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(54) **REGIONAL OXIMETRY POD**

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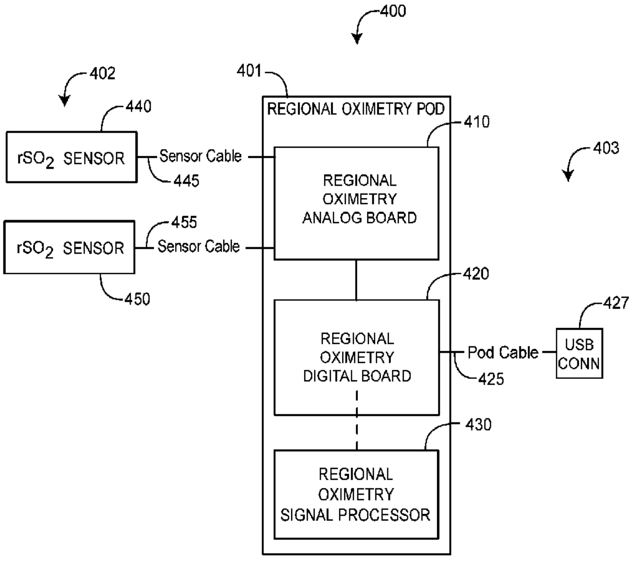
(57) **ABSTRACT**

A regional oximetry pod drives optical emitters on regional oximetry sensors and receives the corresponding detector signals in response. The sensor pod has a dual sensor connector configured to physically attach and electrically connect one or two regional oximetry sensors. The pod housing has a first housing end and a second housing end. The dual sensor connector is disposed proximate the first housing end. The housing at least partially encloses the dual sensor connector. A monitor connector is disposed proximate a second housing end. An analog board is disposed within the pod housing and is in communications with the dual sensor connector. A digital board is disposed within the pod housing in communications with the monitor connector.

16 Claims, 15 Drawing Sheets



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See application file for complete search history.

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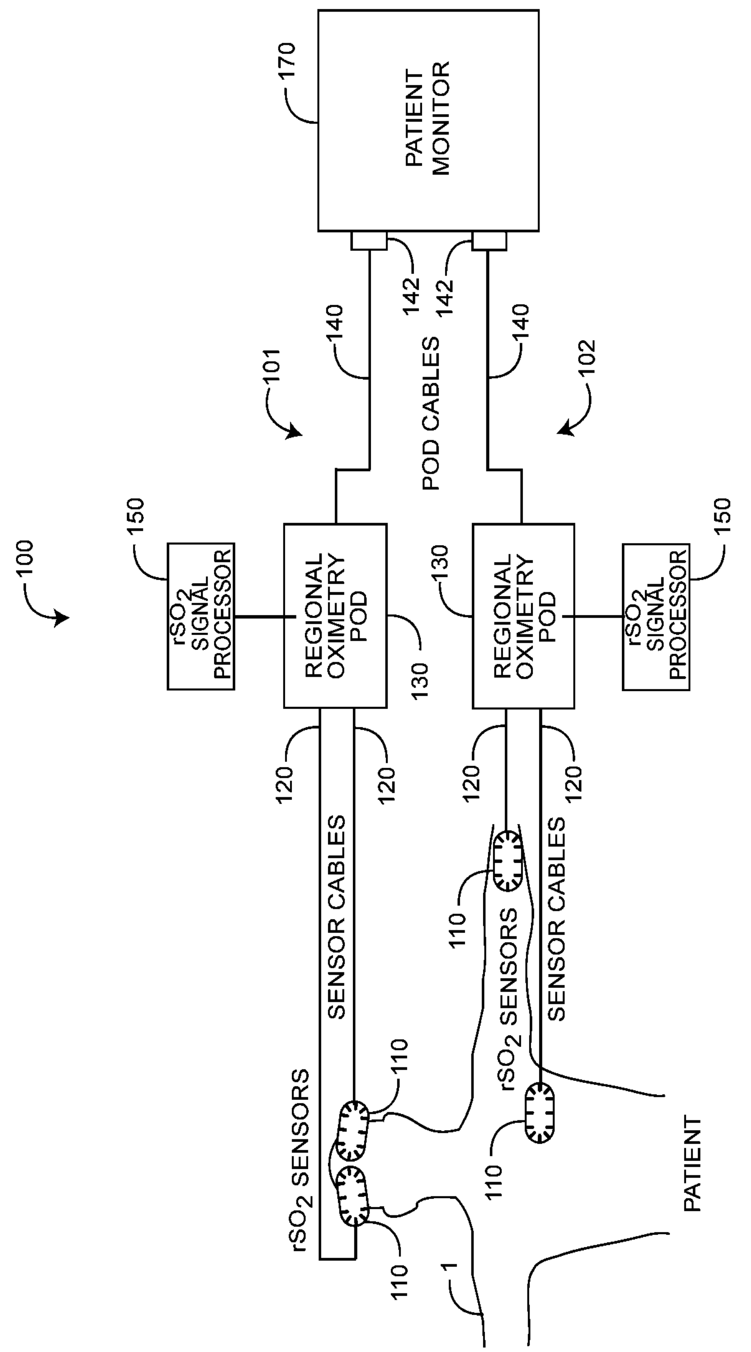
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142
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140
101
102
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rSO2 SIGNAL PROCESSOR
REGIONAL OXIMETRY POD
REGIONAL OXIMETRY POD
130
130
120
120
120
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SENSOR CABLES
rSO2 SENSORS
rSO2 SENSORS
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110
110
110
1
PATIENT

FIG. 1

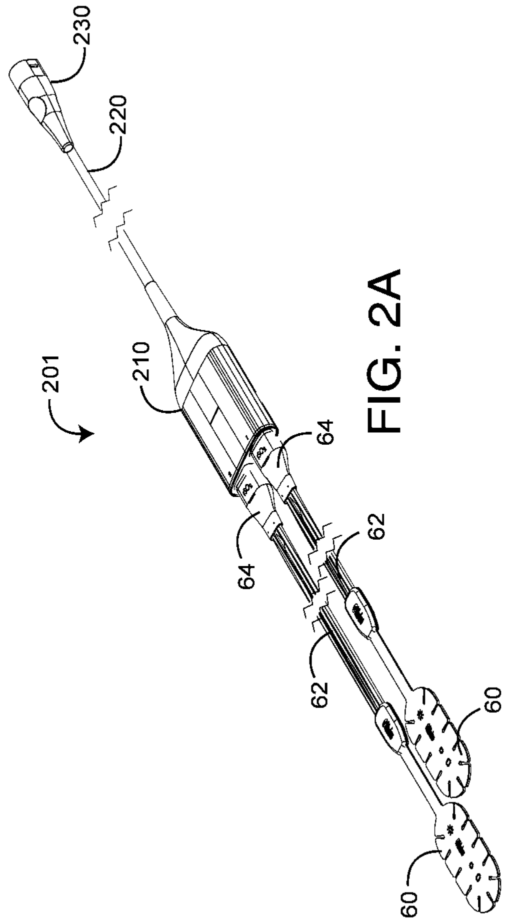
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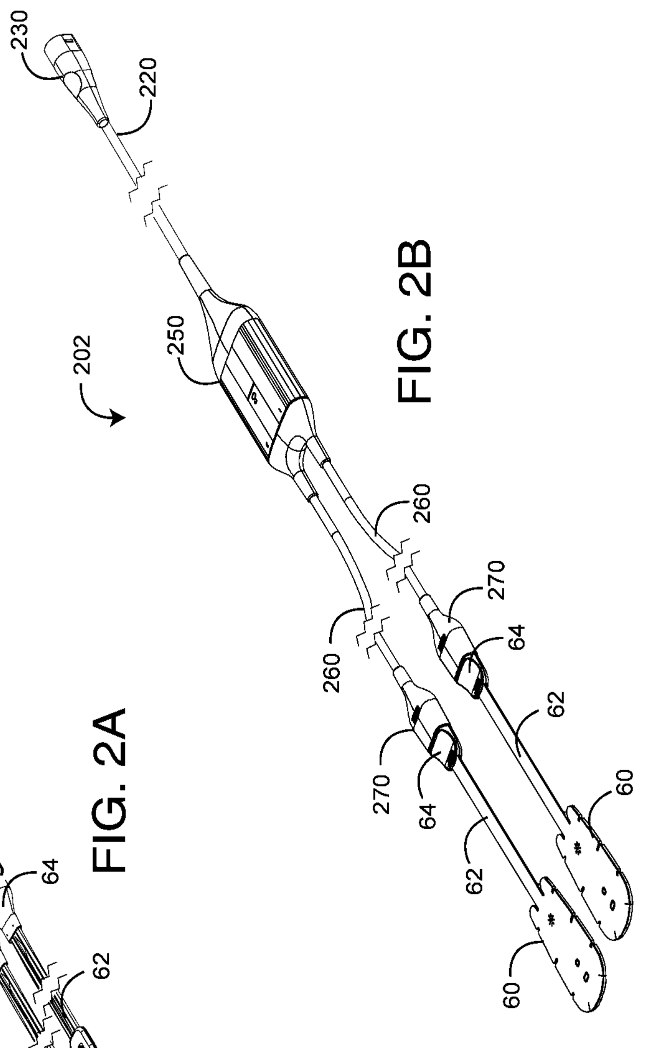
FIG. 2A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62
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60

FIG. 2B

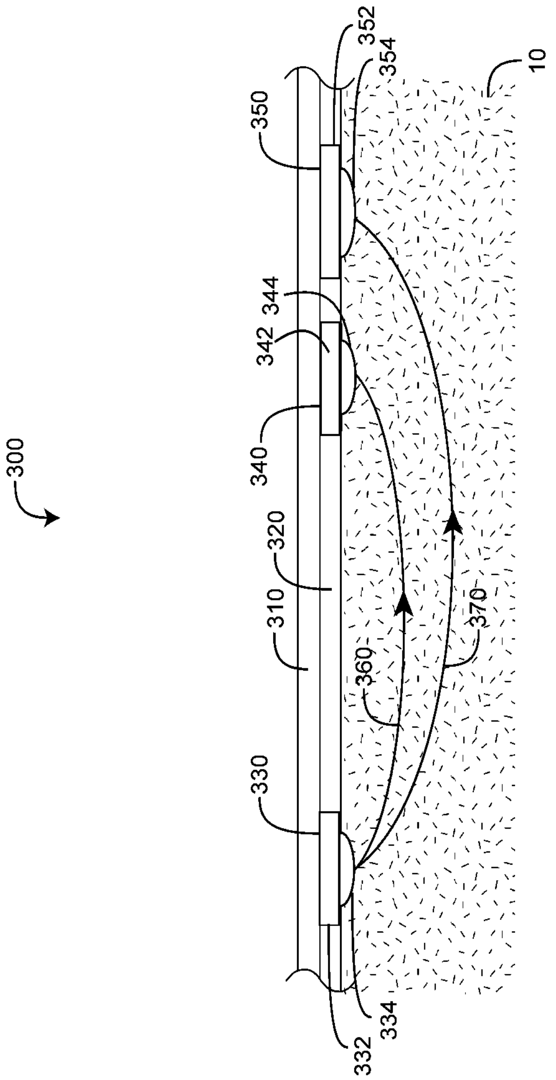

FIG. 3

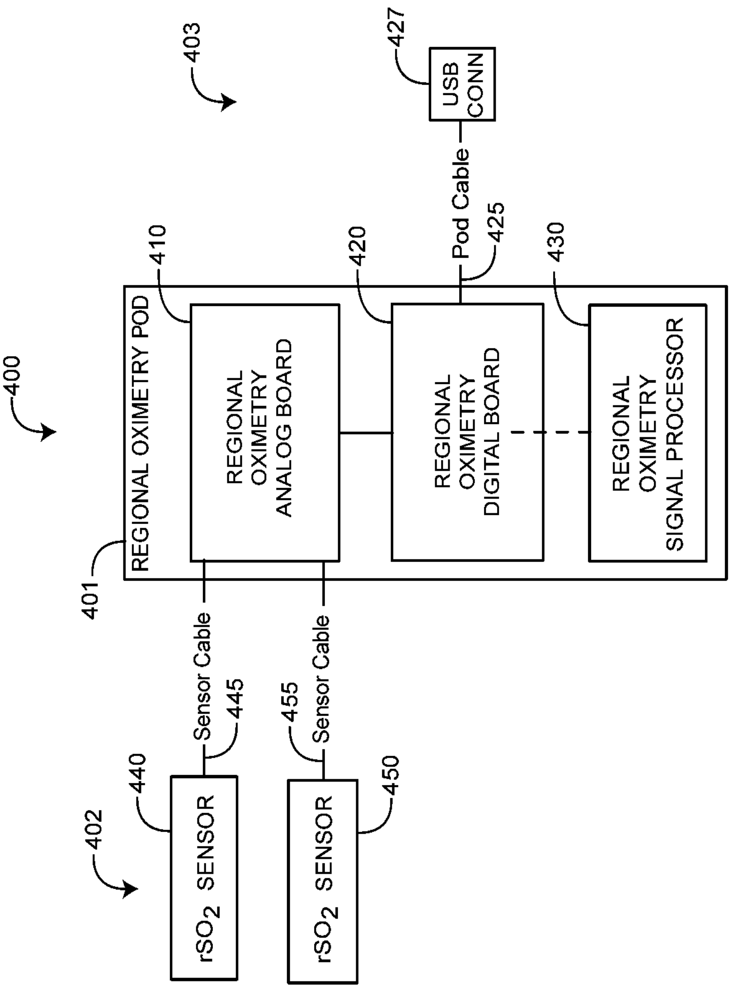
400
401
REGIONAL OXIMETRY POD
410
REGIONAL OXIMETRY ANALOG BOARD
420
REGIONAL OXIMETRY DIGITAL BOARD
430
REGIONAL OXIMETRY SIGNAL PROCESSOR
425
Pod Cable
427
USB CONN
403
402
440
rSO_2 SENSOR
445
Sensor Cable
450
rSO_2 SENSOR
455
Sensor Cable

FIG. 4

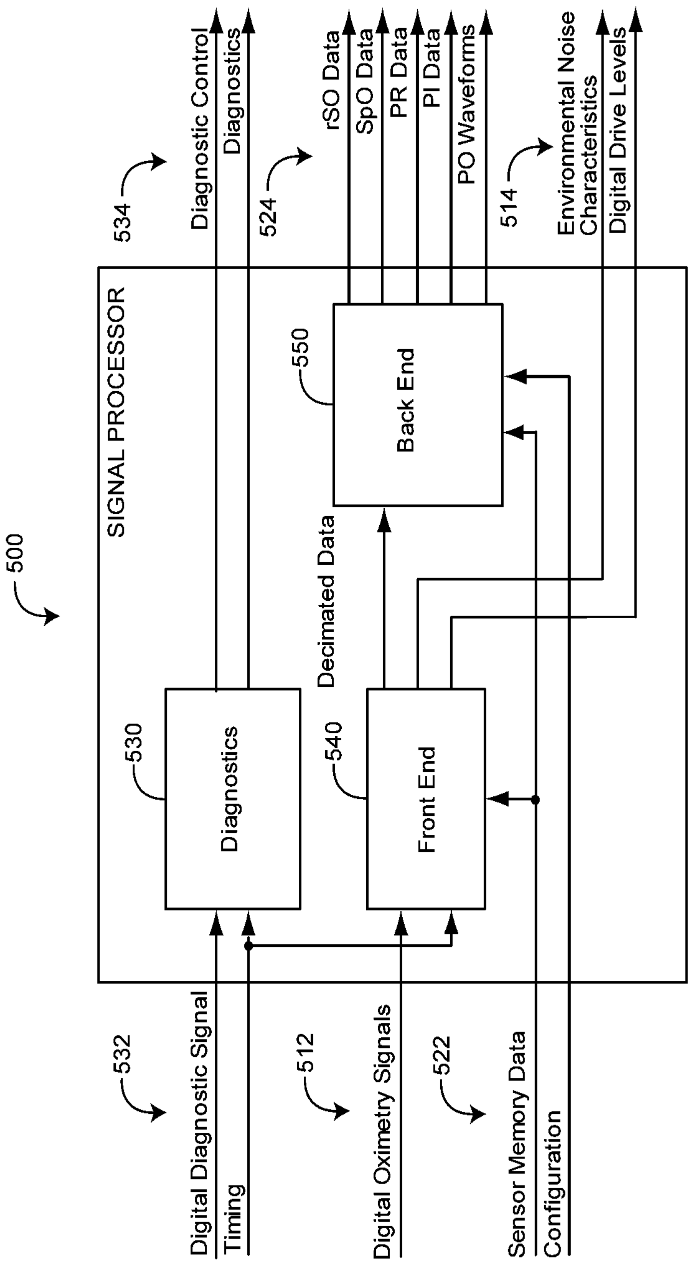
500
SIGNAL PROCESSOR
532
Digital Diagnostic Signal
Timing
512
Digital Oximetry Signals
522
Sensor Memory Data
Configuration
530
Diagnostics
540
Front End
Decimated Data
550
Back End
534
Diagnostic Control
Diagnostics
524
rSO Data
SpO Data
PR Data
PI Data
PO Waveforms
514
Environmental Noise Characteristics
Digital Drive Levels

FIG. 5

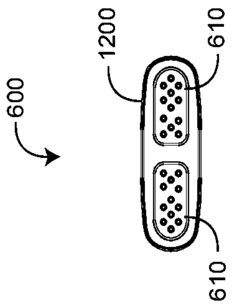

FIG. 6C

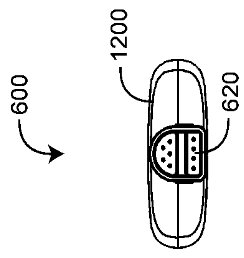

FIG. 6D

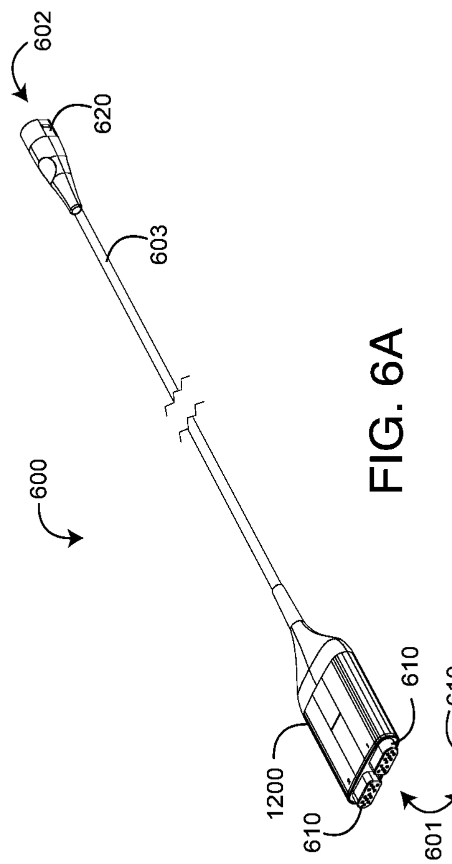

FIG. 6A

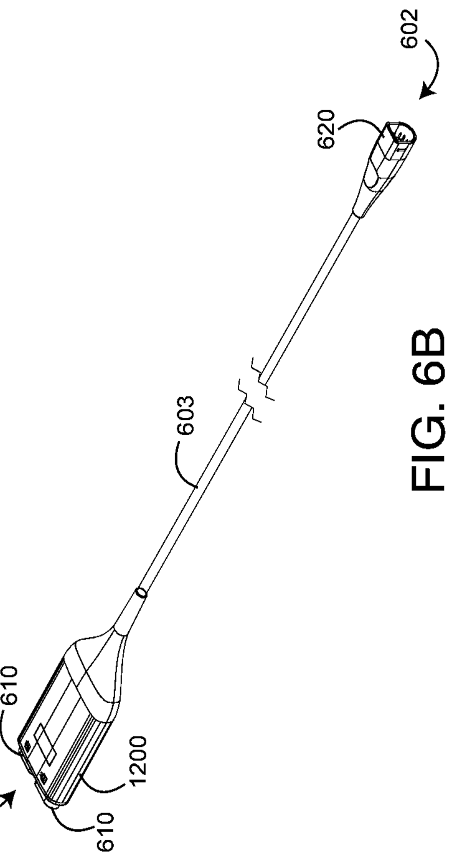

FIG. 6B

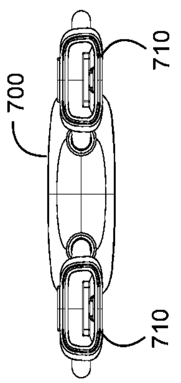

FIG. 7C

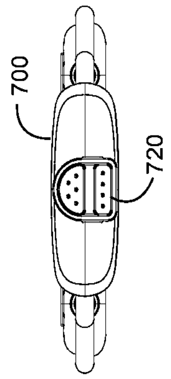

FIG. 7D

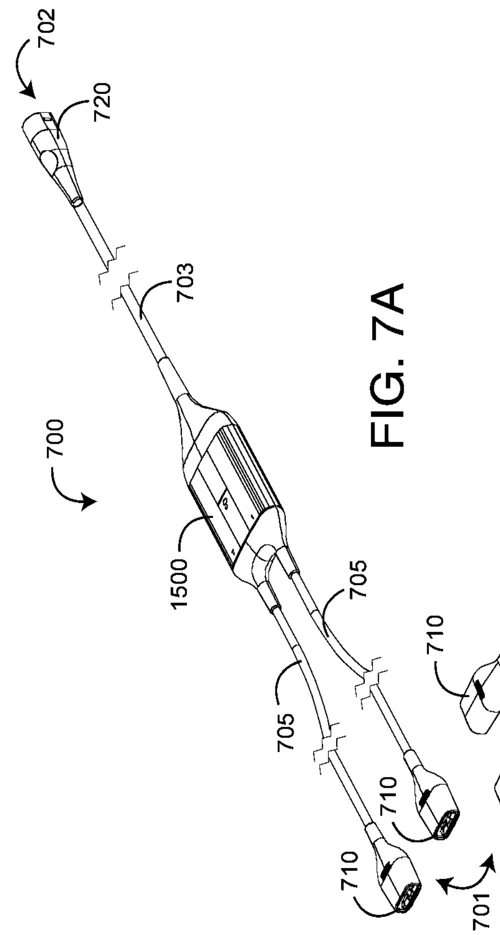

FIG. 7A

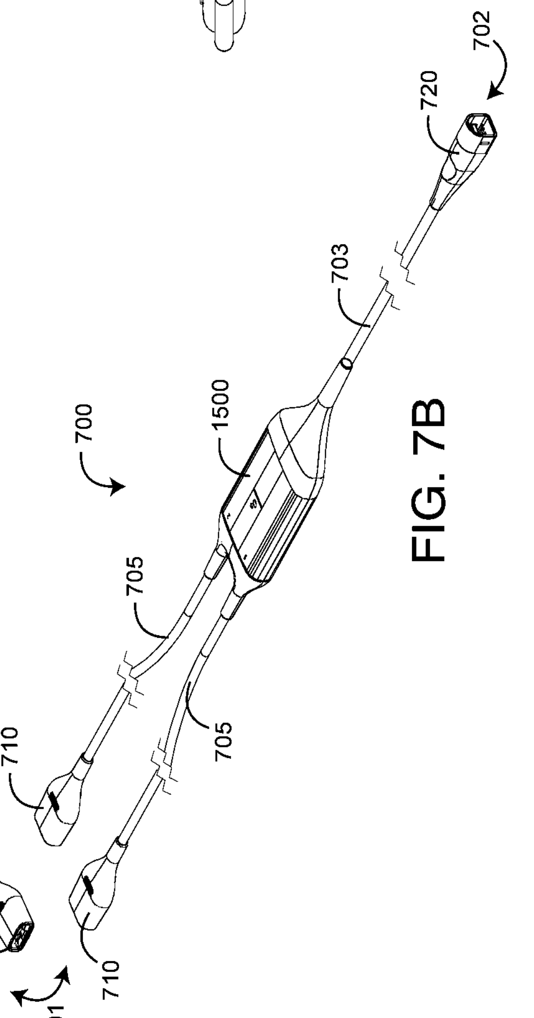

FIG. 7B

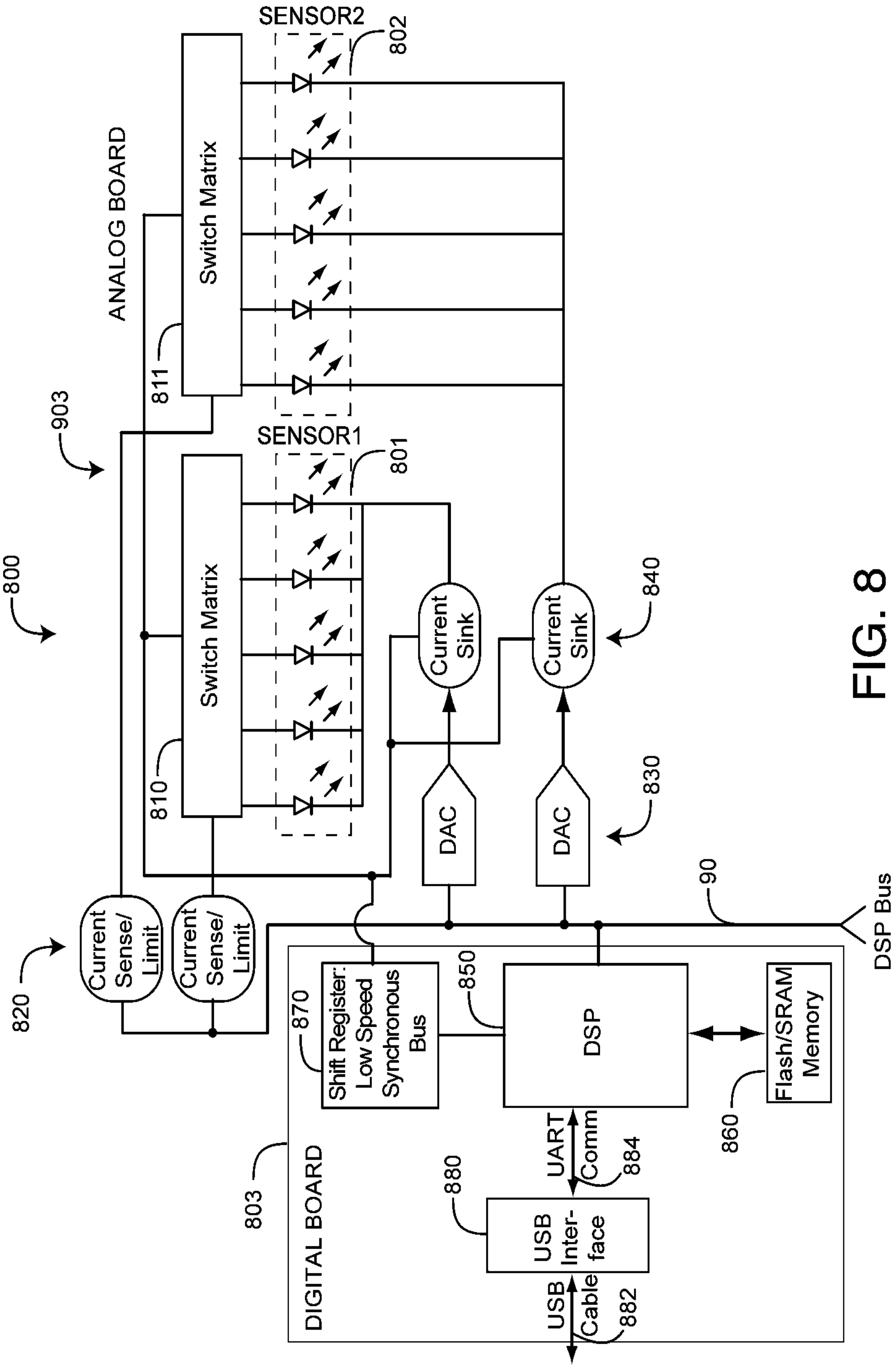
800
903
820
ANALOG BOARD
SENSOR2
802
SENSOR1
801
811
Switch Matrix
810
Switch Matrix
Current Sense/ Limit
Current Sense/ Limit
Current Sink
Current Sink
840
DAC
DAC
830
90
DSP Bus
DIGITAL BOARD
803
870
Shift Register: Low Speed Synchronous Bus
850
DSP
Flash/SRAM Memory
860
UART Comm
884
880
USB Inter-face
USB Cable
882

FIG. 8

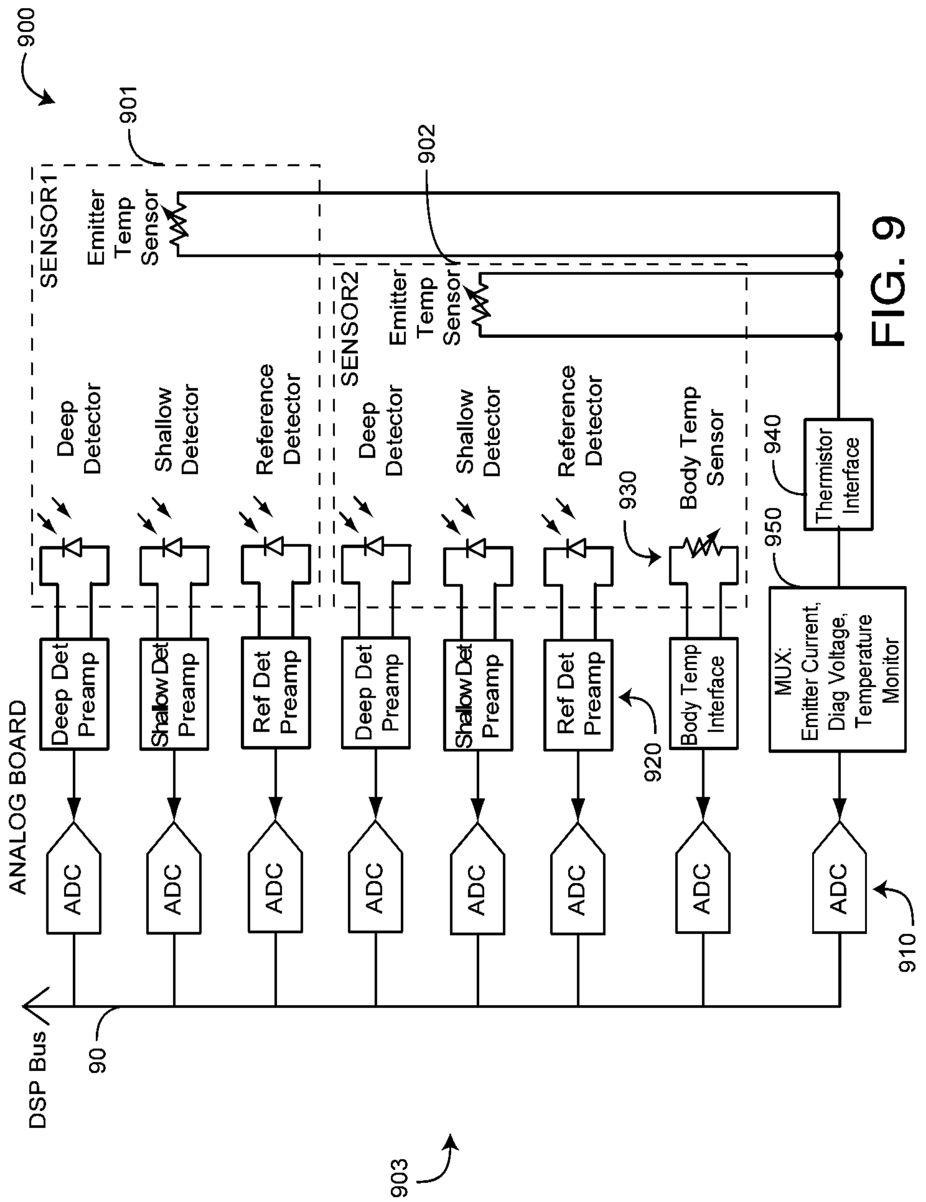
900
901
902
903
SENSOR1
SENSOR2
Emitter Temp Sensor
Emitter Temp Sensor
Deep Detector
Shallow Detector
Reference Detector
Deep Detector
Shallow Detector
Reference Detector
Body Temp Sensor
930
940
950
Thermistor Interface
MUX: Emitter Current, Diag Voltage, Temperature Monitor
ANALOG BOARD
Deep Det Preamp
Shallow Det Preamp
Ref Det Preamp
Deep Det Preamp
Shallow Det Preamp
Ref Det Preamp
Body Temp Interface
920
ADC
ADC
ADC
ADC
ADC
ADC
ADC
ADC
910
DSP Bus
90

FIG. 9

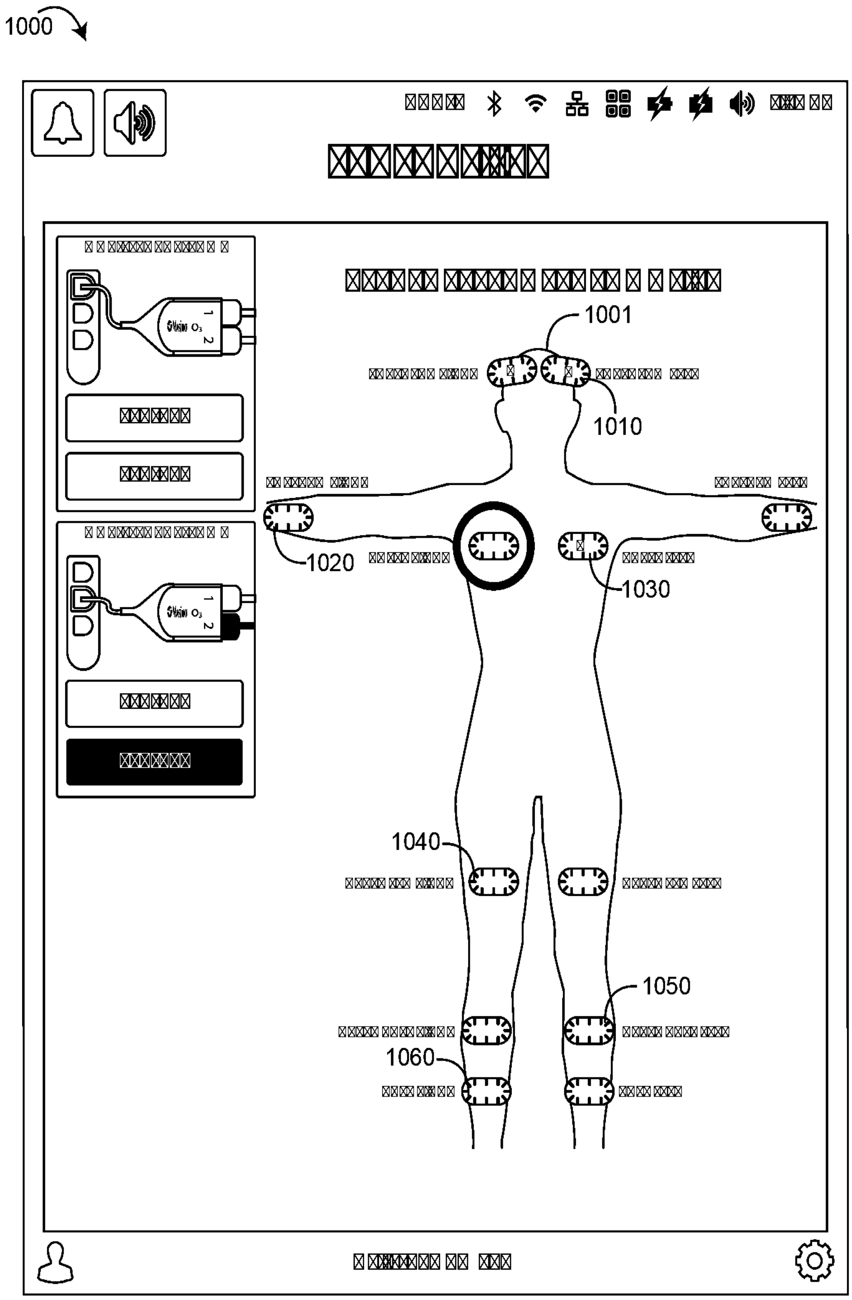

FIG. 10

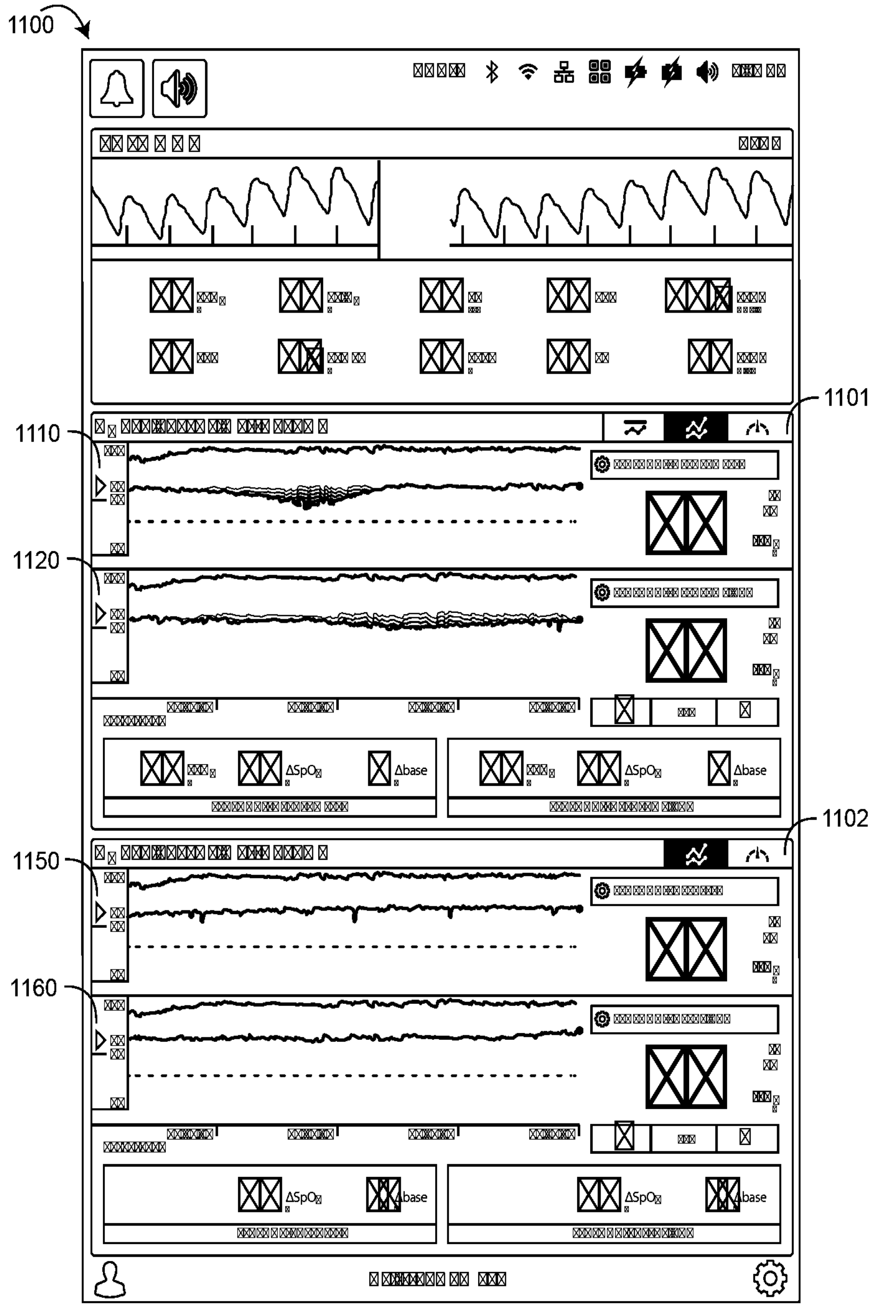

FIG. 11

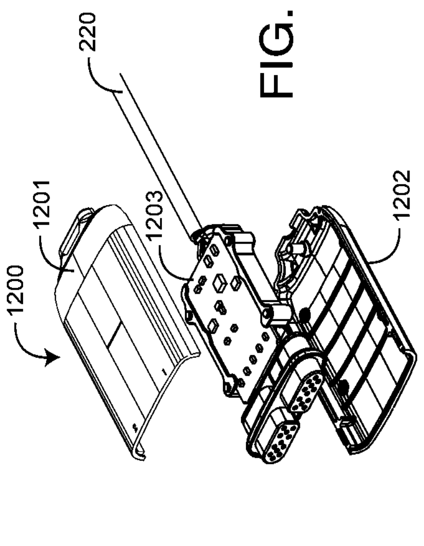

FIG. 12A

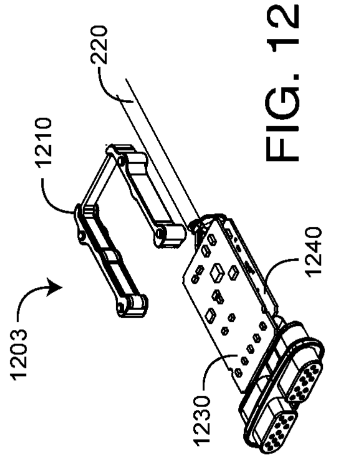

FIG. 12B

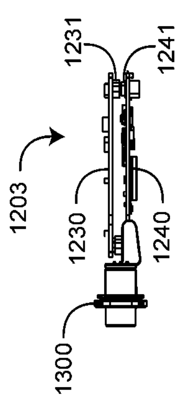

FIG. 12C

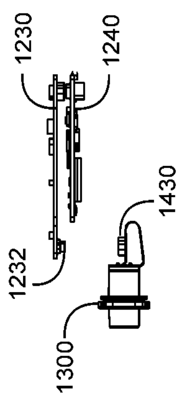

FIG. 12D

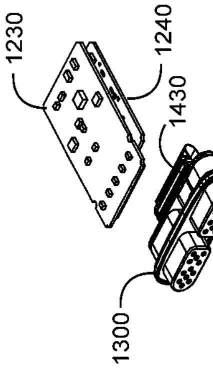

FIG. 12E

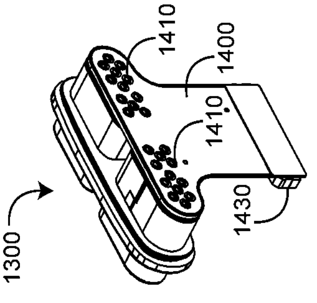

FIG. 13C

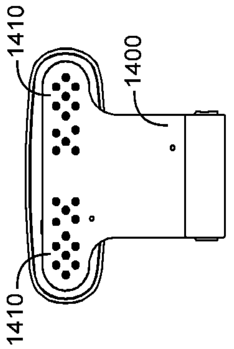

FIG. 13B

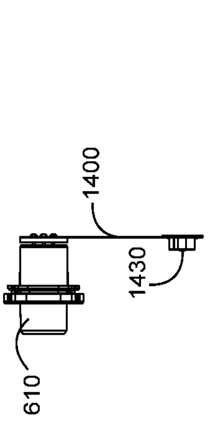

FIG. 13A

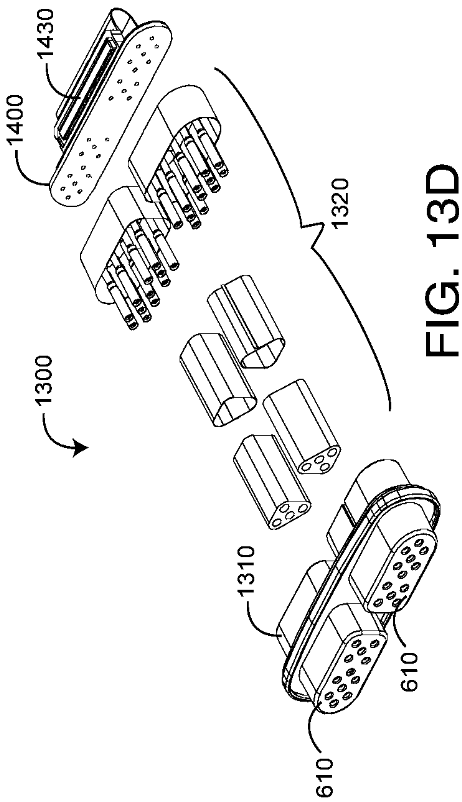

FIG. 13D

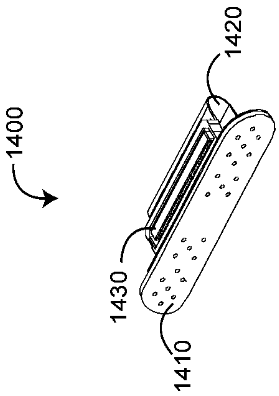

FIG. 14C

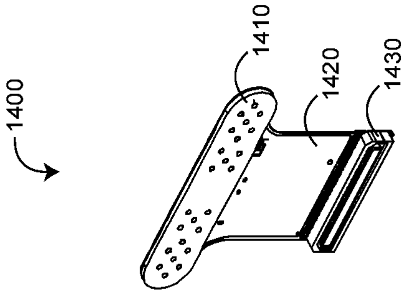

FIG. 14B

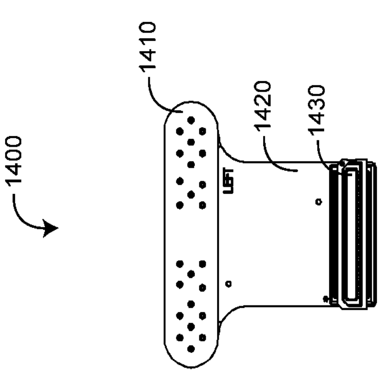

FIG. 14A

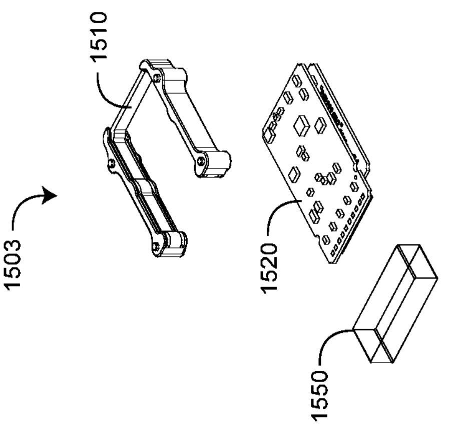

FIG. 15B

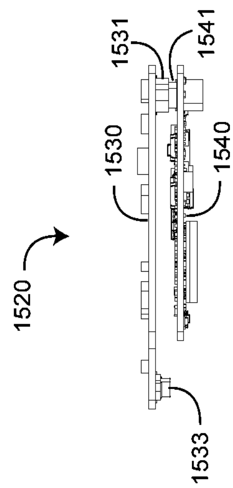

FIG. 15C

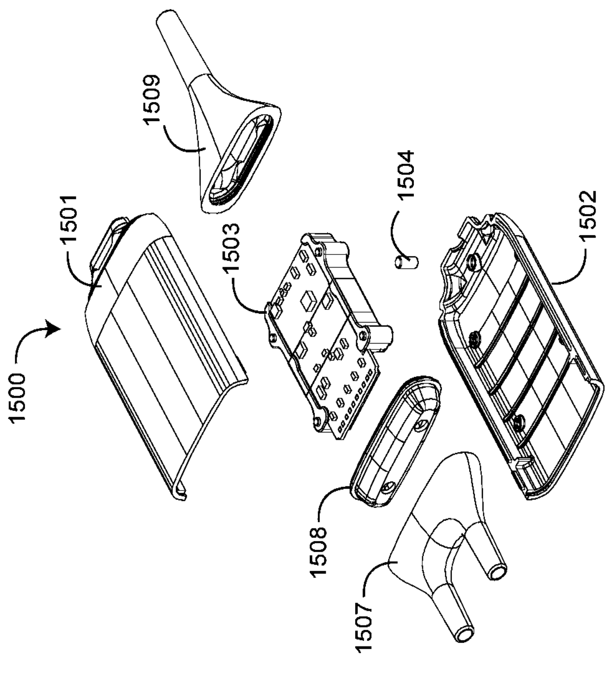

FIG. 15A

REGIONAL OXIMETRY POD

PRIORITY CLAIM TO RELATED PROVISIONAL APPLICATIONS

Any and all applications for which a foreign or domestic priority claim is identified in the Application Data Sheet as filed with the present application are hereby incorporated by reference under 37 CFR 1.57. The present application claims priority benefit under 35 U.S.C. §119(e) to U.S. Provisional Patent Application Ser. No. 62/012,170, filed Jun. 13, 2014, titled Peel-Off Resistant Regional Oximetry Sensor, U.S. Provisional Patent Application Ser. No. 61/887,878 filed Oct. 7, 2013, titled Regional Oximetry Pod; U.S. Provisional Patent Application Ser. No. 61/887,856 filed Oct. 7, 2013, titled Regional Oximetry Sensor; and U.S. Provisional Patent Application Ser. No. 61/887,883 filed Oct. 7, 2013, titled Regional Oximetry User Interface; all of the above-referenced provisional patent applications are hereby incorporated in their entireties by reference herein.

BACKGROUND

Pulse oximetry is a widely accepted noninvasive procedure for measuring the oxygen saturation level of arterial blood, an indicator of a person's oxygen supply. A typical pulse oximetry system utilizes an optical sensor attached to a fingertip to measure the relative volume of oxygenated hemoglobin in pulsatile arterial blood flowing within the fingertip. Oxygen saturation (SpO_2), pulse rate and a plethysmograph waveform, which is a visualization of pulsatile blood flow over time, are displayed on a monitor accordingly.

Conventional pulse oximetry assumes that arterial blood is the only pulsatile blood flow in the measurement site. During patient motion, venous blood also moves, which causes errors in conventional pulse oximetry. Advanced pulse oximetry processes the venous blood signal so as to report true arterial oxygen saturation and pulse rate under conditions of patient movement. Advanced pulse oximetry also functions under conditions of low perfusion (small signal amplitude), intense ambient light (artificial or sunlight) and electrosurgical instrument interference, which are scenarios where conventional pulse oximetry tends to fail.

Advanced pulse oximetry is described in at least U.S. Pat. Nos. 6,770,028; 6,658,276; 6,157,850; 6,002,952; 5,769,785 and 5,758,644, which are assigned to Masimo Corporation ("Masimo") of Irvine, Calif. and are incorporated in their entireties by reference herein. Corresponding low noise optical sensors are disclosed in at least U.S. Pat. Nos. 6,985,764; 6,813,511; 6,792,300; 6,256,523; 6,088,607; 5,782,757 and 5,638,818, which are also assigned to Masimo and are also incorporated in their entireties by reference herein. Advanced pulse oximetry systems including Masimo SET® low noise optical sensors and read through motion pulse oximetry monitors for measuring SpO_2, pulse rate (PR) and perfusion index (PI) are available from Masimo. Optical sensors include any of Masimo LNOP®, LNCS®, SofTouch™ and Blue™ adhesive or reusable sensors. Pulse oximetry monitors include any of Masimo Rad-8®, Rad-5®, Rad®-5v or SatShare® monitors.

Advanced blood parameter measurement systems are described in at least U.S. Pat. No. 7,647,083, filed Mar. 1, 2006, titled Multiple Wavelength Sensor Equalization; U.S. Pat. No. 7,729,733, filed Mar. 1, 2006, titled Configurable Physiological Measurement System; U.S. Pat. Pub. No. 2006/0211925, filed Mar. 1, 2006, titled Physiological Parameter Confidence Measure and U.S. Pat. Pub. No. 2006/0238358, filed Mar. 1, 2006, titled Noninvasive Multi-Parameter Patient Monitor, all assigned to Cercacor Laboratories, Inc., Irvine, Calif. (Cercacor) and all incorporated in their entireties by reference herein. Advanced blood parameter measurement systems include Masimo Rainbow® SET, which provides measurements in addition to SpO_2, such as total hemoglobin (SpHb™), oxygen content (SpOC™), methemoglobin (SpMet®), carboxyhemoglobin (SpCO®) and PVI®. Advanced blood parameter sensors include Masimo Rainbow® adhesive, ReSposable™ and reusable sensors. Advanced blood parameter monitors include Masimo Radical-7™, Rad-87™ and Rad-57™ monitors, all available from Masimo. Such advanced pulse oximeters, low noise sensors and advanced blood parameter systems have gained rapid acceptance in a wide variety of medical applications, including surgical wards, intensive care and neonatal units, general wards, home care, physical training, and virtually all types of monitoring scenarios.

SUMMARY

Regional oximetry, also referred to as tissue oximetry and cerebral oximetry, enables the continuous assessment of tissue oxygenation beneath a regional oximetry optical sensor. Regional oximetry helps clinicians detect regional hypoxemia that pulse oximetry alone can miss. In addition, the pulse oximetry capability in regional oximetry sensors can automate a differential analysis of regional to central oxygen saturation. Regional oximetry monitoring is as simple as applying regional oximetry sensors to any of various body sites including the forehead, forearms, chest, upper thigh, upper calf or calf, to name a few. Up to four sensors are connected to a conventional patient monitor via one or two regional oximetry pods. The pods advantageously drive the sensor optics, receive the detected optical signals, perform signal processing on the detected signals to derive regional oximetry parameters and communicate those parameters to a conventional patient monitor through, for example, standard USB ports.

One aspect of a regional oximetry pod drives the optical emitters of one or two regional oximetry sensors and receives the corresponding detector signals in response. The sensor pod has a dual sensor connector configured to physically attach and electrically connect one or two regional oximetry sensors. The pod housing has a first housing end and a second housing end. The dual sensor connector is disposed proximate the first housing end. The housing at least partially encloses the dual sensor connector. A monitor connector disposed proximate a second housing end. An analog board is disposed within the pod housing in communications with the dual sensor connector, and a digital board is disposed within the pod housing in communications with the monitor connector.

In various embodiments, the dual sensor connector has a pair of pod cables partially disposed within the pod housing. A first end of the pod cables is electrically connected to and mechanically attached to the analog board. A second end of the pod cables extends from the pod housing and terminates at a pair of sensor connectors. The sensor connectors are configured to physically attach and electrically connect up to two regional oximetry sensors. The dual sensor has a socket block at least partially disposed within the pod housing, and the socket block has socket contacts configured to electrically connect to a pair of regional oximetry sensors. The socket contacts are in electrical communications with the

analog board. The monitor connector has a pod cable extending from the digital board and terminates at a monitor connector. The analog board has an analog board connector disposed on the analog board surface. The digital board has a digital board connector disposed on the digital board surface, and the analog board connector is physically and electrically connected to the digital board connector.

In further embodiments, the analog board mounts emitter drivers that activate the regional oximetry sensor emitters, the analog board has detector amplifiers that receive sensor signals from the regional oximetry detectors, and the analog board digitizes the sensor signals. The digital board has a digital signal processor (DSP) that inputs the digitized sensor signals. The DSP derives regional oximetry parameters from the sensor signals, and the regional oximetry parameters are communicated to a patient monitor via the pod cable and the monitor connector.

Another aspect of a regional oximetry pod is defining a pod having a first pod end and a second pod end, disposing a signal processor within the pod, extending a sensor connector from the first pod end and extending a monitor connector from the second pod end. Sensor signals are received from the first pod end. Signal processing on the sensor signals calculates a regional oximetry parameter, and the parameter is transmitted to the monitor connector for display on a standard patient monitor.

In various embodiments, disposing a signal processor within the pod comprises stacking an analog board to a digital board, extending a sensor cable from the analog board to the sensor connector and extending a monitor cable from the digital board to the monitor connector. This also comprises mounting and electrically connecting a DSP to the digital board and calculating the regional oximetry parameter within the DSP. This also comprises driving sensor emitters and receiving detector signals on the analog board, wherein extending a monitor connector includes attaching a monitor cable first end to the signal processor and attaching the monitor connector to a monitor cable second end. Extending a sensor connector comprises extending sensor connector cables from the first pod end, and attaching the sensor connector to the sensor connector cable distal the pod. Extending a sensor connector comprises attaching a socket block partially within the pod at the first pod end.

An additional aspect of a regional oximetry pod is a driver means for transmitting a drive signal to a plurality of emitters, and an amplifier means for receiving a response signal from at least one detector in optical communications with the emitters. A dual connector means is for communicating the drive signal and the response signal to the drive means and the amplifier means. A housing means is for enclosing the driver means and the amplifier means and for at least partially enclosing the dual connector means. An analysis means is for deriving physiological parameters from the response signal, and a monitoring means is for communicating the physiological parameters to a display. The driver means and the amplifier means comprise an analog board means disposed within the housing means.

For various embodiments, the analysis means comprises a digital board means disposed within the housing means. Board connectors interconnect the analog board means and the digital board means. A frame means is for mechanically stabilizing the analog board means connected to the digital board means. The dual connector means has connector cables extending from the housing means between the analog board means and a plurality of sensor connectors. The dual connector means has a socket block partially disposed within the housing means and is configured to receive dual sensor plugs. A monitoring means comprises a pod cable extending from the digital board means and the housing means and terminating at a USB connector.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a general block diagram of a pod-based regional oximeter that interconnects with regional oximetry sensors so as to derive regional oximetry parameters and communicate those parameters to a patient monitor;

FIGS. **2**A-B are perspective views of an internal-connector regional oximetry pod and an external-connector regional oximetry pod, respectively;

FIG. **3** is a cross-sectional view of a regional oximetry sensor attached to a tissue site, illustrating corresponding near-field and far-field emitter-to-detector optical paths;

FIG. **4** is a general block diagram of a regional oximetry pod housing a regional oximetry analog board, digital board and signal processor;

FIG. **5** is a general block diagram of regional oximetry signal processing;

FIGS. **6**A-D are top perspective, bottom perspective, sensor connector and monitor connector views, respectively, of an internal-connector regional oximetry pod;

FIGS. **7**A-D are top perspective, bottom perspective, detailed sensor connector and detailed monitor connector views, respectively, of an external-connector regional oximetry pod;

FIG. **8** is a detailed block diagram of the emitter drive for dual, regional oximetry sensors;

FIG. **9** is a detailed block diagram of the detector interface for dual regional oximetry sensors;

FIG. **10** is a regional oximetry monitor display that provides user I/O showing placement of up to four sensors on a patient; and

FIG. **11** is a regional oximetry parameter display for up to four regional oximetry sensors;

FIGS. **12**A-E are various exploded views of an internal-connector regional oximetry pod;

FIGS. **13**A-D are side, back, back perspective and exploded views, respectively, of a dual sensor connector for an internal-connector pod;

FIGS. **14**A-C are front, front perspective and folded front perspective views, respectively, of an internal-connector flex-circuit assembly for an internal-connector pod; and

FIGS. **15**A-C are various exploded views of an external-connector regional oximetry pod;

DETAILED DESCRIPTION

FIG. **1** generally illustrates a pod-based regional oximeter **100** including pod assemblies **101**, **102** each communicating with an array of regional oximetry sensors **110** via sensor cables **120**. The sensors **110** are attached to various patient **1** locations. One or two regional oximetry pods **130** and a corresponding number of pod cables **140** advantageously provide communications between the sensors **110** and a patient monitor **170**. Regional oximetry (rSO_2) signal processors **150** housed in each of the pods **130** perform the algorithmic processing normally associated with patient monitors and/or corresponding monitor plug-ins so as to derive various regional oximetry parameters. The pods **130** communicate these parameters to the patient monitor **170** for display and analysis by medical staff. Further, in an embodiment, each pod **130** utilizes USB communication protocols and connectors **142** to easily integrate with a third party monitor **170**. A monitor **170** may range from a relatively "dumb" display device to a relatively "intelligent" multi-parameter patient monitor so as to display physiological parameters indicative of health and wellness.

FIGS. 2A-B illustrate an internal-connector regional oximetry pod **201** (FIG. 2A) and an external-connector regional oximetry pod **202** (FIG. 2B). As shown in FIG. 2A, in the internal-connector embodiment **201**, pod sockets (not visible) are recessed into the pod housing **210**. RSO_2 sensors **60** have sensor cables **62** extending between the sensors **60** and sensor plugs **64**. The sensor plugs **64** insert into the pod sockets so as communicate sensor signals between the sensors **60** and pod analog and digital boards (not visible) within the pod housing **210**. Pod boards derive regional oximetry parameters, which are communicated to a monitor **170** (FIG. **1**) via a monitor cable **220** and a corresponding USB connector **230**. Pod boards are described with respect to FIG. **4**, below. Sensor optics and corresponding sensor signals are described with respect to FIG. **3**, below.

As shown in FIG. 2B, in the external-connector embodiment **202**, pod cables **260** extend from the pod housing **250**, providing external pod sockets **270**. Sensor plugs **64** insert into the external pod sockets **270** so as communicate sensor signals between the sensors **60** and the analog and digital boards within the pod housing **250**. As generally described above and in further detail below, pod boards **410**, **420** (FIG. **4**) derive regional oximetry parameters from the sensor signals, and the parameters are communicated to a monitor **170** (FIG. **1**) via the monitor cable **220** and corresponding USB connector **230**.

FIG. **3** illustrates a regional oximetry sensor **300** attached to a tissue site **10** so as to generate near-field **360** and far-field **370** emitter-to-detector optical paths through the tissue site **10**. The resulting detector signals are processed so as to calculate and display oxygen saturation (SpO_2), delta oxygen saturation (ΔSpO_2) and regional oxygen saturation (rSO_2), as shown in FIG. **11**, below. The regional oximetry sensor **300** has a flex circuit layer **310**, a tape layer **320**, an emitter **330**, a near-field detector **340** and a far-field detector **350**. The emitter **330** and detectors **340**, **350** are mechanically and electrically connected to the flex circuit **310**. The tape layer **320** is disposed over and adheres to the flex circuit **310**. Further, the tape layer **320** attaches the sensor **300** to the skin **10** surface.

As shown in FIG. **3**, the emitter **330** has a substrate **332** mechanically and electrically connected to the flex circuit **310** and a lens **334** that extends from the tape layer **320**. Similarly, each detector **340**, **350** has a substrate **342**, **352** and each has a lens **344**, **354** that extends from the tape layer. In this manner, the lenses **334**, **344**, **354** press against the skin **10**, advantageously maximizing the optical transmission and reception of the emitter **330** and detectors **340**, **350**.

FIG. **4** generally illustrates a regional oximetry pod **401** that houses a regional oximetry analog board **410** and a regional oximetry digital board **420**. A regional oximetry signal processor **430** executes on a digital signal processor (DSP) residing on the digital board **420**. The regional oximetry signal processor **430** is described with respect to FIG. **5**, below. The regional oximetry analog board **410** and digital board **420** are described in detail with respect to FIGS. **8-9**, below.

As shown in FIG. **4**, on the patient side **402**, the regional oximetry analog board **410** communicates with one or more regional oximetry (rSO_2) sensors **440**, **450** via one or more sensor cables **445**, **455**. On the caregiver side **403**, a pod cable **425** has a USB connector **427** so as to provide a standard interface between the digital board **420** and a monitor **170** (FIG. **1**).

Also shown in FIG. **4**, the analog board **410** and the digital board **420** enable the pod **401** itself to perform the sensor communications and signal processing functions of a conventional patient monitor. This advantageously allows pod-derived regional oximetry parameters to be displayed on a variety of monitors ranging from simple display devices to complex multiple parameter patient monitoring systems via the simple USB interface **427**.

FIG. **5** generally illustrates a regional oximetry signal processor **500** having a front-end signal processor **540**, a back-end signal processor **550** and diagnostics **530**. The front end **540** controls LED modulation, detector demodulation and data decimation. The back-end **550** computes sensor parameters from the decimated data. The diagnostics **530** analyze data corresponding to various diagnostic voltages within or external to the digital board so as to verify system integrity.

FIGS. **6-7** generally illustrate regional oximetry pod **600**, **700** embodiments, each having a pod end **601**, **701**; a monitor end **602**, **702** and an interconnecting pod cable **603**, **703**. The pod end **601**, **701** has dual sensor connectors **610**, **710**. The monitor end **602**, **702** has a monitor connector **620**, **720**. In a particular embodiment, the monitor connector **620**, **720** is a USB connector.

As shown in FIGS. **6**A-D, in an internal sensor connector embodiment **600**, the sensor connectors **610** are integrated within the pod housing **1200**. Advantageously, this configuration provides a relatively compact sensor/monitor interconnection having sensor connectors **610**, a monitor connector **620** and an interconnecting pod cable **603**. The pod **1200** internals, including the housed portion of the sensor connectors **610**, are described in detail with respect to FIGS. **12-14**, below.

As shown in FIGS. **7**A-D, in an external sensor connector embodiment **700**, sensor connector cables **705** extend from the pod housing **1500**. Advantageously, by removing the dual sensor connectors from within the pod housing **1500**, the pod internal complexity is reduced, which reduces manufacturing costs and increases pod reliability. The pod **1500** internals are described in detail with respect to FIG. **15**, below.

FIGS. **8-9** illustrate a regional oximetry signal processor embodiment **800**, **900** having a digital board **803** (FIG. **8**) and an analog board **903** (FIGS. **8-9**) in communications with up to two regional oximetry sensors **801**, **802** (FIG. **8**); **901**, **902** (FIG. **9**). The digital board **803** (FIG. **8**) has a DSP **850** in communications with an external monitor via a USB cable **882** and corresponding UART communications **884**. The DSP **850** is also in communications with the sensors **801-802**, **901-902** via DACs **830** and ADCs **910** on the analog board **903**.

As shown in FIG. **8-9**, sensor emitters **801**, **802** are driven from the analog board **903** under the control of the digital board DSP **850** via a shift register **870**. Each regional sensor **801-802**, **901-902** has a shallow detector and a deep detector. Further, each sensor **801-802**, **901-902** may have a reference detector and an emitter temperature sensor. In a cerebral regional oximetry embodiment, the sensor(s) may have a body temperature sensor **930** and corresponding analog board ADC **910** interface.

FIG. **10** illustrates a user I/O display **1000** for indicating the placement of up to four sensors on a patient. An adult form **1001** is generated on the display. Between one and four sensor sites can be designated on the adult form **1001**, including left and right forehead **1010**, forearm **1020**, chest **1030**, upper leg **1040**, upper calf **1050** and right calf **1060** sites. Accordingly, between one and four sensors **110** (FIG.

1) can be located on these sites. A monitor in communication with these sensors then displays between one and four corresponding regional oximetry graphs and readouts, as described with respect to FIG. **11**, below.

FIG. **11** illustrates a regional oximetry parameter display **1100** embodiment for accommodating up to four regional oximetry sensor inputs. In this particular example, a first two sensor display **1101** is enabled for monitoring a forehead left site **1110** and a forehead right site **1120**. A second two sensor display **1102** is enabled for monitoring a chest left site **1150** and a chest right site **1160**.

FIGS. **12**A-E further illustrate a regional oximetry pod **1200** embodiment. As shown in FIG. **12**A, the pod **1200** has a top shell **1201**, a bottom shell **1202**, a pod assembly **1203** enclosed between the shells **1201**, **1202** and a cable **1241** extending from the pod assembly **1203** through a bend relief (not shown). As shown in FIG. **12**B, an analog board **1230** and a digital board **1240** are seated within a frame **1210**.

As shown in FIGS. **12**C-E, an analog board **1230** is plugged into a dual sensor connector assembly **1300**. In particular, an analog board plug **1232** is inserted into a flex circuit assembly socket **1430**. With this arrangement, sensor connectors **64** (FIG. **2**A) have electrical continuity with the analog board **1230** and the (USB) cable **220** has electrical continuity with the digital board **1240**, as described above with respect to FIG. **4**.

FIGS. **13**A-D illustrate a dual sensor connector assembly **1300** that provides communications between the analog board **1230** (FIGS. **12**A-E) and the dual sensor connectors **610**. The dual sensor connector assembly **1300** has a socket block **1310**, a contact assembly **1320** and a flex-circuit assembly **1400**. The socket block **1310** retains the contact assembly **1320** so as to form the dual sensor connectors **610**. The flex-circuit assembly **1400** provides a socket connector **1430** that mechanically receives analog board plug **1232** (FIG. **12**D) and electrically connects the analog board sensor inputs to the sensor connectors **610**. In this manner, the analog board **1230** (FIGS. **12**A-E) receives sensor signals for signal processing, such as filtering and analog-to-digital conversion.

FIGS. **14**A-C illustrate a connector flex-circuit assembly **1400** having flex circuit contacts **1410**, a flex cable **1420** and a flex circuit socket **1430**. The contacts **1410** receive the sensor connector pins **1320** (FIG. **13**D), which are soldered in place. When installing the flex-circuit assembly **1400** within a pod **1200** (FIGS. **12**A-E) the flex cable **1420** folds into a U-shape (FIG. **14**C) so as to expose the flex circuit socket **1430** (FIG. **12**D) to the analog board plug **1232** (FIG. **12**D), which is then inserted into the socket **1430** (FIG. **12**D).

FIGS. **15**A-C illustrate an external-connector regional oximetry pod housing **1500** having an upper pod shell **1501** and a lower pod shell **1502** that enclose a board assembly **1503**. The board assembly **1503** has a board frame **1510**, a signal processing assembly **1520** and a wrap **1550**. The board frame **1510** and wrap **1550** mechanically stabilize the signal processing assembly **1520**.

As shown in FIGS. **15**A-C, the signal processing assembly **1520** has an analog board **1530** and a digital board **1540** as described with respect to FIG. **4**, above. The analog board **1530** and a digital board **1540** mechanically and electrically interconnect at board connectors **1531**, **1541**. A sensor cable **705** (FIGS. **7**A-B) threads through an outer sensor cable boot **1507** and an inner sensor cable boot **1508** so as to mechanically and electrically interconnect with an analog board sensor cable connector **1533** (FIG. **15**C).

A regional oximetry pod has been disclosed in detail in connection with various embodiments. These embodiments are disclosed by way of examples only and are not to limit the scope of the claims that follow. One of ordinary skill in art will appreciate many variations and modifications.

What is claimed is:

1. A regional oximetry pod which drives optical emitters of one or two regional oximetry sensors and receives corresponding detector signals in response, the regional oximetry pod comprising:

a dual sensor connector configured to physically attach and electrically connect to one or two regional oximetry sensors;

a pod housing having a first housing end and a second housing end;

the dual sensor connector disposed proximate the first housing end;

the housing at least partially enclosing the dual sensor connector;

a monitor connector disposed proximate the second housing end;

an analog board disposed within the pod housing in communication with the dual sensor connector, the analog board including

emitter drivers that activate emitters of the one or two regional oximetry sensor sensors, and

detector amplifiers that receive sensor signals from detectors of the one or two regional oximetry sensors, wherein the analog board digitizes the sensor signals; and

a digital board disposed within the pod housing in communication with the monitor connector, the digital board including a digital signal processor (DSP) that receives the digitized sensor signals, the DSP configured to derive regional oximetry parameters from the digitized sensor signals and communicate the regional oximetry to a patient monitor via the monitor connector,

wherein the analog board and the digital board are stacked within the pod housing.

2. The regional oximetry pod according to claim **1** wherein the dual sensor connector comprises:

a pair of pod cables partially disposed within the pod housing;

a first end of the pod cables electrically connected to and mechanically attached to the analog board; and

a second end of the pod cables extending from the pod housing and terminating at a pair of sensor connectors,

the sensor connectors configured to physically attach and electrically connect to the one or two regional oximetry sensors.

3. The regional oximetry pod according to claim **1** wherein the dual sensor connector comprises:

a socket block at least partially disposed within the pod housing,

the socket block having socket contacts configured to electrically connect to the one or two regional oximetry sensors, and

the socket contacts in electrical communications with the analog board.

4. The regional oximetry pod according to claim **2** wherein the monitor connector comprises a pod cable extending from the digital board and terminating at a connector configured for connecting to a patient monitor.

5. The regional oximetry pod according to claim **4** wherein:

the analog board comprises an analog board connector disposed on a surface of the analog board;

the digital board comprises a digital board connector disposed on a surface of the digital board; and

the analog board connector physically and electrically connects to the digital board connector.

6. The regional oximetry pod according to claim **1** further comprising a flex circuit assembly, the flex circuit assembly including

flex circuit contacts in electrical communication with the dual sensor connector,

a flex cable, wherein a first end of the flex cable is connected to the flex circuit contacts, and

a flex circuit socket connected to a second end of the flex cable;

wherein the flex circuit socket is connected to the an analog board plug.

7. The regional oximetry pod according to claim **6** wherein the flex cable folds into a U-shape so as to connect the flex circuit socket to the analog board plug.

8. The regional oximetry pod according to claim **1** further comprising a board frame at least partially surrounding the analog board and the digital board in the stacked configuration, wherein the board frame is configured to mechanically stabilize the analog board and the digital board.

9. The regional oximetry pod according to claim **1** wherein the pod housing comprises a single pod housing.

10. The regional oximetry pod according to claim **1** wherein the single pod housing comprises a top shell and a bottom shell, and wherein the analog board and the digital board are disposed between the top shell and the bottom shell.

11. A regional oximetry pod comprising:

a driver means for transmitting a drive signal to a plurality of emitters;

an amplifier means for receiving a response signal from at least one detector in optical communications with the emitters;

a dual connector means for communicating the drive signal and the response signal to the drive means and the amplifier means;

a housing means for enclosing the driver means and the amplifier means and for at least partially enclosing the dual connector means;

an analysis means enclosed within the housing means for deriving a plurality of physiological parameters from the response signal; and

a monitoring means enclosed within the housing means for communicating the physiological parameters to a display,

wherein the amplifier means and the analysis means are stacked within the housing means.

12. The regional oximetry pod according to claim **11** wherein the driver means and the amplifier means comprise an analog board means disposed within the housing means.

13. The regional oximetry pod according to claim **12** wherein:

the analysis means comprises a digital board means disposed within the housing means; and

wherein the regional oximetry pod further comprises

a plurality of board connectors interconnecting the analog board means and the digital board means; and

a frame means for mechanically stabilizing the analog board means connected to the digital board means.

14. The regional oximetry pod according to claim **13** wherein the dual connector means comprises a plurality of connector cables extending from the housing means between the analog board means and a plurality of sensor connectors.

15. The regional oximetry pod according to claim **13** wherein the dual connector means comprises a socket block partially disposed within the housing means and configured to receive dual sensor plugs.

16. The regional oximetry pod according to claim **15** wherein the monitoring means comprises a pod cable extending from the digital board means and the housing means and terminating at a USB connector.

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摘要(译)

区域血氧测定盒在区域血氧测定传感器上驱动光学发射器，并接收相应的检测器信号作为响应。传感器盒具有双传感器连接器，配置为物理连接和电连接一个或两个区域血氧测定传感器。吊舱壳体具有第一壳体端部和第二壳体端部。双传感器连接器设置在第一壳体端部附近。壳体至少部分地包围双传感器连接器。监视器连接器靠近第二壳体端部设置。模拟板设置在盒壳体内并与双传感器连接器通信。数字板设置在盒壳体内，与监视器连接器通信。