Omni MedSci, Inc. v. Apple Inc.
Case No. 2:18-cv-134-RWS (E.D. Tex.)

DEFENDANT'S INVALIDITY CONTENTIONS
August 28, 2018

EXHIBIT P

EXHIBIT P-1

U.S. Patent No. 9,651,533 vs Lisogurki

Priority Date/Publication Date:	May 31, 2012/Jan. 26, 2016	Prior Art Status:	§§ 102(a), (b), and (e) (pre-AIA) §§ 102(a), (b), and (d)

US Patent No. 9,241,676 to Lisogurki ("Lisogurki") anticipates the asserted claims of U.S. Patent No. 9,651,533 ("the '533 Patent") or renders those claims obvious alone and/or in view of at least any of the references identified in Apple's Obviousness Combinations Chart.

As set forth in Apple's Invalidity Contentions, the below contentions apply the prior art in part in accordance with Apple's assumption that Omni contends the claims are not invalid under 35 U.S.C. § 112. However, Apple's below contentions do not represent Apple's agreement or view as to the meaning, definiteness, written description support for, or enablement of any of the asserted claims. For each dependent claim, the disclosures cited for the claim from which it depends are incorporated by reference.

CHART ONE: U.S. Patent No. 9,651,533 vs Lisogurki

Asserted Claim of ’533 Patent	Lisogurski (US 9,241,676)
[5] A measurement system, comprising:	To the extent the preamble is limiting, Lisogurki discloses and/or renders obvious “[a] measurement system.” “A physiological monitoring system may use photonic signals to determine physiological parameters. The system may vary parameters of a light drive signal used to generate the photonic signal from a light source such that power consumption is reduced or optimized. Parameters may include light intensity, firing rate, duty cycle, other suitable parameters, or any combination thereof. In some embodiments, the system may use information from a first light source to generate a light drive signal for a second light source. In some embodiments, the system may vary parameters in a way substantially synchronous with physiological pulses, for example, cardiac pulses. In some embodiments, the system may vary parameters in response to an external trigger.” Lisogurski, Abstract. “The present disclosure is directed towards power optimization in a medical device. A physiological monitoring system may monitor one or more physiological parameters of a patient, typically using one or more physiological sensors.” Lisogurski, 3:43-46. “An oximeter is a medical device that may determine the oxygen saturation of an analyzed tissue. One common type of oximeter is a pulse oximeter, which may non-invasively measure the oxygen saturation of a patient's blood (as opposed to measuring oxygen saturation directly by analyzing a blood sample taken from the patient). Pulse oximeters may be included in patient monitoring systems that measure and display various blood flow characteristics including, but not limited to, the oxygen saturation of hemoglobin in arterial blood.” Lisogurski, 3:61-4:3. “The system may process data to determine physiological parameters using techniques well known in the art. For example, the system may determine blood oxygen saturation using two wavelengths of light and a ratio-of-ratios calculation. The system also may identify pulses and determine pulse amplitude, respiration, blood pressure, other suitable parameters, or any combination thereof, using any suitable calculation techniques. In some embodiments, the system

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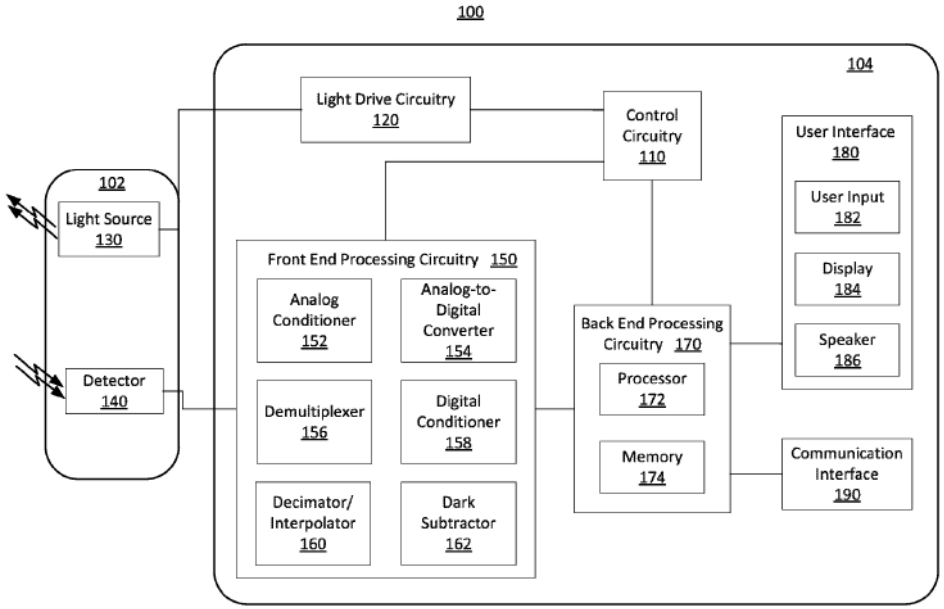
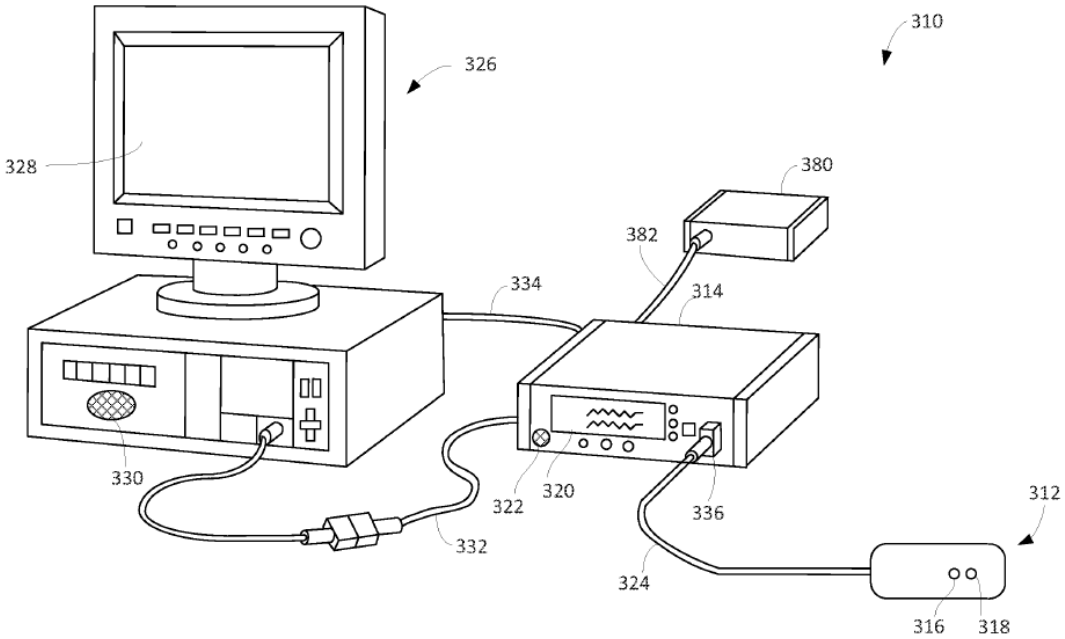
	may use information from external sources (e.g., tabulated data, secondary sensor devices) to determine physiological parameters.” Lisogurski, 4:52-62.  FIG. 1

Asserted Claim of ’533 Patent	Lisogurski (US 9,241,676)
	 FIG. 3

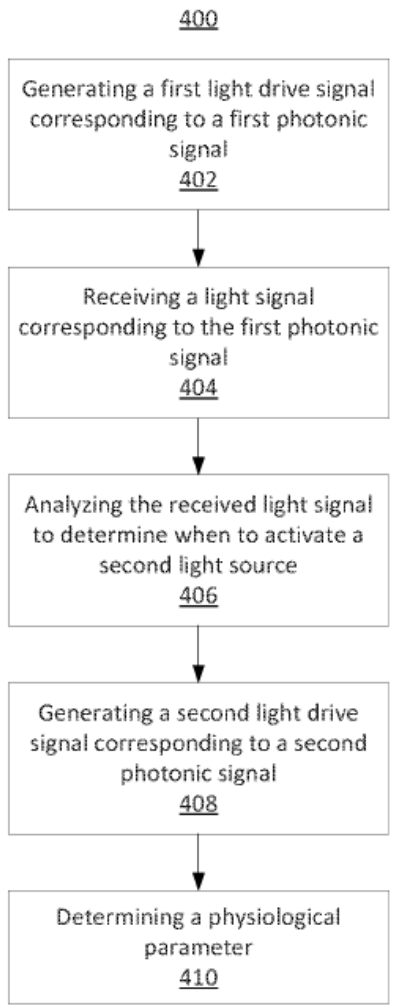

400
Generating a first light drive signal corresponding to a first photonic signal
402
Receiving a light signal corresponding to the first photonic signal
404
Analyzing the received light signal to determine when to activate a second light source
406
Generating a second light drive signal corresponding to a second photonic signal
408
Determining a physiological parameter
410

FIG. 4

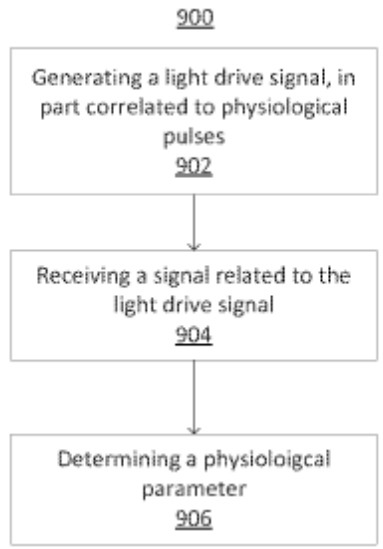

900
Generating a light drive signal, in part correlated to physiological pulses
902
Receiving a signal related to the light drive signal
904
Determining a physioloigcal parameter
906

FIG. 9

Asserted Claim of ’533 Patent	Lisogurski (US 9,241,676)
[5A] a light source comprising a plurality of semiconductor sources that are light emitting diodes, the light emitting diodes configured to generate an output optical beam with one or more optical wavelengths,	Lisogurki discloses and/or renders obvious “a light source comprising a plurality of semiconductor sources that are light emitting diodes, the light emitting diodes configured to generate an output optical beam with one or more optical wavelengths.” *See* CHART ONE: ’533 Patent, Claim Element 13A below.
[5B] wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers,	Lisogurki discloses and/or renders obvious “wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers.” “In one embodiment, the Red wavelength may be between about 600 nm and about 700 nm, and the IR wavelength may be between about 800 nm and about 1000 nm.” Lisogurski, 10:56-58. “Red and infrared (IR) wavelengths may be used because it has been observed that highly oxygenated blood will absorb relatively less red light and more IR light than blood with a lower oxygen saturation.” Lisogurski, 4:45-48. “In some embodiments of cardiac cycle modulation, the system may modulate multiple light sources using a plurality of modulation techniques. For example, in a system with two light sources, the system may operate a first light source at full or regular brightness, while operating one or more additional light sources in a switched or otherwise modulated mode. In some embodiments, the system may operate a first light source according to a first cardiac cycle modulation technique and a second light source according to a second cardiac modulation technique. The first and second cardiac cycle modulation techniques may be the same, correlated, or unrelated. In some embodiments, the system may use the first light source to determine periods of interest in the cardiac cycle. The system may, according to the periods of interest, power additional light sources, alter the modulation of the additional light sources, perform other suitable power optimization techniques, or any combination thereof. In some embodiments, the system may include a first light source (e.g., a light source powered at full or regular brightness) of a type that is a more efficient light source than the one or more additional light sources. For example, the first light source may be a high efficiency infrared (IR) LED while the one or more additional light

Asserted Claim of ’533 Patent	Lisogurski (US 9,241,676)
	sources may be lower efficiency red LEDs or laser diodes. In some embodiments, the first light source may be selected based on efficiency parameters and information from the first light source may be used only to control a second light source. For example, a highly efficient first light source that is not at a wavelength of interest for physiological parameter determination may be used to control one or more second light sources at wavelengths of interest. In this case, the light from the first light source may be used only for controlling the second light source and not for determining physiological parameters.” Lisogurski, 7:38-8:3.
[5C] the light source configured to increase signal-to-noise ratio by increasing a light intensity from at least one of the plurality of semiconductor sources and by increasing a pulse rate of at least one of the plurality of semiconductor sources;	Lisogurki discloses and/or renders obvious “the light source configured to increase signal-to-noise ratio by increasing a light intensity from at least one of the plurality of semiconductor sources and by increasing a pulse rate of at least one of the plurality of semiconductor sources.” “A physiological monitoring system may use photonic signals to determine physiological parameters. The system may vary parameters of a light drive signal used to generate the photonic signal from a light source such that power consumption is reduced or optimized. Parameters may include light intensity, firing rate, duty cycle, other suitable parameters, or any combination thereof. In some embodiments, the system may use information from a first light source to generate a light drive signal for a second light source. In some embodiments, the system may vary parameters in a way substantially synchronous with physiological pulses, for example, cardiac pulses. In some embodiments, the system may vary parameters in response to an external trigger.” Lisogurski, Abstract. “As used herein, “drive cycle modulation” (described below) will refer to a relatively higher frequency modulation technique that the system may use to generate one or more wavelengths of intensity signals. Cardiac cycle modulation may have a period of, for example, around 1 second, while drive cycle modulation may have a period around, for example, 1.6 milliseconds.” Lisogurski, 5:48-54. “In some embodiments, conventional servo algorithms may be used in addition to any combination of cardiac cycle modulation and drive cycle modulation. Conventional servo algorithms may adjust the light drive signals due to, for example, ambient light changes, emitter and detector spacing changes, sensor positioning, other suitable parameters, or any combination thereof. Generally, conventional servo algorithms vary parameters at a slower rate than cardiac

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	cycle modulation. For example, a conventional servo algorithm may adjust drive signal brightness due to ambient light every several seconds. The system may use conventional servo algorithms in part to keep received signal levels within the range of an analog to digital converter's dynamic range. For example, a signal with amplitudes that are large may saturate an analog to digital convertor. In response to a signal with high amplitudes, the system may reduce emitter brightness. In a further example, the quality of a low amplitude signal may be degraded by quantization noise by an analog to digital converter. In response, the system may increase the emitter brightness.” Lisogurski, 5:55-6:6. “In some embodiments, the system may alter the cardiac cycle modulation technique based on the level of noise, ambient light, other suitable reasons, or any combination thereof. The system may receive, for example, an increased level of background noise in the signal due to patient motion. The system may increase the brightness of the light sources in response to the noise to improve the signal-to-noise ratio.” Lisogurski, 9:46-52. “In some embodiments, the system may alter the cardiac cycle modulation technique based on the level of noise, ambient light, other suitable reasons, or any combination thereof. The system may receive, for example, an increased level of background noise in the signal due to patient motion. The system may increase the brightness of the light sources in response to the noise to improve the signal-to-noise ratio. In some embodiments, the system may increase brightness throughout the cardiac cycle because the system may require increased signal amplitudes to differentiate between fiducial and other points of interest related to physiological parameters and those related to noise or motion. In some embodiments, the system may change from a modulated light output to a constant light output in response to noise, patient motion, or ambient light.” Lisogurski, 9:46-60. “The system may generate the light drive signal such that a parameter of the emitted one or more photonic signals varies substantially synchronously with physiological pulses of the subject. For example, the system may generate a light drive signal that varies with a period the same as or closely related to the period of the cardiac cycle, thus generating a cardiac cycle modulation. The system may vary parameters related to the light drive signal including drive current or light

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	brightness, duty cycle, firing rate, modulation parameters, other suitable parameters, or any combination thereof.” Lisogurski, 25:46-55. “It will also be understood that modulation of the light drive signal (i.e., the “on” and “off” states illustrated by light drive signal 1010) is merely exemplary and may include modulation of parameters including drive current or light brightness, duty cycle, firing rate, modulation parameters, other suitable parameters, or any combination thereof. It will also be understood that the “on” and “off” states are merely exemplary and that the system may use any suitable variations of discrete and/or continuous modulations. For example, discrete modulations may include drive signals with one or more step functions. Continuous modulations may include sinusoidal waveforms.” Lisogurski, 27:44-55. “In some embodiments, the sampling rate may represent the amount of time between “on” periods. For example, the time between “on” periods may be the length of time of “off” period 220 of FIG. 2A. Increasing the duration of the “off” periods (i.e., decreasing the emitter firing rate) relates to a decreased sampling rate. Similarly, decreasing the duration of the “off” periods (i.e., increasing the emitter firing rate) relates to an increased sampling rate.” Lisogurski, 35:24-31.
[5D] an apparatus comprising a plurality of lenses configured to receive a portion of the output optical beam and to deliver an analysis output beam to a sample	Lisogurki discloses and/or renders obvious “an apparatus comprising a plurality of lenses configured to receive a portion of the output optical beam and to deliver an analysis output beam to a sample.” “One or more detector 318 may also be provided in sensor unit 312 for detecting the light that is reflected by or has traveled through the subject’s tissue.” Lisogurski, 17:39-42. “In some embodiments, detector 140 may be configured to detect the intensity of light at the Red and IR wavelengths. In some embodiments, an array of sensors may be used and each sensor in the array may be configured to detect an intensity of a single wavelength. In operation, light may enter detector 140 after passing through the subject's tissue. Detector 140 may convert the intensity of the received light into an electrical signal. The light intensity may be directly related to the absorbance and/or reflectance of light in the tissue. That is, when more light at a certain wavelength is absorbed or reflected, less light of that wavelength is received from the tissue by

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	detector 140. After converting the received light to an electrical signal, detector 140 may send the detection signal to monitor 104, where the detection signal may be processed and physiological parameters may be determined (e.g., based on the absorption of the Red and IR wavelengths in the subject's tissue). In some embodiments, the detection signal may be preprocessed by sensor 102 before being transmitted to monitor 104.” Lisogurski, 11:9-20.
[5E] a receiver configured to receive and process at least a portion of the analysis output beam reflected or transmitted from the sample and to generate an output signal,	Lisogurki discloses and/or renders obvious “a receiver configured to receive and process at least a portion of the analysis output beam reflected or transmitted from the sample and to generate an output signal.” “FIG. 1 is a block diagram of an illustrative physiological monitoring system 100 in accordance with some embodiments of the present disclosure. System 100 may include a sensor 102 and a monitor 104 for generating and processing physiological signals of a subject. In some embodiments, sensor 102 and monitor 104 may be part of an oximeter.” Lisogurski, 10:42-47. “In some embodiments, detector 140 may be configured to detect the intensity of light at the Red and IR wavelengths. In some embodiments, an array of sensors may be used and each sensor in the array may be configured to detect an intensity of a single wavelength. In operation, light may enter detector 140 after passing through the subject's tissue. Detector 140 may convert the intensity of the received light into an electrical signal. The light intensity may be directly related to the absorbance and/or reflectance of light in the tissue. That is, when more light at a certain wavelength is absorbed or reflected, less light of that wavelength is received from the tissue by detector 140. After converting the received light to an electrical signal, detector 140 may send the detection signal to monitor 104, where the detection signal may be processed and physiological parameters may be determined (e.g., based on the absorption of the Red and IR wavelengths in the subject's tissue). In some embodiments, the detection signal may be preprocessed by sensor 102 before being transmitted to monitor 104.” Lisogurski, 11:9-27. “Referring back to FIG. 1, front end processing circuitry 150 may receive a detection signal from detector 140 and provide one or more processed signals to back end processing circuitry 170. The term “detection signal,” as used herein, may refer to any of the signals generated within front end processing circuitry 150 as it processes the output signal of detector 140. Front end processing circuitry 150 may perform various analog and digital processing of the detector signal. One

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	suitable detector signal that may be received by front end processing circuitry 150 is shown in FIG. 2B.” Lisogurski, 12:41-51; *see id.*, 12:52-14:10 (describing processing of the output signal). “FIG. 3 is a perspective view of an embodiment of a physiological monitoring system 310 in accordance with some embodiments of the present disclosure. In some embodiments, one or more components of physiological monitoring system 310 may include one or more components of physiological monitoring system 100 of FIG. 1. System 310 may include sensor unit 312 and monitor 314. In some embodiments, sensor unit 312 may be part of an oximeter. Sensor unit 312 may include one or more light source 316 for emitting light at one or more wavelengths into a subject's tissue. One or more detector 318 may also be provided in sensor unit 312 for detecting the light that is reflected by or has traveled through the subject's tissue. Any suitable configuration of light source 316 and detector 318 may be used. In an embodiment, sensor unit 312 may include multiple light sources and detectors, which may be spaced apart. System 310 may also include one or more additional sensor units (not shown) that may, for example, take the form of any of the embodiments described herein with reference to sensor unit 312. An additional sensor unit may be the same type of sensor unit as sensor unit 312, or a different sensor unit type than sensor unit 312 (e.g., a photoacoustic sensor). Multiple sensor units may be capable of being positioned at two different locations on a subject's body.” Lisogurski, 17:30-53. *See also* Lisogurski, Fig. 2A, 2B, 10:48-11:8; 17:42-45, 19:40-43, 26:26-32.
[5F] wherein the receiver is configured to be synchronized to the light source;	Lisogurki discloses and/or renders obvious “wherein the receiver is configured to be synchronized to the light source.” “In some embodiments, the system may correct for non-linearity of light sources. For example, the emitted intensity of light from an LED may not vary linearly with the drive current. The system may account for non-linearity by adjusting drive signals, by adjusting amplification of received signal gain, by adjusting received signal processing, by any other suitable method, or any combination thereof. For example, the system may adjust the drive signal to an LED to improve the linearity. Corrections may be determined using a calibration step, lookup tables for known components, empirical data, any other suitable techniques, or any combination thereof. For example, the emission intensity relative to a drive signal may be known for a particular LED. Information may be encoded in a calibration resistor or non-volatile calibration memory included

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	in the sensor or the system. In another example, the system may calibrate emission output by comparing the intensity of received signals generated in response to a high current drive signal with those generated in response to a low current drive signal. In some embodiments, the operating range of a component (e.g., an LED) may be limited. In some embodiments, a component may operate with a linear relationship between drive signal and output intensity within a known range of drive signals, and in a non-linear relationship outside that range of drive signals.” Lisogurski, 7:12-37. “In some embodiments, the system may optimize power consumption by varying a sampling rate. The system may digitize a received signal using an analog to digital converter operating at a particular rate. In some embodiments, the digitizer rate may be constant. In some embodiments, the digitizer rate may be modulated using a technique correlated to a cardiac cycle modulation. For example, the system may sample at a high rate during a period of interest and at a low rate during other periods. In some embodiments, the system may modulate both a light drive signal and a sampling rate. The modulations of the light drive signal and the sampling rate may be correlated. For example, the system may sample the received signal at a low rate during a period of low light output and at a high rate during a period of high light output. The system may decimate or interpolate the digitized signal such that the rate of the processed signal is constant.” Lisogurski, 10:23-38; *see id.*, 34:14-25. “Control circuitry 110 may be coupled to light drive circuitry 120, front end processing circuitry 150, and back end processing circuitry 170, and may be configured to control the operation of these components. In some embodiments, control circuitry 110 may be configured to provide timing control signals to coordinate their operation. For example, light drive circuitry 120 may generate a light drive signal, which may be used to turn on and off the light source 130, based on the timing control signals. The front end processing circuitry 150 may use the timing control signals to operate synchronously with light drive circuitry 120. For example, front end processing circuitry 150 may synchronize the operation of an analog-to-digital converter and a demultiplexer with the light drive signal based on the timing control signals. In addition, the back end processing circuitry 170 may use the timing control signals to coordinate its operation with front end processing circuitry 150.” Lisogurski, 11:33-49.

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	“Referring back to FIG. 1, front end processing circuitry 150 may receive a detection signal from detector 140 and provide one or more processed signals to back end processing circuitry 170. The term “detection signal,” as used herein, may refer to any of the signals generated within front end processing circuitry 150 as it processes the output signal of detector 140. Front end processing circuitry 150 may perform various analog and digital processing of the detector signal. One suitable detector signal that may be received by front end processing circuitry 150 is shown in FIG. 2B.” Lisogurski, 12:41-51. “FIG. 2B shows an illustrative plot of detector signal 214 that may be generated by a sensor in accordance with some embodiments of the present disclosure. The peaks of detector current waveform 214 may represent current signals provided by a detector, such as detector 140 of FIG. 1, when light is being emitted from a light source. The amplitude of detector current waveform 214 may be proportional to the light incident upon the detector. The peaks of detector current waveform 214 may be synchronous with light ‘on’ periods driving one or more emitters of a light source, such as light source 130 of FIG 1. For example, detector current waveform 214 may be generated in response to a light source being driven by the light drive signal of FIG 2A. The valleys of detector current waveform may be synchronous with periods of time during which no light is being emitted by the light source. While no light is being emitted by a light source during the valleys, detector current waveform 214 may not fall all of the way to zero. Rather, dark current 222 may be present in the detector waveform.” Lisogurski, 12:52-13:3; *see id.*, 13:4-14:10 (describing processing of the output signal). “In some embodiments, the sampling rate may represent the amount of time between “on” periods. For example, the time between “on” periods may be the length of time of “off” period 220 of FIG. 2A. Increasing the duration of the “off” periods (i.e., decreasing the emitter firing rate) relates to a decreased sampling rate. Similarly, decreasing the duration of the “off” periods (i.e., increasing the emitter firing rate) relates to an increased sampling rate.” Lisogurski, 35:24-31.

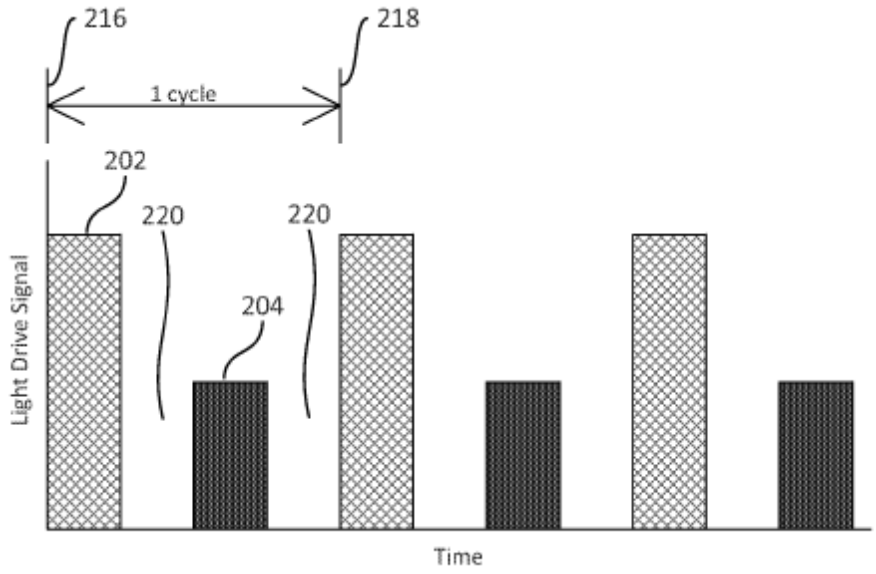
216
218
1 cycle
202
220
220
204
Light Drive Signal
Time

FIG. 2A

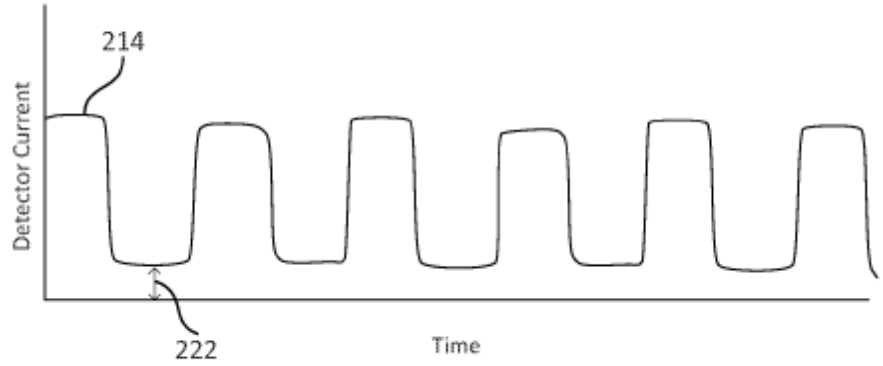
214
Detector Current
222
Time

FIG. 2B

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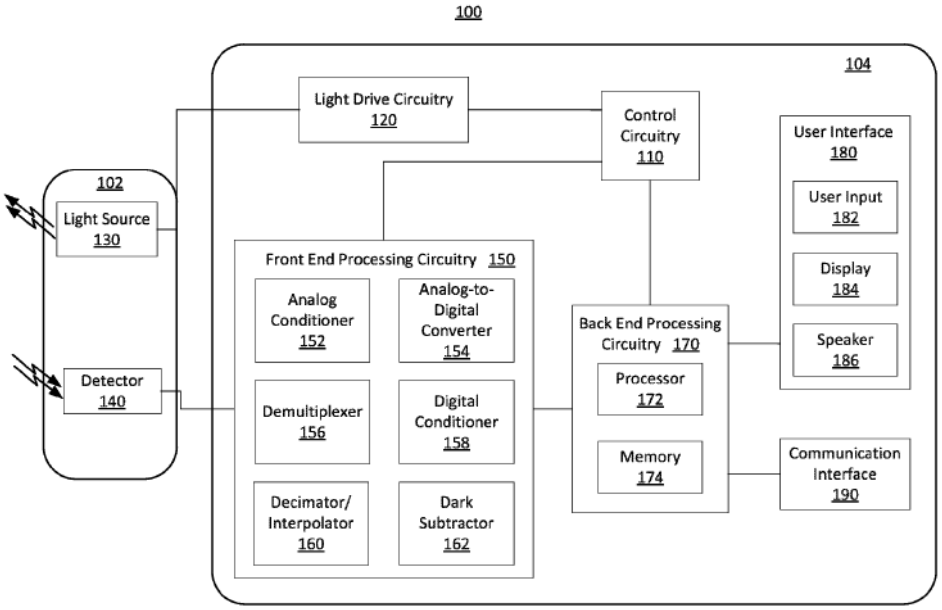
[5G] a personal device comprising a wireless receiver, a wireless transmitter, a display, a microphone, a speaker, one or more buttons or knobs, a microprocessor and a touch screen,	Lisogurki discloses and/or renders obvious “a personal device comprising a wireless receiver, a wireless transmitter, a display, a microphone, a speaker, one or more buttons or knobs, a microprocessor and a touch screen.” “FIG. 1 is a block diagram of an illustrative physiological monitoring system 100 in accordance with some embodiments of the present disclosure. System 100 may include a sensor 102 and a monitor 104 for generating and processing physiological signals of a subject. In some embodiments, sensor 102 and monitor 104 may be part of an oximeter.” Lisogurski, 10:42-47.  FIG. 1 “User interface 180 may include user input 182, display 184, and speaker 186. User input 182 may include any type of user input device such as a keyboard, a mouse, a touch screen, buttons, switches, a microphone, a joy stick, a touch pad, or any other suitable input device. The inputs

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	received by user input 182 can include information about the subject, such as age, weight, height, diagnosis, medications, treatments, and so forth. In an embodiment, the subject may be a medical patient and display 184 may exhibit a list of values which may generally apply to the patient, such as, for example, age ranges or medication families, which the user may select using user input 182. Additionally, display 184 may display, for example, an estimate of a subject's blood oxygen saturation generated by monitor 104(referred to as an “SpO2” measurement), pulse rate information, respiration rate information, blood pressure, any other parameters, and any combination thereof. Display 184 may include any type of display such as a cathode ray tube display, a flat panel display such a liquid crystal display or plasma display, or any other suitable display device. Speaker 186 within user interface 180 may provide an audible sound that may be used in various embodiments, such as for example, sounding an audible alarm in the event that a patient's physiological parameters are not within a predefined normal range. Communication interface 190 may enable monitor 104 to exchange information with external devices. Communications interface 190 may include any suitable hardware, software, or both, which may allow monitor 104 to communicate with electronic circuitry, a device, a network, a server or other workstations, a display, or any combination thereof. Communications interface 190 may include one or more receivers, transmitters, transceivers, antennas, plug-in connectors, ports, communications buses, communications protocols, device identification protocols, any other suitable hardware or software, or any combination thereof. Communications interface 190 may be configured to allow wired communication (e.g., using USB, RS-232 or other standards), wireless communication (e.g., using WiFi, IR, WiMax, BLUETOOTH, UWB, or other standards), or both. For example, communications interface 190 may be configured using a universal serial bus (USB) protocol (e.g., USB 2.0, USB 3.0), and may be configured to couple to other devices (e.g., remote memory devices storing templates) using a four-pin USB standard Type-A connector (e.g., plug and/or socket) and cable. In some embodiments, communications interface 190 may include an internal bus such as, for example, one or more slots for insertion of expansion cards.” Lisogurski, 15:19-65. “It will be understood that the components of physiological monitoring system 100 that are shown and described as separate components are shown and described as such for illustrative purposes only. In some embodiments the functionality of some of the components may be combined in a

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	single component. For example, the functionality of front end processing circuitry 150 and back end processing circuitry 170 may be combined in a single processor system. Additionally, in some embodiments the functionality of some of the components of monitor 104 shown and described herein may be divided over multiple components. For example, some or all of the functionality of control circuitry 110 may be performed in front end processing circuitry 150, in back end processing circuitry 170, or both. In other embodiments, the functionality of one or more of the components may be performed in a different order or may not be required. In an embodiment, all of the components of physiological monitoring system 100 can be realized in processor circuitry.” Lisogurski, 15:66-16:16. *See also* Lisogurski, 17:54-18:67.
[5H] the personal device configured to receive and process at least a portion of the output signal,	Lisogurki discloses and/or renders obvious “the personal device configured to receive and process at least a portion of the output signal.” “FIG. 1 is a block diagram of an illustrative physiological monitoring system 100 in accordance with some embodiments of the present disclosure. System 100 may include a sensor 102 and a monitor 104 for generating and processing physiological signals of a subject. In some embodiments, sensor 102 and monitor 104 may be part of an oximeter.” Lisogurski, 10:42-47.

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	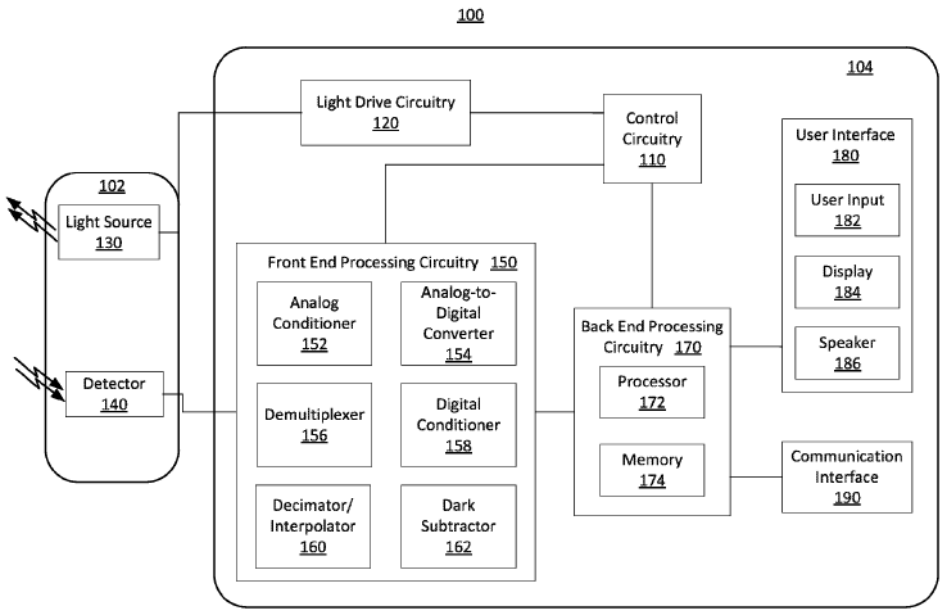 FIG. 1 “In some embodiments, detector 140 may be configured to detect the intensity of light at the Red and IR wavelengths. In some embodiments, an array of sensors may be used and each sensor in the array may be configured to detect an intensity of a single wavelength. In operation, light may enter detector 140 after passing through the subject's tissue. Detector 140 may convert the intensity of the received light into an electrical signal. The light intensity may be directly related to the absorbance and/or reflectance of light in the tissue. That is, when more light at a certain wavelength is absorbed or reflected, less light of that wavelength is received from the tissue by detector 140. After converting the received light to an electrical signal, detector 140 may send the detection signal to monitor 104, where the detection signal may be processed and physiological parameters may be determined (e.g., based on the absorption of the Red and IR wavelengths in the

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	subject's tissue). In some embodiments, the detection signal may be preprocessed by sensor 102 before being transmitted to monitor 104. In the embodiment shown, monitor 104 includes control circuitry 110, light drive circuitry 120, front end processing circuitry 150, back end processing circuitry 170, user interface 180, and communication interface 190. Monitor 104 may be communicatively coupled to sensor 102. Control circuitry 110 may be coupled to light drive circuitry 120, front end processing circuitry 150, and back end processing circuitry 170, and may be configured to control the operation of these components. In some embodiments, control circuitry 110 may be configured to provide timing control signals to coordinate their operation. For example, light drive circuitry 120 may generate a light drive signal, which may be used to turn on and off the light source 130, based on the timing control signals. The front end processing circuitry 150 may use the timing control signals to operate synchronously with light drive circuitry 120. For example, front end processing circuitry 150 may synchronize the operation of an analog-to-digital converter and a demultiplexer with the light drive signal based on the timing control signals. In addition, the back end processing circuitry 170 may use the timing control signals to coordinate its operation with front end processing circuitry 150.” Lisogurski, 11:9-49. “Referring back to FIG. 1, front end processing circuitry 150 may receive a detection signal from detector 140 and provide one or more processed signals to back end processing circuitry 170. The term ‘detection signal,’ as used herein, may refer to any of the signals generated within front end processing circuitry 150 as it processes the output signal of detector 140. Front end processing circuitry 150 may perform various analog and digital processing of the detector signal. One suitable detector signal that may be received by front end processing circuitry 150 is shown in FIG. 2B.” Lisogurski, 12:42-51. “Back end processing circuitry 170 may include processor 172 and memory 174. Processor 172 may be adapted to execute software, which may include an operating system and one or more applications, as part of performing the functions described herein. Processor 172 may receive and process physiological signals received from front end processing circuitry 150. For example, processor 172 may determine one or more physiological parameters based on the received

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	physiological signals. Memory 174 may include any suitable computer-readable media capable of storing information that can be interpreted by processor 172. This information may be data or may take the form of computer-executable instructions, such as software applications, that cause the microprocessor to perform certain functions and/or computer-implemented methods. Depending on the embodiment, such computer-readable media may include computer storage media and communication media. Computer storage media may include volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or other data. Computer storage media may include, but is not limited to, RAM, ROM, EPROM, EEPROM, flash memory or other solid state memory technology, CD-ROM, DVD, or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by components of the system. Back end processing circuitry 170 may be communicatively coupled with use interface 180 and communication interface 190.” Lisogurski, 14:56-15:18. “Communication interface 190 may enable monitor 104 to exchange information with external devices. Communications interface 190 may include any suitable hardware, software, or both, which may allow monitor 104 to communicate with electronic circuitry, a device, a network, a server or other workstations, a display, or any combination thereof. Communications interface 190 may include one or more receivers, transmitters, transceivers, antennas, plug-in connectors, ports, communications buses, communications protocols, device identification protocols, any other suitable hardware or software, or any combination thereof. Communications interface 190 may be configured to allow wired communication (e.g., using USB, RS-232 or other standards), wireless communication (e.g., using WiFi, IR, WiMax, BLUETOOTH, UWB, or other standards), or both. For example, communications interface 190 may be configured using a universal serial bus (USB) protocol (e.g., USB 2.0, USB 3.0), and may be configured to couple to other devices (e.g., remote memory devices storing templates) using a four-pin USB standard Type-A connector (e.g., plug and/or socket) and cable. In some embodiments, communications interface 190 may include an internal bus such as, for example, one or more slots for insertion of expansion cards.” Lisogurski, 15:19-65.

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	“In some embodiments, sensor unit 312 may be connected to monitor 314 as shown. Sensor unit 312 may be powered by an internal power source, e.g., a battery (not shown). Sensor unit 312 may draw power from monitor 314. In another embodiment, the sensor may be wirelessly connected to monitor 314 (not shown). Monitor 314 may be configured to calculate physiological parameters based at least in part on data relating to light emission and acoustic detection received from one or more sensor units such as sensor unit 312. For example, monitor 314 may be configured to determine pulse rate, blood pressure, blood oxygen saturation (e.g., arterial, venous, or both), hemoglobin concentration (e.g., oxygenated, deoxygenated, and/or total), any other suitable physiological parameters, or any combination thereof. In some embodiments, calculations may be performed on the sensor units or an intermediate device and the result of the calculations may be passed to monitor 314. Further, monitor 314 may include display 320 configured to display the physiological parameters or other information about the system. In the embodiment shown, monitor 314 may also include a speaker 322 to provide an audible sound that may be used in various other embodiments, such as for example, sounding an audible alarm in the event that a subject's physiological parameters are not within a predefined normal range. In some embodiments, the system 310 includes a stand-alone monitor in communication with the monitor 314via a cable or a wireless network link. In some embodiments, monitor 314 may be implemented as monitor 104 of FIG. 1.” Lisogurski, 17:54-18:15. “In step 2202, the system may receive a signal. The signal may be, for example, an attenuated photonic signal. The signal may have been detected by a detector. The detected signal may be processed by processing equipment including, for example, digitizers, filters, decimators, interpolators, other suitable processing equipment, or any combination thereof. In some embodiments, the system may amplify the received signal using front end processor circuitry. The gain of the amplifier may be adjusted based on the emitted light brightness, historical information related to the brightness of prior received attenuated signals, other suitable information, or any combination thereof, so that the amplified signal matches the range of the analog-to-digital converter and thus increases resolution. In some embodiments, the system may account for the gain using hardware, software, or any combination thereof, such that the original intensity information is retained.” Lisogurski, 38:59-39:8.

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	See also Lisogurski, Figs. 4, 9, 17, 19, 22, 13:53-59, 33:44-46, 34:26-33.
[5I] wherein the personal device is configured to store and display the processed output signal,	Lisogurki discloses and/or renders obvious “wherein the personal device is configured to store and display the processed output signal.” “In some embodiments, historical information may be used to determine the timing of cardiac cycle modulation. For example, information from previous pulse cycles may be used to determine “on” and “off” states. In some embodiments, the system may use statistical information from historical information, for example, mean period and/or standard deviation of one or more previous pulse cycles. The system may use a mean period to determine or estimate the time period between a previous period of interest and the next period of interest. For example, the system may wait a particular percentage (e.g., 80%) of the mean period following a period of interest before returning to an “on” state. In some embodiments, the particular percentage or other criteria may be based on statistical information. For example, a smaller standard deviation in the period of historical pulses may indicate that there is relatively less variation in the pulse period. The system may increase the amount of time it waits before turning a drive signal back to an “on” state, as the confidence of the position in time of the next period of interest is high. Similarly, the system may reduce the waiting period in response to a relatively high standard deviation in the period of historical pulses. For example, the system may identify a relatively high standard deviation in the period of historical pulses when a significant respiratory sinus arrhythmia is present. In some embodiments, the system may remain in a particular cardiac cycle modulation mode for an amount of time following a historical event. For example, the system may operate in a high power mode without cardiac cycle modulation for a certain time period following, for example, high noise levels, a loss of signal, or an irregular cardiac rhythm. In some embodiments, the system may use a cardiac cycle modulation during periodic abnormal rhythms such as a 2nd degree AC block, bundle branch block, or sustained ventricular tachycardia.” Lisogurski, 8:45-9:11. “Such patient monitoring systems may also measure and display additional physiological parameters, such as a patient’s pulse rate and blood pressure.” Lisogurski, 4:3-5. “Referring back to FIG. 1, front end processing circuitry 150 may receive a detection signal from detector 140 and provide one or more processed signals to back end processing circuitry 170. The term “detection signal,” as used herein, may refer to any of the signals generated within front end

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	processing circuitry 150 as it processes the output signal of detector 140. Front end processing circuitry 150 may perform various analog and digital processing of the detector signal. One suitable detector signal that may be received by front end processing circuitry 150 is shown in FIG. 2B.” Lisogurski, 12:41-51; *see id.*, 12:52-14:10 (describing processing of the output signal). “Back end processing circuitry 170 may include processor 172 and memory 174. Processor 172 may be adapted to execute software, which may include an operating system and one or more applications, as part of performing the functions described herein. Processor 172 may receive and process physiological signals received from front end processing circuitry 150. For example, processor 172 may determine one or more physiological parameters based on the received physiological signals. Memory 174 may include any suitable computer-readable media capable of storing information that can be interpreted by processor 172. This information may be data or may take the form of computer-executable instructions, such as software applications, that cause the microprocessor to perform certain functions and/or computer-implemented methods. Depending on the embodiment, such computer-readable media may include computer storage media and communication media. Computer storage media may include volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or other data. Computer storage media may include, but is not limited to, RAM, ROM, EPROM, EEPROM, flash memory or other solid state memory technology, CD-ROM, DVD, or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by components of the system. Back end processing circuitry 170 may be communicatively coupled with use interface 180 and communication interface 190.” Lisogurski, 14:56-15:18. “In some embodiments, sensor unit 312 may be connected to monitor 314 as shown. Sensor unit 312 may be powered by an internal power source, e.g., a battery (not shown). Sensor unit 312 may draw power from monitor 314. In another embodiment, the sensor may be wirelessly connected to monitor 314 (not shown). Monitor 314 may be configured to calculate physiological parameters based at least in part on data relating to light emission and acoustic detection received from one or more sensor units such as sensor unit 312. For example, monitor 314 may be configured to determine pulse rate, blood pressure, blood oxygen saturation (e.g., arterial, venous,

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	or both), hemoglobin concentration (e.g., oxygenated, deoxygenated, and/or total), any other suitable physiological parameters, or any combination thereof. In some embodiments, calculations may be performed on the sensor units or an intermediate device and the result of the calculations may be passed to monitor 314. Further, monitor 314 may include display 320 configured to display the physiological parameters or other information about the system. In the embodiment shown, monitor 314 may also include a speaker 322 to provide an audible sound that may be used in various other embodiments, such as for example, sounding an audible alarm in the event that a subject's physiological parameters are not within a predefined normal range. In some embodiments, the system 310 includes a stand-alone monitor in communication with the monitor 314via a cable or a wireless network link. In some embodiments, monitor 314 may be implemented as monitor 104 of FIG. 1.” Lisogurski, 17:54-18:15. *See also* Lisogurski, 18:44-57, 20:5-9, 20:49-60, 21:56-59, 26:15-25, 49-60, 26:40-45, 28:25-30, Fig. 1.
[5J] and wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link; and	Lisogurki discloses and/or renders obvious “and wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link.” “Back end processing circuitry 170 may include processor 172 and memory 174. Processor 172 may be adapted to execute software, which may include an operating system and one or more applications, as part of performing the functions described herein. Processor 172 may receive and process physiological signals received from front end processing circuitry 150. For example, processor 172 may determine one or more physiological parameters based on the received physiological signals. Memory 174 may include any suitable computer-readable media capable of storing information that can be interpreted by processor 172. This information may be data or may take the form of computer-executable instructions, such as software applications, that cause the microprocessor to perform certain functions and/or computer-implemented methods. Depending on the embodiment, such computer-readable media may include computer storage media and communication media. Computer storage media may include volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or other data. Computer storage media may include, but is not limited to, RAM, ROM, EPROM, EEPROM, flash memory

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	or other solid state memory technology, CD-ROM, DVD, or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by components of the system. Back end processing circuitry 170 may be communicatively coupled with use interface 180 and communication interface 190.” Lisogurski, 14:56-15:18. “Communication interface 190 may enable monitor 104 to exchange information with external devices. Communications interface 190 may include any suitable hardware, software, or both, which may allow monitor 104 to communicate with electronic circuitry, a device, a network, a server or other workstations, a display, or any combination thereof. Communications interface 190 may include one or more receivers, transmitters, transceivers, antennas, plug-in connectors, ports, communications buses, communications protocols, device identification protocols, any other suitable hardware or software, or any combination thereof. Communications interface 190 may be configured to allow wired communication (e.g., using USB, RS-232 or other standards), wireless communication (e.g., using WiFi, IR, WiMax, BLUETOOTH, UWB, or other standards), or both. For example, communications interface 190 may be configured using a universal serial bus (USB) protocol (e.g., USB 2.0, USB 3.0), and may be configured to couple to other devices (e.g., remote memory devices storing templates) using a four-pin USB standard Type-A connector (e.g., plug and/or socket) and cable. In some embodiments, communications interface 190 may include an internal bus such as, for example, one or more slots for insertion of expansion cards.” Lisogurski, 15:43-65. “In some embodiments, sensor unit 312 may be connected to monitor 314 as shown. Sensor unit 312 may be powered by an internal power source, e.g., a battery (not shown). Sensor unit 312 may draw power from monitor 314. In another embodiment, the sensor may be wirelessly connected to monitor 314 (not shown). Monitor 314 may be configured to calculate physiological parameters based at least in part on data relating to light emission and acoustic detection received from one or more sensor units such as sensor unit 312. For example, monitor 314 may be configured to determine pulse rate, blood pressure, blood oxygen saturation (e.g., arterial, venous, or both), hemoglobin concentration (e.g., oxygenated, deoxygenated, and/or total), any other suitable physiological parameters, or any combination thereof. In some embodiments, calculations may be performed on the sensor units or an intermediate device and the result of the calculations

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	may be passed to monitor 314. Further, monitor 314 may include display 320 configured to display the physiological parameters or other information about the system. In the embodiment shown, monitor 314 may also include a speaker 322 to provide an audible sound that may be used in various other embodiments, such as for example, sounding an audible alarm in the event that a subject's physiological parameters are not within a predefined normal range. In some embodiments, the system 310 includes a stand-alone monitor in communication with the monitor 314via a cable or a wireless network link. In some embodiments, monitor 314 may be implemented as monitor 104 of FIG. 1.” Lisogurski, 17:54-18:15. “In step 410, the system may determine a physiological parameter using information from the attenuated photonic signals. The physiological parameter may be determined using any suitable hardware technique, software technique, or combination thereof. In some embodiments, processing equipment remote to the system may be used to determine physiological parameters. The system may display the determined physiological parameter using a local display (e.g., display 320 of FIG. 3 or display 328 of FIG. 3), display them on a remote display, publish the data to a server or website, make the parameters available to a user by any other suitable technique, or any combination thereof.” Lisogurski, 20:49-60. *See also* Lisogurski, 18:16-67.
[5K] a remote device configured to receive over the wireless transmission link an output status comprising the at least a portion of the processed output signal, to process the received output status to generate processed data and to store the processed data.	Lisogurki discloses and/or renders obvious “a remote device configured to receive over the wireless transmission link an output status comprising the at least a portion of the processed output signal, to process the received output status to generate processed data and to store the processed data.” “Communication interface 190 may enable monitor 104 to exchange information with external devices. Communications interface 190 may include any suitable hardware, software, or both, which may allow monitor 104 to communicate with electronic circuitry, a device, a network, a server or other workstations, a display, or any combination thereof. Communications interface 190 may include one or more receivers, transmitters, transceivers, antennas, plug-in connectors, ports, communications buses, communications protocols, device identification protocols, any other suitable hardware or software, or any combination thereof. Communications

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	interface 190 may be configured to allow wired communication (e.g., using USB, RS-232 or other standards), wireless communication (e.g., using WiFi, IR, WiMax, BLUETOOTH, UWB, or other standards), or both. For example, communications interface 190 may be configured using a universal serial bus (USB) protocol (e.g., USB 2.0, USB 3.0), and may be configured to couple to other devices (e.g., remote memory devices storing templates) using a four-pin USB standard Type-A connector (e.g., plug and/or socket) and cable. In some embodiments, communications interface 190 may include an internal bus such as, for example, one or more slots for insertion of expansion cards.” Lisogurski, 15:43-65. “In some embodiments, sensor unit 312 may be connected to monitor 314 as shown. Sensor unit 312 may be powered by an internal power source, e.g., a battery (not shown). Sensor unit 312 may draw power from monitor 314. In another embodiment, the sensor may be wirelessly connected to monitor 314 (not shown). Monitor 314 may be configured to calculate physiological parameters based at least in part on data relating to light emission and acoustic detection received from one or more sensor units such as sensor unit 312. For example, monitor 314 may be configured to determine pulse rate, blood pressure, blood oxygen saturation (e.g., arterial, venous, or both), hemoglobin concentration (e.g., oxygenated, deoxygenated, and/or total), any other suitable physiological parameters, or any combination thereof. In some embodiments, calculations may be performed on the sensor units or an intermediate device and the result of the calculations may be passed to monitor 314. Further, monitor 314 may include display 320 configured to display the physiological parameters or other information about the system. In the embodiment shown, monitor 314 may also include a speaker 322 to provide an audible sound that may be used in various other embodiments, such as for example, sounding an audible alarm in the event that a subject's physiological parameters are not within a predefined normal range. In some embodiments, the system 310 includes a stand-alone monitor in communication with the monitor 314via a cable or a wireless network link. In some embodiments, monitor 314 may be implemented as monitor 104 of FIG. 1.” Lisogurski, 17:54-18:15. “In step 410, the system may determine a physiological parameter using information from the attenuated photonic signals. The physiological parameter may be determined using any suitable hardware technique, software technique, or combination thereof. In some embodiments, processing equipment remote to the system may be used to determine physiological parameters.

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	The system may display the determined physiological parameter using a local display (e.g., display 320 of FIG. 3 or display 328 of FIG. 3), display them on a remote display, publish the data to a server or website, make the parameters available to a user by any other suitable technique, or any combination thereof.” Lisogurski, 20:49-60. *See also* Lisogurski, 26:49-60.
[7] The system of claim 5, wherein the remote device is further configured to transmit at least a portion of the processed data to one or more other locations, wherein the one or more other locations is selected from the group consisting of the personal device, a doctor, a healthcare provider, a cloud-based server and one or more designated recipients, and wherein the remote device is capable of transmitting information related to a time and a position associated with the at least a portion of the processed data.	Lisogurki discloses and/or renders obvious “[t]he system of claim 5, wherein the remote device is further configured to transmit at least a portion of the processed data to one or more other locations, wherein the one or more other locations is selected from the group consisting of the personal device, a doctor, a healthcare provider, a cloud-based server and one or more designated recipients, and wherein the remote device is capable of transmitting information related to a time and a position associated with the at least a portion of the processed data.” “In some embodiments, historical information may be used to determine the timing of cardiac cycle modulation. For example, information from previous pulse cycles may be used to determine “on” and “off” states. In some embodiments, the system may use statistical information from historical information, for example, mean period and/or standard deviation of one or more previous pulse cycles. The system may use a mean period to determine or estimate the time period between a previous period of interest and the next period of interest. For example, the system may wait a particular percentage (e.g., 80%) of the mean period following a period of interest before returning to an “on” state. In some embodiments, the particular percentage or other criteria may be based on statistical information. For example, a smaller standard deviation in the period of historical pulses may indicate that there is relatively less variation in the pulse period. The system may increase the amount of time it waits before turning a drive signal back to an “on” state, as the confidence of the position in time of the next period of interest is high. Similarly, the system may reduce the waiting period in response to a relatively high standard deviation in the period of historical pulses. For example, the system may identify a relatively high standard deviation in the period of historical pulses when a significant respiratory sinus arrhythmia is present. In some embodiments, the system may remain in a particular cardiac cycle modulation mode for an amount of time following a historical event. For example, the system may operate in a high power mode without cardiac cycle modulation for a certain time period following, for example, high noise levels, a loss of signal, or an irregular cardiac rhythm. In some embodiments, the system may use

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	a cardiac cycle modulation during periodic abnormal rhythms such as a 2nd degree AC block, bundle branch block, or sustained ventricular tachycardia.” Lisogurski, 8:45-9:11. “In step 410, the system may determine a physiological parameter using information from the attenuated photonic signals. The physiological parameter may be determined using any suitable hardware technique, software technique, or combination thereof. In some embodiments, processing equipment remote to the system may be used to determine physiological parameters. The system may display the determined physiological parameter using a local display (e.g., display 320 of FIG. 3 or display 328 of FIG. 3), display them on a remote display, publish the data to a server or website, make the parameters available to a user by any other suitable technique, or any combination thereof.” Lisogurski, 20:49-60. “*Communication interface 190 may enable monitor 104 to exchange information with external devices*. Communications interface 190 may include any suitable hardware, software, or both, which may allow *monitor 104 to communicate with electronic circuitry, a device, a network, a server or other workstations*, a display, or any combination thereof. Communications interface 190 may include one or more receivers, transmitters, transceivers, antennas, plug-in connectors, ports, communications buses, communications protocols, device identification protocols, any other suitable hardware or software, or any combination thereof. Communications interface 190 may be configured to allow wired communication (e.g., using USB, RS-232 or other standards), wireless communication (e.g., using WiFi, IR, WiMax, BLUETOOTH, UWB, or other standards), or both. For example, communications interface 190 may be configured using a universal serial bus (USB) protocol (e.g., USB 2.0, USB 3.0), and may be configured to couple to other devices (e.g., remote memory devices storing templates) using a four-pin USB standard Type-A connector (e.g., plug and/or socket) and cable. In some embodiments, communications interface 190 may include an internal bus such as, for example, one or more slots for insertion of expansion cards.” Lisogurski, 15:43-65. “In some embodiments, sensor unit 312 may be connected to monitor 314 as shown. Sensor unit 312 may be powered by an internal power source, e.g., a battery (not shown). Sensor unit 312 may draw power from monitor 314. In another embodiment, the sensor may be wirelessly connected to monitor 314 (not shown). Monitor 314 may be configured to calculate physiological

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	parameters based at least in part on data relating to light emission and acoustic detection received from one or more sensor units such as sensor unit 312. For example, monitor 314 may be configured to determine pulse rate, blood pressure, blood oxygen saturation (e.g., arterial, venous, or both), hemoglobin concentration (e.g., oxygenated, deoxygenated, and/or total), any other suitable physiological parameters, or any combination thereof. In some embodiments, calculations may be performed on the sensor units or an intermediate device and the result of the calculations may be passed to monitor 314. Further, monitor 314 may include display 320 configured to display the physiological parameters or other information about the system. In the embodiment shown, monitor 314 may also include a speaker 322 to provide an audible sound that may be used in various other embodiments, such as for example, sounding an audible alarm in the event that a subject's physiological parameters are not within a predefined normal range. In some embodiments, the system 310 includes a stand-alone monitor in communication with the monitor 314via a cable or a wireless network link. In some embodiments, monitor 314 may be implemented as monitor 104 of FIG. 1.” Lisogurski, 17:54-18:15. “In step 906, the system may determine a physiological parameter using information from the attenuated photonic signals. The physiological parameter may be determined using any suitable hardware technique, software technique, or combination thereof. In some embodiments, processing equipment remote to the system may be used to determine physiological parameters. The system may display the determined physiological parameter using a local display (e.g., display 320 of FIG. 3 or display 328 of FIG. 3), display them on a remote display, publish the data to a server or website, make the parameters available to a user by any other suitable technique, or any combination thereof.” Lisogurski, 26:49-60. “FIG. 17 is flow diagram 1700 showing illustrative steps for decimating and interpolating a signal in accordance with some embodiments of the present disclosure. In some embodiments, the system may sample a signal at different rates throughout a cardiac cycle. The system may process the sampled signal to produce an output signal with a constant rate. In some embodiments, the system may vary the sampling rate to reduce or optimize power consumption. In some embodiments, sampling rate modulation may be correlated with light drive signal modulation. Varying the sampling rate may reduce power consumption by reducing emitter drive time and lowering utilization of an analog-to-digital converter. In some embodiments, varying the sampling

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	rate may increase the time resolution of identified features. For example, in a continuous non-invasive blood pressure measurement where the pulse transit time is used in calculations, increasing the sampling rate for a portion of the cardiac cycle may result in more accurate and reliable physiological information. In another example, varying the sampling rate around a cardiac pulse cycle feature, such as a peak or notch, may increase the accuracy of determining the location of that feature in time. In some embodiments, lower frequency or less critical parts of the cardiac pulse cycle may be sampled at a lower rate while maintaining highly accuracy and reliable physiological parameter determination.” Lisogurski, 33:40-64. *See also* Lisogurski, 18:16-67.
[8] The system of claim 5, wherein the receiver is located a first distance from a first one of the plurality of light emitting diodes and a different, second distance from a second one of the plurality of light emitting diodes such that the receiver receives a first signal from the first light emitting diode and a second signal from the second light emitting diode.	Lisogurki discloses and/or renders obvious “[t]he system of claim 5, wherein the receiver is located a first distance from a first one of the plurality of light emitting diodes and a different, second distance from a second one of the plurality of light emitting diodes such that the receiver receives a first signal from the first light emitting diode and a second signal from the second light emitting diode.” “FIG. 3 is a perspective view of an embodiment of a physiological monitoring system 310 in accordance with some embodiments of the present disclosure. In some embodiments, one or more components of physiological monitoring system 310 may include one or more components of physiological monitoring system 100 of FIG. 1. System 310 may include sensor unit 312 and monitor 314. In some embodiments, sensor unit 312 may be part of an oximeter. Sensor unit 312 may include one or more light source 316 for emitting light at one or more wavelengths into a subject's tissue. One or more detector 318 may also be provided in sensor unit 312 for detecting the light that is reflected by or has traveled through the subject's tissue. Any suitable configuration of light source 316 and detector 318 may be used. In an embodiment, sensor unit 312 may include multiple light sources and detectors, which may be spaced apart. System 310 may also include one or more additional sensor units (not shown) that may, for example, take the form of any of the embodiments described herein with reference to sensor unit 312. An additional sensor unit may be the same type of sensor unit as sensor unit 312, or a different sensor unit type than sensor unit 312 (e.g., a photoacoustic sensor). Multiple sensor units may be capable of being positioned at two different locations on a subject's body.” Lisogurski, 17:30-53.

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[9] The system of claim 8, wherein the output signal is generated in part by comparing the first and second signals	Lisogurki discloses and/or renders obvious “[t]he system of claim 5, wherein the output signal is generated in part by comparing the first and second signals.” “In some embodiments, a technique to remove ambient and background signals may be used in addition to or in place of a power saving light modulation scheme. In a drive cycle modulation technique, the system may cycle light output at a rate significantly greater than the cardiac cycle. For example, a drive cycle modulation cycle may include the system turning on a first light source, followed by a “dark” period, followed by a second light source, followed by a “dark” period. The system may measure the ambient light detected by the detector during the “dark” period and then subtract this ambient contribution from the signals received during the first and second “on” periods. In some embodiments, drive cycle modulation may be implemented using time division multiplexing as described above, code division multiplexing, carrier frequency multiplexing, phase division multiplexing, feedback circuitry, DC restoration circuitry, any other suitable technique, or any combination thereof. For example, the system may use frequency division multiplexing in a drive cycle modulation technique. The cardiac cycle modulation may represent a lower frequency envelope function on the higher frequency drive cycle. For example, cardiac cycle modulation may be an envelope on the order of 1 Hz superimposed on a 1 kHz sine wave drive cycle modulation.” Lisogurski, 6:7-31. “Dark subtractor 162 may operate on the digital signal. In some embodiments, dark subtractor 162 may subtract dark values from the Red and IR components to generate adjusted Red and IR signals. For example, dark subtractor 162 may determine a subtraction amount from the dark signal portion of the detection signal and subtract it from the peak portion of the detection signal in order to reduce the effect of the dark signal on the peak. For example, in reference to FIG. 2A, a detection signal peak corresponding to red “on” period 202 may be adjusted by determining the amount of dark signal during the “off” period 220 preceding red “on” period 202. The dark signal amount determined in this manner may be subtracted from the detector peak corresponding to red “on” period 202. Alternatively, the “off” period 220 after red “on” period 202 may be used to correct red “on” period 202 rather than the “off” period 220 preceding it. Additionally, an average of the “off” periods 220 before and after red “on” period 202 may be used.” Lisogurski, 13:60-14:10; *see id.*, 14:40-55.

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	“Region **256** of plot **250** indicates an interval of the timing diagram where both red light modulation **252** and IR light modulation **254** are in an “on” portion of the cardiac cycle modulation. Plot **270** shows an illustrative portion of region **256**, where the system is employing a cardiac cycle modulation in addition to the drive cycle modulation. Plot **250** may include a drive cycle modulation technique with a period of time interval **272**. The time scale of plot **270** may be significantly shorter than the time scale of plot **250**, such that time interval **272** is significantly shorter than time interval **260**. For example, time interval **260** (i.e., the period of the cardiac cycle modulation) may be on the order of 1 second, while time interval **272** (i.e., the period of the drive cycle modulation) may be on the order of 1 ms. Time interval 272 may include a sequence of red “on” portion 274, a first “off” portion 276, IR “on” portion 278, and a second “off” portion 280. The first “off” portion 276 and second “off” portion 280 may be used to determine the level of ambient light, noise, dark current, other suitable signals, or any combination thereof. The system may subtract the background or dark level from the levels received during red “on” portion 274 and IR “on” period 278.” Lisogurski, 16:33-54. *See also* Lisogurski, 12:64-13:6.
[10] The system of claim 5, wherein the output signal comprises one or more physiological parameters, and the remote device is capable of storing a history of at least a portion of the one or more physiological parameters over a specified period of time.	Lisogurki discloses and/or renders obvious “[t]he system of claim 5, wherein the output signal comprises one or more physiological parameters, and the remote device is capable of storing a history of at least a portion of the one or more physiological parameters over a specified period of time.” “A physiological monitoring system may use photonic signals to determine physiological parameters . . . In some embodiments, the system may vary parameters in a way substantially synchronous with physiological pulses, for example, cardiac pulses.” Lisogurski at Abstract. “The generated signals may be used to determine physiological parameters such as blood oxygen saturation, hemoglobin, blood pressure, pulse rate, other suitable parameters, or any combination thereof.” Lisogurski, 1:21-25. “The present disclosure is directed towards power optimization in a medical device. A physiological monitoring system may monitor one or more physiological parameters of a patient, typically using one or more physiological sensors. The system may include, for example, a light

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	source and a photosensitive detector. Providing a light drive signal to the light source may account for a significant portion of the system's total power consumption. Thus, it may be desirable to reduce the power consumption of the light source, while still enabling high quality physiological parameters to be determined. The system may reduce the power consumption by modulating parameters associated with the light drive signal in techniques correlated to the cardiac cycle or other cyclical physiological activity. For example, the system may decrease brightness during a particular portion of the cardiac cycle. It may also be desirable to reduce the power consumption by the light drive signal to reduce heating effects caused by an emitter.” Lisogurski, 3:43-60. *See also* Lisogurski, 3:61-4:5, 4:36-41, 5:25-47, 6:31-35, 6:53-57, passim, Figs. 4, 9, 19. “In some embodiments, historical information may be used to determine the timing of cardiac cycle modulation. For example, information from previous pulse cycles may be used to determine “on” and “off” states. In some embodiments, the system may use statistical information from historical information, for example, mean period and/or standard deviation of one or more previous pulse cycles. The system may use a mean period to determine or estimate the time period between a previous period of interest and the next period of interest. For example, the system may wait a particular percentage (e.g., 80%) of the mean period following a period of interest before returning to an “on” state. In some embodiments, the particular percentage or other criteria may be based on statistical information. For example, a smaller standard deviation in the period of historical pulses may indicate that there is relatively less variation in the pulse period. The system may increase the amount of time it waits before turning a drive signal back to an “on” state, as the confidence of the position in time of the next period of interest is high. Similarly, the system may reduce the waiting period in response to a relatively high standard deviation in the period of historical pulses. For example, the system may identify a relatively high standard deviation in the period of historical pulses when a significant respiratory sinus arrhythmia is present. In some embodiments, the system may remain in a particular cardiac cycle modulation mode for an amount of time following a historical event. For example, the system may operate in a high power mode without cardiac cycle modulation for a certain time period following, for example, high noise levels, a loss of signal, or an irregular cardiac rhythm. In some embodiments, the system may use

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	a cardiac cycle modulation during periodic abnormal rhythms such as a 2nd degree AC block, bundle branch block, or sustained ventricular tachycardia.” Lisogurski, 8:45-9:11. “Back end processing circuitry 170 may include processor 172 and memory 174. Processor 172 may be adapted to execute software, which may include an operating system and one or more applications, as part of performing the functions described herein. Processor 172 may receive and process physiological signals received from front end processing circuitry 150. For example, processor 172 may determine one or more physiological parameters based on the received physiological signals. Memory 174 may include any suitable computer-readable media capable of storing information that can be interpreted by processor 172. This information may be data or may take the form of computer-executable instructions, such as software applications, that cause the microprocessor to perform certain functions and/or computer-implemented methods. Depending on the embodiment, such computer-readable media may include computer storage media and communication media. Computer storage media may include volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or other data. Computer storage media may include, but is not limited to, RAM, ROM, EPROM, EEPROM, flash memory or other solid state memory technology, CD-ROM, DVD, or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by components of the system. Back end processing circuitry 170 may be communicatively coupled with use interface 180 and communication interface 190.” Lisogurski, 14:56-15:18.
[13] A measurement system comprising	To the extent the preamble is limiting, Lisogurki discloses and/or renders obvious “a measurement system.” *See* CHART ONE: ’533 Patent, Claim Element 5 above.
[13A] a wearable measurement device for measuring one or more	Lisogurki discloses and/or renders obvious “a wearable measurement device for measuring one or more physiological parameters, including a light source comprising a plurality of semiconductor

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physiological parameters, including a light source comprising a plurality of semiconductor sources that are light emitting diodes, the light emitting diodes configured to generate an output optical beam with one or more optical wavelengths,	sources that are light emitting diodes, the light emitting diodes configured to generate an output optical beam with one or more optical wavelengths.” “A physiological monitoring system may use photonic signals to determine physiological parameters. The system may vary parameters of a light drive signal used to generate the photonic signal from a light source such that power consumption is reduced or optimized. Parameters may include light intensity, firing rate, duty cycle, other suitable parameters, or any combination thereof. In some embodiments, the system may use information from a first light source to generate a light drive signal for a second light source. In some embodiments, the system may vary parameters in a way substantially synchronous with physiological pulses, for example, cardiac pulses. In some embodiments, the system may vary parameters in response to an external trigger.” Lisogurski, Abstract. “Systems and methods are provided for optimizing power consumption in an optical physiological monitoring system. The system may vary light drive signal parameters to reduce power consumption or vary power use. The system may vary parameters in a technique correlated to cardiac pulse cycles. In some embodiments, reducing power consumption may allow for increased battery life in portable systems or increased portability. In some embodiments, varying light output during a cardiac cycle may reduce heating effects of the emitters. Parameters that may be varied include light intensity, firing rate, duty cycle, other suitable parameters, or any combination thereof. The generated signals may be used to determined physiological parameters such as blood oxygen saturation, hemoglobin, blood pressure, pulse rate, other suitable parameters, or any combination thereof.” Lisogurski, 1:10-25; *see id.*, 4:65-5:2, 17:55-58, 18:58-67. “The present disclosure is directed towards power optimization in a medical device. A physiological monitoring system may monitor one or more physiological parameters of a patient, typically using one or more physiological sensors.” Lisogurski, 3:43-46. “An oximeter is a medical device that may determine the oxygen saturation of an analyzed tissue. One common type of oximeter is a pulse oximeter, which may non-invasively measure the oxygen saturation of a patient's blood (as opposed to measuring oxygen saturation directly by analyzing a blood sample taken from the patient). Pulse oximeters may be included in patient monitoring

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	systems that measure and display various blood flow characteristics including, but not limited to, the oxygen saturation of hemoglobin in arterial blood.” Lisogurski, 3:61-4:3. “The system may process data to determine physiological parameters using techniques well known in the art. For example, the system may determine blood oxygen saturation using two wavelengths of light and a ratio-of-ratios calculation. The system also may identify pulses and determine pulse amplitude, respiration, blood pressure, other suitable parameters, or any combination thereof, using any suitable calculation techniques. In some embodiments, the system may use information from external sources (e.g., tabulated data, secondary sensor devices) to determine physiological parameters.” Lisogurski, 4:52-62. “In some embodiments of cardiac cycle modulation, the system may modulate multiple light sources using a plurality of modulation techniques. For example, in a system with two light sources, the system may operate a first light source at full or regular brightness, while operating one or more additional light sources in a switched or otherwise modulated mode. In some embodiments, the system may operate a first light source according to a first cardiac cycle modulation technique and a second light source according to a second cardiac modulation technique. The first and second cardiac cycle modulation techniques may be the same, correlated, or unrelated. In some embodiments, the system may use the first light source to determine periods of interest in the cardiac cycle. The system may, according to the periods of interest, power additional light sources, alter the modulation of the additional light sources, perform other suitable power optimization techniques, or any combination thereof. In some embodiments, the system may include a first light source (e.g., a light source powered at full or regular brightness) of a type that is a more efficient light source than the one or more additional light sources. For example, the first light source may be a high efficiency infrared (IR) LED while the one or more additional light sources may be lower efficiency red LEDs or laser diodes**.** In some embodiments, the first light source may be selected based on efficiency parameters and information from the first light source may be used only to control a second light source. For example, a highly efficient first light source that is not at a wavelength of interest for physiological parameter determination may be used to control one or more second light sources at wavelengths of interest. In this case, the light from the

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	first light source may be used only for controlling the second light source and not for determining physiological parameters.” Lisogurski, 7:38-8:3. “Multiple sensor units may be capable of being positioned at two different locations on a subject's body.” Lisogurski, 17:51-53, 21:67-22:7. “Sensor of physiological monitoring system may include light source and detector. Light source may be configured to emit photonic signals having one or more wavelengths of light (e.g. RED and IR) into a subject’s tissue. For example, light source may include a Red light emitting light source and an IR light emitting light source, e.g., Red and IR light emitting diodes (LEDs), for emitting light into the tissue of a subject to generate physiological signals. In one embodiment, the Red wavelength may be between about 600 nm and about 700 nm, and the IR wavelength may be between about 800 nm and about 1000 nm.” Lisogurski, 10:48-58. “It will be understood that light source may include any number of light sources with any suitable characteristics. In embodiments where an array of sensors is used in place of single sensor, each sensor may be configured to emit a single wavelength. For example, a first sensor may emit only a Red light while a second may emit only an IR light.” Lisogurski, 10:58-64. “Control circuitry 110 may be coupled to light drive circuitry 120, front end processing circuitry 150, and back end processing circuitry 170, and may be configured to control the operation of these components. In some embodiments, control circuitry 110 may be configured to provide timing control signals to coordinate their operation. For example, light drive circuitry 120 may generate a light drive signal, which may be used to turn on and off the light source 130, based on the timing control signals.” Lisogurksi, 11:33-41. “Any suitable configuration of light source and detector may be used. In an embodiment, sensor unit may include multiple light sources and detectors, which may be spaced apart.” Lisogurski, 17:42-45.

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	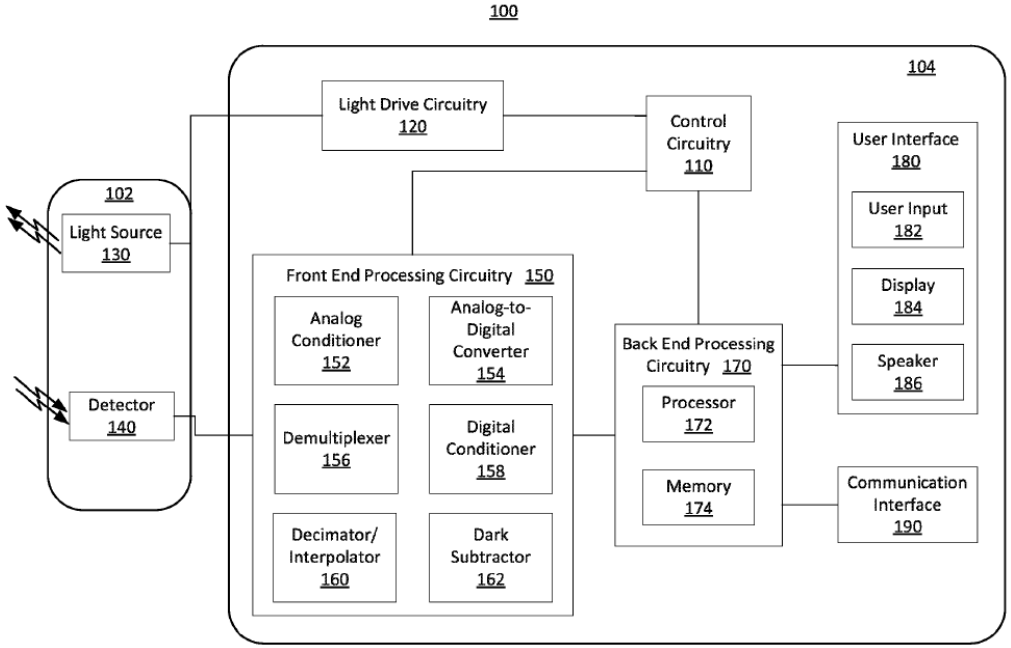 FIG. 1 Lisogurski, Fig. 1.

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	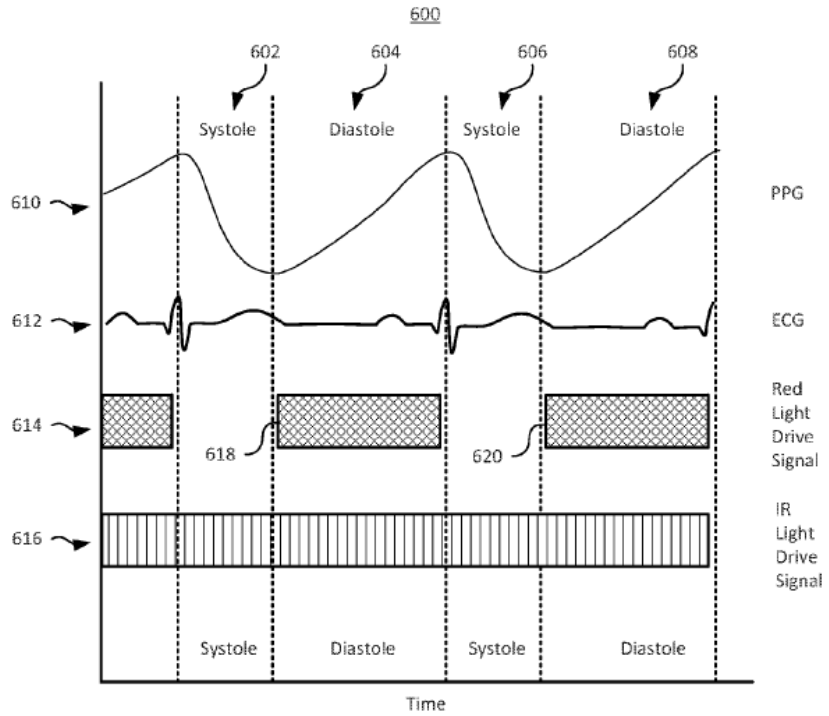 Lisogurski, Fig. 6; *see also* Lisogurski, Figs. 2A, 2C, 4, 5, 7, 8A, 8B, 9-16, 18, 19, 21. See also Lisogurski, 1:26-59; 4:36-41, 5:25-47, 6:31-35, 6:53-57, 7:13-36; 7:58-61; 8:48-64; 9:13-35; 11:50-60; 12:11-22; 17:37-39; 19:20-39; 25:22-65; 26:30-32; Claims 1, 16.
[13B] wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers,	Lisogurki discloses and/or renders obvious “wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers.” *See* CHART ONE: ’533 Patent, Claim Element 5B above.

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[13C] the light source configured to increase signal-to-noise ratio by increasing a light intensity from at least one of the plurality of semiconductor sources and by increasing a pulse rate of at least one of the plurality of semiconductor sources;	Lisogurki discloses and/or renders obvious “the light source configured to increase signal-to-noise ratio by increasing a light intensity from at least one of the plurality of semiconductor sources and by increasing a pulse rate of at least one of the plurality of semiconductor sources.” *See* CHART ONE: ’533 Patent, Claim Element 5C above.
[13D] the wearable measurement device comprising a plurality of lenses configured to receive a portion of the output optical beam and to deliver an analysis output beam to a sample;	Lisogurki discloses and/or renders obvious “the wearable measurement device comprising a plurality of lenses configured to receive a portion of the output optical beam and to deliver an analysis output beam to a sample.” *See* CHART ONE: ’533 Patent, Claim Element 5D above.
[13E] the wearable measurement device further comprising a receiver configured to receive and process at least a portion of the analysis output beam reflected or transmitted from the sample and to generate an output signal	Lisogurki discloses and/or renders obvious “the wearable measurement device further comprising a receiver configured to receive and process at least a portion of the analysis output beam reflected or transmitted from the sample and to generate an output signal.” *See* CHART ONE: ’533 Patent, Claim Element 5E above.
[13F] wherein the wearable measurement device receiver is configured to be synchronized to pulses of the light source;	Lisogurki discloses and/or renders obvious “wherein the wearable measurement device receiver is configured to be synchronized to pulses of the light source.” *See* CHART ONE: ’533 Patent, Claim Element 5F above.
[13G] a personal device comprising a wireless receiver, a wireless transmitter, a display, a	Lisogurki discloses and/or renders obvious “a personal device comprising a wireless receiver, a wireless transmitter, a display, a microphone, a speaker, one or more buttons or knobs, a microprocessor and a touch screen.”

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microphone, a speaker, one or more buttons or knobs, a microprocessor and a touch screen,	*See* CHART ONE: ’533 Patent, Claim Element 5G above.
[13H] the personal device configured to receive and process at least a portion of the output signal,	Lisogurki discloses and/or renders obvious “the personal device configured to receive and process at least a portion of the output signal, wherein the personal device is configured to store and display the processed output signal.” *See* CHART ONE: ’533 Patent, Claim Element 5H above.
[13I] wherein the personal device is configured to store and display the processed output signal, and	Lisogurki discloses and/or renders obvious “wherein the personal device is configured to store and display the processed output signal.” *See* CHART ONE: ’533 Patent, Claim Element 5I above.
[13J] wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link; and	Lisogurki discloses and/or renders obvious “wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link.” *See* CHART ONE: ’533 Patent, Claim Element 5J above.
[13K] a remote device configured to receive over the wireless transmission link an output status comprising the at least a portion of the processed output signal, to process the received output status to generate processed data and to store the processed data, and	Lisogurki discloses and/or renders obvious “a remote device configured to receive over the wireless transmission link an output status comprising the at least a portion of the processed output signal, to process the received output status to generate processed data and to store the processed data.” *See* CHART ONE: ’533 Patent, Claim Element 5K above.
[13L] wherein the remote device is capable of storing a history of at least a portion of the received	Lisogurki discloses and/or renders obvious “wherein the remote device is capable of storing a history of at least a portion of the received output status over a specified period of time.”

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output status over a specified period of time.	*See* CHART ONE: ’533 Patent, Claim Element 10 above.
[16] The system of claim 13, wherein the receiver is located a first distance from a first one of the plurality of light emitting diodes and a different, second distance from a second one of the plurality of light emitting diodes such that the receiver receives a first signal from the first light emitting diode and a second signal from the second light emitting diode.	Lisogurki discloses and/or renders obvious “[t]he system of claim 13, wherein the receiver is located a first distance from a first one of the plurality of light emitting diodes and a different, second distance from a second one of the plurality of light emitting diodes such that the receiver receives a first signal from the first light emitting diode and a second signal from the second light emitting diode.” *See* CHART ONE: ’533 Patent, Claim Element 8 above.
[17] The system of claim 16, wherein the output signal is generated in part by comparing the first and second signals.	Lisogurki discloses and/or renders obvious “[t]he system of claim 16, wherein the output signal is generated in part by comparing the first and second signals.” *See* CHART ONE: ’533 Patent, Claim Element 9 above.

EXHIBIT P-2

U.S. Patent No. 9,757,040 vs Lisogurki

Priority Date/Publication Date:	May 31, 2012/Jan. 26, 2016	Prior Art Status:	§§ 102(a), (b), and (e) (pre-AIA) §§ 102(a), (b), and (d)

US Patent No. 9,241,676 to Lisogurki ("Lisogurki") anticipates the asserted claims of U.S. Patent No. 9,757,040 ("the '040 Patent") or renders those claims obvious alone and/or in view of at least any of the references identified in Apple's Obviousness Combinations Chart.

As set forth in Apple's Invalidity Contentions, the below contentions apply the prior art in part in accordance with Apple's assumption that Omni contends the claims are not invalid under 35 U.S.C. § 112. However, Apple's below contentions do not represent Apple's agreement or view as to the meaning, definiteness, written description support for, or enablement of any of the asserted claims. For each dependent claim, the disclosures cited for the claim from which it depends are incorporated by reference.

CHART TWO: U.S. Patent No. 9,757,040 vs Lisogurki

Asserted Claim of ’040 Patent	Lisogurski (US 9,241,676)
[1] A wearable device for use with a smart phone or tablet, the wearable device comprising:	To the extent the preamble is limiting, Lisogurki discloses and/or renders obvious “[a] wearable device for use with a smart phone or tablet.” *See* CHART ONE: ’533 Patent, Claim Elements 5, 5G, and 13A above. “Communication interface 190 may enable monitor 104 to exchange information with external devices. Communications interface 190 may include any suitable hardware, software, or both, which may allow monitor 104 to communicate with electronic circuitry, a device, a network, a server or other workstations, a display, or any combination thereof. Communications interface 190 may include one or more receivers, transmitters, transceivers, antennas, plug-in connectors, ports, communications buses, communications protocols, device identification protocols, any other suitable hardware or software, or any combination thereof. Communications interface 190 may be configured to allow wired communication (e.g., using USB, RS-232 or other standards), wireless communication (e.g., using WiFi, IR, WiMax, BLUETOOTH, UWB, or other standards), or both. For example, communications interface 190 may be configured using a universal serial bus (USB) protocol (e.g., USB 2.0, USB 3.0), and may be configured to couple to other devices (e.g., remote memory devices storing templates) using a four-pin USB standard Type-A connector (e.g., plug and/or socket) and cable. In some embodiments, communications interface 190 may include an internal bus such as, for example, one or more slots for insertion of expansion cards.” Lisogurski, 15:19-65.

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	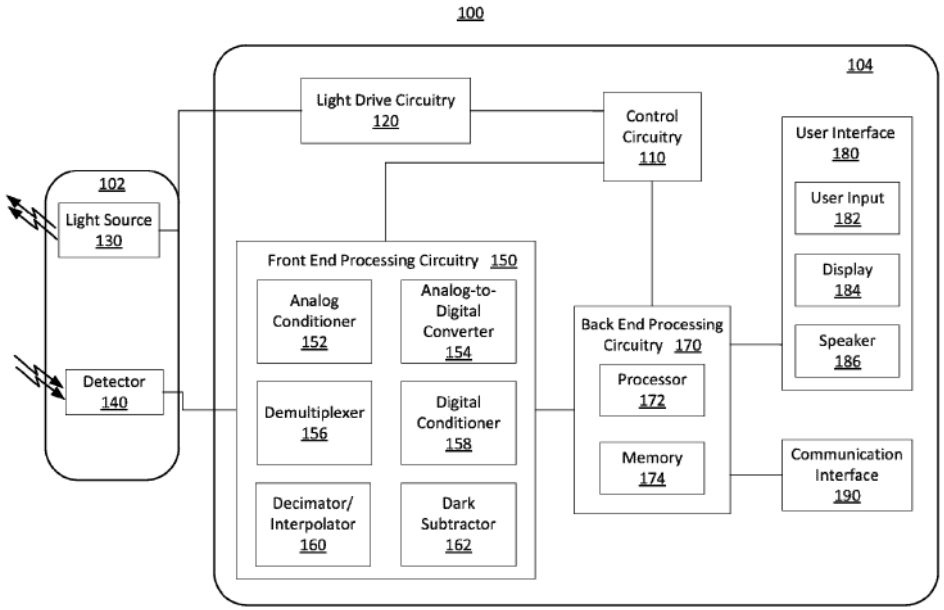 FIG. 1 *See also* Lisogurski, 17:54-18:67.
[1A] a measurement device including a light source comprising a plurality of light emitting diodes (LEDs) for measuring one or more physiological parameters	Lisogurki discloses and/or renders obvious “a measurement device including a light source comprising a plurality of light emitting diodes (LEDs) for measuring one or more physiological parameters.” *See* CHART ONE: ’533 Patent, Claim Element 13A above.

Asserted Claim of ’040 Patent	Lisogurski (US 9,241,676)
[1B] the measurement device configured to generate, by modulating at least one of the LEDs having an initial light intensity, an input optical beam having one or more optical wavelengths,	Lisogurki discloses and/or renders obvious “the measurement device configured to generate, by modulating at least one of the LEDs having an initial light intensity, an input optical beam having one or more optical wavelengths.” “In some embodiments, the brightness of one of more light sources may be modulated in a technique that is related to the cardiac cycle. The cardiac cycle is the substantially periodic repetition of events that occur, for example, during heartbeats. The cardiac cycle may include a systole period and diastole period. The cardiac cycle may include pressure changes in the ventricles, pressure changes in the atria, volume changes in the ventricles, volume changes in the atria, opening and closing of heart valves, heart sounds, and other cyclic events. In some embodiments, the heart may enter a non-periodic state, for example, in certain types of arrhythmia and fibrillation.” Lisogurski, 5:13-24. “As used herein, “drive cycle modulation” (described below) will refer to a relatively higher frequency modulation technique that the system may use to generate one or more wavelengths of intensity signals. Cardiac cycle modulation may have a period of, for example, around 1 second, while drive cycle modulation may have a period around, for example, 1.6 milliseconds.” Lisogurski, 5:48-54. “In some embodiments, the system may use various cardiac cycle modulation schemes to adjust the brightness of a light source controlled by the light drive signal used in determining physiological parameters. The system may modulate the brightness of the light source using a periodic waveform, for example, a sinusoidal or triangle wave. The period of the waveform may be substantially related to the cardiac pulse rate, for example, in a one-to-one relationship, a two-to-one relationship, any other suitable relationship, or any suitable combination thereof. The system may align the peak of the modulated light drive signal with a particular point in the cardiac cycle to improve the quality of the determined physiological parameter, for example, it may be aligned with the diastolic period, the systolic period, the dicrotic notch, any other suitable point, or any combination thereof. In some embodiments, the system may modulate the light drive signal with a square wave function, such that it is at a low brightness level during a first part of the cardiac cycle and a high brightness level during a second part of the cardiac cycle. In some

Asserted Claim of ’040 Patent	Lisogurski (US 9,241,676)
	embodiments, the low brightness level may include turning one or more light sources off.” Lisogurski, 6:31-52. “In some embodiments of cardiac cycle modulation, the system may modulate multiple light sources using a plurality of modulation techniques. For example, in a system with two light sources, the system may operate a first light source at full or regular brightness, while operating one or more additional light sources in a switched or otherwise modulated mode. In some embodiments, the system may operate a first light source according to a first cardiac cycle modulation technique and a second light source according to a second cardiac modulation technique. The first and second cardiac cycle modulation techniques may be the same, correlated, or unrelated. In some embodiments, the system may use the first light source to determine periods of interest in the cardiac cycle. The system may, according to the periods of interest, power additional light sources, alter the modulation of the additional light sources, perform other suitable power optimization techniques, or any combination thereof. In some embodiments, the system may include a first light source (e.g., a light source powered at full or regular brightness) of a type that is a more efficient light source than the one or more additional light sources. For example, the first light source may be a high efficiency infrared (IR) LED while the one or more additional light sources may be lower efficiency red LEDs or laser diodes**.** In some embodiments, the first light source may be selected based on efficiency parameters and information from the first light source may be used only to control a second light source. For example, a highly efficient first light source that is not at a wavelength of interest for physiological parameter determination may be used to control one or more second light sources at wavelengths of interest. In this case, the light from the first light source may be used only for controlling the second light source and not for determining physiological parameters.” Lisogurski, 7:38-8:3. *See also* Lisogurski, Fig. 2B, 2C, Fig. 19, 3:53-56, 5:25-7:3, 7:38-10:38.
[1C] wherein at least a portion of the one or more optical wavelengths is a near-infrared	Lisogurki discloses and/or renders obvious “wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers.” *See* CHART ONE: ’533 Patent, Claim Element 5B above.

Asserted Claim of ’040 Patent	Lisogurski (US 9,241,676)
wavelength between 700 nanometers and 2500 nanometers;	
[1D] the measurement device comprising one or more lenses configured to receive and to deliver a portion of the input optical beam to tissue, wherein the tissue reflects at least a portion of the input optical beam delivered to the tissue;	Lisogurki discloses and/or renders obvious “the measurement device comprising one or more lenses configured to receive and to deliver a portion of the input optical beam to tissue, wherein the tissue reflects at least a portion of the input optical beam delivered to the tissue.” *See* CHART ONE: ’533 Patent, Claim Element 5D above.
[1E] the measurement device further comprising a reflective surface configured to receive and redirect at least a portion of light reflected from the tissue;	Lisogurki discloses and/or renders obvious “the measurement device further comprising a reflective surface configured to receive and redirect at least a portion of light reflected from the tissue.” “An oximeter may include a light sensor that is placed at a site on a patient, typically a fingertip, toe, forehead or earlobe, or in the case of a neonate, across a foot. The oximeter may use a light source to pass light through blood perfused tissue and photoelectrically sense the absorption of the light in the tissue. In addition, locations which are not typically understood to be optimal for pulse oximetry serve as suitable sensor locations for the blood pressure monitoring processes described herein, including any location on the body that has a strong pulsatile arterial flow. For example, additional suitable sensor locations include, without limitation, the neck to monitor carotid artery pulsatile flow, the wrist to monitor radial artery pulsatile flow, the inside of a patient's thigh to monitor femoral artery pulsatile flow, the ankle to monitor tibial artery pulsatile flow, and around or in front of the ear. Suitable sensors for these locations may include sensors for sensing absorbed light based on detecting reflected light. In all suitable locations, for example, the oximeter may measure the intensity of light that is received at the light sensor as a function of time. The oximeter may also include sensors at multiple locations. A signal representing light intensity versus time or a mathematical manipulation of this signal (e.g., a scaled version thereof; a logarithm taken thereof, a scaled version of a logarithm taken thereof; a derivative taken thereof, a difference taken thereof, etc.) may be referred to as the photoplethysmograph (PPG) signal. In

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	addition, the term “PPG signal,” as used herein, may also refer to an absorption signal (i.e., representing the amount of light absorbed by the tissue), a transmission signal (i.e., representing the amount of light received from the tissue), any suitable mathematical manipulation thereof; or any combination thereof. The light intensity or the amount of light absorbed may then be used to calculate any of a number of physiological parameters, including an amount of a blood constituent (e.g., oxyhemoglobin) being measured as well as a pulse rate and when each individual pulse occurs.” Lisogurski, 4:6-41. “In step 402, the system may generate a first light drive signal. The light drive signal may be used by a light source to emit a photonic signal. The light source may be one or more LEDs, laser diodes, other suitable device, or any combination thereof. For example, the light source may include light source 130 of FIG. 1 or light source 316 of FIG. 3. In some embodiments, the light source may include LEDs of multiple wavelengths, for example, a red LED and an IR led. In some embodiments, the light source may include multiple LEDs of the same wavelength, multiple LEDs of different wavelengths, any other suitable arrangement, or any combination thereof. In some embodiments, the light source may include a fiber optic or other light pipe to communicate light from one location to another. In some embodiments, the light drive signal may include or be a component of a cardiac cycle modulation. For example, the first light drive signal may be configured to activate one LED to emit a photonic signal and not activate other LEDs, such that some physiological parameters may be determined, but with lower power consumption than when the other LEDs are illuminated.” Lisogurski, 19:20-39. “In step 902, the system may generate a light drive signal, in part correlated to physiological pulses. The system may generate a light drive signal used by a light source to emit a photonic signal. The light source may be one or more emitters of one or more wavelengths, and they may emit one or more photonic signals. For example, the light source may include light source 130 of FIG. 1 or light source 316 of FIG. 3. In some embodiments, the light source may include LEDs of multiple wavelengths, for example, a red LED and an IR LED. In some embodiments, the light source may include multiple LEDs of the same wavelength, multiple LEDs of different wavelengths, any other suitable arrangement, or any combination thereof. In some embodiments, the light source may include a fiber optic or other light pipe to communicate light from one location to another.” Lisogurski, 25:31-45.

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[1F] the measurement device further comprising a receiver configured to: capture light while the LEDs are off and convert the captured light into a first signal and capture light while at least one of the LEDs is on and convert the captured light into a second signal, the captured light including at least a portion of the input optical beam reflected from the tissue;	Lisogurki discloses and/or renders obvious “the measurement device further comprising a receiver configured to: capture light while the LEDs are off and convert the captured light into a first signal and capture light while at least one of the LEDs is on and convert the captured light into a second signal, the captured light including at least a portion of the input optical beam reflected from the tissue.” “In some embodiments, a technique to remove ambient and background signals may be used in addition to or in place of a power saving light modulation scheme. In a drive cycle modulation technique, the system may cycle light output at a rate significantly greater than the cardiac cycle. For example, a drive cycle modulation cycle may include the system turning on a first light source, followed by a “dark” period, followed by a second light source, followed by a “dark” period. The system may measure the ambient light detected by the detector during the “dark” period and then subtract this ambient contribution from the signals received during the first and second “on” periods. In some embodiments, drive cycle modulation may be implemented using time division multiplexing as described above, code division multiplexing, carrier frequency multiplexing, phase division multiplexing, feedback circuitry, DC restoration circuitry, any other suitable technique, or any combination thereof. For example, the system may use frequency division multiplexing in a drive cycle modulation technique. The cardiac cycle modulation may represent a lower frequency envelope function on the higher frequency drive cycle. For example, cardiac cycle modulation may be an envelope on the order of 1 Hz superimposed on a 1 kHz sine wave drive cycle modulation.” Lisogurski, 6:7-31. “Dark subtractor 162 may operate on the digital signal. In some embodiments, dark subtractor 162 may subtract dark values from the Red and IR components to generate adjusted Red and IR signals. For example, dark subtractor 162 may determine a subtraction amount from the dark signal portion of the detection signal and subtract it from the peak portion of the detection signal in order to reduce the effect of the dark signal on the peak. For example, in reference to FIG. 2A, a detection signal peak corresponding to red “on” period 202 may be adjusted by determining the amount of dark signal during the “off” period 220 preceding red “on” period 202. The dark signal amount determined in this manner may be subtracted from the detector peak corresponding to red “on” period 202. Alternatively, the “off” period 220 after red “on” period 202 may be used to correct red “on” period 202 rather than the “off” period 220 preceding it. Additionally, an average

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	of the “off” periods 220 before and after red “on” period 202 may be used.” Lisogurski, 13:60-14:10; *see id.*, 14:40-55. “Region **256** of plot **250** indicates an interval of the timing diagram where both red light modulation **252** and IR light modulation **254** are in an “on” portion of the cardiac cycle modulation. Plot **270** shows an illustrative portion of region **256**, where the system is employing a cardiac cycle modulation in addition to the drive cycle modulation. Plot **250** may include a drive cycle modulation technique with a period of time interval **272**. The time scale of plot **270** may be significantly shorter than the time scale of plot **250**, such that time interval **272** is significantly shorter than time interval **260**. For example, time interval **260** (i.e., the period of the cardiac cycle modulation) may be on the order of 1 second, while time interval **272** (i.e., the period of the drive cycle modulation) may be on the order of 1 ms. Time interval 272 may include a sequence of red “on” portion 274, a first “off” portion 276, IR “on” portion 278, and a second “off” portion 280. The first “off” portion 276 and second “off” portion 280 may be used to determine the level of ambient light, noise, dark current, other suitable signals, or any combination thereof. The system may subtract the background or dark level from the levels received during red “on” portion 274 and IR “on” period 278.” Lisogurski, 16:33-54. *See also* Lisogurski, 12:64-13:6.
[1G] the measurement device configured to improve a signal-to-noise ratio of the input optical beam reflected from the tissue by differencing the first signal and the second signal;	Lisogurki discloses and/or renders obvious “the measurement device configured to improve a signal-to-noise ratio of the input optical beam reflected from the tissue by differencing the first signal and the second signal.” “In some embodiments, a technique to remove ambient and background signals may be used in addition to or in place of a power saving light modulation scheme. In a drive cycle modulation technique, the system may cycle light output at a rate significantly greater than the cardiac cycle. For example, a drive cycle modulation cycle may include the system turning on a first light source, followed by a “dark” period, followed by a second light source, followed by a “dark” period. The system may measure the ambient light detected by the detector during the “dark” period and then subtract this ambient contribution from the signals received during the first and second “on” periods. In some embodiments, drive cycle modulation may be implemented using

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	time division multiplexing as described above, code division multiplexing, carrier frequency multiplexing, phase division multiplexing, feedback circuitry, DC restoration circuitry, any other suitable technique, or any combination thereof. For example, the system may use frequency division multiplexing in a drive cycle modulation technique. The cardiac cycle modulation may represent a lower frequency envelope function on the higher frequency drive cycle. For example, cardiac cycle modulation may be an envelope on the order of 1 Hz superimposed on a 1 kHz sine wave drive cycle modulation.” Lisogurski, 6:7-31. “Dark subtractor 162 may operate on the digital signal. In some embodiments, dark subtractor 162 may subtract dark values from the Red and IR components to generate adjusted Red and IR signals. For example, dark subtractor 162 may determine a subtraction amount from the dark signal portion of the detection signal and subtract it from the peak portion of the detection signal in order to reduce the effect of the dark signal on the peak. For example, in reference to FIG. 2A, a detection signal peak corresponding to red “on” period 202 may be adjusted by determining the amount of dark signal during the “off” period 220 preceding red “on” period 202. The dark signal amount determined in this manner may be subtracted from the detector peak corresponding to red “on” period 202. Alternatively, the “off” period 220 after red “on” period 202 may be used to correct red “on” period 202 rather than the “off” period 220 preceding it. Additionally, an average of the “off” periods 220 before and after red “on” period 202 may be used.” Lisogurski, 13:60-14:10; *see id.*, 14:40-55. “Region **256** of plot **250** indicates an interval of the timing diagram where both red light modulation **252** and IR light modulation **254** are in an “on” portion of the cardiac cycle modulation. Plot **270** shows an illustrative portion of region **256**, where the system is employing a cardiac cycle modulation in addition to the drive cycle modulation. Plot **250** may include a drive cycle modulation technique with a period of time interval **272**. The time scale of plot **270** may be significantly shorter than the time scale of plot **250**, such that time interval **272** is significantly shorter than time interval **260**. For example, time interval **260** (i.e., the period of the cardiac cycle modulation) may be on the order of 1 second, while time interval **272** (i.e., the period of the drive cycle modulation) may be on the order of 1 ms. Time interval 272 may include a sequence of red “on” portion 274, a first “off” portion 276, IR “on” portion 278, and a second “off” portion 280. The first “off” portion 276 and second “off” portion 280 may be used to determine the level of

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	ambient light, noise, dark current, other suitable signals, or any combination thereof. The system may subtract the background or dark level from the levels received during red “on” portion 274 and IR “on” period 278.” Lisogurski, 16:33-54. *See also* Lisogurski, 12:64-13:6.
[1H] the light source configured to further improve the signal-to-noise ratio of the input optical beam reflected from the tissue by increasing the light intensity relative to the initial light intensity from at least one of the LEDs;	Lisogurki discloses and/or renders obvious “the light source configured to further improve the signal-to-noise ratio of the input optical beam reflected from the tissue by increasing the light intensity relative to the initial light intensity from at least one of the LEDs.” *See* CHART ONE: ’533 Patent, Claim Element 5C above.
[1I] the measurement device further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue; and	Lisogurki discloses and/or renders obvious “the measurement device further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue.” *See* CHART ONE: ’533 Patent, Claim Element 10 above.
[1J] the wearable device configured to communicate with the smart phone or tablet, the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a voice input module, a speaker, and a touch screen, the smart phone or tablet configured to receive and to	Lisogurki discloses and/or renders obvious “the wearable device configured to communicate with the smart phone or tablet, the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a voice input module, a speaker, and a touch screen, the smart phone or tablet configured to receive and to process at least a portion of the output signal.” *See* CHART ONE: ’533 Patent, Claim Elements 5G and 5H above. “User interface 180 may include user input 182, display 184, and speaker 186. User input 182 may include any type of user input device such as a keyboard, a mouse, a touch screen, buttons, switches, a microphone, a joy stick, a touch pad, or any other suitable input device. The inputs received by user input 182 can include information about the subject, such as age, weight, height,

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process at least a portion of the output signal,	diagnosis, medications, treatments, and so forth. In an embodiment, the subject may be a medical patient and display 184 may exhibit a list of values which may generally apply to the patient, such as, for example, age ranges or medication families, which the user may select using user input 182. Additionally, display 184 may display, for example, an estimate of a subject's blood oxygen saturation generated by monitor 104(referred to as an “SpO2” measurement), pulse rate information, respiration rate information, blood pressure, any other parameters, and any combination thereof. Display 184 may include any type of display such as a cathode ray tube display, a flat panel display such a liquid crystal display or plasma display, or any other suitable display device. Speaker 186 within user interface 180 may provide an audible sound that may be used in various embodiments, such as for example, sounding an audible alarm in the event that a patient's physiological parameters are not within a predefined normal range. Lisogurski, 15:19-65. “Communication interface 190 may enable monitor 104 to exchange information with external devices. Communications interface 190 may include any suitable hardware, software, or both, which may allow monitor 104 to communicate with electronic circuitry, a device, a network, a server or other workstations, a display, or any combination thereof. Communications interface 190 may include one or more receivers, transmitters, transceivers, antennas, plug-in connectors, ports, communications buses, communications protocols, device identification protocols, any other suitable hardware or software, or any combination thereof. Communications interface 190 may be configured to allow wired communication (e.g., using USB, RS-232 or other standards), wireless communication (e.g., using WiFi, IR, WiMax, BLUETOOTH, UWB, or other standards)**,** or both. For example, communications interface 190 may be configured using a universal serial bus (USB) protocol (e.g., USB 2.0, USB 3.0), and may be configured to couple to other devices (e.g., remote memory devices storing templates) using a four-pin USB standard Type-A connector (e.g., plug and/or socket) and cable. In some embodiments, communications interface 190 may include an internal bus such as, for example, one or more slots for insertion of expansion cards.”

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[1K] wherein the smart phone or tablet is configured to store and display the processed output signal, wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link.	Lisogurki discloses and/or renders obvious “wherein the smart phone or tablet is configured to store and display the processed output signal, wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link.” *See* CHART ONE: ’533 Patent, Claim Elements 5I and 5J above.
[2] The wearable device of claim 1, wherein the receiver is configured to be synchronized to the modulation of the at least one of the LEDs.	Lisogurki discloses and/or renders obvious “[t]he wearable device of claim 1, wherein the receiver is configured to be synchronized to the modulation of the at least one of the LEDs.” *See* CHART ONE: ’533 Patent, Claim Element 5F above.
[4] The wearable device of claim 1, wherein the receiver is located a first distance from a first one of the LEDs and a different distance from a second one of the LEDs such that the receiver can capture a third signal from the first LED and a fourth signal from the second LED, and wherein the output signal is generated in part by comparing the third and fourth signals.	Lisogurki discloses and/or renders obvious “[t]he wearable device of claim 1, wherein the receiver is located a first distance from a first one of the LEDs and a different distance from a second one of the LEDs such that the receiver can capture a third signal from the first LED and a fourth signal from the second LED, and wherein the output signal is generated in part by comparing the third and fourth signals.” *See* CHART ONE: ’533 Patent, Claim Element 8 above.

EXHIBIT P-3

U.S. Patent No. 9,861,286 vs Lisogurki

Priority Date/Publication Date:	May 31, 2012/Jan. 26, 2016	Prior Art Status:	§§ 102(a), (b), and (e) (pre-AIA) §§ 102(a), (b), and (d)

US Patent No. 9,241,676 to Lisogurki ("Lisogurki") anticipates the asserted claims of U.S. Patent No. 9,861,286 ("the '286 Patent") or renders those claims obvious alone and/or in view of at least any of the references identified in Apple's Obviousness Combinations Chart.

As set forth in Apple's Invalidity Contentions, the below contentions apply the prior art in part in accordance with Apple's assumption that Omni contends the claims are not invalid under 35 U.S.C. § 112. However, Apple's below contentions do not represent Apple's agreement or view as to the meaning, definiteness, written description support for, or enablement of any of the asserted claims. For each dependent claim, the disclosures cited for the claim from which it depends are incorporated by reference.

CHART THREE: U.S. Patent No. 9,861,286 vs Lisogurki

Asserted Claim of ’286 Patent	Lisogurski (US 9,241,676)
[16] A wearable device for use with a smart phone or tablet, the wearable device comprising:	To the extent the preamble is limiting, Lisogurki discloses and/or renders obvious “[a] wearable device for use with a smart phone or tablet.” *See* CHART ONE: ’533 Patent, Claim Elements 5, 5G, and 13A above.
[16A] a measurement device including a light source comprising a plurality of light emitting diodes (LEDs) for measuring one or more physiological parameters,	Lisogurki discloses and/or renders obvious “a measurement device including a light source comprising a plurality of light emitting diodes (LEDs) for measuring one or more physiological parameters.” *See* CHART ONE: ’533 Patent, Claim Element 13A above.
[16B] the measurement device configured to generate, by modulating at least one of the LEDs having an initial light intensity, an optical beam having a plurality of optical wavelengths,	Lisogurki discloses and/or renders obvious “the measurement device configured to generate, by modulating at least one of the LEDs having an initial light intensity, an optical beam having a plurality of optical wavelengths.” *See* CHART TWO: ’040 Patent, Claim Element 1B above.
[16C] wherein at least a portion of the plurality of optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers;	Lisogurki discloses and/or renders obvious “wherein at least a portion of the plurality of optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers.” *See* CHART ONE: ’533 Patent, Claim Element 5B above.
[16D] the measurement device comprising one or more lenses configured to receive and to deliver a portion of the optical beam to tissue, wherein the tissue reflects at least a portion of the	Lisogurki discloses and/or renders obvious “the measurement device comprising one or more lenses configured to receive and to deliver a portion of the optical beam to tissue, wherein the tissue reflects at least a portion of the optical beam delivered to the tissue, and wherein the measurement device is adapted to be placed on a wrist or an ear of a user.” *See* CHART ONE: ’533 Patent, Claim Element 5D above.

Asserted Claim of ’286 Patent	Lisogurski (US 9,241,676)
optical beam delivered to the tissue, and	
[16E] wherein the measurement device is adapted to be placed on a wrist or an ear of a user;	Lisogurki discloses and/or renders obvious “wherein the measurement device is adapted to be placed on a wrist or an ear of a user.” “For example, additional suitable sensor locations include, without limitation, the neck to monitor carotid artery pulsatile flow, the wrist to monitor radial artery pulsatile flow, the inside of a patient’s thigh to monitor femoral artery pulsatile flow, the ankle to monitor tibial artery pulsatile flow, and around or in front of the ear.” Lisogurski, 4:15-20. “An oximeter may include a light sensor that is placed at a site on a patient, typically a fingertip, toe, forehead or earlobe, or in the case of a neonate, across a foot.” Lisogurski, 4:6-8.
[16F] the measurement device further comprising a receiver configured to: capture light while the LEDs are off and convert the captured light into a first signal and capture light while at least one of the LEDs is on and convert the captured light into a second signal, the captured light including at least a portion of the optical beam reflected from the tissue;	Lisogurki discloses and/or renders obvious “the measurement device further comprising a receiver configured to: capture light while the LEDs are off and convert the captured light into a first signal and capture light while at least one of the LEDs is on and convert the captured light into a second signal, the captured light including at least a portion of the optical beam reflected from the tissue.” *See* CHART TWO: ’040 Patent, Claim Element 1F above.
[16G] the measurement device configured to improve a signal-to-noise ratio of the optical beam reflected from the tissue by	Lisogurki discloses and/or renders obvious “the measurement device configured to improve a signal-to-noise ratio of the optical beam reflected from the tissue by differencing the first signal and the second signal.”

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differencing the first signal and the second signal;	*See* CHART TWO: ’040 Patent, Claim Element 1G above.
[16H] the light source configured to further improve the signal-to-noise ratio of the optical beam reflected from the tissue by increasing the light intensity relative to the initial light intensity from at least one of the LEDs;	Lisogurki discloses and/or renders obvious “the light source configured to further improve the signal-to-noise ratio of the optical beam reflected from the tissue by increasing the light intensity relative to the initial light intensity from at least one of the LEDs.” *See* CHART ONE: ’533 Patent, Claim Element 5C above.
[16I] the measurement device further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue; and	Lisogurki discloses and/or renders obvious “the measurement device further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue.” *See* CHART ONE: ’533 Patent, Claim Element 10 above.
[16J] wherein the receiver includes a plurality of spatially separated detectors,	Lisogurki discloses and/or renders obvious “wherein the receiver includes a plurality of spatially separated detectors.” “FIG. 3 is a perspective view of an embodiment of a physiological monitoring system 310 in accordance with some embodiments of the present disclosure. In some embodiments, one or more components of physiological monitoring system 310 may include one or more components of physiological monitoring system 100 of FIG. 1. System 310 may include sensor unit 312 and monitor 314. In some embodiments, sensor unit 312 may be part of an oximeter. Sensor unit 312 may include one or more light source 316 for emitting light at one or more wavelengths into a subject's tissue. One or more detector 318 may also be provided in sensor unit 312 for detecting the light that is reflected by or has traveled through the subject's tissue. Any suitable configuration of light source 316 and detector 318 may be used. In an embodiment, sensor unit 312 may include multiple light sources and detectors, which may be spaced apart. System 310 may also include one or more additional sensor units (not shown) that may, for example, take the form of any of the

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	embodiments described herein with reference to sensor unit 312. An additional sensor unit may be the same type of sensor unit as sensor unit 312, or a different sensor unit type than sensor unit 312 (e.g., a photoacoustic sensor). Multiple sensor units may be capable of being positioned at two different locations on a subject's body.” Lisogurski, 17:30-53. Lisogurski, 21:67-22:7.
[16K] wherein at least one analog to digital converter is coupled to the spatially separated detectors.	Lisogurki discloses and/or renders obvious “wherein at least one analog to digital converter is coupled to the spatially separated detectors.” “Analog-to-digital converter 154 may use timing control signals from control circuitry 110 to determine when to sample the analog signal. Analog-to-signal converter 154 may be any suitable type of analog-to-digital converter of sufficient resolution to enable a physiological monitor to accurately determine physiological parameters.” Lisogurski, 13:25-30. Lisogurski, Fig. 1:

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	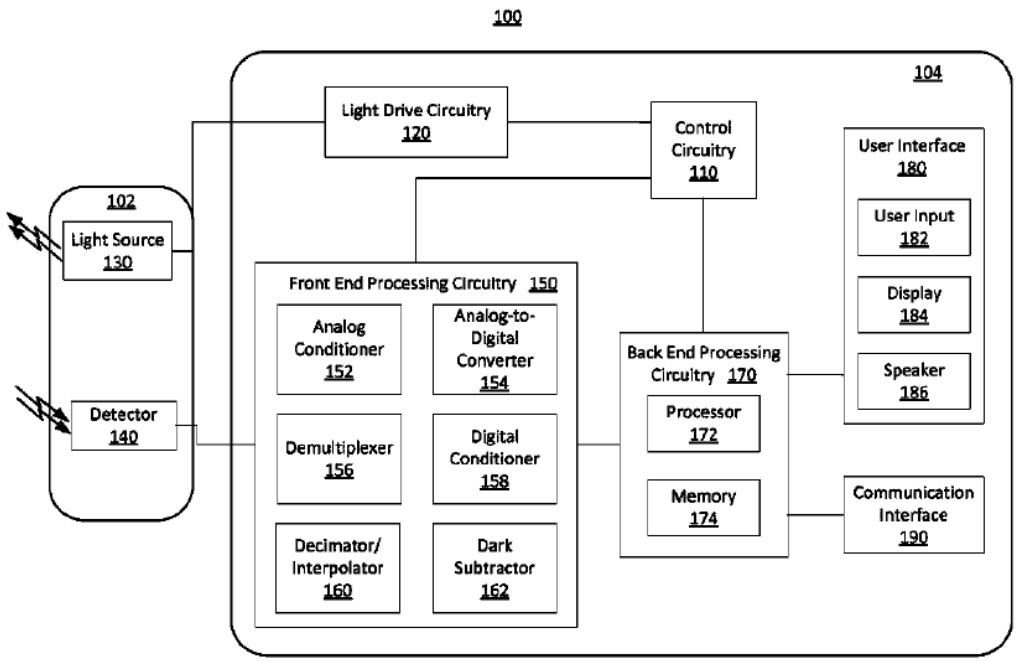 *See also* Lisogurski, 5:65-67, 6:3-5, 10:23-26, 11:43-46, 13:7-12, 23-26, 13:25-30, 14:15-39, 33:65-13, Claim 8.
[17] The wearable device of claim 16, wherein at least one LED emits at a first wavelength and at least another LED emits at a second wavelength, and wherein the first wavelength has a first penetration depth into the tissue and wherein the second wavelength has a second	Lisogurki discloses and/or renders obvious “[t]he wearable device of claim 16, wherein at least one LED emits at a first wavelength and at least another LED emits at a second wavelength, and wherein the first wavelength has a first penetration depth into the tissue and wherein the second wavelength has a second penetration depth into the tissue different from the first penetration depth..” “For example, a highly efficient first light source that is not at a wavelength of interest for physiological parameter determination may be used to control one or more second light sources at wavelengths of interest. In this case, the light from the first light source may be used only for

Asserted Claim of ’286 Patent	Lisogurski (US 9,241,676)
penetration depth into the tissue different from the first penetration depth.	controlling the second light source and not for determining physiological parameters.” Lisogurski, 7:64-8:3. “Light source 130 may be configured to emit photonic signals having one or more wavelengths of light (e.g. Red and IR) into a subject’s tissue. For example, light source 130 may include a Red light emitting light source and an IR light emitting light source, e.g., Red and IR light emitting diodes (LEDs), for emitting light into the tissue of a subject to generate physiological signals. In one embodiment, the Red wavelength may be between about 600 nm and about 700 nm, and the IR wavelength may be between about 800 nm and about 1000 nm. It will be understood that light source 130 may include any number of light sourses with any suitable characteristics. In embodiments where an array of sensors is used in place of single sensor 102, each sensor may be configured to emit a signal wavelength. For example, a first sensor may emit only a Red light while a second may emit only an IR light.” Lisogurski, 10:49-64. “Detector 140 may convert the intensity of the received light into an electrical signal. The light intensity may be directly related to the absorbance and/or reflectance of light in the tissue. That is, when more light at a certain wavelength is absorbed or reflected, less light of that wavelength is received from the tissue by detector 140.” Lisogurski, 11:14-20. “When light source 130 is configured to emit two or more wavelengths of light, the light drive signal may be configured to control the operation of each wavelength of light.” Lisogurski, 11:54-56. “FIG. 2A shows an illustrative plot of a light drive signal including red light “on” period 202 and IR light “on period” 204 in accordance with some embodiments of the present disclosure. Light “on” periods 202, and 204 may be generated by light drive circuitry 120 under the control of control circuitry 110. As used herein, “on” and “off” may refer to switching power or other components, high and low output states, high and low values within a continuous modulation, high and low duty cycles, other suitable relatively distinct states, or any combination thereof. The light drive signal may be provided to light source 130, including red “on” period 202 and IR “on” period 204 to drive red and IR light emitters, respectively, within light source 130. Red “on” period 202 may have a higher amplitude than IR “on” period 204since red LEDs may be less

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	efficient than IR LEDs at converting electrical energy into light energy. Additionally, red light may be absorbed and scattered more than IR light when passing through perfused tissue at certain oxygen saturations. When the red and IR light sources are driven in this manner they emit pulses of light at their respective wavelengths into the tissue of a subject in order generate physiological signals that physiological monitoring system 100 may process to calculate physiological parameters. It will be understood that the light drive amplitudes of FIG. 2A are merely exemplary, and that any suitable amplitudes or combination of amplitudes may be used, and may be based on the light sources, the subject tissue, the determined physiological parameter, modulation techniques, power sources, any other suitable criteria, or any combination thereof.” Lisogurski, 11:61-12:22. *See also* Lisogurski, 4:42-51, 17:30-53, 19:20-64, 25:31-45, 26:26-48, Figs. 2A, 5-7, 8A, 8B, 21.
[19] The wearable device of claim 16, wherein the receiver is configured to be synchronized to the modulating of at least one of the LEDs.	Lisogurki discloses and/or renders obvious “[t]he wearable device of claim 16, wherein the receiver is configured to be synchronized to the modulating of at least one of the LEDs.” *See* CHART ONE: ’533 Patent, Claim Element 5F above.
[20] The wearable device of claim 16, wherein the receiver is located a first distance from a first one of the LEDs and a different distance from a second one of the LEDs such that the receiver can capture a third signal from the first LED and a fourth signal from the second LED, and wherein the output signal is generated in part	Lisogurki discloses and/or renders obvious “[t]he wearable device of claim 16, wherein the receiver is located a first distance from a first one of the LEDs and a different distance from a second one of the LEDs such that the receiver can capture a third signal from the first LED and a fourth signal from the second LED, and wherein the output signal is generated in part by comparing the third and fourth signals..” *See* CHART ONE: ’533 Patent, Claim Element 8 above.

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by comparing the third and fourth signals.	

EXHIBIT P-4

U.S. Patent No. 9,885,698 vs Lisogurki

Priority Date/Publication Date:	May 31, 2012/Jan. 26, 2016	Prior Art Status:	§§ 102(a), (b), and (e) (pre-AIA) §§ 102(a), (b), and (d)

US Patent No. 9,241,676 to Lisogurki ("Lisogurki") anticipates the asserted claims of U.S. Patent No. 9,885,698 ("the '698 Patent") or renders those claims obvious alone and/or in view of at least any of the references identified in Apple's Obviousness Combinations Chart.

As set forth in Apple's Invalidity Contentions, the below contentions apply the prior art in part in accordance with Apple's assumption that Omni contends the claims are not invalid under 35 U.S.C. § 112. However, Apple's below contentions do not represent Apple's agreement or view as to the meaning, definiteness, written description support for, or enablement of any of the asserted claims. For each dependent claim, the disclosures cited for the claim from which it depends are incorporated by reference.

CHART FOUR: U.S. Patent No. 9,885,698 vs Lisogurki

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[1] A wearable device, comprising:	To the extent the preamble is limiting, Lisogurki discloses and/or renders obvious “[a] wearable device.” *See* CHART ONE: ’533 Patent, Claim Elements 5 and 13A above.
[1A] a measurement device including a light source comprising a plurality of light emitting diodes (LEDs) for measuring one or more physiological parameters,	Lisogurki discloses and/or renders obvious “a measurement device including a light source comprising a plurality of light emitting diodes (LEDs) for measuring one or more physiological parameters.” *See* CHART ONE: ’533 Patent, Claim Element 13A above.
[1B] the measurement device configured to generate, by modulating at least one of the LEDs having an initial light intensity, an input optical beam having one or more optical wavelengths,	Lisogurki discloses and/or renders obvious “the measurement device configured to generate, by modulating at least one of the LEDs having an initial light intensity, an input optical beam having one or more optical wavelengths.” *See* CHART TWO: ’040 Patent, Claim Element 1B above.
[1C] wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers;	Lisogurki discloses and/or renders obvious “wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers.” *See* CHART ONE: ’533 Patent, Claim Element 5B above.
[1D] the measurement device comprising one or more lenses configured to receive and to deliver a portion of the input optical beam to tissue, wherein	Lisogurki discloses and/or renders obvious “the measurement device comprising one or more lenses configured to receive and to deliver a portion of the input optical beam to tissue, wherein the tissue reflects at least a portion of the input optical beam delivered to the tissue.” *See* CHART ONE: ’533 Patent, Claim Element 5D above.

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the tissue reflects at least a portion of the input optical beam delivered to the tissue;	
[1E] the measurement device further comprising a receiver, wherein the receiver includes a plurality of spatially separated detectors, the detectors configured to: capture light while the LEDs are off and convert the captured light into a first signal; and capture light while at least one of the LEDs is on and convert the captured light into a second signal, the captured light including at least a portion of the input optical beam reflected from the tissue;	Lisogurki discloses and/or renders obvious “the measurement device further comprising a receiver, wherein the receiver includes a plurality of spatially separated detectors, the detectors configured to: capture light while the LEDs are off and convert the captured light into a first signal; and capture light while at least one of the LEDs is on and convert the captured light into a second signal, the captured light including at least a portion of the input optical beam reflected from the tissue.” *See* CHART TWO: ’040 Patent, Claim Element 1F and CHART THREE: ’286 Patent, Claim Element 16J above.
[1F] wherein at least one analog to digital converter is coupled to the spatially separated detectors and is configured to generate at least a first data signal from the first signal and at least a second data signal from the second signal;	Lisogurki discloses and/or renders obvious “wherein at least one analog to digital converter is coupled to the spatially separated detectors and is configured to generate at least a first data signal from the first signal and at least a second data signal from the second signal.” *See* CHART TWO: ’040 Patent, Claim Element 1F and CHART THREE: ’286 Patent, Claim Element 16K above.

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[1G] the measurement device configured to improve a signal-to-noise ratio of the input optical beam reflected from the tissue by differencing the first data signal and the second data signal to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue; and	Lisogurki discloses and/or renders obvious “the measurement device configured to improve a signal-to-noise ratio of the input optical beam reflected from the tissue by differencing the first data signal and the second data signal to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue.” *See* CHART ONE: ’533 Patent, Claim Element 10 and CHART TWO: ’040 Patent, Claim Element 1G above.
[1H] wherein the modulating at least one of the LEDs has a modulation frequency, and wherein the receiver is configured to use a lock-in technique that detects the modulation frequency.	Lisogurki discloses and/or renders obvious “wherein the modulating at least one of the LEDs has a modulation frequency, and wherein the receiver is configured to use a lock-in technique that detects the modulation frequency.” “In some embodiments, the brightness of one of more light sources may be modulated in a technique that is related to the cardiac cycle. The cardiac cycle is the substantially periodic repetition of events that occur, for example, during heartbeats. The cardiac cycle may include a systole period and diastole period. The cardiac cycle may include pressure changes in the ventricles, pressure changes in the atria, volume changes in the ventricles, volume changes in the atria, opening and closing of heart valves, heart sounds, and other cyclic events. In some embodiments, the heart may enter a non-periodic state, for example, in certain types of arrhythmia and fibrillation.” Lisogurski, 5:13-24. “In some embodiments, the system may use various cardiac cycle modulation schemes to adjust the brightness of a light source controlled by the light drive signal used in determining physiological parameters. The system may modulate the brightness of the light source using a periodic waveform, for example, a sinusoidal or triangle wave. The period of the waveform may be substantially related to the cardiac pulse rate, for example, in a one-to-one relationship, a two-to-one relationship, any other suitable relationship, or any suitable combination thereof. The system may align the peak of the modulated light drive signal with a particular point in the cardiac cycle to improve the quality of the determined physiological parameter, for example, it may be

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	aligned with the diastolic period, the systolic period, the dicrotic notch, any other suitable point, or any combination thereof. In some embodiments, the system may modulate the light drive signal with a square wave function, such that it is at a low brightness level during a first part of the cardiac cycle and a high brightness level during a second part of the cardiac cycle. In some embodiments, the low brightness level may include turning one or more light sources off.” Lisogurski, 6:31-52. “In some embodiments of cardiac cycle modulation, the system may modulate multiple light sources using a plurality of modulation techniques. For example, in a system with two light sources, the system may operate a first light source at full or regular brightness, while operating one or more additional light sources in a switched or otherwise modulated mode. In some embodiments, the system may operate a first light source according to a first cardiac cycle modulation technique and a second light source according to a second cardiac modulation technique. The first and second cardiac cycle modulation techniques may be the same, correlated, or unrelated. In some embodiments, the system may use the first light source to determine periods of interest in the cardiac cycle. The system may, according to the periods of interest, power additional light sources, alter the modulation of the additional light sources, perform other suitable power optimization techniques, or any combination thereof. In some embodiments, the system may include a first light source (e.g., a light source powered at full or regular brightness) of a type that is a more efficient light source than the one or more additional light sources. For example, the first light source may be a high efficiency infrared (IR) LED while the one or more additional light sources may be lower efficiency red LEDs or laser diodes. In some embodiments, the first light source may be selected based on efficiency parameters and information from the first light source may be used only to control a second light source. For example, a highly efficient first light source that is not at a wavelength of interest for physiological parameter determination may be used to control one or more second light sources at wavelengths of interest. In this case, the light from the first light source may be used only for controlling the second light source and not for determining physiological parameters.” Lisogurski, 7:38-8:3. “In some embodiments, the system may correct for non-linearity of light sources. For example, the emitted intensity of light from an LED may not vary linearly with the drive current. The system may account for non-linearity by adjusting drive signals, by adjusting amplification of received

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	signal gain, by adjusting received signal processing, by any other suitable method, or any combination thereof. For example, the system may adjust the drive signal to an LED to improve the linearity. Corrections may be determined using a calibration step, lookup tables for known components, empirical data, any other suitable techniques, or any combination thereof. For example, the emission intensity relative to a drive signal may be known for a particular LED. Information may be encoded in a calibration resistor or non-volatile calibration memory included in the sensor or the system. In another example, the system may calibrate emission output by comparing the intensity of received signals generated in response to a high current drive signal with those generated in response to a low current drive signal. In some embodiments, the operating range of a component (e.g., an LED) may be limited. In some embodiments, a component may operate with a linear relationship between drive signal and output intensity within a known range of drive signals, and in a non-linear relationship outside that range of drive signals.” Lisogurski, 7:12-37. “In some embodiments, the system may optimize power consumption by varying a sampling rate. The system may digitize a received signal using an analog to digital converter operating at a particular rate. In some embodiments, the digitizer rate may be constant. In some embodiments, the digitizer rate may be modulated using a technique correlated to a cardiac cycle modulation. For example, the system may sample at a high rate during a period of interest and at a low rate during other periods. In some embodiments, the system may modulate both a light drive signal and a sampling rate. The modulations of the light drive signal and the sampling rate may be correlated. For example, the system may sample the received signal at a low rate during a period of low light output and at a high rate during a period of high light output. The system may decimate or interpolate the digitized signal such that the rate of the processed signal is constant.” Lisogurski, 10:23-38; *see id.*, 34:14-25. “Control circuitry 110 may be coupled to light drive circuitry 120, front end processing circuitry 150, and back end processing circuitry 170, and may be configured to control the operation of these components. In some embodiments, control circuitry 110 may be configured to provide timing control signals to coordinate their operation. For example, light drive circuitry 120 may generate a light drive signal, which may be used to turn on and off the light source 130, based on the timing control signals. The front end processing circuitry 150 may use the timing control

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	signals to operate synchronously with light drive circuitry 120. For example, front end processing circuitry 150 may synchronize the operation of an analog-to-digital converter and a demultiplexer with the light drive signal based on the timing control signals. In addition, the back end processing circuitry 170 may use the timing control signals to coordinate its operation with front end processing circuitry 150.” Lisogurski, 11:33-49. “Referring back to FIG. 1, front end processing circuitry 150 may receive a detection signal from detector 140 and provide one or more processed signals to back end processing circuitry 170. The term “detection signal,” as used herein, may refer to any of the signals generated within front end processing circuitry 150 as it processes the output signal of detector 140. Front end processing circuitry 150 may perform various analog and digital processing of the detector signal. One suitable detector signal that may be received by front end processing circuitry 150 is shown in FIG. 2B.” Lisogurski, 12:41-51. “FIG. 2B shows an illustrative plot of detector signal 214 that may be generated by a sensor in accordance with some embodiments of the present disclosure. The peaks of detector current waveform 214 may represent current signals provided by a detector, such as detector 140 of FIG. 1, when light is being emitted from a light source. The amplitude of detector current waveform 214 may be proportional to the light incident upon the detector. The peaks of detector current waveform 214 may be synchronous with light ‘on’ periods driving one or more emitters of a light source, such as light source 130 of FIG 1. For example, detector current waveform 214 may be generated in response to a light source being driven by the light drive signal of FIG 2A. The valleys of detector current waveform may be synchronous with periods of time during which no light is being emitted by the light source. While no light is being emitted by a light source during the valleys, detector current waveform 214 may not fall all of the way to zero. Rather, dark current 222 may be present in the detector waveform.” Lisogurski, 12:52-13:3; *see id.*, 13:4-14:10 (describing processing of the output signal). “In some embodiments, the sampling rate may represent the amount of time between “on” periods. For example, the time between “on” periods may be the length of time of “off” period 220 of FIG. 2A. Increasing the duration of the “off” periods (i.e., decreasing the emitter firing rate) relates to a

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	decreased sampling rate. Similarly, decreasing the duration of the “off” periods (i.e., increasing the emitter firing rate) relates to an increased sampling rate.” Lisogurski, 35:24-31.

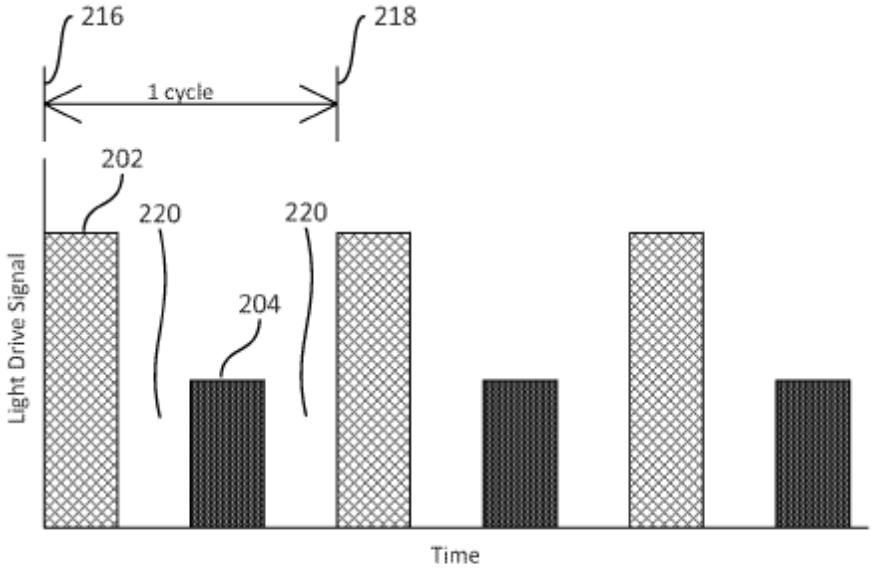
216
218
1 cycle
202
220
220
204
Light Drive Signal
Time

FIG. 2A

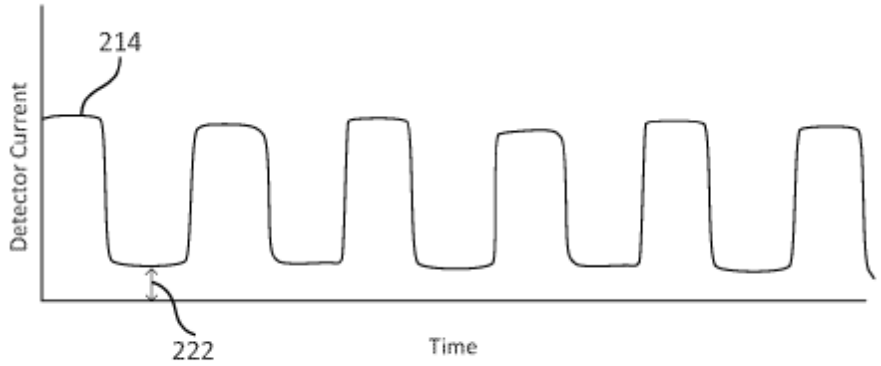
214
Detector Current
222
Time

FIG. 2B

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	See also Lisogurski, Fig. 2B, 2C, Fig. 19, 3:53-56, 5:25-7:3, 7:38-10:38.
[2] The wearable device of claim 1, wherein the plurality of LEDs and the plurality of spatially separated detectors are mounted on a common structure, and wherein the plurality of LEDs are coupled electrically to a power supply.	Lisogurki discloses and/or renders obvious “[t]he wearable device of claim 1, wherein the plurality of LEDs and the plurality of spatially separated detectors are mounted on a common structure, and wherein the plurality of LEDs are coupled electrically to a power supply..” “FIG. 3 is a perspective view of an embodiment of a physiological monitoring system 310 in accordance with some embodiments of the present disclosure. In some embodiments, one or more components of physiological monitoring system 310 may include one or more components of physiological monitoring system 100 of FIG. 1. System 310 may include sensor unit 312 and monitor 314. In some embodiments, sensor unit 312 may be part of an oximeter. Sensor unit 312 may include one or more light source 316 for emitting light at one or more wavelengths into a subject's tissue. One or more detector 318 may also be provided in sensor unit 312 for detecting the light that is reflected by or has traveled through the subject's tissue. Any suitable configuration of light source 316 and detector 318 may be used. In an embodiment, sensor unit 312 may include multiple light sources and detectors, which may be spaced apart. System 310 may also include one or more additional sensor units (not shown) that may, for example, take the form of any of the embodiments described herein with reference to sensor unit 312. An additional sensor unit may be the same type of sensor unit as sensor unit 312, or a different sensor unit type than sensor unit 312 (e.g., a photoacoustic sensor). Multiple sensor units may be capable of being positioned at two different locations on a subject's body.” Lisogurski, 17:30-53. “In some embodiments, sensor unit 312 may be connected to monitor 314 as shown. Sensor unit 312 may be powered by an internal power source, e.g., a battery (not shown). Sensor unit 312 may draw power from monitor 314. In another embodiment, the sensor may be wirelessly connected to monitor 314 (not shown). Monitor 314 may be configured to calculate physiological parameters based at least in part on data relating to light emission and acoustic detection received from one or more sensor units such as sensor unit 312. For example, monitor 314 may be configured to determine pulse rate, blood pressure, blood oxygen saturation (e.g., arterial, venous, or both), hemoglobin concentration (e.g., oxygenated, deoxygenated, and/or total), any other suitable physiological parameters, or any combination thereof. In some embodiments, calculations may be

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	performed on the sensor units or an intermediate device and the result of the calculations may be passed to monitor 314. Further, monitor 314 may include display 320 configured to display the physiological parameters or other information about the system. In the embodiment shown, monitor 314 may also include a speaker 322 to provide an audible sound that may be used in various other embodiments, such as for example, sounding an audible alarm in the event that a subject's physiological parameters are not within a predefined normal range. In some embodiments, the system 310 includes a stand-alone monitor in communication with the monitor 314 via a cable or a wireless network link. In some embodiments, monitor 314 may be implemented as monitor 104 of FIG. 1.” Lisogurski, 17:54-18:14.
[3] The wearable device of claim 1, wherein the light source is configured to further improve the signal-to-noise ratio of the input beam reflected from the tissue by increasing the light intensity relative to the initial light intensity from at least one of the LEDs, and wherein the receiver is configured to be synchronized to at least one of the LEDs.	Lisogurki discloses and/or renders obvious “[t]he wearable device of claim 1, wherein the light source is configured to further improve the signal-to-noise ratio of the input beam reflected from the tissue by increasing the light intensity relative to the initial light intensity from at least one of the LEDs, and wherein the receiver is configured to be synchronized to at least one of the LEDs.” *See* CHART ONE: ’533 Patent, Claim Elements 5C and 5F above.
[5] The wearable device of claim 1, wherein the wearable device is configured to communicate with a smart phone or tablet, the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a voice input module, a speaker, and a	Lisogurki discloses and/or renders obvious “[t]he wearable device of claim 1, wherein the wearable device is configured to communicate with a smart phone or tablet, the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a voice input module, a speaker, and a touch screen, the smart phone or tablet configured to receive and to process at least a portion of the output signal, wherein the smart phone or tablet is configured to store and display the processed output signal, wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link.”

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touch screen, the smart phone or tablet configured to receive and to process at least a portion of the output signal, wherein the smart phone or tablet is configured to store and display the processed output signal, wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link.	*See* CHART ONE: ’533 Patent, Claim Elements 5G, 5H, 5I, and 5J above.