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(71) Applicant: **Samsung Electronics Co., Ltd.**
Gyeonggi-do, 443-742 (KR)

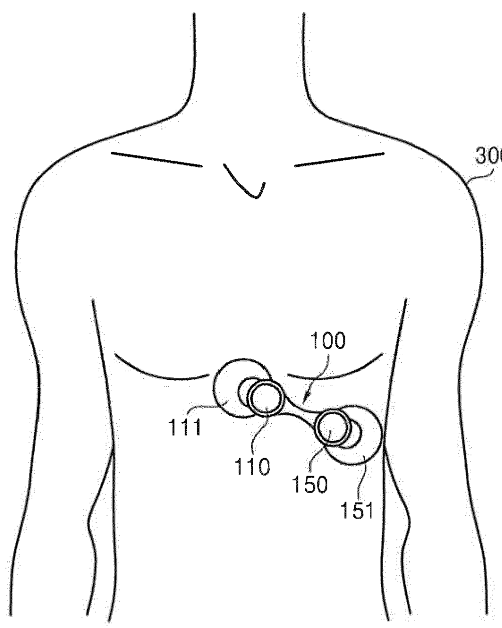
(72) Inventors:
- **YAN, Long**
445-701 Hwaseong-si, Gyeonggi-do (KR)
- **BAEK, Min Gun**
445-701 Hwaseong-si, Gyeonggi-do (KR)
- **JO, Hee Jae**
445-701 Hwaseong-si, Gyeonggi-do (KR)

(74) Representative: **Kuhnen & Wacker**
Patent- und Rechtsanwaltsbüro
Prinz-Ludwig-Straße 40A
85354 Freising (DE)

(54) **PATCH INCLUDING AN EXTERNAL FLOATING HIGH-PASS FILTER AND AN ELECTROCARDIOGRAPH (ECG) PATCH INCLUDING THE SAME**

(57) An electrocardiograph (ECG) patch including: a first electrode; a second electrode; a high pass filter configured to receive a bias voltage and provide the bias voltage to the first electrode and the second electrode; and a signal processing unit configured to generate the bias voltage and provide the bias voltage to the high pass filter.

FIG. 2



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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application No. 62/256,951 filed on November 18, 2015, and under 35 U.S.C. § 119(a) to Korean Patent Application No. 10-2016-0028210 filed on March 09, 2016, the disclosures of which are incorporated by reference herein in their entireties.

Technical Field

[0002] Exemplary embodiments of the inventive concept relate to an electrocardiograph (ECG) patch, and more particularly, to an ECG patch including two electrodes and a floating high-pass filter.

Discussion of Related Art

[0003] ECG monitoring is the process of recording the electrical activity of the heart over a period of time using electrodes placed on a person's body. These electrodes detect tiny electrical changes on the person's skin that arise from the heart depolarizing during each heartbeat. An ECG patch placed near the heart allows ECG signals to be easily acquired. Generally, an ECG patch includes ECG electrodes for detecting ECG signals and a bias electrode for supplying a bias voltage to a person's body. The bias electrode is typically attached to the person's body together with the ECG electrodes.

SUMMARY

[0004] According to an exemplary embodiment of the inventive concept, there is provided an electrocardiograph (ECG) patch comprising: a first electrode; a second electrode; a high pass filter configured to receive a bias voltage and provide the bias voltage to the first electrode and the second electrode; and a signal processing unit configured to generate the bias voltage and provide the bias voltage to the high pass filter.

[0005] According to an exemplary embodiment of the inventive concept, there is provided an ECG patch comprising: a first patch including a first electrode, a high pass filter and an ECG signal processing unit; a second patch including a second electrode and a battery; and a cable including a first wire for providing a bias voltage from the first patch to the second electrode, a second wire for providing an operating voltage to the second patch and a third wire for providing a ground voltage to the second patch.

[0006] According to an exemplary embodiment of the inventive concept, there is provided a data processing system comprising: an ECG patch comprising a first electrode, a second electrode, a high pass filter configured to generate a bias voltage to be provided to the first electrode and the second electrode, and a wireless transceiver; and a mobile communication device configured to communicate with the ECG patch.

[0007] According to an exemplary embodiment of the inventive concept, there is provided a data processing system comprising: an ECG patch comprising a first electrode, a second electrode, a high pass filter configured to generate a bias voltage to be provided to the first electrode and the second electrode, and a wireless transceiver; a health care server configured to receive ECG medical data of a person wearing the ECG patch; and a mobile computing device configured to the receive the ECG medical data of the person from the health care server.

[0008] According to an exemplary embodiment of the inventive concept, an ECG patch comprises: a first electrode configured to detect a first ECG signal; a second electrode configured to detect a second ECG signal; a high-pass filter configured to perform high-pass filtering on the first ECG signal to generate a first high-pass filtered signal, and to perform high-pass filtering on the second ECG signal to generate a second high-pass filtered signal; and a signal processing unit configured to generate an ECG output signal based on a difference between the first ECG signal and the second ECG signal, wherein the high-pass filter is further configured to generate a first bias voltage based on a driving voltage and provide the first bias voltage to the first electrode, and to generate a second bias voltage based on the driving voltage and provide the second bias voltage to the second electrode.

[0009] According to an exemplary embodiment of the inventive concept, an ECG patch comprises: a first patch including a first electrode and an ECG sensor; a second patch including a second electrode; and a cable connected between the first patch and the second patch, wherein the ECG sensor is configured to receive a first high-pass filtered signal and a second high-pass filtered signal and amplify a voltage difference between the first and second high-pass filtered signals to generate an output voltage, wherein the first patch includes a high-pass filter configured to generate a first bias voltage and a second bias voltage using a driving voltage and to provide the first bias voltage to the first electrode and the second bias voltage to the second electrode.

[0010] According to an exemplary embodiment of the inventive concept, there is provided an ECG patch comprising: a first electrode; a second electrode; a wire; and a high-pass filter configured to generate a first bias voltage and a second bias voltage, apply the first bias voltage to the first electrode via a transmission line and apply the second bias voltage to the second electrode via the wire.

[0011] According to an exemplary embodiment of the inventive concept, there is provided an ECG patch comprising: a first electrode configured to detect a first ECG signal from a heart of a person; a second electrode configured to detect a second ECG signal from the heart of the person; a high-pass filter configured to perform high-pass filtering on the first ECG signal to generate a first high-pass filtered signal, and to perform high-pass filtering on the second ECG signal to generate a second high-pass filtered signal; and an ECG processing unit including an ECG sensor configured to sense a difference between the first high-pass filtered signal and the second high-pass filtered signal and generate an ECG output signal corresponding to the sensing result, and a bias voltage generating circuit configured to provide a bias voltage to the high pass filter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The above and other features of the inventive concept will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

FIG. 1 is a perspective view of a wearable electrocardiograph (ECG) patch including two ECG electrodes and a floating high-pass filter according to an exemplary embodiment of the inventive concept;
FIG. 2 is a perspective view showing a state where the wearable ECG patch illustrated in FIG. 1 is placed around a human heart, according to an exemplary embodiment of the inventive concept;
FIG. 3 is a detailed block diagram of the wearable ECG patch illustrated in FIG. 1, according to an exemplary embodiment of the inventive concept;
FIG. 4 is a schematic diagram of the layout of a floating high-pass filter and ECG transmission lines included in a first patch of the wearable ECG patch illustrated in FIG. 1, according to an exemplary embodiment of the inventive concept; and
FIG. 5 is a schematic diagram of the layout of a printed circuit board (PCB) included in the first patch of the wearable ECG patch illustrated in FIG. 1, according to an exemplary embodiment of the inventive concept.
FIG. 6 is a detailed block diagram of the wearable ECG patch illustrated in FIG. 1, according to an exemplary embodiment of the inventive concept;
FIG. 7 is a diagram of a data processing system which includes the ECG signal processing unit shown in FIG. 6, according to an exemplary embodiment of the inventive concept; and
FIGS. 8, 9, and 10 are diagrams illustrating data processing systems which include the wearable ECG patch shown in FIG. 1, according to an exemplary embodiment of the inventive concept.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0013] FIG. 1 is a perspective view of a wearable electrocardiograph (ECG) patch 100 including two ECG electrodes and a floating high-pass filter according to an exemplary embodiment of the inventive concept. FIG. 2 is a perspective view showing a state where the wearable ECG patch 100 illustrated in FIG. 1 is placed around a human heart, according to an exemplary embodiment of the inventive concept.

[0014] Referring to FIG. 1, the wearable ECG patch 100 may include a first patch 110, a second patch 150, and a cable 170. The wearable ECG patch 100 may be called an ECG patch or an ECG sensor patch.

[0015] ECG electrodes 112 and 152 are placed on the patches 110 and 150, respectively. The wearable ECG patch 100 does not require special ECG electrodes for body biasing to be implemented in any of the patches 110 and 150. Accordingly, the wearable ECG patch 100 includes only two ECG electrodes 112 and 152. The ECG electrodes 112 and 152 are ECG electrodes or ECG signal electrodes which are placed on the body, and more particularly, around the heart of a person 300.

[0016] In FIG. 2, reference numeral 111 denotes an adhesive layer for fixing or attaching the first ECG electrode 112 of the first patch 110 to the surface of the person's chest around the heart and reference numeral 151 denotes an adhesive layer for fixing or attaching the second ECG electrode 152 of the second patch 150 to the surface of the person's chest around the heart. Each of the adhesive layers 111 and 151 may include a conductive gel but is not limited thereto. In addition, reference numerals 111 and 151 may denote disposable ECG electrodes which are electrically connected to ECG electrodes 112 and 152, respectively.

[0017] FIG. 3 is a detailed block diagram of the wearable ECG patch 100 illustrated in FIG. 1, according to an exemplary embodiment of the inventive concept. Referring to FIG. 3, V_{ECG} denotes the voltage of an ECG signal generated by the heartbeat of the person 300; Z_{elec} in an electrode interface model IFM denotes a contact impedance between each modeled ECG electrode 112 or 152 and the person 300; V_{hc} denotes a voltage difference, e.g., a direct current (DC) component between the ECG electrodes 112 and 152; and ΔZ denotes a difference between the impedance of the first patch 110 and the contact impedance of the second patch 150. ΔZ is one of the factors increasing motion noise. The motion noise may be increased by the motion of the person 300 or a physical difference between the ECG electrodes 112 and 152 (e.g., a difference between the thicknesses of the adhesive layers 111 and 151 existing between the respective ECG electrodes 112 and 152 and the body of the person 300). The contact impedance Z_{elec} may be determined by resistance (e.g., 51 kΩ) and capacitance (e.g., 47 nF) and the voltage difference V_{hc} may be ±300 mV, but these values 51 kΩ, 47 nF, and ±300 mV are just examples.

[0018] 50/60 Hz denotes power noise generated from a noise source (NS) and I_C denotes noise current generated from the NS. For instance, when the person 300 with the wearable ECG patch 100 placed on the body around the heart is near the NS, e.g., a fluorescent light or a measuring device, which operates at a frequency of 50 or 60 Hz, the power noise 50/60 Hz and the noise current I_C may influence the body of the person 300. Fc denotes capacitance between an earth ground (GND) and the body of the person 300; VSS_{PCB} denotes a ground (or a ground of a printed circuit board (PCB)) of an ECG signal processing unit 120; and CC denotes capacitance between the earth GND and the PCB ground VSS_{PCB}.

[0019] Referring to FIGS. 1 through 3, the first patch 110 includes the first ECG electrode 112, the ECG signal processing unit 120, a high-pass filter 130, and transmission lines 122-1, 122-2, and L1.

[0020] The first ECG electrode 112 may detect a first ECG signal from the heart of the person 300. The high-pass filter 130 may perform high-pass filtering on the first ECG signal to generate a first high-pass filtered ECG signal ECG_P.

[0021] The ECG signal processing unit 120 may include a plurality of pads 121-1, 121-2, 121-3, 121-4, and 121-5, an ECG sensor 123, a voltage regulator 125, a voltage divider 127, and a driver 129. The ECG signal processing unit 120, which can process bio signals ECG_P and ECG_N, may be an ECG chip or a bio-processor.

[0022] The ECG sensor 123 may sense a difference between the first high-pass filtered ECG signal ECG_P input through the first pad 121-1 and a second high-pass filtered ECG signal ECG_N input through the second pad 121-2 and may generate and process an ECG output signal corresponding to the sensing result.

[0023] The voltage regulator 125 may receive an operating voltage VDD through the third pad 121-3, may regulate the operating voltage VDD, and may generate an operating voltage of the ECG sensor 123 included in the ECG signal processing unit 120. The operating voltage VDD is generated by a battery 154 embedded in the second patch 150 and may be supplied to the voltage regulator 125 through a second wire W2 and the third pad 121-3.

[0024] The voltage divider 127 may divide the voltage (e.g., VDD) that has been regulated by the voltage regulator 125 to generate a driving voltage. The driving voltage may be VDD/2 but is not limited thereto. The driver 129 may drive the driving voltage VDD/2 to the high-pass filter 130 through the fifth pad 121-5. The driver 129 may have a gain of 1 and may be implemented as a current driver, but the inventive concept is not limited to this example.

[0025] The high-pass filter 130 may generate a first bias voltage and a second bias voltage using the driving voltage VDD/2, may apply the first bias voltage to the body of the person 300 through the third transmission line L1 and the first ECG electrode 112, and may apply the second bias voltage to the body of the person 300 through a first wire W1 and the second ECG electrode 152. The level of the first bias voltage may be the same as the level of the second bias voltage, but the inventive concept is not limited to this example. The levels of the first and second bias voltages may be determined by the driving voltage, e.g., VDD/2, output from the driver 129 when the ECG electrodes 112 and 152 are attached to the body of the person 300.

[0026] Accordingly, the first ECG electrode 112 may apply the first bias voltage to the body of the person 300 and detect a first ECG signal at a time, and the second ECG electrode 152 may apply the second bias voltage to the body of the person 300 and detect a second ECG signal at a time. The times may be the same, substantially simultaneous or different from each other.

[0027] Since the driving voltage VDD/2 is applied to the high-pass filter 130, the high-pass filter 130 may be implemented as a floating high-pass filter. The high-pass filter 130 may include a plurality of capacitors 132 and 135 and a plurality of resistors 131, 133, 134, and 136. Although the high-pass filter 130 is placed outside the ECG signal processing unit 120 in the embodiment illustrated in FIG. 3, the high-pass filter 130 may be integrated into or placed within the ECG signal processing unit 120.

[0028] The first capacitor 132 is connected between the third transmission line L1 and the first transmission line 122-1. The second capacitor 135 is connected between the first wire W1 and the second transmission line 122-2. The first transmission line 122-1 is connected to the first pad 121-1. The second transmission line 122-2 is connected to the second pad 121-2.

[0029] The first resistor 131 is connected between the third transmission line L1 and a node ND connected to the fifth pad 121-5. The second resistor 133 is connected between the first transmission line 122-1 and the node ND. The third resistor 134 is connected between the node ND and the second transmission line 122-2. The fourth resistor 136 is connected between the node ND and the first wire W1.

[0030] The capacitors 132 and 135 may have the same capacitance C and the resistors 131, 133, 134, and 136 may have the same resistance R. However, the resistors 131 and 136 may have a resistance R1 and the resistors 133 and 134 may have a resistance R2. In this case, the resistance R1 may be different from the resistance R2. Each of the resistors 131, 133, 134, and 136 may be a passive or an active resistance element. Each of the capacitors 132 and 135 may be a switched capacitor.

[0031] A common-mode DC gain $G_{CM, DC}$ of the high-pass filter 130 may be 1. For instance, when R=R1=R2, a cutoff frequency $f_{HPf, -3dB}$ of the high-pass filter 130 is $1/2\pi$ RC and a differential input impedance $Z_{in, Diff}$ approximates R.

[0032] When the ECG electrodes 112 and 152 are attached to the body of the person 300 around the heart and the driving voltage VDD/2 is applied to the high-pass filter 130, a voltage of the first transmission line 122-1 is $VDD/2 + G1 \cdot V_{ECG}/2 + V_{hc}/2$ and a voltage of the second transmission line 122-2 is $VDD/2 - G1 \cdot V_{ECG}/2 + V_{hc}/2$, where G1 may denote a gain which is determined by the capacitance C, the resistance R2, and a frequency of the voltage V_{ECG}. Although the formulas illustrated in FIG. 3 do not include G1, in practice these formulas may include

G1.

[0033] Accordingly, differential DC inputs (e.g., V_{hc}) are attenuated by the high-pass filter 130 and the attenuated differential DC inputs may be eliminated from the ECG sensor 123. The body of the person 300 is biased by two resistors 131 and 136 and two ECG electrodes 112 and 152. In other words, the ECG patch 100 does not include a separate bias electrode for exclusively supplying a bias voltage.

[0034] The ground of the battery 154 and the PCB ground VSS_{PCB} may be connected with each other through a third wire W3 and the fourth pad 121-4.

[0035] The second patch 150 may include the second electrode 152 and the battery 154. The second ECG signal detected by the second electrode 152 is transmitted to the high-pass filter 130 through the first wire W1. The high-pass filter 130 performs high-pass filtering on the second ECG signal to output the second high-pass filtered ECG signal ECG_N. The second high-pass filtered ECG signal ECG_N may be transmitted to the ECG sensor 123 through the second transmission line 122-2 and the second pad 121-2.

[0036] The cable 170 may include the first wire W1 for transmitting the second ECG signal detected by the second ECG electrode 152 placed in the second patch 150 to the first patch 110, the second wire W2 for transmitting the operating voltage VDD to the first patch 110, and the third wire W3 for transmitting a ground voltage to the first patch 110. The cable 170 may be a shielded cable.

[0037] FIG. 4 is a schematic diagram of the layout of the floating high-pass filter 130 and ECG transmission lines included in the first patch 110 of the wearable ECG patch 100 illustrated in FIG. 1, according to an exemplary embodiment of the inventive concept. Referring to FIG. 4, when the ECG patch 100 is implemented in a PCB including a plurality of layers LAYER1 through LAYER6, the ECG signal processing unit 120 may be placed at the first layer LAYER1 and the high-pass filter 130 may be placed at the sixth layer LAYER6, but the inventive concept is not limited to the current embodiment.

[0038] A first electrostatic discharge (ESD) protection circuit 140 may be placed between the electrodes 112 and 152 and the high-pass filter 130. The high-pass filter 130 may be placed as close as possible to the ECG sensor 123. A transmission line for supplying a ground voltage VSS may be placed at the fifth layer LAYER5. ESD protection circuits 140 and 142, the first transmission line 122-1 for transmitting the first high-pass filtered ECG signal ECG_P, and the second transmission line 122-2 for transmitting the second high-pass filtered ECG signal ECG_N may be placed at the sixth layer LAYER6, but the inventive concept is not limited to the current embodiment.

[0039] FIG. 5 is a schematic diagram of the layout of a PCB included in the first patch 110 of the wearable ECG patch 100 illustrated in FIG. 1, according to an exemplary embodiment of the inventive concept. Referring to FIG. 5, a transmission line for transmitting the first high-pass filtered ECG signal ECG_P and the high-pass filter 130 are placed at the sixth layer LAYER6, a transmission line 210 placed at the fifth layer LAYER5 to transmit a ground voltage may have a structure for shielding the transmission line for transmitting the first high-pass filtered ECG signal ECG_P to prevent coupling noise between digital lines 230 placed at the fourth layer LAYER4 and the transmission line placed at the sixth layer LAYER6 to transmit the first high-pass filtered ECG signal ECG_P. In addition, a shielding structure 220 or a shielding layer 220 may be placed between the digital lines 230 and the high-pass filter 130 to prevent coupling noise between the digital lines 230 and the high-pass filter 130.

[0040] FIG. 6 is a detailed block diagram of the wearable ECG patch illustrated in FIG. 1, according to an exemplary embodiment of the inventive concept. Referring to FIGS. 1, 2, 3, and 6, an ECG processing unit 120-1 may include an ECG sensor 123, an analog-to-digital converter (ADC) 410, a central processing unit (CPU) 420, a memory controller 430, an internal memory device 435, a security circuit 440, and a wireless transceiver 450. Referring to FIGS. 1,3, and 6, the ECG patch may include a memory device 460 and a sensor 470.

[0041] Referring to FIGS. 3 and 6, the ECG sensor 123 may receive a first high-pass filtered ECG signal ECG_P and a second high-pass filtered ECG signal ECG_N, process (or amplify) a voltage difference between the first high-pass filtered ECG signal ECG_P and the second high-pass filtered ECG signal ECG_N, and generate an ECG output corresponding to a result of the process (or amplification).

[0042] The ADC 410 may convert the ECG output into an ECG digital signal and output the ECG digital signal to the CPU 420. The CPU 420 may analyze a heart rhythm of a person using the ECG digital signal. The CPU 420 may detect, predict, or analyze sudden cardiac arrest (SCA) of a person using the ECG digital signal. For example, the CPU 420 may detect, predict, or analyze cardiac arrhythmias such as ventricular fibrillation and/or ventricular tachycardia using the ECG digital signal.

[0043] The memory controller 430, under the control of the CPU 420, may transmit data related to the high-pass filtered ECG signals ECG_P and ECG_N to the internal memory device 435 and/or the memory device 460 and receive data related to the high-pass filtered ECG signals ECG_P and ECG_N from the internal memory device 435 and/or the memory device 460.

[0044] The internal memory device 435 may be a read only memory (ROM), a random access memory (RAM), a dynamic RAM (DRAM), or a static RAM (SRAM), but is not limited thereto. The memory device 460 may store a boot image for booting the ECG patch 100 and an application program to be performed by the CPU 420. The memory device 460 may comprise a volatile memory and/or a non-volatile memory. The volatile memory may be a RAM, a DRAM, or an SRAM, but is not limited thereto. The non-volatile memory may be an electrically erasable programmable ROM (EEPROM), a NAND-type flash memory, a NOR-type flash memory, a magnetic RAM (MRAM), a spin-transfer torque MRAM, a ferroelectric RAM (FeRAM), a phase change RAM (PRAM), a resistive RAM (RRAM), a holographic memory, a molecular electronics memory device, or an insulator resistance change memory, but is not limited thereto.

[0045] The internal memory device 435 and/or the memory device 460 may store information on a person such as a patient (e.g., patient data) and/or data related to the high-pass filtered ECG signals ECG_P and ECG_N under the control of the memory controller 430. For example, the data may include high-pass filtered ECG signals ECG_P and ECG_N, data related to a heart rate, data related to cardiac arrhythmias, data related to ventricular fibrillation (e.g., a history of ventricular fibrillation and a history of defibrillation), and/or sensing data generated by the sensor 470. For example, the data may be encoded or decoded by the security circuit 440.

[0046] The security circuit 440 may encode data output from the CPU 420 and related to a heart rhythm into security data, and output the encoded security data to the wireless transceiver 450. In addition, the security circuit 440 may decode the data transmitted from the wireless transceiver 450 and transmit the decoded data to the CPU 420. For example, the security circuit 440 may be configured, e.g., programmed, with an encryption and decryption code.

[0047] The wireless transceiver 450 may transmit encoded security data output from the security circuit 440 to an external Internet of Things (IoT) device 500 (e.g., a wireless communication device, a smart watch, a smart phone, a tablet personal computer (PC), a wearable computer, a mobile internet device, etc.) under the control of the CPU 440. The ECG processing unit 120-1 may use a communication circuit, e.g., the wireless transceiver 450, for connecting to the external IoT device 500. For example, the ECG processing unit 120-1 may determine what kind of external smart device the communication circuit is connected to.

[0048] The wireless transceiver 450 may transmit data related to the high-pass filtered ECG signals ECG_P and ECG_N, e.g., security data or biological data, to the external IoT device 500 through a local area network (LAN), a wireless LAN (WLAN) such as wireless fidelity (Wi-Fi), a wireless personal area network (WPAN) such as Bluetooth, a wireless universal serial bus (USB), a Zigbee connection, a near field communication (NFC) connection, a radio-frequency identification (RFID) connection, or a mobile cellular network. For example, the mobile communication network may be a 3rd generation (3G) mobile communication network, a 4th generation (4G) mobile communication network, or a long term evolution mobile communication network (LTE™). For example, the wireless transceiver 450 may include a transceiver and an antenna for modem communication. The Bluetooth interface may support Bluetooth Low Energy (BLE).

[0049] FIG. 7 is a diagram of a data processing system which includes the ECG signal processing unit 120-1 shown in FIG. 6, according to an exemplary embodiment of the inventive concept. Referring to FIGS. 6 and 7, a user of a IoT device 500 may execute, e.g., select for use, an application installed in the IoT device 500 (S110).

[0050] A communication module (or wireless transceiver) of the IoT device 500 may transmit an information request to the ECG processing unit 120 or 120-1 (hereinafter collectively referred to as 120) under the control of the application performed by a CPU of the IoT device 500 (S120). A CPU 420 of the ECG processing unit 120, for example bio-processor 120, may require authentication by performing an information request through the wireless transceiver 450 (S130).

[0051] After the authentication is completed, the CPU 420 may read patient information and biological information from the memory device 435 or 460 using the memory controller 430, and transmit the patient information and the biological information to the wireless transceiver 450 through the security circuit 440. The wireless transceiver 450 may transmit the patient information and the biological information to the IoT device 500 through a wireless network (S140).

[0052] The application executed by a CPU included in the IoT device 500 may display patient information 520 and/or biological information 530 on a display device 510 of the IoT device 500 (S150). For example, the patient information 520 may include the age 521, blood type 522, family doctor (medical attendant) 523, and/or a medical history 524 of the patient. The biological information 530 may include heart rate 531 and an ECG waveform 532.

[0053] A user of the IoT device 500 may determine a state of a patient to which the wearable ECG patch 100 is attached using the patient information 520 and/or the biological information 530, and perform a proper medical treatment or emergency diagnosis on the patient according to a result of the determination.

[0054] FIGS. 8, 9, and 10 are diagrams illustrating data processing systems which include the wearable ECG patch shown in FIG. 1, according to exemplary embodiments of the inventive concept. Referring to FIG. 8, a data processing system 800A may be used to provide a telemedicine service. The data processing system 800A may include the wearable ECG patch 100 and a first medical server (health care sever) 820 which can communicate with the wearable ECG patch 100 through a wireless network 810, e.g., the internet or Wi-Fi.

[0055] According to one example, the data processing system 800A may further include a second medical server (health care server) 850 which can communicate with the wearable ECG patch 100 and/or the first medical server 820 through the wireless network 810. For example, a health insurance corporation and/or an insurance company may manage the second medical server 850 and a database 855.

[0056] The wireless transceiver 450 of the wearable ECG patch 100 may transmit data HDATA corresponding to the ECG signals ECG_P and ECG_N. The application may store a uniform resource locator (URL) of the first medical server 820 and/or a URL of the second medical server 850. Accordingly, the wireless transceiver 450 of the wearable ECG patch 100 may transmit data HDATA to the first medical server 820 (S801) and/or the second medical server 850 (S821) through the network 810 under the control of the CPU 420 or a control of an application program ("app") performed by the CPU 420.

[0057] The data HDATA may include the ECG signals ECG_P and ECG_N, data generated based on the ECG signals ECG_P and ECG_N, and patient information. For example, data generated based on the ECG signals ECG_P and ECG_N may include data on ventricular fibrillation, data on ventricular tachycardia, a heart rate, arrhythmia, or a defibrillation history of the patient, but is not limited thereto.

[0058] The wireless network 810 may transmit the data HDATA to the first medical server 820 and/or the second medical server 850 (S803 and/or S821). The first medical server 820 may store the data HDATA in database 821 (S804), and transmit the data HDATA to a computing device 845 of a doctor working at a medical institution 840 through a network 830 (S805). For example, the computing device 845 of a doctor may be a PC or a tablet PC, but is not limited thereto. The doctor may work at a medical institution, a public health care center, a clinic, a hospital, or a rescue center, for example.

[0059] The doctor may diagnose a state of the patient using the data HDATA displayed through the computing device 845 and input diagnostic data into the computing device 845 (S807). The computing device 845 transmits the diagnostic data DDATA to the first medical server 820 through the network 830 (S809), and the first medical server 820 stores the diagnostic data DDATA in the database 821 (S804) and transmits the diagnostic data DDATA to the network 810 (S811). The network 810 may transmit the diagnostic data DDATA to the wearable ECG patch 100 (S813) or to the second medical server 850 (S821). The ECG patch 100 may store the diagnostic data DDATA in the memory device 435 or 460. The second medical server 850 may store the diagnostic data DDATA in the database 855 (S823).

[0060] Each of the servers 820 and 850 may store or analyze each of the data HDATA and DDATA in the databases 821 and 855. In addition, each of the servers 820 and 850 may transmit a result of the analysis to the networks 810 and 830.

[0061] Referring to FIG. 9, a data processing system 800B may be used to provide a remote medical service. The data processing system 800B may include the wearable ECG patch 100, an IoT device 801 (for example a smart watch or a smart phone), and the first medical server 820 which can communicate with the IoT device 801 through the wireless network 810. The IoT device 801 may be the IoT device 500 of the examples shown in and described with reference to FIGS. 6 and 7, but is not limited thereto. The data processing system 800A of FIG. 9 is similar to the data processing system 800B of FIG. 8, in terms of its structure and operation, except for the IoT device 801 through which the wearable ECG patch 100 transmits or receives data to or from the wireless network 810.

[0062] The wearable ECG patch 100 may transmit data HDATA generated by the wearable ECG patch 100 to the IoT device 801 (S800). For example, the wearable ECG patch 100 may automatically transmit the data HDATA to the IoT device 801 according to a request of the IoT device 801 or when an abnormality is detected in the heart function of a patient (S800). The IoT device 801 may transmit the data HDATA to the network 810 (S801), and receive diagnostic data DDATA output from the network 810 (S813). The IoT device 801 may display the diagnostic data DDATA on a display of the IoT device 801. Accordingly, a user of the IoT device 801 may provide appropriate medical care to or perform first aid on a patient who wears the wearable ECG patch 100, using the diagnostic data DDATA.

[0063] Referring to FIG. 10, a data processing system 900 may be used to provide a remote medical service. The data processing system 900 may include the wearable ECG patch 100 and a mobile computing device 910 which can communicate with the wearable ECG patch 100 through a network 905. The data processing system 900 may further include a medical server (health care server) 915 which can communicate with the mobile computing device 910 through a network 912.

[0064] The wireless transceiver 450 of the wearable ECG patch 100 may transmit data HDATA corresponding to the ECG signals ECG_P and ECG_N to the mobile computing device 910 through the network 905 under the control of the CPU 420 or a control of an app performed by the CPU 420 (S901).

[0065] For example, the mobile computing device 910 may be a smart phone, a tablet PC, a minimally invasive device (MID), an IoT device, or an internet of everything (IoE) device, but is not limited thereto. A user of the mobile computing device 910 which can perform an app to be described with reference to FIG. 10 may be a medical team, a guardian, or a passerby. The passerby may be someone who has completed first aid training; however, the inventive concept is not limited thereto.

[0066] An app performed by a CPU of the mobile computing device 910 may be represented by an icon(s), interface, etc. displayed on a display of the mobile computing device 910. The mobile computing device 910 may transmit the data HDATA to the medical server 915 through the network 912 under the control of the app (S903 and S905). The mobile computing device 910 stores a URL of the medial server 915, such that the mobile computing device 910 may transmit the data HDATA to the medical server 915 corresponding to a URL under the control of an app (S903 and S905).

[0067] The medical server 915 may store the data HDATA in the database 917 (S906), and transmit the data HDATA to a computing device 925 of a doctor working at a medical institution 920 through a network 914.

[0068] The doctor may diagnose a state of a patient using the data HDATA displayed through the computing device 925 and input diagnostic data into the computing device 925 (S907). The computing device 925 may transmit the diagnostic data DDATA to the medical server 915 through the network 914, and the medical server 915 may store the diagnostic data DDATA in the database 917 (S906), and transmit the diagnostic data DDATA to the mobile computing device 910 through the network 912 (S909 and S911). The mobile computing device 910 may display the diagnostic data DDATA of the doctor on a display of the mobile computing device 910. Accordingly, a user of the mobile computing device 910 may provide appropriate medical care to or perform first aid on a patient who wears the wearable ECG patch 100, using the diagnostic data DDATA.

[0069] As described above, according to an exemplary embodiment of the inventive concept, an ECG patch includes two electrodes and a floating high-pass filter but does not include a bias electrode for applying a bias voltage to a human body. To generate the bias voltage, the ECG patch uses the high-pass filter, and applies the bias voltage to the human body through the ECG electrodes. In other words, since the ECG patch does not include a bias electrode, a form factor for the ECG patch is reduced in size. Further, since the ECG patch has a minimum number of electrodes, a contact area between the ECG patch and the skin is minimized, so that the convenience of attaching/detaching the ECG patch to the skin increases and an area of the skin impacted by the attached electrodes is also minimized.

[0070] While the inventive concept has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in forms and details may be made therein without departing from the spirit and scope of the inventive concept as defined by the following claims.

Claims

1. An electrocardiograph (ECG) patch, comprising:

a first electrode;
a second electrode;
a high pass filter configured to receive a bias voltage and provide the bias voltage to the first electrode and the second electrode; and
a signal processing unit configured to generate the bias voltage and provide the bias voltage to the high pass filter.

2. The ECG patch of claim 1, wherein the signal processing unit comprises:

a voltage regulator configured to receive an operating voltage;
a voltage divider configured to divide the voltage that has been regulated by the voltage regulator to generate the bias voltage; and
a driver configured to drive the bias voltage to the high pass filter.

3. The ECG patch of claim 2, wherein the driver is a current driver.

4. The ECG patch of claim 2 or 3, wherein the operating voltage is provided from a battery to the voltage regulator.

5. The ECG patch of any one of claims 1 to 4, wherein the high pass filter is a floating high pass filter.

6. An electrocardiograph (ECG) patch, comprising:

a first patch including a first electrode, a high pass filter and an ECG signal processing unit;
a second patch including a second electrode and a battery; and
a cable including a first wire for providing a bias voltage from the first patch to the second electrode, a second wire for providing an operating voltage to the second patch and a third wire for providing a ground voltage to the second patch.

7. The ECG patch of claim 6, wherein the ECG signal processing unit comprises:

a voltage regulator configured to receive the operating voltage;
a voltage divider configured to divide the voltage that has been regulated by the voltage regulator to generate the bias voltage; and
a driver configured to drive the bias voltage to the high pass filter.

8. The ECG patch of claim 6 or 7, wherein the high pass filter is configured to receive the bias voltage from the ECG signal processing unit, provide the bias voltage to the first electrode and provide the bias voltage to the second electrode through the first wire.

9. The ECG patch of any one of claims 6 to 8, wherein the high pass filter is configured to perform a high pass filtering on a first ECG signal detected by the first electrode to generate a first high pass signal, and to perform a high pass filtering on a second ECG signal detected by the second electrode to generate a second high pass signal, and
wherein the ECG signal processing unit is configured to generate an ECG output signal based on a difference between the first high pass filtered ECG signal and the second high pass filtered ECG signal.

10. The ECG of any one of claims 6 to 9, wherein the first patch includes a printed circuit board having a plurality of layers, and wherein the ECG signal processing unit is disposed at a first layer of the plurality of layers and the high pass filter is disposed at a last layer of the plurality of layers.

11. The ECG of claim 10, wherein the ECG signal processing unit and the high pass filter are disposed opposite each other.

12. The ECG of claim 10 or 11, wherein a transmission line for transmitting a ground voltage is configured to shield a transmission line for transmitting a first high pass filtered signal.

13. The ECG of claim 12, wherein a shielding layer is disposed between the high pass filter and signal lines of the ECG signal processing unit.

14. An electrocardiograph (ECG) patch, comprising:

a first electrode configured to detect a first ECG signal;
a second electrode configured to detect a second ECG signal;
a high-pass filter configured to perform high-pass filtering on the first ECG signal to generate a first high-pass filtered signal, and to perform high-pass filtering on the second ECG signal to generate a second high-pass filtered signal; and
a signal processing unit configured to generate an ECG output signal based on a difference between the first ECG signal and the second ECG signal,
wherein the high-pass filter is further configured to generate a first bias voltage based on a driving voltage and provide the first bias voltage to the first electrode, and to generate a second bias voltage based on the driving voltage and provide the second bias voltage to the second electrode.

15. The ECG patch of claim 14, wherein the first bias voltage and the second bias voltage have the same level.

16. The ECG patch of claim 14 or 15, wherein the first ECG signal is detected when the first bias voltage is applied to a person's body and the second ECG signal is detected when the second bias voltage is applied to the person's body.

17. The ECG patch of any one of claims 14 to 16, wherein the high-pass filter is a floating high-pass filter.

18. The ECG patch of any one of claims 14 to 17, wherein the high-pass filter comprises:

a first capacitor connected between a first transmission line and a third transmission line, wherein the first transmission line is connected to a first pad of the signal processing unit;
a second capacitor connected between a first wire and a second transmission line, wherein the second capacitor is connected to a second pad of the signal processing unit;
a first resistor connected between the third transmission line and a first node connected to a fifth pad of the signal processing unit;
a second resistor connected between the first transmission line and the first node;
a third resistor connected between the first node and the second transmission line; and
a fourth resistor connected between the first node and the first wire.

19. The ECG patch of claim 18, wherein the first and second capacitors have the same capacitances as each other and the first to fourth resistors have the same resistances as each other.

20. The ECG patch of claim 18 or 19, wherein the signal processing unit comprises:

a voltage regulator connected to a third pad of the signal processing unit and configured to receive an operating voltage via the third pad and regulate the operating voltage, wherein the third pad is connected to a second wire;
a voltage divider configured to divide the voltage that has been regulated by the voltage generator to generate a driving voltage; and
a driver configured to drive the driving voltage and provide the driving voltage to the high-pass filter through the fifth pad.

FIG. 1

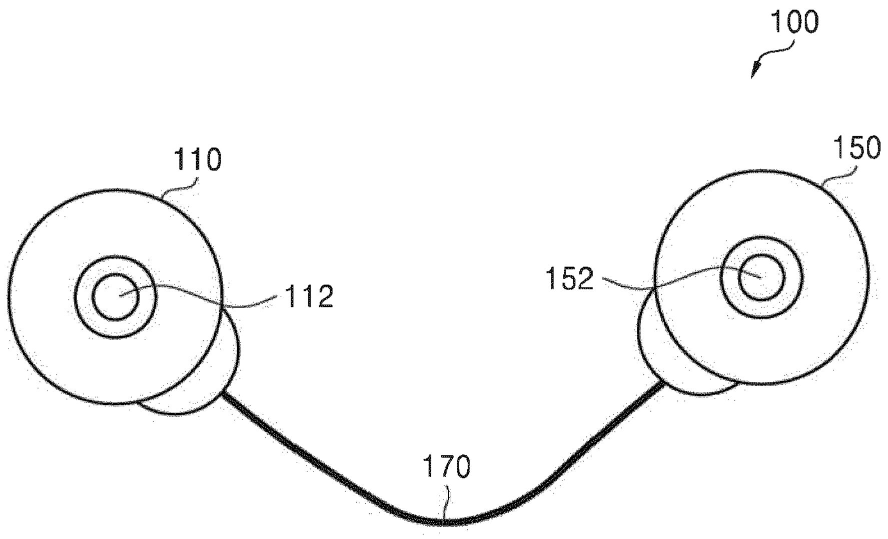


FIG. 2

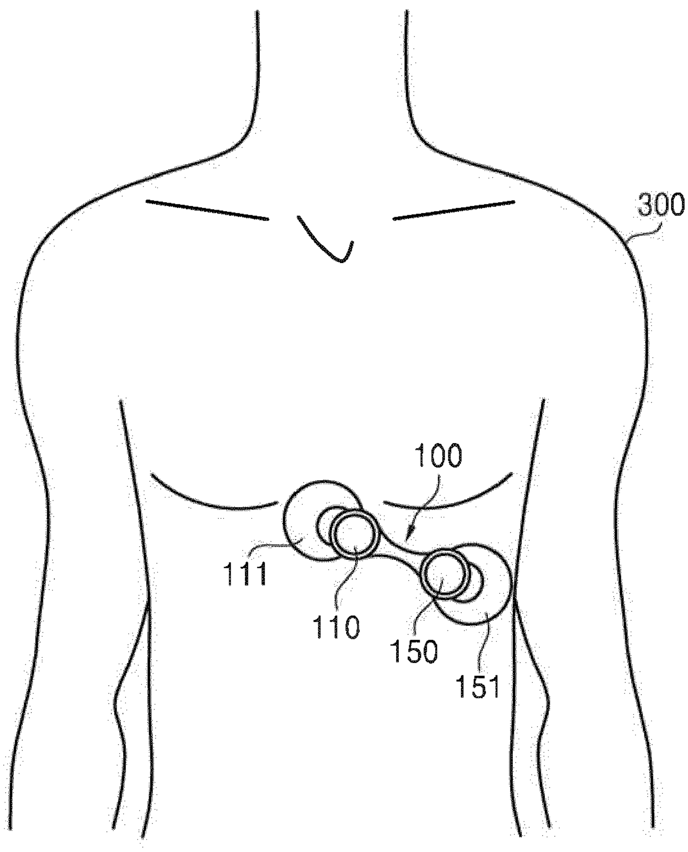


FIG. 3

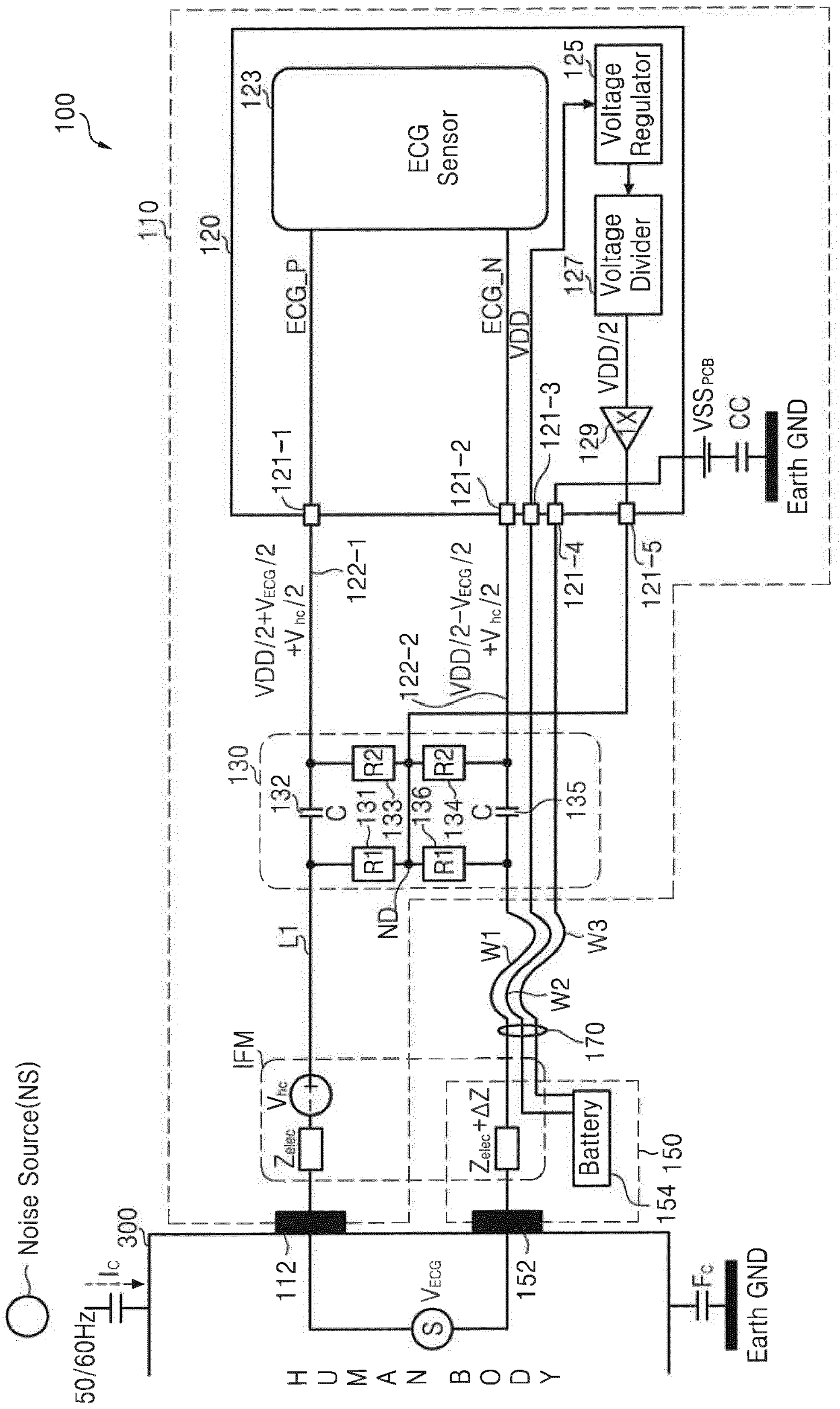

100
110
120
123
ECG Sensor
125
Voltage Regulator
127
Voltage Divider
ECG_P
ECG_N
VDD
VDD/2
129
X
VSS PCB
CC
Earth GND
121-1
121-2
121-3
121-4
121-5
122-1
122-2
VDD/2+VECG/2 +Vnc/2
VDD/2−VECG/2 +Vnc/2
130
132
C
131
133
R1
R2
136
134
135
ND
L1
W1
W2
W3
170
IFM
Vnc
Zelec
Zelec+ΔZ
Battery
154
150
Noise Source(NS)
300
Ic
50/60Hz
112
152
VECG
S
HUMAN BODY
Fc
Earth GND

FIG. 4

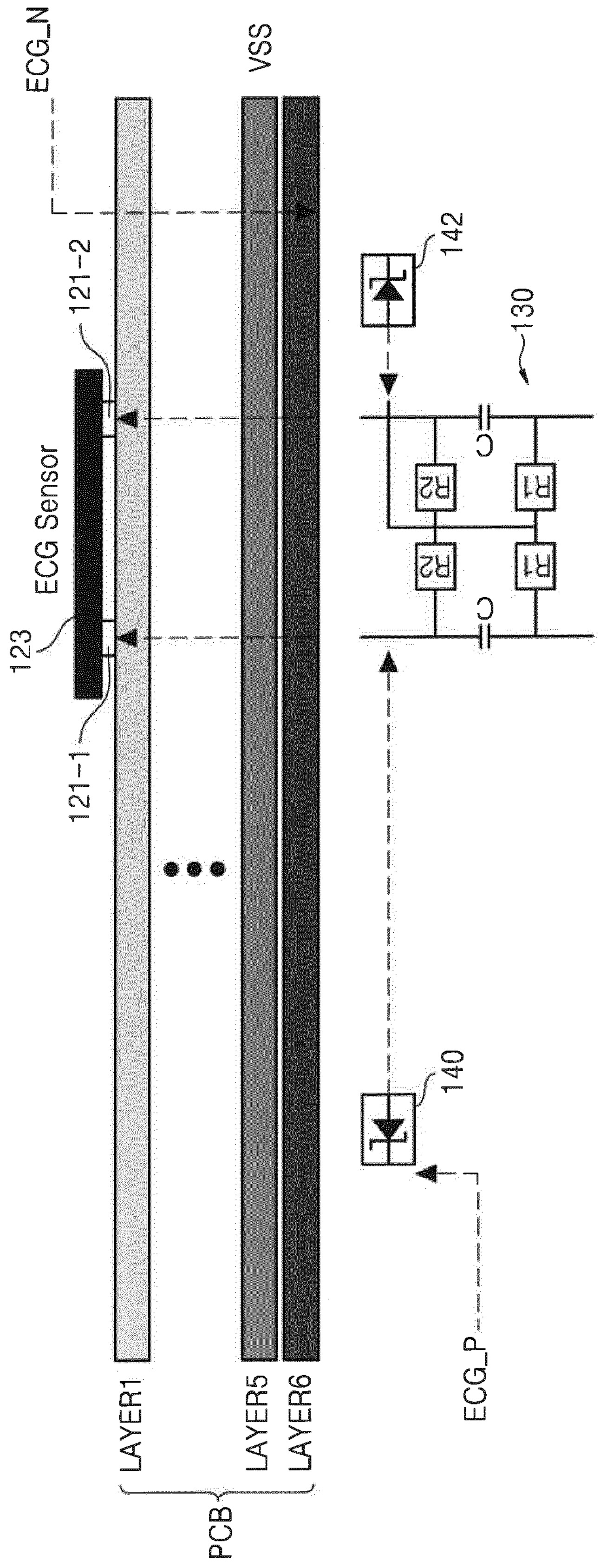

ECG_N
VSS
121-2
ECG Sensor
123
121-1
142
130
R2
R2
R1
R1
C
C
140
LAYER1
LAYER5
LAYER6
PCB
ECG_P

FIG. 5

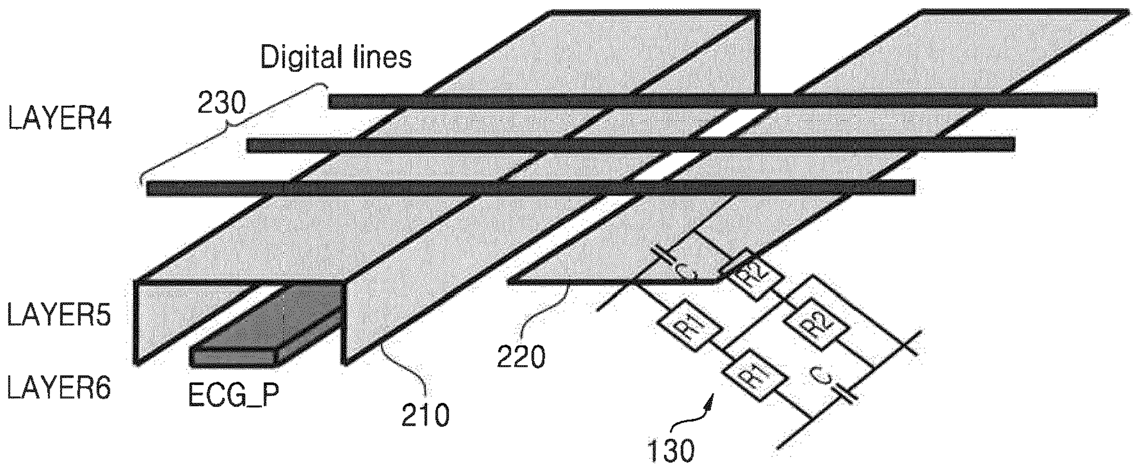

Digital lines
230
LAYER4
LAYER5
LAYER6
ECG_P
210
220
C
R2
R1
R2
R1
C
130

FIG. 6

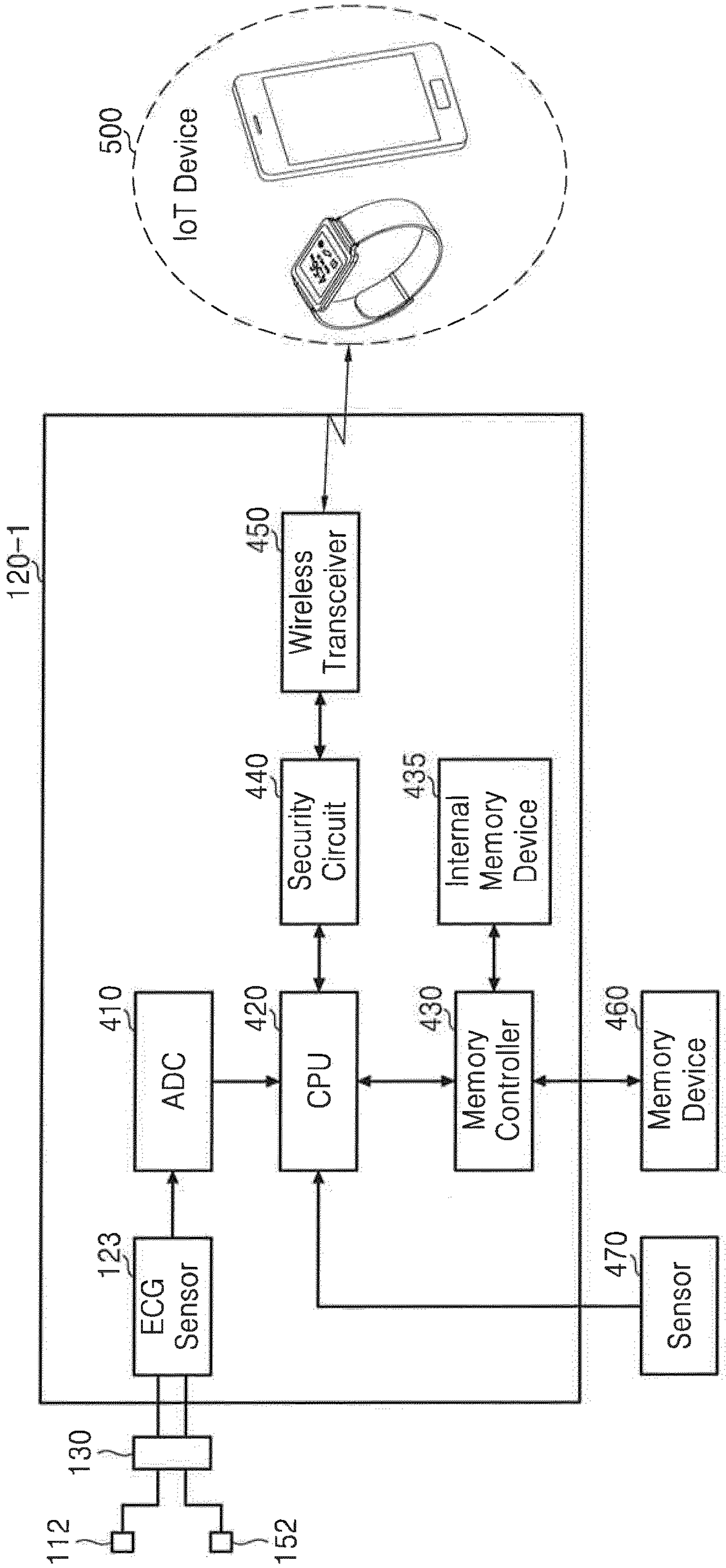

500
IoT Device
120-1
450
Wireless Transceiver
440
Security Circuit
435
Internal Memory Device
410
ADC
420
CPU
430
Memory Controller
460
Memory Device
123
ECG Sensor
470
Sensor
130
112
152

FIG. 7

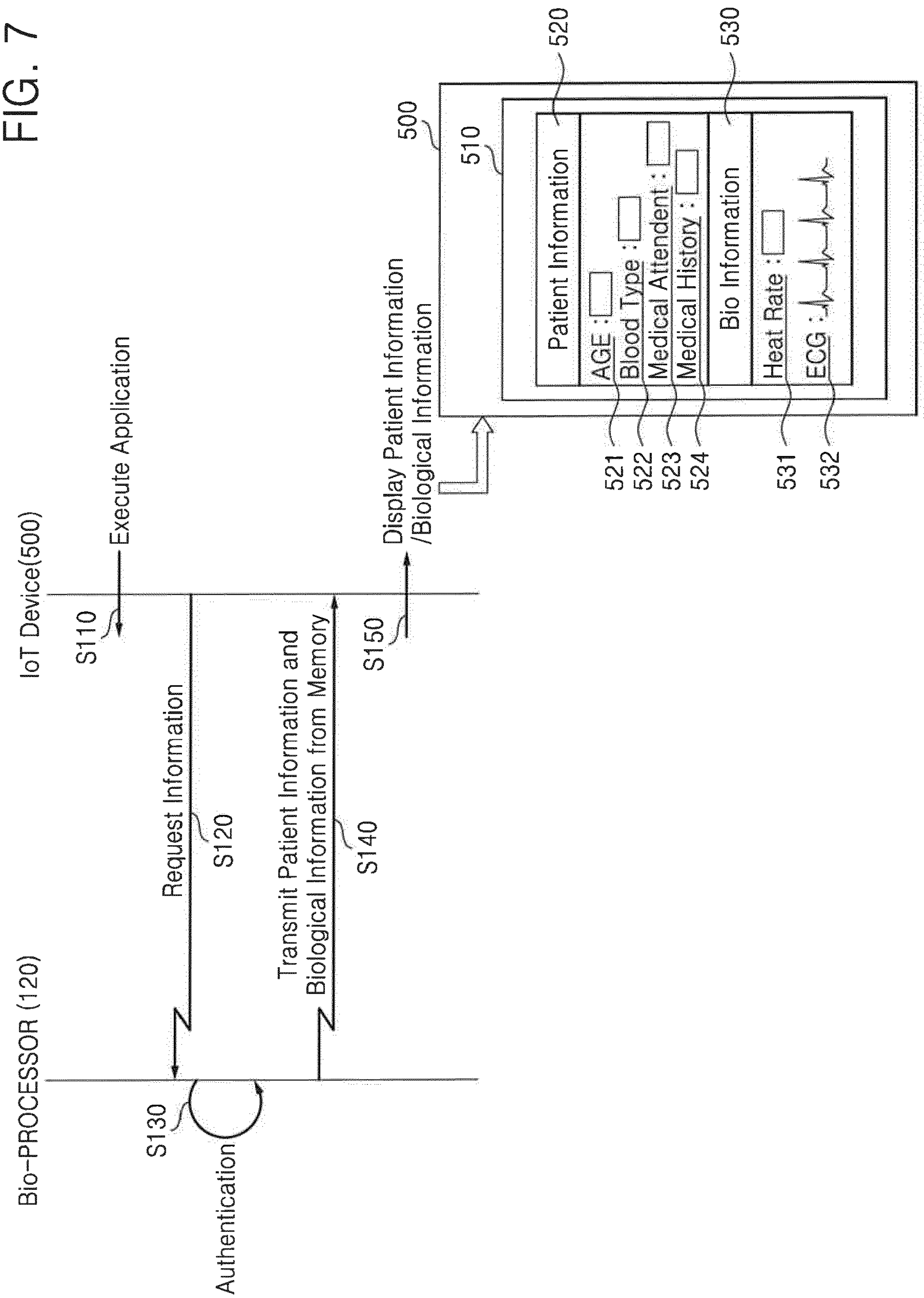

Bio-PROCESSOR (120)
IoT Device(500)
Execute Application
S110
Request Information
S120
S130
Authentication
Transmit Patient Information and Biological Information from Memory
S140
S150
Display Patient Information /Biological Information
500
510
520
530
Patient Information
AGE :
Blood Type :
Medical Attendent :
Medical History :
Bio Information
Heat Rate :
ECG :
521
522
523
524
531
532

FIG. 8

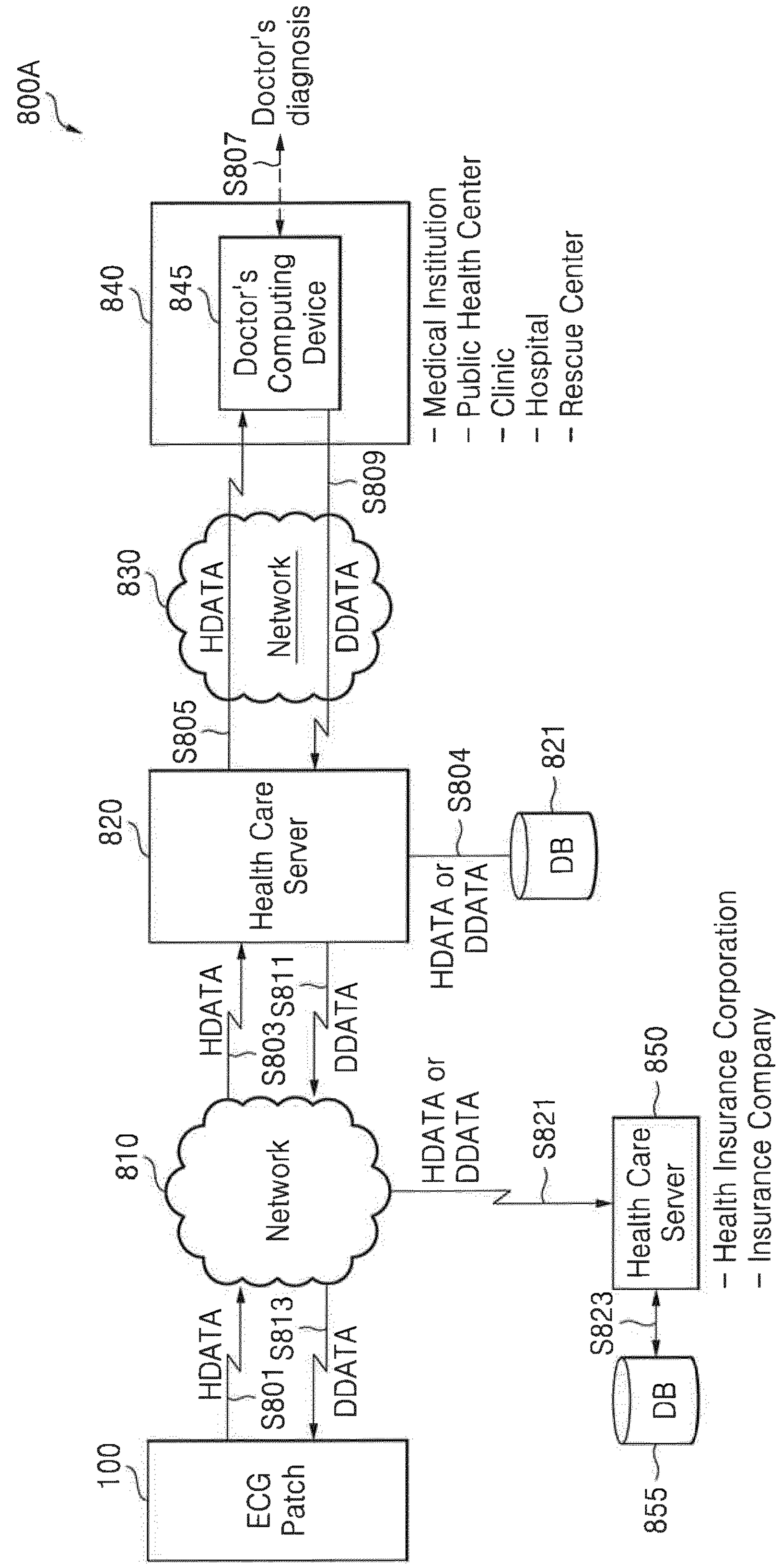
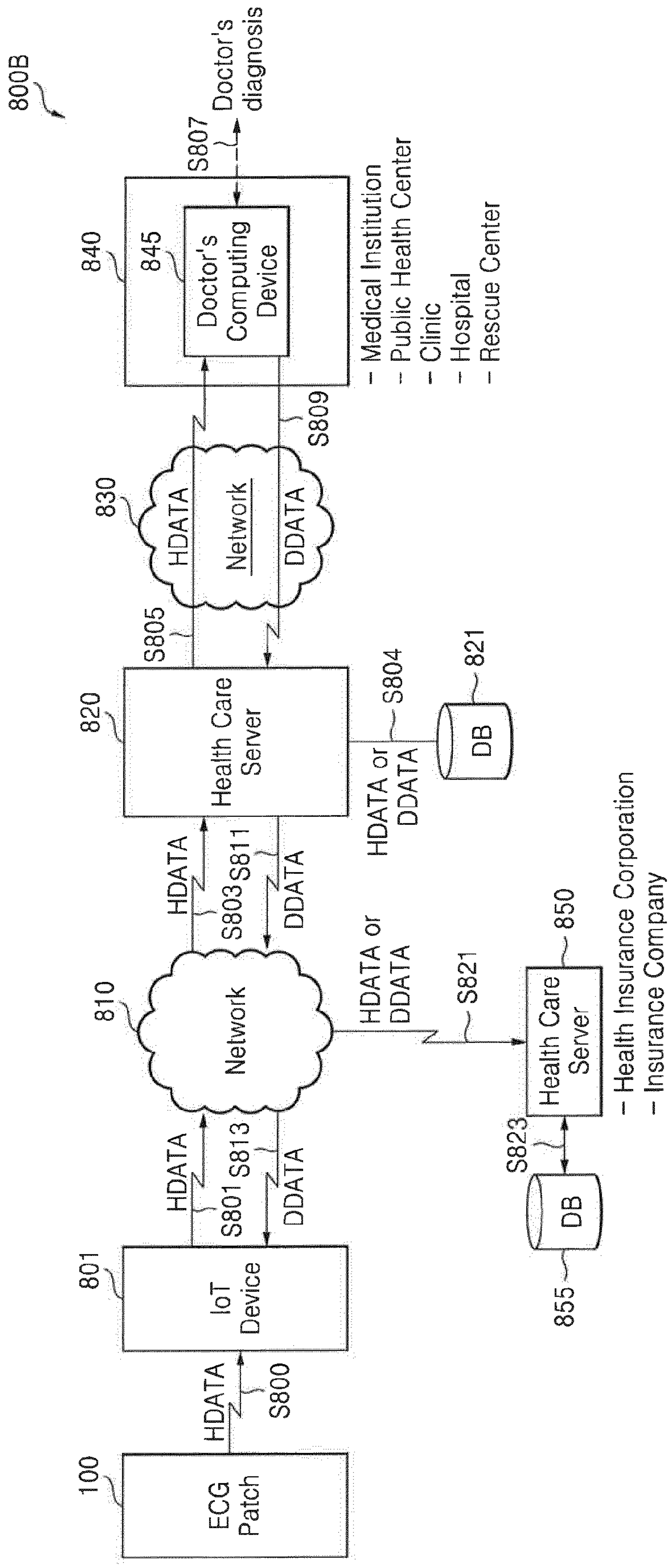
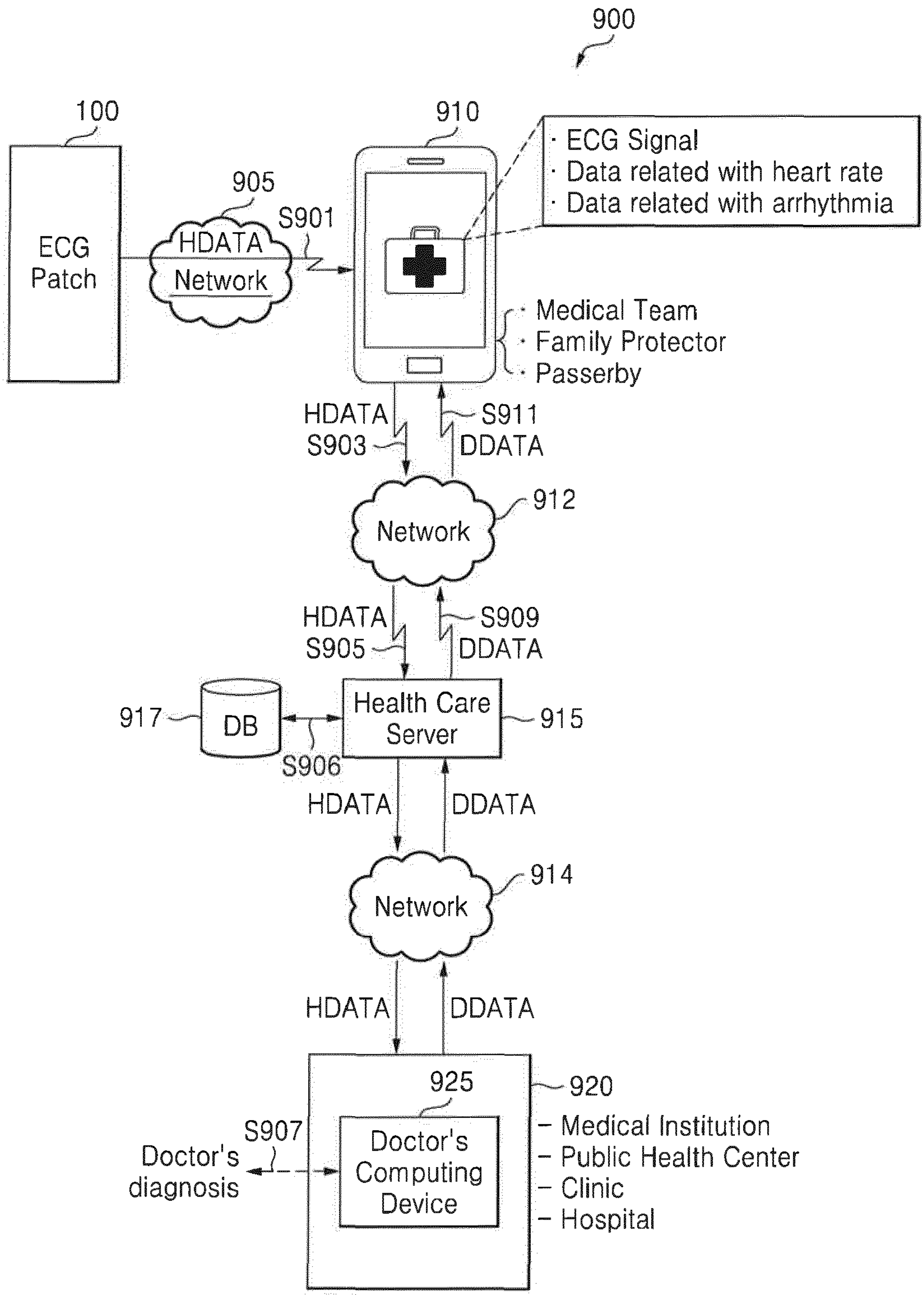

800A
100
ECG Patch
HDATA
S801
S813
DDATA
810
Network
HDATA
S803
S811
DDATA
820
Health Care Server
S804
HDATA or DDATA
DB
821
S805
830
HDATA
Network
DDATA
S809
840
845
Doctor's Computing Device
S807
Doctor's diagnosis
- Medical Institution
- Public Health Center
- Clinic
- Hospital
- Rescue Center
HDATA or DDATA
S821
850
Health Care Server
- Health Insurance Corporation
- Insurance Company
S823
DB
855

FIG. 9



800B
ECG Patch
100
HDATA
S800
IoT Device
801
HDATA
S801
S813
DDATA
Network
810
HDATA
S803
S811
DDATA
HDATA or DDATA
S821
Health Care Server
850
- Health Insurance Corporation
- Insurance Company
S823
DB
855
Health Care Server
820
HDATA or DDATA
S804
DB
821
S805
HDATA
Network
DDATA
830
S809
Doctor's Computing Device
845
840
S807
Doctor's diagnosis
- Medical Institution
- Public Health Center
- Clinic
- Hospital
- Rescue Center

FIG. 10


900
100
ECG Patch
905
HDATA Network
S901
910
· ECG Signal
· Data related with heart rate
· Data related with arrhythmia
· Medical Team
· Family Protector
· Passerby
HDATA
S903
S911
DDATA
Network
912
HDATA
S905
S909
DDATA
917
DB
S906
Health Care Server
915
HDATA
DDATA
Network
914
HDATA
DDATA
925
920
Doctor's Computing Device
S907
Doctor's diagnosis
- Medical Institution
- Public Health Center
- Clinic
- Hospital

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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 9339

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	US 2014/221850 A1 (FARRINGDON JONATHAN [US] ET AL) 7 August 2014 (2014-08-07) * abstract; figures 4-13-23 * * paragraphs [0024] - [0030], [0077] - [0094], [0184] - [0195] *	1-5, 14-20 6-13	INV. A61B5/0408 A61B5/0428 A61B5/00
X A	US 2011/009729 A1 (SHIN SEUNGCHUL [KR] ET AL) 13 January 2011 (2011-01-13) * abstract; figures 1-14 * * paragraphs [0023] - [0082] *	6-13 1-5, 14-20	
A	US 2008/150631 A1 (KIM JONG PAL [KR] ET AL) 26 June 2008 (2008-06-26) * abstract; figure 1 * * paragraphs [0010] - [0013], [0017] - [0018], [0021] - [0056] *	1-20	
A	KR 2012 0097997 A (LAXTHA [KR]) 5 September 2012 (2012-09-05) * abstract; figure 6 * * paragraphs [0047] - [0057] *	1-20	

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A61B H03F A61N

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	31 March 2017	Carta, Riccardo

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 16 19 9339

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31-03-2017

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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patsnap

专利名称(译)	贴片包括外部浮动高通滤波器和包括其的心电图（ECG）贴片		
公开(公告)号	EP3170450A1	公开(公告)日	2017-05-24
申请号	EP2016199339	申请日	2016-11-17
[标]申请(专利权)人(译)	三星电子株式会社		
申请(专利权)人(译)	SAMSUNG ELECTRONICS CO.，LTD.		
当前申请(专利权)人(译)	SAMSUNG ELECTRONICS CO.，LTD.		
[标]发明人	YAN LONG BAEK MIN GUN JO HEE JAE		
发明人	YAN, LONG BAEK, MIN GUN JO, HEE JAE		
IPC分类号	A61B5/0408 A61B5/0428 A61B5/00		
CPC分类号	A61B5/04017 A61B5/04085 A61B5/04087 A61B5/0428 A61B5/04282 A61B5/6823 A61B5/6832 A61B5/7203 A61B5/725 A61B2560/0412 A61B2560/0468 A61B2562/222		
优先权	62/256951 2015-11-18 US 1020160028210 2016-03-09 KR		
其他公开文献	EP3170450B1		
外部链接	Espacenet		

摘要(译)

一种心电图（ECG）贴片，包括：第一电极;第二个电极;高通滤波器，被配置为接收偏置电压并向第一电极和第二电极提供偏置电压;信号处理单元，被配置为产生偏置电压并将偏置电压提供给高通滤波器。

FIG. 2