

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	MASIMO.317C9
		Application Number	
Title of Invention	BODY WORN MOBILE MEDICAL PATIENT MONITOR		
<p>The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.</p> <p>This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.</p>			

Secrecy Order 37 CFR 5.2:

<input type="checkbox"/>	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
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Inventor Information:

Inventor	1				Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Ammar		Al-Ali			
Residence Information (Select One) • <input checked="" type="radio"/> US Residency <input type="radio"/> Non US Residency <input type="radio"/> Active US Military Service						
City	San Juan Capistrano	State/Province	CA	Country of Residence	US	
Mailing Address of Inventor:						
Address 1	30312 Via Bella					
Address 2						
City	San Juan Capistrano	State/Province	CA			
Postal Code	92675	Country	US			
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button. Add						

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
<input type="checkbox"/> An Address is being provided for the correspondence information of this application.			
Customer Number	64735		
Email Address	efiling@knobbe.com	Add Email	Remove Email

Application Information:

Title of the Invention	BODY WORN MOBILE MEDICAL PATIENT MONITOR		
Attorney Docket Number	MASIMO.317C9	Small Entity Status Claimed	<input type="checkbox"/>
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	17	Suggested Figure for Publication (if any)	

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Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not be** the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Please Select One:	<input checked="" type="radio"/> Customer Number	US Patent Practitioner	<input type="radio"/> Limited Recognition (37 CFR 11.9)
Customer Number	64735		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	15/448989	2017-03-03

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		Application Number			
Title of Invention		BODY WORN MOBILE MEDICAL PATIENT MONITOR			

Prior Application Status		Abandoned		Remove	
Application Number		Continuity Type		Filing or 371(c) Date (YYYY-MM-DD)	
15/448989		Continuation of		14/815232 2015-07-31	
Prior Application Status		Patented		Remove	
Application Number		Continuity Type		Filing Date (YYYY-MM-DD)	
14/815232		Continuation of		14/217788 2014-03-18	
Prior Application Status		Patented		Remove	
Application Number		Continuity Type		Filing Date (YYYY-MM-DD)	
14/217788		Continuation of		14/037137 2013-09-25	
Prior Application Status		Patented		Remove	
Application Number		Continuity Type		Filing Date (YYYY-MM-DD)	
14/037137		Continuation of		12/955826 2010-11-29	
Prior Application Status		Patented		Remove	
Application Number		Continuity Type		Filing Date (YYYY-MM-DD)	
12/955826		Continuation of		11/417006 2006-05-03	
Prior Application Status		Patented		Remove	
Application Number		Continuity Type		Filing Date (YYYY-MM-DD)	
11/417006		Continuation of		11/048330 2005-02-01	
Prior Application Status		Patented		Remove	
Application Number		Continuity Type		Filing Date (YYYY-MM-DD)	
11/048330		Continuation of		10/377933 2003-02-28	
Prior Application Status		Expired		Remove	
Application Number		Continuity Type		Filing or 371(c) Date (YYYY-MM-DD)	
10/377933		Claims benefit of provisional		60/367428 2002-03-25	
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button. Add					

Foreign Priority Information:

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		Application Number	
Title of Invention	BODY WORN MOBILE MEDICAL PATIENT MONITOR		

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)ⁱ the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ⁱ (if applicable)

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Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

<input type="checkbox"/> This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

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NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant	1	<input type="button" value="Remove"/>
<p>If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.</p> <p style="text-align: right;"><input type="button" value="Clear"/></p>		
<input checked="" type="radio"/> Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.		Person who shows sufficient proprietary interest
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:		
<div style="border: 1px solid black; height: 20px; width: 100%;"></div>		
Name of the Deceased or Legally Incapacitated Inventor: <div style="border: 1px solid black; height: 20px; width: 100%;"></div>		
If the Applicant is an Organization check here. <input checked="" type="checkbox"/>		
Organization Name	MASIMO CORPORATION	
Mailing Address Information For Applicant:		
Address 1	52 Discovery	
Address 2		
City	Irvine	State/Province
Country	US	Postal Code
Phone Number		Fax Number
Email Address		
Additional Applicant Data may be generated within this form by selecting the Add button. <input type="button" value="Add"/>		

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	MASIMO.317C9
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Assignee	1			
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.				
				<input type="button" value="Remove"/>
If the Assignee or Non-Applicant Assignee is an Organization check here.				<input type="checkbox"/>
Prefix	Given Name	Middle Name	Family Name	Suffix
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Mailing Address Information For Assignee including Non-Applicant Assignee:				
Address 1		<input type="text"/>		
Address 2		<input type="text"/>		
City	<input type="text"/>	State/Province	<input type="text"/>	
Country ⁱ	<input type="text"/>	Postal Code	<input type="text"/>	
Phone Number	<input type="text"/>	Fax Number	<input type="text"/>	
Email Address	<input type="text"/>			
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.				<input type="button" value="Add"/>

Signature:

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This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Scott Cromar/		Date (YYYY-MM-DD)	2017-04-27
First Name	Scott	Last Name	Cromar	Registration Number
				65066
Additional Signature may be generated within this form by selecting the Add button.				<input type="button" value="Add"/>

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	MASIMO.317C9
		Application Number	
Title of Invention	BODY WORN MOBILE MEDICAL PATIENT MONITOR		

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

BODY WORN MOBILE MEDICAL PATIENT MONITOR**REFERENCE TO RELATED APPLICATION**

[0001] The present application is a continuation of U.S. Patent Application No. 15/448,989, filed on March 3, 2017, entitled “*Physiological Measurement Communications Adapter*,” which is a continuation of U.S. Patent Application No. 14/815,232, filed on July 31, 2015, entitled “*Physiological Measurement Communications Adapter*,” which is a continuation of U.S. Patent Application No. 14/217,788, filed on March 18, 2014, entitled “*Wrist-Mounted Physiological Measurement Device*,” now U.S. Patent No. 9,113,832, which is a continuation of U.S. Patent Application No. 14/037,137, filed on September 25, 2013, entitled “*Physiological Measurement Communications Adapter*,” now U.S. Patent No. 9,113,831, which is a continuation of U.S. Patent Application No. 12/955,826, filed on November 29, 2010, entitled “*Physiological Measurement Communications Adapter*,” now U.S. Patent No. 8,548,548, which is a continuation of U.S. Patent Application No. 11/417,006, filed on May 3, 2006, entitled “*Physiological Measurement Communications Adapter*,” now U.S. Patent No. 7,844,315, which claims priority benefit under 35 U.S.C. § 120 to, and is a continuation of, U.S. Patent Application No. 11/048,330, filed February 1, 2005, entitled “*Physiological Measurement Communications Adapter*,” now U.S. Patent No. 7,844,314, which is a continuation of U.S. Patent Application No. 10/377,933, entitled “*Physiological Measurement Communications Adapter*,” now U.S. Patent 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 March 25, 2002, entitled “*Physiological Measurement Communications Adapter*.” The present application also incorporates the foregoing utility disclosures herein by reference.

BACKGROUND OF THE INVENTION

[0002] 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.

[0003] 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

[0004] 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.

[0005] 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.

[0006] 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.

[0007] 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.

[0008] 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.

[0009] 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 re-modulating 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.

[0010] 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

- [0011]** FIG. 1 is an illustration of a prior art pulse oximetry system;
- [0012]** FIG. 2 is a functional block diagram of a prior art pulse oximetry system;
- [0013]** FIG. 3 is an illustration of a physiological measurement communications adapter;
- [0014]** FIGS. 4A-B are illustrations of communications adapter sensor modules;
- [0015]** FIGS. 5A-C are illustrations of communications adapter monitor modules;
- [0016]** FIG. 6 is a functional block diagram of a communications adapter sensor module;
- [0017]** FIG. 7 is a functional block diagram of a communications adapter monitor module;
- [0018]** FIG. 8 is a functional block diagram of a sensor module configured to transmit measured pulse oximeter parameters;
- [0019]** FIG. 9 is a functional block diagram of a monitor module configured to received measured pulse oximeter parameters;

[0020] FIG. 10 is a functional block diagram of a sensor module configured to transmit a plethysmograph;

[0021] FIG. 11 is a functional block diagram of a monitor module configured to receive a plethysmograph;

[0022] FIG. 12 is a functional block diagram of a waveform modulator;

[0023] FIG. 13 is a functional block diagram of a sensor module configured for multiple sensors; and

[0024] FIG. 14 is a functional block diagram of a monitor module configured for multiple sensors.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Overview

[0025] FIG. 3 illustrates one embodiment of a communications adapter. FIGS. 4-5 illustrate physical configurations for a communications adapter. In particular, FIGS. 4A-B illustrate sensor module configurations and FIGS. 5A-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.

[0026] 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.

[0027] 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.

[0028] 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

[0029] FIGS. 4A-B illustrate physical embodiments of a sensor module **400**. FIG. 4A 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**.

[0030] FIG. **4B** 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. **4A**) of the wrist-mounted module **410** (FIG. **4A**), described above. The clip-on module **460** may have a display **463** and keys **464** as for the wrist-mounted module **410** (FIG. **4A**). 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

[0031] FIGS. **5A-C** illustrate physical embodiments of a monitor module **500**. FIG. **5A** 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**.

[0032] FIG. **5B** 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. **5A**), 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**.

[0033] FIG. **5C** 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. **5A**) or a cable-connect module **540** (FIG. **5B**) may also be used with a multiparameter monitor **370**.

[0034] 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. **5B**) may have multiple auxiliary cables **550** (FIG. **5B**) 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

[0035] 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.

[0036] 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**.

[0037] 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.

[0038] 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.

[0039] 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.

[0040] 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.

[0041] 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

[0042] 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

[0043] 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, CA.

[0044] 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.

[0045] 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).

[0046] 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 SpO₂ 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.

[0047] 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 US Patent Application No. 60/117,097 entitled "Universal/Upgrading Pulse Oximeter," assigned to Masimo Corporation, Irvine, CA 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.

[0048] 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 US Patent Application No. 60/117,092, referenced above. Monitor-specific SatShare™ brand interface cables are available from Masimo Corporation, Irvine, CA. 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

[0049] 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.

[0050] 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.

[0051] 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**).

[0052] 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**.

[0053] 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**).

[0054] 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.

[0055] 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

[0056] 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 conveys data responsive to one or more of the sensor signals **1314**.

[0057] 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.

[0058] 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).

[0059] 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.

[0060] 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. A personal, wearable, wireless physiological system comprising:
 - a physiological sensor configured to be attached to a patient and further configured to measure data useable to determine a physiological parameter;
 - a housing including a first processor configured to receive sensor signals from said physiological sensor and further configured calculate at least one physiological parameter of a patient, said housing configured to be wearable by the patient;
 - a first communications link in communication with said first processor, the communication link configured to at least wirelessly transmit an indication of the calculated at least one physiological parameter;
 - a second communications link configured to wirelessly receive the transmitted indication of the calculated at least one physiological parameter transmitted by the first communications link;
 - a second processor in communication with the second communications link, the second processor configured to provide a signal to the sensor input of a physiological monitor to cause the physiological monitor to display a physiological measurement consistent with the calculated at least one physiological parameter of the patient.

ABSTRACT

A sensor interface is configured to receive a sensor signal. A transmitter generates a transmit signal. A receiver receives the signal corresponding to the transmit signal. Further, a monitor interface is configured to communicate a waveform to the monitor so that measurements derived by the monitor from the waveform are generally equivalent to measurements derivable from the sensor signal.

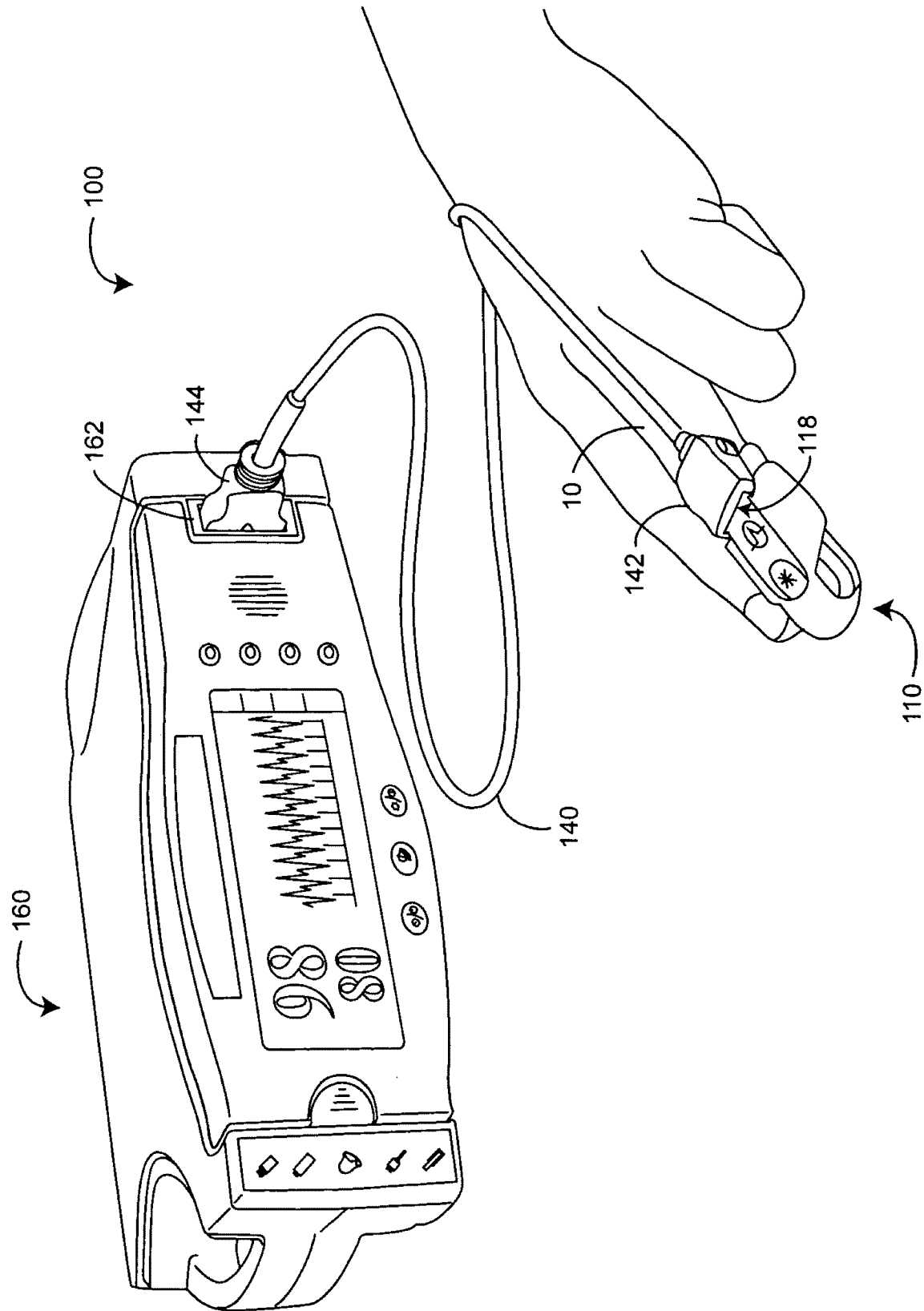


FIG. 1 (Prior Art)

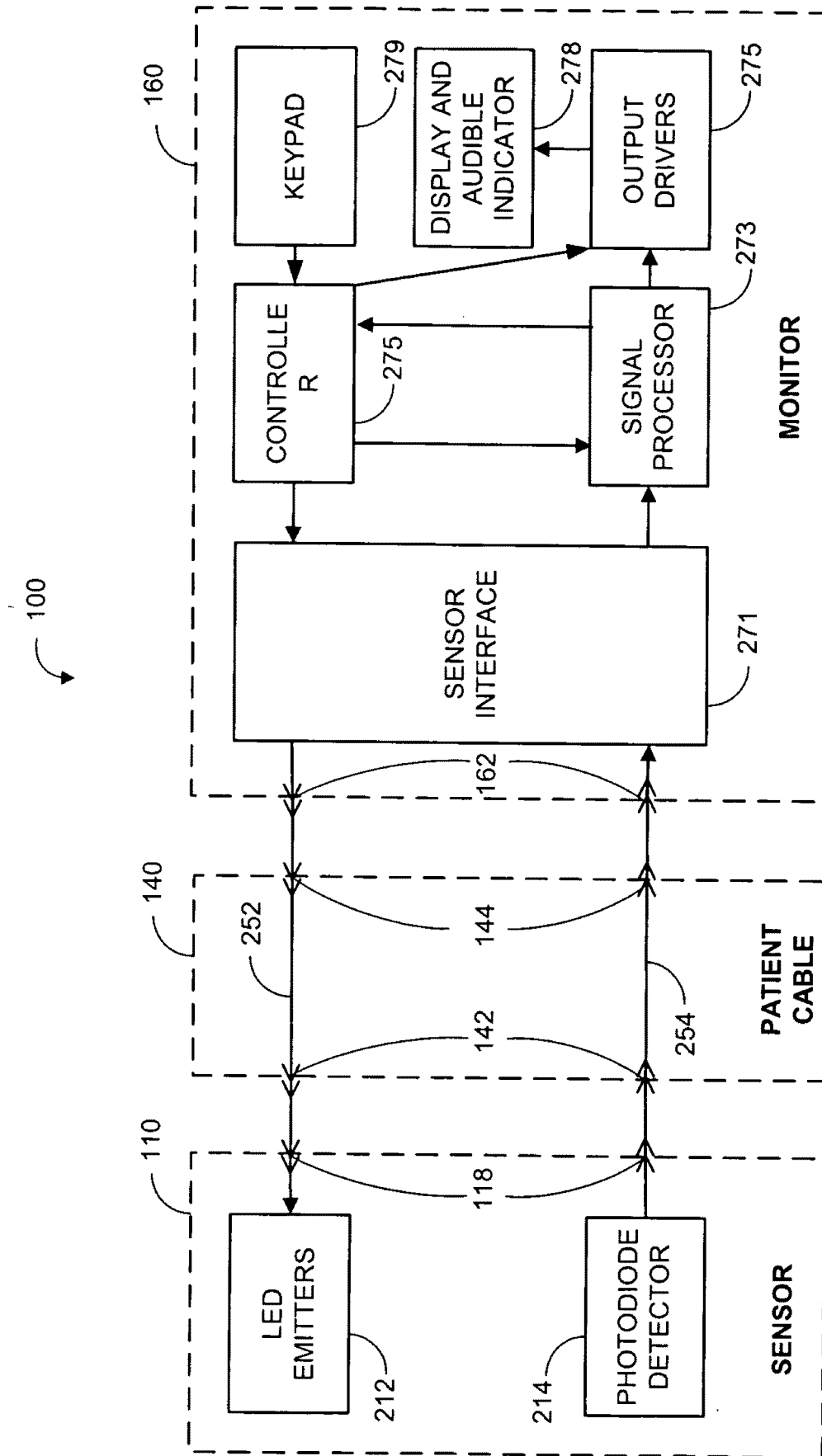


FIG. 2 (Prior Art)

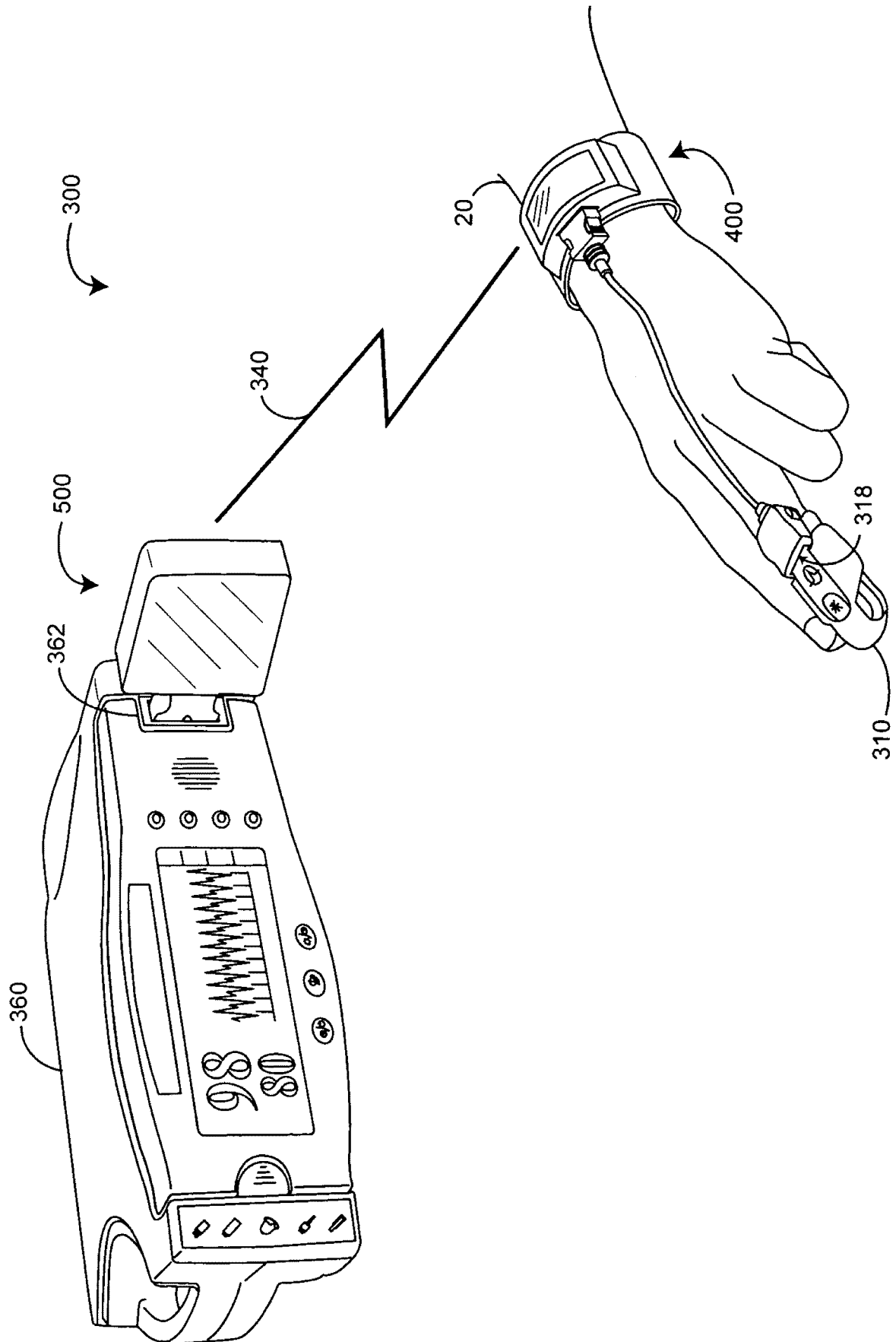


FIG. 3

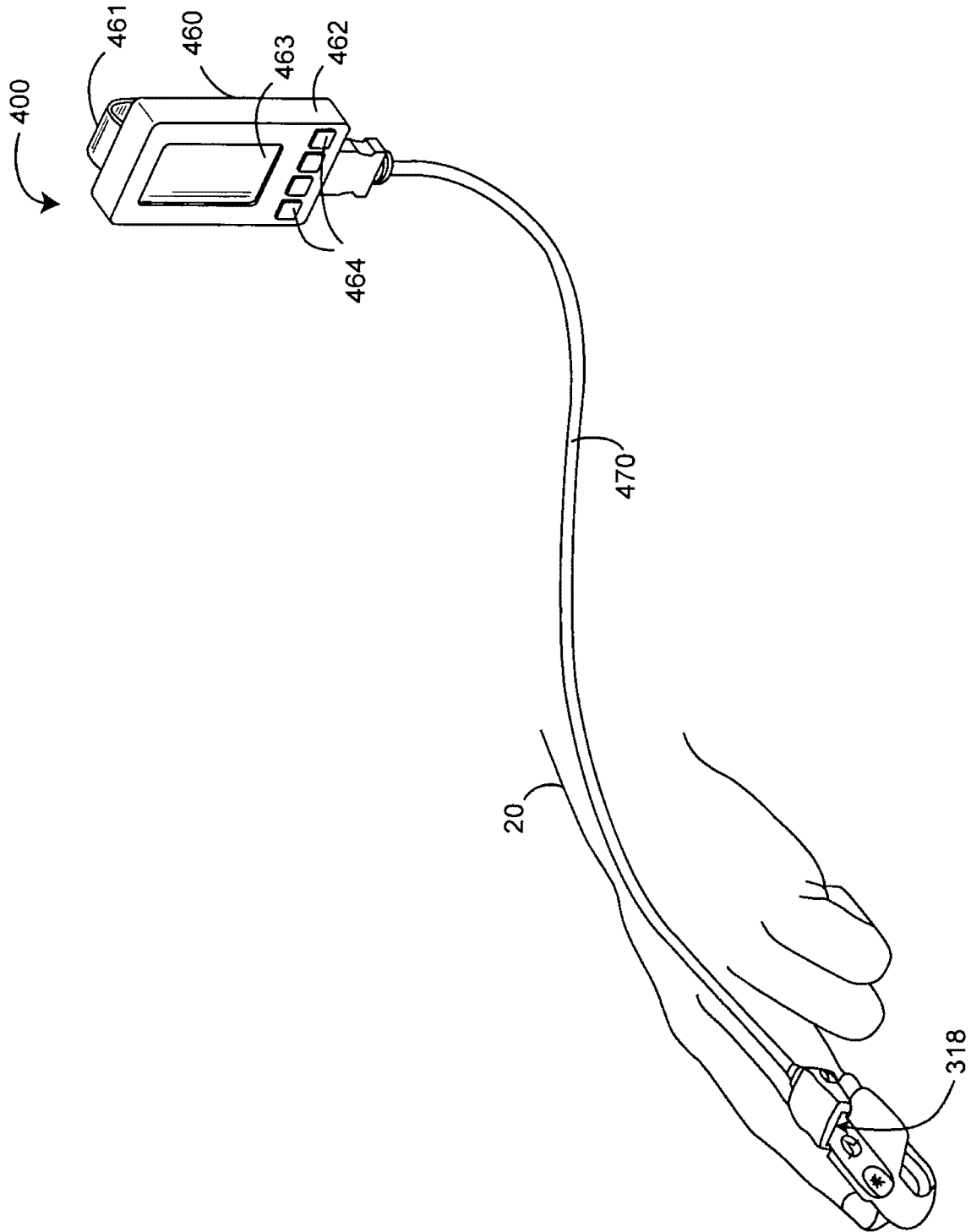


FIG. 4B

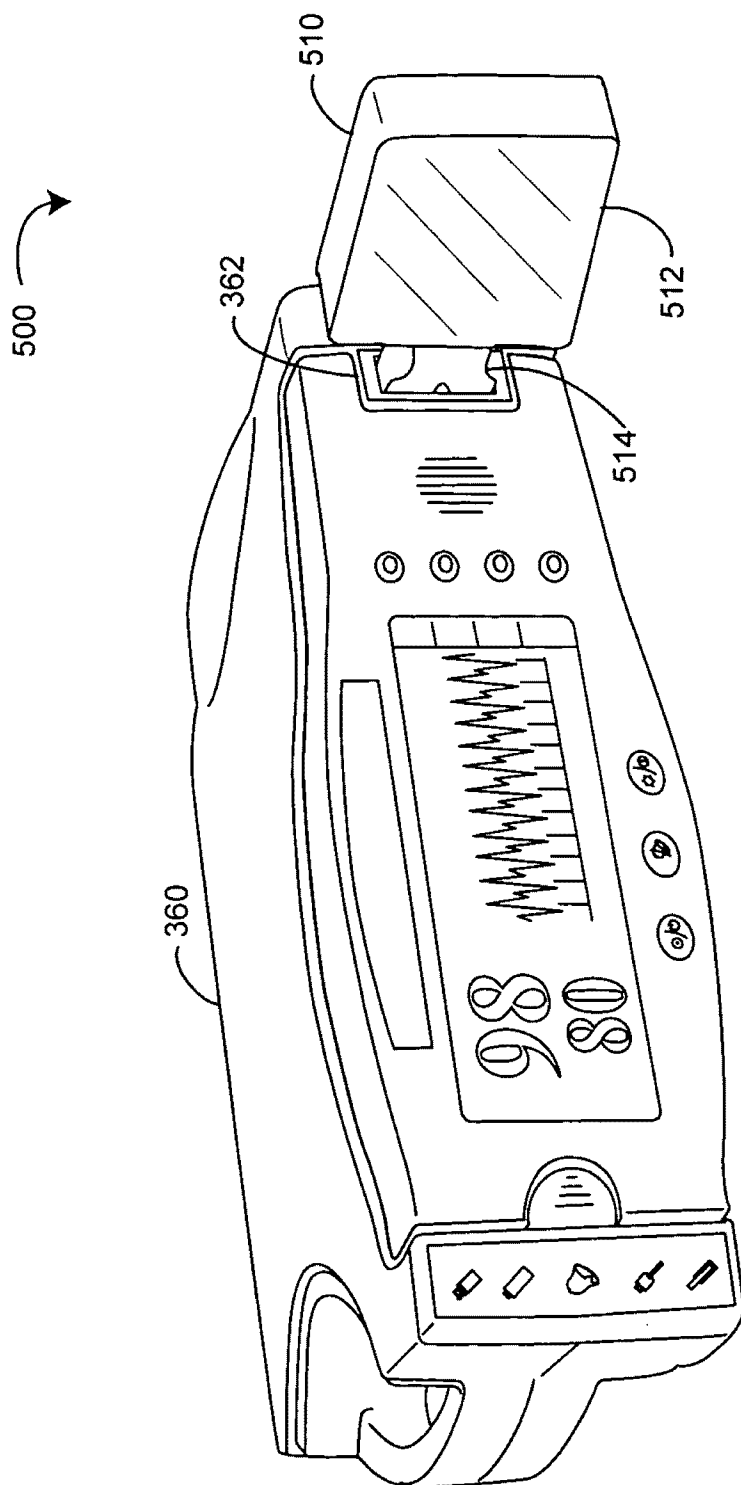


FIG. 5A

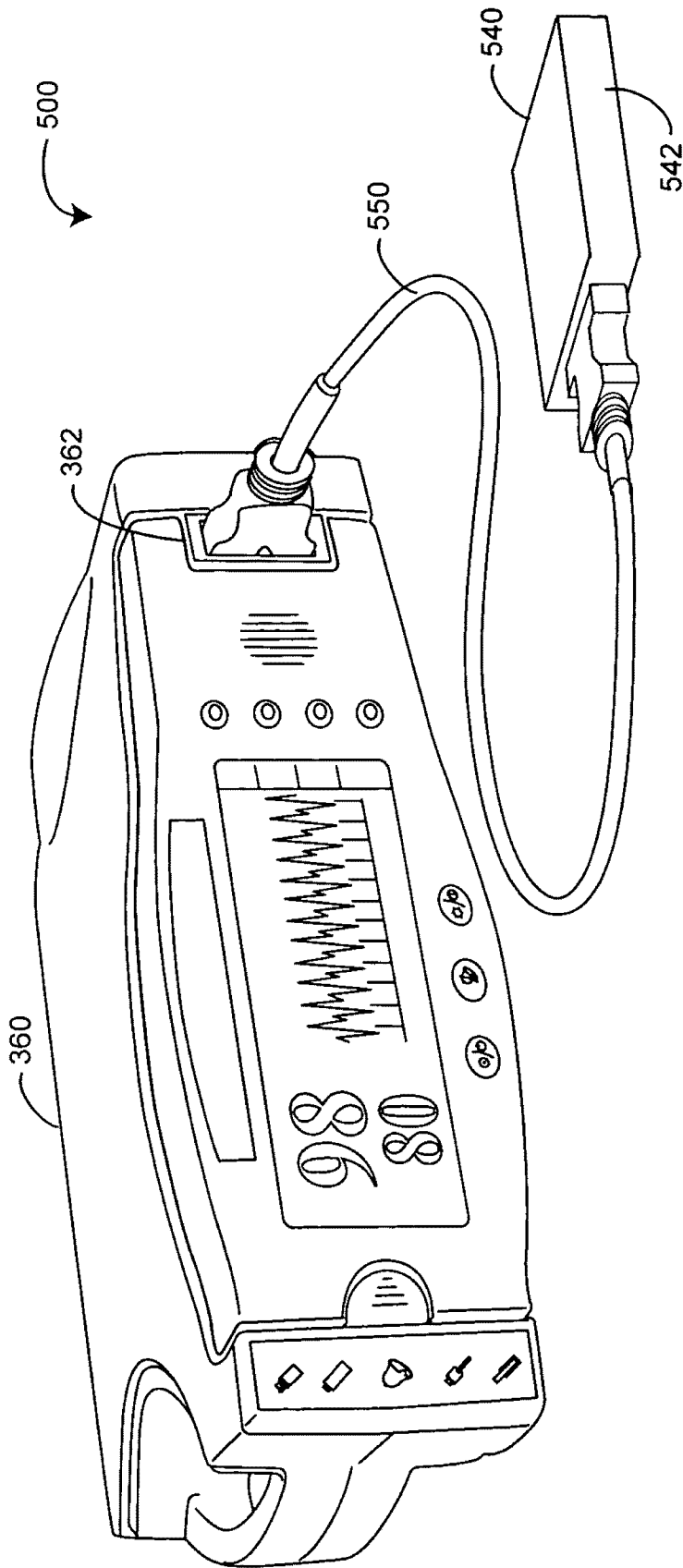


FIG. 5B

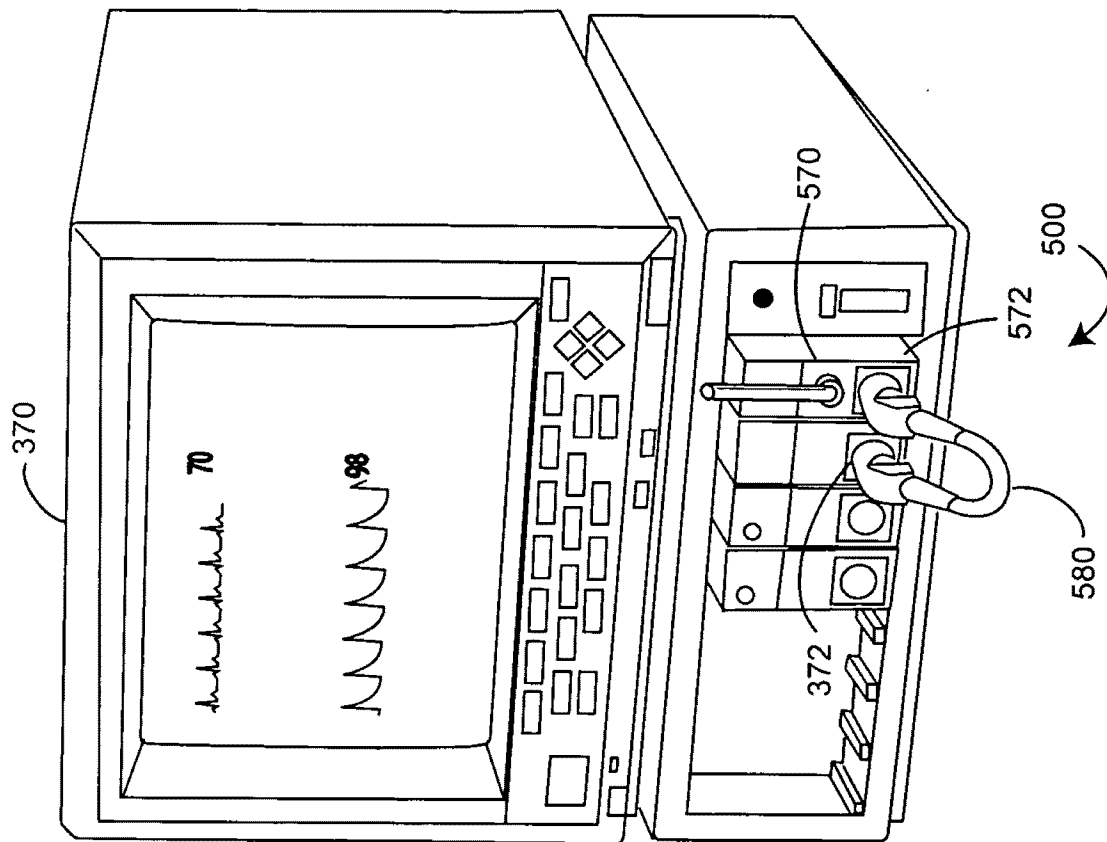


FIG. 5C

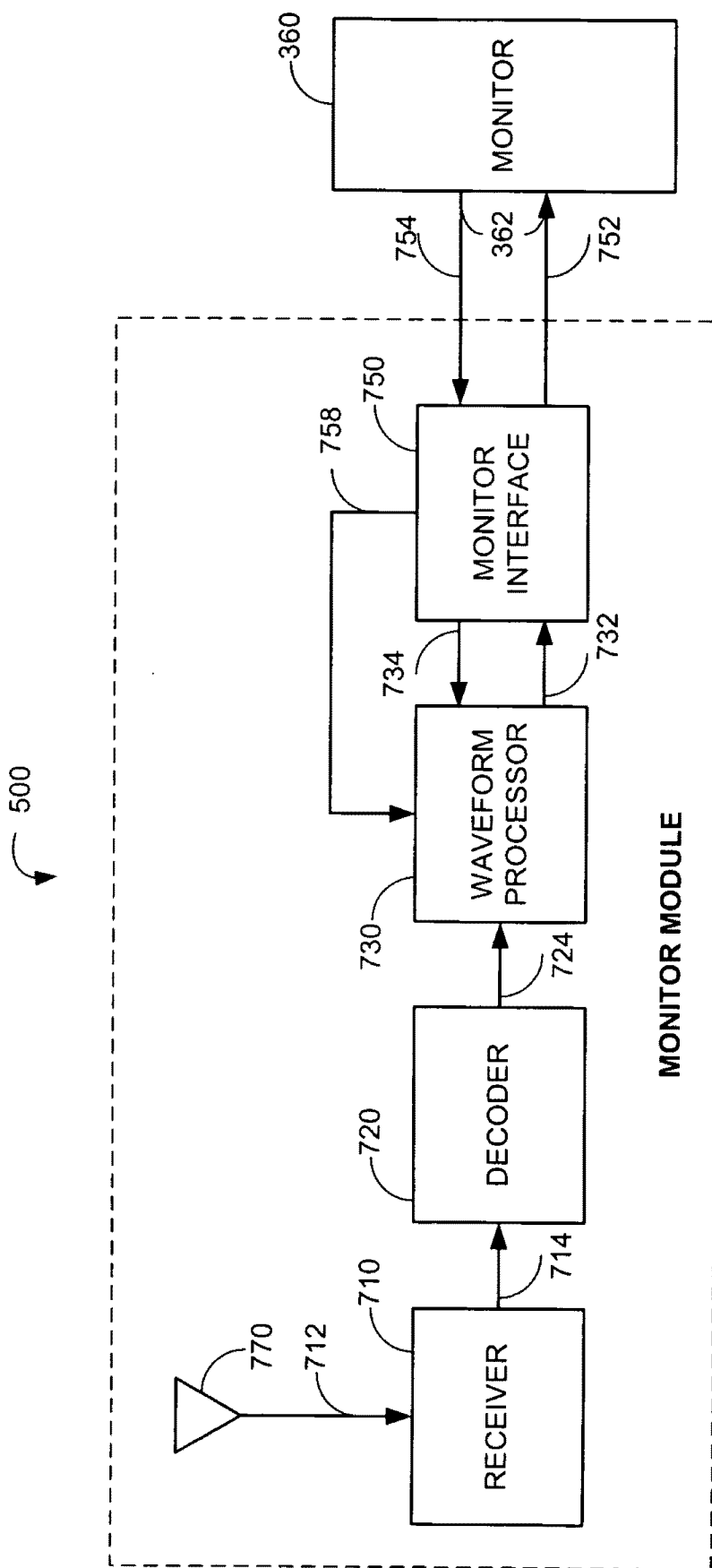


FIG. 7

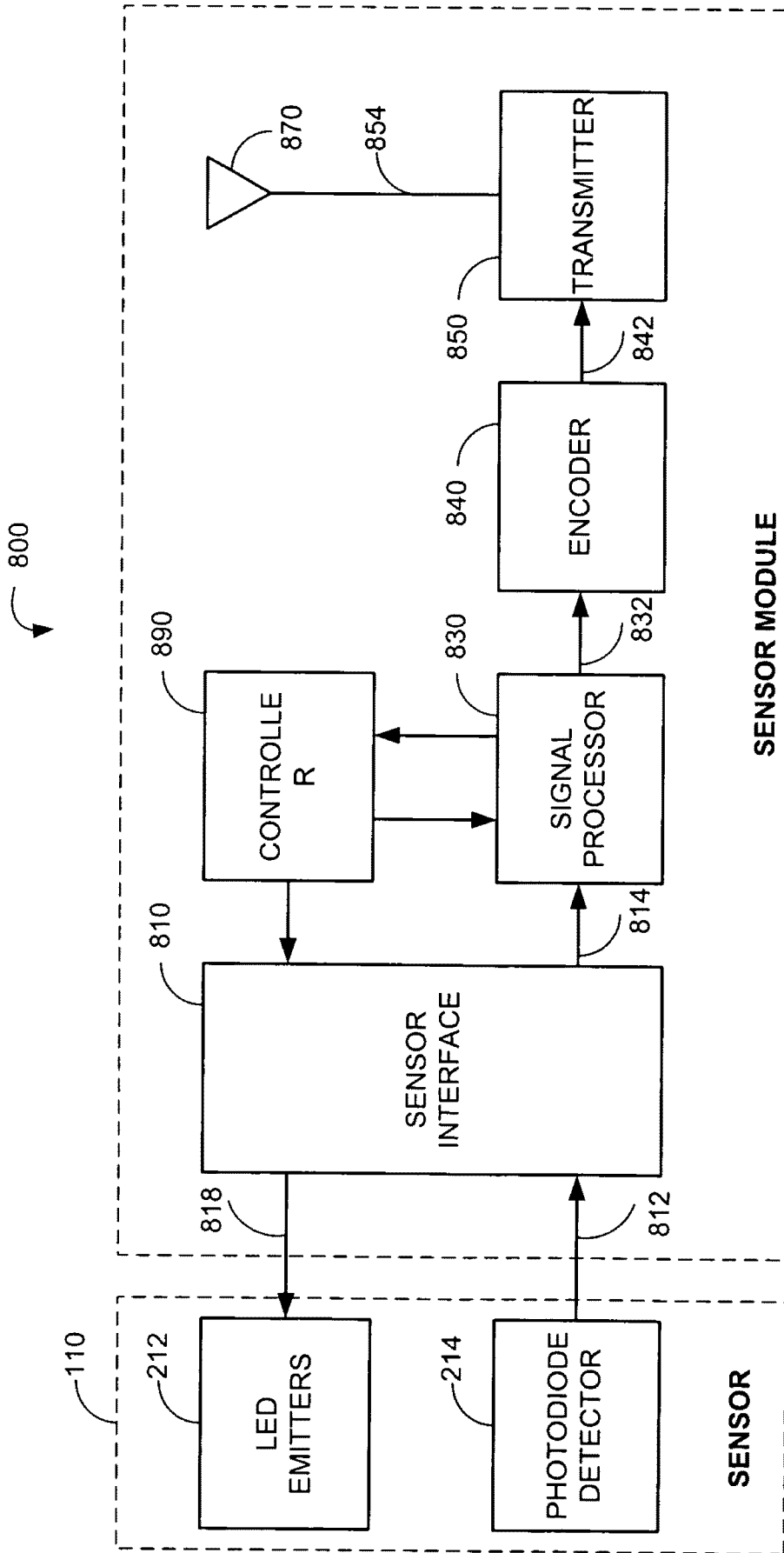


FIG. 8

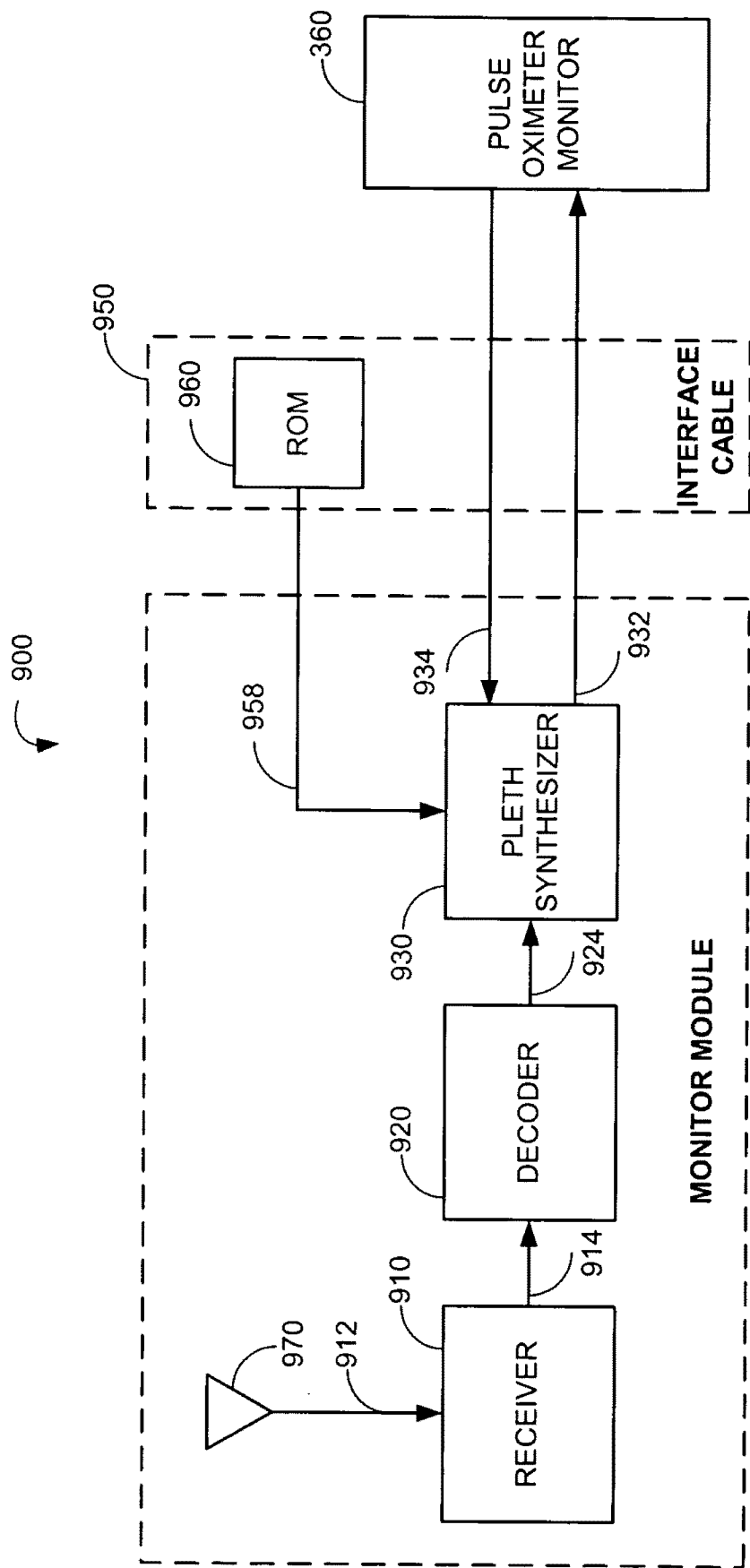


FIG. 9

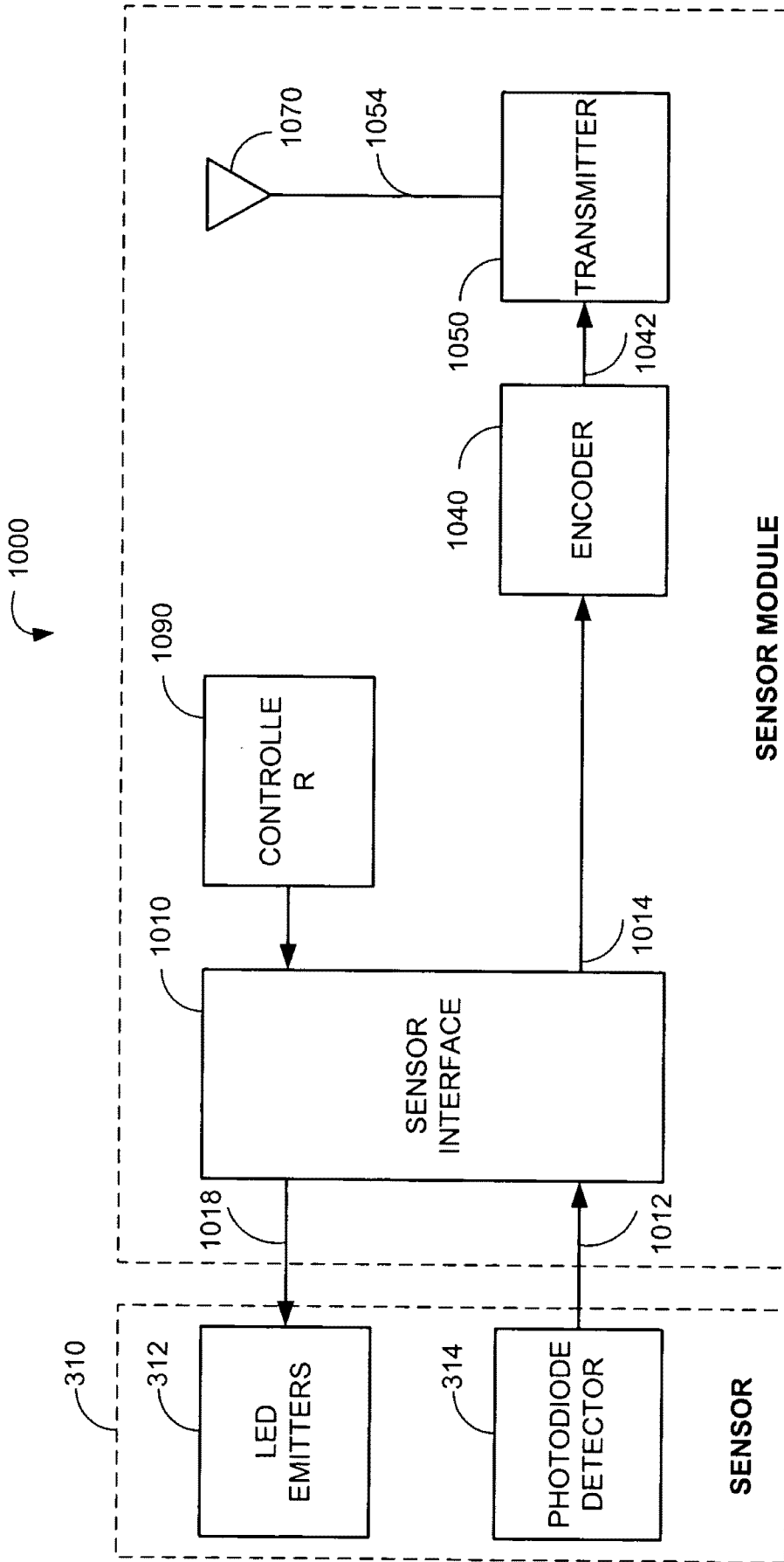


FIG. 10

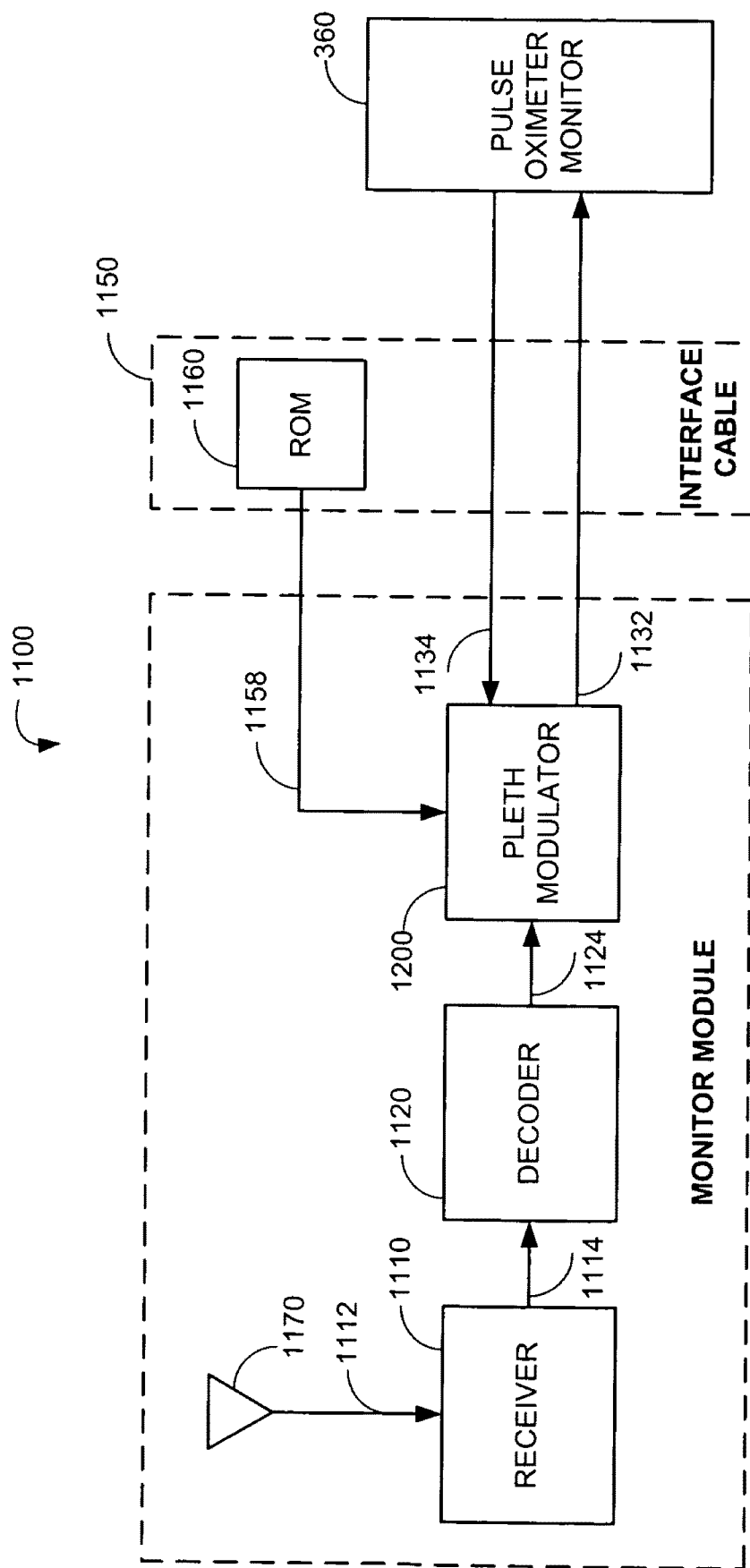


FIG. 11

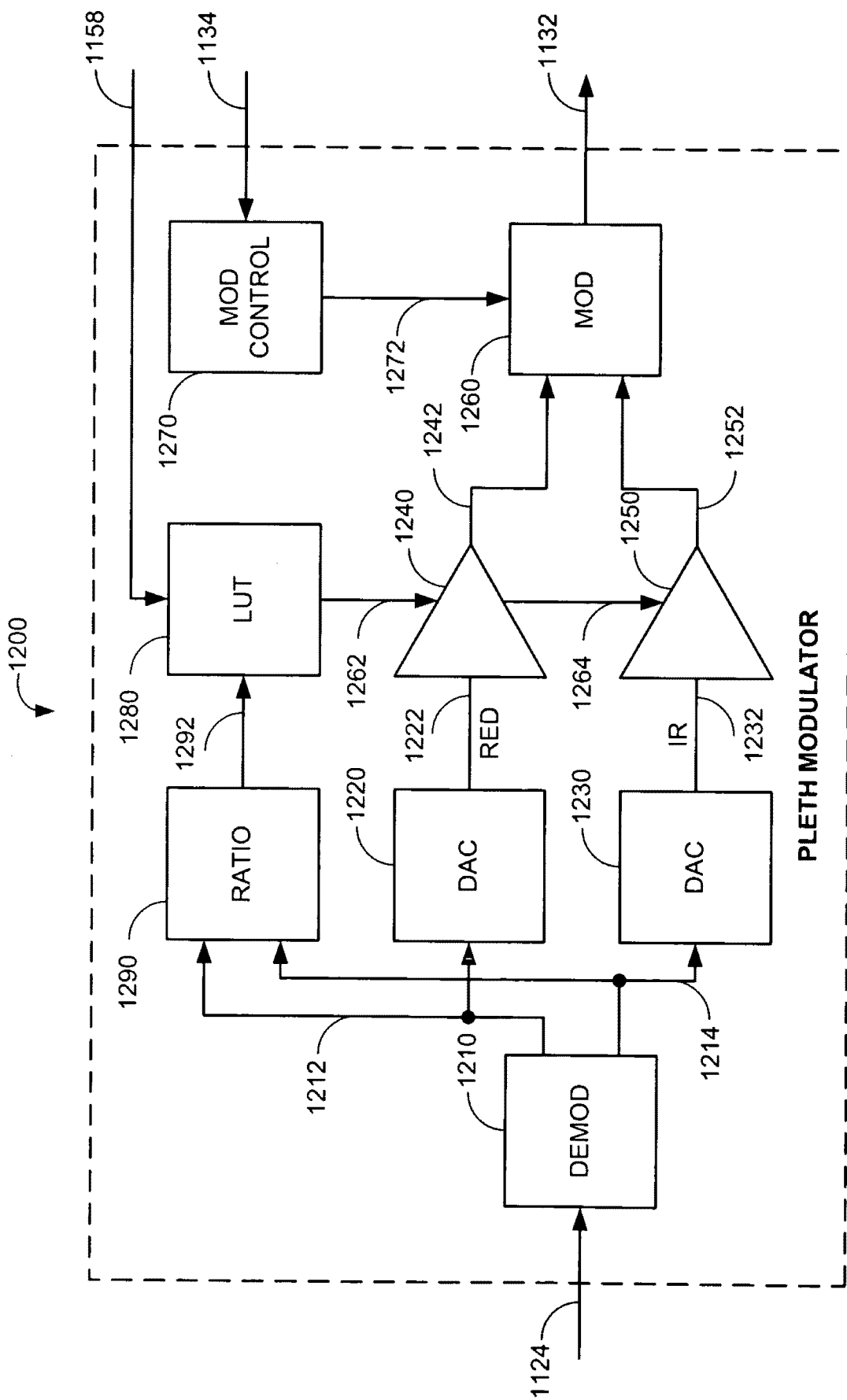


FIG. 12

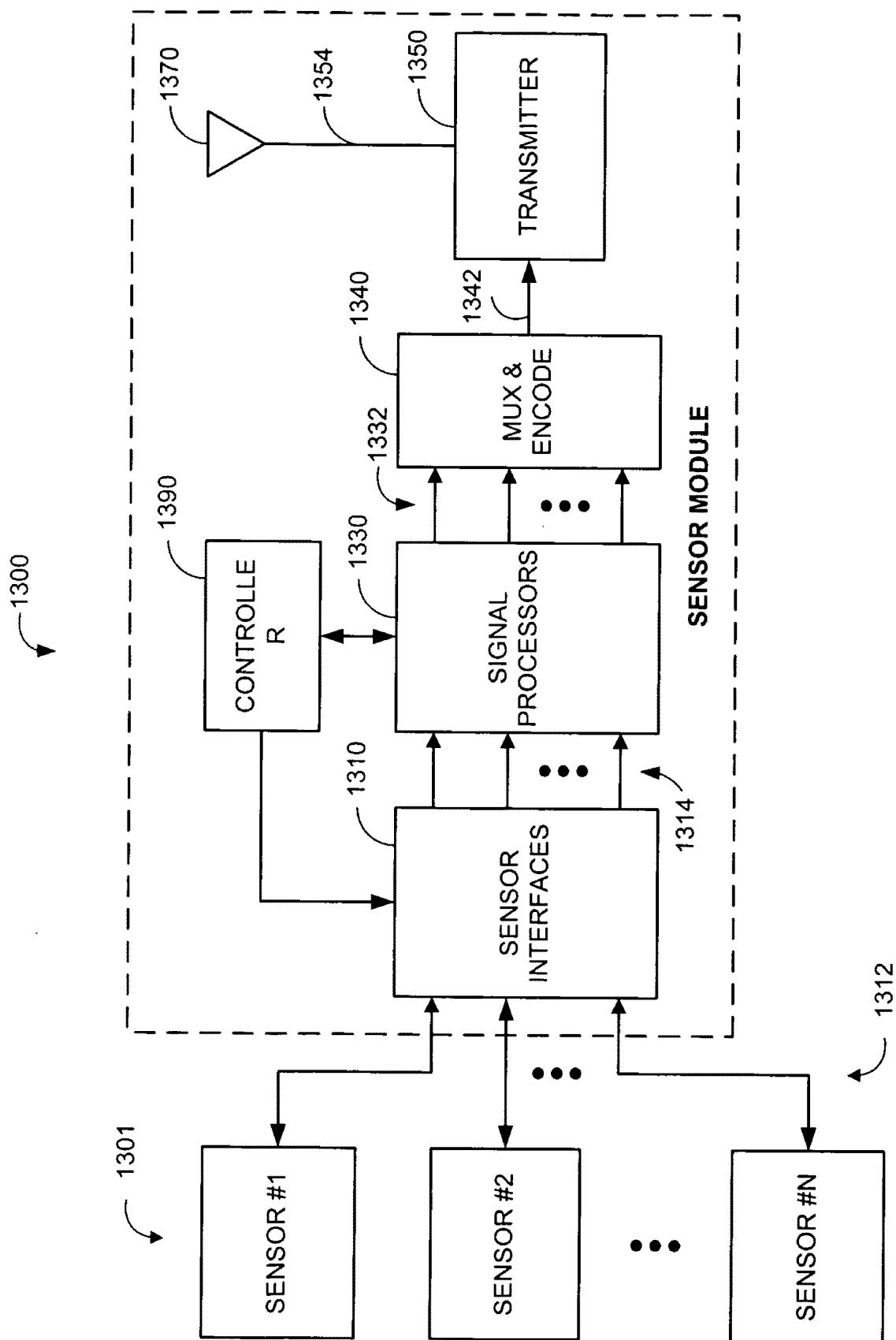


FIG. 13

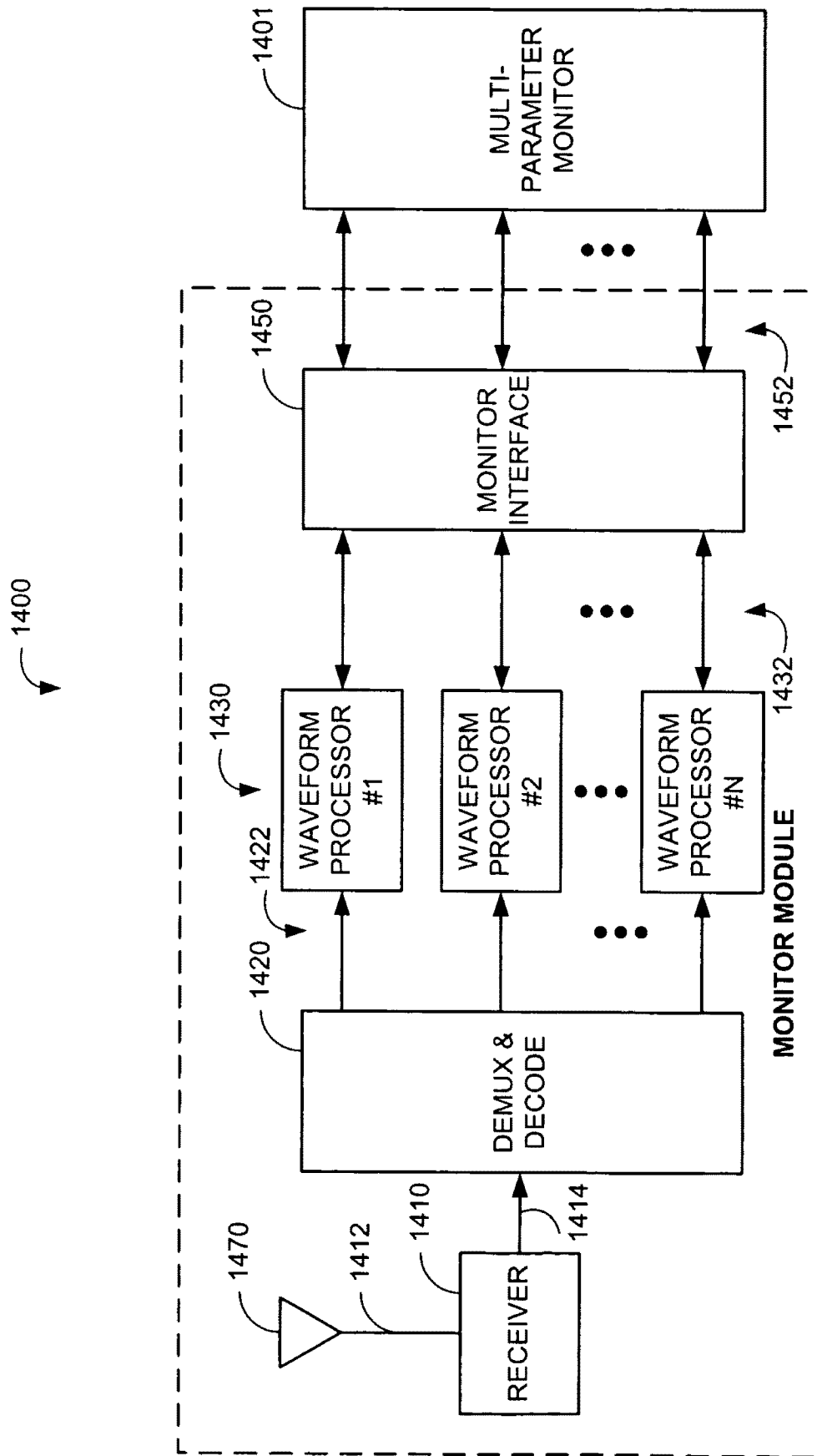


FIG. 14