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(54) **INTEGRATED PULSE OXIMETRY SENSOR**
INTEGRIERTES PULSOXIMETER
CAPTEUR OXYMETRE DE POULS INTEGRE

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Description

[0001] The present invention relates to measurement of patient pulse oximetry, that is, the measure of the amount of Oxygen in a patient's blood.

[0002] SpO_2, an abbreviation used for pulse oximetry, is a method that is widely accepted in the medical world to measure the content of oxygen in the arterial blood by means of light. Typically, SpO_2 sensors include light emitting diodes (LEDs) that shine red and infrared light through the tissue. Most sensors are used at relatively narrow extremities, such as a finger, toe, or ear. The blood bone and tissue at the measurement site absorb much of the incident light, but sufficient light traverses the tissue to be useful for measurement. Typically, a light sensitive detector such as a photodiode opposite the source receives the light that passes through the extremity.

[0003] The sensor measures the amount of red and infrared light received by the detector and calculates the amount of each wavelength absorbed. The amounts of light absorbed by tissue, bone, and venous blood do not change dramatically over short periods of time. The amount of arterial blood does change over short periods of time due to natural pulsation of the extremity, but because it is the only variable that is changing over short periods of time, it can be isolated from the other components.

[0004] The amount of light received by the detector indicates the amount of oxygen bound to hemoglobin in the blood. Oxygenated hemoglobin (HbO_2) absorbs more infrared light than red light. Deoxygenated hemoglobin (Hb) absorbs more red light than infrared light. By comparing the amounts of red and infrared light received, the instrument can calculate the SpO_2 reading of the blood.

[0005] Due to the amount of surrounding ambient light sources that overlay the useful signal, it is necessary to modulate and demodulate the light from the two LEDs. Currently, a standard pulse oximetry sensor includes a passive photodiode packaged into a finger clip or similar housing together with the LEDs. The modulation/demodulation of the light source and the amplification filtering and processing of the signal is then typically done on a printed circuit board remote from the actual sensor, typically with a relatively long, high impedance cable connecting the systems.

[0006] Multiple disadvantages are inherent with such a system. Typical current designs are costly, consume significant power, and are relatively bulky. Current picosat boards typically in use consume 200mW of power and the board alone has a volume of 30 cm^3 and costs about $110 without the sensor. Wireless use is impracticable for both power consumption reasons and size/weight reasons. Further, the cost makes it impracticable for personal health care type products.

[0007] In addition to size/cost restraints, the separation of the amplifier and photodiode forces the system to run a small photocurrent through the high impedance long cable to the preamplifier. This setup complicates the matter due to shielding requirements and crosstalk issues. US 6,496,711 B1 discloses a similar prior art sensor.

[0008] The present application contemplates a new and improved pulse oximetry monitoring system for use in conjunction with units capable of both wired and wireless communication, which overcomes the above-referenced problems of size, cost, and outsourcing issues, and others.

[0009] In accordance with one aspect of the present invention, a medical pulse oximetry sensor is provided. A carriage housing houses first and second light emitting diodes, one emitting light in the red spectrum, and the other emitting light in the infrared spectrum. A photodiode detects incumbent light from the first and second light emitting diodes after the emitted light has passed through a blood oxygenated portion of a subject. Electrical signals are generated. A processing circuit integrally formed on an integrated semiconducting component chip mounted in the carriage housing comprises an amplifier for amplifying the signals from the at least one photodiode, and a processing unit for processing the signals into one of a pulse oximetry value and plethysmographic waveforms from at least one of the wavelengths.

[0010] In accordance with another aspect of the present invention, a method of manufacturing a pulse oximetry sensor is provided. At least first and second light emitting diodes are embedded into a carriage housing. An integrated circuit is embedded in the housing opposite the light emitting diodes such that light emitted by the diodes must pass through the portion of the subject's anatomy before impinging upon the integrated circuit. The integrated circuit includes at least one photodiode for detection of light signals from the at least two light emitting diodes and generating signals indicative thereof. The circuit also includes an amplifier for amplifying the signals from the photodiode. The circuit includes digital conversion elements for digitizing the signals from the photodiode. Also the circuit includes a processing unit for processing the digital signals into the pulse oximetry value.

[0011] In accordance with another aspect of the present invention, a method of measuring blood oxygen is provided. Pulses of red light are emitted from a first LED mounted in a carriage housing adapted to fit snugly about a portion of a subject's anatomy with a relatively high oxygenated blood throughput. Pulses of infrared light are emitted from a second LED also mounted in the carriage housing. Light from the LEDs is received which has traversed a blood oxygenated portion of a person with a photodiode mounted in the carriage housing. The photodiode generates electrical signals. The signals are amplified using an amplifier provided in a processing circuit integrally formed on a semiconductor chip that is mounted in the carriage housing. The signals are processed using a processing unit provided in the processing circuit into one of a blood oximetry value and plethysmographic waveforms from at least one of the wavelengths

[0012] One advantage of the present invention resides in its small size.

[0013] Another advantage resides in the close proximity of detection elements and signal conditioning, which gives better noise performance and eliminates expensive wiring.

[0014] Another advantage resides in the separation of special functions in different semiconductor processes which leads to top overall performance for all parts of the system.

[0015] Another advantage resides in independent testability of all subsystems of the sensor.

[0016] Another advantage resides in smaller and more specialized subsystems that can be produced with a higher yield.

[0017] Another advantage resides in increased automation in processing.

[0018] Another advantage resides in low cost.

[0019] Another advantage resides in significant reduction in direct weight of the sensor.

[0020] Another advantage resides in reduced power consumption.

[0021] Still further advantages and benefits of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description of the preferred embodiments.

[0022] The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating the preferred embodiments and are not to be construed as limiting the invention.

FIGURE 1 is an illustration of a preferred implementation of a wired medical pulse oximetry sensor with integrated processing in the finger unit;

FIGURE 2 is an illustration of a preferred implementation of a wireless embodiment of the medical pulse oximetry sensor of FIGURE 1;

FIGURE 3 is a circuit diagram, of the integrated circuitry of the pulse oximetry sensors of FIGURES 1 and 2;

FIGURE 4 depicts an alternate embodiment of the circuit shown in FIGURE 3.

[0023] With reference to FIGURE 1, a preferred medical pulse oximetry sensor **10** is illustrated. Typically, the sensor **10** is adapted to fit over the finger of a subject, but it is to be understood that the sensor **10** could be easily adapted to accommodate alternate sites that have relatively good blood oxygenated throughput, and are sufficiently light translucent, such as the toe or the earlobe. The sensor 10 includes a housing **12** which fits snugly around the anatomy in question, so as to keep the sensor **10** from falling off of the anatomy, but not so snug as to prevent circulation of blood therein.

[0024] The preferred sensor includes a light emitting array **14** which in the illustrated embodiment, includes two light emitting diodes **16**, **18**. Diode **16**, when stimulated emits light from the visible red wavelength of the electromagnetic spectrum, and the diode **18**, when stimulated emits light from the infrared portion of the electromagnetic spectrum. It is to be understood that a plurality of additional wavelengths can be used in conjunction with, or in lieu of the two types of light illustrated in FIGURE 1. As many as ten or more different wavelengths could be utilized in a preferred embodiment of the pulse oximetry sensor according to the present application.

[0025] With continuing reference to FIGURE 1, following the arrows from the light emitting diodes **16**, **18** and through the depicted finger, there is a photoreceptor array 20. This array preferably includes a photodiode capable of being stimulated by at least the red and infrared spectra, but as noted previously, compatibility with many more wavelengths is preferable. Immediately adjacent the photoreceptor array **20**, preferably on a common CMOS chip **21**, resides signal processing electronics **22** of the preferred pulse oximetry sensor **10**. Depicted in FIGURE 1 as an extension of the photoreceptor array **20** for the sake of clarity, it is to be understood that the signal processing electronics **22** can be located anywhere adjacent to the photoreceptor array **20**, but is most preferably integrated with the photoreceptor array **20**. The photodiode is preferably integrally formed on the same CMOS chip as the electronic components **22** described in detail below. However, it is contemplated that the photodiode can be formed separately from the CMOS chip **21**, bonded or otherwise electrically connected to it. A data transmission cable **24** is attached to the housing **12** to transport the analyzed pulse oximetry data to a typical means of display or recordation and to provide power to the components of the pulse oximetry sensor. Because the data has been processed, preferably digitized, and amplified, the transmission cable need not be shielded and can be low impedance.

[0026] With reference now to FIGURE 2, a wireless embodiment of the pulse oximetry sensor **10** is depicted. It is to be understood that the functional discussion that applies to FIGURE 1 also applies to FIGURE 2, inasmuch as like indicators indicate like components. Most significant differences, of course, are an on-board power supply, a wireless transmitter/receiver, and the lack of a connecting power/data transmission cable. Functionally, the pulse oximetry sensor depicted in FIGURE 1 is operationally very similar to the wireless embodiment depicted in FIGURE 2.

[0027] A wireless transmitter **30** transmits the analyzed pulse oximetry data from the CMOS chip **21** to a remote console for viewing. The transmitter is preferably a Bluetooth™ type transmitter because it is a power and processing efficient format and because shorter range transmissions are preferred. The transmitter is relatively short range, preferably transmitting to a console within the subject's room, and not reaching the consoles of similar units in other parts of the medical facility. More powerful and longer range transmitters are also contemplated, such as RF embodiments, where appropriate. Preferably, the transmitter/receiver is a separate chip from the signal processing electronics **22**, as opposed to integrated within the electronics chip **21**. Optionally, the wireless transmitter **30** is a transceiver for receiving post processing and control instructions and the like from a dedicated host system. Such messages or indicators could be battery status monitoring messages, on/off commands, encryption codes, processing instructions, and the like. In the preferred embodiment, the transmitter **30** is located adjacent to the integrated processing electronics **22**, but it is to be understood that the transmitter may be also integrated into the CMOS chip **21** that houses the signal processing electronics **22** or located in a more remote portion of the sensor assembly.

[0028] The wireless embodiment includes an on-board power supply housing **32** wherein is located a power supply, preferably a battery **34**. The battery **34** is preferably a lithium-ion battery. The battery **34** is the most bulky component of the wireless pulse oximetry embodiment, so a balance is desired between battery life and bulk. In a hospital environment, it is conceivable that battery lives of at ½ day or a day are acceptable. Rechargeable batteries could be recharged periodically on convenient in-room battery chargers designed to receive the pulse oximetry sensors that are not in use. If, however, longer battery lives are desired, for such applications as home use or extended hospital stays, larger (such as a AA or AAA cell) are possible. Other power supplies such as solar cells, other charge storage devices, inductive couplings, and the like are also contemplated.

[0029] Now with reference to FIGURE 3, the processing electronics **22** are depicted in greater detail. All of the components are **22** integrated into a single CMOS chip **21**. Integrated design enables significant reduction of size, cost, direct weight of the sensor, reduction of power consumption, and thus further reduction of other components and parameters due to shrinking the power supply. The disclosed embodiment reduces the production cost of an SpO_2 sensor including demodulation, filtering, and pre-processing, LED control and drivers to be comparable with the current cost of the photodiode and finger mounting assembly.

[0030] The first component integrated is the photoreceptor array **20**. As discussed previously, the photoreceptor array receives light data from the red emitting diode **16** and the infrared emitting diode **18**. These signals are immediately amplified by an attached photo preamplifier **40**. With no cable to traverse between the photodiode and the amplifier, amplification is performed before the light signals undergo significant attenuation or acquire significant background noise. The amplified signals are sampled and held by a sample/hold **42** until an iteration of each wavelength has been sampled (two in the preferred embodiment, but as many as is practically allowable, such as ten as discussed previously) including a reference (dark) channel in which no light is emitted. The dark channel is sampled to provide a reference so that the system can create a baseline and cancel out any ambient light contribution and exclude it from the pulse oximetry measurement. The individual wavelength signals are then separately digitized by an analog to digital converter **44**, and passed to a microprocessor **46** (CPU) of the integrated electronics **22**. Optionally, the sample/hold **42** and the analog to digital converter **44** are combined into a Sigma Delta ($\Sigma\Delta$) converter **47**, combining the holding and digitizing into a single step.

[0031] The flow of samples is filtered digitally by the CPU **46** and adjusted according to intensity based on detected light levels. To aid the CPU **46** in adjusting the intensities of the signals, a dynamic rangefinder **48** is included to compensate for different measurement sites, (e.g. finger vs. earlobe) LED efficiencies, skin color/tone, and the like. Information from the rangefinder **48** is fed back into preamplifier **40** to be used in the next iteration of detected LED emissions.

[0032] A timing circuit **50** coordinates the rangefinder **48**, the lighting of the LEDs **16**, **18**, and the processing and hold of data through the sample **42**, the A/D converter **44** and the CPU **46**. In the preferred embodiment, the timing circuit **50** coordinates alternating bursts from the diodes **16**, **18** and dark channels on the order of 1 KHz iterations, e.g., every millisecond. This value is chosen to be well above the frequency of most ambient light sources (e.g. florescent) and in this manner, may be as small as about 250 Hz. At slower switching speeds, the pauses between light emissions are longer to avoid prematurely burning out the LEDs **16**, **18.** The CPU **46** guided by the timing circuit **50** coordinates with an LED controller **52** for precise lighting of the LEDs **16**, **18**. After receiving iterations of the detected light, the CPU **46** translates the detected light signals into a pulse oximetry measurement. The updated pulse oximetry measurement is then passed on from the CPU **46** to a suitable display via the cable **24**, (as per FIGURE 1) or via the transmitter **30** (as per FIGURE 2).

[0033] In an alternate embodiment, as shown in FIGURE 4 the use of a current to voltage converter **54** instead of the sample/hold **42**, ADC **44** combination is contemplated. This alternate embodiment may be used for analog modulation schemes such as frequency or phase multiplexed LED modulation.

[0034] Also alternatively, multiple parallel sample/holds **42** and ADCs **44** can be added to relax requirements on the single ADC **44** processing channel. Analog or hardwired digital filters and demodulation can also be used in this concept.

[0035] Also alternatively, it is contemplated that the red and infrared signals received from the light emitting diodes be converted into plethysmographic waveforms from at least one of the red and infra-red spectra/

[0036] The invention has been described with reference to the preferred embodiments. Modifications and alterations will occur to others upon a reading and understanding of the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

Claims

1. A medical pulse oximetry sensor (**10**) comprising:

   a carriage housing (**12**) adapted to fit snugly about a portion of a subject's anatomy with a relatively high oxygenated blood throughput;
   a first light emitting diode (**16**) mounted in the housing (**12**) for emitting light in the electromagnetic spectrum of the red wavelengths;
   a second light emitting diode (**18**) mounted in the housing (**12**) for emitting light in the electromagnetic spectrum of the infrared wavelengths;
   at least one photodiode (**20**) for detecting incumbent light from the first and second light emitting diodes (**16**,**18**) after the emitted light has passed through a blood oxygenated portion of a subject and generating electrical signals indicative thereof;
   characterised by a processing circuit (**22**) integrally formed on an integrated semiconducting chip (**21**) mounted in the carriage housing (**12**), the processing circuit (**22**) comprising:

      an amplifier (**40**) for amplifying the signals from the at least one photodiode (**20**); and
      a processing unit (**46**) for processing the signals into one of a pulse oximetry value and plethysmographic waveforms from at least one of the wavelengths.

2. The medical pulse oximetry sensor (**10**) as set forth in claim 1 wherein the processing circuit (**22**) comprises:

   a sigma delta modulator (**47**) for sampling the amplified signals and converting the signals into digital format.

3. The medical pulse oximetry sensor (**10**) as set forth in claim 1, wherein the processing circuit (**22**) comprises:

   a current to voltage converter (**54**) for analog modulation and one of frequency and phase multiplexed LED modulation of the signals from the photodiode (**20**).

4. The medical pulse oximetry sensor (**10**) as set forth in claim 1, wherein processing circuit (**22**) comprises:

   a sample and hold (**42**) operatively connected to the amplifier (**40**) for sampling and holding the amplified signals.

5. The medical pulse oximetry sensor (**10**) as set forth in claim 4, wherein the processing circuit (**22**) comprises:

   an analog to digital converter (**44**) for digitizing sampled and held amplified signals.

6. The medical pulse oximetry sensor as set forth in claim 5, wherein the processing unit (**46**) is operationally connected to the analog to digital converter (**44**) for processing the digitized signals into the pulse oximetry value and for controlling operation of the light emitting diodes (**16,18**).

7. The medical pulse oximetry sensor (**10**) as claimed in any one of the preceding claims, wherein the processing circuit (**22**) comprises:

   a light emitting diode control portion (**52**) operationally connected to the processing unit (**46**) that controls light emissions from the first and second light emitting diodes (**16**,**18**).

8. The medical pulse oximetry sensor (**10**) as claimed in any one of the preceding claims, wherein the processing circuit (**22**) comprises:

   a timing circuit (**50**) that coordinates signal processing by the processing unit (46), the analog to digital converter (**44**), and the sample and hold (**42**), and the emission of light by the first and second light emitting diodes (**16**,**18**).

9. The medical pulse oximetry sensor (**10**) as claimed in any one of the preceding claims, wherein the processing circuit (**22**) comprises:

   a range finder (**48**) that selects an amplification range or the amplifier (**40**).

10. The medical pulse oximetry sensor (**10**) as set forth in claim 1, further comprising:

    additional light emitting diodes, each emitting additional wavelengths of electromagnetic radiation.

11. The medical pulse oximetry sensor (**10**) as set forth in claim 1, wherein the photodiode (**20**) is integrally formed in the semiconductor chip (**21**).

12. The medical pulse oximetry sensor (**10**) as set forth in claim 1, wherein the photodiode (**20**) is electrically connected to the semiconductor chip (**21**).

13. The medical pulse oximetry sensor (**10**) as set forth in claim 1, wherein the semiconductor chip (**21**) is a CMOS chip.

14. The medical pulse oximetry sensor (**10**) as claimed in any one of the preceding claims, further comprising:

a wireless transmitter (**30**) for transmitting the calculated pulse oximetry value to at least one of a display console and a recordation means;
a battery (**34**) for providing power to the pulse oximetry sensor (**10**).

15. The medical pulse oximetry sensor (**10**) as claimed in any one of claims 1 to 13, further comprising:

a cable (**24**) for providing power to the pulse oximetry sensor (**10**) and for transmitting the calculated pulse oximetry value to at least one of a display console and a recordation means.

16. A method manufacturing a pulse oximetry sensor (**10**) comprising:

embedding at least first and second light emitting diodes (**16**,**18**) into a carriage housing (**12**) adapted to fit snugly about a portion of a subject's anatomy with a relatively high oxygenated blood throughput;
embedding an integrated circuit (**22**) opposite the light emitting diodes (**16**,**18**), such that light emitted by the diodes must pass through the portion of the subject's anatomy before impinging upon the integrated circuit (**22**), the integrated circuit (**22**) including:

at least one photodiode (**20**) for detection of light signals from the at least two light emitting diodes (**16**,**18**) and generating signals indicative thereof;
an amplifier (**40**) for amplifying the signals from the photodiode (**20**);
digital conversion elements (**42**, **44**) for digitizing the signals from the photodiode (**20**);
a processing unit (**46**) for processing the digital signals into the pulse oximetry value.

17. The method of manufacturing a pulse oximetry sensor (**10**) as set forth in claim 16, wherein the integrated circuit (**22**) is formed on a single CMOS substrate (**21**).

18. A method of measuring blood oxygen comprising:

emitting pulses of red light from a first LED (**16**) mounted in a carriage housing (**12**) adapted to fit snugly about a portion of a subject's anatomy with a relatively high oxygenated blood throughput;
emitting pulses of infrared light from a second LED (**18**) mounted in the carriage housing (**12**);
receiving light from the LEDs (**16**, **18**) which has traversed a blood oxygenated portion of a person with a photodiode (**20**) mounted in the carriage housing (**12**) and generating electrical signals;
amplifying the electrical signals from the photodiode (**20**) using an amplifier provided in a processing circuit (**22**) integrally formed on an integrated semiconducting component chip (**21**) that is mounted in the carriage housing (**12**); and
processing the electrical signals from the amplifier using a processing unit provided in the processing circuit (**22**) into one of a blood oximetry value and plethysmographic waveforms from at least one of the wavelengths.

19. The method of measuring blood oxygen as set forth in claim 18, wherein the photodiode (**20**) is an integral part of the semiconductor chip (**21**).

Patentansprüche

1. Medizinisches Pulsoximeter (10), das Folgendes umfasst:

ein Trägergehäuse (12), das so ausgelegt, das es eng um einen Teil der Anatomie eines Subjekts herum anliegt, der von relativ hoch oxygeniertem Blut durchströmt wird;
eine erste Leuchtdiode (16) montiert in dem Gehäuse (12) zum Emittieren von Licht in dem elektromagnetischen Spektrum der roten Wellenlängen;
eine zweite Leuchtdiode (18) montiert in dem Gehäuse (12) zum Emittieren von Licht in dem elektromagnetischen Spektrum der infraroten Wellenlängen;
mindestens eine Photodiode (20) zum Detektieren von einfallendem Licht von der ersten und der zweiten Leuchtdiode (16, 18), nachdem das emittierte Licht einen blut-oxygenierten Teil eines Subjekts durchquert hat, und zum Erzeugen darauf hinweisender elektrischer Signale;
<u>**gekennzeichnet**</u> **durch** eine Verarbeitungsschaltung (22), die integral auf einem integrierten Halbleiterchip (21) gebildet ist, der in dem Trägergehäuse (12) montiert ist, wobei die Verarbeitungsschaltung (22) Folgendes umfasst:

einen Verstärker (40) zum Verstärken der Signale von der mindestens einen Photodiode (20); und
eine Verarbeitungseinheit (46) zum Verar-

beiten der Signale zu entweder einem Pulsoximetriewert oder plethysmographischen Wellenformen ausgehend von mindestens einer der Wellenlängen.

2. Medizinisches Pulsoximeter (10) nach Anspruch 1, wobei die Verarbeitungsschaltung (22) Folgendes umfasst:

einen Sigma-Delta-Modulator (47) zum Abtasten der verstärkten Signale und zum Umwandeln der Signale in digitales Format.

3. Medizinisches Pulsoximeter (10) nach Anspruch 1, wobei die Verarbeitungsschaltung (22) Folgendes umfasst:

einen Strom-Spannung-Umsetzer (54) zur analogen Modulation und entweder frequenz- oder phasengemultiplexten LED-Modulation der Signale von der Photodiode (20).

4. Medizinisches Pulsoximeter (10) nach Anspruch 1, wobei die Verarbeitungsschaltung (22) Folgendes umfasst:

eine Abtast-Halte-Schaltung (42), die operativ mit dem Verstärker (40) verbunden ist, um die verstärkten Signale abzutasten und zu halten.

5. Medizinisches Pulsoximeter (10) nach Anspruch 4, wobei die Verarbeitungsschaltung (22) Folgendes umfasst:

einen Analog-Digital-Umsetzer (44) zum Digitalisieren der abgetasteten und gehaltenen verstärkten Signale.

6. Medizinisches Pulsoximeter nach Anspruch 5, wobei die Verarbeitungseinheit (46) operativ mit dem Analog-Digital-Umsetzer (44) verbunden ist, um die digitalisierten Signale zu dem Pulsoximeterwert zu verarbeiten und um den Betrieb der Leuchtdioden (16, 18) zu steuern.

7. Medizinisches Pulsoximeter (10) nach einem der vorhergehenden Ansprüche, wobei die Verarbeitungsschaltung (22) Folgendes umfasst:

einen operativ mit der Verarbeitungseinheit (46) verbundenen Leuchtdioden-Steuerteil (52), der die Lichtemissionen von der ersten und der zweiten Leuchtdiode (16, 18) steuert.

8. Medizinisches Pulsoximeter (10) nach einem der vorhergehenden Ansprüche, wobei die Verarbeitungsschaltung (22) Folgendes umfasst:

eine Zeitsteuerungsschaltung (50), die die Signalverarbeitung durch die Verarbeitungseinheit (46), den Analog-Digital-Umsetzer (44) und die Abtast-Halte-Schaltung (42) sowie die Lichtemission von der ersten und der zweiten Leuchtdiode (16, 18) koordiniert.

9. Medizinisches Pulsoximeter (10) nach einem der vorhergehenden Ansprüche, wobei die Verarbeitungsschaltung (22) Folgendes umfasst:

einen Bereichssucher (48), der einen Verstärkungsbereich des Verstärkers (40) auswählt.

10. Medizinisches Pulsoximeter (10) nach Anspruch 1, das weiterhin Folgendes umfasst:

zusätzliche Leuchtdioden, die jeweils zusätzliche Wellenlängen elektromagnetischer Strahlung emittieren.

11. Medizinisches Pulsoximeter (10) nach Anspruch 1, wobei die Photodiode (20) integral in dem Halbleiterchip (21) gebildet ist.

12. Medizinisches Pulsoximeter (10) nach Anspruch 1, wobei die Photodiode (20) elektrisch mit dem Halbleiterchip (21) verbunden ist.

13. Medizinisches Pulsoximeter (10) nach Anspruch 1, wobei der Halbleiterchip (21) ein CMOS-Chip ist.

14. Medizinisches Pulsoximeter (10) nach einem der vorhergehenden Ansprüche, das weiterhin Folgendes umfasst:

einen drahtlosen Sender (30) zum Senden des berechneten Pulsoximetriewertes an mindestens entweder eine Anzeigekonsole oder ein Aufzeichnungsmittel;
eine Batterie (34) zum Versorgen des Pulsoximeters (10) mit Energie.

15. Medizinisches Pulsoximeter (10) nach einem der Ansprüche 1 bis 13, das weiterhin Folgendes umfasst:

ein Kabel (24) zum Versorgen des Pulsoximeters (10) mit Energie und zum Übertragen des berechneten Pulsoximetriewertes an mindestens entweder eine Anzeigekonsole oder ein Aufzeichnungsmittel.

16. Verfahren zur Herstellung eines Pulsoximeters (10), wobei das Verfahren Folgendes umfasst:

Einbetten von mindestens ersten und zweiten Leuchtdioden (16, 18) in ein Trägergehäuse

(12), das so ausgelegt, das es eng um einen Teil der Anatomie eines Subjekts herum anliegt, der von relativ hoch oxygeniertem Blut durchströmt wird;
Einbetten einer integrierten Schaltung (22) gegenüber den Leuchtdioden (16, 18), so dass das durch die Dioden emittierte Licht den Teil der Anatomie des Subjekts durchqueren muss, bevor es auf der integrierten Schaltung (22) auftrifft, wobei die integrierte Schaltung (22) Folgendes umfasst:

mindestens eine Photodiode (20) zum Detektieren von Lichtsignalen von den mindestens zwei Leuchtdioden (16, 18) und zum Erzeugen darauf hinweisender Signale;
einen Verstärker (40) zum Verstärken der Signale von der Photodiode (20);
digitale Umsetzungsmittel (42, 44) zum Digitalisieren der Signale von der Photodiode (20);
eine Verarbeitungseinheit (46) zum Verarbeiten der digitalen Signale zu dem Pulsoximetriewert.

17. Verfahren zur Herstellung eines Pulsoximeters (10) nach Anspruch 16, wobei die integrierte Schaltung (22) auf einem einzelnen CMOS-Substrat (21) gebildet wird.

18. Verfahren zum Messen von Blutsauerstoff, das Folgendes umfasst:

Emittieren von Impulsen roten Lichts von einer ersten LED (16), die in dem Trägergehäuse (12) montiert ist, das so ausgelegt, das es eng um einen Teil der Anatomie eines Subjekts herum anliegt, der von relativ hoch oxygeniertem Blut durchströmt wird;
Emittieren von Impulsen infraroten Lichts von einer zweiten LED (18), die in dem Trägergehäuse (12) montiert ist;
Empfangen von Licht von den LEDs (16, 18), das einen blut-oxygenierten Teil einer Person durchquert hat, mit einer in dem Trägergehäuse (12) montierten Photodiode (20) und Erzeugen elektrischer Signale;
Verstärken der elektrischen Signale von der Photodiode (20) unter Verwendung eines Verstärkers, der in einer Verarbeitungsschaltung (22) vorgesehen ist, welche integral auf einen integrierten Halbleiterchip (21) gebildet ist, der in dem Trägergehäuse (12) montiert ist; und
Verarbeiten der elektrischen Signale von dem Verstärker unter Verwendung einer Verarbeitungseinheit, die in der Verarbeitungsschaltung vorgesehen ist, zu entweder einem Pulsoximetriewert oder plethysmographischen Wellenformen ausgehend von mindestens einer der Wellenlängen.

19. Verfahren zum Messen von Blutsauerstoff nach Anspruch 18, wobei die Photodiode (20) ein integraler Teil des Halbleiterchips (21) ist.

Revendications

1. Capteur oxymètre de pouls médical (10) comprenant :

un boîtier porteur (12) apte à s'adapter étroitement autour d'une partie de l'anatomie d'un sujet présentant un débit de sang oxygéné relativement élevé ;
une première diode électroluminescente (16) montée dans le boîtier (12) pour émettre de la lumière dans le spectre électromagnétique des longueurs d'ondes rouges ;
une deuxième diode électroluminescente (18) montée dans le boîtier (12) pour émettre de la lumière dans le spectre électromagnétique des longueurs d'ondes infrarouges ;
au moins une photodiode (20) pour détecter la lumière provenant des première et deuxième diodes électroluminescentes (16, 18) après que la lumière émise a traversé une partie de sang oxygéné d'un sujet et pour générer des signaux électriques indiquant cela ;
caractérisé par un circuit de traitement (22) formé de manière intégrale sur une puce de semiconducteurs intégrée (21) montée dans le boîtier porteur (12), le circuit de traitement (22) comprenant :

un amplificateur (40) pour amplifier les signaux de l'au moins une photodiode (20) ; et
une unité de traitement (46) pour traiter les signaux en l'une d'une valeur d'oxymétrie de pouls et de formes d'ondes pléthysmographiques d'au moins l'une des longueurs d'ondes.

2. Capteur oxymètre de pouls médical (10) selon la revendication 1, dans lequel le circuit de traitement (22) comprend :

un modulateur sigma delta (47) pour échantillonner les signaux amplifiés et convertir les signaux au format numérique.

3. Capteur oxymètre de pouls médical (10) selon la revendication 1, dans lequel le circuit de traitement (22) comprend :

un convertisseur d'intensité en tension (54) pour une modulation analogique et l'une d'une modulation de LED à multiplexage de fréquence et d'une modulation de LED à multiplexage de phase des signaux de la photodiode (20).

4. Capteur oxymètre de pouls médical (10) selon la revendication 1, dans lequel le circuit de traitement (22) comprend :

un dispositif d'échantillonnage et de maintien (42) relié de manière opérationnelle à l'amplificateur (40) pour échantillonner et maintenir les signaux amplifiés.

5. Capteur oxymètre de pouls médical (10) selon la revendication 4, dans lequel le circuit de traitement (22) comprend :

un convertisseur analogique-numérique (44) pour numériser les signaux amplifiés échantillonnés et maintenus.

6. Capteur oxymètre de pouls médical selon la revendication 5, dans lequel l'unité de traitement (46) est reliée de manière opérationnelle au convertisseur analogique-numérique (44) pour traiter les signaux numérisés en valeur d'oxymétrie de pouls et pour commander le fonctionnement des diodes électroluminescentes (16, 18).

7. Capteur oxymètre de pouls médical (10) selon l'une quelconque des revendications précédentes, dans lequel le circuit de traitement (22) comprend :

une partie de commande de diodes électroluminescentes (52) reliée de manière opérationnelle à l'unité de traitement (46) qui commande les émissions de lumière des première et deuxième diodes électroluminescentes (16, 18).

8. Capteur oxymètre de pouls médical (10) selon l'une quelconque des revendications précédentes, dans lequel le circuit de traitement (22) comprend :

un circuit de timing (50) qui coordonne le traitement de signal par l'unité de traitement (46), le convertisseur analogique-numérique (44), et le dispositif d'échantillonnage et de maintien (42), et l'émission de lumière par les première et deuxième diodes électroluminescentes (16, 18).

9. Capteur oxymètre de pouls médical (10) selon l'une quelconque des revendications précédentes, dans lequel le circuit de traitement (22) comprend :

un chercheur de plage (48) qui sélectionne une plage d'amplification de l'amplificateur (40).

10. Capteur oxymètre de pouls médical (10) selon la revendication 1, comprenant en outre :

des diodes électroluminescentes supplémentaires, émettant chacune des longueurs d'onde supplémentaires de rayonnement électromagnétique.

11. Capteur oxymètre de pouls médical (10) selon la revendication 1, dans lequel la photodiode (20) est formée de manière intégrale dans la puce de semi-conducteurs (21).

12. Capteur oxymètre de pouls médical (10) selon la revendication 1, dans lequel la photodiode (20) est reliée électriquement à la puce de semi-conducteurs (21).

13. Capteur oxymètre de pouls médical (10) selon la revendication 1, dans lequel la puce de semi-conducteurs (21) est une puce CMOS.

14. Capteur oxymètre de pouls médical (10) selon l'une quelconque des revendications précédentes, comprenant en outre :

un émetteur sans fil (30) pour transmettre la valeur d'oxymétrie de pouls calculée à au moins l'un d'une console d'affichage et d'un moyen d'enregistrement ;
une batterie (34) pour fournir l'alimentation électrique au capteur oxymètre de pouls (10).

15. Capteur oxymètre de pouls médical (10) selon l'une quelconque des revendications 1 à 13, comprenant en outre :

un câble (24) pour fournir l'alimentation électrique au capteur oxymètre de pouls (10) et pour transmettre la valeur d'oxymétrie de pouls calculée à au moins l'un d'une console d'affichage et d'un moyen d'enregistrement.

16. Procédé de fabrication d'un capteur oxymètre de pouls (10) comprenant :

l'intégration d'au moins des première et deuxième diodes électroluminescentes (16, 18) dans un boîtier porteur (12) apte à s'adapter étroitement autour d'une partie de l'anatomie d'un sujet avec un débit de sang oxygéné relativement élevé ;
l'intégration d'un circuit intégré (22) à l'opposé des diodes électroluminescentes (16, 18), de sorte que la lumière émise par les diodes doit traverser la partie de l'anatomie du sujet avant

d'empiéter sur le circuit intégré (22), le circuit intégré (22) comprenant :

au moins une photodiode (20) pour la détection de signaux de lumière des au moins deux diodes électroluminescentes (16, 18) et la génération de signaux indiquant cela ;
un amplificateur (40) pour amplifier les signaux de la photodiode (20) ;
des éléments de conversion numérique (42, 44) pour numériser les signaux de la photodiode (20) ;
une unité de traitement (46) pour traiter les signaux numériques en valeur d'oxymétrie de pouls.

17. Procédé de fabrication d'un capteur oxymètre de pouls (10) selon la revendication 16, dans lequel le circuit intégré (22) est formé sur un substrat CMOS unique (21).

18. Procédé de mesure de l'oxygène du sang, comprenant :

l'émission d'impulsions de lumière rouge d'une première LED (16) montée dans un boîtier porteur (12) apte à s'adapter étroitement autour d'une partie de l'anatomie d'un sujet avec un débit de sang oxygéné relativement élevé ;
l'émission d'impulsions de lumière infrarouge d'une deuxième LED (18) montée dans le boîtier porteur (12) ;
la réception d'une lumière des LED (16, 18) qui a traversé une partie de sang oxygéné d'une personne avec une photodiode (20) montée dans le boîtier porteur (12) et la génération de signaux électriques ;
l'amplification des signaux électriques de la photodiode (20) en utilisant un amplificateur fourni dans un circuit de traitement (22) formé de manière intégrale sur une puce de composant de semi-conducteurs intégrée (21) qui est montée dans le boîtier porteur (12) ; et
le traitement des signaux électriques de l'amplificateur en utilisant une unité de traitement fournie dans le circuit de traitement (22) en l'une d'une valeur d'oxymétrie de sang et de formes d'ondes pléthysmographiques d'au moins l'une des longueurs d'ondes.

19. Procédé de mesure de l'oxygène du sang selon la revendication 18, dans lequel la photodiode (20) fait partie intégrale de la puce de semi-conducteurs (21).

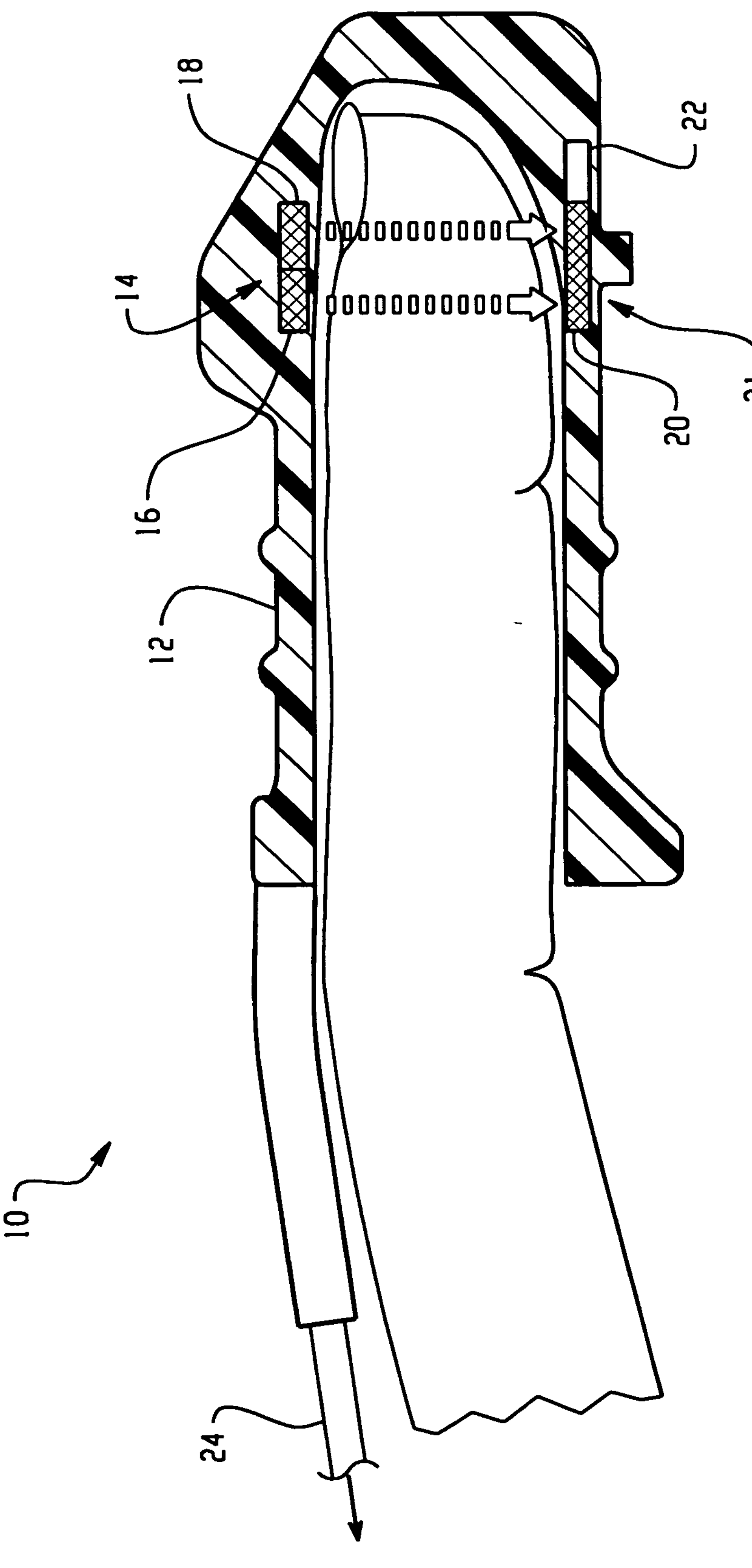

Fig. 1

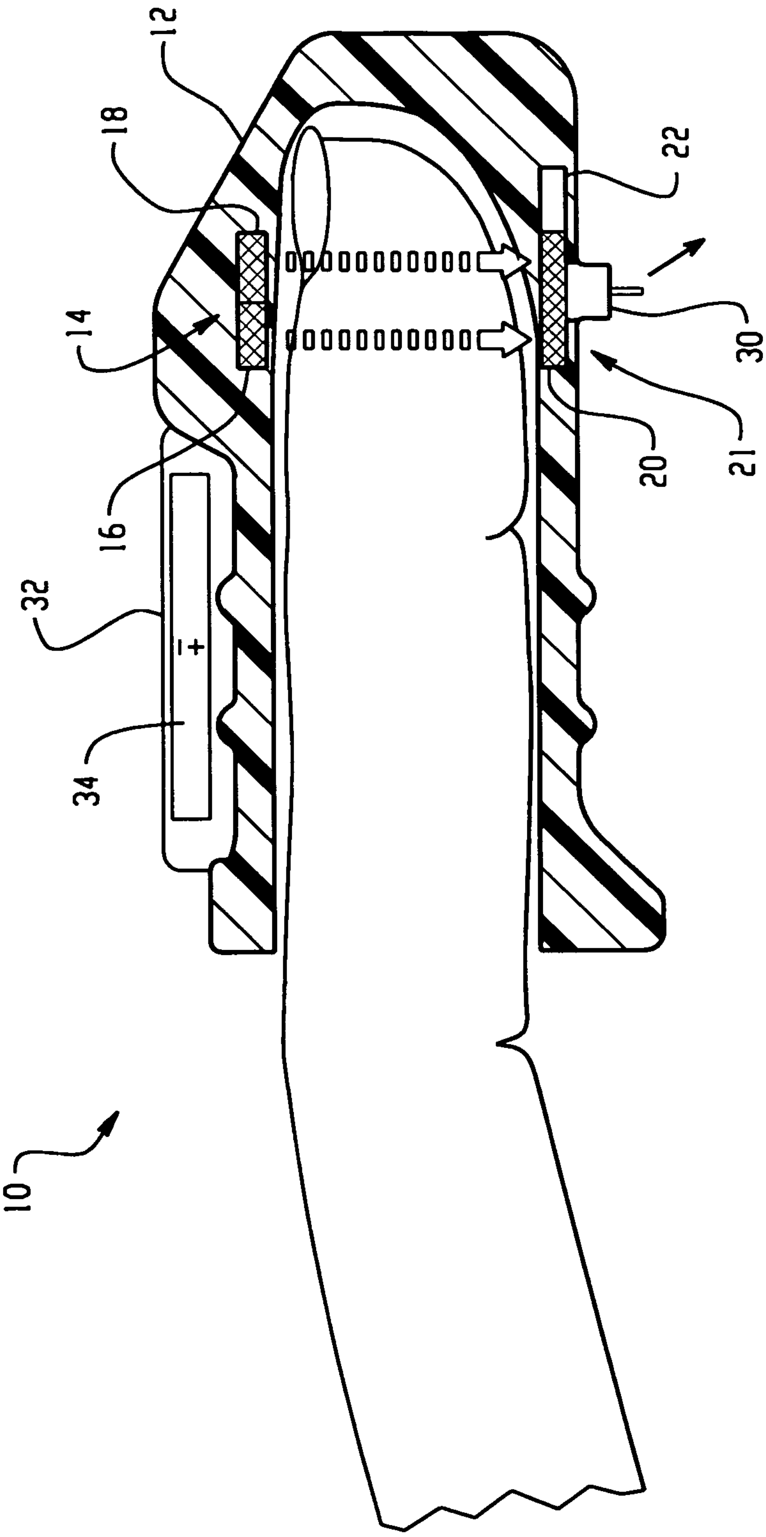

Fig. 2

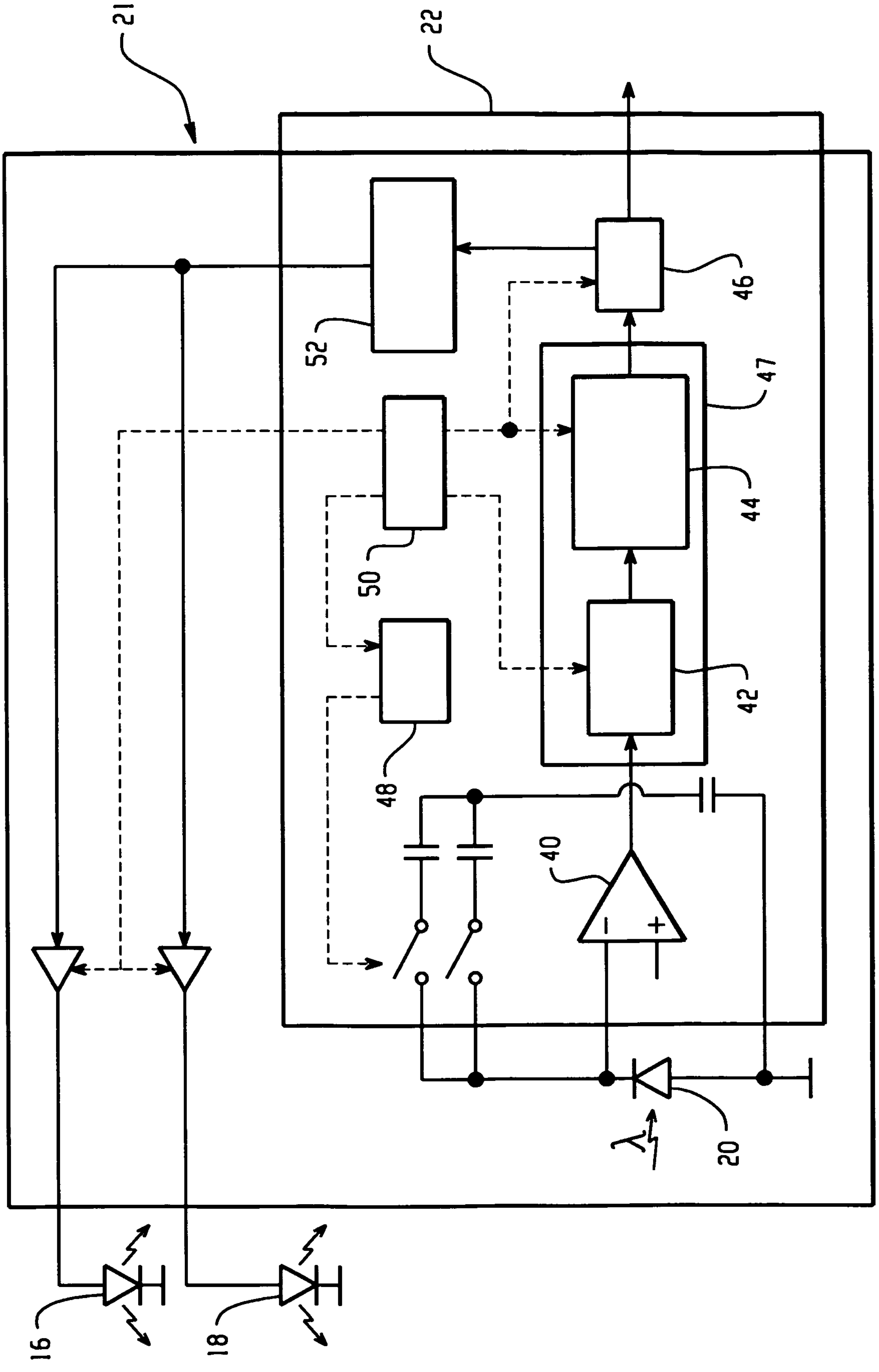

Fig. 3

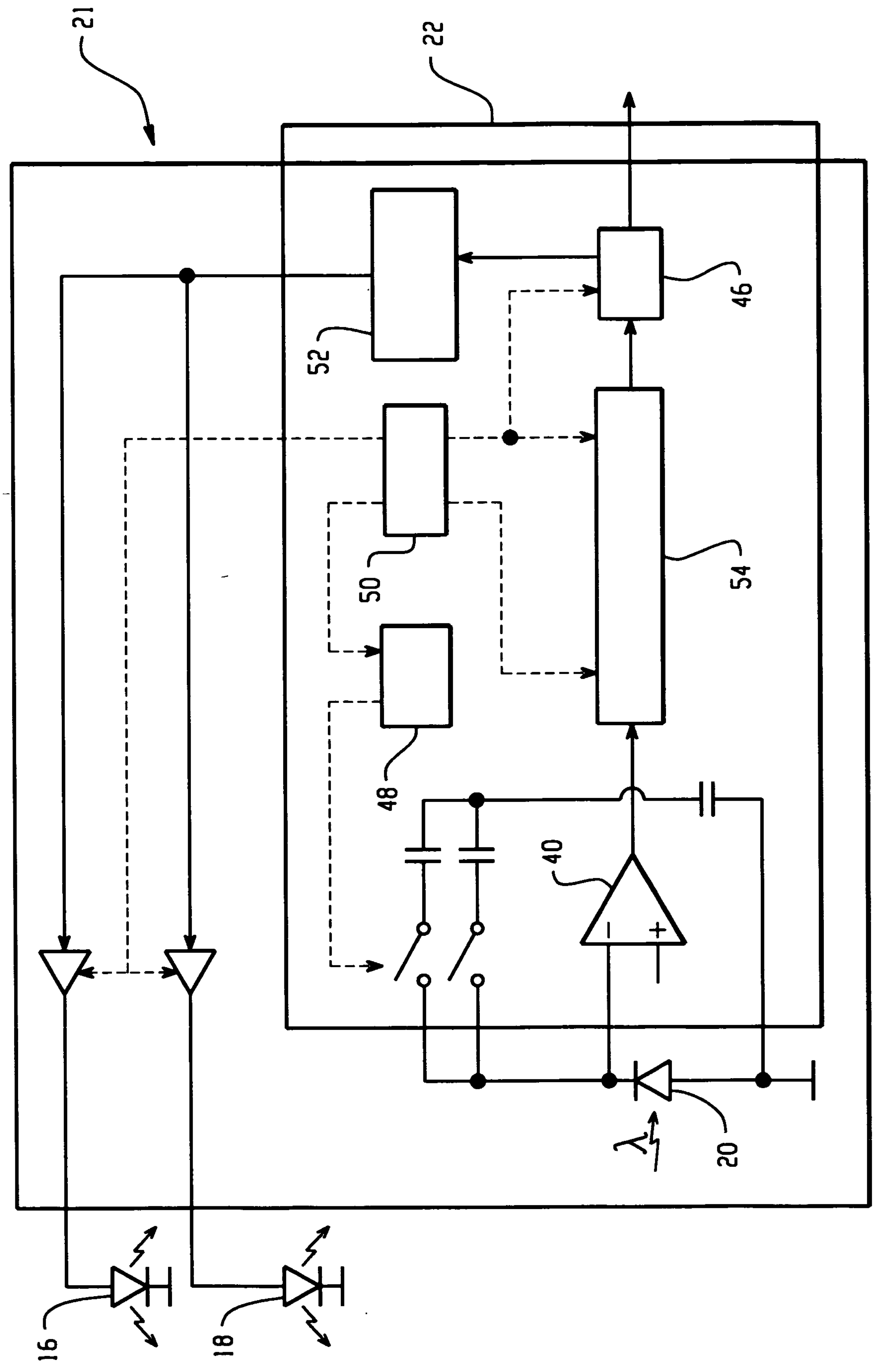

Fig. 4

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- US 6496711 B1 **[0007]**

专利名称(译)	集成脉搏血氧饱和度传感器		
公开(公告)号	EP1830695B1	公开(公告)日	2011-11-30
申请号	EP2005826722	申请日	2005-12-05
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦电子N.V.		
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IPC分类号	A61B5/00		
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优先权	60/635985 2004-12-14 US		
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外部链接	Espacenet		

摘要(译)

在医疗脉搏血氧饱和度传感器（10）中，设置至少两个发光二极管（16,18）以通过对象的解剖结构的一部分发射红光和红外光，其具有通常高的氧合血液通量。通常，该区域也相对较窄，以允许光通过具有可接受衰减的区域，例如手指或耳垂。从LED（16,18）发射的光在从单个CMOS基板（21）印刷的集成电路（22）上有效。集成电路（22）包括将检测到的光信号转换成脉搏血氧测量所需的所有预处理和后处理元件。这些元件包括光检测器（20），光预放大器（40），采样器/支架（42），模数转换器（44），微处理器（46），测距仪（48），定时控制电路（50）和LED控制电路（52）。通过将所有前处理和后处理功能集成到托架壳体（12）中，系统变得更有效，制造成本更低，并且对环境光和X射线辐射更稳健。