US010213108B2

(12) **United States Patent**
Al-Ali

(10) **Patent No.: US 10,213,108 B2**
(45) **Date of Patent: *Feb. 26, 2019**

(54) **ARM MOUNTABLE PORTABLE PATIENT MONITOR**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 169 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/448,989**

(22) Filed: **Mar. 3, 2017**

(65) **Prior Publication Data**

US 2017/0224262 A1 Aug. 10, 2017

Related U.S. Application Data

(63) Continuation of application No. 14/815,232, filed on Jul. 31, 2015, which is a continuation of application
(Continued)

(51) **Int. Cl.**
A61B 5/1455 (2006.01)
A61B 5/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A61B 5/0024*** (2013.01); ***A61B 5/002*** (2013.01); ***A61B 5/0004*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC ... A61B 5/0002; A61B 5/0004; A61B 5/0024; A61B 5/02; A61B 5/0205; A61B 5/0402;
(Continued)

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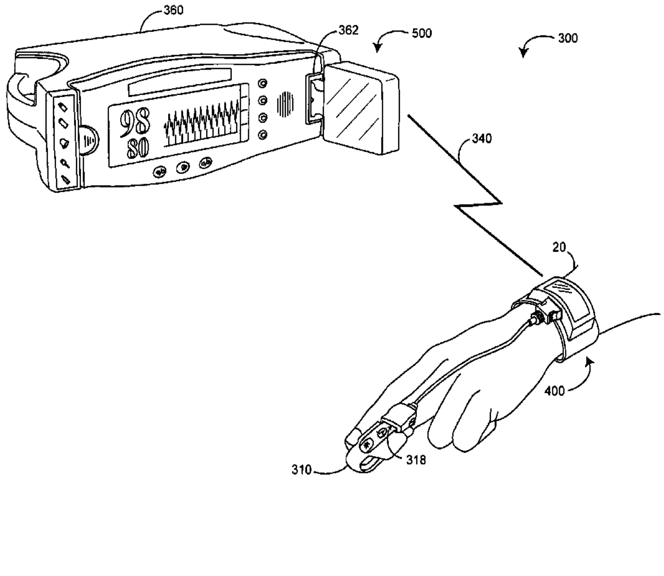
(57) **ABSTRACT**

An arm mountable portable patient monitoring device configured to receive physiological information from a plurality of sensors attached to a patient via wired connections for on-patient monitoring of parameter measurements and wireless transmission of parameter measurements to separate monitoring devices. The arm mountable portable patient monitoring device includes a housing, a strap, a display, a first sensor port positioned on a first side of the housing configured to face toward a hand of the patient when the housing is secured to the arm of the patient, second and third sensor ports configured to receive signals from additional sensor arrangements via a wired connections, one or more signal processing arrangements configured to cause to be displayed measurements of oxygen saturation and pulse rate, and a transmitter configured to wirelessly transmit information indicative of the measurements of oxygen saturation and pulse rate to a separate monitoring device.

22 Claims, 17 Drawing Sheets



Related U.S. Application Data

No. 14/217,788, filed on Mar. 18, 2014, now Pat. No. 9,113,832, which is a continuation of application No. 14/037,137, filed on Sep. 25, 2013, now Pat. No. 9,113,831, which is a continuation of application No. 12/955,826, filed on Nov. 29, 2010, now Pat. No. 8,548,548, which is a continuation of application No. 11/417,006, filed on May 3, 2006, now Pat. No. 7,844,315, which is a continuation of application No. 11/048,330, filed on Feb. 1, 2005, now Pat. No. 7,844,314, which is a continuation of application No. 10/377,933, filed on Feb. 28, 2003, now Pat. No. 6,850,788.

(60) Provisional application No. 60/367,428, filed on Mar. 25, 2002.

(51) **Int. Cl.**

A61B 5/0205	(2006.01)
A61B 5/024	(2006.01)
A61B 5/021	(2006.01)
A61B 5/0404	(2006.01)
A61B 5/0428	(2006.01)
G08B 21/04	(2006.01)
A61B 5/0402	(2006.01)
H04W 4/70	(2018.01)

(52) **U.S. Cl.**

CPC ***A61B 5/0015*** (2013.01); ***A61B 5/0026*** (2013.01); ***A61B 5/021*** (2013.01); ***A61B 5/0205*** (2013.01); ***A61B 5/02427*** (2013.01); ***A61B 5/02438*** (2013.01); ***A61B 5/0404*** (2013.01); ***A61B 5/0428*** (2013.01); ***A61B 5/14552*** (2013.01); ***A61B 5/6824*** (2013.01); ***A61B 5/6826*** (2013.01); ***A61B 5/6831*** (2013.01); ***A61B 5/6838*** (2013.01); ***A61B 5/72*** (2013.01); ***A61B 5/7228*** (2013.01); ***A61B 5/7271*** (2013.01); ***A61B 5/742*** (2013.01); ***A61B 5/7425*** (2013.01); ***A61B 5/7445*** (2013.01); ***A61B 5/7475*** (2013.01); ***G08B 21/0453*** (2013.01); *A61B 5/0402* (2013.01); *A61B 5/1455* (2013.01); *A61B 2560/0214* (2013.01); *A61B 2562/222* (2013.01); *A61B 2562/227* (2013.01); *H04W 4/70* (2018.02); *Y10S 128/903* (2013.01)

(58) **Field of Classification Search**

CPC . A61B 5/1455; A61B 5/14551; A61B 5/6825; A61B 5/6826; A61B 5/6831; A61B 5/72; A61B 2560/0043; A61B 2562/06

See application file for complete search history.

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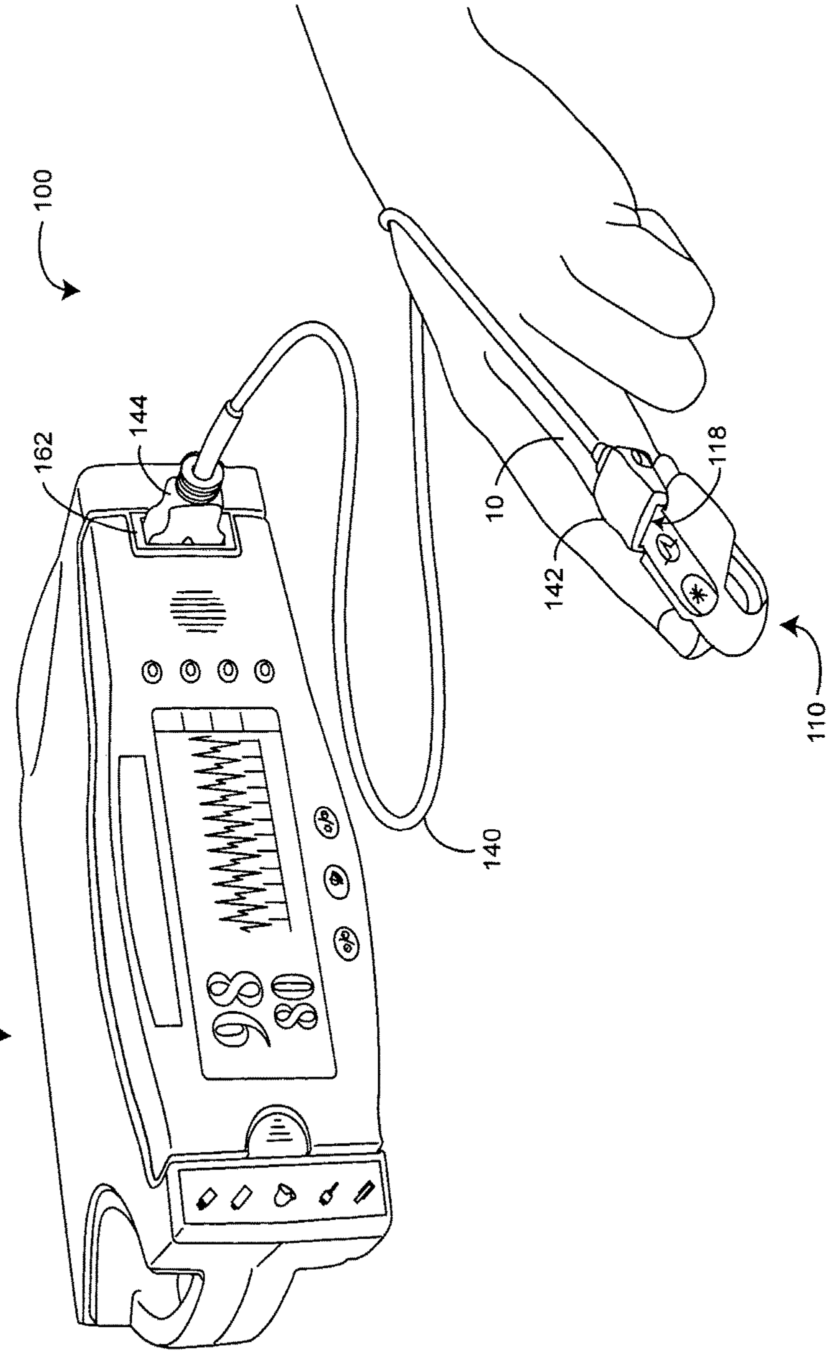


FIG. 1 (Prior Art)

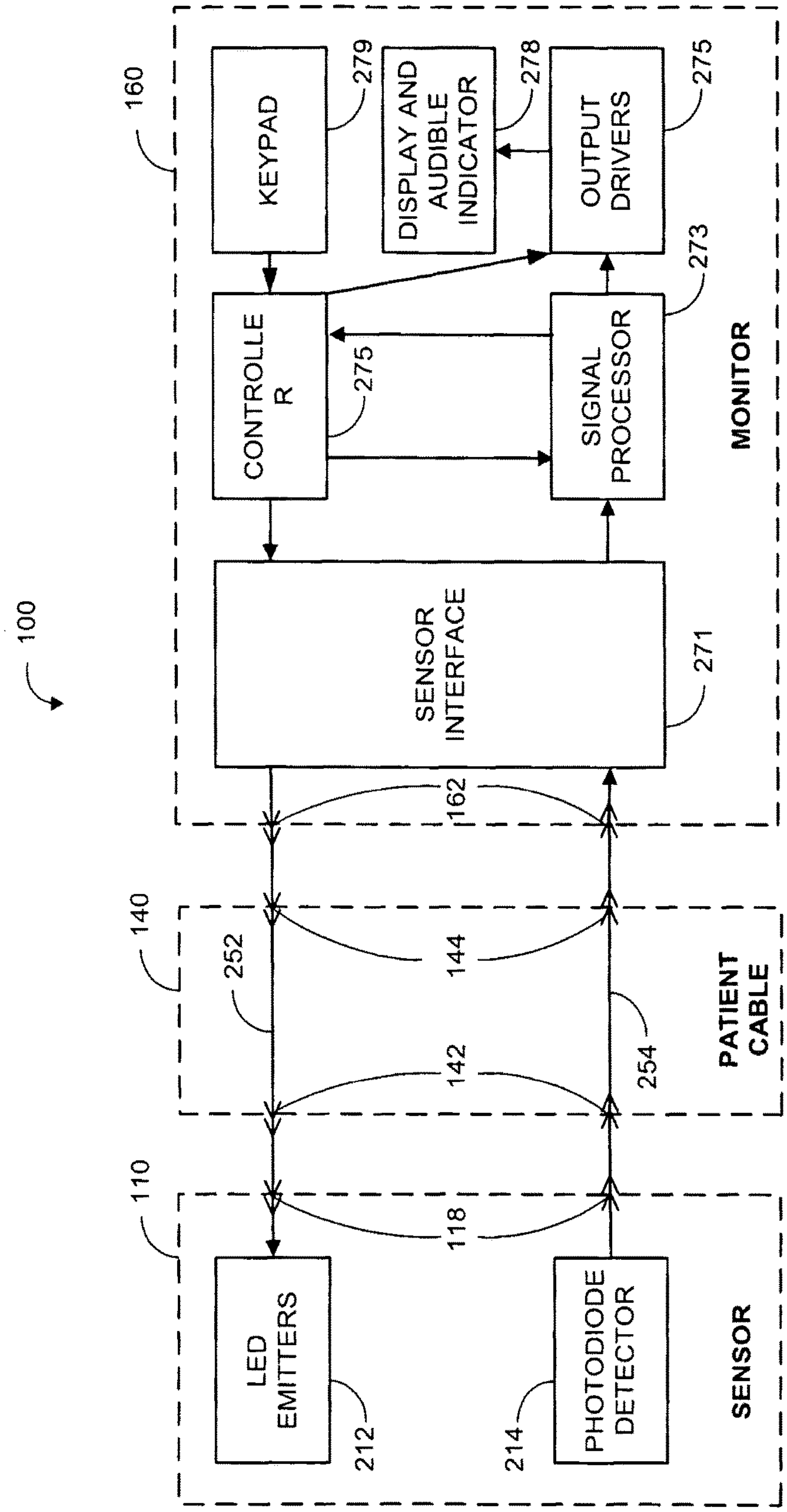


FIG. 2 (Prior Art)

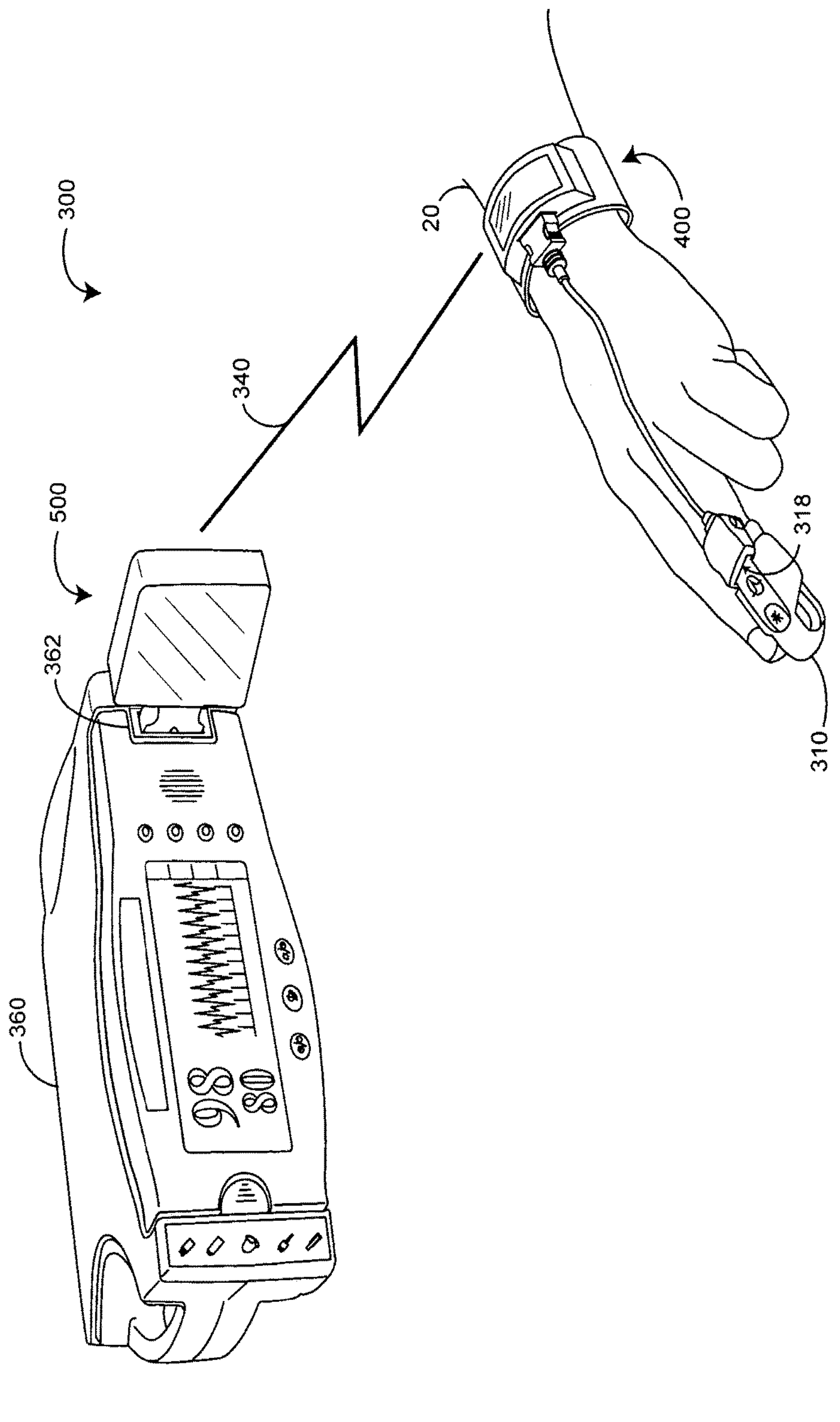


FIG. 3

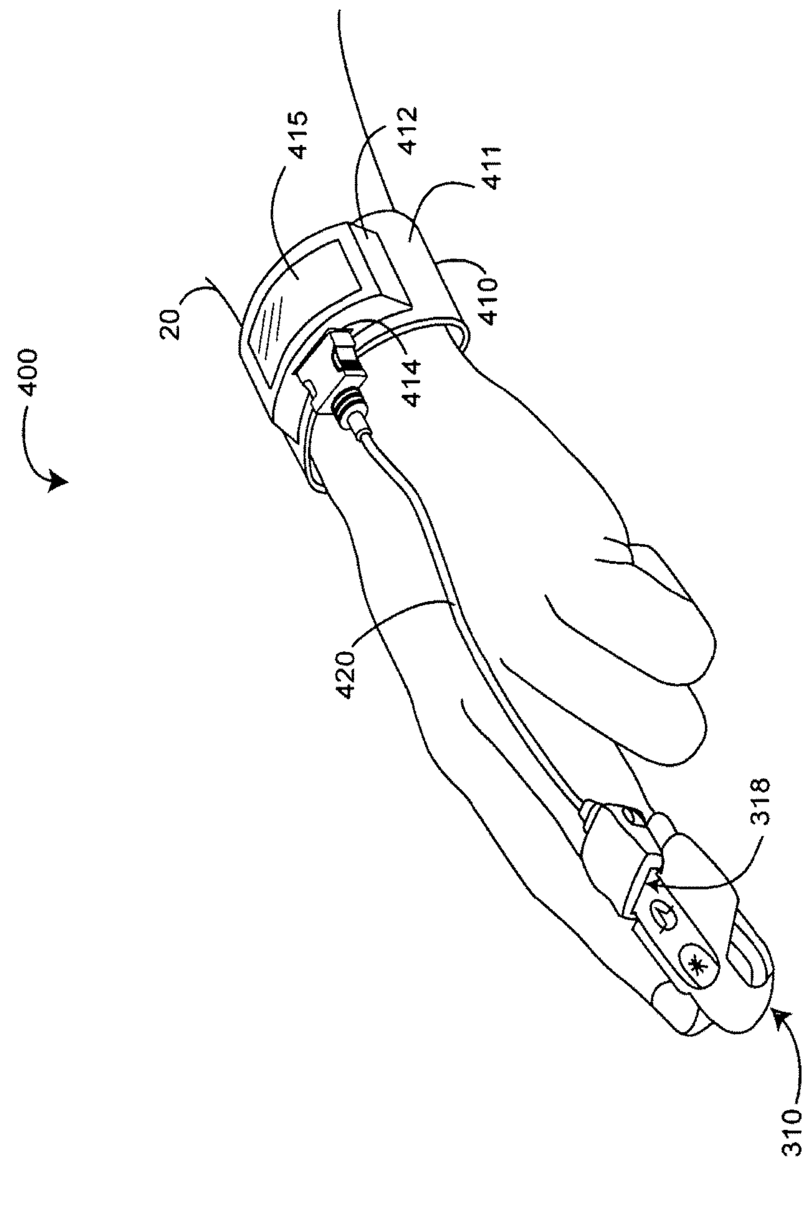


FIG. 4A

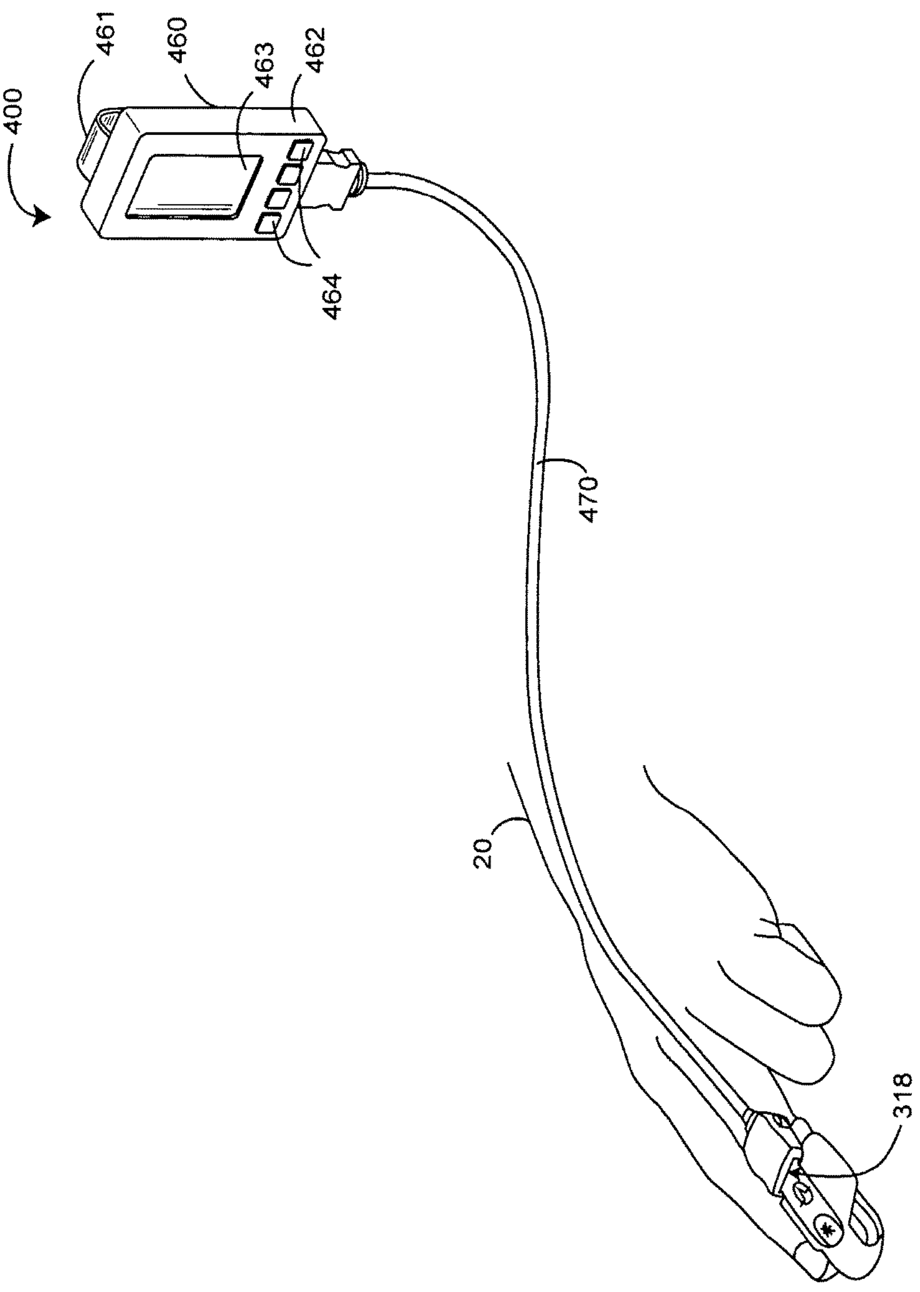


FIG. 4B

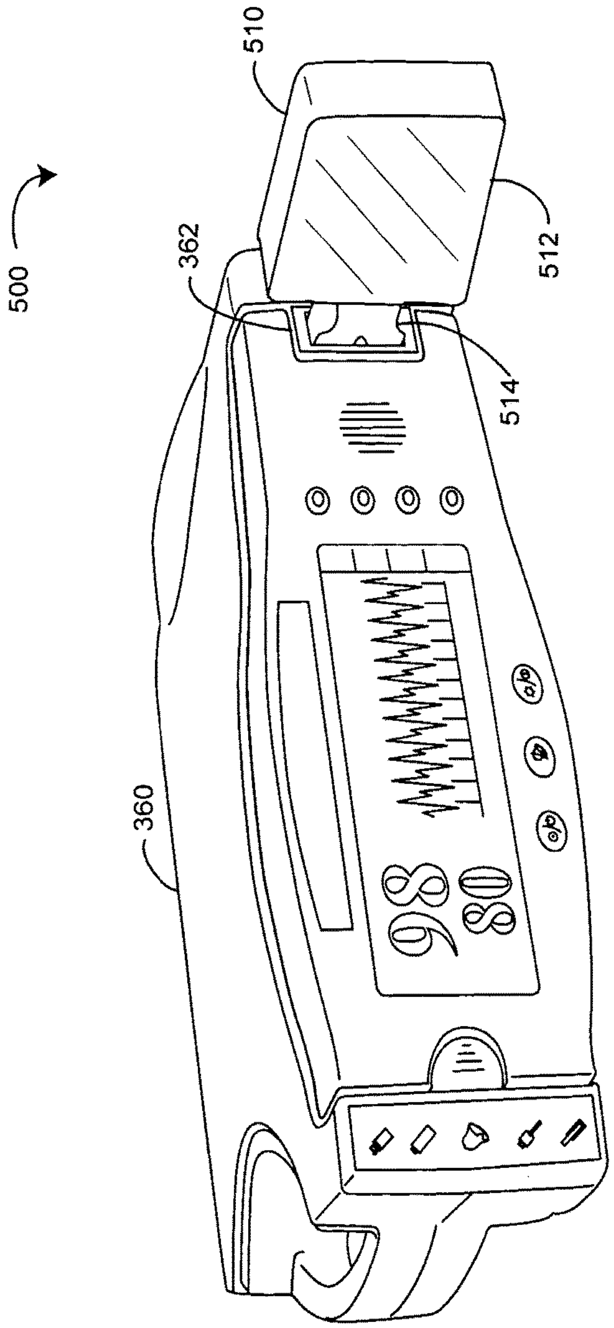


FIG. 5A

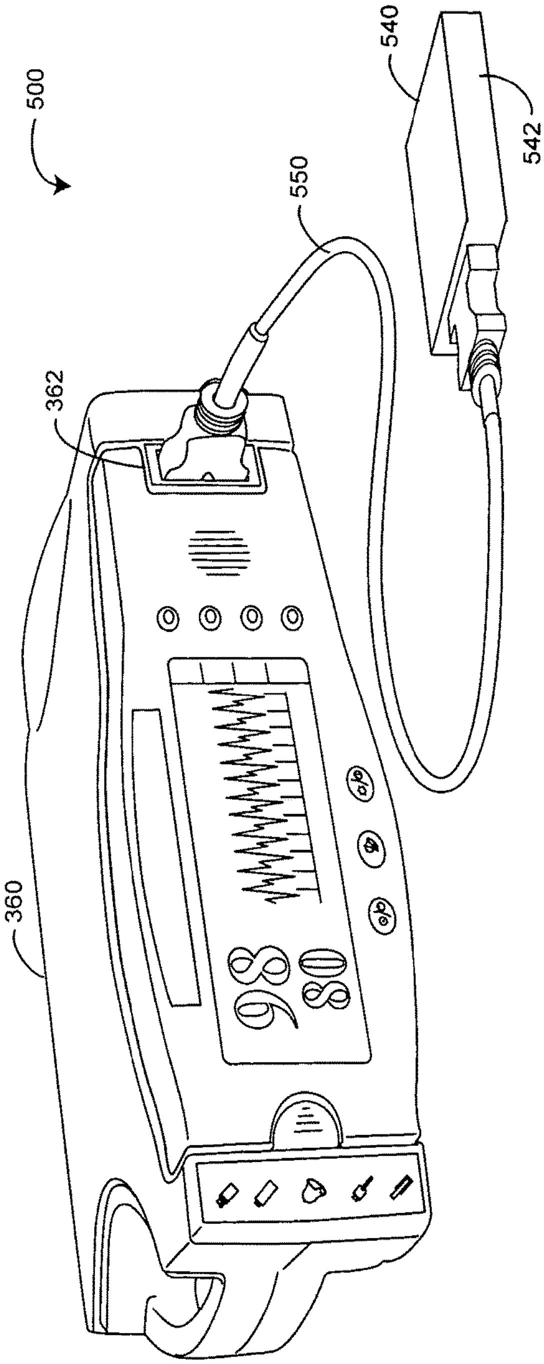


FIG. 5B

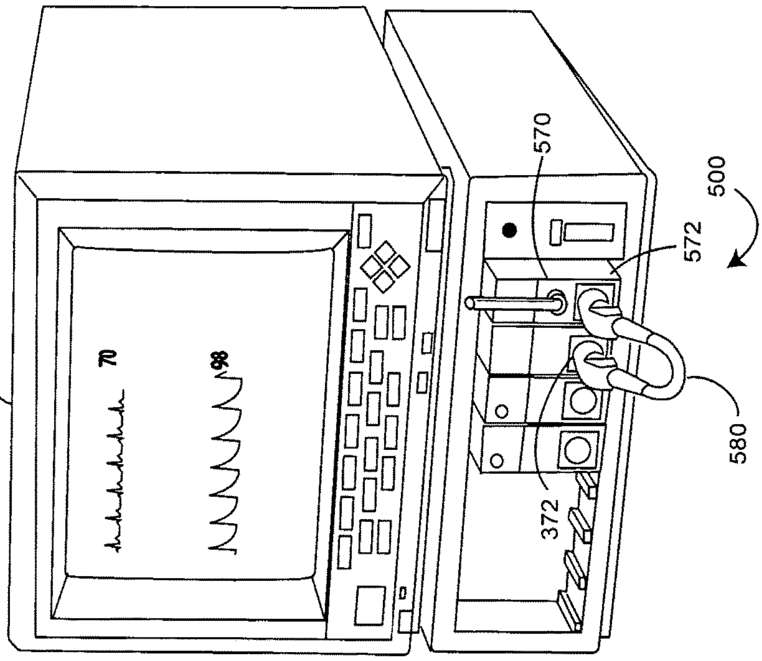


FIG. 5C

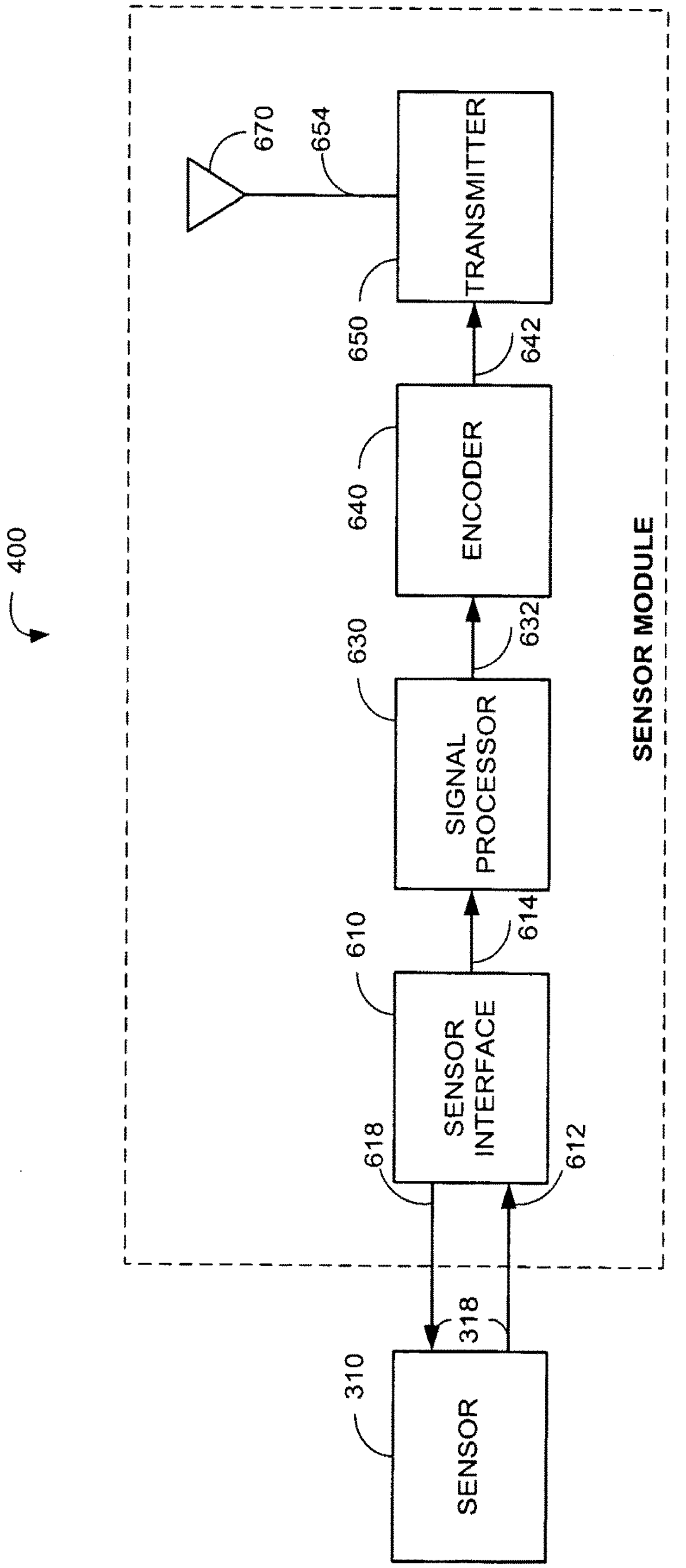

400
SENSOR MODULE
TRANSMITTER
ENCODER
SIGNAL PROCESSOR
SENSOR INTERFACE
SENSOR
670
654
650
642
640
632
630
614
610
618
612
318
310

FIG. 6

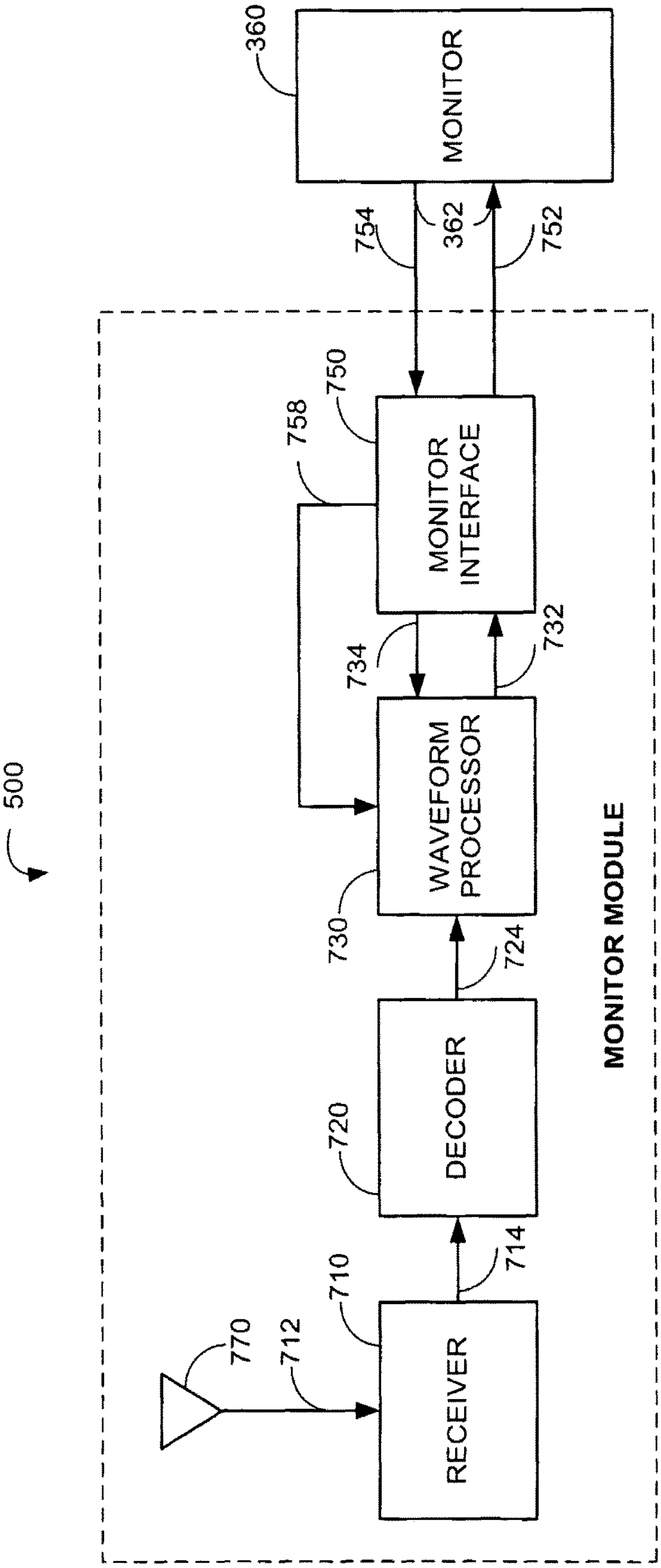

500
360
MONITOR
754
362
752
750
758
MONITOR INTERFACE
734
732
WAVEFORM PROCESSOR
730
724
DECODER
720
714
710
770
712
RECEIVER
MONITOR MODULE

FIG. 7

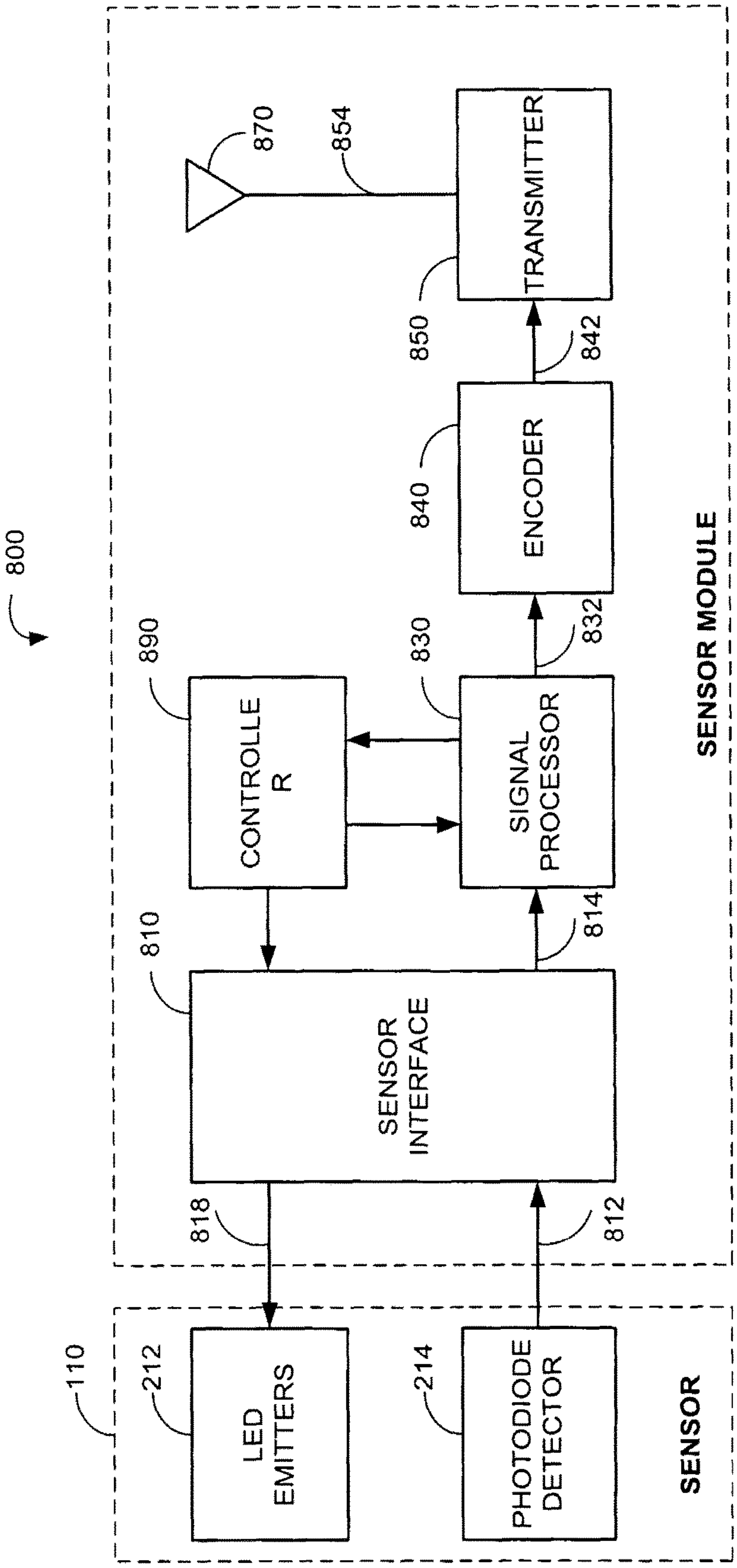
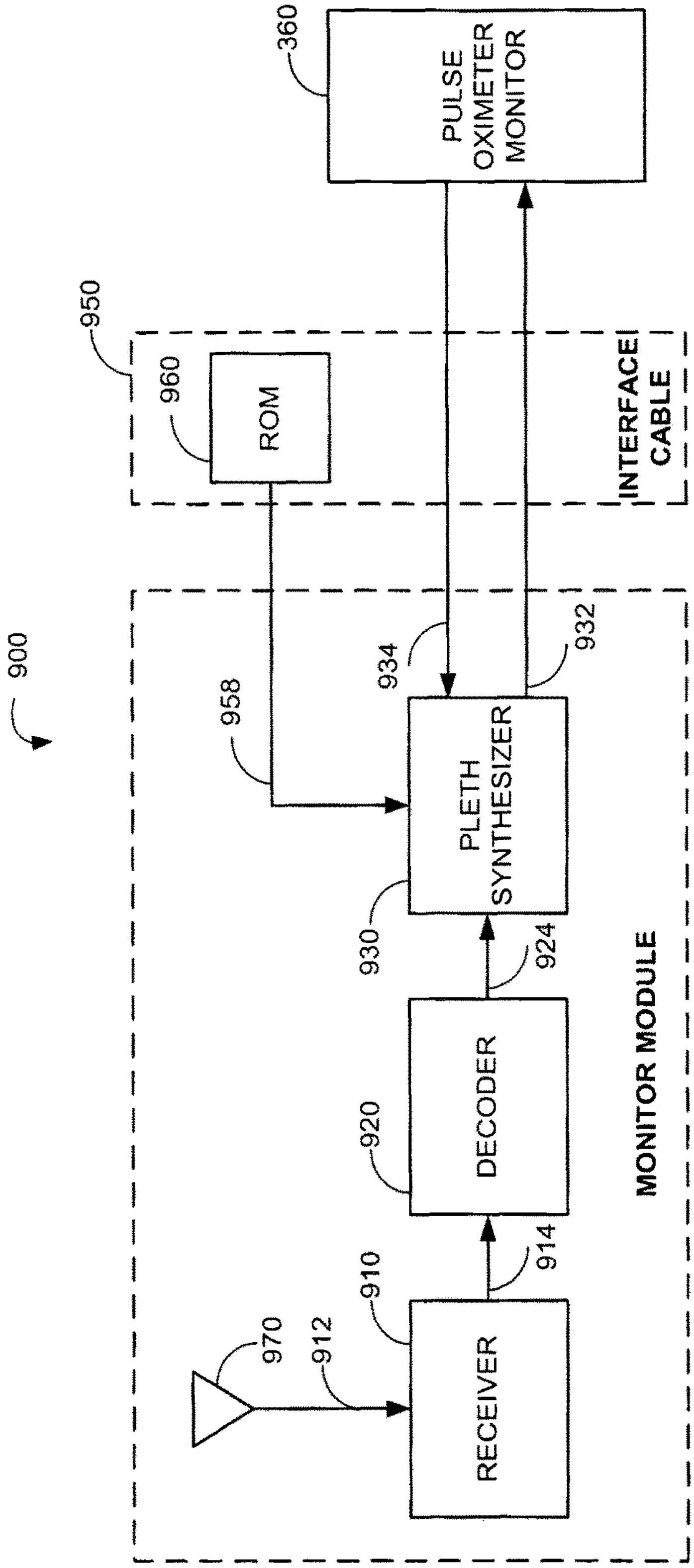

800
SENSOR MODULE
870
854
TRANSMITTER
850
842
ENCODER
840
832
890
CONTROLLE
R
830
SIGNAL
PROCESSOR
810
814
SENSOR
INTERFACE
818
812
110
212
LED
EMITTERS
214
PHOTODIODE
DETECTOR
SENSOR

FIG. 8



900
360
PULSE OXIMETER MONITOR
950
960
ROM
INTERFACE CABLE
958
934
932
PLETH SYNTHESIZER
930
924
DECODER
920
914
910
970
912
RECEIVER
MONITOR MODULE

FIG. 9

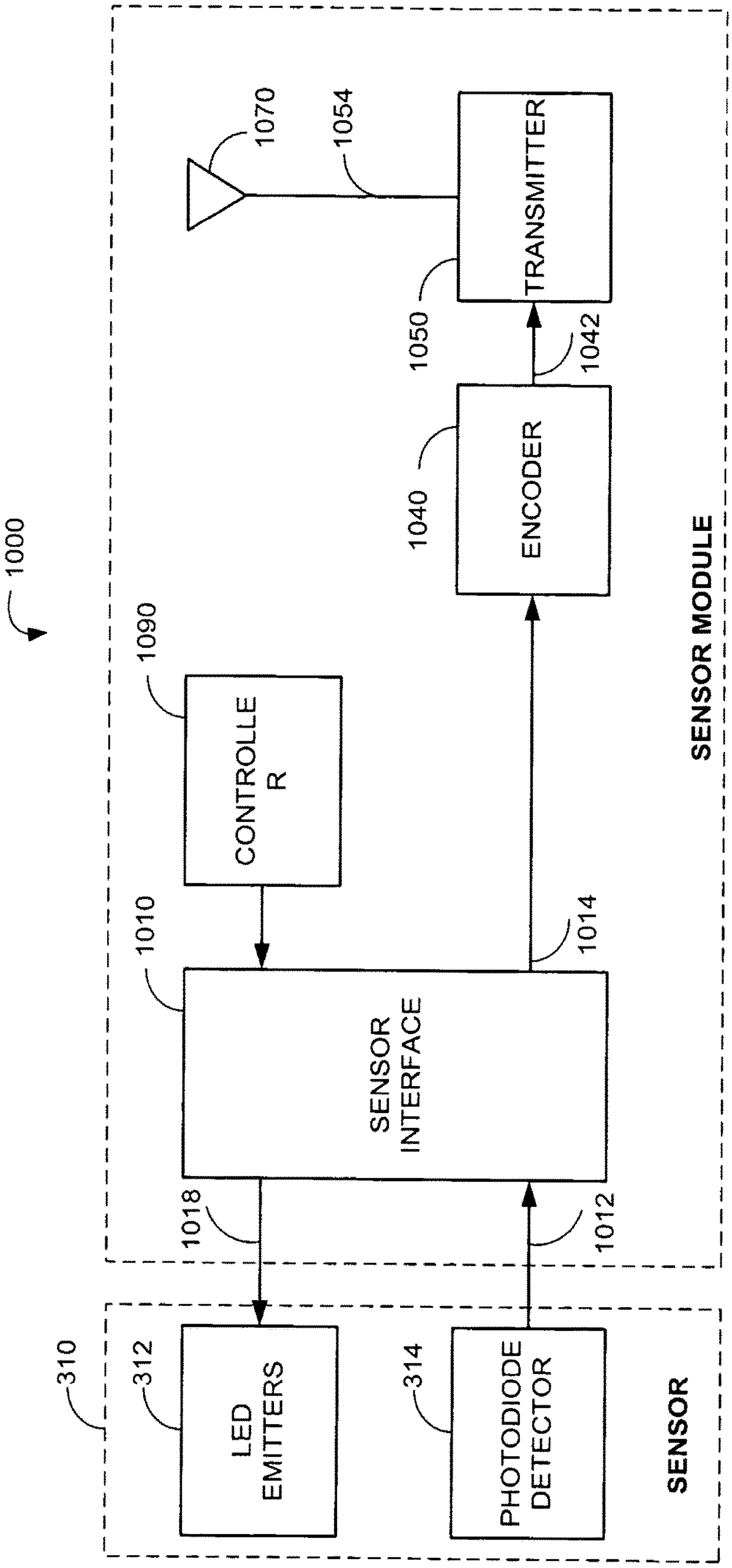

1000
1070
1054
TRANSMITTER
1050
1042
ENCODER
1040
1090
CONTROLLE
R
SENSOR MODULE
1010
1014
SENSOR
INTERFACE
1018
1012
310
312
LED
EMITTERS
314
PHOTODIODE
DETECTOR
SENSOR

FIG. 10

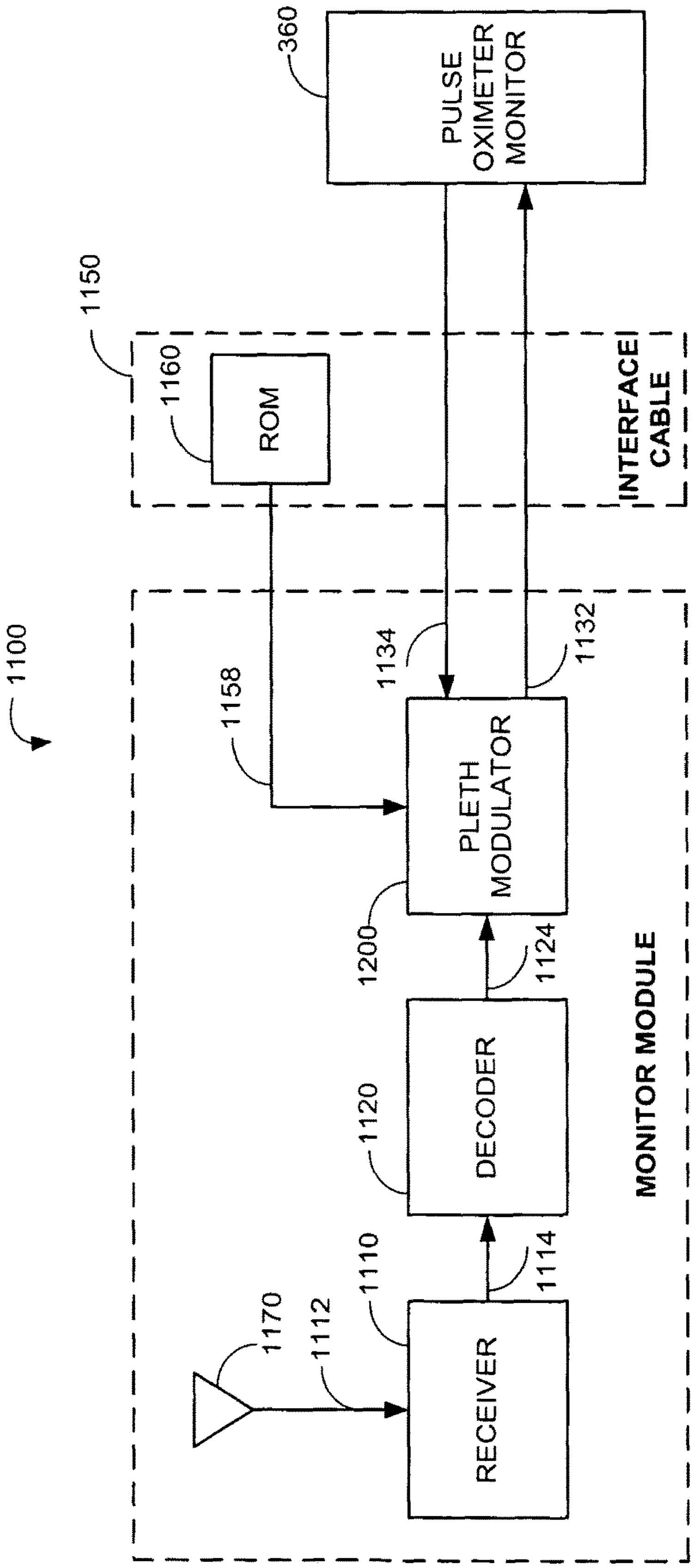
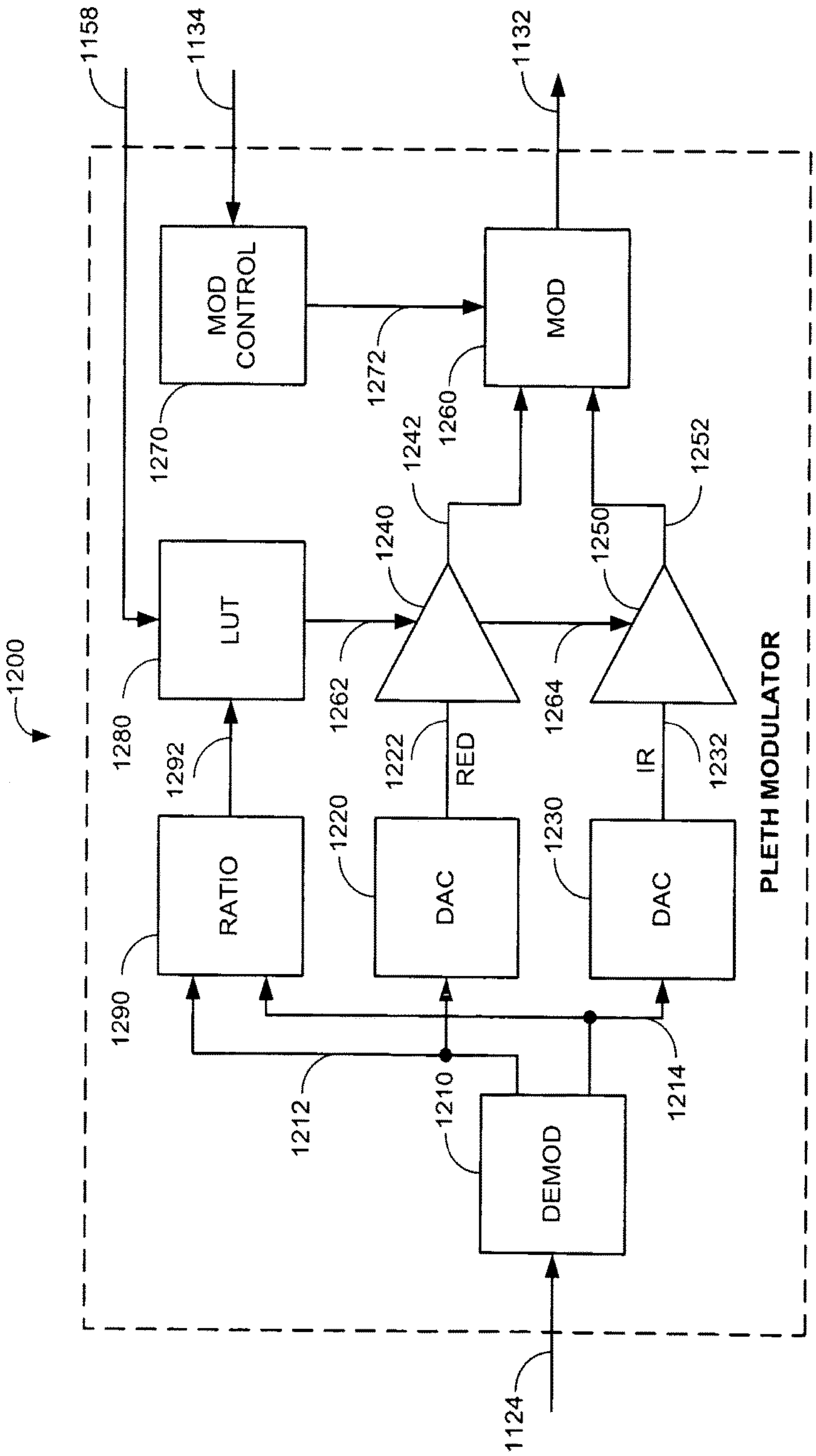

360
PULSE OXIMETER MONITOR
1150
1160
ROM
INTERFACE CABLE
1100
1158
1134
1132
PLETH MODULATOR
1200
1124
DECODER
1120
MONITOR MODULE
1170
1112
1110
1114
RECEIVER

FIG. 11



1200
1158
1134
1132
MOD CONTROL
MOD
1270
1272
1260
1242
1252
LUT
1280
1262
1240
1250
1264
RED
IR
1222
1232
1292
RATIO
DAC
DAC
1290
1220
1230
1212
1210
1214
DEMOD
1124
PLETH MODULATOR

FIG. 12

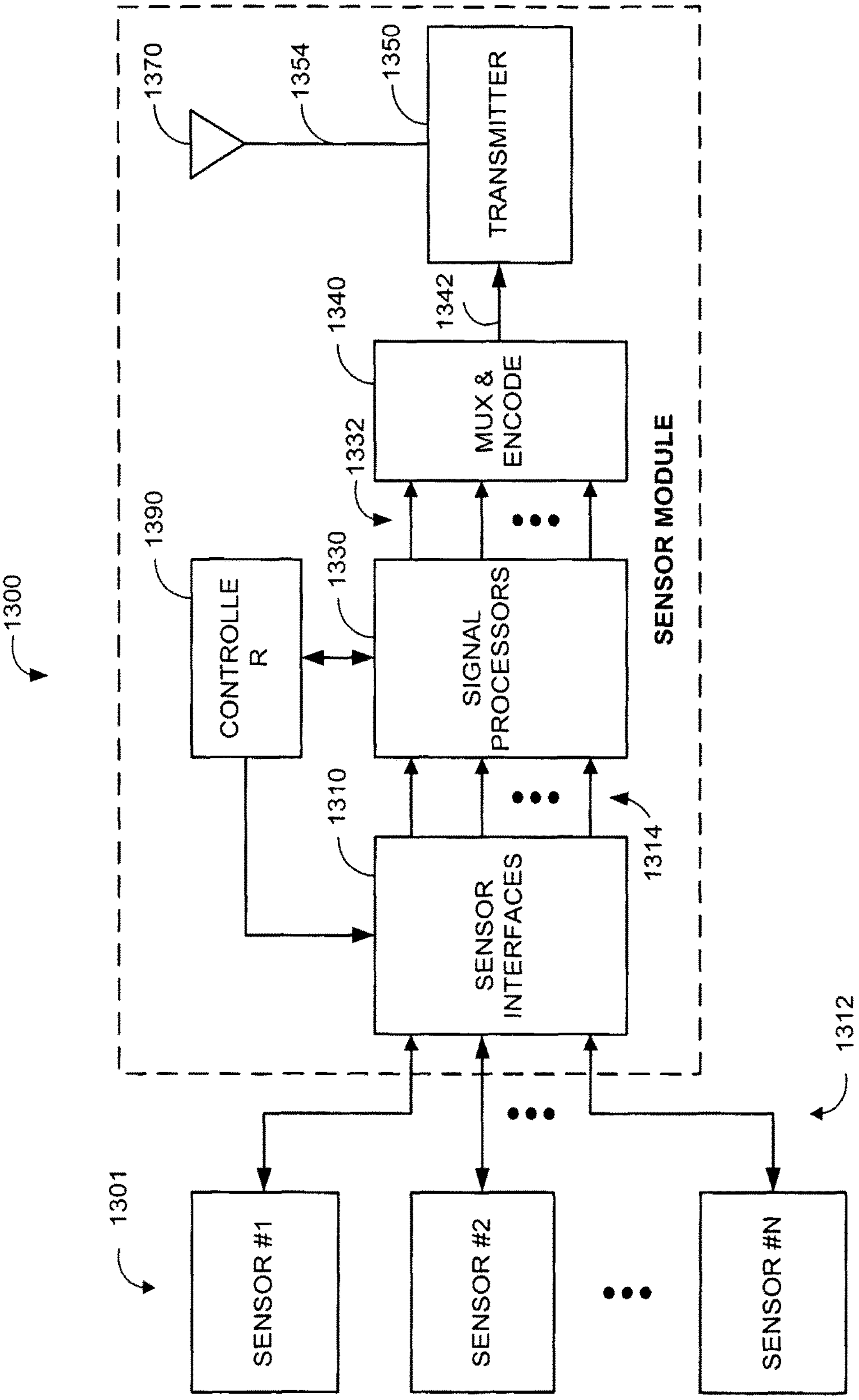

1300
SENSOR MODULE
1370
1354
1350
TRANSMITTER
1342
1340
MUX &
ENCODE
1332
1390
CONTROLLE
R
1330
SIGNAL
PROCESSORS
1310
SENSOR
INTERFACES
1314
1312
1301
SENSOR #1
SENSOR #2
SENSOR #N

FIG. 13

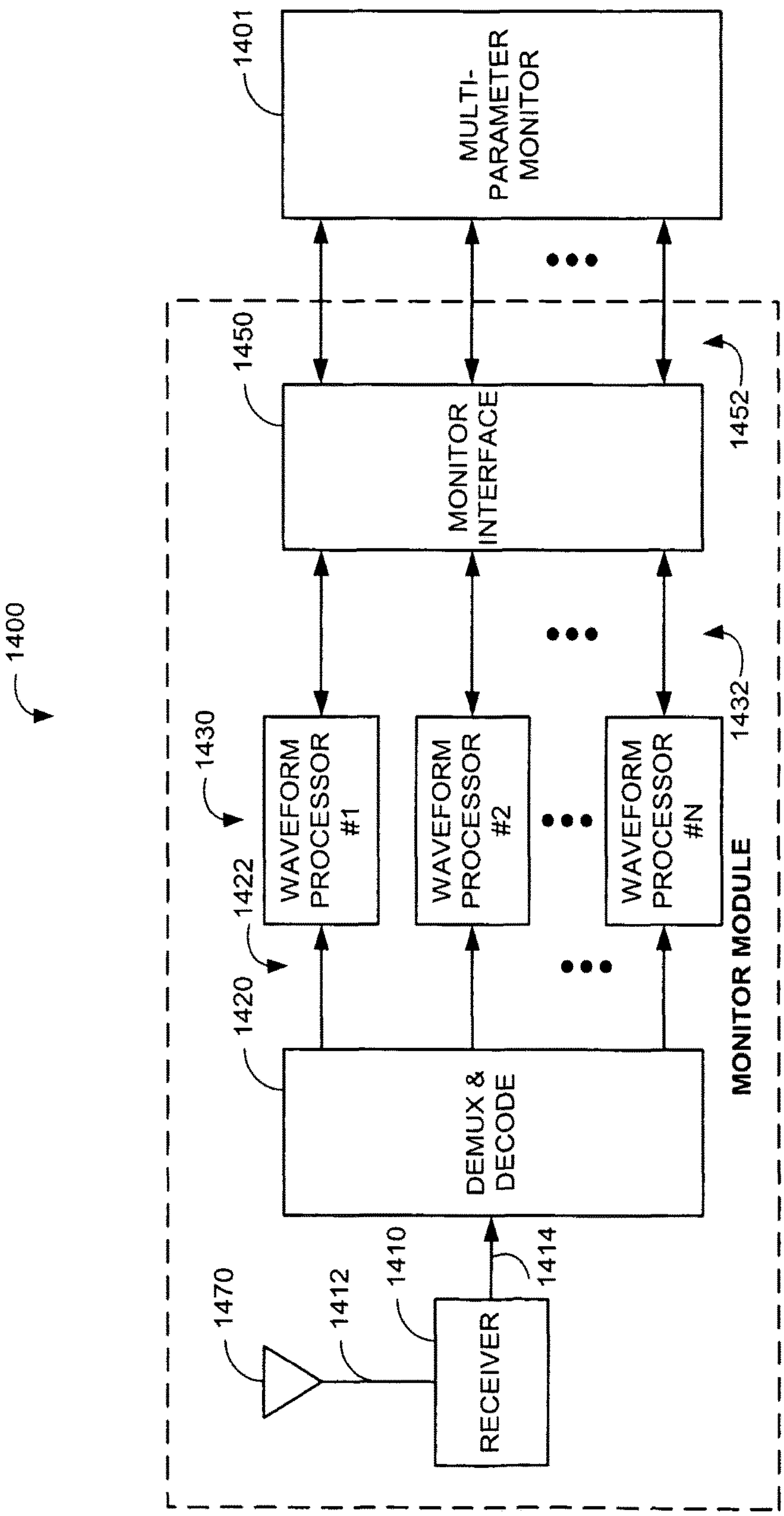

1400
1401
MULTI-PARAMETER MONITOR
1450
MONITOR INTERFACE
1452
1430
WAVEFORM PROCESSOR #1
WAVEFORM PROCESSOR #2
WAVEFORM PROCESSOR #N
1432
1422
1420
DEMUX & DECODE
1470
1412
1410
RECEIVER
1414
MONITOR MODULE

FIG. 14

ARM MOUNTABLE PORTABLE PATIENT MONITOR

REFERENCE TO RELATED APPLICATION

The present application is a continuation of U.S. patent application Ser. No. 14/815,232, filed on Jul. 31, 2015, entitled "Physiological Measurement Communications Adapter," which is a continuation of U.S. patent application Ser. No. 14/217,788, filed on Mar. 18, 2014, entitled "Wrist-Mounted Physiological Measurement Device," now U.S. Pat. No. 9,113,832, which is a continuation of U.S. patent application Ser. No. 14/037,137, filed on Sep. 25, 2013, entitled "Physiological Measurement Communications Adapter," now U.S. Pat. No. 9,113,831, which is a continuation of U.S. patent application Ser. No. 12/955,826, filed on Nov. 29, 2010, entitled "Physiological Measurement Communications Adapter," now U.S. Pat. No. 8,548,548, which is a continuation of U.S. patent application Ser. No. 11/417,006, filed on May 3, 2006, entitled "Physiological Measurement Communications Adapter," now U.S. Pat. No. 7,844,315, which claims priority benefit under 35 U.S.C. § 120 to, and is a continuation of, U.S. patent application Ser. No. 11/048,330, filed Feb. 1, 2005, entitled "Physiological Measurement Communications Adapter," now U.S. Pat. No. 7,844,314, which is a continuation of U.S. patent application Ser. No. 10/377,933, entitled "Physiological Measurement Communications Adapter," now U.S. Pat. No. 6,850,788, which claims priority benefit under 35 U.S.C. § 119(e) from U.S. Provisional Application No. 60/367,428, filed Mar. 25, 2002, entitled "Physiological Measurement Communications Adapter." The present application also incorporates the foregoing utility disclosures herein by reference.

BACKGROUND OF THE INVENTION

Patient vital sign monitoring may include measurements of blood oxygen, blood pressure, respiratory gas, and EKG among other parameters. Each of these physiological parameters typically requires a sensor in contact with a patient and a cable connecting the sensor to a monitoring device. For example, FIGS. **1-2** illustrate a conventional pulse oximetry system **100** used for the measurement of blood oxygen. As shown in FIG. **1**, a pulse oximetry system has a sensor **110**, a patient cable **140** and a monitor **160**. The sensor **110** is typically attached to a finger **10** as shown. The sensor **110** has a plug **118** that inserts into a patient cable socket **142**. The monitor **160** has a socket **162** that accepts a patient cable plug **144**. The patient cable **140** transmits an LED drive signal **252** (FIG. **2**) from the monitor **160** to the sensor **110** and a resulting detector signal **254** (FIG. **2**) from the sensor **110** to the monitor **160**. The monitor **160** processes the detector signal **254** (FIG. **2**) to provide, typically, a numerical readout of the patient's oxygen saturation, a numerical readout of pulse rate, and an audible indicator or "beep" that occurs in response to each arterial pulse.

As shown in FIG. **2**, the sensor **110** has both red and infrared LED emitters **212** and a photodiode detector **214**. The monitor **160** has a sensor interface **271**, a signal processor **273**, a controller **275**, output drivers **276**, a display and audible indicator **278**, and a keypad **279**. The monitor **160** determines oxygen saturation by computing the differential absorption by arterial blood of the two wavelengths emitted by the sensor emitters **212**, as is well-known in the art. The sensor interface **271** provides LED drive current **252** which alternately activates the red and IR LED emitters **212**. The photodiode detector **214** generates a signal **254** corresponding to the red and infrared light energy attenuated from transmission through the patient finger **10** (FIG. **1**). The sensor interface **271** also has input circuitry for amplification, filtering and digitization of the detector signal **254**. The signal processor **273** calculates a ratio of detected red and infrared intensities, and an arterial oxygen saturation value is empirically determined based on that ratio. The controller **275** provides hardware and software interfaces for managing the display and audible indicator **278** and keypad **279**. The display and audible indicator **278** shows the computed oxygen status, as described above, and provides the pulse beep as well as alarms indicating oxygen desaturation events. The keypad **279** provides a user interface for setting alarm thresholds, alarm enablement, and display options, to name a few.

SUMMARY OF THE INVENTION

Conventional physiological measurement systems are limited by the patient cable connection between sensor and monitor. A patient must be located in the immediate vicinity of the monitor. Also, patient relocation requires either disconnection of monitoring equipment and a corresponding loss of measurements or an awkward simultaneous movement of patient equipment and cables. Various devices have been proposed or implemented to provide wireless communication links between sensors and monitors, freeing patients from the patient cable tether. These devices, however, are incapable of working with the large installed base of existing monitors and sensors, requiring caregivers and medical institutions to suffer expensive wireless upgrades. It is desirable, therefore, to provide a communications adapter that is plug-compatible both with existing sensors and monitors and that implements a wireless link replacement for the patient cable.

An aspect of a physiological measurement communications adapter comprises a sensor interface configured to receive a sensor signal. A transmitter modulates a first baseband signal responsive to the sensor signal so as to generate a transmit signal. A receiver demodulates a receive signal corresponding to the transmit signal so as to generate a second baseband signal corresponding to the first baseband signal. Further, a monitor interface is configured to communicate a waveform responsive to the second baseband signal to a sensor port of a monitor. The waveform is adapted to the monitor so that measurements derived by the monitor from the waveform are generally equivalent to measurements derivable from the sensor signal. The communications adapter may further comprise a signal processor having an input in communications with the sensor interface, where the signal processor is operable to derive a parameter responsive to the sensor signal and where the first baseband signal is responsive to the parameter. The parameter may correspond to at least one of a measured oxygen saturation and a pulse rate.

One embodiment may further comprise a waveform generator that synthesizes the waveform from a predetermined shape. The waveform generator synthesizes the waveform at a frequency adjusted to be generally equivalent to the pulse rate. The waveform may have a first amplitude and a second amplitude, and the waveform generator may be configured to adjusted the amplitudes so that measurements derived by the monitor are generally equivalent to a measured oxygen saturation.

In another embodiment, the sensor interface is operable on the sensor signal to provide a plethysmograph signal output, where the first baseband signal is responsive to the plethysmograph signal. This embodiment may further comprise a waveform modulator that modifies a decoded signal responsive to the second baseband signal to provide the waveform. The waveform modulator may comprise a demodulator that separates a first signal and a second signal from the decoded signal, an amplifier that adjusts amplitudes of the first and second signals to generate a first adjusted signal and a second adjusted signal, and a modulator that combines the first and second adjusted signals into the waveform. The amplitudes of the first and second signals may be responsive to predetermined calibration data for the sensor and the monitor.

An aspect of a physiological measurement communications adapter method comprises the steps of inputting a sensor signal at a patient location, communicating patient data derived from the sensor signal between the patient location and a monitor location, constructing a waveform at the monitor location responsive to the sensor signal, and providing the waveform to a monitor via a sensor port. The waveform is constructed so that the monitor calculates a parameter generally equivalent to a measurement derivable from the sensor signal.

In one embodiment, the communicating step may comprise the substeps of deriving a conditioned signal from the sensor signal, calculating a parameter signal from the conditioned signal, and transmitting the parameter signal from the patient location to the monitor location. The constructing step may comprise the substep of synthesizing the waveform from the parameter signal. In an alternative embodiment, the communicating step may comprise the substeps of deriving a conditioned signal from said sensor signal and transmitting the conditioned signal from the patient location to the monitor location. The constructing step may comprise the substeps of demodulating the conditioned signal and remodulating the conditioned signal to generate the waveform. The providing step may comprise the substeps of inputting a monitor signal from an LED drive output of the sensor port, modulating the waveform in response to the monitor signal, and outputting the waveform on a detector input of the sensor port.

Another aspect of a physiological measurement communications adapter comprises a sensor interface means for inputting a sensor signal and outputting a conditioned signal, a transmitter means for sending data responsive to the sensor signal, and a receiver means for receiving the data. The communications adapter further comprises a waveform processor means for constructing a waveform from the data so that measurements derived by a monitor from the waveform are generally equivalent to measurements derivable from the sensor signal, and a monitor interface means for communicating the waveform to a sensor port of the monitor. The communications adapter may further comprise a signal processor means for deriving a parameter signal from the conditioned signal, where the data comprises the parameter signal. The waveform processor means may comprise a means for synthesizing the waveform from the parameter signal. The data may comprise the conditioned signal, and the waveform processor means may comprise a means for modulating the conditioned signal in response to the monitor.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an illustration of a prior art pulse oximetry system;

FIG. **2** is a functional block diagram of a prior art pulse oximetry system;

FIG. **3** is an illustration of a physiological measurement communications adapter;

FIGS. **4**A-B are illustrations of communications adapter sensor modules;

FIGS. **5**A-C are illustrations of communications adapter monitor modules;

FIG. **6** is a functional block diagram of a communications adapter sensor module;

FIG. **7** is a functional block diagram of a communications adapter monitor module;

FIG. **8** is a functional block diagram of a sensor module configured to transmit measured pulse oximeter parameters;

FIG. **9** is a functional block diagram of a monitor module configured to received measured pulse oximeter parameters;

FIG. **10** is a functional block diagram of a sensor module configured to transmit a plethysmograph;

FIG. **11** is a functional block diagram of a monitor module configured to receive a plethysmograph;

FIG. **12** is a functional block diagram of a waveform modulator;

FIG. **13** is a functional block diagram of a sensor module configured for multiple sensors; and

FIG. **14** is a functional block diagram of a monitor module configured for multiple sensors.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Overview

FIG. **3** illustrates one embodiment of a communications adapter. FIGS. **4**-**5** illustrate physical configurations for a communications adapter. In particular, FIGS. **4**A-B illustrate sensor module configurations and FIGS. **5**A-C illustrate monitor module configurations. FIGS. **6**-**14** illustrate communications adapter functions. In particular, FIGS. **6**-**7** illustrate general functions for a sensor module and a monitor module, respectively. FIGS. **8**-**9** functionally illustrate a communications adapter where derived pulse oximetry parameters, such as saturation and pulse rate are transmitted between a sensor module and a monitor module. Also, FIGS. **10**-**12** functionally illustrate a communications adapter where a plethysmograph is transmitted between a sensor module and a monitor module. FIGS. **13**-**14** functionally illustrate a multiple-parameter communications adapter.

FIG. **3** illustrates a communications adapter **300** having a sensor module **400** and a monitor module **500**. The communications adapter **300** communicates patient data derived from a sensor **310** between the sensor module **400**, which is located proximate a patient **20** and the monitor module **500**, which is located proximate a monitor **360**. A wireless link **340** is provided between the sensor module **400** and the monitor module **500**, replacing the conventional patient cable, such as a pulse oximetry patient cable **140** (FIG. **1**). Advantageously, the sensor module **400** is plug-compatible with a conventional sensor **310**. In particular, the sensor connector **318** connects to the sensor module **400** in a similar manner as to a patient cable. Further, the sensor module **400** outputs a drive signal to the sensor **310** and inputs a sensor signal from the sensor **310** in an equivalent manner as a conventional monitor **360**. The sensor module **400** may be battery powered or externally powered. External power may be for recharging internal batteries or for powering the sensor module during operation or both.

As shown in FIG. **3**, the monitor module **500** is advantageously plug-compatible with a conventional monitor **360**. In particular, the monitor's sensor port **362** connects to the monitor module **500** in a similar manner as to a patient cable, such as a pulse oximetry patient cable **140** (FIG. **1**). Further, the monitor module **500** inputs a drive signal from the monitor **360** and outputs a corresponding sensor signal to the monitor **360** in an equivalent manner as a conventional sensor **310**. As such, the combination sensor module **400** and monitor module **500** provide a plug-compatible wireless replacement for a patient cable, adapting an existing wired physiological measurement system into a wireless physiological measurement system. The monitor module **500** may be battery powered, powered from the monitor, such as by tapping current from a monitor's LED drive, or externally powered from an independent AC or DC power source.

Although a communications adapter **300** is described herein with respect to a pulse oximetry sensor and monitor, one of ordinary skill in the art will recognize that a communications adapter may provide a plug-compatible wireless replace for a patient cable that connects any physiological sensor and corresponding monitor. For example, a communications adapter **300** may be applied to a biopotential sensor, a non-invasive blood pressure (NIBP) sensor, a respiratory rate sensor, a glucose sensor and the corresponding monitors, to name a few.

Sensor Module Physical Configurations

FIGS. **4**A-B illustrate physical embodiments of a sensor module **400**. FIG. **4**A illustrates a wrist-mounted module **410** having a wrist strap **411**, a case **412** and an auxiliary cable **420**. The case **412** contains the sensor module electronics, which are functionally described with respect to FIG. **6**, below. The case **412** is mounted to the wrist strap **411**, which attaches the wrist-mounted module **410** to a patient **20**. The auxiliary cable **420** mates to a sensor connector **318** and a module connector **414**, providing a wired link between a conventional sensor **310** and the wrist-mounted module **410**. Alternatively, the auxiliary cable **420** is directly wired to the sensor module **400**. The wrist-mounted module **410** may have a display **415** that shows sensor measurements, module status and other visual indicators, such as monitor status. The wrist-mounted module **410** may also have keys (not shown) or other input mechanisms to control its operational mode and characteristics. In an alternative embodiment, the sensor **310** may have a tail (not shown) that connects directly to the wrist-mounted module **410**, eliminating the auxiliary cable **420**.

FIG. **4**B illustrates a clip-on module **460** having a clip **461**, a case **462** and an auxiliary cable **470**. The clip **461** attaches the clip-on module **460** to patient clothing or objects near a patient **20**, such as a bed frame. The auxiliary cable **470** mates to the sensor connector **318** and functions as for the auxiliary cable **420** (FIG. **4**A) of the wrist-mounted module **410** (FIG. **4**A), described above. The clip-on module **460** may have a display **463** and keys **464** as for the wrist-mounted module **410** (FIG. **4**A). Either the wrist-mounted module **410** or the clip-on module **460** may have other input or output ports (not shown) that download software, configure the module, or provide a wired connection to other measurement instruments or computing devices, to name a few examples.

Monitor Module Physical Configurations

FIGS. **5**A-C illustrate physical embodiments of a monitor module **500**. FIG. **5**A illustrates a direct-connect module **510** having a case **512** and an integrated monitor connector **514**. The case **512** contains the monitor module electronics, which are functionally described with respect to FIG. **7**, below. The monitor connector **514** mimics that of the monitor end of a patient cable, such as a pulse oximetry patient cable **140** (FIG. **1**), and electrically and mechanically connects the monitor module **510** to the monitor **360** via the monitor's sensor port **362**.

FIG. **5**B illustrates a cable-connect module **540** having a case **542** and an auxiliary cable **550**. The case **542** functions as for the direct-connect module **510** (FIG. **5**A), described above. Instead of directly plugging into the monitor **360**, the cable-connect module **540** utilizes the auxiliary cable **550**, which mimics the monitor end of a patient cable, such as a pulse oximetry patient cable **140** (FIG. **1**), and electrically connects the cable-connect module **540** to the monitor sensor port **362**.

FIG. **5**C illustrates a plug-in module **570** having a plug-in case **572** and an auxiliary cable **580**. The plug-in case **572** is mechanically compatible with the plug-in chassis of a multiparameter monitor **370** and may or may not electrically connect to the chassis backplane. The auxiliary cable **580** mimics a patient cable and electrically connects the plug-in module **570** to the sensor port **372** of another plug-in device. A direct-connect module **510** (FIG. **5**A) or a cable-connect module **540** (FIG. **5**B) may also be used with a multiparameter monitor **370**.

In a multiparameter embodiment, such as described with respect to FIGS. **13**-**14**, below, a monitor module **500** may connect to multiple plug-in devices of a multiparameter monitor **370**. For example, a cable-connect module **540** (FIG. **5**B) may have multiple auxiliary cables **550** (FIG. **5**B) that connect to multiple plug-in devices installed within a multiparameter monitor chassis. Similarly, a plug-in module **570** may have one or more auxiliary cables **580** with multiple connectors for attaching to the sensor ports **372** of multiple plug-in devices.

Communications Adapter Functions

FIGS. **6**-**7** illustrate functional embodiments of a communications adapter. FIG. **6** illustrates a sensor module **400** having a sensor interface **610**, a signal processor **630**, an encoder **640**, a transmitter **650** and a transmitting antenna **670**. A physiological sensor **310** provides an input sensor signal **612** at the sensor connector **318**. Depending on the sensor **310**, the sensor module **400** may provide one or more drive signals **618** to the sensor **310**. The sensor interface **610** inputs the sensor signal **612** and outputs a conditioned signal **614**. The conditioned signal **614** may be coupled to the transmitter **650** or further processed by a signal processor **630**. If the sensor module configuration utilizes a signal processor **630**, it derives a parameter signal **632** responsive to the sensor signal **612**, which is then coupled to the transmitter **650**. Regardless, the transmitter **650** inputs a baseband signal **642** that is responsive to the sensor signal **612**. The transmitter **650** modulates the baseband signal **642** with a carrier to generate a transmit signal **654**. The transmit signal **654** may be derived by various amplitude, frequency or phase modulation schemes, as is well known in the art. The transmit signal **654** is coupled to the transmit antenna **670**, which provides wireless communications to a corresponding receive antenna **770** (FIG. **7**), as described below.

As shown in FIG. **6**, the sensor interface **610** conditions and digitizes the sensor signal **612** to generate the conditioned signal **614**. Sensor signal conditioning may be performed in the analog domain or digital domain or both and may include amplification and filtering in the analog domain and filtering, buffering and data rate modification in the digital domain, to name a few. The resulting conditioned signal **614** is responsive to the sensor signal **612** and may be used to calculate or derive a parameter signal **632**.

Further shown in FIG. **6**, the signal processor **630** performs signal processing on the conditioned signal **614** to generate the parameter signal **632**. The signal processing may include buffering, digital filtering, smoothing, averaging, adaptive filtering and frequency transforms to name a few. The resulting parameter signal **632** may be a measurement calculated or derived from the conditioned signal, such as oxygen saturation, pulse rate, blood glucose, blood pressure and EKG to name a few. Also, the parameter signal **632** may be an intermediate result from which the above-stated measurements may be calculated or derived.

As described above, the sensor interface **610** performs mixed analog and digital pre-processing of an analog sensor signal and provides a digital output signal to the signal processor **630**. The signal processor **630** then performs digital post-processing of the front-end processor output. In alternative embodiments, the input sensor signal **612** and the output conditioned signal **614** may be either analog or digital, the front-end processing may be purely analog or purely digital, and the back-end processing may be purely analog or mixed analog or digital.

In addition, FIG. **6** shows an encoder **640**, which translates a digital word or serial bit stream, for example, into the baseband signal **642**, as is well-known in the art. The baseband signal **642** comprises the symbol stream that drives the transmit signal **654** modulation, and may be a single signal or multiple related signal components, such as in-phase and quadrature signals. The encoder **640** may include data compression and redundancy, also well-known in the art.

FIG. **7** illustrates a monitor module **500** having a receive antenna **770**, a receiver **710**, a decoder **720**, a waveform processor **730** and a monitor interface **750**. A receive signal **712** is coupled from the receive antenna **770**, which provides wireless communications to a corresponding transmit antenna **670** (FIG. **6**), as described above. The receiver **710** inputs the receive signal **712**, which corresponds to the transmit signal **654** (FIG. **6**). The receiver **710** demodulates the receive signal to generate a baseband signal **714**. The decoder **720** translates the symbols of the demodulated baseband signal **714** into a decoded signal **724**, such as a digital word stream or bit stream. The waveform processor **730** inputs the decoded signal **724** and generates a constructed signal **732**. The monitor interface **750** is configured to communicate the constructed signal **732** to a sensor port **362** of a monitor **360**. The monitor **360** may output a sensor drive signal **754**, which the monitor interface **750** inputs to the waveform processor **730** as a monitor drive signal **734**. The waveform processor **730** may utilize the monitor drive signal **734** to generate the constructed signal **732**. The monitor interface **750** may also provide characterization information **758** to the waveform processor **730**, relating to the monitor **360**, the sensor **310** or both, that the waveform processor **730** utilizes to generate the constructed signal **732**.

The constructed signal **732** is adapted to the monitor **360** so that measurements derived by the monitor **360** from the constructed signal **732** are generally equivalent to measurements derivable from the sensor signal **612** (FIG. **6**). Note that the sensor **310** (FIG. **6**) may or may not be directly compatible with the monitor **360**. If the sensor **310** (FIG. **6**) is compatible with the monitor **360**, the constructed signal **732** is generated so that measurements derived by the monitor **360** from the constructed signal **732** are generally equivalent (within clinical significance) with those derivable directly from the sensor signal **612** (FIG. **6**). If the sensor **310** (FIG. **6**) is not compatible with the monitor **360**, the constructed signal **732** is generated so that measurements derived by the monitor **360** from the constructed signal **732** are generally equivalent to those derivable directly from the sensor signal **612** (FIG. **6**) using a compatible monitor.

Wireless Pulse Oximetry

FIGS. **8-11** illustrate pulse oximeter embodiments of a communications adapter. FIGS. **8-9** illustrate a sensor module and a monitor module, respectively, configured to communicate measured pulse oximeter parameters. FIG. **10-11** illustrate a sensor module and a monitor module, respectively, configured to communicate a plethysmograph signal.

Parameter Transmission

FIG. **8** illustrates a pulse oximetry sensor module **800** having a sensor interface **810**, signal processor **830**, encoder **840**, transmitter **850**, transmitting antenna **870** and controller **890**. The sensor interface **810**, signal processor **830** and controller **890** function as described with respect to FIG. **2**, above. The sensor interface **810** communicates with a standard pulse oximetry sensor **310**, providing an LED drive signal **818** to the LED emitters **312** and receiving a sensor signal **812** from the detector **314** in response. The sensor interface **810** provides front-end processing of the sensor signal **812**, also described above, providing a plethysmograph signal **814** to the signal processor **830**. The signal processor **830** then derives a parameter signal **832** that comprises a real time measurement of oxygen saturation and pulse rate. The parameter signal **832** may include other parameters, such as measurements of perfusion index and signal quality. In one embodiment, the signal processor is an MS-5 or MS-7 board available from Masimo Corporation, Irvine, Calif.

As shown in FIG. **8**, the encoder **840**, the transmitter **850** and the transmitting antenna **870** function as described with respect to FIG. **6**, above. For example, the parameter signal **832** may be a digital word stream that is serialized into a bit stream and encoded into a baseband signal **842**. The baseband signal **842** may be, for example, two bit symbols that drive a quadrature phase shift keyed (QPSK) modulator in the transmitter **850**. Other encodings and modulations are also applicable, as described above. The transmitter **850** inputs the baseband signal **842** and generates a transmit signal **854** that is a modulated carrier having a frequency suitable for short-range transmission, such as within a hospital room, doctor's office, emergency vehicle or critical care ward, to name a few. The transmit signal **854** is coupled to the transmit antenna **870**, which provides wireless communications to a corresponding receive antenna **970** (FIG. **9**), as described below.

FIG. **9** illustrates a monitor module **900** having a receive antenna **970**, a receiver **910**, a decoder **920**, a waveform generator **930** and an interface cable **950**. The receive antenna **970**, receiver **910** and decoder **920** function as described with respect to FIG. **7**, above. In particular, the receive signal **912** is coupled from the receive antenna **970**, which provides wireless communications to a corresponding transmit antenna **870** (FIG. **8**). The receiver **910** inputs the receive signal **912**, which corresponds to the transmit signal **854** (FIG. **8**). The receiver **810** demodulates the receive signal **912** to generate a baseband signal **914**. Not accounting for transmission errors, the baseband signal **914** corresponds to the sensor module baseband signal **842** (FIG. **8**), for example a symbol stream of two bits each. The decoder **920** assembles the baseband signal **914** into a parameter signal **924**, which, for example, may be a sequence of digital words corresponding to oxygen saturation and pulse rate. Again, not accounting for transmission errors, the monitor module parameter signal **924** corresponds to the sensor module parameter signal **832** (FIG. **8**), derived by the signal processor **830** (FIG. **8**).

Also shown in FIG. **9**, the waveform generator **930** is a particular embodiment of the waveform processor **730** (FIG. **7**) described above. The waveform generator **930** generates a synthesized waveform **932** that the pulse oximeter monitor **360** can process to calculate SpO_2 and pulse rate values or exception messages. In the present embodiment, the waveform generator output does not reflect a physiological waveform. In particular, the synthesized waveform is not physiological data from the sensor module **800**, but is a waveform synthesized from predetermined stored waveform data to cause the monitor **360** to calculate oxygen saturation and pulse rate equivalent to or generally equivalent (within clinical significance) to that calculated by the signal processor **830** (FIG. **8**). The actual intensity signal from the patient received by the detector **314** (FIG. **8**) is not provided to the monitor **360** in the present embodiment. Indeed, the waveform provided to the monitor **360** will usually not resemble a plethysmographic waveform or other physiological data from the patient to whom the sensor module **800** (FIG. **8**) is attached.

The synthesized waveform **932** is modulated according to the drive signal input **934**. That is, the pulse oximeter monitor **360** expects to receive a red and IR modulated intensity signal originating from a detector, as described with respect to FIGS. **1-2**, above. The waveform generator **930** generates the synthesized waveform **932** with a predetermined shape, such as a triangular or sawtooth waveform stored in waveform generator memory or derived by a waveform generator algorithm. The waveform is modulated synchronously with the drive input **934** with first and second amplitudes that are processed in the monitor **360** as red and IR portions of a sensor signal. The frequency and the first and second amplitudes are adjusted so that pulse rate and oxygen saturation measurements derived by the pulse oximeter monitor **360** are generally equivalent to the parameter measurements derived by the signal processor **830** (FIG. **8**), as described above. One embodiment of a waveform generator **930** is described in U.S. Patent Application No. 60/117,097 entitled "Universal/Upgrading Pulse Oximeter," assigned to Masimo Corporation, Irvine, Calif. and incorporated by reference herein. Although the waveform generator **930** is described above as synthesizing a waveform that does not resemble a physiological signal, one of ordinary skill will recognize that another embodiment of the waveform generator **930** could incorporate, for example, a plethysmograph simulator or other physiological signal simulator.

Further shown in FIG. **9**, the interface cable **950** functions in a manner similar to the monitor interface **750** (FIG. **7**) described above. The interface cable **950** is configured to communicate the synthesized waveform **932** to the monitor **360** sensor port and to communicate the sensor drive signal **934** to the waveform generator **930**. The interface cable **950** may include a ROM **960** that contains monitor and sensor characterization data. The ROM **960** is read by the waveform generator **930** so that the synthesized waveform **932** is adapted to a particular monitor **360**. For example, the ROM **960** may contain calibration data of red/IR versus oxygen saturation, waveform amplitude and waveform shape information. An interface cable is described in U.S. Patent Application No. 60/117,092, referenced above. Monitor-specific SatShare™ brand interface cables are available from Masimo Corporation, Irvine, Calif. In an alternative embodiment, such as a direct connect monitor module as illustrated in FIG. **5A**, an interface cable **950** is not used and the ROM **960** may be incorporated within the monitor module **900** itself.

Plethysmograph Transmission

FIG. **10** illustrates another pulse oximetry sensor module **1000** having a sensor interface **1010**, encoder **1040**, transmitter **1050**, transmitting antenna **1070** and controller **1090**, which have the corresponding functions as those described with respect to FIG. **8**, above. The encoder **1040**, however, inputs a plethysmograph signal **1014** rather than oxygen saturation and pulse rate measurements **832** (FIG. **8**). Thus, the sensor module **1000** according to this embodiment encodes and transmits a plethysmograph signal **1014** to a corresponding monitor module **1100** (FIG. **11**) in contrast to derived physiological parameters, such as oxygen saturation and pulse rate. The plethysmograph signal **1014** is illustrated in FIG. **10** as being a direct output from the sensor interface **1010**. In another embodiment, the sensor module **1000** incorporates a decimation processor, not shown, after the sensor interface **1010** so as to provide a plethysmograph signal **1014** having a reduced sample rate.

FIG. **11** illustrates another pulse oximetry monitor module **1100** having a receive antenna **1170**, a receiver **1110**, a decoder **1120** and an interface cable **1150**, which have the corresponding functions as those described with respect to FIG. **9**, above. This monitor module embodiment **1100**, however, has a waveform modulator **1200** rather than a waveform generator **930** (FIG. **9**), as described above. The waveform modulator **1200** inputs a plethysmograph signal from the decoder **1120** rather than oxygen saturation and pulse rate measurements, as described with respect to FIG. **9**, above. Further, the waveform modulator **1200** provides an modulated waveform **1132** to the pulse oximeter monitor **360** rather than a synthesized waveform, as described with respect to FIG. **9**. The modulated waveform **1132** is a plethysmographic waveform modulated according to the monitor drive signal input **1134**. That is, the waveform modulator **1200** does not synthesize a waveform, but rather modifies the received plethysmograph signal **1124** to cause the monitor **360** to calculate oxygen saturation and pulse rate generally equivalent (within clinical significance) to that derivable by a compatible, calibrated pulse oximeter directly from the sensor signal **1012** (FIG. **10**). The waveform modulator **1200** is described in further detail with respect to FIG. **12**, below.

FIG. **12** shows a waveform modulator **1200** having a demodulator **1210**, a red digital-to-analog converter (DAC) **1220**, an IR DAC **1230**, a red amplifier **1240**, an IR amplifier **1250**, a modulator **1260**, a modulator control **1270**, a look-up table (LUT) **1280** and a ratio calculator **1290**. The waveform modulator **1200** demodulates red and IR plethysmographs ("pleths") from the decoder output **1124** into a separate red pleth **1222** and IR pleth **1232**. The waveform modulator **1200** also adjusts the amplitudes of the pleths **1222**, **1232** according to stored calibration curves for the sensor **310** (FIG. **10**) and the monitor **360** (FIG. **11**). Further, the waveform modulator **1200** re-modulates the adjusted red pleth **1242** and adjusted IR pleth **1252**, generating a modulated waveform **1132** to the monitor **360** (FIG. **11**).

As shown in FIG. **12**, the demodulator **1210** performs the demodulation function described above, generating digital red and IR pleth signals **1212**, **1214**. The DACs **1220**, **1230** convert the digital pleth signals **1212**, **1214** to corresponding analog pleth signals **1222**, **1232**. The amplifiers **1240**, **1250** have variable gain control inputs **1262**, **1264** and perform the amplitude adjustment function described above, generating adjusted red and IR pleth signals **1242**, **1252**. The modulator **1260** performs the re-modulation function described above, combining the adjusted red and IR pleth signals **1242**, **1252** according to a control signal **1272**. The modulator control **1270** generates the control signal **1272** synchronously with the LED drive signal(s) **1134** from the monitor **360**.

Also shown in FIG. **12**, the ratio calculator **1290** derives a red/IR ratio from the demodulator outputs **1212**, **1214**. The LUT **1280** stores empirical calibration data for the sensor **310** (FIG. **10**). The LUT **1280** also downloads monitor-specific calibration data from the ROM **1160** (FIG. **11**) via the ROM output **1158**. From this calibration data, the LUT **1280** determines a desired red/IR ratio for the modulated waveform **1132** and generates red and IR gain outputs **1262**, **1264** to the corresponding amplifiers **1240**, **1250**, accordingly. A desired red/IR ratio is one that allows the monitor **360** (FIG. **11**) to derive oxygen saturation measurements from the modulated waveform **1132** that are generally equivalent to that derivable directly from the sensor signal **1012** (FIG. **10**).

One of ordinary skill in the art will recognize that some of the signal processing functions described with respect to FIGS. **8-11** may be performed either within a sensor module or within a monitor module. Signal processing functions performed within a sensor module may advantageously reduce the transmission bandwidth to a monitor module at a cost of increased sensor module size and power consumption. Likewise, signal processing functions performed within a monitor module may reduce sensor module size and power consumption at a cost of increase transmission bandwidth.

For example, a monitor module embodiment **900** (FIG. **9**) described above receives measured pulse oximeter parameters, such as oxygen saturation and pulse rate, and generates a corresponding synthesized waveform. In that embodiment, the oxygen saturation and pulse rate computations are performed within a sensor module **800** (FIG. **8**). Another monitor module embodiment **1100** (FIG. **11**), also described above, receives a plethysmograph waveform and generates a remodulated waveform. In that embodiment, minimal signal processing is performed within a sensor module **1000** (FIG. **10**). In yet another embodiment, not shown, a sensor module transmits a plethysmograph waveform or a decimated plethysmograph waveform having a reduced sample rate. A corresponding monitor module has a signal processor, such as described with respect to FIG. **8**, in addition to a waveform generator, as described with respect to FIG. **9**. The signal processor computes pulse oximeter parameters and the waveform generator generates a corresponding synthesized waveform, as described above. In this embodiment, minimal signal processing is performed within the sensor module, and the monitor module functions are performed on the pulse oximeter parameters computed within the monitor module.

Wireless Multiple Parameter Measurements

FIGS. **13-14** illustrate a multiple parameter communications adapter. FIG. **13** illustrates a multiple parameter sensor module **1300** having sensor interfaces **1310**, one or more signal processors **1330**, a multiplexer and encoder **1340**, a transmitter **1350**, a transmitting antenna **1370** and a controller **1390**. One or more physiological sensors **1301** provide input sensor signals **1312** to the sensor module **1300**. Depending on the particular sensors **1301**, the sensor module **1300** may provide one or more drive signals **1312** to the sensors **1301** as determined by the controller **1390**. The sensor interfaces **1310** input the sensor signals **1312** and output one or more conditioned signals **1314**. The conditioned signals **1314** may be coupled to the transmitter **1350** or further processed by the signal processors **1330**. If the sensor module configuration utilizes signal processors **1330**, it derives multiple parameter signals **1332** responsive to the sensor signals **1312**, which are then coupled to the transmitter **1350**. Regardless, the transmitter **1350** inputs a baseband signal **1342** that is responsive to the sensor signals **1312**. The transmitter **1350** modulates the baseband signal **1342** with a carrier to generate a transmit signal **1354**, which is coupled to the transmit antenna **1370** and communicated to a corresponding receive antenna **1470** (FIG. **14**), as described with respect to FIG. **6**, above. Alternatively, there may be multiple baseband signals **1342**, and the transmitter **1350** may transmit on multiple frequency channels, where each channel coveys data responsive to one or more of the sensor signals **1314**.

As shown in FIG. **13**, the sensor interface **1310** conditions and digitizes the sensor signals **1312** as described for a single sensor with respect to FIG. **6**, above. The resulting conditioned signals **1314** are responsive to the sensor signals **1312**. The signal processors **1330** perform signal processing on the conditioned signals **1314** to derive parameter signals **1332**, as described for a single conditioned signal with respect to FIG. **6**, above. The parameter signals **1332** may be physiological measurements such as oxygen saturation, pulse rate, blood glucose, blood pressure, EKG, respiration rate and body temperature to name a few, or may be intermediate results from which the above-stated measurements may be calculated or derived. The multiplexer and encoder **1340** combines multiple digital word or serial bit streams into a single digital word or bit stream. The multiplexer and encoder also encodes the digital word or bit stream to generate the baseband signal **1342**, as described with respect to FIG. **6**, above.

FIG. **14** illustrates a multiple parameter monitor module **1400** having a receive antenna **1470**, a receiver **1410**, a demultiplexer and decoder **1420**, one or more waveform processors **1430** and a monitor interface **1450**. The receiver **1410** inputs and demodulates the receive signal **1412** corresponding to the transmit signal **1354** (FIG. **13**) to generate a baseband signal **1414** as described with respect to FIG. **7**, above. The demultiplexer and decoder **1420** separates the symbol streams corresponding to the multiple conditioned signals **1314** (FIG. **13**) and/or parameter signals **1332** (FIG. **13**) and translates these symbol streams into multiple decoded signals **1422**, as described for a single symbol stream with respect to FIG. **7**, above. Alternatively, multiple frequency channels are received to generate multiple baseband signals, each of which are decoded to yield multiple decoded signals **1422**. The waveform processors **1430** input the decoded signals **1422** and generate multiple constructed signals **1432**, as described for a single decoded signal with respect to FIGS. **7-12**, above. The monitor interface **1450** is configured to communicate the constructed signals **1432** to the sensor ports of a multiple parameter monitor **1401** or multiple single parameter monitors, in a manner similar to that for a single constructed signal, as described with respect to FIGS. **7-12**, above. In particular, the constructed signals **1432** are adapted to the monitor **1401** so that measurements derived by the monitor **1401** from the constructed signals **1432** are generally equivalent to measurements derivable directly from the sensor signals **1312** (FIG. **13**).

A physiological measurement communications adapter is described above with respect to wireless communications and, in particular, radio frequency communications. A sensor module and monitor module, however, may also communicate via wired communications, such as telephone, Internet or fiberoptic cable to name a few. Further, wireless communications can also utilize light frequencies, such as IR or laser to name a few.

A physiological measurement communications adapter has been disclosed in detail in connection with various embodiments. These embodiments are disclosed by way of examples only. One of ordinary skill in the art will appreciate many variations and modifications of a physiological measurement communications adapter within the scope of the claims that follow.

What is claimed is:

1. An arm mountable portable patient monitoring device configured to receive physiological information from a plurality of sensors attached to a patient at at least two different measurement sites via wired connections for on-patient monitoring of parameter measurements and wireless transmission of parameter measurements to separate monitoring devices, the portable patient monitoring device comprising:

a housing configured to be secured to an arm of a patient under measurement;

a strap mountable to a back side of the housing and configured to secure the housing to the arm of the patient;

a display positioned on a front side of the housing, the display configured to show at least one status indicator of the portable patient monitoring device and one or more parameter measurements;

a first sensor port positioned on a first side of the housing, the first side of the housing configured to face toward a hand of the arm of the patient when the housing is secured to the arm of the patient, the first sensor port configured to electrically receive a signal from a pulse oximetry sensor via a wired connection from the pulse oximetry sensor to the first sensor port, the wired connection configured to extend from the first sensor port along a path substantially perpendicular to the first side of the housing;

a second sensor port positioned on the housing and configured to receive a signal from a second sensor arrangement via a wired connection;

a third sensor port positioned on the housing configured to receive a signal from a third sensor arrangement via a wired connection;

one or more signal processing arrangements configured to:

receive the signal from the pulse oximetry sensor; and

cause to be displayed, on the display, at least measurements of oxygen saturation and pulse rate derived from the signal; and

a transmitter configured to:

wirelessly transmit information indicative of the measurements of oxygen saturation and pulse rate to a separate monitoring device configured to receive the information indicative of the measurements of oxygen saturation and pulse rate.

2. The portable patient monitoring device of claim **1**, wherein the wired connection from the pulse oximetry sensor to the first sensor port is provided at least in part via a tail of the pulse oximetry sensor.

3. The portable patient monitoring device of claim **2**, wherein the wired connection is configured to run from the first sensor port, at least part way down the arm of the patient, and to a digit of the patient to which the pulse oximetry sensor is configured to be attached.

4. The portable patient monitoring device of claim **3**, wherein the digit is a thumb of the patient.

5. The portable patient monitoring device of claim **1** further comprising:

a cable providing the wired connection from the pulse oximetry sensor to the first sensor port.

6. The portable patient monitoring device of claim **5**, wherein the cable is configured to be removably coupled to the housing via the first sensor port.

7. The portable patient monitoring device of claim **6**, wherein the cable is configured to run from the first sensor port, at least part way down the arm of the patient, and to a digit of the patient to which the pulse oximetry sensor is configured to be attached, wherein the digit is on the hand of the arm of the patient.

8. The portable patient monitoring device of claim **7**, wherein the digit is a thumb of the patient.

9. The portable patient monitoring device of claim **1**, further comprising:

a battery configured to provide power to at least the display and the first sensor port.

10. The portable patient monitoring device of claim **1**, wherein the front side of the housing comprises a single user interface.

11. The portable patient monitoring device of claim **10**, wherein the single user interface comprises the display.

12. The portable patient monitoring device of claim **11**, wherein the display is positioned centrally on the front side of the housing.

13. The portable patient monitoring device of claim **12**, wherein the display positioned on the front side of the housing is sized such that the display covers most of a length of a shortest dimension of the front side of the housing.

14. The portable patient monitoring device of claim **1**, wherein the one or more signal processing arrangements are further configured to:

receive signals from the second and third sensor arrangements; and

cause to be displayed, on the display, at least measurements of one or more additional physiological parameters based on the signals from the second and third sensor arrangements.

15. The portable patient monitoring device of claim **14**, wherein the one or more signal processing arrangements are further configured to:

receive signals from the second and third sensor arrangements; and

cause to be displayed, on the display, measurements of all of the oxygen saturation, pulse rate, and the one or more additional physiological parameters.

16. The portable patient monitoring device of claim **15**, wherein the transmitter is further configured to:

wirelessly transmit information indicative of the measurements of oxygen saturation, pulse rate, and the one or more additional physiological parameters to the separate monitoring device.

17. A method of portable patient monitoring comprising:

providing a portable patient monitoring device according to claim **1**;

attaching the strap to the arm of the patient;

mounting the housing to the strap such that the first sensor port positioned on a first side of the housing faces toward the hand of the arm of the patient;

wrapping the pulse oximetry sensor around a digit of the hand of the patient;

attaching the wired connection from the pulse oximetry sensor to the first sensor port positioned on the first side of the housing; and

activating the portable patient monitoring device such that measurements of oxygen saturation and pulse rate are both:

displayed on the display of the portable patient monitoring device on the patient; and

wirelessly transmitted to the separate monitoring device configured to receive the measurements of oxygen saturation and pulse rate.

18. The method of claim **17**, further comprising:

attaching the second sensor arrangement to a second measurement site on the patient different from the hand of the patient;

attaching the wired connection from the second sensor arrangement to the second sensor port;

attaching the third sensor arrangement to a third measurement site on the patient different from both the hand of the patient and the second measurement site; and

attaching the wired connection from the third sensor arrangement to the third sensor port,

wherein the portable patient monitoring device is further activated such that measurements of one or more additional physiological parameters are both:

displayed on the display of the portable patient monitoring device on the patient; and

wirelessly transmitted to the separate monitoring device.

19. An arm mountable portable patient monitoring device configured to receive physiological information from a plurality of sensors attached to a patient at at least two different measurement sites via wired connections for on-patient monitoring of parameter measurements and wireless transmission of parameter measurements to separate monitoring devices, the portable patient monitoring device comprising:

a housing configured to be secured to an arm of a patient under measurement, the housing comprising a front side including a single user interface, the single user interface comprising a display configured to show at least one or more parameter measurements;

a strap mountable to a back side of the housing and configured to secure the housing to the arm of the patient;

a first sensor port positioned on a first side of the housing, the first side of the housing configured to face toward a hand of the arm of the patient when the housing is secured to the arm of the patient, the first sensor port configured to electrically receive a signal from a pulse oximetry sensor via a wired connection from the pulse oximetry sensor to the first sensor port, the signal from the pulse oximetry sensor including analog information;

a second sensor port positioned on the housing and configured to receive a signal from a second sensor arrangement via a wired connection, the signal from the second sensor arrangement including digital information;

a third sensor port positioned on the housing configured to receive a signal from a third sensor arrangement via a wired connection;

one or more signal processing arrangements configured to:

receive the signal from the pulse oximetry sensor including the analog information;

receive the signal from the second sensor arrangement including the digital information;

determine digital transmit information based at least in part on: the analog information included in the signal from the pulse oximetry sensor, and the digital information included in the signal from the second sensor arrangement; and

cause to be displayed, on the display, at least measurements of oxygen saturation and pulse rate derived from the signal from the pulse oximetry sensor; and

a transmitter configured to:

wirelessly transmit the digital transmit information to a separate monitoring device configured to receive the digital transmit information, wherein the digital transmit information includes at least measurements of oxygen saturation and pulse rate derived from the signal from the pulse oximetry sensor, and wherein the digital transmit information further includes at least physiological measurements derived from the signal from the second sensor arrangement.

20. The portable patient monitoring device of claim **19**, wherein the display is positioned centrally on the front side of the housing and sized such that, if measured along a shortest dimension of the front side of the housing, the display comprises most of a length of the shortest dimension.

21. A method of portable patient monitoring comprising:

providing a portable patient monitoring device according to claim **19**;

attaching the housing to the arm of the patient via the strap such that the first sensor port positioned on a first side of the housing faces toward the hand of the arm of the patient;

attaching the pulse oximetry sensor to a digit of the hand of the patient;

attaching the second sensor arrangement to the patient;

attaching the wired connection from the pulse oximetry sensor to the first sensor port positioned on the first side of the housing;

attaching the wired connection from the second sensor arrangement to the second sensor port; and

activating the portable patient monitoring device such that measurements of oxygen saturation and pulse rate are displayed on the display of the portable patient monitoring device on the patient.

22. The method of claim **21**, wherein activating the portable patient monitoring device further includes causing the digital transmit information to be wirelessly transmitted to the separate monitoring device configured to receive the digital transmit information.

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专利名称(译)	手臂可安装便携式病人监护仪		
公开(公告)号	[US10213108](US10213108)	公开(公告)日	2019-02-26
申请号	US15/448989	申请日	2017-03-03
[标]申请(专利权)人(译)	梅西莫股份有限公司		
申请(专利权)人(译)	Masimo公司		
当前申请(专利权)人(译)	Masimo公司		
[标]发明人	AL ALI AMMAR		
发明人	AL-ALI, AMMAR		
IPC分类号	A61B5/1455 A61B5/00 A61B5/0205 G08B21/04 A61B5/0428 A61B5/024 A61B5/021 A61B5/0404 A61B5/0402 H04W4/70		
CPC分类号	A61B5/0024 A61B5/0004 A61B5/0015 A61B5/0026 A61B5/021 A61B5/0205 A61B5/02427 A61B5/02438 A61B5/0404 A61B5/0428 A61B5/14552 A61B5/6824 A61B5/6826 A61B5/6831 A61B5/6838 A61B5/72 A61B5/7228 A61B5/7271 A61B5/742 A61B5/7425 A61B5/7445 A61B5/7475 G08B21/0453 A61B5/002 Y10S128/903 A61B5/0402 A61B5/1455 A61B2560/0214 A61B2562/222 A61B2562/227 H04W4/70		
优先权	14/217788 2015-08-25 US 14/037137 2015-08-25 US 60/367428 2002-03-25 US		
其他公开文献	US20170224262A1		
外部链接	Espacenet		

摘要(译)

一种可安装臂的便携式患者监测装置，其被配置为通过有线连接从附接到患者的多个传感器接收生理信息，用于对患者进行参数测量的监测以及将参数测量的无线传输分离到单独的监测装置。可安装于臂上的便携式患者监测装置包括壳体，带子，显示器，位于壳体的第一侧上的第一传感器端口，当壳体固定到患者的手臂时，第一传感器端口构造成面向患者的手，第二和第三传感器端口，被配置为经由有线连接从附加传感器装置接收信号，一个或多个信号处理装置被配置为使得显示氧饱和度和脉冲率的测量值，以及发射器被配置为无线传输指示测量值的信息氧饱和度和脉率对单独的监测装置的影响。