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(54) **MEDICAL INSTRUMENT WITH LOW POWER, HIGH CONTRAST DISPLAY**

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(57) **ABSTRACT**

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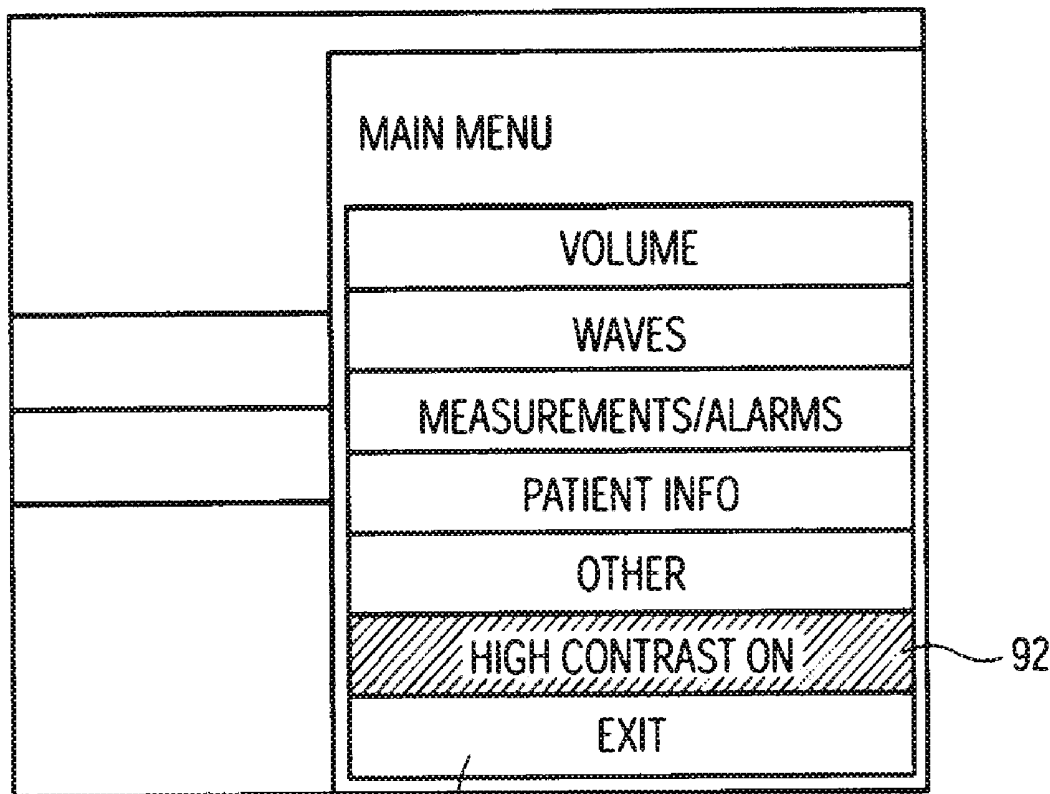
A patient monitoring/defibrillation instrument displays patient vital signs in numeric form or as graphical waveform traces. Under normal room lighting conditions the numeric and waveform information is displayed in color against a black or gray background. When the patient monitor is operated outside or in bright light, the user has the option to select a color map for display of the patient vital signs information in a highly contrasting manner such as black numeric or waveform information against a bright background such as yellow. The high contrast display, while being objectionable in most indoor settings, has been found to comfortably and effectively display the monitored information in sunlight without the need to increase power to the display.

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Related U.S. Application Data

(63) Continuation of application No. 10/544,407, filed on Aug. 3, 2005, now Pat. No. 8,517,939, filed as application No. PCT/IB2005/051836 on Jun. 6, 2005.

(60) Provisional application No. 60/582,613, filed on Jun. 24, 2004.



90

92

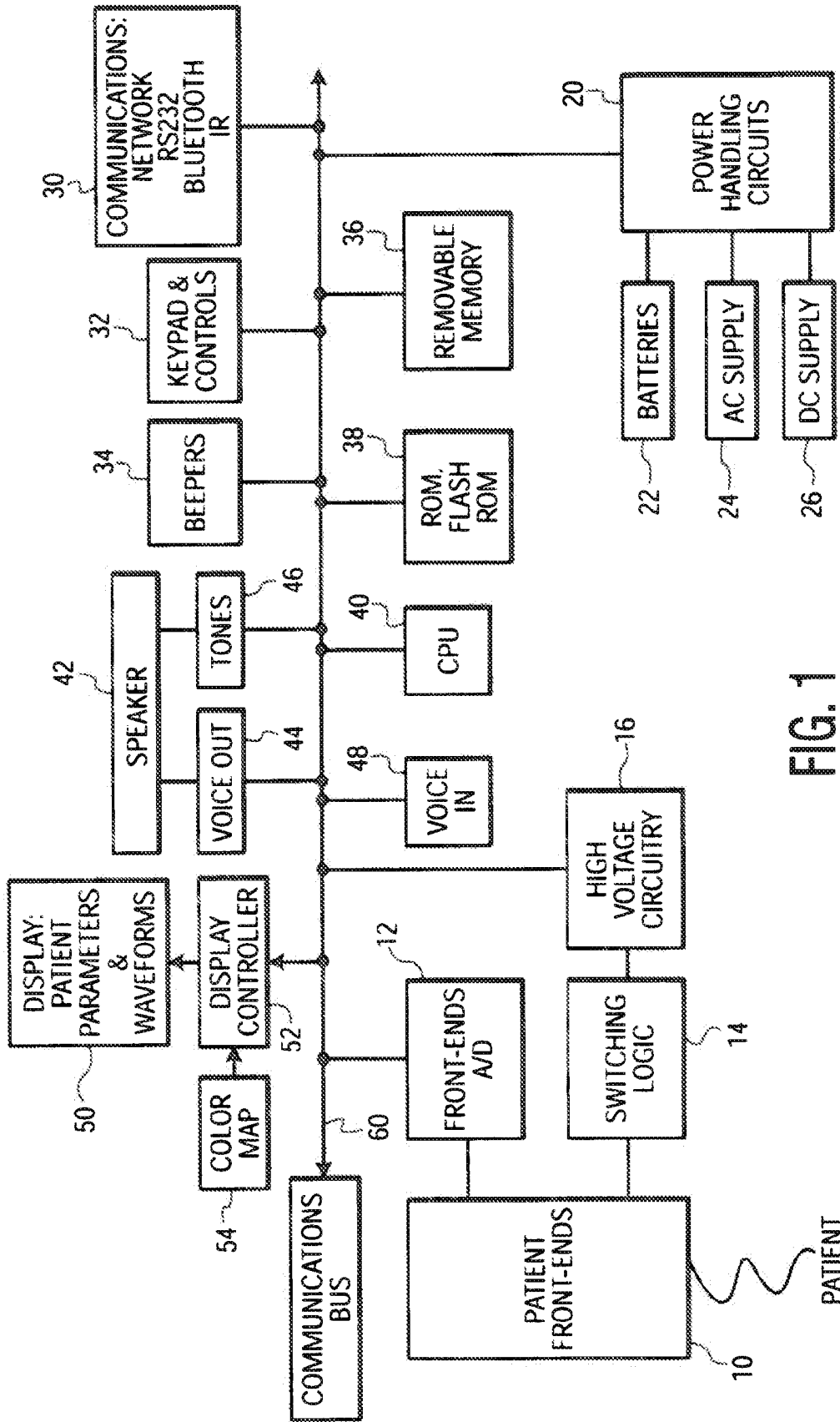


FIG. 1

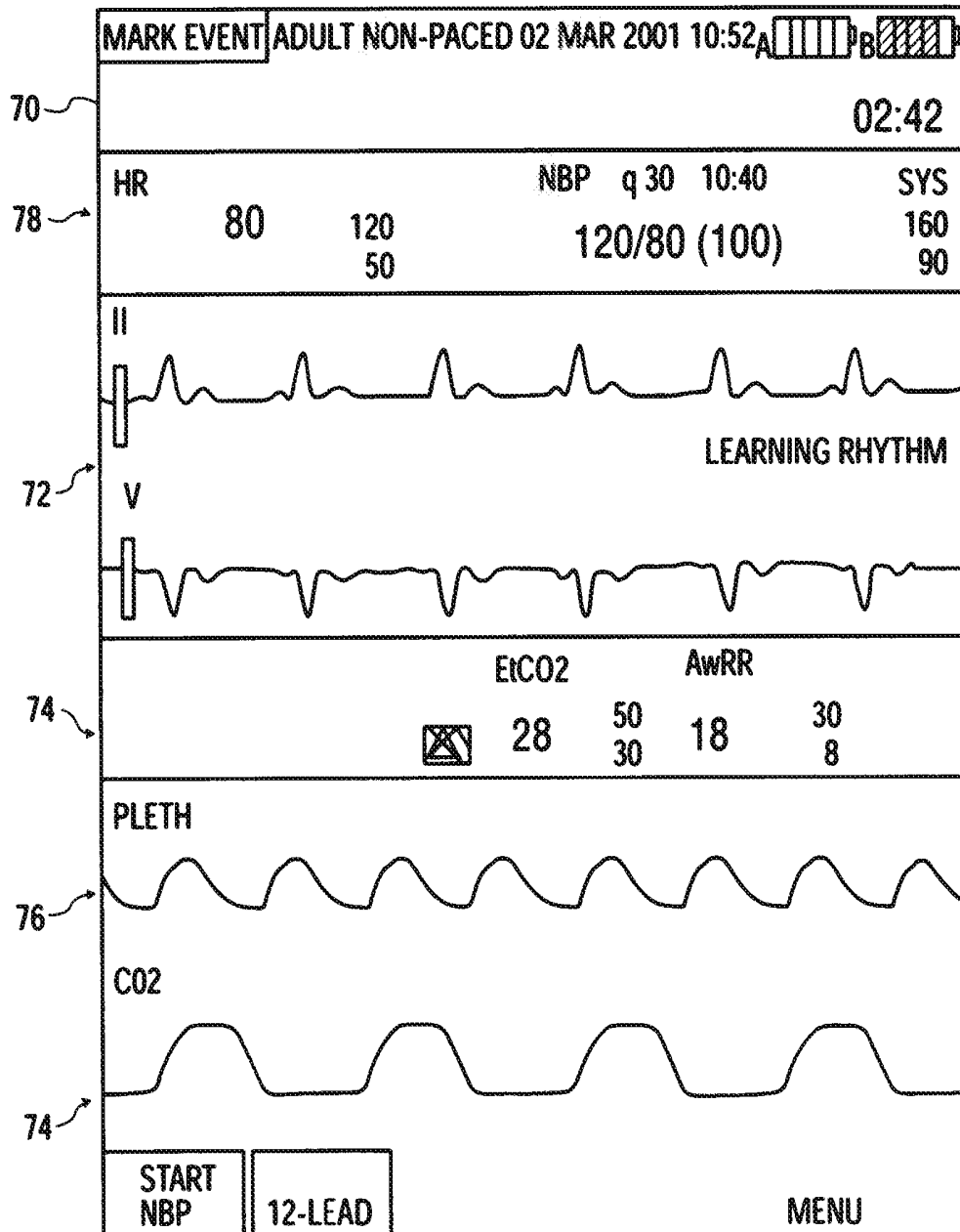


FIG. 2

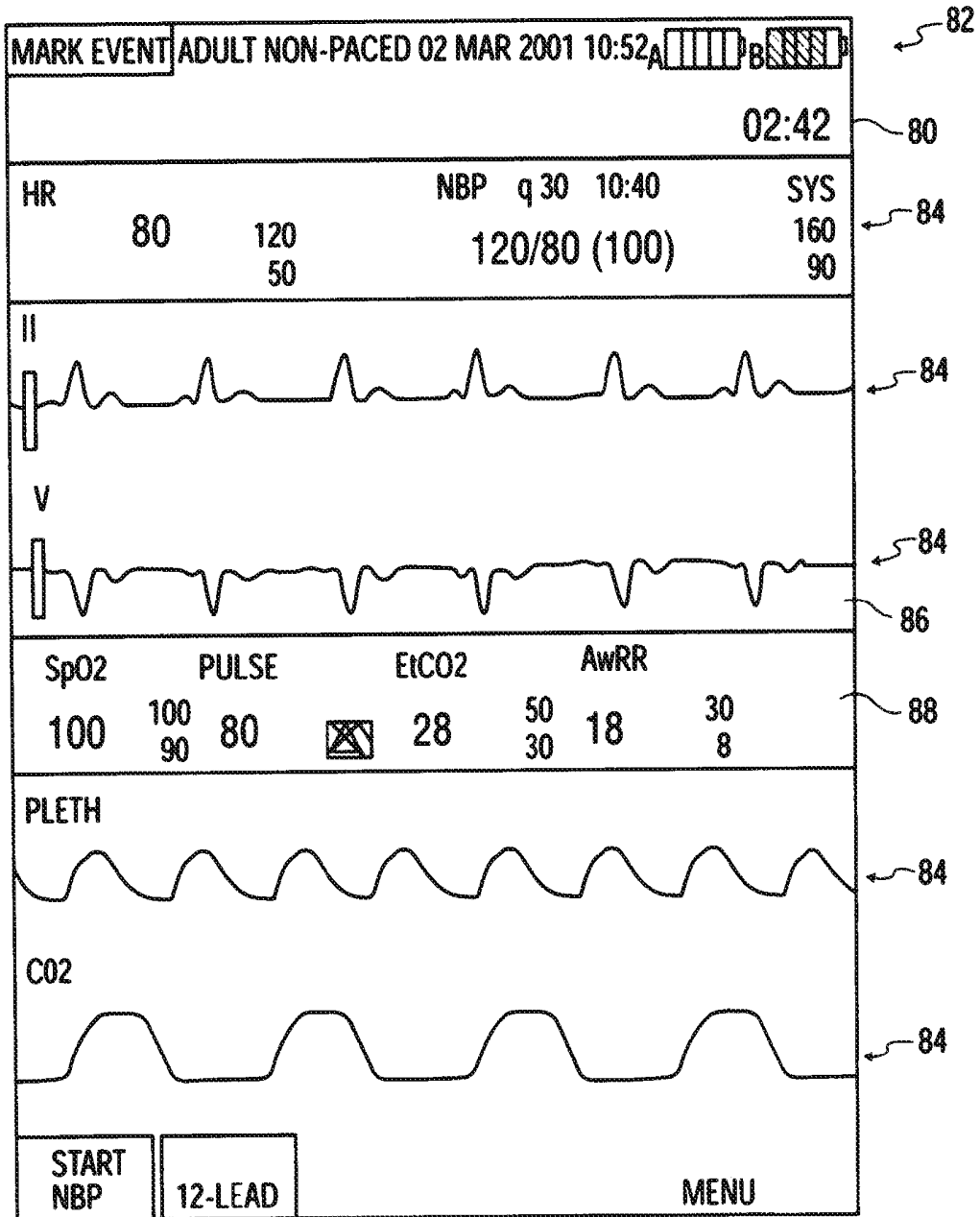


FIG. 3

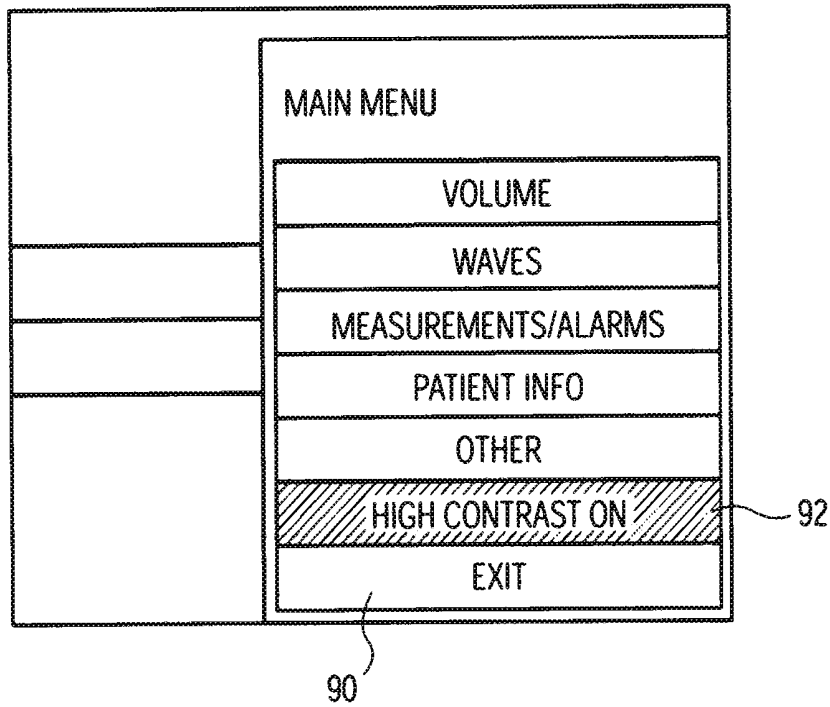


FIG. 4A

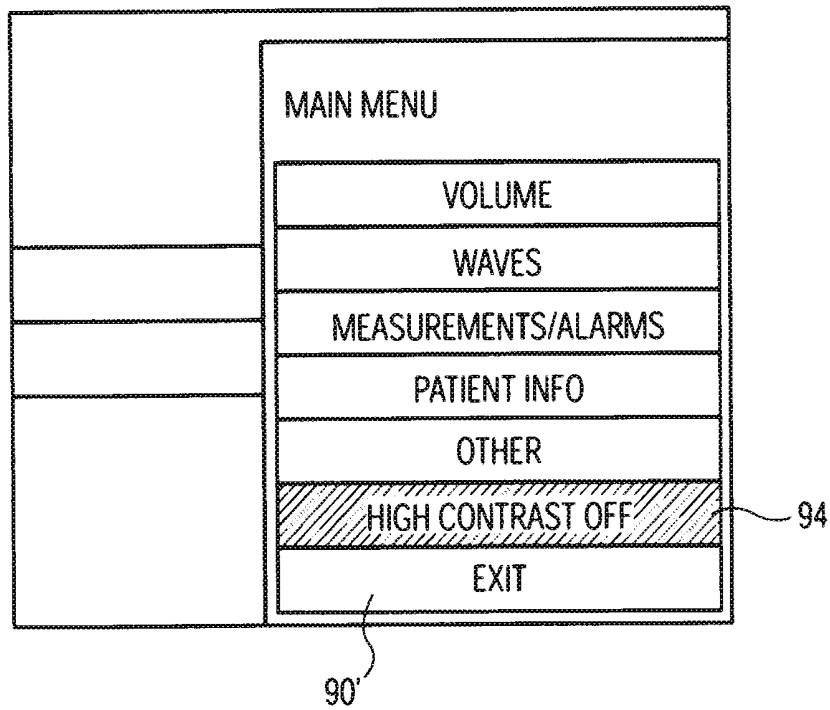


FIG. 4B

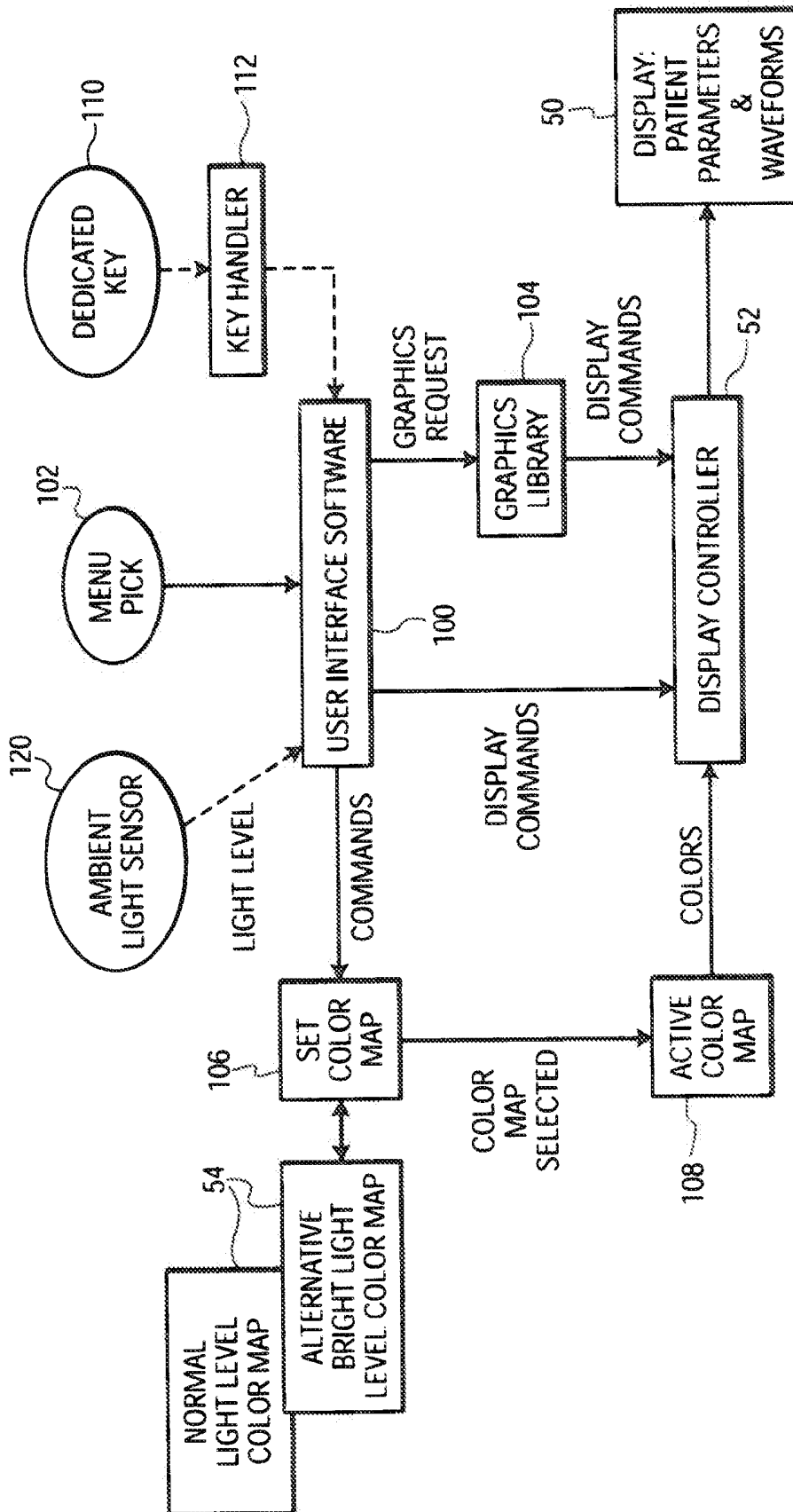


FIG. 5

MEDICAL INSTRUMENT WITH LOW POWER, HIGH CONTRAST DISPLAY

[0001] This invention relates to medical instruments and, in particular, to patient monitoring and resuscitation instruments for use in a variety of ambient lighting conditions.

[0002] Patient monitors and defibrillators are in widespread use in hospitals and by emergency medical personnel for monitoring the vital signs of patients and responding thereto as, for instance, by defibrillating ventricular fibrillation. In the past these monitors have been of substantial size and weight and employed a cathode ray tube monitor to display patient vital signs such as heartbeat, respiration, blood oxygen, and other parameters of bodily functions. Today these monitors are becoming smaller and lighter and, in many instances, are designed for portability. This portability enables the monitors to be used in their conventional settings in emergency rooms and intensive care units, and also enables them to be hung on a bedrail as a patient is moved from one location in a hospital to another. It also enables the monitors and defibrillators to be used in ambulances and other emergency vehicles, and even to be used at the site of an accident or other medical emergency. Such a portable instrument can even be placed in use out-of-doors, enabling emergency personnel to immediately begin monitoring a patient's vital signs and administering life-saving treatments afforded by the instrument.

[0003] Patient monitors and defibrillators typically include a display in which the aforementioned patient vital signs are graphically and numerically displayed. The portability of the instrument can mean that the display must be viewed in a wide range of ambient lighting conditions. For example, the instrument may at times be used in a dimly lighted lab or clinic where ambient lighting is kept low to optimally view the images on diagnostic imaging equipment. At other times a portable instrument may be used in bright sunlight. Regardless of the ambient lighting conditions the monitor display must be easy to view against brightly or dimly lighted backgrounds. In sunlight, where the ambient light reduces the contrast and apparent brightness of the display, the immediate inclination of a user is to turn up the display brightness or contrast. However, such higher display drive levels can require more power and decrease the operating time of the battery-powered instrument. Accordingly it is desirable to enable the display to be viewed under varying lighting conditions but without resorting to a mode of operation which will excessively reduce the battery operating time.

[0004] In accordance with the principles of the present invention, a patient monitor/defibrillator is provided with a display that will selectively increase the contrast of displayed numerical and graphical information without excessively reducing battery life. This is provided by a display which displays brightly colored numbers and traces against a dark background in dimly lighted or normal room lighted environments. When the monitor is used in sunlight or in brightly lighted conditions, the display pixels are remapped to display dark numbers and traces against a bright background. While such a remapping of the display would seem out-of-place—and actually uncomfortable—at normal indoor light levels, the remapping provides an acceptable display contrast under brightly lighted conditions. The remapping can avoid the need to compensate for bright ambient lighting by significantly increasing the power supplied to the display. In an illustrated embodiment, the display is remapped from colored numbers and traces against a black or gray background to black traces and numbers against a yellow background,

affording a contrast improvement in bright daylight operation without adjustment of the brightness or contrast control of the display.

IN THE DRAWINGS

[0005] FIG. 1 illustrates in block diagram form a portable patient monitor/defibrillator constructed in accordance with the principles of the present invention.

[0006] FIG. 2 illustrates a patient monitor/defibrillator display of the present invention with colored numbers and traces against black and gray backgrounds for room lighted operating conditions.

[0007] FIG. 3 illustrates the patient monitor/defibrillator display of FIG. 2 when remapped for outdoor display of black numbers and traces against a yellow background.

[0008] FIGS. 4a and 4b illustrate the menu of a patient monitor/defibrillator constructed in accordance with the principles of the present invention showing the selection of normal and high contrast operating modes.

[0009] FIG. 5 illustrates in block diagram form a process for switching between normal and high contrast operating modes in response to the menu settings of FIGS. 4A and 4B.

[0010] Referring first to FIG. 1, a patient monitor/defibrillator constructed in accordance with the principles of the present invention is shown in block diagram form. The instrument shown in FIG. 1 is capable of performing defibrillation of a patient who is experiencing ventricular fibrillation. It is also capable of performing ECG monitoring including the cardiac monitoring necessary for automatic defibrillation decision-making. The illustrated monitor is also capable of SpO₂ oxygen sensing, noninvasive blood pressure monitoring, and end tidal CO₂ monitoring. Other functions such as invasive blood pressure monitoring and patient temperature monitoring may also be found in such a multi-functional instrument. The monitor has a plurality of patient front-ends, which are input circuitry for the sensors attached to the patient. This circuitry includes conventional sensing and amplification circuitry for ECG electrodes, for optical oxygen sensors, for pressure sensing and for carbon dioxide sensing, among others. The information received by the patient sensors and processed by the front-end circuitry 10 is digitized by front-end A/D converters 12. The digitized information is coupled to processing circuitry of the instrument by a communications bus 60 which connects data between the various modules of the instrument.

[0011] The instrument includes high voltage circuitry 16 for defibrillator operation. The high voltage circuitry produces the high voltage pulse necessary for defibrillation which is connected at the appropriate time by switching logic 14 to defibrillator electrodes coupled to the patient. This circuitry provides the high voltage shock needed to disrupt the ventricular fibrillation and returns the heart to a normal rhythm. The shock level and waveform delivered for defibrillation can be automatically calculated by a processor in the monitor or can be manually set by an experienced medical technician or physician.

[0012] Power for the modules within the instrument is distributed by power handling circuits 20. The power handling circuits 20 will distribute power from batteries 22, from an AC supply 24, or from a DC supply 26. The AC and DC supplies are also coupled to circuitry which charges the batteries when the monitor is powered from these external power sources.

[0013] The information obtained by the instrument may be sent to other instruments or locations by communications

circuitry **30**. This may include a network connection, an RS232 connection, or a wireless connection (e.g. Bluetooth, WiFi or infrared, etc.).

[0014] The instrument is operated and adjusted by means of a keypad and controls **32**. In a constructed embodiment the keypad is a membrane keypad providing integrity against environmental conditions. Controls such as an on/off switch, power level and shock delivery controls for defibrillation, a printer, and other functions may also be provided.

[0015] The monitor is operated under control of a central processing unit (CPU) **40**. The CPU runs software stored on a read-only memory (ROM) **38**. Flash ROM is also provided for the control of feature setups and new or special capabilities such as waveform information. Removable memory **36** is provided for storage of information generated during a patient episode such as a ventricular fibrillation. Patient information such as cardiac waveforms before and after defibrillation are also stored on the removable memory **36**, which can be removed and given to a subsequent care-giver for review, record-keeping, and subsequent diagnosis. The removable memory **36** could also record voice information from a care-giver speaking into a microphone **48**.

[0016] Beepers **34** are used to drive a solid-state sound source that produces short “chirping” sounds. These sounds indicate that the instrument’s resident self-test has detected a low battery level or a malfunction in a patient-critical circuit group. There is also a dedicated display on the front of the instrument that presents a large, flashing, red X to indicate a low battery level or a large, fixed, red X to identify a circuit failure.

[0017] Tones **46** are produced by the software and then used to drive the speaker **42**. This capability is used during certain monitoring functions such as a short tone in response to each heart cycle. Combinations of tones are used to issue audible alerts and alarms when a patient’s vital measurements fall outside the alarm limits selected.

[0018] The speaker **42** can reproduce pre-recorded voice instructions and information stored and reproduced from voice out circuitry **44**.

[0019] In accordance with the principles of the present invention a display **50** is provided for the display of patient parameters and waveforms as discussed more particularly below. The information to be displayed is provided to a display controller **52** which provides the necessary drive signals for display of the information on the display. In a constructed embodiment the display is a color LCD display, although other types of display such as a CRT display may be used in a particular embodiment. The display controller **52** displays information in accordance with a color map provided by color map store **54**. In a constructed embodiment the color map is stored in tabular form. In other embodiments the color map may be stored as an algorithm or other programmed information. In the constructed embodiment the display information is coupled to the display with a color code by which the display controller selects the pixels for display of the desired information and background colors, as explained more fully below.

[0020] FIG. 2 illustrates the display **70** of a monitor constructed in accordance with the principles of the present invention during normal operation as might be found inside a hospital. Under such room light conditions the background of the display **70** is black, or gray as indicated by reference numeral **78**. The graphical information at the very top of the display **70** is displayed in which against the black back-

ground. To readily distinguish and associate the different types of information displayed, the numerical and graphical information is displayed in color. For instance the numerical heart rate **80** and the heart traces below as indicated at **72** are displayed in green. The numerical CO₂ reading of 28 and the CO₂ trace indicated at **74** are displayed in light blue. The plethysmograph trace **76** is displayed in purple. Such a color display against a black or gray background has been found to be pleasing to view in an indoors environment where ambient light conditions are not high.

[0021] FIG. 3 illustrates the information of FIG. 2 when displayed in a high contrast display **80** for brightly lighted or sunlight conditions in accordance with the present invention. In FIG. 3 the display colors have all been remapped so that the background color **86** is yellow instead of black. In the illustrated embodiment some of the rows of information such as that indicated at **88** are contrasted from other rows by being offset by a slightly grayed yellow color. The graphical information **82** at the top of the display and the traces and numbers in other areas of the display are all displayed in black. While this display appearance might be irritating and seem out of place indoors, it has been found to convey a satisfactory and highly contrasted and readable display in sunlight and brightly lighted conditions. Other contrasting color combinations such as dark gray or green against an orange or white background may also be suitable for the high contrast display **80**.

[0022] FIGS. 4a and 4b illustrate the selection of the normal and high contrast viewing modes in a constructed embodiment of the present invention. The user depresses a “Menu” button on the keypad which displays a pop-up menu **90** as shown in FIG. 4a. The user then depresses the “up” or “down” arrow buttons to highlight the “High Contrast On” menu row **92** in FIG. 4a. When the “Enter” button is depressed, the menu disappears, and the display is remapped to the high contrast mode shown in FIG. 3. When the user desires to return to the normal display mode the “Menu” button is depressed again, the arrow buttons are used if necessary to highlight the “High Contrast Off” menu row **94** as shown in FIG. 4b. When the “Enter” button is depressed, the menu disappears and the display is remapped to the conventional format shown in FIG. 2.

[0023] FIG. 5 illustrates in greater detail a process for changing the display mode. The user selects the new display mode as shown by menu pick **102**. The user interface software **100** responds to this selection by setting a new color map **106** from the normal light level and bright light level color maps stored in the color map store **54**. A new graphics request is issued to a graphics library **104** which provides new display commands for the new color map to the display controller **52**. The newly selected color map is loaded into the active color map buffer **108**, making the colors of the new map available to the display controller. The display controller then commands the display **50** to display the currently displayed information in accordance with the new color map.

[0024] FIG. 5 illustrates two other alternative implementations of the present invention. Instead of selecting the display map from a pop-up menu as shown in FIGS. 4a and 4b, the keypad may have a dedicated key **110** for changing the display contrast. Each time the user depresses the dedicated key, a key handler **112** responds by toggling the display to the other display mode. Another alternative is to have an ambient light sensor **120** on the instrument which senses the ambient light level in which the monitor is operating. The user inter-

face software responds to a change in light level above or below a preset or user adjustable threshold or thresholds by changing the display automatically. In a constructed embodiment the user may be given a choice of automatic or manual selection of the display mode.

[0025] While the above embodiments have illustrated the use of color maps for the display, it will be appreciated that a monochrome display may also be set for normal and high contrast display by adjustment and switching of the display luminance levels.

1-13. (canceled)

14. A patient monitoring instrument which may be operated in different ambient lighting conditions comprising:

- circuitry which produces a measure of one or more patient bodily functions;
- a display, coupled to the circuitry, which displays the bodily function measure in numeric or graphical form;
- a user interface for selecting one of a plurality of display maps of different contrast; and
- a display controller, coupled to the display and coupled to the user interface, for setting the display to display the bodily function measure in accordance with a selected display map, wherein one of the display maps acts to cause the display of a bright bodily function measure against a dark background, and another of the display maps acts to cause the display of a dark bodily function measure against a bright background.

15. The patient monitoring instrument of claim **14** further comprising an ambient light sensor, coupled to the user interface, and configured to sense an ambient light level in which the instrument is operating, wherein the user interface in responsive to a change in the ambient light level above or below a preset or user-adjusted threshold by automatically changing the selected display map.

16. The patient monitoring instrument of claim **14** further comprising an ambient light sensor, coupled to the user interface, and configured to sense an ambient light level in which the instrument is operating, wherein (i) the user interface in responsive to a change in the ambient light level above or below a preset or user-adjusted threshold to automatically change the selected display map, or (ii) the user interface is responsive to a user selection to change the selected display map, and wherein the user interface is configured for the user to choose whether the user interface is responsive to the change in the ambient light level to automatically change the selected display map or responsive to the user selection to change the display map.

17. The patient monitoring instrument of claim **14** wherein the user interface is responsive to a user selection to change the selected display map, and wherein the user selection is made by at least one of a menu pick on the display, a dedicated button for display contrast control, or depressing a dedicated key on a keypad for changing the display contrast.

18. The patient monitoring instrument of claim **14**, wherein one of the display maps acts to cause the display of at least one of a colored bodily function measure or a brightly displayed bodily function measure against a black or gray background, and another of the display maps acts to cause the display of a black or gray bodily function measure against a white background.

19. The patient monitoring instrument of claim **14**, wherein the display maps are stored in the instrument in at least one of tabular form or algorithmic form.

20. The patient monitoring instrument of claim **14** further comprising a defibrillator, wherein the bodily function information includes information of a defibrillation patient.

21. A patient monitoring instrument which may be operated in different ambient lighting conditions comprising:

- circuitry which produces a measure of one or more patient bodily functions;
- a display which displays the bodily function measure in numeric or graphical form; and
- a display controller, coupled to the circuitry and to the display, for setting the display of the bodily function measure and background, wherein the display controller is configured to cause the display of at least one of a colored bodily function measure against a dark background, a bright bodily function measure against a dark background, or a dark bodily function measure against a bright background.

22. The patient monitoring instrument of claim **21**, wherein when the display controller causes the display of the bright bodily function measure against the dark background, the display controller causes the display of a white bodily function measure against a black or gray background, and wherein when the display controller causes the display of the dark bodily function measure against the bright background, the display controller causes the display of a black or gray bodily function measure against a white background.

23. The patient monitoring instrument of claim **21**, wherein the display controller sets the display in accordance with an algorithm or other programmed information which includes pixel selections for displaying the bodily function measure and background colors.

24. The patient monitoring instrument of claim **21** further comprising an ambient light sensor, coupled to the display controller, and configured to sense an ambient light level in which the instrument is operating, wherein the display controller is responsive to a change in the ambient light level above or below one or more preset or user-adjusted thresholds to automatically change the display from the at least one of the colored bodily function measure against the dark background, the bright bodily function measure against the dark background, or the dark bodily function measure against the bright background, to another one of the at least one of the colored bodily function measure against the dark background, the bright bodily function measure against the dark background, or the dark bodily function measure against the bright background.

25. The patient monitoring instrument of claim **21** further comprising a user interface, coupled to the display controller, for changing the display from the at least one of the colored bodily function measure against the dark background, the bright bodily function measure against the dark background, or the dark bodily function measure against the bright background, to another one of the at least one of the colored bodily function measure against the dark background, the bright bodily function measure against the dark background, or the dark bodily function measure against the bright background.

26. The patient monitoring instrument of claim **25** further comprising an ambient light sensor, coupled to the user interface, and configured to sense an ambient light level in which the instrument is operating, wherein

- (i) the user interface is responsive to a change in the ambient light level above or below one or more preset or user-adjusted thresholds to automatically change the display from the at least one of the colored bodily func-

tion measure against the dark background, the bright bodily function measure against the dark background, or the dark bodily function measure against the bright background, to another one of the at least one of the colored bodily function measure against the dark background, the bright bodily function measure against the dark background, or the dark bodily function measure against the bright background, or

- (ii) the user interface is responsive to a user selection to change the display from the at least one of the colored bodily function measure against the dark background, the bright bodily function measure against the dark background, or the dark bodily function measure against the bright background, to another one of the at least one of the colored bodily function measure against the dark background, the bright bodily function measure against the dark background, or the dark bodily function measure against the bright background, and

wherein the user interface is configured for the user to choose whether the user interface is responsive to the change in the ambient light level to automatically change the display or responsive to the user selection to change the display.

27. The patient monitoring instrument of claim **26**, wherein the user interface is responsive to a user selection made by at least one of a menu pick on the display, a dedicated button for display contrast control, or depressing a dedicated key on a keypad for changing the display contrast.

28. The patient monitoring instrument of claim **21**, wherein the display controller causes the display of at least one of the colored bodily function measure or the bright bodily function measure against a black or gray background, and wherein the bright bodily function measure comprises at least one of a brightly colored bodily function measure or a white bodily function measure.

29. The patient monitoring instrument of claim **21**, wherein the display controller causes the display of a black bodily function measure against a white background.

30. A patient monitoring instrument which may be operated in different ambient lighting conditions comprising:

circuitry which produces a measure of one or more patient bodily functions;

a display which displays the bodily function measure in numeric or graphical form in at least one of a normal contrast viewing mode or a high contrast viewing mode; and

a display controller, coupled to the display, which, in the normal viewing mode causes the display of at least one of a color bodily function measure or a bright bodily function measure against a dark background, and, in the high contrast viewing mode, causes the display of a dark bodily function measure against a bright background, wherein the display displays the bodily function measure in the normal viewing mode when the instrument is used in an indoor setting of relatively low ambient light and the display displays the bodily function measure in the high contrast viewing mode when the instrument is used in an outdoor setting of relatively high ambient light.

31. The patient monitoring instrument of claim **30**, wherein the display controller is responsive to a user selection to change the display from the low contrast viewing mode to the high contrast viewing mode, or from the high contrast viewing mode to the low contrast viewing mode.

32. The patient monitoring instrument of claim **30** further comprising an ambient light sensor, coupled to the display controller, and configured to sense an ambient light level in which the instrument is operating, wherein the display controller is responsive to a change in the ambient light level above or below one or more preset or user-adjusted thresholds to automatically change the display from the low contrast viewing mode to the high contrast viewing mode, or from the high contrast viewing mode to the low contrast viewing mode.

33. The patient monitoring instrument of claim **30** further comprising:

a user interface, coupled to the display controller; and an ambient light sensor, coupled to the user interface, and configured to sense an ambient light level in which the instrument is operating, wherein (i) the user interface is responsive to a change in the ambient light level above or below a preset or user-adjusted threshold to automatically cause the display to change the viewing mode, or (ii) the user interface is responsive to a user selection to cause the display to change the viewing mode, and wherein the user interface is configured for the user to choose whether the user interface is responsive to the change in the ambient light level or responsive to the user selection.

34. The patient monitoring instrument of claim **30**, wherein, when the display is in the normal viewing mode, the display controller causes the display of at least one of the colored bodily function measure or the bright bodily function measure against a black or gray background, and wherein the bright bodily function measure comprises at least one of a brightly colored bodily function measure or a white bodily function measure.

35. The patient monitoring instrument of claim **30**, wherein, when the display is in the high contrast viewing mode, the display controller causes the display of a black or gray bodily function measure against the bright background, and wherein the bright background comprises at least one of a brightly colored background or a white background.

36. The patient monitoring instrument of claim **30** further comprising a defibrillator, wherein the bodily function measure includes information of a defibrillation patient including at least one of heart rate information or ECG information, and wherein at least one of the heart rate information or ECG information is displayed on the display in graphical form.

37. The patient monitoring instrument of claim **30**, wherein the display comprises a color LCD display or a monochrome LCD display.

38. A method for operating a patient monitoring instrument comprising:

locating the instrument in a setting with relatively high ambient light;

manipulating a control to selectively change a display contrast from one which displays at least one of numeric or graphical information in a bright color against a dark background to one which displays at least one of the numeric or graphical information in a dark color against a bright background when the instrument is used in the setting with relatively high ambient light,

wherein selectively changing the display contrast is based on ambient lighting conditions.

39. The method of claim **38**, wherein the control is automatically manipulated to selectively change the display con-

trast in response to a change in an ambient light level above at least one of a preset or user-adjusted threshold.

40. The method of claim **38**, wherein manipulating, further comprises changing the display contrast to one which displays at least one of the numeric or graphical information in black or gray against at least one of a brightly colored or white background.

41. The method of claim **38** further comprising:

locating the instrument in a setting with relatively low ambient light; and

manipulating the control to selectively change the display contrast from one which displays at least one of the numeric or graphical information in the dark color against the bright background to one which displays at least one of the numeric or graphical information in the bright color against the dark background.

42. The method of claim **38**, wherein the bright color is white and the dark background is black or gray, and wherein the dark color is black or gray and the background is white.

43. The method of claim **38**, further comprising choosing whether the control is (i) automatically manipulated to selectively change the display contrast in response to a change in the ambient light level above at least one of a preset or user-adjusted threshold, or (ii) manually manipulated by a user.

* * * * *

专利名称(译)	医疗仪器具有低功率，高对比度显示		
公开(公告)号	US20130338451A1	公开(公告)日	2013-12-19
申请号	US13/975803	申请日	2013-08-26
[标]申请(专利权)人(译)	PARNAGIAN EDWARD		
申请(专利权)人(译)	PARNAGIAN, EDWARD		
当前申请(专利权)人(译)	皇家飞利浦N.V.		
[标]发明人	PARNAGIAN EDWARD		
发明人	PARNAGIAN, EDWARD		
IPC分类号	A61B5/00 G09G3/00 G09G5/00		
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优先权	PCT/IB2005/051836 2005-06-06 WO 60/582613 2004-06-24 US		
其他公开文献	US8823729		
外部链接	Espacenet USPTO		

摘要(译)

患者监测/除颤仪器以数字形式或以图形波形迹线显示患者生命体征。在正常室内照明条件下，数字和波形信息在黑色或灰色背景下以彩色显示。当患者监视器在室外或在强光下操作时，用户可以选择以高对比度方式显示患者生命体征信息的颜色图，例如针对诸如黄色的明亮背景的黑色数字或波形信息。已经发现高对比度显示器虽然在大多数室内环境中令人反感，但是在不需要增加显示器功率的情况下，可以舒适且有效地在阳光下显示所监视的信息。

