

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
9 September 2005 (09.09.2005)

PCT

(10) International Publication Number  
WO 2005/082242 A1

- (51) International Patent Classification<sup>7</sup>: A61B 5/00
- (21) International Application Number: PCT/US2005/006336
- (22) International Filing Date: 24 February 2005 (24.02.2005)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 10/787,854 25 February 2004 (25.02.2004) US

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(71) Applicant (for all designated States except US): **NELL-COR PURITAN BENNETT INCORPORATED** [US/US]; 4280 Hacienda Drive, Pleasanton, CA 94588 (US).

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

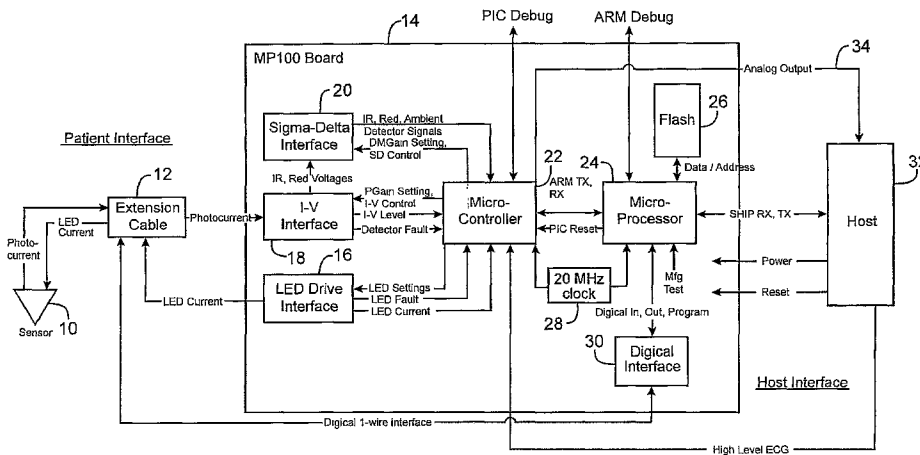
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **PETERSEN, Ethan** [US/US]; 18968 Thornbury Avenue, Castro Valley, CA 94546 (US). **SHEA, William** [US/US]; 4049 Findlay Way, Livermore, CA 94550 (US). **CHEW, Bradford, B.** [US/US]; 805 Springbrook Drive, San Ramon, CA 94583 (US).
- (74) Agent: **SLAYDEN Bruce, W. II**; Baker Botts, L.L.P., 98 San Jacinto Blvd., 1500 San Jacinto Center, Austin, TX 78701-4039 (US).

**Declaration under Rule 4.17:**

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM,

[Continued on next page]

(54) Title: OXIMETER AMBIENT LIGHT CANCELLATION



(57) Abstract: A pulse oximeter method and apparatus which provides (1) a notch filter (46) at a distance between a modulation frequency and a common multiple of commonly used power line frequencies (50, 60, 100 and 120) and also (2) a demodulation frequency greater than a highest pulse rate of a person and lower than any harmonic of 50, 60, 100 or 120 Hz, to filter ambient light interference, while choosing an optimum demodulation frequency that avoids interference from the notch filter or from harmonics of the line interference. Also, ambient light for any low frequency interference, such as power line interference, is measured both before and after each of the light emitter wavelengths and the average of the ambient light is then subtracted from the detected signal.

WO 2005/082242 A1



PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

**Published:**

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

## OXIMETER AMBIENT LIGHT CANCELLATION

### BACKGROUND OF THE INVENTION

5 [0001] The present invention relates to oximeters, and in particular to techniques for ambient light cancellation in pulse oximeters.

[0002] Pulse oximetry is typically used to measure various blood flow characteristics including, but not limited to, the blood-oxygen saturation of hemoglobin in arterial blood, the volume of individual blood pulsations supplying the tissue, and the rate of blood pulsations corresponding to each heartbeat of a patient. Measurement of these characteristics has been  
10 accomplished by use of a non-invasive sensor which scatters light through a portion of the patient's tissue where blood perfuses the tissue, and photoelectrically senses the absorption of light in such tissue. The amount of light absorbed is then used to calculate the amount of blood constituent being measured.

[0003] The light scattered through the tissue is selected to be of one or more wavelengths  
15 that are absorbed by the blood in an amount representative of the amount of the blood constituent present in the blood. The amount of transmitted light scattered through the tissue will vary in accordance with the changing amount of blood constituent in the tissue and the related light absorption. For measuring blood oxygen level, such sensors have typically been provided with a light source that is adapted to generate light of at least two different  
20 wavelengths, and with photodetectors sensitive to both of those wavelengths, in accordance with known techniques for measuring blood oxygen saturation.

[0004] Known non-invasive sensors include devices that are secured to a portion of the body, such as a finger, an ear or the scalp. In animals and humans, the tissue of these body portions is perfused with blood and the tissue surface is readily accessible to the sensor.

25 [0005] One problem with oximeter measurements is that in addition to receiving the light that was directed at the tissue, ambient light is also detected by the photodetector. Attempts can be made to block out ambient light, but some amount of ambient light will typically be detected. One particular concern is the light at the power line frequency of fluorescent or other lights, which is 60 Hz in the United States and 50 Hz in Europe and other countries.

[0006] Since a single photodetector is typically used, the light of different wavelengths, such as red and infrared, is time multiplexed. The detected signal must be demultiplexed. The demultiplexing frequency must be high enough so that it is much larger than the pulse rate. However, choosing a demultiplexing frequency is also impacted by the ambient light interference. One issue is the aliasing of harmonics of the AC power line frequency. U.S. Patent No. 5,713,355 discusses a technique of altering the demultiplexing frequency depending upon the amount of ambient interference detected at each frequency.

[0007] U.S. Patent No. 5,885,213 discusses subtracting a dark signal (detected ambient light) from the detected light signal. This is accomplished by leaving both the red and infrared light emitters off, in between turning them on, so that a "dark" signal supposedly composed of the ambient light present can be detected. This can then be subtracted from the desired signal. Other examples of patents dealing with the ambient light issue are U.S. Patent No. 6,385,471, No. 5,846,190 and No. 4,781,195.

[0008] U.S. Patent No. 6,449,501 discusses using a notch filter to filter out line frequency. However, the sampling rate is described as being set to twice the fundamental frequency of the power line interference, leaving higher harmonics of the power line interference as a problem, and it is unclear how the interference can be filtered without filtering the modulation frequency. Another example of a notch filter being used is set forth in U.S. Patent No. 4,802,486, which uses a notch filter for the EKG signal.

#### BRIEF SUMMARY OF THE INVENTION

[0009] The present invention provides a pulse oximeter method and apparatus which provides (1) a notch filter at a distance between a demodulation frequency and a common multiple of commonly used power line frequencies (50, 60, 100, and 120) and also (2) a demodulation frequency greater than a highest pulse rate of a person and lower than any harmonic of 50, 60, 100, or 120 Hz. The invention thus allows the filtering of a significant source of ambient light interference, while choosing an optimum demodulation frequency that avoids interference from the notch filter or from harmonics of the power line interference.

[0010] In one embodiment, the common multiple is 1200, with the demodulation frequency being between 5 and 20 Hz away from 1200, preferably approximately 1211 in one embodiment.

[0011] In another aspect of the invention, dark signals, or ambient light, are measured both before and after each of the light emitter wavelengths (red and infrared in one embodiment). Instead of simply subtracting one of the dark levels, the two dark levels are averaged and then subtracted from the detected signal. This compensates for a variation in ambient light during the detected signal, reducing the effect of power line interference or any other low frequency interference.

[0012] In a another aspect of the present invention, digital filtering and decimation are done in the digital domain. When there is a change in a gain setting on the front end hardware, or in the LED power, the filters are preloaded to put values in their memory to correspond to an estimate of the settled value of the output at the new gain or power settings. This preloading speeds up when valid data will be available at the output of the filter.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Figure 1 is a block diagram of an oximeter incorporating the present invention.

[0014] Figure 2 is a block diagram of a portion of the digital manipulations in one embodiment of the invention, including a notch filter.

[0015] Figure 3 is a diagram illustrating the multiple dark levels that are averaged in an embodiment of the invention.

[0016] Figure 4 is a diagram illustrating the preloading of the digital filter and decimator according to an embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

##### Overall System

[0017] Fig. 1 illustrates an embodiment of an oximetry system incorporating the present invention. A sensor 10 includes red and infrared LEDs and a photodetector. These are connected by a cable 12 to a board 14. LED drive current is provided by an LED drive interface 16. The received photocurrent from the sensor is provided to an I-V interface 18. The IR and red voltages are then provided to a sigma-delta interface 20 incorporating the present invention. The output of sigma-delta interface 20 is provided to a microcontroller 22. Microcontroller 22 includes flash memory for a program, and EEPROM memory for data. The oximeter also includes a microprocessor chip 24 connected to a flash memory 26. Finally, a clock 28 is used and an interface 30 to a digital calibration in the sensor 10 is

provided. A separate host 32 receives the processed information, as well as receiving an analog signal on a line 34 for providing an analog display.

#### Notch Filter

[0018] Figure 2 shows an analog-to-digital converter 40 which provides a digital signal to be manipulated by microcontroller 22 of Figure 1. The microprocessor would include a demodulator 42, four stages of filter/decimators 44, a low pass filter with a notch 46, as well as other blocks for digital manipulation of the signals and calculation of oxygen saturation as is well known in the art. Only the red channel is shown after the demodulation, but a similar channel is used for the IR signal.

[0019] Notch filter 46 deals with power line interference which, in the United States, comes from lights which operate on 60 Hz or 120 Hz, depending upon the power requirements. Europe and other areas use 50 Hz and 100 Hz. A common multiple of 50, 60, 100, and 120 Hz is 1200 Hz. The modulation bandwidth is chosen to be higher than the highest possible human pulse rate, preferably higher than 5 Hz. At the same time, it is chosen to be lower than any harmonic of the power line interference signals. Twenty hertz is chosen as a desirable upper limit because a second harmonic of 2450 will alias in at 2025 Hz. In one embodiment, the modulation frequency chosen is 1211.23 Hz. This is 11.23 Hz distant from 1200 Hz. (within a range of 5-20 Hz). Accordingly, in a preferred embodiment, a zero is provided in the notch filter at 11.23 Hz. The low pass filter with notch (46), in one embodiment, is an 8 pole Bessel filter with a notch at 11.25 Hz.

[0020] The present invention thus provides an effective means of eliminating interference from power line interference, such as the ripple on fluorescent lights which can alias onto the detected signal. Although anti-aliasing filters have been provided in hardware before a demodulator, it is difficult to make these effective, and thus there will be some residual line interference in the detected signal to be dealt with in the digital domain.

#### Averaging Ambient Dark Levels to Reduce Low Frequency Interference

[0021] Figure 3 illustrates another aspect of the present invention, reducing ambient interference by averaging the ambient dark levels before and after a sampling period to account for low frequency interference from power lines or other sources. Fig. 3 shows a signal at a sampling rate of 2400. The upward sloping line in Fig. 3 is due to 60 Hz power

line interference. It is desirable to eliminate the effect of this upward slope (which will be downward on other parts of the 60 Hz (or 50 Hz, etc.) signal.

[0022] Fig. 3 shows a detected signal during different periods of modulation. The detected signal level is illustrated by a line 50. During a first dark period 52, neither the red nor IR  
5 LED are on, allowing a sampling of the dark, or ambient, light. After this sampling, during a time period 54, the red LED is turned on, with signal 50 rising during this period as the red LED comes on to its full intensity. During the time period 56, the detected signal corresponds to the red LED being on.

[0023] After the red LED is turned off and the signal decays during a period 58, a second  
10 dark period 60 is sampled.

[0024] Subsequently, the IR LED is turned on during a period 62, and sampled during a period 64. It is turned off and the signal decays during a period 66, with a third dark sample being taken during a period 68. The third dark sample also corresponds to the first dark period 52, as the process repeats itself.

[0025] As can be seen from Fig. 3, if only one of the dark levels is used, an inaccurate ambient level may be measured if the ambient level is varying, such as due to a low frequency interference. By averaging the dark periods before and after the sampling period for a particular wavelength, a more accurate measurement of the ambient dark level signal is obtained. For example, the ambient interference during the red modulation period 56 is  
15 determined by measuring the dark 1 signal during period 52 and the dark 2 signal during period 60 and averaging these signals. Similarly, for the infrared modulation period 64, the dark 2 signal during period 60 and the dark 3 signal during period 68 are averaged and subtracted from the detected IR signal to eliminate the ambient interference. All of these  
20 calculations are done in the digital domain by microcontroller 22 of Fig. 1.

## 25 Preloading Decimation and Bessel Filters

[0026] Fig. 4 illustrates another aspect of the present invention where filters and software are preloaded. Before the analog input signal is processed through the sigma-delta modulator and multi-bit analog digital converter, it is typically amplified in a hardware amplifier 84. After processing by the sigma-delta modulator 86 and conversion into digital domain, it is  
30 decimated to reduce the sample rate by a decimator 88 and filtered by a Bessel filter 88. A controller 92 pre-loads the memories of the Bessel filter and decimator with an estimate of

what the settled value of the output would be. This will significantly reduce the settling time of the filter after a step change in its input. Such a step change in the input can occur from a change in the gain settings of the amplifier 84. Alternately, a step change can be the result of a change in the particular LED being activated, the power of the LED, or other gain settings of the front end hardware. Since the controller 92 would be activating such changes, it will have the knowledge of when to pre-load the filter and decimator with the appropriate values. Although these are shown as blocks in Fig. 4, it is understood that in the preferred embodiment this is done by a software program which functions as controller 92, filter 88 and decimator 90. This preloading of the filter and decimator provides that valid data is available sooner by shortening the settling time.

[0027] As will be understood by those skilled in the art, the present invention may be embodied in other specific forms without departing from the essential characteristics thereof. For example, more than two different wavelengths of light could be used. Alternately, a different demodulation frequency could be chosen. In addition, the notch filtering can be done either before or after other digital processing of the detected signal. Accordingly, the foregoing description is intended to be illustrative, but not limiting, of the scope of the invention which is set forth in the following claims.

WHAT IS CLAIMED IS:

- 1           1.       A method for operating a pulse oximeter, comprising:  
2                   alternately generating light at two wavelengths using a modulation frequency  
3 that is a predetermined distance from a common multiple of 50, 60, 100, and 120;  
4                   said predetermined distance being greater than a highest pulse rate of a person  
5 and lower than a distance of any harmonic of 50, 60, 100, or 120;  
6                   directing said light at a tissue site;  
7                   detecting a detected light signal scattered off said tissue site;  
8                   notch filtering said detected light signal at a frequency at said common  
9 multiple.
- 1           2.       The method of claim 1 further comprising:  
2                   digitizing said detected light signal to provide a digitized signal; and  
3                   said notch filtering being performed on said digitized signal.
- 1           3.       The method of claim 1 wherein said common multiple is 1200.
- 1           4.       The method of claim 1 wherein said predetermined distance is between  
2 5 and 20 hertz.
- 1           5.       The method of claim 1 wherein said predetermined distance is  
2 approximately 11 hertz.
- 1           6.       The method of claim 1 wherein said notch filtering is performed by  
2 providing a zero in a digital filter at said distance.
- 1           7.       The method of claim 1 wherein  
2                   said modulation frequency is used to alternate between a first period of light of  
3 said first wavelength being generated, a dark period of no light being generated, and a second  
4 period of light of said second wavelength being generated;  
5                   estimating a level of ambient light in said detected light signal during said first  
6 period by averaging an amount of said detected light signal in said dark periods before and  
7 after said first period;

8                   estimating a level of ambient light in said detected light signal during said  
9 second period by averaging an amount of said detected light signal in said dark periods  
10 before and after said second period.

1                   8.       A method for measuring a detected light signal in a pulse oximeter  
2 comprising:  
3                   alternately generating light at two wavelengths using a modulation frequency;  
4                   directing said light at a tissue site;  
5                   detecting a detected light signal scattered off said tissue site;  
6                   using said modulation frequency to alternate between a first period of light of  
7 said first wavelength being generated, a dark period of no light being generated, and a second  
8 period of light of said second wavelength being generated;  
9                   estimating a level of ambient light in said detected light signal during said first  
10 period by averaging an amount of said detected light signal in said dark periods before and  
11 after said first period; and  
12                   estimating a level of ambient light in said detected light signal during said  
13 second period by averaging an amount of said detected light signal in said dark periods  
14 before and after said second period.

1                   9.       The method of claim 8 further comprising:  
2                   subtracting an estimated level of ambient light from said detected light signal.

1                   10.     A pulse oximeter, comprising:  
2                   at least one light emitter;  
3                   a control circuit for alternately generating light at two wavelengths from said  
4 at least one light emitter using a modulation frequency that is a predetermined distance from  
5 a common multiple of 50, 60, 100, and 120;  
6                   said predetermined distance being greater than a highest pulse rate of a person  
7 and lower than a distance of any harmonic of 50, 60, 100, or 120;  
8                   a detector for detecting a detected light signal scattered off a tissue site;  
9                   a processing circuit for processing said detected light signal, said processing  
10 circuit including a notch filter configured to filter said detected light signal at a frequency at  
11 said common multiple.

- 1                   11.     The pulse oximeter of claim 10 further comprising:  
2                   an analog-to-digital converter for digitizing said detected light signal to  
3 provide a digitized signal; and  
4                   said notch filter being a digital filter.
- 1                   12.     The pulse oximeter of claim 10 wherein said common multiple is 1200.
- 1                   13.     The pulse oximeter of claim 10 wherein said predetermined distance is  
2 between 5 and 20 hertz.
- 1                   14.     The pulse oximeter of claim 10 wherein said predetermined distance is  
2 approximately 11 hertz.
- 1                   15.     The pulse oximeter of claim 10 wherein said notch filter provides a  
2 zero in a digital filter at said distance.
- 1                   16.     The pulse oximeter of claim 1 further comprising:  
2                   said control circuit being configured to alternate between a first period of light  
3 of said first wavelength being generated, a dark period of no light being generated, and a  
4 second period of light of said second wavelength being generated;  
5                   said processing circuit being configured to estimate a level of ambient light in  
6 said detected light signal during said first period by averaging an amount of said detected  
7 light signal in said dark periods before and after said first period, and estimate a level of  
8 ambient light in said detected light signal during said second period by averaging an amount  
9 of said detected light signal in said dark periods before and after said second period.
- 1                   17.     A pulse oximeter comprising:  
2                   at least one light emitter;  
3                   a control circuit for alternately generating light at two wavelengths from said  
4 at least one light emitter using a modulation frequency;  
5                   a detector for detecting a detected light signal scattered off said tissue site;  
6                   said control circuit being configured to alternate between a first period of light  
7 of said first wavelength being generated, a dark period of no light being generated, and a  
8 second period of light of said second wavelength being generated;

9                   a processing circuit configured to estimate a level of ambient light in said  
10 detected light signal during said first period by averaging an amount of said detected light  
11 signal in said dark periods before and after said first period, and estimate a level of ambient  
12 light in said detected light signal during said second period by averaging an amount of said  
13 detected light signal in said dark periods before and after said second period.

1                   18.     An oximeter apparatus comprising:  
2                   a sigma-delta modulator having an input coupled to receive an analog sensor  
3 signal;  
4                   a hardware amplifier for amplifying a sensor signal to provide an amplified  
5 signal as said analog sensor signal;  
6                   a multiple bit analog-to-digital converter coupled to said output of said sigma-  
7 delta modulator to provide a digital output;  
8                   a decimator configured to operate on said digital output;  
9                   a digital filter configured to operate on said digital output; and  
10                  a control program for preloading said decimator and digital filter with an  
11 estimate of a settled output value after modifying the gain of said hardware amplifier.

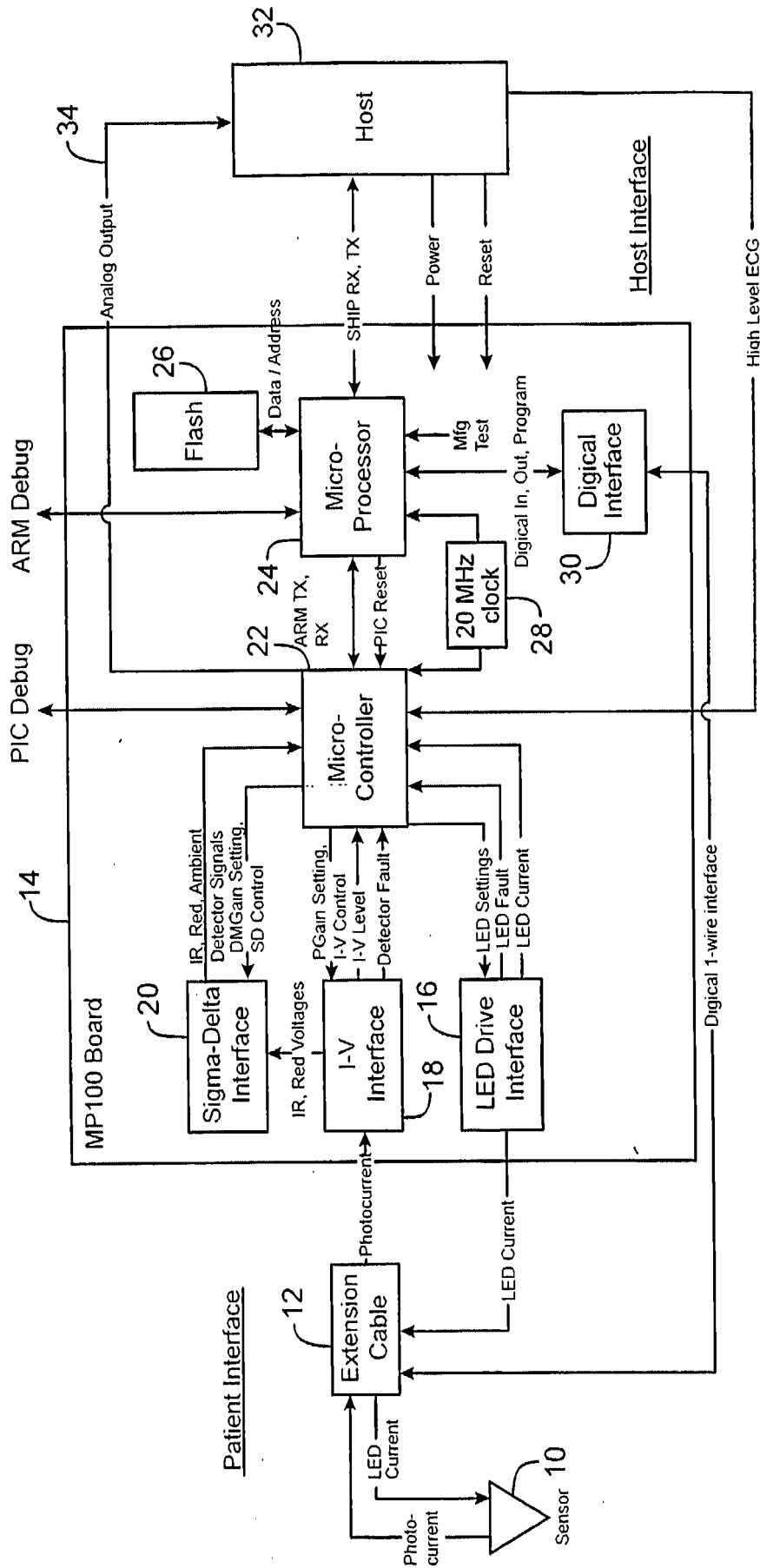
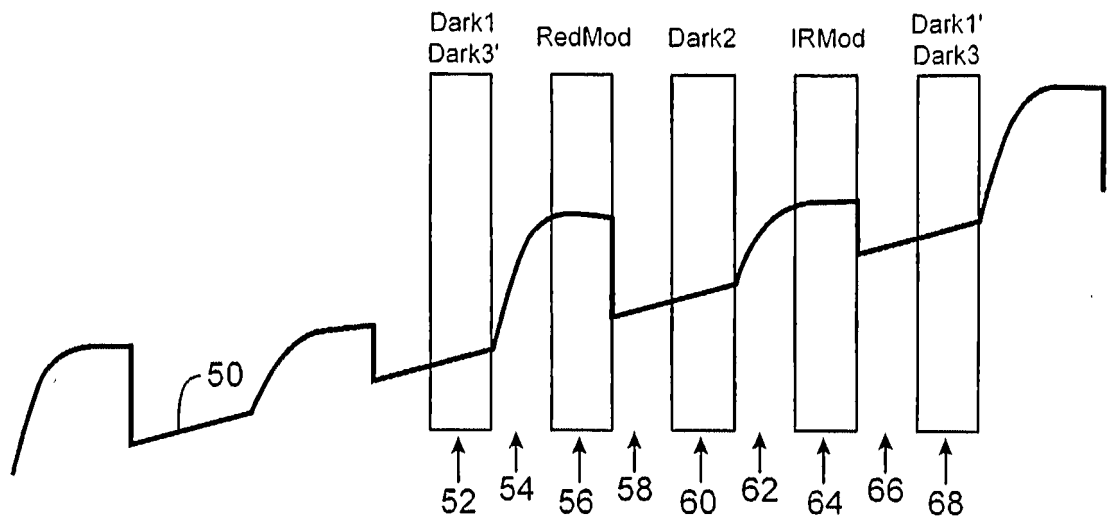


FIG. 1



$$Red = RedMod - \frac{Dark1 + Dark2}{2}$$

$$IR = IRMod - \frac{Dark2 + Dark3}{2}$$

FIG. 3

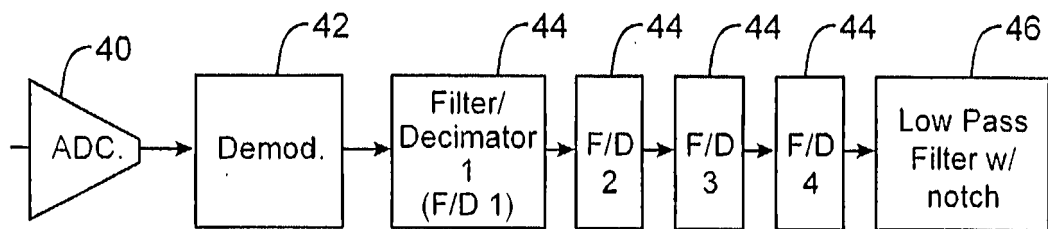


FIG. 2

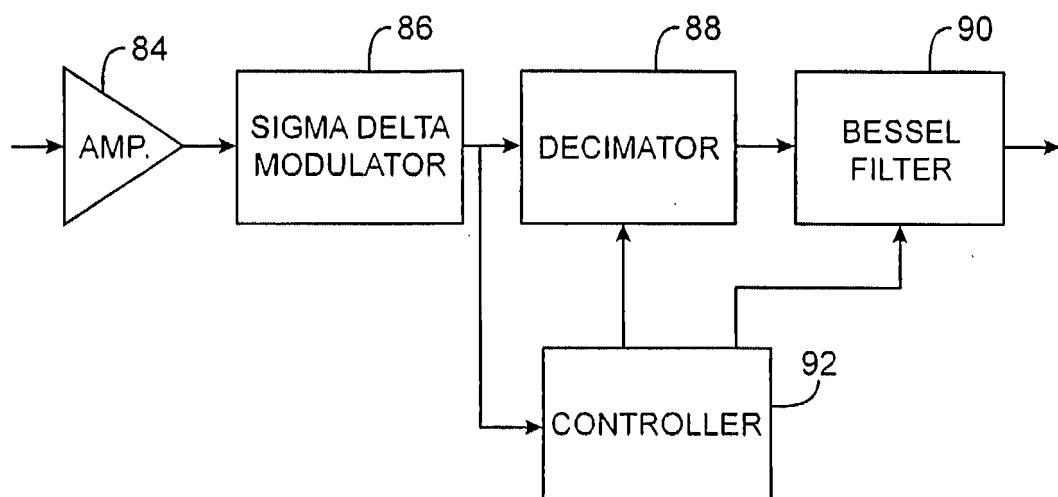


FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No  
PCT S2005/006336

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 A61B5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 645 060 A (YORKEY ET AL) 8 July 1997 (1997-07-08) column 1, line 30 column 3, line 46 column 7, line 20 - line 63 -----	1-7, 10-16
Y	US 5 368 224 A (RICHARDSON ET AL) 29 November 1994 (1994-11-29) column 1, line 10 - column 2, line 35 column 3, line 65 - column 6, line 26 figure 1 -----	1,3-5, 10,12-14
A	US 2003/028357 A1 (NORRIS MARK A ET AL) 6 February 2003 (2003-02-06) paragraphs [0057], [0077], [0078] ----- -/--	1,3-5, 10,12-14

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

° Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

31 May 2005

Date of mailing of the international search report

10 AUG 2005

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Visser, R

## INTERNATIONAL SEARCH REPORT

International Application No

PC 32005/006336

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2001/002206 A1 (DIAB MOHAMED K ET AL) 31 May 2001 (2001-05-31) paragraphs [0025], [0042], [0096], [0125], [0126], [0128] figures 1,2,5,14 -----	2,6,11, 15
Y	US 5 846 190 A (WOEHRLE ET AL) 8 December 1998 (1998-12-08) column 1, line 53 - line 61 column 3, line 1 - line 60 column 7, line 55 - column 9, line 16 column 10, line 41 - column 11, line 22 figure 1 -----	7,16

# INTERNATIONAL SEARCH REPORT

ational application No.  
PCT/US2005/006336

## Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
  
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
  
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-7, 10-16

### Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-7,10-16

Notch filtering at a common multiple of 50, 60, 100 and 120 Hz

---

2. claims: 8,9,17

Averaging signals from two dark periods

---

3. claim: 18

Amplifier, ADC, and filter preloaded by a control program

---

**INTERNATIONAL SEARCH REPORT**

International Application No  
**P S2005/006336**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5645060	A 08-07-1997	AU 6279196 A WO 9700041 A1	15-01-1997 03-01-1997
US 5368224	A 29-11-1994	AU 681357 B2 AU 5163993 A DE 69307912 D1 DE 69307912 T2 EP 0665727 A1 JP 8502434 T WO 9409698 A1 US 5555882 A US 5713355 A US 5885213 A	28-08-1997 24-05-1994 13-03-1997 04-09-1997 09-08-1995 19-03-1996 11-05-1994 17-09-1996 03-02-1998 23-03-1999
US 2003028357	A1 06-02-2003	US 6505133 B1 AU 3045002 A WO 0241536 A1	07-01-2003 27-05-2002 23-05-2002
US 2001002206	A1 31-05-2001	US 6229856 B1 US 2004152965 A1 EP 1067861 A1 JP 2002511291 T WO 9952420 A1 AU 6895498 A US 5919134 A WO 9846125 A1	08-05-2001 05-08-2004 17-01-2001 16-04-2002 21-10-1999 11-11-1998 06-07-1999 22-10-1998
US 5846190	A 08-12-1998	DE 19537646 A1 JP 9108203 A	17-04-1997 28-04-1997

专利名称(译)	血氧计环境光消除		
公开(公告)号	<a href="#">EP1722675A1</a>	公开(公告)日	2006-11-22
申请号	EP2005723983	申请日	2005-02-24
[标]申请(专利权)人(译)	内尔科尔普里坦贝内特公司		
申请(专利权)人(译)	NELLCOR PURITAN BENNETT INCORPORATED		
当前申请(专利权)人(译)	NELLCOR PURITAN BENNETT INCORPORATED		
[标]发明人	PETERSEN ETHAN SHEA WILLIAM CHEW BRADFORD B		
发明人	PETERSEN, ETHAN SHEA, WILLIAM CHEW, BRADFORD, B.		
IPC分类号	A61B5/00 A61B5/024		
CPC分类号	A61B5/14552 A61B5/0205 A61B5/02416 A61B5/14551 A61B5/7203 A61B5/7225 A61B5/7228 A61B5/725 A61B5/7278		
代理机构(译)	GRUBERT , ANDREAS		
优先权	10/787854 2004-02-25 US		
其他公开文献	EP1722675B1		
外部链接	<a href="#">Espacenet</a>		

#### 摘要(译)

一种脉冲血氧计方法和装置，其在调制频率和常用电力线频率（50,60,100和120）的公倍数之间的距离处提供（1）陷波滤波器（46），并且还提供（2）解调频率大于人的最高脉冲率且低于50,60,100或120 Hz的任何谐波，以滤除环境光干扰，同时选择最佳解调频率以避免陷波滤波器或线路谐波的干扰干扰。此外，在每个光发射器波长之前和之后测量用于任何低频干扰（例如电力线干扰）的环境光，然后从检测到的信号中减去环境光的平均值。