network environment 100 may communicate with an electronic device 102 via a first network 198 (e.g., a short-range wireless communication network), or an electronic device 104 or a server 108 via a second network 199 (e.g., a long-range wireless communication network). According to an embodiment, the electronic device 101 may communicate with the electronic device 104 via the server 108. According to an embodiment, the electronic device 101 may include a processor 120, memory 130, an input device 150, a sound output device 155, a display device 160, an audio module 170, a sensor module 176, an interface 177, a haptic module 179, a camera module 180, a power management module 188, a battery 189, a communication module 190, a subscriber identification module (SIM) 196, or an antenna module 197. In various embodiments, at least one (e.g., the display device 160 or the camera module 180) of the components may be omitted from the electronic device 101, or one or more other components may be added in the electronic device 101. In various embodiments, some of the components may be implemented as single integrated circuitry. For example, the sensor module 176 (e.g., a fingerprint sensor, an iris sensor, or an illuminance sensor) may be implemented as embedded in the display device 160 (e.g., a display).

[0014] The processor 120 may execute, for example, software (e.g., a program 140) to control at least one other component (e.g., a hardware or software component) of the electronic device 101 coupled with the processor 120, and may perform various data processing or computation. According to an embodiment, as at least part of the data processing or computation, the processor 120 may load a command or data received from another component (e.g., the sensor module 176 or the communication module 190) in volatile memory 132, process the command or the data stored in the volatile memory 132, and store resulting data in non-volatile memory 134. According to an embodiment, the processor 120 may include a main processor 121 (e.g., a central processing unit (CPU) or an application processor (AP)), and an auxiliary processor 123 (e.g., a graphics processing unit (GPU), an image signal processor (ISP), a sensor hub processor, or a communication processor (CP)) that is operable independently from, or in conjunction with, the main processor 121. Additionally or alternatively, the auxiliary processor 123 may be adapted to consume less power than the main processor 121, or to be specific to a specified function. The auxiliary processor 123 may be implemented as separate from, or as part of the main processor 121.

[0015] The auxiliary processor 123 may control at least some of functions or states related to at least one component (e.g., the display module 160, the sensor module 176, or the communication module 190) among the components of the electronic device 101, instead of the main processor 121 while the main processor 121 is in an inactive (e.g., sleep) state, or together with the main processor 121 while the main processor 121 is in an active state (e.g., executing an application). According to an embodiment, the auxiliary processor 123 (e.g., an image signal processor or a communication processor) may be implemented as part of another component (e.g., the camera module 180 or the communication module 190) functionally related to the auxiliary processor 123. According to an embodiment, the auxiliary processor 123 (e.g., the neural processing unit) may include a hardware structure specified for artificial intelligence model processing. An artificial intelligence model may be generated by machine learning. Such learning may be performed, e.g., by the electronic device 101 where the artificial intelligence is performed or via a separate server (e.g., the server 108). Learning algorithms may include, but are not limited to, e.g., supervised learning, unsupervised learning, semi-supervised learning, or reinforcement learning. The artificial intelligence model may include a plurality of artificial neural network layers. The artificial neural network may be a deep neural network (DNN), a convolutional neural network (CNN), a recurrent neural network (RNN), a restricted boltzmann machine (RBM), a deep belief network (DBN), a bidirectional recurrent deep neural network (BRDNN), deep Q-network or a combination of two or more thereof but is not limited thereto. The artificial intelligence model may, additionally or alternatively, include a software structure other than the hardware structure.

[0016] The memory 130 may store various data used by at least one component (e.g., the processor 120 or the sensor module 176) of the electronic device 101. The various data may include, for example, software (e.g., the program 140) and input data or output data for a command related thereto. The memory 130 may include the volatile memory 132 or the non-volatile memory 134.

[0017] The program 140 may be stored in the memory 130 as software, and may include, for example, an operating system (OS) 142, middleware 144, or an application 146.

[0018] The input module 150 may receive a command or data to be used by another component (e.g., the processor 120) of the electronic device 101, from the outside (e.g., a user) of the electronic device 101. The input module 150 may include, for example, a microphone, a mouse, a keyboard, a key (e.g., a button), or a digital pen (e.g., a stylus pen).

[0019] The sound output module 155 may output sound signals to the outside of the electronic device 101. The sound output module 155 may include, for example, a speaker or a receiver. The speaker may be used for general purposes, such as playing multimedia or playing record. The receiver may be used for receiving incoming calls. According to an embodiment, the receiver may be implemented as separate from, or as part of the speaker.

[0020] The display module 160 may visually provide information to the outside (e.g., a user) of the electronic device 101. The display module 160 may include, for example, a display, a hologram device, or a projector and control circuitry to control a corresponding one of the display, hologram device, and projector. According to an embodiment, the display module 160 may include a touch sensor adapted to detect a touch, or a pressure sensor adapted to measure the intensity of force incurred by the touch.

[0021] The audio module 170 may convert a sound into an electrical signal and vice versa. According to an embodiment, the audio module 170 may obtain the sound via the input module 150, or output the sound via the sound output module 155 or a headphone of an external electronic device (e.g., an electronic device 102) directly (e.g., wiredly) or wirelessly coupled with the electronic device 101.

[0022] The sensor module 176 may detect an operational state (e.g., power or temperature) of the electronic device 101 or an environmental state (e.g., a state of a user) external to the electronic device 101, and then generate an electrical signal or data value corresponding to the detected state. According to an embodiment, the sensor module 176 may include, for example, a gesture sensor, a gyro sensor, an atmospheric pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a proximity sensor, a color sensor, an infrared (IR) sensor, a biometric sensor, a temperature sensor, a humidity sensor, or an illuminance sensor.

[0023] The interface 177 may support one or more specified protocols to be used for the electronic device 101 to be coupled with the external electronic device (e.g., the electronic device 102) directly (e.g., wiredly) or wirelessly. According to an embodiment, the interface 177 may include, for example, a high definition multimedia interface (HDMI), a universal serial bus (USB) interface, a secure digital (SD) card interface, or an audio interface.

[0024] connecting terminal 178 may include a connector via which the electronic device 101 may be physically connected with the external electronic device (e.g., the electronic device 102). According to an embodiment, the connecting terminal 178 may include, for example, a HDMI connector, a USB connector, a SD card connector, or an audio connector (e.g., a headphone connector).

[0025] The haptic module 179 may convert an electrical signal into a mechanical stimulus (e.g., a vibration or a movement) or electrical stimulus which may be recognized by a user via his tactile sensation or kinesthetic sensation. According to an embodiment, the haptic module 179 may include, for example, a motor, a piezoelectric element, or an electric stimulator.

[0026] The camera module 180 may capture a still image or moving images. According to an embodiment, the camera module 180 may include one or more lenses, image sensors, image signal processors, or flashes.

[0027] The power management module 188 may manage power supplied to the electronic device 101. According to an embodiment, the power management module 188 may be implemented as at least part of, for example, a power management integrated circuit (PMIC).

[0028] The battery 189 may supply power to at least one component of the electronic device 101. According to an embodiment, the battery 189 may include, for example, a primary cell which is not rechargeable, a secondary cell which is rechargeable, or a fuel cell.

[0029] The communication module 190 may support establishing a direct (e.g., wired) communication channel or a wireless communication channel between the electronic device 101 and the external electronic device (e.g., the electronic device 102, the electronic device 104, or the server 108) and performing communication via the established communication channel. The communication module 190 may include one or more communication processors that are operable independently from the processor 120 (e.g., the application processor (AP)) and supports a direct (e.g., wired) communication or a wireless communication. According to an embodiment, the communication module 190 may include a wireless communication module 192 (e.g., a cellular communication module, a short-range wireless communication module, or a global navigation satellite system (GNSS) communication module) or a wired communication module 194 (e.g., a local area network (LAN) communication module or a power line communication (PLC) module). A corresponding one of these communication modules may communicate with the external electronic device via the first network 198 (e.g., a short-range communication network, such as Bluetooth™, wireless-fidelity (Wi-Fi) direct, or infrared data association (IrDA)) or the second network 199 (e.g., a long-range communication network, such as a legacy cellular network, a 5G network, a next-generation communication network, the Internet, or a computer network (e.g., LAN or wide area network (WAN)). These various types of communication modules may be implemented as a single component (e.g., a single chip), or may be implemented as multi components (e.g., multi chips) separate from each other. The wireless communication module 192 may identify and authenticate the electronic device 101 in a communication network, such as the first network 198 or the second network 199, using subscriber information (e.g., international mobile subscriber identity (IMSI)) stored in the subscriber identification module 196).

[0030] The wireless communication module 192 may support a 5G network, after a 4G network, and next-generation communication technology, e.g., new radio (NR) access technology. The NR access technology may support enhanced mobile broadband (eMBB), massive machine type communications (mMTC), or ultra-reliable and low-latency communications (URLLC). The wireless communication module 192 may support a high-frequency band (e.g., the mmWave band) to achieve, e.g., a high data transmission rate. The wireless communication module 192 may support various technologies for securing performance on a high-frequency band, such as, e.g., beamforming, massive multiple-input and multiple-output (massive MIMO), full dimensional MIMO (FD-MIMO), array antenna, analog beam-forming, or large scale antenna. The wireless communication module 192 may support various requirements specified in the electronic device 101, an external electronic device (e.g., the electronic device 104), or a network system (e.g., the second network 199). According to an embodiment, the wireless communication module 192 may support a peak data rate (e.g., 20Gbps or more) for implementing eMBB, loss coverage (e.g., 164dB or less) for implementing mMTC, or U-plane latency (e.g., 0.5ms or less for each of downlink (DL) and uplink (UL), or a round trip of 1ms or less) for implementing URLLC.

[0031] The antenna module 197 may transmit or receive a signal or power to or from the outside (e.g., the external electronic device) of the electronic device 101. According to an embodiment, the antenna module 197 may include an antenna including a radiating element including a conductive material or a conductive pattern formed in or on a substrate (e.g., a printed circuit board (PCB)). According to an embodiment, the antenna module 197 may include a plurality of antennas (e.g., array antennas). In such a case, at least one antenna appropriate for a communication scheme used in the communication network, such as the first network 198 or the second network 199, may be selected, for example, by the communication module 190 (e.g., the wireless communication module 192) from the plurality of antennas. The signal or the power may then be transmitted or received between the communication module 190 and the external electronic device via the selected at least one antenna. According to an embodiment, another component (e.g., a radio frequency integrated circuit (RFIC)) other than the radiating element may be additionally formed as part of the antenna module 197.

[0032] According to various embodiments, the antenna module 197 may form a mmWave antenna module. According to an embodiment, the mmWave antenna module may include a printed circuit board, a RFIC disposed on a first surface (e.g., the bottom surface) of the printed circuit board, or adjacent to the first surface and capable of supporting a designated high-frequency band (e.g., the mmWave band), and a plurality of antennas (e.g., array antennas) disposed on a second surface (e.g., the top or a side surface) of the printed circuit board, or adj acent to the second surface and capable of transmitting or receiving signals of the designated high-frequency band.

[0033] At least some of the above-described components may be coupled mutually and communicate signals (e.g., commands or data) therebetween via an inter-peripheral communication scheme (e.g., a bus, general purpose input and output (GPIO), serial peripheral interface (SPI), or mobile industry processor interface (MIPI).

[0034] According to an embodiment, commands or data may be transmitted or received between the electronic device 101 and the external electronic device 104 via the server 108 coupled with the second network 199. Each of the electronic devices 102 or 104 may be a device of a same type as, or a different type, from the electronic device 101. According to an embodiment, all or some of operations to be executed at the electronic device 101 may be executed at one or more of the external electronic devices 102, 104, or 108. For example, if the electronic device 101 should perform a function or a service automatically, or in response to a request from a user or another device, the electronic device 101, instead of, or in addition to, executing the function or the service, may request the one or more external electronic devices to perform at least part of the function or the service. The one or more external electronic devices receiving the request may perform the at least part of the function or the service requested, or an additional function or an additional service related to the request, and transfer an outcome of the performing to the electronic device 101. The electronic device 101 may provide the outcome, with or without further processing of the outcome, as at least part of a reply to the request. To that end, a cloud computing, distributed computing, mobile edge computing (MEC), or client-server computing technology may be used, for example. The electronic device 101 may provide ultra low-latency services using, e.g., distributed computing or mobile edge computing. In an embodiment, the external electronic device 104 may include an internet-of-things (IoT) device. The server 108 may be an intelligent server using machine learning and/or a neural network. According to an embodiment, the external electronic device 104 or the server 108 may be included in the second network 199. The electronic device 101 may be applied to intelligent services (e.g., smart home, smart city, smart car, or healthcare) based on 5G communication technology or IoT-related technology.

[0035] FIG. 2 is a block diagram 200 illustrating the electronic device 101 for supporting legacy network communication and 5G network communication according to various embodiments.

[0036] Referring to FIG. 2, the electronic device 101 may include a first communication processor 212, a second communication processor 214, a first radio frequency integrated circuit (RFIC) 222, a second RFIC 224, a third RFIC 226, a fourth RFIC 228, a first radio frequency front end (RFFE) 232, a second RFFE 234, a first antenna module 242, a second antenna module 244, and an antenna 248. The electronic device 101 may further include a processor 120 and a memory 130. The network 199 may include a first network 292 and a second network 294. According to another embodiment, the electronic device 101 may further include at least one component among the components described in FIG. 1, and the network 199 may further include at least one other network. According to an embodiment, the first communication processor 212, the second communication processor 214, the first RFIC 222, the second RFIC 224, the fourth RFIC 228, the first RFFE 232, and the second RFFE 234 may form at least some of the wireless communication modules 192. According to another embodiment, the fourth RFIC 228 may be omitted or included as part of the third RFIC 226.

[0037] The first communication processor 212 may establish a communication channel of a band to be used for wireless communication with the first network 292, and may support legacy network communication through the established communication channel. According to various embodiments, the first network may be a legacy network including a second generation (2G), 3G, 4G, or long-term evolution (LTE) network. The second communication processor 214 may establish a communication channel corresponding to a designated band (e.g., about 6 GHz to about 60 GHz) among bands to be used for wireless communication with the second network 294, and may support 5G network communication through the established communication channel. According to various embodiments, the second network 294 may be a 5G network defined by 3GPP. Additionally, according to an embodiment, the first communication processor 212 or the second communication processor 214 may establish a communication channel corresponding to another designated band (e.g., about 6 GHz or less) among bands to be used for wireless communication with the second network 294, and may support 5G network communication through the established communication channel. According to an embodiment, the first communication processor 212 and the second communication processor 214 may be implemented in a single chip or a single package. According to various embodiments, the first communication processor 212 or the second communication processor 214 may be provided in a single chip or a single package with the processor 120, the auxiliary processor 123, or the communication module 190.

[0038] The first RFIC 222 may convert, upon transmission, a baseband signal generated by the first communication processor 212 into a radio frequency (RF) signal of about 700 MHz to about 3 GHz used in the first network 292 (e.g., legacy network). Upon reception, an RF signal may be acquired from the first network 292 (e.g., legacy network) through an antenna (e.g., the first antenna module 242) and may be preprocessed through an RFFE (e.g., the first RFFE 232). The first RFIC 222 may convert the preprocessed RF signal into a baseband signal to be processed by the first communication processor 212.

[0039] The second RFIC 224 may convert, upon transmission, the baseband signal generated by the first communication processor 212 or the second communication processor 214 into an RF signal (hereinafter, referred to as 5G Sub6 RF signal) of a Sub6 band (e.g., about 6 GHz or less) used in the second network 294 (e.g., 5G network). Upon reception, the 5G Sub6 RF signal may be acquired from the second network 294 (e.g., 5G network) through an antenna (e.g., the second antenna module 244) and may be preprocessed through an RFFE (e.g., the second RFFE 234). The second RFIC 224 may convert the preprocessed 5G Sub6 RF signal into a baseband signal to be processed by a corresponding communication processor among the first communication processor 212 and the second communication processor 214.

[0040] The third RFIC 226 may convert the baseband signal generated by the second communication processor 214 into an RF signal (hereinafter, referred to as 5G Above6 RF signal) of a 5G Above6 band (e.g., about 6 GHz to about 60 GHz) to be used in the second network 294 (e.g., 5G network). Upon reception, the 5G Above6 RF signal may be acquired from the second network 294 (e.g., 5G network) through an antenna (e.g., the antenna 248) and may be preprocessed through the third RFFE 236. The third RFIC 226 may convert the preprocessed 5G Above6 RF signal into a baseband signal to be processed by the second communication processor 214. According to an embodiment, the third RFFE 236 may be provided as a part of the third RFIC 226.

[0041] According to an embodiment, the electronic device 101 may include the fourth RFIC 228 separately from or at least as part of the third RFIC 226. In this case, the fourth RFIC 228 may convert the baseband signal generated by the second communication processor 214 into an RF signal (hereinafter, referred to as an IF signal) of an intermediate frequency band (e.g., about 9 GHz to about 11 GHz), and may then transmit the RF signal to the third RFIC 226. The third RFIC 226 may convert the IF signal into a 5G Above6 RF signal. Upon reception, the 5G Above6 RF signal may be received from the second network 294 (e.g., 5G network) through the antenna (e.g., the antenna 248) and may be converted into the IF signal by the third RFIC 226. The fourth RFIC 228 may convert the IF signal into the baseband signal to be processed by the second communication processor 214.

[0042] According to an embodiment, the first RFIC 222 and the second RFIC 224 may be implemented as at least a part of a single chip or a single package. According to an embodiment, the first RFFE 232 and the second RFFE 234 may be implemented as at least a part of a single chip or a single package. According to an embodiment, at least one antenna module of the first antenna module 242 or the second antenna module 244 may be omitted or combined with another antenna module to process RF signals of a plurality of corresponding bands.

[0043] According to an embodiment, the third RFIC 226 and the antenna 248 may be arranged on the same substrate to form the third antenna module 246. For example, the wireless communication module 192 or the processor 120 may be arranged on a first substrate (e.g., main PCB). In this case, the third antenna module 246 may be formed in such a manner that the third RFIC 226 is arranged on a portion (e.g., bottom surface) of the second substrate (e.g., sub PCB) separate from the first substrate and the antenna 248 is arranged on the other portion (e.g., top surface) thereof. By arranging the third RFIC 226 and the antenna 248 on the same substrate, it is possible to reduce the length of the transmission line therebetween. This, for example, may reduce a loss (e.g., attenuation) of a signal of a high frequency band (e.g., about 6 GHz to about 60 GHz) used in 5G network communication by the transmission line. As a result, the electronic device 101 may improve the quality or speed of communication with the second network 294 (e.g., 5G network).

[0044] According to an embodiment, the antenna 248 may be formed of an antenna array including a plurality of antenna elements that may be used for beamforming. In this case, the third RFIC 226 may include, for example, a plurality of phase shifters 238 corresponding to the plurality of antenna elements as a part of the third RFFE 236. Upon transmission, each of the plurality of phase shifters 238 may shift the phase of a 5G Above6 RF signal to be transmitted to the outside of the electronic device 101 (e.g., a base station of 5G network) through the corresponding antenna element. Upon reception, each of the plurality of phase shifters 238 may shift the phase of the 5G Above6 RF signal received from the outside through the corresponding antenna element into the same or substantially the same phase. This may enable transmission or reception through beamforming between the electronic device 101 and the outside.

[0045] The second network 294 (e.g., 5G network) may operate independently of (e.g., stand-alone {SA}) or in connection with (non-stand-alone {NSA}) the first network 292 (e.g., legacy network). For example, the 5G network may include only an access network (e.g., a 5G radio access network {RAN} or a next generation RAN {NG RAN}) and no core network (e.g., a next generation core {NGC}). In this case, after accessing the access network of the 5G network, the electronic device 101 may access an external network (e.g., the Internet) under the control of a core network (e.g., evolved packed core {EPC}) of the legacy network. Protocol information (e.g., LTE protocol information) for communication with the legacy network or protocol information (e.g., new radio {NR} protocol information) for communication with the 5G network may be stored in the memory 230, and may be accessed by other components (e.g., the processor 120, the first communication processor 212, or the second communication processor 214).

[0046] FIGS. 3A, 3B, and 3C illustrate an embodiment of, for example, the structure of the third antenna module 246 described with reference to FIG. 2. FIG. 3A is a perspective view illustrating the third antenna module 246 viewed from one side, FIG. 3B is a perspective view illustrating the third antenna module 246 viewed from another side, and FIG. 3C is a cross-sectional view illustrating the third antenna module 246 along line A-A'.

[0047] Referring to FIG. 3, according to an embodiment, the third antenna module 246 may include a first printed circuit board 310, an antenna array 330, a radio frequency integrate circuit (RFIC) 352, a power manage integrate circuit (PMIC) 354, and a module interface (not shown). According to another embodiment, the third antenna module 246 may further include a shielding member 390. In other embodiments, at least one of the aforementioned components may be omitted or at least two of the components may be integrally formed.

[0048] The first printed circuit board 310 may include a plurality of conductive layers and a plurality of non-conductive layers stacked alternately with the conductive layers. The first printed circuit board 310 may provide an electrical connection between the first printed circuit board 310 and/or various electronic components arranged externally using wires and conductive vias provided on the conductive layer.

[0049] The antenna array 330 (e.g., 248 of FIG. 2) may include a plurality of antenna elements 332, 334, 336, and 338 arranged to form a directional beam. As shown, the antenna elements may be provided on a first surface 310a of the first printed circuit board 310. According to another embodiment, the antenna array 330 may be provided inside the first printed circuit board 310. According to various embodiments, the antenna array 330 may include a plurality of antenna arrays (e.g., a dipole antenna array and/or a patch antenna array) of the same or different shapes or types.

[0050] The RFIC 352 (e.g., 226 of FIG. 2) may be arranged on another area (e.g., a second surface 310b opposite to the first surface 310a) of the first printed circuit board 310, spaced apart from the antenna array. The

RFIC is configured to process signals of a selected frequency band, which are transmitted/received through the antenna array 330. According to an embodiment, during transmission, the RFIC 352 may convert a baseband signal acquired from a communication processor (e.g., the second communication processor 214 of FIG. 2) into an RF signal of a designated band. Upon reception, the RFIC 352 may convert the RF signal received through the antenna array 330 into a baseband signal and may transmit the converted baseband signal to the communication processor.

[0051] According to another embodiment, upon transmission, the RFIC 352 may convert-up the IF signal (e.g., about 9 GHz to about 11 GHz) acquired from an intermediate frequency integrate circuit (IFIC) (e.g., the fourth RFIC 228 of FIG. 2) into an RF signal of a selected band. Upon reception, the RFIC 352 may down-convert the RF signal acquired through the antenna array 330 into an IF signal and may transmit the IF signal to the IFIC.

[0052] The PMIC 354 may be arranged on another partial area (e.g., the second surface 310b) of the first printed circuit board 310, spaced apart from the antenna array 330. The PMIC 354 may receive voltage from the main printed circuit board (e.g., the second printed circuit board 430 of FIG. 4) and may provide power necessary for various components (e.g., the RFIC 352) on the antenna module.

[0053] The shielding member 390 may be arranged on a portion (e.g., the second surface 31 0b) of the first printed circuit board 310 to electromagnetically shield at least one of the RFIC 352 and the PMIC 354. According to an embodiment, the shielding member 390 may include a shield can.

[0054] Although not shown, in various embodiments, the third antenna module 246 may be electrically connected to another printed circuit board (e.g., the second printed circuit board 430 of FIG. 4) through a module interface. The module interface may include a connection member, for example, a coaxial cable connector, a board to board connector, an interposer, or a flexible printed circuit board (FPCB). Through the connection member, the RFIC 352 and/or the PMIC 354 of the antenna module may be electrically connected to the main printed circuit board (e.g., the second printed circuit board 430 of FIG. 4).

[0055] According to various embodiments, an electronic device (e.g., the electronic device 101 of FIG. 1) may include a single third antenna module 246 or a plurality of third antenna modules 246.

[0056] Hereinafter, the connection member of the electronic device 101, for example, a wiring structure of an interconnection cable will be described.

[0057] FIGS. 4A and 4B illustrate a wiring structure for a millimeter wave band according to an embodiment. FIG. 4A is a diagram illustrating an upper surface of a wiring structure 410 viewed in a first direction ①, and FIG. 4B is a diagram illustrating a cross section along the line A-A' of 4A.

[0058] Referring to FIGS. 4A and 4B, the electronic device 101 according to various embodiments may include an interconnection wiring structure (or wiring cable) that connects an antenna array (e.g., the antenna array 330 of FIG. 3) and components (or electrical components) of the electronic device.

[0059] According to an embodiment, the wiring structure 410 may include a millimeter wave band signal transmission and power transmission line. The wiring structure 410 may include multiple layers in which dielectric layers and conductive layers are alternately stacked to enable DC power supply and millimeter wave band (extremely high frequency {EHF}) (e.g., mmWave) signal transmission.

[0060] As an example, the wiring structure 410 may include a first conductive layer 420, a first dielectric layer 430 sequentially stacked on the first conductive layer 420 in a second direction ②, a second conductive layer 440, a second dielectric layer 450, and a third conductive layer 460.

[0061] In the wiring structure 410, a stacked area between the second conductive layer 440 and the third conductive layer 460 may be utilized as a signal transmission line in the millimeter wave band and simultaneously as a positive (+) wire of a power transmission line. The first conductive layer 420 of the wiring structure 410 may be utilized as a minus (-) wire of the power transmission line, allowing the wiring structure 410 to form a structure capable of both power supply and millimeter wave signal transmission.

[0062] The first conductive layer 420 may be connected to an input/output terminal of a direct current (DC) signal and may operate as a ground plane for power transmission. For example, one end (e.g., power input terminal) 4201 located in a third direction (3) of the first conductive layer 420 may be connected to a negative (-) wire of a power supply source (e.g., the PMIC 354 of FIG. 3), and the other end (e.g., power output terminal) 4202 located in a fourth direction ④ of the first conductive layer 420 may be connected to a component (or electronic component) of the electronic device to which power is supplied.

[0063] The second conductive layer 440 and the third conductive layer 460 may be connected to the input/output terminal of millimeter band signals (e.g., alternating current {AC} signals) in a first portion 4610, and simultaneously connected to the input/output terminal of DC signals in a second portion 4611. For example, in the first portion 4610, the third conductive layer 460 may have one end 4601 located in the third direction ③ connected to a signal source (e.g., mmWave in), and the other end 4602 located in the fourth direction ④ connected to a signal output unit (e.g., mmWave out).

[0064] In the second portion 4611, the third conductive layer 460 may have one end (e.g., power input terminal) 4603 located in the third direction (3) connected to a positive (+) wire of the power supply source, and the other end (e.g., power output terminal) 4604 located in the fourth direction ④ connected to the component (or the electronic component) of the electronic device.

[0065] The second conductive layer 440 may operate as a ground plane of an AC signal. One end (e.g., signal input terminal) 4401 located in the third direction of the second conductive layer 440 and the other end 4402 located in the fourth direction ④ may be grounded to the signal transmission line (or connected to the ground). The second conductive layer 440 may be utilized as the power transmission line together with the third conductive layer 460.

[0066] In the wiring structure 410, while the first conductive layer 420 operates as the ground plane during power transmission, more power may be supplied from the input terminal (e.g., 4603) to the output terminal 4604 by using the area of the second conductive layer 440 and the third conductive layer 460. At the same time, in the wiring structure 410, while the second conductive layer 440 operates as the ground plane during transmission of the millimeter wave band signal, the millimeter wave band signal input from the input terminal (e.g., 4601 or 4401) may be transmitted to the other end (e.g., 4602 or 4402) through a waveguide provided between the second conductive layer 440 and the third conductive layer 460. Signal transmission and power transmission may be performed in the fourth direction ④.

[0067] According to an embodiment, the stacked structure of the second conductive layer 440, the second dielectric layer 450, and the third conductive layer 460 may be formed as a substrate-integrated waveguide (SIW) structure. The second dielectric layer 450 may be a flexible printed circuit board (FPCB), but may include other suitable dielectric substrates. The second conductive layer 440 and the third conductive layer 460 may include two conductive via hole lines 470a and 470b spaced at a predetermined interval w with the second dielectric layer 450 interposed therebetween. The wiring structure 410 may form a rectangular waveguide through the two via hole lines 470a and 470b. The via hole lines 470a and 470b may be designed to transmit a millimeter wave band signal along the second direction ② through resonance. A distance a between the via holes, a spacing w of the via hole lines, a thickness h of the second dielectric layer 450, and a radius r of the via hole may vary depending on signal transmission characteristics in the millimeter band.

[0068] As another example, the second conductive layer 440, the second dielectric layer 450, and the third conductive layer 460 may be formed in a hollow substrate-integrated waveguide (HSIW) structure, but are not limited thereto. Otherwise, other waveguide structures that can be implemented in multiple layers may be formed.

[0069] According to an embodiment, the wiring structure 410 may utilize the second conductive layer 440 and the third conductive layer 460 to transmit a millimeter wave band signal (e.g., an AC signal) and simultaneously transmit a power signal (e.g., a DC signal). The wiring structure 410 may further include an isolation structure for isolating the AC signal from the DC signal at both the input and output terminals of the power transmission line or the signal transmission line.

[0070] For example, the isolation structure may include DC blocking circuits (e.g., AC capacitors) 490 arranged at the input/output terminals of the AC signals, which are connected to the second conductive layer 440 and the third conductive layer 460. The AC capacitor is a filter for preventing the DC signal from flowing into the signal transmission line, and may block the DC signal and allow the AC signal to pass therethrough.

[0071] For another example, the isolation structure may include an isolation region (e.g., an isolation region 530 of FIG. 5) in which a via hole group 480 for blocking the AC signal from flowing into the power transmission line is arranged, on the third conductive layer 460. The isolation region may be formed in the second portion 4611 of the third conductive layer 460 and the second conductive layer 440. According to some examples, an isolation structure may further include an AC blocking circuit (not shown) arranged at the input/output terminal of the DC signal connected to the second conductive layer 440 and the third conductive layer 460.

[0072] In the wiring structure 210, the first conductive layer 420 used as the ground for power transmission and the isolation structure (e.g., isolation region, DC blocking circuit, and AC blocking circuit) that isolates the AC signal from the DC signal may be additionally implemented while the conductive layers (e.g., the second conductive layer 440 and the third conductive layer 460) of the signal transmission line in which the substrate-integrated waveguide is formed are used as the power transmission line, thereby transmitting high power through a wide width and a plurality of conductive layers while improving loss of signal transmission in the millimeter wave band.

[0073] According to an embodiment, the wiring structure 210 may implement the signal transmission line of the millimeter wave band as the SIW structure, and may include a transition region (e.g., a transition region 520 of FIG. 5) to resolve structural discontinuities resulting from connections with other components or the transmission line (e.g., waveguide). Hereinafter, the transition region and the isolation region will be described in detail.

[0074] FIGS. 5A and 5B illustrate plan views illustrating a third conductive layer and a second conductive layer. FIG. 5A is a plan view illustrating the third conductive layer in FIG. 4B, and FIG. 5B is a plan view illustrating the second conductive layer in FIG. 4B.

[0075] Referring to FIGS. 5A and 5B, according to an embodiment, the third conductive layer 460 included in the wiring structure 410 may include a waveguide region 520 and transition regions 530 and 540 extending in the third direction (3) and the fourth direction ④ from both ends of the waveguide region 520 in the first portion 4610, and may include an isolation region 550 extending in the first direction (1) from another portion of the waveguide region 520 in the second portion 4611.

[0076] In the waveguide region 520, the two conductive via hole lines 470a and 470b spaced apart at a predetermined interval w may be arranged in parallel. In the wiring structure 410, a spherical waveguide may be formed through the via hole line.

[0077] The transition regions 520 and 530 may include an input/output line 521 that matches with an impedance value of 50 Ω and a transformer line 522 for path transformation in the input/output line. The input/output line 521 and the transformer line 522 may include a microstrip, strip, or slot line structure.

[0078] For example, the transformer line 522 may extend from both ends of a waveguide region 510 of the third conductive layer 460, but may be arranged as three transformer lines 522 spaced apart at a predetermined interval. Here, one input/output line 521 extending from any one transformer line may be arranged, but is not limited thereto.

[0079] In the wiring structure 410, the waveguide region 510 may be formed in an SIW structure, and the transformer line 522 and the input/output line 521 connected to the waveguide region 510 may be formed to reduce loss of the millimeter wave band signal. For example, the millimeter wave band signal transmitted from the signal source through the input terminal may be matched with an impedance of 50 Ωohm and may be output while passing through the input/output line 521. The transformer line 522 may convert between the impedance-matched signal and the signal transmitted through the waveguide, and when there is a transmission interruption, a transition for maintaining the signal flow in the same direction may be performed.

[0080] The isolation region 530 may include a via hole group 480 implemented to have a higher cut-off frequency than the frequency band of the signal (e.g., mmWave) transmitted to the signal transmission line. The via hole group 531 arranged in the isolation region 530 may serve as a filter to block the millimeter wave band signal (i.e., AC signal) transmitted through the SIW, and may prevent the AC signal and the DC signal from being coupled.

[0081] As illustrated in FIG. 5B, the second conductive layer 440 may be formed with a relatively larger area than the third conductive layer 460. Similar to the third conductive layer 460, in the second conductive layer 440, two conductive via hole lines 470a and 470b may be arranged in parallel in the first portion 4610, and the via hole group 480 may be arranged in the second portion 4611.

[0082] FIG. 6 illustrates a configuration of a wiring structure for a millimeter wave band according to an embodiment.

[0083] Referring to FIG. 6, according to an embodiment, a wiring structure (e.g., 410 in FIG. 4) or a wiring cable for a millimeter wave band may include a substrate-integrated waveguide line 611 used as a signal transmission line and a power transmission line in the millimeter wave band, a multi-layer 610 including a DC ground panel 612 for power transmission, a first signal isolation unit 620 arranged at a line input terminal, and a second signal isolation unit 630 arranged at a line output terminal.

[0084] The first signal isolation unit 620 and the second signal isolation unit 630 may include DC blocking circuits 621 and 631 that block DC signals from flowing into the signal transmission line and AC blocking circuits 622 and 632 that block AC signals from flowing into the power transmission line. One of the DC blocking circuits 621 and 631 may be connected to conductive layers (e.g., the second conductive layer 440 and the third conductive layer 460 of FIG. 4) used as the substrate-integrated waveguide line 611, and the other thereof may be connected to a DC ground panel 612. The DC blocking circuits 621 and 631 may include AC capacitors, but are not limited thereto.

[0085] According to some embodiments, the AC blocking circuits 622 and 632 may be implemented as circuits that allow DC signals to pass therethrough and block AC signals, but may also be implemented to filter the AC signals through the via hole group.

[0086] According to various embodiments, a wiring structure (e.g., the wiring structure 410 of FIGS. 4A and 4B) included in an electronic device (e.g., the electronic device 101 of FIG. 1) may be a power and transmission line for transmitting a millimeter wave signal and power, and the power and transmission line may be formed as a stacked structure including: a first conductive layer 420 connected to a negative wire of a direct current (DC) signal; a first dielectric layer 430 stacked on the first conductive layer 420; a second conductive layer 440 stacked on the first dielectric layer 430 and grounded to a ground of an alternating current (AC) signal; a second dielectric layer 450 stacked on the second conductive layer 440; and a third conductive layer 460 stacked on the second dielectric layer 450 and connected to an input/output port of the AC signal and a positive wire of the DC signal, wherein the third conductive layer 460 may include a waveguide region 520 in which a waveguide for transmitting the millimeter wave signal is formed, a transition region 530 or 540 which extends from both ends of the waveguide region 520 in a first direction and forms a portion of a millimeter wave signal transmission line, and an isolation region which extends in a second direction of the waveguide region and is for blocking the DC signal and the AC signal from each other.

[0087] According to various embodiments, the second dielectric layer may include a flexible circuit board, and the waveguide may be formed as a substrate-integrated waveguide in which two conductive via hole lines are arranged in the second conductive layer and the third conductive layer with the second dielectric layer interposed therebetween.

[0088] According to various embodiments, AC capacitors that block the DC signal and allow the AC signal to pass therethrough may be arranged at input/output terminals connected to the second conductive layer, the third conductive layer, and the millimeter wave signal transmission line.

[0089] According to various embodiments, the transition region may further include at least a plurality of transformer lines that extend from both ends of the waveguide region and are spaced apart from each other at a predetermined interval; and an input/output line that extends from at least one line of the plurality of transformer lines and matches with an impedance value of 50 S2.

[0090] According to various embodiments, the transformer line and the input/output line may be implemented by at least one of a microstrip, strip, and slot line structure.

[0091] According to various embodiments, the isolation region may include a via hole group arranged to have a cut-off frequency higher than a frequency of a millimeter wave band.

[0092] According to various embodiment, the wiring structure may further include an isolation circuit(or AC blocking circuit) that blocks the AC signal and allows the DC signal to pass therethrough at an input/output terminal connected to the third conductive layer and the positive wire of the DC signal.

[0093] According to various embodiments, a wiring structure included in an electronic device (e.g., the electronic device 101 of FIG. 1) may be a power and transmission line for transmitting a millimeter wave signal and power, and may include a ground panel 612 connected to a ground of a DC signal; and a multi-layer 610 including a substrate-integrated waveguide line 611 that is isolated from the ground panel with a dielectric layer interposed therebetween and is connected to an input/output terminal of an AC signal and a positive wire of the DC signal, wherein the substrate-integrated waveguide line may include a waveguide region 520 in which a waveguide for transmitting the millimeter wave signal is formed, a transition region 530 or 540 that extends from both ends of the waveguide region in a first direction and transforms the millimeter wave signal, and an isolation region 550 that extends in a second direction of the waveguide region and blocks between the DC signal and the AC signal.

[0094] According to various embodiments, in the substrate-integrated waveguide line, two conductive via hole lines may be arranged on an upper conductive layer disposed in a third direction of a flexible circuit board and a lower conductive layer disposed in a fourth direction of the flexible circuit board.

[0095] According to various embodiments, a DC blocking circuit that blocks the DC signal and allows the AC signal to pass therethrough may be further arranged at a transmission input/output terminal of the millimeter wave signal.

[0096] According to various embodiments, the transition region may further include at least a plurality of transformer lines that extend from both ends of the waveguide region and are spaced apart from each other at a predetermined interval, and an input/output line that extends from at least one line of the plurality of transformer lines and matches with an impedance value of 50 S2.

[0097] According to various embodiments, the transformer line and the input/output line may be implemented by at least one of a microstrip, strip, and slot line structure.

[0098] According to various embodiments, the isolation region may include a via hole group arranged to have a cut-off frequency higher than a frequency of a millimeter wave band.

[0099] According to various embodiments, the wiring structure may further include a blocking circuit that blocks the AC signal and allows the DC signal to pass therethrough at an input/output terminal connected to the upper conductive layer and the positive wire of the DC signal.

[0100] According to various embodiments, the millimeter wave band may include signals in 37 to 45 GHz bands.

[0101] FIG. 7 illustrates results of testing performance of a wiring structure of an electronic device according to various embodiments.

[0102] As a result of measuring signals at an input terminal and an output terminal of a wiring structure for millimeter wave band according to various embodiments, isolation characteristics between an AC signal and a DC signal can be confirmed as illustrated in FIG. 7. In FIG. 7, a horizontal axis may be a frequency and a vertical axis may be a signal level. Signal S11 may denote input reflection characteristics, and signal S21 may denote forward transmission characteristics. The input reflection characteristics may correspond to a signal with no noise as the magnitude reaches 0. Referring to signal 511, it can be seen that the transmission characteristics are excellent as the magnitude reaches zero from 24 GHz. The forward transmission characteristics may correspond to a signal in which the isolation between the AC signal and the DC signal is improved as the magnitude decreases to a negative level. Referring to signal S21, it can be seen that transmission characteristics are excellent in the 37.5 GHz band.

[0103] FIG. 8 illustrates results of testing performance of a wiring structure of an electronic device according to various embodiments.

[0104] As a result of measuring reflection characteristics at various locations in a wiring structure for millimeter wave band according to various embodiments, isolation characteristics between an AC signal and a DC signal can be confirmed as illustrated in FIG. 8. Reference numerals 8001 and 8003 in FIG. 8 denote reflection characteristics measured at a signal input terminal (e.g., 4601) and a power transmission input terminal (e.g., 4603) of the third conductive layer 460 in FIG. 4, and reference numerals 8002 and 8004 denote reflection characteristics measured at a signal input terminal (e.g., 4601) and a power transmission output terminal (e.g., 4604) of the third conductive layer 460. As a result of the test, it can be confirmed that the wiring structure for the millimeter wave band has excellent isolation characteristics from the DC signal while the signal loss of the millimeter wave band is small.

[0105] According to various embodiments, each component (e.g., a module or a program) of the above-described components may include a single entity or multiple entities. According to various embodiments, one or more of the above-described components may be omitted, or one or more other components may be added. Alternatively or additionally, a plurality of components (e.g., modules or programs) may be integrated into a single component. In such a case, according to various embodiments, the integrated component may still perform one or more functions of each of the plurality of components in the same or similar manner as they are performed by a corresponding one of the plurality of components before the integration. According to various embodiments, operations performed by the module, the program, or another component may be carried out sequentially, in parallel, repeatedly, or heuristically, or one or more of the operations may be executed in a different order or omitted, or one or more other operations may be added.

Claims

1. A wiring structure included in an electronic device and configured to function as a power and transmission line for transmitting a millimeter wave signal and power, the power and transmission line being configured to have a lamination structure comprising:

    a first conductive layer connected to a negative wire of a direct current (DC) signal;
    a first dielectric layer stacked on the first conductive layer;
    a second conductive layer stacked on the first dielectric layer and grounded to a ground of an alternating current (AC) signal;
    a second dielectric layer stacked on the second conductive layer; and
    a third conductive layer stacked on the second dielectric layer and connected to an input/output port of the AC signal and a positive wire of the DC signal,
    wherein the third conductive layer comprises:

        a waveguide region in which a waveguide for transmitting the millimeter wave signal is formed;
        a transition region which extends from both ends of the waveguide region in a first direction and forms a portion of a millimeter wave signal transmission line; and
        an isolation region which extends in a second direction of the waveguide region and is for blocking the DC signal and the AC signal from each other.

2. The wiring structure of claim 1, wherein the second dielectric layer comprises a flexible circuit board, and the waveguide is formed as a substrate-integrated waveguide in which two conductive via hole lines are arranged in the second conductive layer and the third conductive layer with the second dielectric layer interposed therebetween.

3. The wiring structure of claim 2, wherein AC capacitors that block the DC signal and allow the AC signal to pass therethrough are arranged at input/output terminals connected to the second conductive layer, the third conductive layer, and the millimeter wave signal transmission line.

4. The wiring structure of claim 1, wherein the transition region further comprises:

    at least a plurality of transformer lines that extend from both ends of the waveguide region and are spaced apart from each other at a predetermined interval; and
    an input/output line that extends from at least one line of the plurality of transformer lines and matches with an impedance value of 50 S2.

5. The wiring structure of claim 4, wherein the transformer line and the input/output line are implemented by at least one of a microstrip, strip, and slot line structure.

6. The wiring structure of claim 1, wherein the isolation region comprises a via hole group arranged to have a cut-off frequency higher than a frequency of a millimeter wave band.

7. The wiring structure of claim 6, further comprising an isolation circuit configured to block the AC signal and allow the DC signal to pass therethrough at an input/output terminal connected to the third conductive layer and the positive wire of the DC signal.

8. A wiring structure included in an electronic device and configured to function as a power and transmission line for transmitting a millimeter wave signal and power, the wiring structure comprising:

    a ground panel connected to a ground of a DC signal; and
    a multi-layer comprising a substrate-integrated waveguide line that is isolated from the ground panel with a dielectric layer interposed therebetween and is connected to an input/output terminal of an AC signal and a positive wire of the DC signal,
    wherein the substrate-integrated waveguide line comprises:

        a waveguide region in which a waveguide for transmitting the millimeter wave signal is formed;

a transition region that extends from both ends of the waveguide region in a first direction and transforms the millimeter wave signal; and

an isolation region that extends in a second direction of the waveguide region and blocks between the DC signal and the AC signal.

9. The wiring structure of claim 8, wherein, in the substrate-integrated waveguide line, two conductive via hole lines are arranged on an upper conductive layer disposed in a third direction of a flexible circuit board and a lower conductive layer disposed in a fourth direction of the flexible circuit board.

10. The wiring structure of claim 8, wherein a DC blocking circuit configured to block the DC signal and allow the AC signal to pass therethrough is further arranged at a transmission input/output terminal of the millimeter wave signal.

11. The wiring structure of claim 8, wherein the transition region further comprises:

at least a plurality of transformer lines that extend from both ends of the waveguide region and are spaced apart from each other at a predetermined interval; and

an input/output line that extends from at least one line of the plurality of transformer lines and matches with an impedance value of 50 S2.

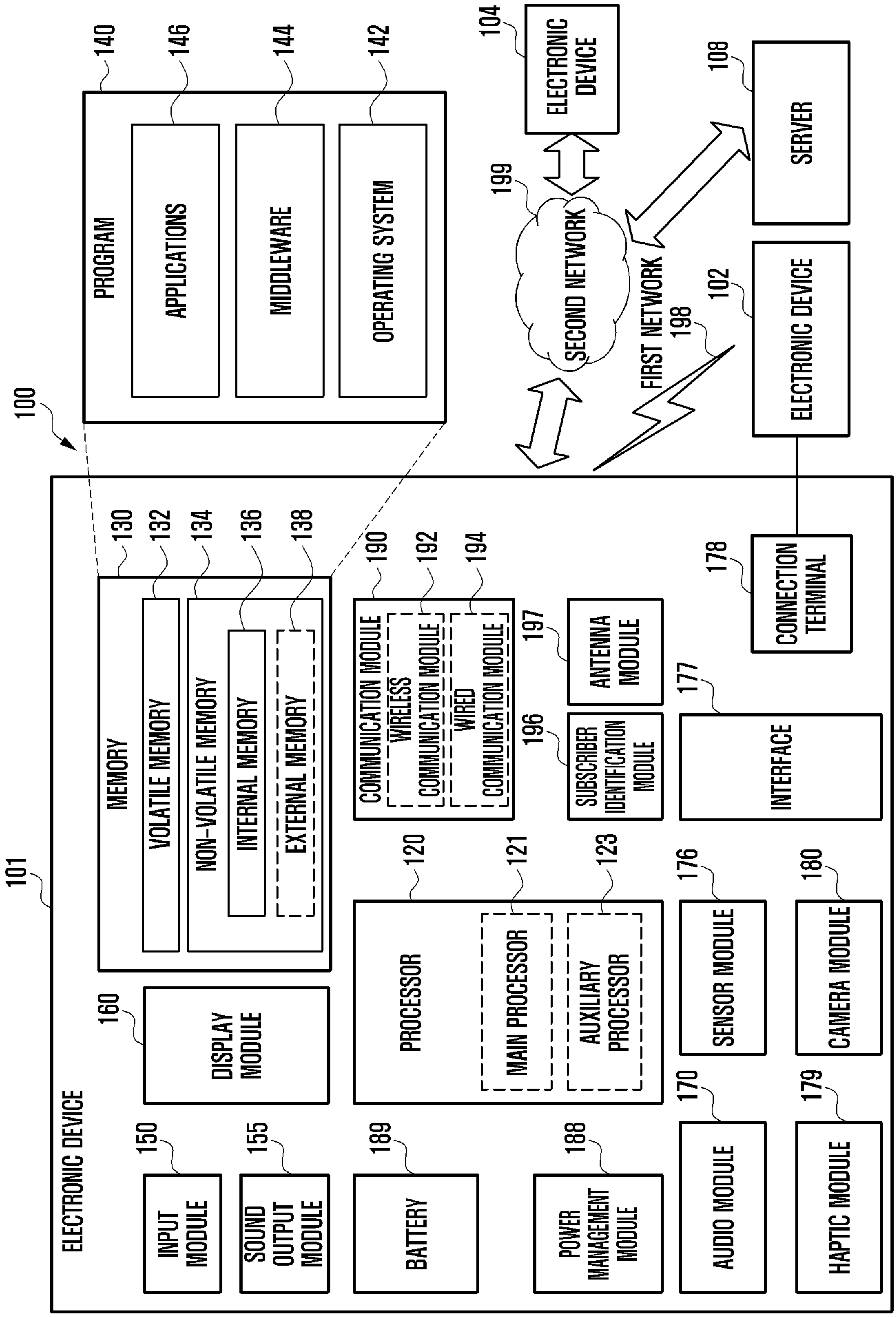
12. The wiring structure of claim 11, wherein the transformer line and the input/output line are implemented by at least one of a microstrip, strip, and slot line structure.

13. The wiring structure of claim 8, wherein the isolation region comprises a via hole group arranged to have a cut-off frequency higher than a frequency of a millimeter wave band.

14. The wiring structure of claim 9, further comprising an AC blocking circuit configured to block the AC signal and allow the DC signal to pass therethrough at an input/output terminal connected to the upper conductive layer and the positive wire of the DC signal.

15. The wiring structure of claim 8, wherein the millimeter wave band comprises signals in 37 to 45 GHz bands.

FIG. 1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101
ELECTRONIC DEVICE
INPUT MODULE
150
SOUND OUTPUT MODULE
155
DISPLAY MODULE
160
MEMORY
130
VOLATILE MEMORY
132
NON-VOLATILE MEMORY
134
INTERNAL MEMORY
136
EXTERNAL MEMORY
138
PROGRAM
140
APPLICATIONS
146
MIDDLEWARE
144
OPERATING SYSTEM
142
BATTERY
189
PROCESSOR
120
MAIN PROCESSOR
121
AUXILIARY PROCESSOR
123
COMMUNICATION MODULE
190
WIRELESS COMMUNICATION MODULE
192
WIRED COMMUNICATION MODULE
194
POWER MANAGEMENT MODULE
188
SUBSCRIBER IDENTIFICATION MODULE
196
ANTENNA MODULE
197
AUDIO MODULE
170
SENSOR MODULE
176
INTERFACE
177
HAPTIC MODULE
179
CAMERA MODULE
180
CONNECTION TERMINAL
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SECOND NETWORK
199
FIRST NETWORK
198
ELECTRONIC DEVICE
104
ELECTRONIC DEVICE
102
SERVER
108

FIG. 2

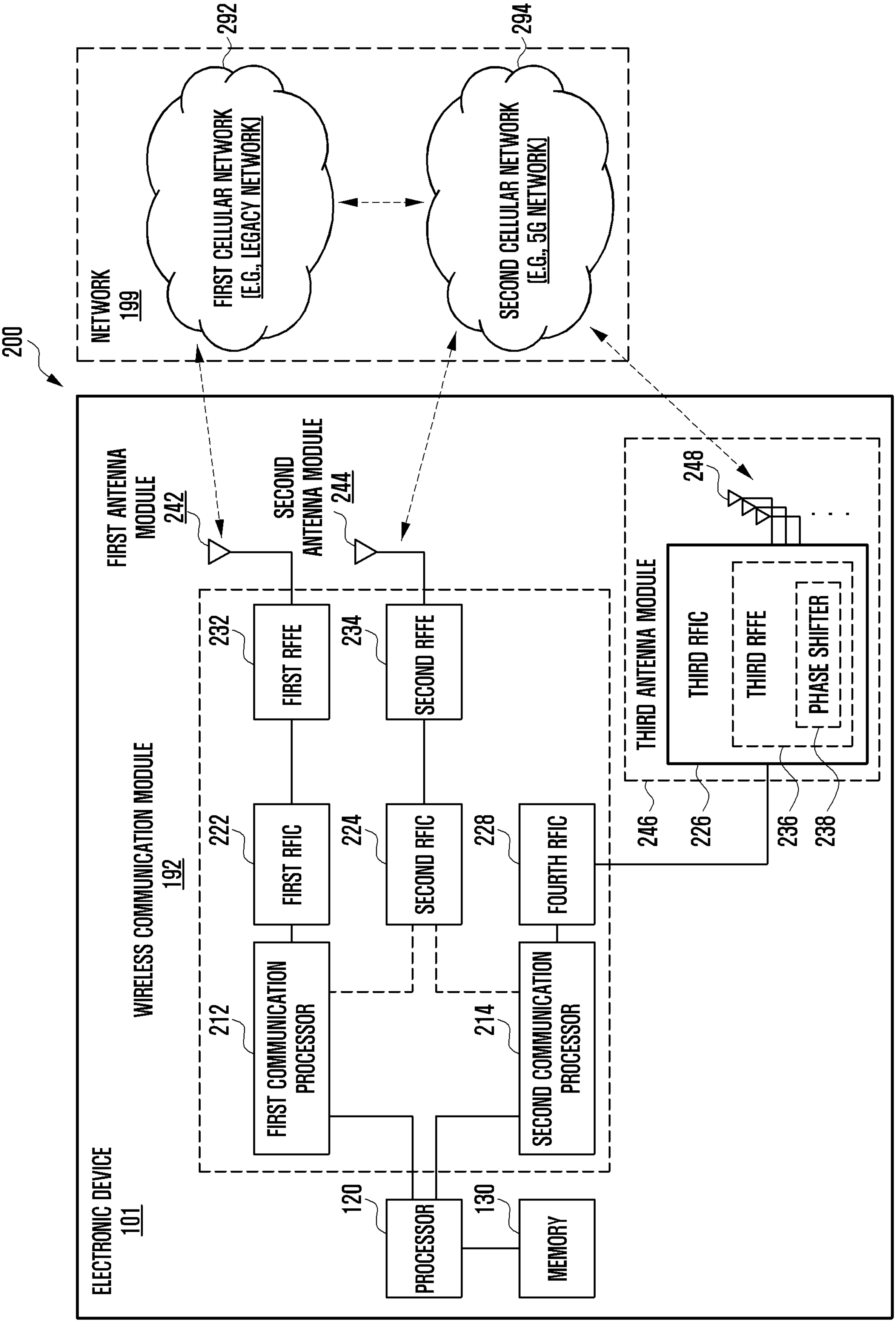

200
NETWORK
199
FIRST CELLULAR NETWORK
(E.G., LEGACY NETWORK)
292
SECOND CELLULAR NETWORK
(E.G., 5G NETWORK)
294
ELECTRONIC DEVICE
101
WIRELESS COMMUNICATION MODULE
192
FIRST ANTENNA MODULE
242
SECOND ANTENNA MODULE
244
THIRD ANTENNA MODULE
246
248
FIRST RFFE
232
SECOND RFFE
234
FIRST RFIC
222
SECOND RFIC
224
FOURTH RFIC
228
THIRD RFIC
226
THIRD RFFE
236
PHASE SHIFTER
238
FIRST COMMUNICATION PROCESSOR
212
SECOND COMMUNICATION PROCESSOR
214
PROCESSOR
120
MEMORY
130

FIG. 3

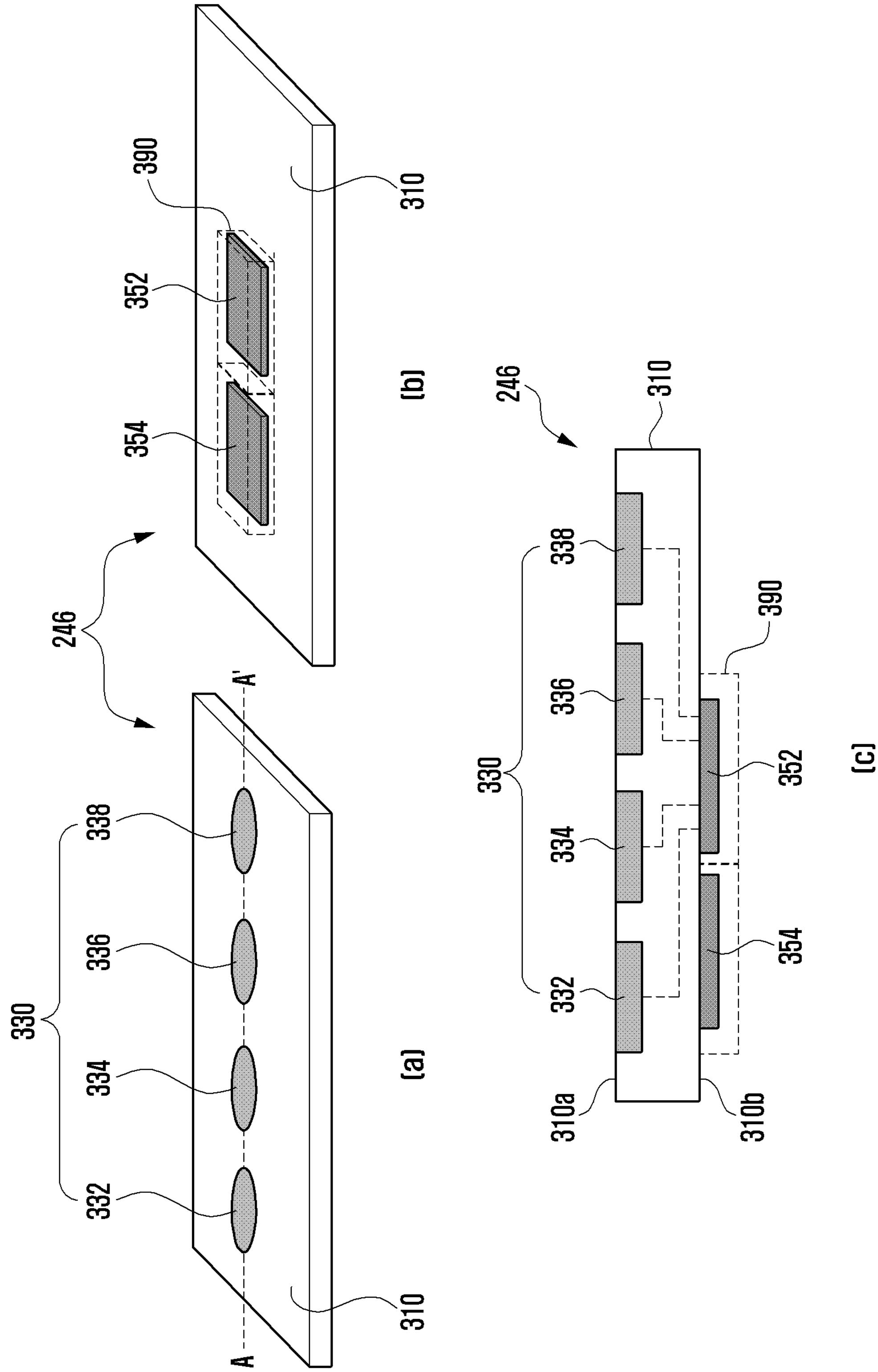
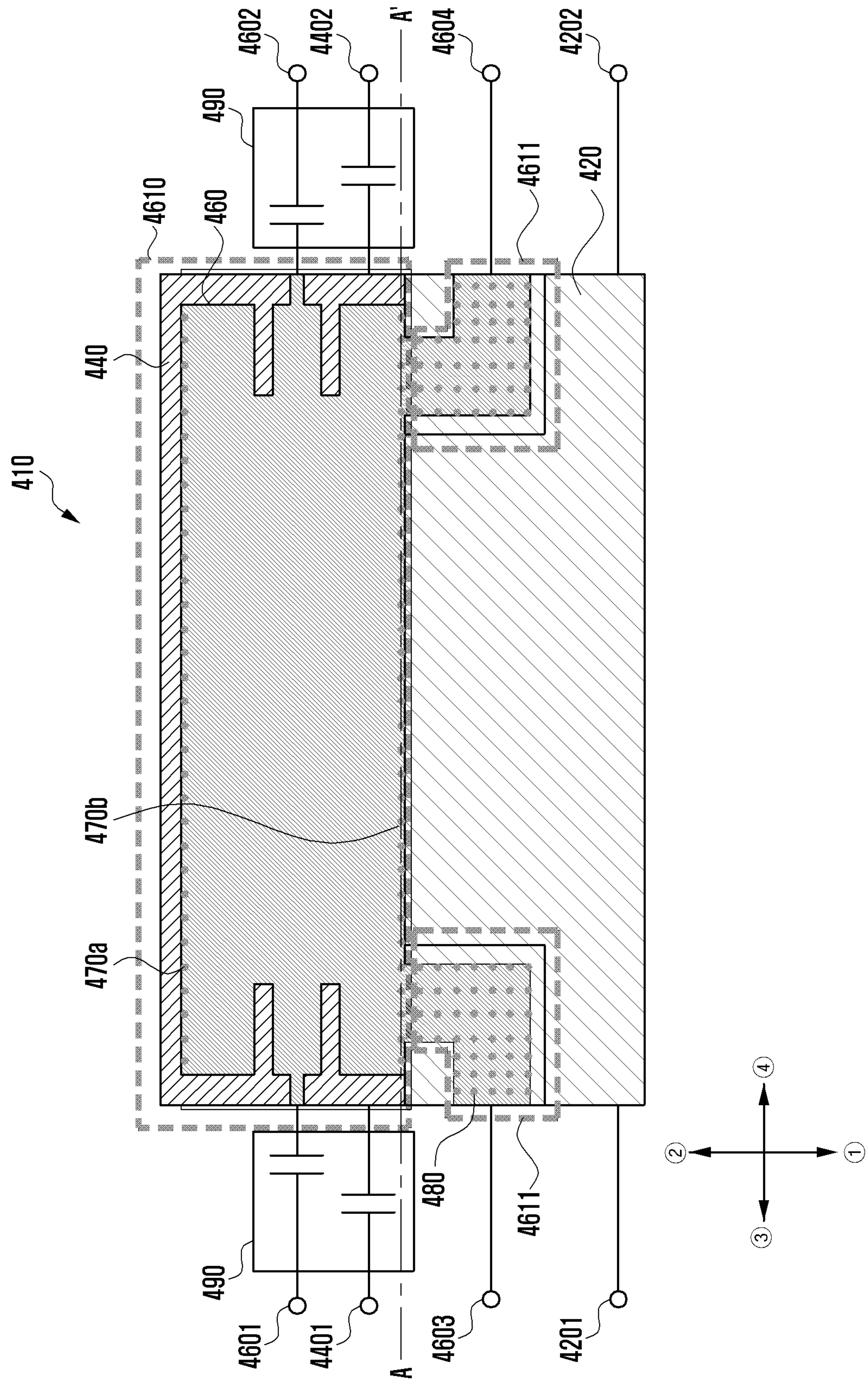

330
332
334
336
338
310
A
A'
(a)
246
354
352
390
310
(b)
246
310
330
332
334
336
338
390
352
354
310a
310b
(c)

FIG. 4A


410
4602
4402
A'
4604
4202
490
4610
460
4611
420
440
470b
470a
480
4611
490
4601
4401
A
4603
4201
①
②
③
④

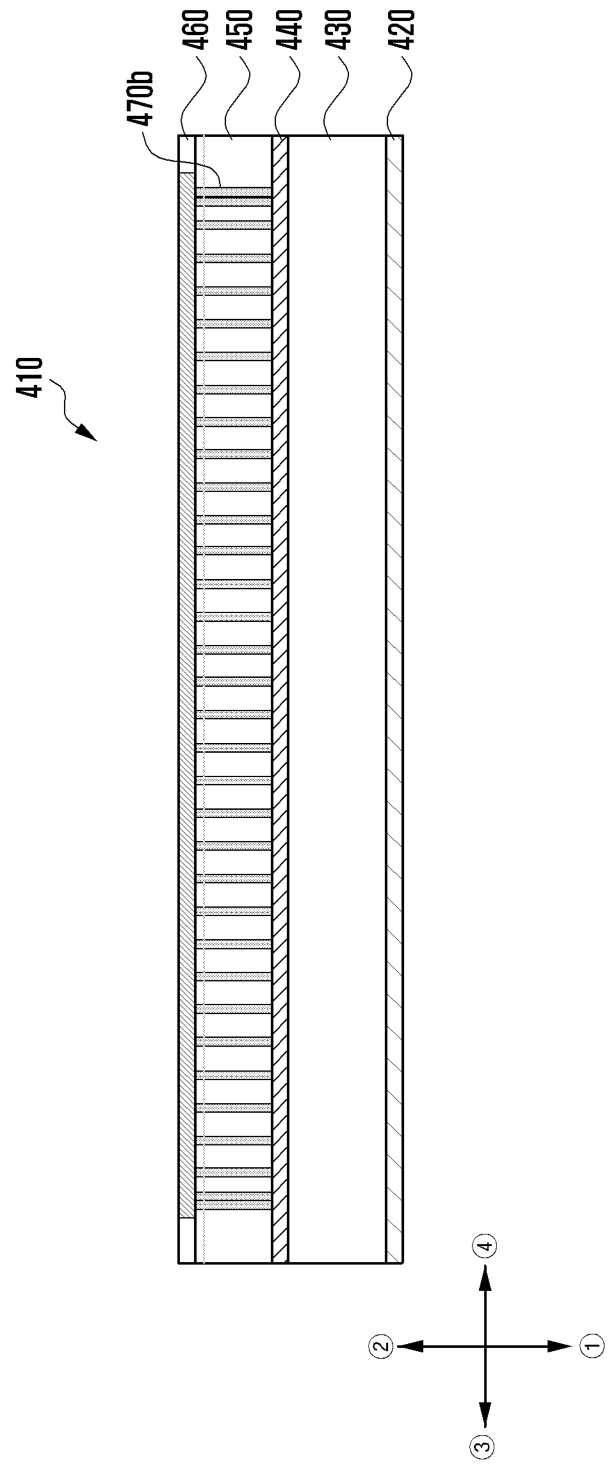


FIG. 4B

FIG. 5A

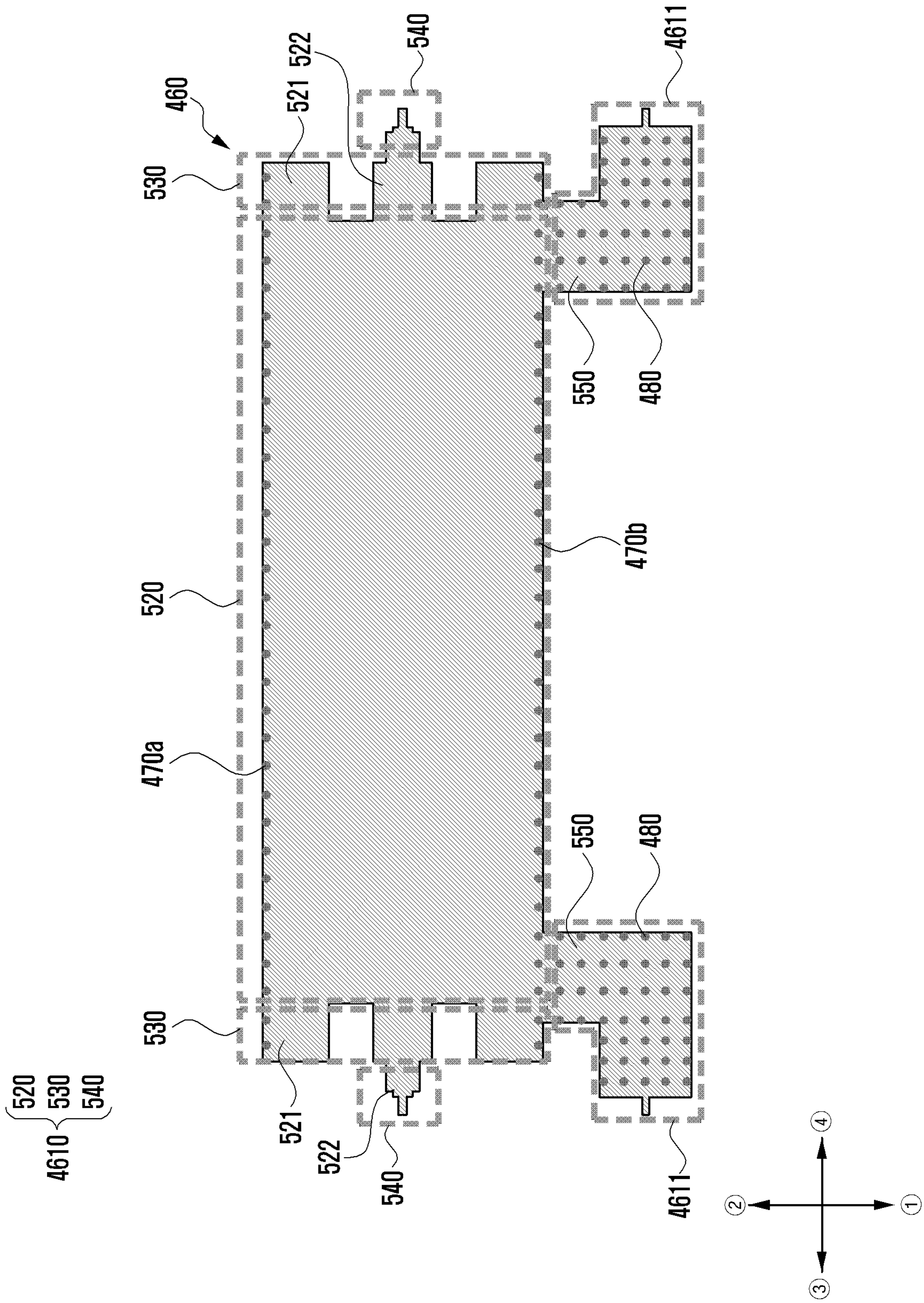


FIG. 5B

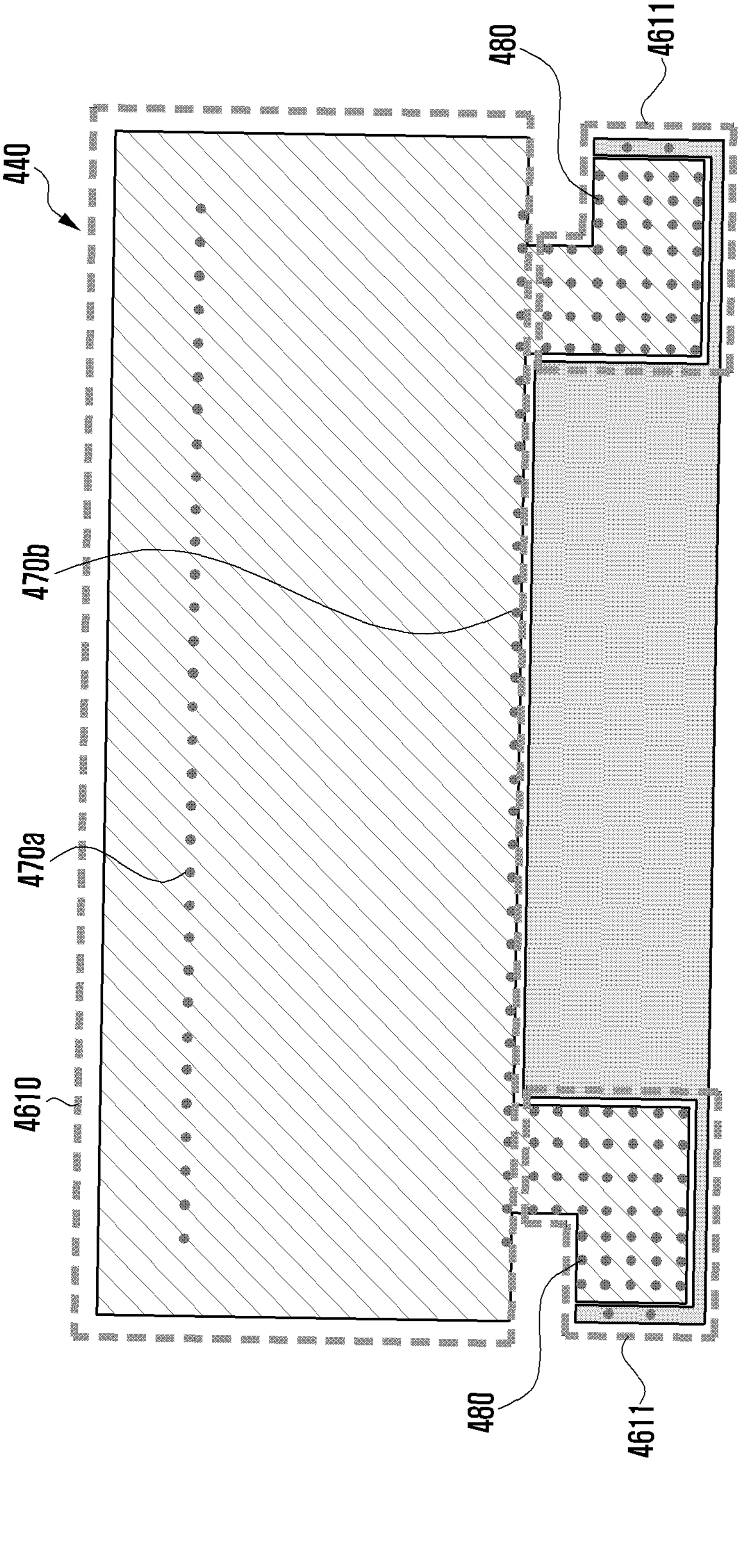


FIG. 6

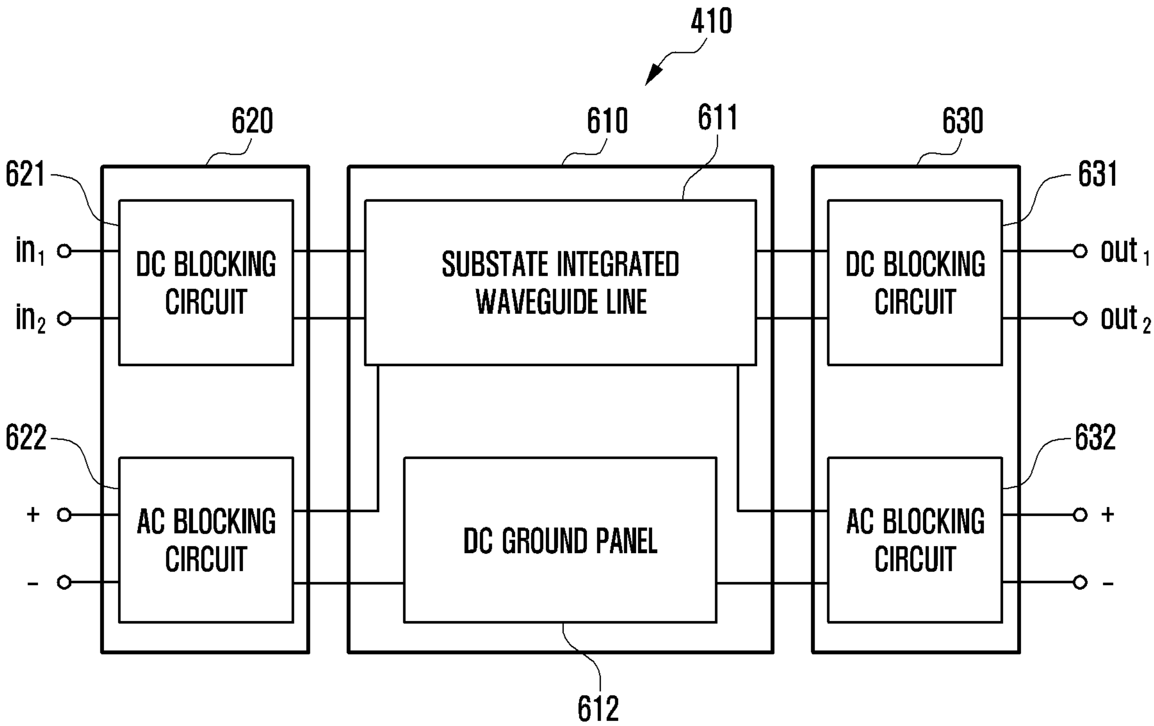
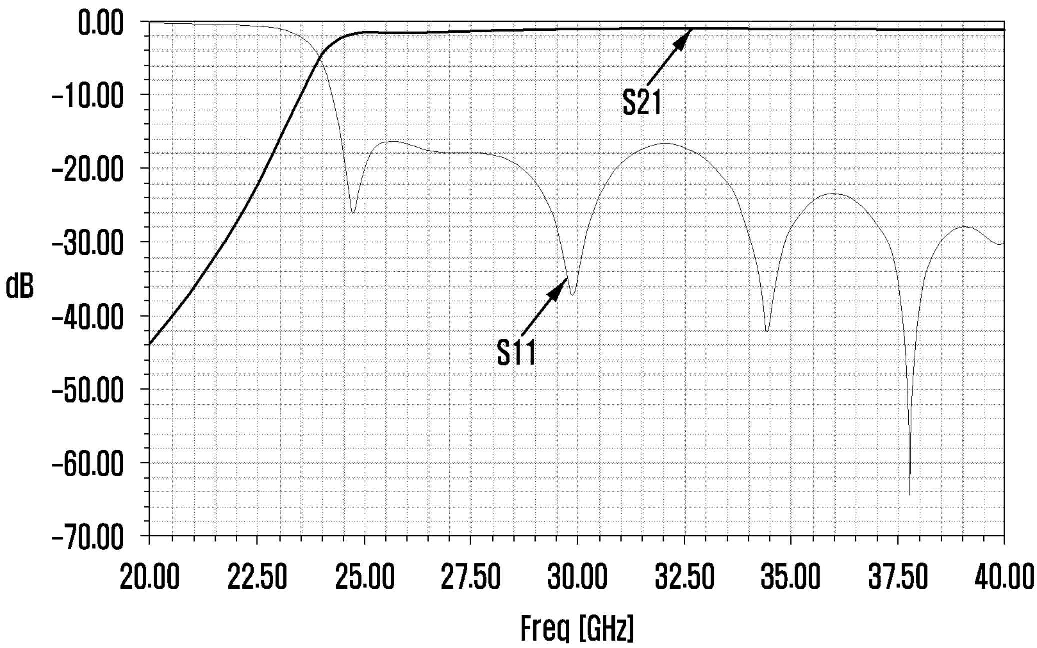

410
620
610
611
630
621
631
in1
in2
DC BLOCKING CIRCUIT
SUBSTATE INTEGRATED WAVEGUIDE LINE
DC BLOCKING CIRCUIT
out1
out2
622
632
+
-
AC BLOCKING CIRCUIT
DC GROUND PANEL
AC BLOCKING CIRCUIT
+
-
612

FIG. 7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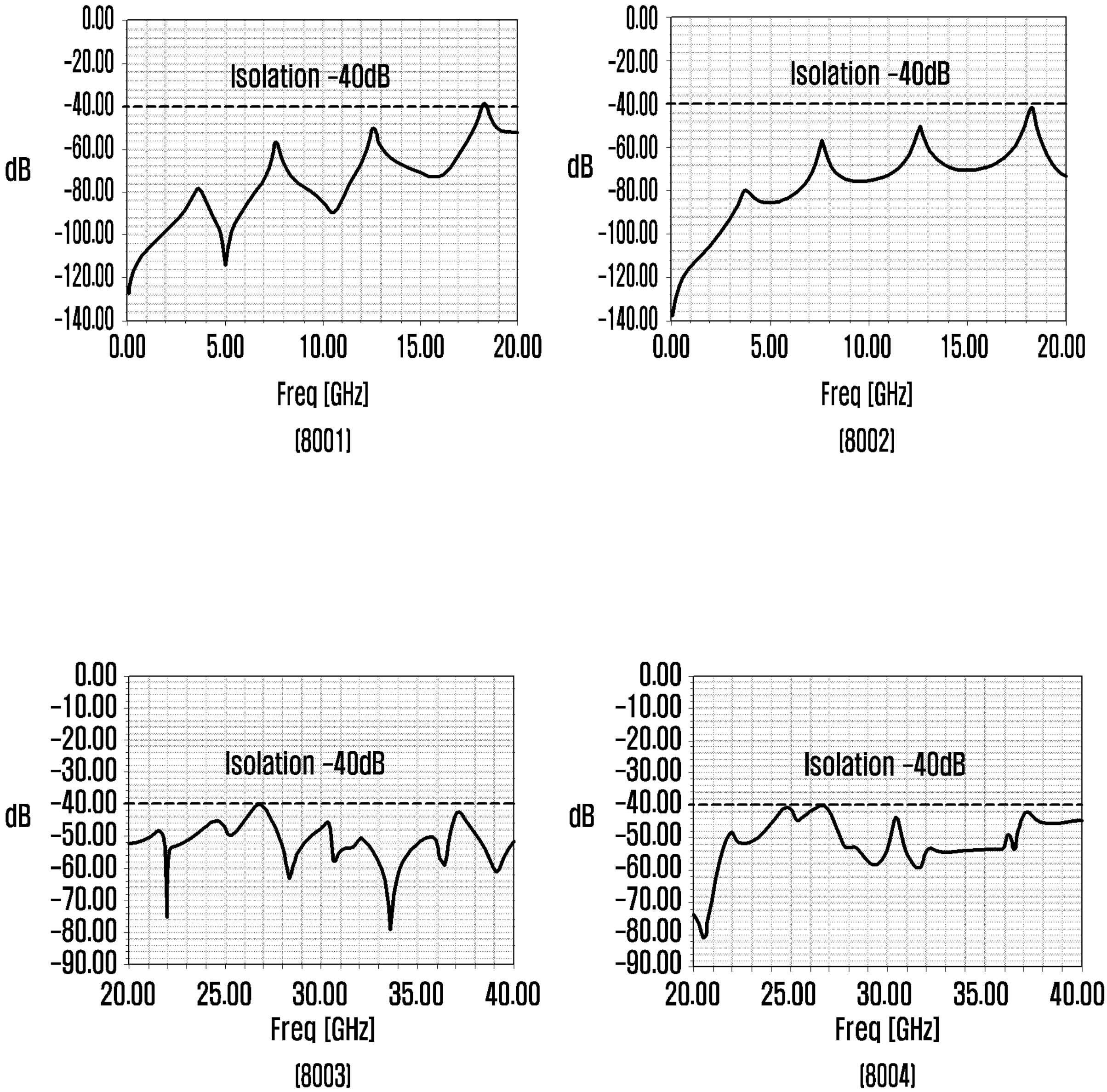
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
dB
20.00
22.50
25.00
27.50
30.00
32.50
35.00
37.50
40.00
Freq [GHz]
S21
S11

FIG. 8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-40.00
-60.00
-80.00
-100.00
-120.00
-140.00
dB
Isolation -40dB
0.00
5.00
10.00
15.00
20.00
Freq [GHz]
(8001)
(8002)
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
-90.00
20.00
25.00
30.00
35.00
40.00
(8003)
(8004)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2022/006555

A. CLASSIFICATION OF SUBJECT MATTER

H01Q 1/38(2006.01)i; **H01Q 1/46**(2006.01)i; **H01P 3/12**(2006.01)i; **H01Q 13/10**(2006.01)i

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)

H01Q 1/38(2006.01); H01P 11/00(2006.01); H01P 3/00(2006.01); H01P 3/12(2006.01); H01P 5/107(2006.01); H01Q 1/48(2006.01); H04B 1/40(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & keywords: 선로(line), 도전층(conductive layer), 유전층(dielectric layer), AC, DC, 도파관 (waveguide)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015-0381229 A1 (SAMSUNG ELECTRONICS CO., LTD.) 31 December 2015 (2015-12-31) See claims 1, 5 and 9 and figures 4-5.	1-15
A	JP 2004-297464 A (KYOCERA CORP.) 21 October 2004 (2004-10-21) See paragraphs [0023]-[0027], claim 1 and figures 1-2.	1-15
A	KR 10-2017-0140691 A (SAMSUNG ELECTRONICS CO., LTD.) 21 December 2017 (2017-12-21) See claims 1-21 and figures 1-7.	1-15
A	JP 2008-271295 A (KYOCERA CORP.) 06 November 2008 (2008-11-06) See claims 1-3 and figures 1-5.	1-15
A	KR 10-2020-0110603 A (TAIWAN SEMICONDUCTOR MANUFACTURING CO., LTD.) 24 September 2020 (2020-09-24) See claims 1-8 and figures 1-5.	1-15

☐ Further documents are listed in the continuation of Box C.　☑ See patent family annex.

* Special categories of cited documents:
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 August 2022	**18 August 2022**

Name and mailing address of the ISA/KR	Authorized officer
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Facsimile No. **+82-42-481-8578**	Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2022/006555

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