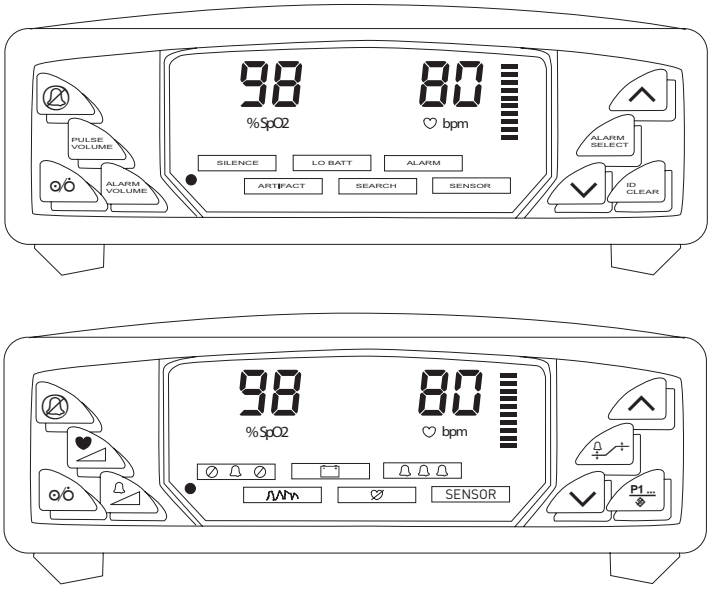
BCI® 3304 Oximeter

Service Manual



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Revision History

REVISION	DATE
Rev.7	April, 2008

CHANGES

- Added design frame, BCI lozenge and Smiths Medical logo to front cover. Deleted Smiths Medical logo from back cover.
- Added the Smiths design mark to trademark statement.
- Updated Warranty section.
- Added the Australian Representative to Warranty section and back cover.
- Updated symbol chart.
- Updated warnings, cautions and notes. Changed some cautions and notes to warnings.
- Updated Appendix for Assembly drawings and Schematics.

REVISION	DATE
Rev.6	June, 2006

CHANGES

- Updated line art.
- Updated copyright statement on front cover.
- Added trademark and patent information to table of contents.
- Updated company name.
- Updated warranty section.
- Moved information from Chapter 3 to Chapter 1.
- Added symbol chart to Chapter 1.
- Added photodynamic therapy warning.
- Added this Revision History page.
- Different page numbering scheme for Appendix drawings.

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Warranty & Service Information

Proprietary Notice

Information contained in this document is copyrighted by Smiths Medical PM, Inc. and may not be duplicated in full or part by any person without prior written approval of Smiths Medical PM, Inc. Its purpose is to provide the user with adequately detailed documentation to efficiently install, operate, maintain and order spare parts for the device supplied. All information contained in this document is believed to be current and accurate as of the date of publication or revision, but does not constitute a warranty.

Warranty

Limited Warranty

Smiths Medical PM, Inc. ("Seller") warrants to the original purchaser that the Product, not including accessories, shall be free from defects in material and workmanship under normal use, if used in accordance with its labeling, for two years from the date of shipment to the original purchaser.

Seller warrants to the original purchaser that the reusable oximeter sensors supplied as accessories, shall be free from defects in materials and workmanship under normal use, if used in accordance with its labeling, for one year from the date of shipment to the original purchaser (USA only).

Disclaimer of Warranties

THE FOREGOING EXPRESS WARRANTY, AS CONDITIONED AND LIMITED, IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED, BY OPERATION OF LAW OR OTHERWISE, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Seller disclaims responsibility of the suitability of the Product for any particular medical treatment or for any medical complications resulting from the use of the Product. This disclaimer is dictated by the many elements which are beyond Seller's control, such as diagnosis of patient, conditions under which the Product may be used, handling of the Product after it leaves Seller's possession, execution of recommended instructions for use and others.

Conditions of Warranty

This warranty is void if the Product has been altered, misused, damaged by neglect or accident, not properly maintained or recharged, or repaired by persons not authorized by Seller. Misuse includes, but is not limited to, use not in compliance with the labeling or use with accessories not manufactured by Seller. This warranty does not cover normal wear and tear and maintenance items.

Limitation of Remedies

The original purchaser's exclusive remedy shall be, at Seller's sole option, the repair or replacement of the Product. **THIS IS THE EXCLUSIVE REMEDY. In no event will Seller's liability arising out of any cause whatsoever (whether such cause is based on contract, negligence, strict liability, tort or otherwise) exceed the price of the Product and in no event shall Seller be responsible for consequential, incidental, or special damages of any kind or nature whatsoever, including but not limited to, lost business, revenues, and profits.**

Warranty Procedure

To obtain warranty service in the USA, you must request a Customer Service Report (CSR) number from Technical Service. Reference the CSR number when returning your Product, freight and insurance prepaid, to:

Smiths Medical PM, Inc.
N7W22025 Johnson Drive
Waukesha, WI 53186-1856

Phone: (262) 542-3100
Fax: (262) 542-0718
Toll Free: (800) 558-2345 (USA Only)

Seller will not be responsible for unauthorized returns or for loss or damage to the Product during the return shipment. The repaired or replaced Product will be shipped, freight prepaid, to Purchaser.

To obtain warranty information outside of the USA, contact your local distributor.

Keep all original packing material, including foam inserts. If you need to ship the device, use only the original packaging material, including inserts. Box and inserts should be in original condition. If original shipping material in good condition is not available, it should be purchased from Smiths Medical PM, Inc.

Damages occurred in transit in other than original shipping containers are the responsibility of the shipper. All costs incurred returning devices for repair are the responsibility of the shipper.

CE Notice

Marking by the symbol CE 0473 indicates compliance of this device to the Medical Device Directive 93/42/EEC.

Authorized Representative (as defined by the Medical Device Directive):

Smiths Medical International Ltd.
Colonial Way, Watford, Herts,
WD24 4LG, UK

Phone: (44) 1923 246434
Fax: (44) 1923 240273

Australian Representative:

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QLD 4113, Australia

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Chapter 1: Introduction

About this Manual

This manual contains circuit descriptions, voltage and waveform test points, detailed parts lists, and circuit diagrams for the oximeter. It is intended for persons trained in service, maintenance, and repair of modern medical equipment. Thorough knowledge of this equipment's operation is required before attempting to repair this equipment.

The remainder of the manual is divided into these sections:

- **Oximeter Circuit Description.** Contains circuit descriptions, voltage test points, and waveform test points for the oximeter and display board.

- **Parts Lists & Circuit Diagrams**. Contains detailed parts lists and circuit diagrams for the oximeter.

Symbol Definitions

SYMBOL	DEFINITION
Rx ONLY	Caution: Federal (U.S.A.) law restricts this device to sale by or on the order of a physician.
	Type CF equipment
	Type B Equipment
	Attention, see instructions for use.
	Refer servicing to qualified service personnel.
	Do not reuse. One use on one patient.
%SpO2	Percent Oxygen Saturation
bpm	Pulse Rate LED (beats per minute)
	On/Off
	Pulse Volume
	Alarm Volume

SYMBOL	DEFINITION
	Up and Down Arrows
	Alarm Select
	ID/CLEAR
	Moisture Sensitive
	Non AP Device
	Output Voltage
	Input Voltage
	Printer output
	Direct Current
	Speaker
	Catalog Number
	Date of Manufacture
 Collect Separately	**Disposal (EU Countries)** Under the Waste Electrical and Electronic Equipment (WEEE) Directive 2006/96/EC and implementing regulations, all devices and service items within the scope of the Directive purchased new after August 13, 2005 must be sent for recycling when ultimately becoming waste. Devices and items must not be disposed of with general waste. If purchased before that date, they may also be sent for recycling if being replaced on a one-for-one, like-for-like basis (this varies depending on the country). Recycling instructions to customers using Smiths Medical products are published on the internet at: **http://www.smiths-medical.com/recycle**

SYMBOL	DEFINITION
	**Disposal (other countries)** When disposing of this device, its batteries or any of its accessories, ensure that any negative impact on the environment is minimized. Contact your local waste disposal service and use local recycling or disposal schemes. Separate any other parts of the equipment where arrangements can be made for their recovery; either by recycling or energy recovery. The main batteries are potentially harmful and will require separate disposal according to manufacturer's instructions or local regulations. **Note: If applicable, EU, national or local regulations concerning waste disposal must take precedence over the above advice.**

KEYWORD	DEFINITION
WARNING!	Tells you about something that could hurt the patient
CAUTION!	Tells you about something that could damage the monitor
NOTE!	Tells you other important information

Warnings

WARNING! Do not use this device in the presence of flammable anesthetics.

WARNING! Do not use this device in the presence of magnetic resonance imaging (MR or MRI) equipment.

WARNING! Operation of this device may be adversely affected in the presence of conducted transients or strong electromagnetic (EM) or radiofrequency (RF) sources, such as electrosurgery and electrocautery equipment, x-rays, and high intensity infrared radiation.

WARNING! Operation of this device may be adversely affected in the presence of computed tomograph (CT) equipment.

WARNING! Any monitor that has been dropped or damaged should be inspected by qualified service personnel, prior to use, to insure proper operation.

WARNING! If the accuracy of any measurement is in question, verify the patient's vital sign (s) by an alternative method and then check the monitor for proper functioning.

WARNING! This device must be used in conjunction with clinical signs and symptoms. This device is only intended to be an adjunct in patient assessment.

WARNING! This device is intended for use by persons trained in professional health care. The operator must be thoroughly familiar with the information in this manual before using the device.

WARNING! It is the operator's responsibility to set alarm limits appropriately for each individual patient.

WARNING! Prolonged use or the patient's condition may require changing the sensor site periodically. Change sensor site and check skin integrity, circulatory status, and correct alignment at least every 4 hours.

WARNING! When attaching sensors with Microfoam® tape, do not stretch the tape or attach the tape too tightly. Tape applied too tightly may cause inaccurate readings and blisters on the patient's skin (lack of skin respiration, not heat, causes the blisters).

WARNING! Connect the Wall Mount Charger to grounded, three-wire outlet. Failure to comply may compromise patient isolation.

WARNING! Patient safety can be compromised by the use of a power supply not supplied by Smiths Medical PM, Inc. Use only the power supply included with your monitor, or approved by Smiths Medical PM, Inc.

WARNING! Verify the functionality of any remote alarm system connected to this monitor before leaving the patient unattended.

WARNING! Use only SpO_2 sensors supplied with, or specifically intended for use with, this device.

WARNING! SpO_2 measurements may be adversely affected in the presence of high ambient light. Shield the sensor area (with a surgical towel, for example) if necessary.

WARNING! Dyes introduced into the bloodstream, such as methylene blue, indocyanine green, indigo carmine, fluorescein, and patent blue V (PBV) may adversely affect the accuracy of the SpO_2 reading.

WARNING! Any condition that restricts blood flow, such as use of a blood pressure cuff or extremes in systemic vascular resistance, may cause an inability to determine accurate pulse rate and SpO_2 readings.

WARNING! Optical cross-talk can occur when two or more sensors are placed in close proximity. It can be eliminated by covering each site with an opaque material.

WARNING! Remove fingernail polish or false fingernails before applying SpO_2 sensors. Fingernail polish or false fingernails may cause inaccurate SpO_2 readings.

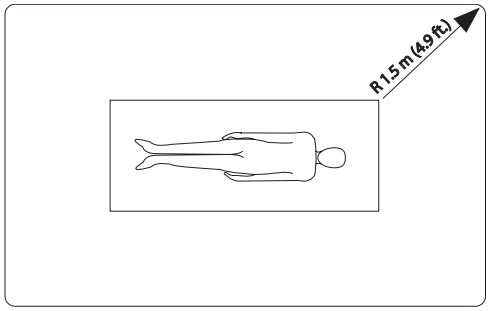
WARNING! Significant levels of dysfunctional hemoglobins, such as carboxyhemoglobin (with CO-poisoning) or methemoglobin (with sulfonamide therapy), will affect the accuracy of the SpO_2 measurement.

WARNING! Tissue damage may result from overexposure to sensor light during photodynamic therapy with agents such as verteporphin, porfimer sodium, and metatetrahydroxyphenylchlorin (mTHPC). Change the sensor site at least every hour and observe for signs of tissue damage. More frequent sensor site changes/ inspections may de indicated depending upon the photodynamic agent used, agent dose, skin condition, total exposure time or other factors. Use multiple sensor sites.

WARNING! When connecting this monitor to any instrument, verify proper operation before clinical use. Refer to the instrument's user manual for full instructions. Accessory equipment connected to the monitor's data interface must be certified according to the respective IEC standards, i.e., IEC 60950 for data processing equipment or IEC 601-1 for electromedical equipment. All combinations of equipment must be in compliance with IEC 601-1 systems requirements. Anyone connecting additional equipment to the signal input port or the signal output port configures a medical system, and therefore is responsible that the system complies with the requirements of the system standard IEC 601-1.

WARNING! IEC 60950 approved equipment must be placed outside the "patient environment." The patient environment is defined as an area 1.5 m (4.92 feet) from the patient.

Figure 1.1: Patient Environment



WARNING! Disconnect the AC power supply from the outlet before disconnecting it from the monitor. Leaving the AC power supply connected to an AC power outlet without being connected to the monitor may result in a safety hazard.

WARNING! Do not allow any moisture to touch the AC power supply connectors or a safety hazard may result. Ensure that hands are thoroughly dry before handling the AC power supply.

WARNING! Do not place the monitor in the patient's bed or crib. Do not place the monitor on the floor.

WARNING! Failure to place the monitor away from the patient may allow the patient to turn off, reset, or damage the monitor, possibly resulting in the patient not being monitored. Make sure the patient cannot reach the monitor from their bed or crib.

WARNING! Failure to carefully route the cable from the sensor to the monitor may allow the patient to become entangled in the cable, possibly resulting in patient strangulation. Route the cable in a way that will prevent the patient from becoming entangled in the cable. If necessary, use tape to secure the cable.

WARNING! If there is a risk of the AC power supply becoming disconnected from the monitor during use, secure the cord to the monitor several inches from the connection.

WARNING! Under certain clinical conditions, pulse oximeters may display dashes if unable to display SpO_2 and/or pulse rate values. Under these conditions, pulse oximeters may also display erroneous values. These conditions include, but are not limited to: patient motion, low perfusion, cardiac arrhythmias, hi or low pulse rates or a combination of the above conditions. Failure of the clinician to recognize the effects of these conditions on pulse oximeter readings may result in patient injury.

WARNING! Verify that all LEDs (light emitting diodes) on the display light up upon startup of the device.

Cautions

CAUTION! The monitor is equipped with an internal rechargeable battery. Do not attempt to remove or replace the internal rechargeable battery. Refer servicing to an authorized repair center.

CAUTION! Failure to charge the monitor while the monitor is not being used may shorten the battery life. Charge the monitor while the monitor is not being used to ensure the longest battery life.

CAUTION! Do not autoclave, ethylene oxide sterilize, or immerse the sensors in liquid.

CAUTION! Do not allow water or any other liquid to spill onto the monitor. Do not autoclave, ethylene oxide sterilize, or immerse the monitor in liquid. Evidence that liquid has been allowed to enter the monitor voids the warranty.

CAUTION! Chemicals used in some cleaning agents may cause brittleness of plastic parts. Follow cleaning instructions in this manual.

CAUTION! Pressing front panel keys with sharp or pointed instruments may permanently damage the keypad. Press front panel keys only with your finger.

Notes

NOTE! If the digital outputs are enabled and a low battery condition is present, the digital outputs will be activated.

NOTE! "SpO_2 averaging" means the number of pulse beats over which the SpO_2 value is averaged; "pulse averaging" means the number of seconds over which the pulse value is averaged.

NOTE! Increasing or decreasing the averaging setting has no effect on the data update rate.

Chapter 2: Oximeter Circuit Description

Functional Structure

The functional structure of the oximeter is shown in drawing no. 71200S1. The oximeter consists of the main board, the display board, two key labels, speaker, probe connector assembly and the battery:

- The oximeter board contains the battery charger, power supplies, the on/off control logic, speaker control circuitry, the microprocessor, and the data acquisition circuitry. It also includes isolated RS-232 printer interface.
- The display board contains the 7-segment displays, the led bar graph, the indicator lights, LED driver chips. The display board connects to the main board through an fourteen-conductor ribbon cable.
- The key labels contains the front panel touch keys.
- The probe connector assembly is a cable connecting main board with patient probe.

Battery Charger

General Description

The wall mount charger has an unregulated 12 V DC output that comes into the main board at J10. Transorb D13 prevents electrostatic discharges from entering the system. The charger circuit built around linear regulator U27 generates a constant charging current of 0.138A defined by resistors R66, R67 and R68. The comparator U28A and U28B monitors the voltage on the battery, and at 7.2V turns off U27. The trickle charge current is then defined by resistor R70. Capacitor C92, being in the discharged state at power up, provides the initial high current condition of the charger. If the battery is fully charged, the ciruitry switches to the trickle current mode in a few seconds.

Oximeter On/Off Control

When the oximeter is off and the O/I key is pressed U19-5 is shorted to ground, which causes flip-flop output U19-3 to go low and turn Q7 off releasing U25 from the shut down mode.

There are two ways the oximeter can be turned off:

- When the O/I key is pressed, the microprocessor generates /HALT signal.
- When the Power Fault Output signal (/PFO), generated by the power monitor/watchdog chip U15, goes low.

When either the /HALT signal is generated or the signal /PFO goes low:

- Flip-flop output U13-3 goes high and Q7 turns power supply converter U25 off.

System Power Supply

System power supply is powered either through diode D4 when the Charger is plugged in or through D6 when running on the battery.

A low power linear 5 V regulator (U26) is used to supply continuous power to RAM, when the unit is turned off. This V-RAM supply also provides power to the ON/OFF circuitry.

The main power supply is built around U25, a pulse width modulated switch mode fly-back converter. The transformer T1 is used to generate +5VDC and -5VDC supplies, and isolated V-ISO supply for the printer interface. Transistor Q8 is used to turn the power supply into a temporary off state during data acquisitions.

Microprocessor Circuit

A dual microprocessor core is formed by microprocessors U10 and U11, PROM U12, and RAM U13. Crystal X1, C47, and C48 form the oscillator circuit. The microprocessor's PHI output at U10-71 is one-half of X1's frequency, and is used as a clock signal for the second microprocessor U11.

Reset Circuit

Watchdog timer chip U15 performs two functions:

- /RESET is generated by U15 if VCC is less than +4.4 VDC.
- /PFO (power fail output) is generated by U15 if the input PFI at U15-4 becomes less than 1.25 VDC. /PFO turns off the oximeter through U18A and Q4.

Gates U19C and U19D disable access to RAM chip U13 while /RESET is active.

Memory and I/O Decoding

Demultiplexer U16A decodes A15, A16, and ME to allocate memory space. The following chart shows the memory address allocation:

FROM	TO	ENABLED DEVICE
00000H	0FFFFH	PROM U12.
10000H	1FFFFH	RAM U13.
20000H	2FFFFH	Display IC load strobe.
30000H	3FFFFH	Interrupt request to microprocessor U11.

Demultiplexer U16B decodes A14, A15, and IOE to allocate I/O space. The following chart shows the I/O address allocation:

FROM	TO	SIGNAL OR ENABLED DEVICE
0000H	3FFFH	not used.
4000H	7FFFH	U20, U21 and U22 strobe signal.
8000H	BFFFH	/HOLD signal to A/D converted U8.
C000H	FFFFH	U29 strobe signal.

Dual microprocessor operation

Microprocessor U11 is a slave Digital Signal Processing (DSP) device. It shares common PROM and RAM with the master U10 microprocessor. U17A, U17B, U17C and U17D mix control signals from both microprocessors together. At power up U11 puts U10 on hold using signal /BUSRQ, and boots from EPROM U12. Then it switches to its internal data and instruction memory releasing U10. Each time U11 needs to access data from the common RAM, it sets U10 to hold. If U10 needs to inform U11, it generates /DINT interrupt signal.

Interface Circuit

Addressable Latch and Speaker Output

Addressable latch U21 and U22 decodes A0-A7 and provides 16 outputs for controlling the oximeter board's circuitry. Four outputs, pins 5, 6, 7 and 9 of U22 create a 16 step D/A converter which defines the speaker volume. Transistor Q5 drives the speaker under control of the TONE signal. Addressable latch U29 generates two more output signals to control LED drives.

Input buffer

Input buffer U20 allows microprocessor to read signals from both keypads and signals from the analog section.

Synchronous Serial Port

The microprocessor's synchronous serial port TXS/CKS is used to send data to the digital potentiometer U6 and to send data to the display driver chips U1 and U2 (on the display board). It is also used to read data from A/D converter U8. U6's data is latched with the I/O strobe POT-LD; display driver chips U1's and U2's data is latched with the I/O strobe DISP-LD.

Asynchronous Serial Port

The microprocessor has two internal asynchronous serial ports: TXA0/RXA0 and TXA1/RXA1. TXA1/RXA1 is used for manufacturer test applications. TXA0/RXA0 is used for sending printer data to the printer through isolation barrier.

RS-232 Isolation Interface

TXA0 is buffered by U18E and controls the LED of the opto coupler ISO1 through transistor switch Q6. The output of ISO1 controls the RS-232 driver U24 which generates both positive and negative voltage levels required by RS-232 interface. The /BUSY signal from the RS-232 connector is converted to CMOS level by U24 and controls LED of opto coupler ISO2 to transfer data or a busy signal back to the microprocessor. The second receive - transmit channel of U24 is used in the production test mode. In this case J5 and J6 are connected together temporarily breaking the isolation barrier, J7 is used to communicate to a personal computer.

A/D Converter

A/D converter (ADC) U8 is configured as a two channel 16-bit ADC. The first channel is used by the signal processing circuitry. The second channel is used to read battery voltage. The ADC's reference voltage input of 3.78VDC is formed by the filter-amplifier U4B. The following sequence describes an ADC conversion cycle:

- After ADC channel is chosen by the signal CH1/2, the CRS/FIN signal is set to log. 1 for a few microseconds to course charge the ADC input sampling capacitor. Then it is switched back to the fine mode to reach 16 bit accuracy level.
- Signal /HOLD is generated to start conversion.
- After a few microseconds data is read serially clocked by the CKS signal.

LED Drive

The red LED drive circuit consists of a programmable current sink formed by U3A, U6 and Q3, and MOSFET bridge Q1 and Q2. LED current is defined by the voltage generated by the second channel of digital potentiometer U6 referred to the output of the 2.5VDC voltage reference U7. This voltage is compared with the voltage across current sense resistors R26 and R27 by amplifier U3A. The MOSFET bridge is controlled by four digital signals connected to the gates of MOSFET's. The combination of these signals reverses polarity of the current through probe LED's and "floats" probe LED's. When LED's are "floating," comparator U30B checks for a possible short of the LED control conductor to ground which may happen during a probe cable failure. If this happens, the microprocessor does not turn the probe LED's on and informs the operator of the probe problem.

Signal Processing

The differential transconductance amplifier formed by U1 and U2B converts the photodetector's current output to a voltage at TP10 (V-AMB). Amplifier U3B offsets the signal at TP10 so the signal baseline is at 3.4 VDC, allowing a wider signal range for the negative-going pulses at TP10.

Comparator U30A is used to inform microprocessor if U2B is saturated by excess of ambient light.

V-AMB is passed through blocking capacitor C19 to remove the signal's DC component. The signal is then buffered and amplified by U2A. Gain is defined by the first channel of digital potentiometer U6. The output of U2A is routed to the integrator-filter U4A, controlled by the analog switch U5. The signal at TP12 is then passed to the ADC for measurement.

Display Board

The display board contains the LED display driver chips, the 7-segment displays, the LED bar graph and the indicator lights. The display board connects to the main board through a fourteen-conductor ribbon cable. The display driver chips U1 and U2 are connected in a data chain and receive synchronous data from the microprocessor's TXS and CKS lines. The data is loaded with the I/O strobe DISP-LD.

U1 and U2 generate electrical noise that may cause inaccurate measurements from the ADC. For this reason, U1 and U2 are turned off for 2 out of 8 msec during the data acquisition time. The signal /BLANK turns off U1 and U2.

U1 controls the 7-segment displays and the LED bar graph according to the data it receives from the TXS serial channel. U2 controls alarm and other signal LED bars. The brightness of the displays is controlled by the I-SET input at U1-18 and U2-18.

Green LED DS14 is directly connected to the charger section to indicate that Charger is plugged to the wall.

Signal Dictionary

This section lists in alphabetical order the signal names used on the schematics. The signal's origin, destination, and purpose are described.

Oximeter Board

SIGNAL	DESCRIPTION
/ADCRST	Reset signal to ADC.
/AMB	Signal informing microprocessor about excess of ambient light.
/BLANK	Signal used to shut down power supply and display board during data acquisitions.
/BUSRQ, /BUSAK	Microprocessor bus access signals used by U11 to access ROM and RAM.
/DINT	Interrupt signal from master microprocessor to the slave microprocessor
/DWR, /DRD, /BMS, /DMS	Signals used by the slave Digital Signal Processing microprocessor to control memory access.
/HALT	Signal used by microprocessor to turn power off.
/INT1	/INT1 is used to inform microprocessor that power control flip-flop U19A - A19B was switched to the power off condition, and power will disappear soon.
/IO1	Strobe to U20 to read input data and to U21 and U22 to latch output data.
/IO2 = /HOLD	ADC strobe signal, starts data conversion.
/IO3	Strobe to U29 to latch output data.
/RD, /WR, /ME, /IOE	Signals used by master microprocessor to control memory and peripheral devices.
/RESET	Microprocessor and peripheral devices reset signal.
A0-A16	A0 through A16 are the microprocessor's address lines. A0-A16 are used to address the RAM, PROM, and I/O ports.
A18 = TONE	Microprocessor output A18 (TOUT) is configured as a timer output and controls the tone of the optional pulse beep speaker.
ADC-RDY	Input signal indicating that ADC is ready for the next conversion.
ANA+5	The +5 volt power supply VCC is filtered to produce ANA+5. ANA+5 powers the analog circuitry.

SIGNAL	DESCRIPTION
ANA-5	The -5 volt power supply is filtered to produce ANA-5. ANA-5 powers the analog circuitry.
BP/UP	ADC bipolar or unipolar conversion mode selection signal.
CAP-GND	Signal used to short blocking capacitor C19 to ground.
CH1/2	ADC channel one or two selection signal.
CKS	CKS is the microprocessor's high-speed, synchronous serial output clock signal.
CLKIN	Clock signal to ADC.
CRS/FIN	Coarse / fine ADC sampling mode selection signal.
D0-D7	D0 through D7 are the microprocessor's data lines. The data lines are routed to RAM, PROM and peripheral devices.
DISP-LD	DISP-LD is used to select display control chips U1 and U2 on the display board.
INTGRAT, RST-INT	Signals used to control integrator U4A.
IR-DRV, RED-DRV, /IR-ENBL, /RED-ENBL	Signals used to control MOSFET bridge Q1 and Q2, which powers probe LED's.
KEY-INx.. KEY-OUTx..	Keypad input / output scan control signals.
LED-DRV	Signal which defines LED drive current.
ME	ME is the microprocessor's memory enable output. ME is routed to decoder U16A to enable memory decoding.
ON-STBY	Line connected to the O/I key.
PFI, /PFO	Power fail input and output signals, used to shut down the monitor if battery is too low.
PHI	Clock signal generated by microprocessor.
POT-LD	POT-LD is used to select digital potentiometer chip U6.
PRB-DET	PRB-DET is used to inform microprocessor if probe is plugged in.
PRB-FAULT	Signal used to inform microprocessor about probe cable problem.
RXS	RXS is the microprocessor's high-speed, synchronous serial input receiving data signal.
SIGNAL	SIGNAL originates at TP9 and is routed to ADC U8 channel one input.

SIGNAL	DESCRIPTION
STBY	Input signal indicating that I/O key was pressed.
TXA0, RXA0	Asynchronous serial communication signals used to control external optional printer.
TXA1, RXA1	Asynchronous serial communication signals used for production testing.
TXS	TXS is the microprocessor's high-speed, synchronous serial output transmitted data signal.
V-AMB	V-AMB is the output of the front-end differential amplifier.
V-BATT	Signal used to monitor battery voltage.
V-POWER	Input external voltage. Also used to light green "CHARGE" LED on the display board
V-RAM	+5 VDC voltage generated by U26 to power RAM and on-off circuitry.
V-REF	2.500 VDC reference voltage.
VCC	VCC is the regulated +5 VDC supply generated by +5 volt power supply regulator chip U26 and its discrete components.
VDD	Same as VCC.
VSS	Digital ground.
WDT	Watch dog timer input signal, resets watch dog timer.

Display Board

SIGNAL	DESCRIPTION
/BLANK	Same as oximeter board /BLANK.
Ba-Bd	Ba-Bd originate at display driver U2 and are routed to the bar displays. The state of Ba through Bd determine which display or bar graph segments light when the corresponding DIG signal is strobed.
CKS	Same as oximeter board CKS.
DIG1-DIG14	DIG1 through DIG14 originate at display drivers U1 and U2 and are routed to the common cathode pins of the seven-segment LED and bar displays DS1 through DS13.
DISP-LD	Same as oximeter board DISP-LD.
DSP+	DSP+ originates at the output of the +5 volt power supply regulator. DSP+ powers the display drivers U1 and U2.
Sa-Sg	Sa-Sg originate at display driver U1 and are routed to the seven-segment displays and the led bar graph. The state of Sa through Sg determine which display or bar graph segments light when the corresponding DIG signal is strobed.
TXS	Same as oximeter board TXS.

Test Equipment and Tools Required

To diagnose and repair the full extent of possible malfunctions on the oximeter and display board, you'll need the following test equipment and tools:

- DMM, volts/ohms/amps, with 10 MΩ input impedance or greater
- Oscilloscope, 50 MHz, with 10 MΩ input impedance or greater
- AC Power Supply
- Small Phillips screwdriver
- Small flat blade screwdriver
- Needle nose pliers
- Diagonal cutters
- Clip leads
- Low-power microscope or magnifying glass
- Soldering iron and solder
- Solder wick or solder remover

Voltage Test Points

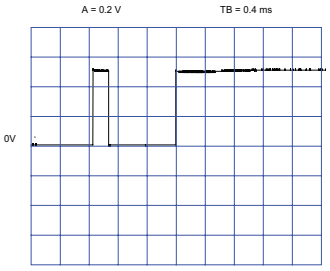
Unless otherwise noted, all voltages are measured with respect to ground at TP-1.

LOCATION	CONDITION	NOMINAL AND RANGE
TP2	Oximeter on.	5 VDC, ± 0.25 VDC
ANA+5	Same as TP2.	Same as TP2.
FLTR+5	Same as TP2.	Same as TP2.
TP3	Oximeter on.	-4.8 VDC to -6.2 VDC
ANA-5	Same as TP3.	Same as TP3.
FLTR-5	Same as TP3.	Same as TP3.
V-REF	Oximeter on.	2.500 VDC
V-RAM	Oximeter on or off.	5VDC, ± 0.25 VDC.
U10-71	Oximeter on.	6.144 MHz, 50% duty cycle.
TP7	Referred to TP6.	4.7 VDC to 5.3 VDC
TP5	Oximeter on or off.	5.2 VDC to 7.2 VDC depending on the state of the charge of the battery.
TP14	Oximeter is on.	3.65 VDC ± 0.1 VDC.

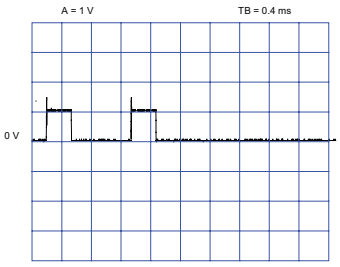
Waveform Test Points

- The waveforms are measured with respect to ground at TP1.
- The oscilloscope is triggered on TP16, falling edge.
- The waveforms are measured with the finger probe attached to the oximeter with finger or piece of paper in probe.

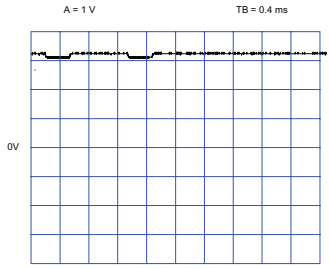
TP16:



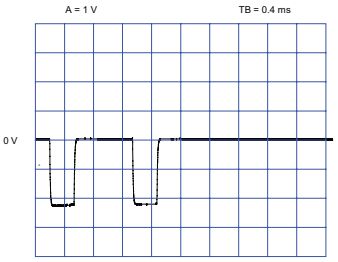
TP15:



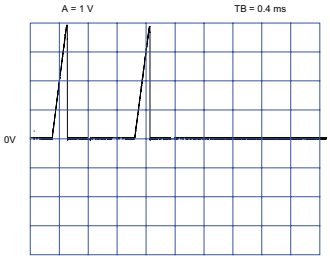
TP10:



TP11:



TP12:



Appendix

Parts Lists

NUMBER	DESCRIPTION	ITEM	# OF PAGES
71200A1	F/ASM Oximeter BOM	A-1	2
71200A1	F/ASM Drawing	A-2	4
71200S1	F/ASM Schematic	A-3	1
71204B1	PWB ASM. Main Bd.	A-4	2
71204B1	PWB ASM Main Bd. Parts List	A-5	4
71204S1	PWB ASM Main Bd. Schematic	A-6	8
71206B1	PWB ASM Display	A-7	1
71206B1	PWB ASM Display Parts List	A-8	1
71206S1	PWB ASM Display Schematic	A-9	1

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CE 0473

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