SUPPLEMENT to the 3700 Operating/Maintenance Manual 0380-0900-001 (BX#1118-300)

1. The *Ohmeda Biox 3700 Operation and Maintenance Manual* contains information on probes and probe accessories, as well as the 3700 oximeter. The *Ohmeda Probes Manual* (0380-0900-085, BX#1000-304), sent with your *3700 Operation and Maintenance Manual*, contains more current, detailed, and dedicated information about probe products. Please refer to the Probes Manual for all information on probe and probe accessories, including product selection, use, cleaning, warranty, and compatibility.

2. New part numbers have been assigned to Revision P and above EPROMs and the digital board. These parts help make the oximeter SoftProbe and EasyProbe compatible.

   To reorder, please use the following numbers:

| PART | P/N |
|---|---|
| Kit, Software, compatible with Rev. P and above (BX#8118-053). Note: Kit contains EPROMs BX#T118-012 and BX#T118-013. | 0380-0800-045 |
| Digital Board with Rev. P and above EPROMs (A118-011) | 0380-0500-018 |

3. Warranty Periods for Probes (update)

   Warranties in the Ohmeda Probes Manual 0380-0900-085 (BX#1000-304) supersede the one given on page W-1 for the FingerProbe and any probe or probe accessory not mentioned on page W-1.

# Ohmeda Biox 3700 Pulse Oximeter Operating/Maintenance Manual

Supplement to the 3700 Operating/Maintenance Manual
P/N 380-0900-001 (BX#1118-300)

Oximeter software Revisions T and later change several oximeter alarms/messages, as well as the reasons why these alarms/messages occur. This addendum describes the resulting changes and additions to information in the *Ohmeda Biox 3700 Pulse Oximeter Operating/Maintenance Manual*. This addendum also notes other current manual changes under Other Manual Changes.

Software Revisions T and later affect sections of this manual that contain the following information:

- Setup and Calibration
- Operation
- Computer Interface
- Chart Recorder, Polygraph and Other Recording Equipment
- Status and Alarm Messages
- Performance Assurance Testing

Software revisions are included in software kit 380-0800-045 (BX#8118-053). Revisions are also included in the complete digital board assembly 380-0500-018 (BX#A118-011).

## Alarm Silence During Powerup

Software Revisions T and later change the audible alarm silencing feature during oximeter powerup.

The patient and probe alarm tone is silenced for one minute after the SYSTEM OPERATIONAL message appears during initial power up. If the probe is off the patient (PROBE OFF alarm) or not connected to the oximeter (NO PROBE alarm) when this minute is up, the alarm tone stays silenced until the condition changes. In other words, the alarm tone is silenced until the probe is connected to the patient and the oximeter.

## Sign-On and Operational Messages

Software Revisions T and later change the sign-on and operational message that display during powerup and after various functions are performed on the oximeter.

After turning the Oximeter on, the following message appears:

OHMEDA-BIOX
3700/3710/3700e
REVISION:X
SYS AND CAL CHECK

**NOTE**: X represents an alphanumeric value.

Next, after the diagnostic self-test, this Status Message appears:

CALIBRATION PASSED
SYSTEM OPERATIONAL



Ohmeda
1315 West Century Drive
Louisville CO 80027
303 666 7001
800 652 2469
Telex 296 445 BTI UR

**Note:** Revision T does not change the LO QUALITY SGNL message that appears when the bar graph on the Graphic Display is at 5 pixels or less continuously for 5 seconds or more.

If a computer interface is used with the oximeter, the following occurs:

- $SaO_2$ and PR readings on the computer screen dash for all modes
- A NO PULSE message appears for the auto output mode
- An NS message appears for the output trend mode
- An error code of 11 appears for the waveform mode

## Probe Placement Warning

## LIST OF ILLUSTRATIONS

## USER RESPONSIBILITY

This product conforms to its operation and design specifications as described in this manual and any accompanying labels and/or inserts, when operated, maintained, and repaired in accordance with the instructions provided. Do NOT use a defective product. Replace parts that are broken, missing, plainly worn, distorted or damaged in any way immediately. This product or any of its components should be repaired by Ohmeda-trained service personnel. Any exceptions to this recommendation must be made according to the written instructions provided by Ohmeda. When service is not provided by Ohmeda Service Personnel, the user of this product shall have the sole responsibility for any losses incurred during unauthorized maintenance, as a result of improper repair, damage, or alteration. Prior to obtaining service by Ohmeda, clean and properly decontaminate the equipment (as described in Section 5 of this manual).

PRODUCT IMPROVEMENT: Ohmeda reserves the right to change or improve its products and accompanying technical literature without specific notice to customers who have purchased products prior to these changes/improvements.

The technical literature accompanying your product corresponds to the product as manufactured at that time. Technical literature produced at later dates may not exactly correspond to earlier products. Manuals are revised each time a product is updated.

Ohmeda has no obligation and absolves itself from improving or retrofitting earlier production units unless the product improvement or change directly affects the safety of the patient or proper functioning of the product.

Customers who have purchased earlier production units and wish to have them updated should contact their local Ohmeda sales representative to determine if that improvement is available.

ROUTINE MAINTENANCE: Neither the Pulse Oximeter nor the probes require maintenance on a routine basis other than what is suggested in the Preoperative Checklist (refer to Section 2.2). Service should be performed whenever a Device Failure Alarm message indicates to do so.

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NOTE: Ohmeda is a trademark of The BOC Group

TRACEABILITY: Federal law in the U.S.A. requires traceability of this equipment. Please fill out the self-addressed traceability registration card included with this product and return it to Ohmeda (Louisville). If additional cards are required, order stock number 380-0900-027 (BX#1000-246).

Traceability Registration/Warranty Information

**Federal law requires traceability of this equipment.**

Federal regulations require us to obtain this information in order to maximize our response to you in the event of a recall.

Facility Name: AMBER-ROSE MEDICAL CENTER

Contact Name: KATHY O'CONNOR Dept: RESP

Address: 1226 HOUDINI Rd.

City: BOULDER State: CO Zip: 80808

Country: USA Serial No.: FMAR0084I

Operator's Manual Part No. & Revision: 1118-300 Rev J

Service Manual Part No. & Revision: 1118-302 Rev C

Date Received: 5/10/88

Signature: K. O'Connor Date: 5/10/88

1000-246

Figure 1. Traceability Registration Card

**CAUTION** Federal law in the USA and Canada restricts this device to sale by or on the order of a licensed medical practitioner.

(NOTE: The Oximeter serial number is located on the rear panel.)

Read the 3700 Operating/Maintenance Manual completely before using this equipment. Ensure that the Oximeter operates correctly.

## UNPACKAGING

Report any signs of external damage or loss immediately. Save the damaged shipping carton as evidence. It is the receiver's duty to notify the specific carrier's local office. The carrier should arrange for pickup of the damaged items. The receiver should contact their local Ohmeda representative or authorized dealer for replacement of any damaged equipment. Unpack the unit and inventory the parts against the packing slip. Inspect the equipment for signs of external damage, dents, cracks, scratches, broken parts, water damage, etc. occurring in transit.

RETURNING EQUIPMENT: PLEASE CLEAN CONTAMINATED OR DIRTY EQUIPMENT BEFORE RETURNING.

If you've had the equipment for 14 CALENDAR DAYS or less:

| | |
|---|---|
| HOSPITALS & CLINICS | Call Ohmeda - Madison Customer Service at 1-800-345-2700. They will issue a Return Authorization (RA) number. Write this number on the outside of the package you are returning. |
| NON-HOSPITALS | Call Ohmeda - Boulder Order Entry at 1-800-652-2469. They will issue an MRB Return Number. Write this number on the outside of the package you are returning. |

In either case, ship equipment to:

Ohmeda
1315 West Century Drive
Louisville, CO 80027

| | |
|---|---|
| OUTSIDE THE USA | Contact the nearest Ohmeda Representative or office listed on the back cover of this manual. |

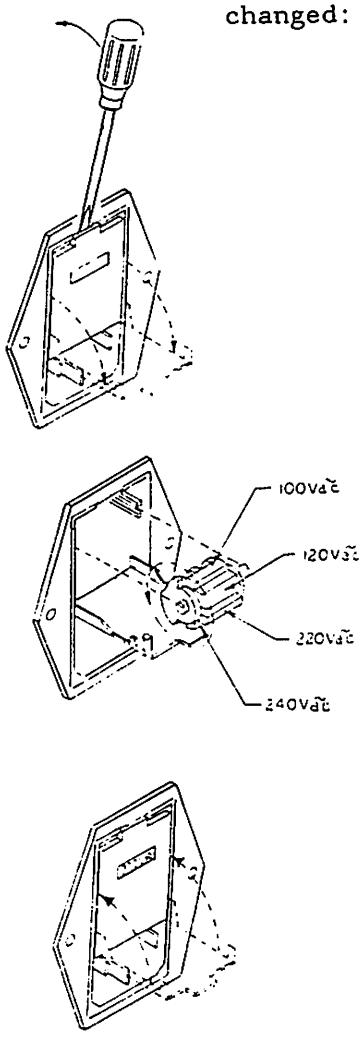
IF YOU'VE HAD THE EQUIPMENT MORE THAN 14 DAYS, REFER TO PAGE 6-1 OF THIS MANUAL FOR INSTRUCTIONS.

---

SOFTPROBE: The SoftProbe carries an out-of-box failure warranty only. Contact the appropriate Ohmeda facility or representative, as outlined above, should you need to exchange a defective probe.

## CHECKING OXIMETER LINE VOLTAGE SELECTION

IMPORTANT: The 3700 Pulse Oximeter is shipped with 120 Vac selected. If the Oximeter voltage needs to be changed:




* Unplug the power cord from the Oximeter.
* Using a small straight blade screwdriver, pry open the cover of the power input module on the Oximeter rear panel.
* Remove the voltage selection drum.
* Rotate the voltage selection drum to the appropriate voltage and place it in the power input module.
* Ensure that the voltage drum is properly seated in the power input module.
* Close the cover of the power input module and snap it into place.
* Verify that the voltage marking matches the voltage available at the AC mains power.

Figure 2.
Voltage Selector

**WARNINGS:** **A WARNING INDICATES THE POSSIBILITY OF INJURY TO THE PATIENT OR THE OPERATOR.**

**CAUTIONS:** **A CAUTION INDICATES A CONDITION THAT MAY LEAD TO EQUIPMENT DAMAGE OR MALFUNCTION.**

Verify proper operation prior to using the Oximeter (refer to the Preoperative Checklist, Section 2.2). Handle the Oximeter equipment with care. Oximeter damage or inaccurate operation may result from improper handling.

---

**WARNINGS:**

**DATA VALIDITY:**

Calibration is verified during power up. Do NOT operate the Oximeter unless it is properly calibrated. Inaccurate patient $SaO_2$ readings will result.

Excessive ambient light, excessive motion, low perfusion, or electrical interference at the probe site may cause erroneous readings. To ensure accuracy, check for adequate signal strength and a repeatable pulsatile waveform.

An inflated blood pressure cuff on the same limb as the probe will cause erroneous readings. Select another site.

**ELECTRICAL SHOCK HAZARD:**

Only Ohmeda-trained service personnel should open the Oximeter.

Measure the leakage current whenever an external device is connected to either the analog or digital ports. Forward and Reverse Polarity: 100 microamperes maximum.

**ELECTRICAL SHOCK AND FLAMMABILITY HAZARD:**

Always turn the Oximeter off and disconnect it from AC mains power before cleaning.

**EXPLOSION HAZARD:**

Do NOT use in the presence of flammable anesthetics or other flammable substances.

**FAILURE OF OPERATION:**

If the Oximeter fails to respond as described do NOT use it until the situation has been corrected by Ohmeda-trained service personnel.

The Oximeter is a microprocessor-based device designed to immediately shut down if the microprocessor fails. This prevents the possible display of erroneous information. **Important:** No alarms forewarn this action.

**PATIENT SAFETY:**

Where patients skin is fragile and/or sensitive to adhesive tape, the Adhesive Disks should NOT be used.

If a probe is damaged in any way, discontinue use immediately.

Prolonged monitoring or patient condition may require changing the probe test site periodically. Move the probe if there is any sign of skin irritation or impaired circulation. (EAR PROBE, FINGER PROBE): **Check** the probe site at least every four hours. (FINGERCLIP PROBE, FLEX II PROBE, SOFTPROBE): **Change** the probe site at least every four hours.

(FLEX II PROBE, SOFTPROBE): Exercise extreme care to assure continued circulation distal to the probe site after application.

Follow ethylene oxide instructions exactly when sterilizing the SoftProbe. Improper aeration may result in chemical burns or chemical sensitivity.

**CAUTIONS**:

Check rear panel voltage setting before connecting the Oximeter to AC mains power.

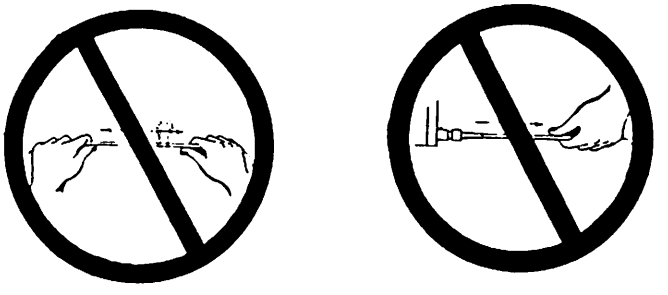
Use hospital-grade grounded receptacle only.

Avoid storing the Oximeter and probes at temperatures below -20° C (-4° F) or above 60° C (140° F).

Repairs should only be undertaken or attempted by Ohmeda-trained service personnel.

Use ONLY the Ohmeda probes and cables specified in Section 4 with this oximeter. Otherwise, equipment damage may result.

Do NOT apply tension to the probe cable. Probe damage may result.



Do NOT autoclave or pressure sterilize this Oximeter. Do NOT soak or immerse this Oximeter in any liquid. Do NOT gas sterilize this Oximeter. Damage to the equipment will result.

Do NOT soak or immerse the probes in any liquid solution. Do NOT autoclave probes. **EXCEPTION:** All but the connector-end of the SoftProbe may be immersed in the recommended disinfectants (see Section 5.1.2).

Improper exposure to ethylene oxide may result in probe damage. Follow ethylene oxide instructions exactly.

**DO NOT** turn the Oximeter on after the RECHARGE BATTERY Alarm condition is displayed without first connecting it to AC mains power. Damage to the lead-acid battery may result.

Connect only a high impedance device (1K Ohm or higher) to the analog output jacks. Improper loading will upset the correspondence between the measured voltage and the intended output voltage.

## 1.1 Introduction

This manual describes the proper operation and maintenance for the Ohmeda Biox 3700 Pulse Oximeter (software Revision R). Operators, please read this manual before using the Pulse Oximeter, paying attention to all details of correct operation along with precautionary measures recommended. All maintenance procedures in this manual are designed to be performed by the operator of the Oximeter.

## 1.2 Description

The Ohmeda Biox 3700 Pulse Oximeter is a stand alone, non-invasive, arterial oxygen saturation monitor. It provides continuous, real time $SaO_2$ and pulse rate readings. Trend information is available through both the analog and digital output ports.

## 1.3 Principles of Operation

THEORY

The Ohmeda Biox 3700 Pulse Oximeter determines a patient's arterial oxygen saturation and pulse rate by measuring the absorption of selected wavelengths of light. The light generated in the probe passes through the tissue and is converted into an electronic signal by the photodetector. (Some light is absorbed by the tissue.) The electronic signal passes to the Oximeter and is amplified. The Oximeter's circuitry processes the signal, converting the light intensity information into $SaO_2$ and Pulse Rate values. A liquid crystal display (LCD) presents patient data and Oximeter status information.

The functioning of the Ohmeda Biox 3700 Pulse Oximeter is based on the assumption that hemoglobin exists in two principle forms in the blood:

* Oxygenated ($HbO_2$) - $O_2$ molecules loosely bound
* Reduced (Hb) - no $O_2$ molecules bound

Arterial oxygen saturation ($SaO_2$) is defined as the ratio of oxygenated hemoglobin ($HbO_2$) to total hemoglobin [$HbO_2$ + Hb + others]:

$$SaO_2 = \frac{HbO_2}{HbO_2 + Hb + \text{others}} *$$

* (others = carboxyhemoglobin, methemoglobin, sulfhemoglobin, + ...; also, see information about interfering substances, Section 1.4)

NOTE: The $SaO_2$ read by pulse oximeters is now referred to as $SpO_2$. This additional definition is required because the presence of dyshemoglobins or other pigments cannot be measured by a two wavelength instrument. The presence of appreciable amounts of these substances may result in erroneous readings.

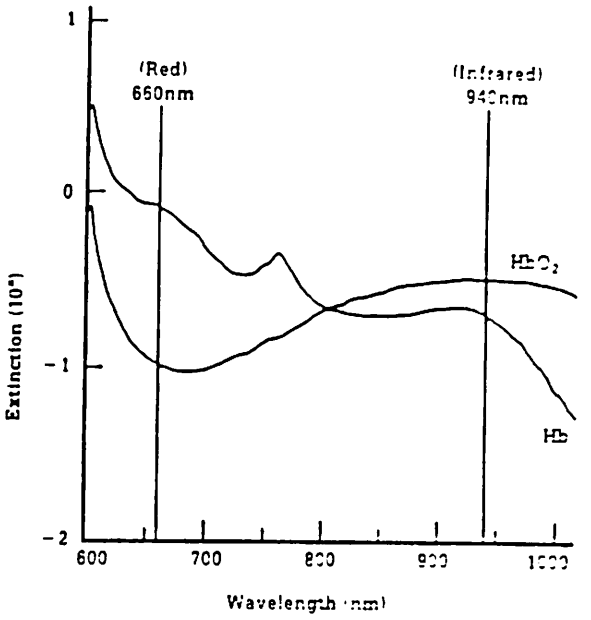



Figure 3. Extinction vs. Wavelength Graph

Oxygenated hemoglobin ($HbO_2$) and reduced hemoglobin (Hb) exhibit markedly different absorption (extinction) characteristics to red light @ 660 nm and infrared light @ 940 nm.

As shown in Figure 3, different amounts of light are absorbed by $HbO_2$ and Hb. The oximeter measures the relative absorption of red light at 660 nm and infrared light at 940 nm by $HbO_2$ and Hb. Because $HbO_2$ and Hb allow different amounts of light to pass at these wavelengths, the Oximeter can convert this relative light intensity information into $SaO_2$ and Pulse Rate values.

The Oximeter differentiates between light absorption of hemoglobin and other fluid and tissue constituents with a patented two wavelength, pulsatile system. This system relies on the observation that arterial blood flow pulsates and other fluids and tissues do not. The pulsating of the arterial blood flow modulates the light passing through it. The light is not modulated by the non-pulsing fluids and tissues. Therefore, the attenuation of light energy due to arterial blood flow can be detected, and isolated (see Figure 4).

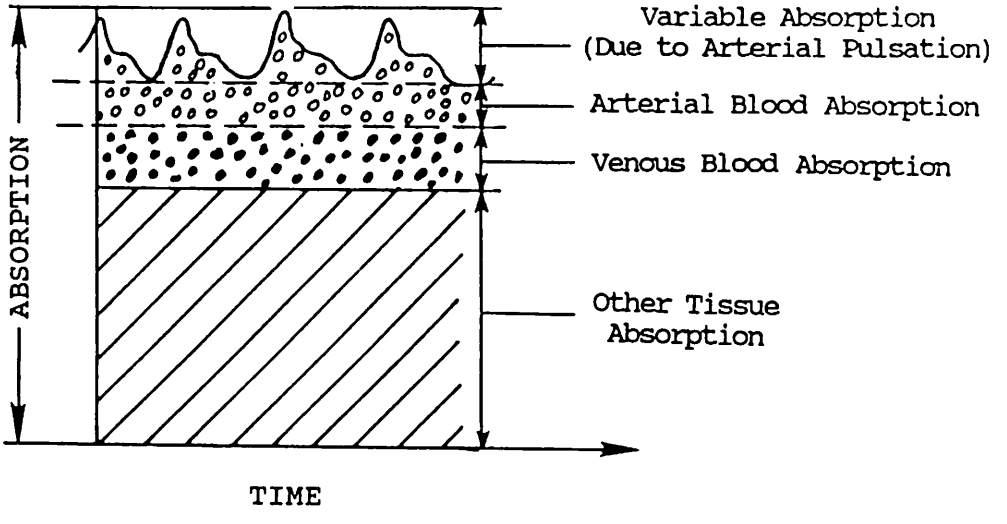



Figure 4. Signal Composite

## FUNCTIONAL COMPONENTS

The Ohmeda Biox 3700 Pulse Oximeter uses electrical components to determine $SaO_2$ and pulse rate values. The key elements are:

* the probe
* the processing of the probe signal
* the calculations made by the microprocessor

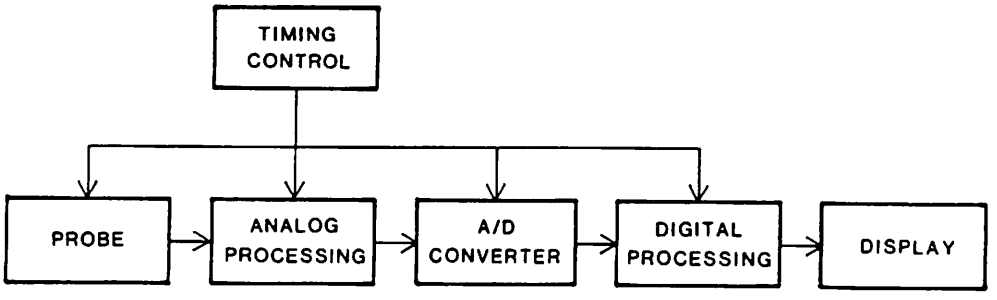



Figure 5. Functional Components

The PROBE consists of:

* the light source - a red LED and an infrared LED

* the photodetector - an electronic device that produces an electrical current proportional to incident light intensity

The two wavelengths of light generated by the LEDs pass through the tissue at the probe site. This light, which is partially absorbed and modulated, is then collected by the photodetector and converted into an electronic signal. This signal is sent to the Oximeter for further processing.

The electronic circuitry takes the current generated by the photodetector, processes it, and passes it to the microprocessor for calculation of the $SaO_2$ and pulse rate.

The calculation of $SaO_2$ assumes 1.6% carboxyhemoglobin, 0.4% methemoglobin, and no other pigments. Appreciable variation from these values will influence the accuracy of $SaO_2$. These values are based on the Ohmeda Biox 3700 Empirical Calibration Study.

The microprocessor calculates the $SaO_2$ 30/25 (60/50 Hz) times per second. The calculations are averaged by a running weighted average* method to determine the displayed $SaO_2$. The displayed average is based on specific time periods and is updated at specific intervals depending on the Response mode selected:

| | MODE | DATA AVERAGING PERIOD | UPDATE INTERVAL |
|---|---|---|---|
| 60 Hz | Slow | 12 seconds | 1.34 seconds |
| | Normal | 6 seconds | 0.67 seconds |
| | Fast | 3 seconds | 0.33 seconds |
| 50 Hz | Slow | 12 seconds | 1.50 seconds |
| | Normal | 6 seconds | 0.75 seconds |
| | Fast | 3 seconds | 0.375 seconds |

The running weighted average method allows erroneous $SaO_2$ values to be discarded from the determination of the displayed $SaO_2$. Erroneous values result from probe movement, electrosurgery, and other sources of signal interference. This method of averaging provides a stable reading, with low sensitivity to interference while retaining the capability of responding quickly to saturation changes.

---

* Obtained by assigning a weight (value) to each calculation based on the signal strength and the current average saturation.

## 1.4 Specifications

NOTE: All specifications are nominal and subject to change without notice.

| | | |
|---|---|---|
| $SaO_2$ Accuracy (1 Standard deviation) | $SaO_2$ Range | Accuracy |
| | 60% - 100% | 2.4% |
| | 90% - 100% | 1.5% |
| | 80% - 89.9% | 2.1% |
| | Below 59.9% | Unspecified |
| | The accuracy measurements are statistically derived and correlated to simultaneous arterial blood gases (ABG) measured on an Instrumentation Laboratory IL-282 Co-Oximeter. | |
| Interfering Substances | Carboxyhemoglobin may erroneously increase readings. The increase is approximately equal to the amount of carboxyhemoglobin present. | |
| | Dyes, or any substances containing dyes that change usual arterial pigmentation may cause erroneous readings. | |
| | See references in Appendix B. | |
| Pulse Accuracy (1 Standard deviation) | ±1.7% of current reading (assuming a constant pulse rate) | |
| $SaO_2$ Range | 0% to 100% | |
| Pulse Rate Range | 40 to 235 Beats per Minute | |
| | Note: The display can show 0 to 255 Beats per Minute | |

**Alarm Limits**

High $SaO_2$ = 70% to 100%
Low $SaO_2$ = 50% to 99%

High Pulse = 70 to 250 Beats per Minute
Low Pulse = 40 to 200 Beats per Minute

**Alarm and Pulse Volumes**

Alarm Volume Range = 1 to 10

Pulse Volume Range = Off to 10

**Audible Alarms**

Minimum Volume (Setting = 1): 55 decibels
Maximum Volume (Setting = 10): 75 decibels

Frequency: 400 to 800 Hertz

**Oximeter**

Height: 10.16 cm (4.00 in)
Width: 25.40 cm (10.00 in)
Depth: 28.70 cm (11.30 in)
Weight: 3.86 kg (8.50 lb)

**Probes**

Cable Length: 2.44 m (8 ft):

Finger Probe
FingerClip Probe
Ear Probe
Flex II Probe
SoftProbe

Cable Length: 3.66 m (12 ft):

Finger Probe
FingerClip Probe
Flex II Probe

**Analog Connector**

Type: 1/8 inch miniature phone plug
Connector plug polarity: tip = signal (+)
sleeve = ground (-)
Output checks: 0, 1.0 volts
Current at full scale output: 3 milliamps
Impedance at full scale output: 300 Ohms

**Digital Connector**

Connector type: 25 pin, standard D female, RS-232C compatible
Baud Rate: 1200 BPS, ASCII format
Bits per character: 7
Parity: Odd
Stop Bits: 1

Connector Pin Out:

pin 1 = chassis ground
pin 2 = receives data by the Oximeter
pin 3 = transmits data from the Oximeter
pin 7 = signal ground

**Power Source Requirements**

Voltage Rating: 100, 120, 220, 240 volts ±10% (50/60 Hz)

**Battery**

Sealed lead-acid, 8 volt, 2.5 Ampere-Hours

Charge Time: (unit on or off)

80% capacity in approximately 4 hours
100% capacity in approximately 16 hours

Operation time: 1.5 hours from a fully charged battery to automatic shutoff (at 5% capacity)

Low Battery Indicator: LO BT message appears at 5% battery capacity

**Environmental Tolerances**

Operating Temp Range: 0° to 50° C (32° to 122° F)

Storage Temp Range: -20° to 60° C (-4° to 140° F)

Note: At temperature extremes, the LCD read-out may exhibit reduced contrast, ghosting or darkening. When returning from temperature extremes, allow the Oximeter temperature to stabilize before use.

**CAUTION: Avoid storing the oximeter and probes at temperatures below -20° C (-4° F) or above 60° C (140° F).**

## 2.1 Features and Controls

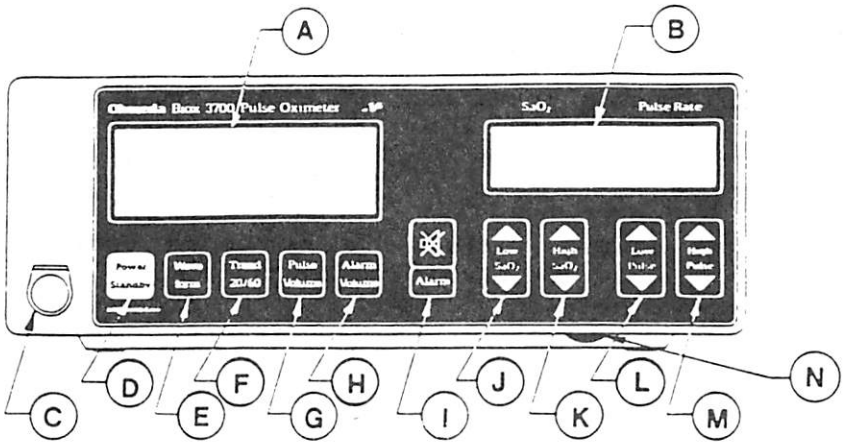



Figure 6. Front Panel

### 2.1.1 Front Panel

A. **Graphic Display** -- displays the Signal Strength Indicator, Response Mode Information, Battery Status Information, Plethysmographic Waveform, Trend Data, Status Messages and Alarm Messages.

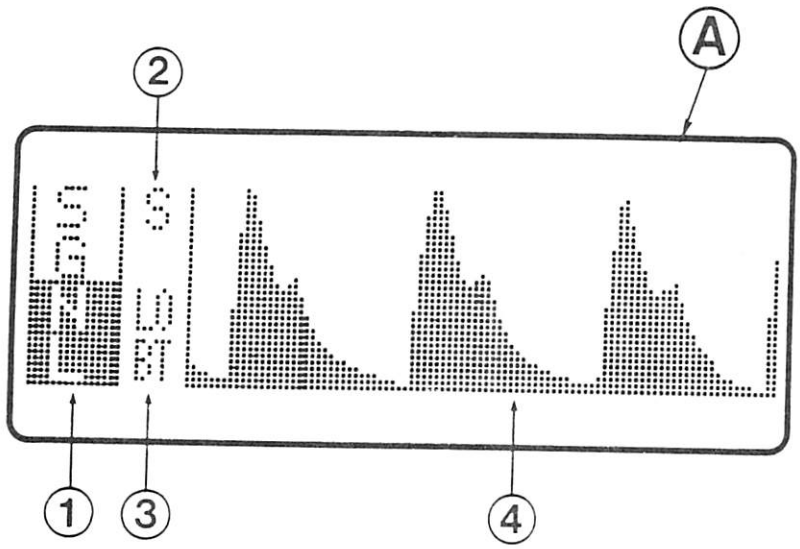



Figure 7. Graphic Display

Parts of the Graphic Display:

1. "SGNL" (Signal Strength Indicator) -- a bar graph that indicates the received pulsatile signal. The higher the bar, the stronger the signal. The height of the bar is determined by several factors including tissue perfusion at the probe site, and the capability of the tissue under test to pass the incident light.

   **If the bar graph is 5 pixels or less continuously for 5 seconds or more, the Status Message LO QUALITY SGNL appears above the waveform on the Graphic Display, indicating $SaO_2$ may not be accurate.** For example, the probe may be improperly attached to the patient. Perfuse (massage) the test site and reapply the probe, or select an alternate test site.

   NOTE: If the bar graph is at 1 pixel for 5 seconds or more, the Digital Display will dash. The audible alarm will sound if either the SaO2 or Pulse rate alarm are activated.

2. "S" (or "F" or "N") -- indicates the selected Response Mode (averaging time for $SaO_2$ and Pulse Rate). The default mode is NORMAL (N).

   To change between the three Response Modes, depress and hold the WAVEFORM key until the message indicating the desired averaging time is displayed.

| RESPONSE MODE | SaO2 AVERAGING | PULSE RATE AVERAGING |
|---|---|---|
| S (Slow) | 12 seconds | 12 seconds |
| N (Normal) | 6 seconds | 12 seconds |
| F (Fast) | 3 seconds | 5 seconds |

3. "BT" (Battery) -- indicates that the Oximeter is operating on battery power (approximately one and one half hours of continuous operation from a full charge).

   "LO BT" (Low Battery) -- displayed when the battery voltage is getting low, indicating that there is approximately 5 minutes of operation time remaining. See Section 5.2 for recharging instructions. (NOTE: This Status Message is not seen when viewing the Trend Graphs.)

4. Plethysmographic Waveform -- The "photo-plethysmographic" waveform represents the blood volume change of the hemodynamic system assuming no other factors (e.g. motion artifact) are present. The waveform autoscales (adjusts automatically) according to the strength of the signal.

B. **Digital Display** -- displays the $SaO_2$ and Pulse Rate alarm limits and the $SaO_2$ and Pulse Rate readings.

The parts of the Digital Display are:

1. $SaO_2$ Numeric Display -- calculated $SaO_2$
2. Low $SaO_2$ Alarm Limit -- threshold for low $SaO_2$ alarm
3. High $SaO_2$ Alarm Limit -- threshold for high $SaO_2$ alarm
4. Pulse Rate Numeric Display -- calculated Pulse Rate
5. Low Pulse Rate Alarm Limit -- threshold for low Pulse Rate alarm
6. High Pulse Rate Alarm Limit -- threshold for high Pulse Rate alarm

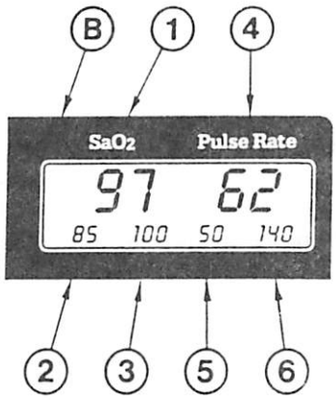



Figure 8.
Digital Display

C. **Probe Plug Connection** -- Plug probes supplied with this model Oximeter into this nine hole connector.

**CAUTION** Use ONLY the Ohmeda probes and cables specified in Section 4 with this oximeter. Otherwise, damage to the equipment may result.

D. **Power/Standby** -- Depressing this key once turns the Oximeter ON (OPERATIONAL MODE). Depressing it a second time turns the Oximeter OFF (STANDBY MODE). In the Standby Mode the battery recharges as long as the unit is plugged into AC mains power; Trend Data is also maintained. NOTE: No displays are visible while in Standby Mode.

E. **Waveform** -- Depressing this key while in the Trend Display mode will restore the plethysmographic waveform.

Also, depress and hold this key to change between the three Response Modes.

## 2.2 PREOPERATIVE CHECKLIST

**WARNINGS** FAILURE OF OPERATION: If the Oximeter fails to respond as described, do NOT use it until the situation has been corrected by Ohmeda-trained service personnel.

PATIENT SAFETY: If a probe is damaged in any way, discontinue use immediately.

**CAUTION** Use ONLY the Ohmeda probes and cables specified in Section 4 with this oximeter. Otherwise, equipment damage may result.

**Perform the following tests DAILY to assure proper operation of the Oximeter and probes:**

### 2.2.1 Oximeter

**VISUAL INSPECTION:**

1. Inspect the Oximeter case for damage.
2. Ensure the display windows are clean. (See Section 5.1.1)

**FUNCTIONAL INSPECTION:**

1. Connect a probe to the Oximeter. Attach the probe to either a finger or an ear.
2. Turn the Oximeter on. An automatic self-diagnostic test is performed with the following message appearing on the Graphic Display:

OHMEDA-BIOX
3700/3710
REVISION:X
SYSTEM CHECK

(NOTE: X represents an alphanumeric value)

Next, the Status Message SYSTEM OPERATIONAL should appear. If necessary, adjust the displays with the Contrast Adjust thumbwheel (located under the right side of the front panel).

**IMPORTANT:** **All patient alarms are automatically suppressed for <u>one minute</u> after the SYSTEM OPERATIONAL message appears.**

3. Verify that high and low $SaO_2$ and Pulse Rate alarm limits and readings appear on the Digital Display.

4. Verify that the Patient Alarms are functional. Set the high and low $SaO_2$ and Pulse Rate alarm limits beyond the patient readings. Ensure the alarm tone sounds, and the violated alarm limit and reading flashes on the Digital Display. The red alarm light should also flash.

5. Verify the Probe Alarms are functional:

   A. Remove the probe from the finger or ear. Ensure the Alarm Message PROBE OFF PATIENT appears on the Graphic Display and the alarm tone sounds and the red alarm light flashes.

      NOTE: The PROBE OFF PATIENT Alarm Message may NOT occur with the Flex II Probe or SoftProbe.

   B. Unplug the probe from the Oximeter. Ensure the Alarm Message NO PROBE CONNECTED TO UNIT appears on the Graphic Display and the alarm tone sounds and the red alarm light flashes.

6. Depress POWER/STANDBY to turn the Oximeter off. No displays should be visible.

### 2.2.2 Probes

1. Check that the probe is the correct model before connecting it to the Oximeter (refer to Section 4).

2. If using a Finger Probe, Ear Probe, or FingerClip Probe verify that the probe opens and closes smoothly. If there is any unevenness or variation in the closing motion, replace the probe.

3. Ensure that there is no foreign material such as tape (EXCEPTON: adhesive disks used to secure probe) or cotton covering either the emitter or detector.

4. Check that the probe connector makes a firm connection with the Oximeter.

5. Check that the probe cable is not twisted, sliced, or frayed.

6. Turn the Oximeter on; check that the probe's red LED is on.

## 2.3 Calibration

**WARNING** DATA VALIDITY: Calibration is verified during power up. Do NOT operate the Oximeter unless it is properly calibrated. Inaccurate patient $SaO_2$ readings will result.

Whenever the Device Failure Message CALIBRATE UNIT appears on the Graphic Display, the operator of the Oximeter should perform the following procedure:

1. Locate the Calibration Access Plug underneath the Oximeter chassis.

2. Remove the Calibration Access Plug. The calibration potentiometer (an adjustment screw) is situated directly inside of the Oximeter.

3. Using a small flat blade screwdriver (plastic or nonconductive), adjust the potentiometer by turning slowly in either direction -- continue until the calibration reading on the Digital Display is 0.0 ($\pm$ 0.1) and wait for it to stabilize.

4. Replace the Calibration Access Plug in the bottom of the Oximeter chassis.

5. Depress the WAVEFORM key. The Status Message OHMEDA-BIOX 3700/3710 REVISION:X SYSTEM CHECK and then SYSTEM OPERATIONAL should appear on the Graphic Display. The Oximeter is ready for use.

If the Oximeter fails to respond as described, DO NOT USE IT. Contact an Authorized Ohmeda Service Representative for assistance (See rear cover of this manual).

## 2.4 Handle Positioning

The handle allows the Oximeter to be used in a variety of positions. To move the handle, gently pull out on its sides and rotate it to the desired position. The spring-loaded handle automatically snaps into position. **Do not force the handle or attempt to rotate it without first pulling out on both sides.**

The following are suggested handle positions:

**POSITIONED ON A FLAT SURFACE**

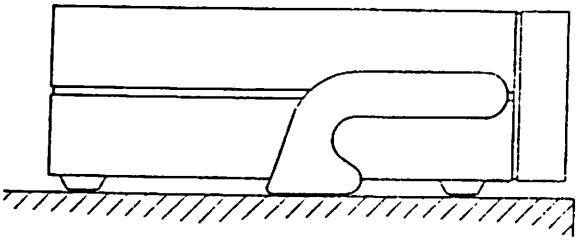
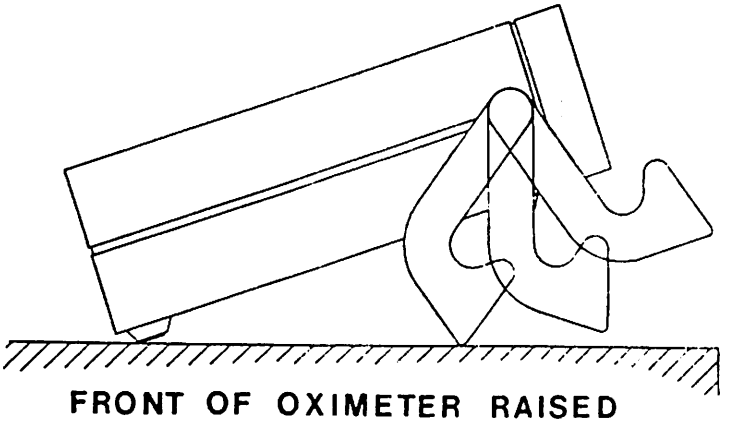
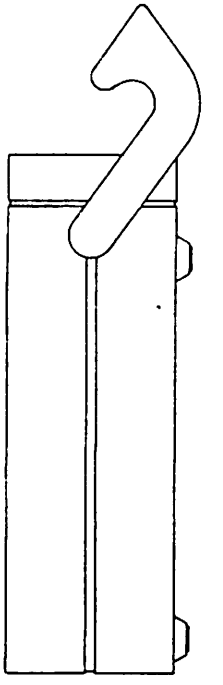


Figure 10.



**FRONT OF OXIMETER RAISED**

Figure 11.



**HAND CARRY**

Figure 12.

2.4 Handle Positioning (cont.)

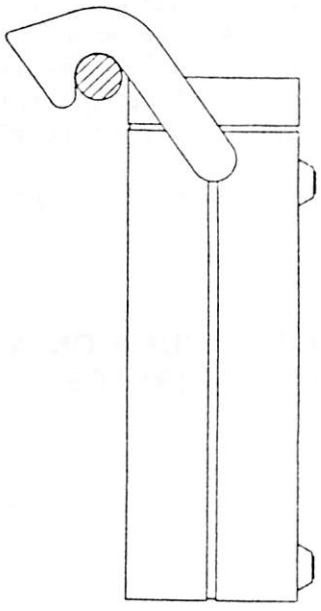
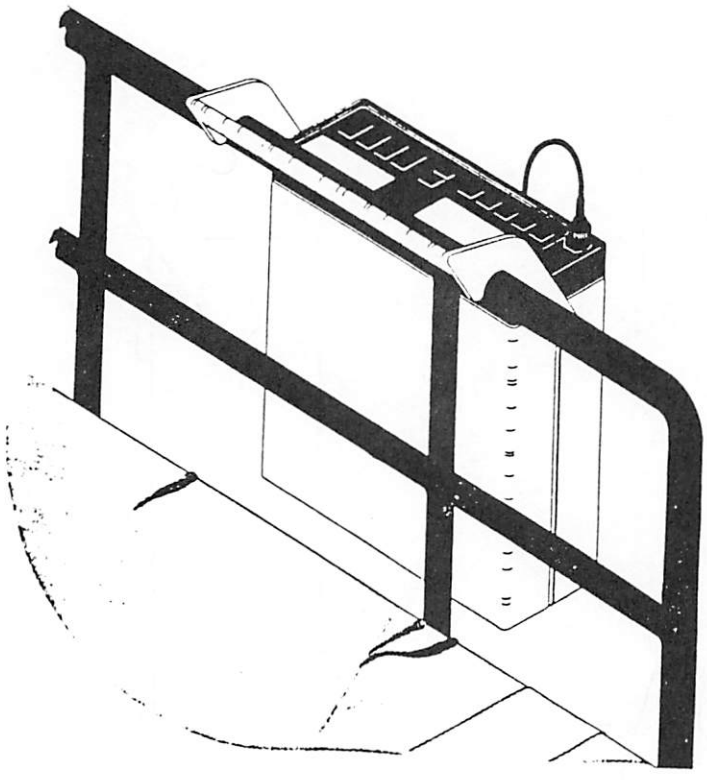


Figure 13.

HOOKED ON TO BED RAIL



## 3.1 General Operation Guidelines

### 3.1.1 Start Up

**WARNINGS**

DATA VALIDITY: Excessive ambient light, excessive motion, low perfusion, or electrical interference at the probe site may cause erroneous readings. To ensure accuracy, check for adequate signal strength and a repeatable pulsatile waveform.

EXPLOSION HAZARD: Do NOT use in the presence of flammable anesthetics or other flammable substances.

FAILURE OF OPERATION: If the Oximeter fails to respond as described, do NOT use it until the situation has been corrected by Ohmeda-trained service personnel.

PATIENT SAFETY: If a probe is damaged in any way, discontinue use immediately.

**CAUTIONS**

Use ONLY the Ohmeda probes and cables specified in Section 4 with this oximeter. Otherwise, equipment damage may result.

Do NOT apply tension to the probe cable. Probe damage may result.

1. Plug Oximeter into AC mains power (MAKE SURE that the voltage selector on the rear panel matches the available line voltage; see page ix), or use battery power.
2. Determine which probe to use and plug it into the probe connector. (See Sections 4.1 & 4.2)
3. Attach the probe to the patient. (See Section 4.3)
4. Depress POWER/STANDBY to turn the Oximeter on. If necessary, adjust the displays with the Contrast Adjust thumbwheel which is located under the front panel.

The following is displayed:

* 8's appear on the Digital Display
* The following Status Message appears on the Graphic Display:

**OHMEDA-BIOX**
**3700/3710**
**REVISION:X**
**SYSTEM CHECK**

with X representing an alphanumeric value.

During this time the system goes through a complete diagnostic self-test (electronics, battery status, calibration accuracy), and sets the Default Parameters (see Section 3.1.2). This self-test takes approximately 10-15 seconds.

5. If no errors are found during the self-test, the following Status Message appears momentarily on the Graphic Display:

**SYSTEM OPERATIONAL**

The Oximeter is now fully operational.

(If the Oximeter is operating on battery power, the message BATTERY IN USE will appear momentarily, too.)

6. The plethysmographic waveform appears on the Graphic Display, along with the Signal Strength Indicator bar graph, and the letter corresponding to the Response Mode selected.

(If the Oximeter is operating on battery power, BT will be displayed next to the plethysmographic waveform.)

Dashes (---) appear on the Digital Display until the $SaO_2$ and Pulse Rate readings have stabilized (approximately 12 seconds). Then $SaO_2$ and Pulse Rate readings appear on the Digital Display.

As the patient's $SaO_2$ reading becomes higher or lower, the pitch of the pulse rate indicator audio tone changes with the reading. For example, as the $SaO_2$ reading becomes lower, the pitch of the pulse indicator audio tones also becomes lower.

7. To determine if the probe is on correctly and the data is verifiable, see the Signal and Data Validity Section (Section 3.2).

### 3.1.2 Default Settings

A DEFAULT PARAMETER refers to a Volume Level or High/Low Alarm Limit automatically set by the Oximeter when it is turned on.

| PARAMETERS | DEFAULT SETTINGS | RANGES |
|---|---|---|
| High $SaO_2$ Limit | --- (indicates OFF) | 70 - 100% |
| Low $SaO_2$ Limit | 90% | 50 - 100% |
| High Pulse Rate | --- (indicates OFF) | 70 - 250 BPM* |
| Low Pulse Rate | 50 BPM | 40 - 200 BPM* |
| Alarm Volume | 4 | 1 - 10 |
| Pulse Volume | 4 | OFF - 10 |
| Response Time | N | N, S, F |

* BPM = Beats Per Minute

### 3.1.3 Key Functions

| KEY | ACTION |
|---|---|
| **POWER/STANDBY** | Turns the Oximeter on (Operational Mode) and off (Standby Mode). |
| **WAVEFORM** | Depressing for 3 seconds will allow you to access (and then change between) the three Response Modes.<br><br>If you are in the Trend 20/60 mode, depressing the Waveform key will return the waveform to the Graphic Display. |
| **TREND 20/60** | If you are in: / Action:<br>Waveform / Changes to 20 Minute Trend Graph<br>20 Min Trend Graph / Changes to 60 Minute Trend Graph<br>60 Min Trend Graph / Changes to 20 Minute Trend Graph<br><br>---<br><br>Depressing this key for 3 seconds puts the Oximeter in the Trend Output Mode, and displays the message TREND OUTPUT MODE, START CHART RECORDER, HIT TREND KEY TO START OUTPUT. (See Appendix C for complete details.)<br><br>---<br><br>Depressing this key while depressing POWER/STANDBY displays PREVIOUS TREND DATA AVAILABLE (see Section 3.3.2), and then the Oximeter is operational.<br><br>--- |

| KEY | ACTION |
|---|---|
| **PULSE VOLUME** | Adjusts the volume setting for the pulse tone |
| **ALARM VOLUME** | Adjusts the volume setting for the audible alarms. |
| **ALARM SILENCE** | Silences all audible alarms for 2 minutes, regardless if other alarms occur during this 2 minute interval. The flashing red alarm light changes to a steady red light to indicate alarm silence. If an alarm condition still exists after 2 minutes, the audible tone and flashing red light resume.<br><br>**EXCEPTION: During a PROBE OFF or NO PROBE alarm, the Alarm Silence key silences the audible alarm until either: the specific alarm condition is remedied, a different alarm condition is detected, or a different message is displayed on the front panel other than Trend.** |
| **LOW $SaO_2$** | Raises or lowers the low $SaO_2$ alarm limit.<br><br>Depressing this button (the DOWN arrow) while depressing POWER/STANDBY turns the Oximeter on and puts it into the User Calibration Mode (see Section 2.3). |
| **HIGH $SaO_2$** | Raises or lowers the high $SaO_2$ alarm limit. |
| **LOW PULSE** | Raises or lowers the low Pulse Rate alarm limit. |
| **HIGH PULSE** | Raises or lowers the high Pulse Rate alarm limit. |

### 3.1.4 Stress and Exercise Testing

**WARNING** DATA VALIDITY: Excessive ambient light, excessive motion, low perfusion, or electrical interference at the probe site may cause erroneous readings. To ensure accuracy, check for adequate signal strength and a repeatable pulsatile waveform.

**CAUTION** Do NOT apply tension to the probe cable. Probe damage may result.

**Proper patient and Oximeter set-up are critical for obtaining accurate data.**

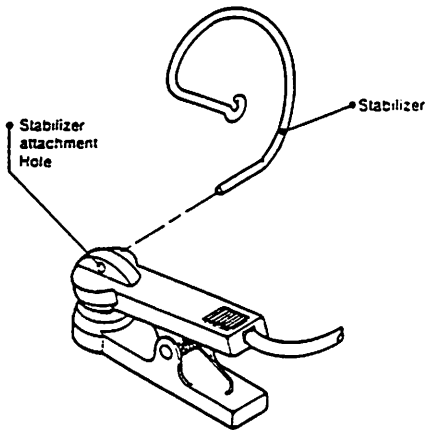
Setting up the Oximeter:

Ensure that the Oximeter is in the Slow Response Mode (12 second average) to decrease the effect of motion artifact on the calculated $SaO_2$.

Set the Patient Alarms at the desired limits (see Section 2.1.1).

Attaching the Ear Probe to the patient:

1. Insert the ear probe stabilizer into the hole on the ear probe housing.
2. Massage the ear lobe with an isopropyl alcohol (70%) pad, or rubefacient cream[1] for 20-30 seconds to increase perfusion. Strong vasodilator cream such as nitroglycerin paste is NOT recommended.




Attachment of Stabilizer to Ear Probe

Figure 14.

[1] An agent that causes reddening of the skin by producing local vasodilation; such agents may be bought over-the-counter and should contain 10-30% Methyl Salicylate and 2-10% Menthol.

3. Place the ear probe stabilizer on the ear.

4. Center the ear probe on the lower fleshy part of the lobe with the rounded (emitter) side toward the head. Be certain that the photodetector window is fully covered by the ear tissue.

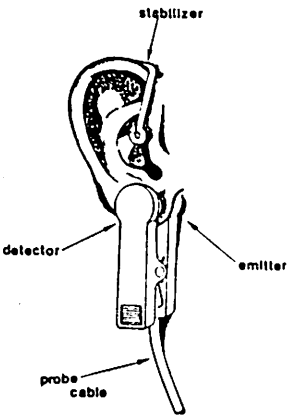



Figure 15.

5. Do NOT position the ear probe where cartilage is present, nor allow it to press against the side of the head.

6. Place the elastic headband on the patient's head.

7. Position the ear probe cable underneath the patient's chin.

8. Route the cable up along the opposite side of the patient's head in front of the ear.

9. Loop the cable up approximately 3 to 6 inches and tuck it inside the headband.

10. Route the cable down behind the ear.

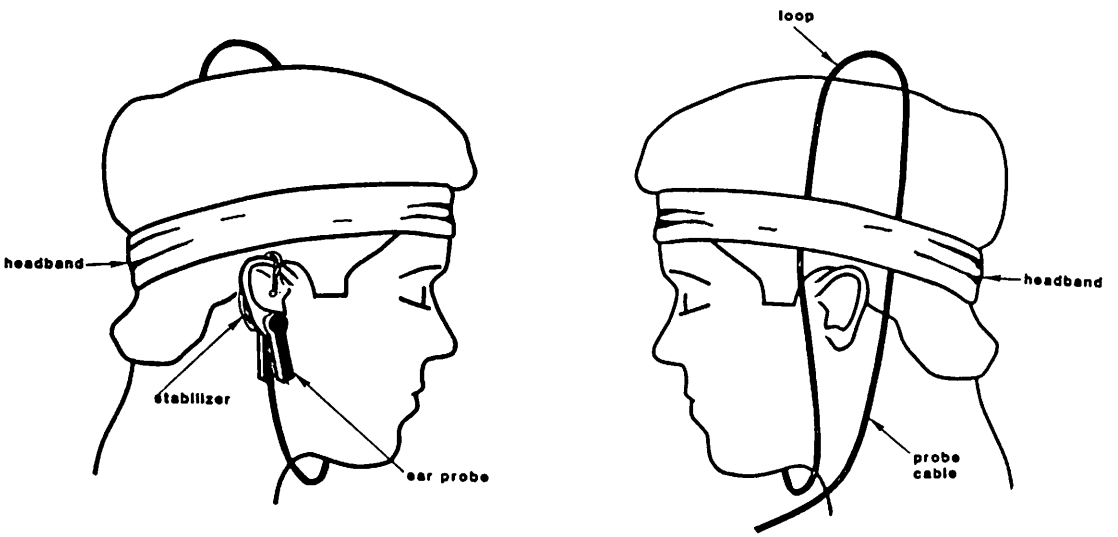



Figure 16.

11. To determine if the probe is attached correctly and the display data is verifiable see the Signal and Data Validity Section (Section 3.2).

12. It has been noted that letting the patient view the plethysmographic waveform enables them to assist in reducing motion artifact. To test for interference during exercise:

    A. Slowly move the patient's head from side to side.
    B. Next, slowly move the patient's head up and down.
    C. The $SaO_2$ should not fluctuate more than 1%.
    D. As the patient's head moves, watch that the ear probe and cable do not move on the ear and the cable does not tug on the probe.

13. If vigorous exercise is anticipated, have the patient quickly move their head. Some readjustment of the cable and headband may be necessary to eliminate motion artifact (See Signal and Data Validity Section, Section 3.2).

    NOTE: Adhesive disks may be used to additionally secure the probe. See Section 4.3.3 B, Adhesive Disks.

## 3.2 Signal and Data Validity

**WARNING** DATA VALIDITY: Excessive ambient light, excessive motion, low perfusion, or electrical interference at the probe site may cause erroneous readings. To ensure accuracy, check for adequate signal strength and a repeatable pulsatile waveform.

It is of utmost importance to determine that the probe is attached to the patient correctly and the data is verifiable. To make this determination three indicators from the Oximeter are of assistance. It is critical to observe all three indicators simultaneously when ascertaining signal and data validity.

1. Three complete passes of the plethysmographic waveform should be easily identified, although the waveform shape may vary from patient to patient. Under normal conditions, the plethysmographic waveform corresponds to the arterial pressure waveform. The typical plethysmographic waveform indicates not only a good waveform, but helps the user find a probe placement with the least noise spikes present.

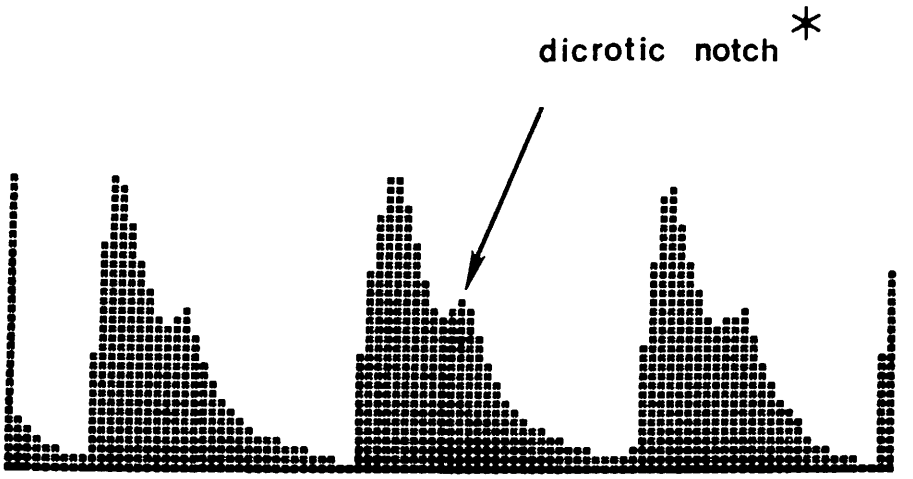



Figure 17. Typical Plethysmographic Waveform

* Dicrotic Notch - a notch on the descending limb of the normal arterial pulse tracing, corresponding to aortic valve closure. (Gould Medical Dictionary, 3rd Ed., New York: McGraw Hill Book Co., 1972.)

If noise is seen on the waveform because of poor probe placement, the detector may not be flush with the test site. Check that the probe is secured and the tissue sample is not too thick. Pulse Rate is determined from the plethysmographic waveform which can be disrupted by a cough or other hemodynamic pressure disturbances. Motion at the test site is indicated by noise spikes in the normal waveform. It has been noted that letting the patient view the plethysmographic waveform enables them to assist in reducing motion artifact (e.g., during stress testing).

**If three good passes of the plethysmographic waveform do not occur, check the patient and the Oximeter set up.**

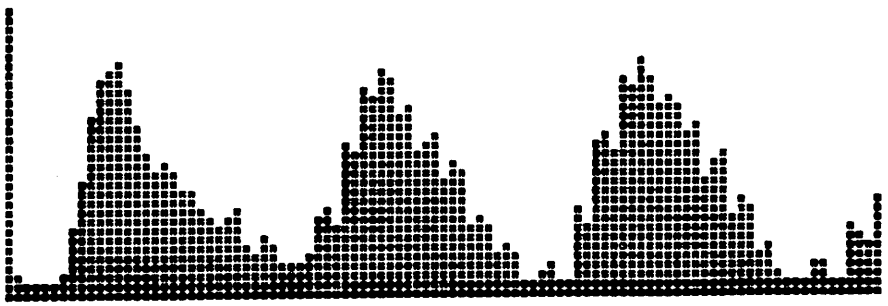


Figure 18. Noisy Plethysmographic Waveform

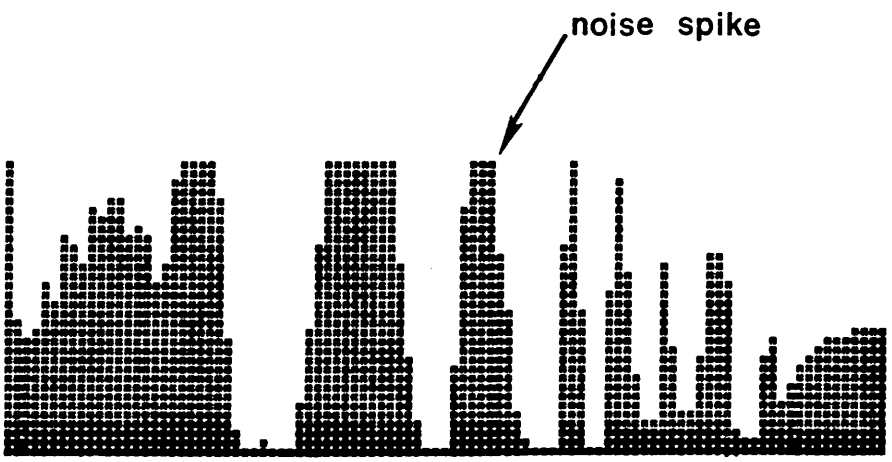



Figure 19. Very Noisy Plethysmographic Waveform (Motion Artifact)

2. The Signal Strength Indicator Bar Graph should be close to full scale, which is the desired height of the bar graph to assure a strong signal. Very dark pigmentation or a large distance between the emitter and the detector can reduce the signal strength and result in a poor signal. In case the signal strength is half scale or less, a test site with a shorter distance between the emitter and the detector might be a possible solution. If the bar graph is 5 pixels or less continuously for 5 seconds or more, the Status Message LO QUALITY SGNL appears above the waveform on the Graphic Display and the data may be questionable. Check the patient and the Oximeter set up.

IMPORTANT: If the pulse rate drops to 20 BPM or less, or if the Signal Strength Indicator remains at 1 pixel for 5 seconds or more, or if the quality of the signal is so low that valid saturation and pulse rate readings cannot be obtained, both $SaO_2$ and Pulse Rate readings will dash. Additionally, if either or both of the $SaO_2$ and Pulse Rate alarms are enabled, the alarm tone sounds, the red alarm light flashes, and the violated limit(s) flash on the Digital Display.

3. The stability of the $SaO_2$ readings can also be used as an indicator of signal validity. Although stability is a relative term, with a small amount of practice one can get a good feeling for changes that are artifactual or physiological and the speed of each. The stability of the readings over time is affected by which Response Mode has been selected. In the Slow mode (twelve second averaging), the readings have a tendency to be more stable since the signal averaging is done over a longer period of time than in the Fast (three seconds) or Normal (six seconds) modes.

## 3.3 Trend Data

### 3.3.1 Description

The minimum calculated $SaO_2$ value for every 12 second period is stored by the Oximeter for the Trend Data. Depress the SaO2 TREND 20/60 key once to display the calculated $SaO_2$ values from the previous 20 minutes. Each column of the 20 minute Trend Graph represents 12 seconds of data. A second depression of the $SaO_2$ TREND 20/60 key displays the calculated $SaO_2$ values from the previous 60 minutes of recorded data. On the 60 minute Trend Graph each column represents the minimum of each 36 seconds of data.

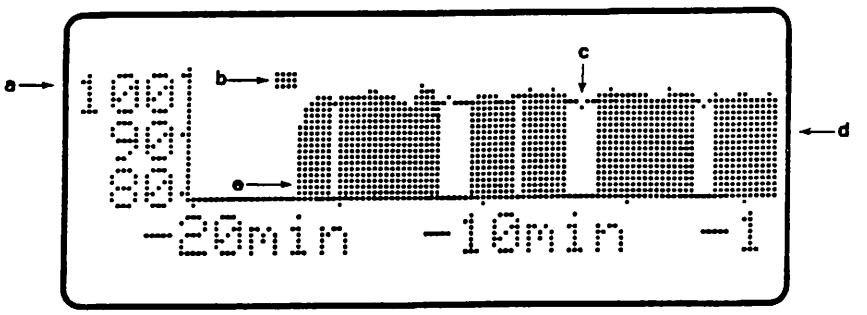



Figure 20. 20 Minute Trend Graph

a. $SaO_2$ percentage.

b. A three pixel (dot) column in the 98% - 100% $SaO_2$ range indicates a Probe Alarm Condition, or an INTERFERENCE DETECTED condition.

c. One pixel (dot) in a column indicates when a LO QUALITY SIGNAL condition occurred. The dot represents the minimum saturation level in that 12 seconds. A LO QUALITY SIGNAL condition must occur at least at the lowest saturation value for the entire 12 seconds for it to be saved in the Trend Data.

d. The Trend Graph continually updates and aligns itself in time, with the most recent Trend Data collected in the right column on the graph.

e. The Trend Data collected 20 minutes ago is in the left column on the graph. In the above example, only about 17 minutes of data has been collected since the Oximeter was turned on.

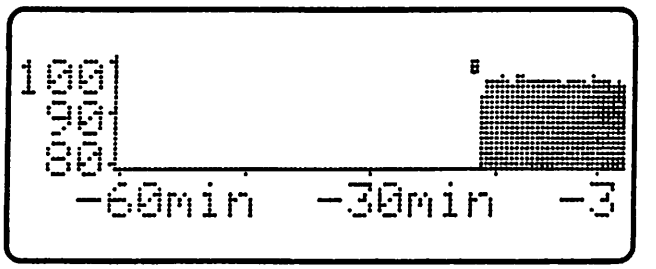



Figure 21. 60 Minute Trend Graph

Each depression of the SaO2 TREND 20/60 key causes the Trend Graph to alternate between displaying 20 minutes of Trend Data and 60 minutes of Trend Data. The Trend Graph remains on the display until the WAVEFORM key is depressed -- then the plethysmographic waveform appears again.

During a PROBE OFF or NO PROBE Alarm Condition, an Alarm Message replaces the Trend Graph on the Graphic Display. Depress the SaO2 TREND 20/60 key to re-enter the Trend Graph Display.

Trend Data is not erased when the Oximeter is turned off, as long as the battery is not disconnected or discharged so much as to be unable to maintain the memory power. (The RECHARGE BATTERY Alarm Message will be displayed before this condition occurs.) The Oximeter is capable of storing up to eight hours of Trend Data, which can be accessed through the analog or digital outputs. The 8 hours of Trend Data is continually updated as new information is collected. It is saved in memory and can be restored for viewing or output.

### 3.3.2 Restoring Previous Trend Data

1. Holding the SaO2 TREND 20/60 key while turning the Oximeter on restores the previous 8 hours of Trend Data. The previous 8 hours of Trend Data can be accessed through the Analog or Digital output. The most recent 20 or 60 minutes of Trend Data can be viewed on the 20 or 60 Minute Trend Graphs.

2. The Status Message, PREVIOUS TREND DATA AVAILABLE is momentarily displayed on the Graphic Display.

3. The Status Message, OHMEDA-BIOX 3700/3710 REVISION:X SYSTEM CHECK IN PROCESS momentarily appears on the Graphic Display while the Oximeter performs its diagnostic self-test.

4. The Status Message SYSTEM OPERATIONAL appears on the Graphic Display indicating the Oximeter is operating correctly. Dashes appear on the Digital Display until the readings have stabilized.

5. When the probe is on a patient, the plethysmographic waveform appears on the Graphic Display and $SaO_2$ and Pulse Rate readings appear on the Digital Display. The system is fully operational.

6. Depress the SaO2 TREND 20/60 key, and the previous Trend Data is displayed along with the present Trend Data.

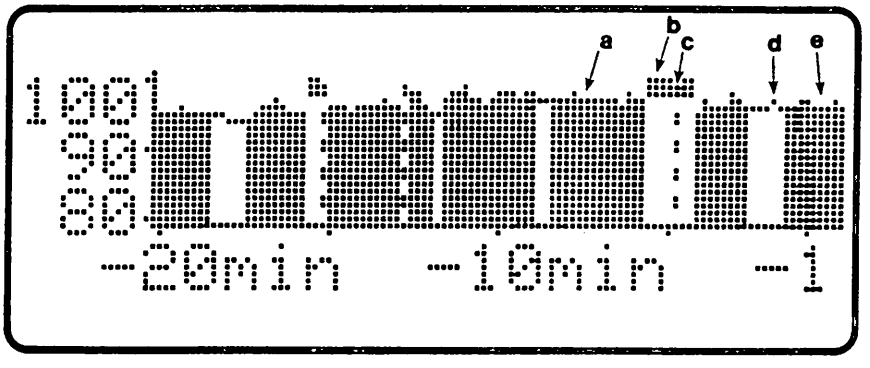



Figure 22. 20 Minute Trend Graph of Restored Trend Data

a. Previous Trend Data.

b. A three pixel (dot) column in the 98% - 100% $SaO_2$ range indicates a condition where $SaO_2$ data could not be collected, (such as a NO PROBE, PROBE OFF, or INTERFERENCE DETECTED condition).

c. A column with five sets of 2 pixel (dot) indicates when the Oximeter was turned off.

d. One pixel (dot) in a column indicates when a LO QUALITY SIGNAL condition occurred. The dot represents the minimum saturation level in that 12 seconds. A LO QUALITY SIGNAL condition must occur at least at the lowest saturation value or the entire 12 seconds for it to be saved in the Trend Data.

e. Current Trend Data.

## 3.4 Status Messages

The Ohmeda Biox 3700 Pulse Oximeter acknowledges the user's actions with the instrument by visually displaying STATUS MESSAGES on the Graphic Display. These messages guide and inform the user on the Oximeter's operating condition.

| MESSAGE | DESCRIPTION |
|---|---|
| ALARM VOLUME HOLD KEY TO SET VOLUME LEVEL IS-1 | Displayed when the ALARM VOLUME key is initially depressed. Continually holding down this key increases the volume in steps and displays the volume level. |
| BATTERY IN USE | Displayed momentarily during Power Up when the battery is being used to operate the Oximeter. |
| BT | Displayed next to the plethysmographic waveform while the Oximeter is operating from battery power. |
| F | Displayed next to the plethysmographic waveform when the Oximeter is in the Fast Response Mode (3 second averaging). |
| FAST RESPONSE SELECTED | Displayed momentarily when the Fast Response Mode has been selected. |
| INTERFERENCE DETECTED $SaO_2$ & PULSE RATE MAY BE INVALID | Displayed when the input signal is too erratic to be processed. This can be caused by strong RF (radio frequency) interference, sometimes generated by electrosurgery.<br><br>**IMPORTANT:** When strong interference is detected by the Oximeter, the $SaO_2$ and pulse rate readings do not change. If this interference persists beyond the time periods indicated below, the INTERFERENCE DETECTED message is displayed. After the interference has stopped, the Oximeter begins collecting |

data again. The $SaO_2$ and pulse rate readings return to the display approximately 2 seconds after the interference stops.

| RESPONSE MODE | Time Period before INTERFERENCE DETECTED message is displayed: |
|---|---|
| Slow | 24 seconds |
| Normal | 24 seconds |
| Fast | 12 seconds |

| MESSAGE | DESCRIPTION |
|---|---|
| LO BT | Displayed next to the waveform when approximately 5 minutes of battery operation are left. (This is not seen when viewing the Trend Graphs.) See Section 5.2 for recharging instructions. |
| LO QUALITY SIGNAL | Displayed above the plethysmographic waveform and indicates that the $SaO_2$ & Pulse Rate reading may be invalid due to unreliable data. |
| N | Displayed next to the plethysmographic waveform when the Oximeter is in the Normal Response Mode (6 second averaging). |
| NORMAL RESPONSE SELECTED | Displayed momentarily when the Normal Response Mode has been selected. |
| OHMEDA-BIOX 3700/3710 REVISION:X SYSTEM CHECK | Displayed momentarily when the Oximeter is turned on. (NOTE: X represents an alphanumeric value.) |

| MESSAGE | DESCRIPTION |
|---|---|
| OUTPUTTING TREND,<br>TIME REMAINING: X:XX<br>HIT TREND KEY<br>TO END OUTPUT | Displayed while the Oximeter is outputting the Trend Data via the $SaO_2$ and Pulse Rate Analog Outputs and Digital Output. |

NOTE: X:XX represents the hours and minutes left in the trend data output. It also represents the time before trend data output is complete, in minutes and seconds.

| | |
|---|---|
| PLEASE PLUG UNIT<br>INTO WALL OUTLET<br>TO DETERMINE<br>LINE FREQUENCY | Displayed at power-up when the Oximeter has lost the battery-backed RAM. |
| THANK YOU<br>UNIT MAY NOW RUN<br>ON BATTERY | Displayed when the Oximeter is plugged in. |
| PREVIOUS TREND<br>DATA AVAILABLE | Displayed when the TREND key is held while the Oximeter is turned on. This is necessary for viewing previous Trend Data on the 20 or 60 minute Trend Graph or outputting previous 8 hours of Trend Data through the Digital and Analog Outputs. |
| PULSE VOLUME<br>HOLD KEY TO SET,<br>VOLUME LEVEL IS OFF | Displayed when the PULSE VOLUME key is initially depressed. Continually holding down this key increases the volume in steps and displays the volume level. |
| PULSE WAVEFORM<br>SELECTED | Displayed momentarily when the WAVEFORM key is depressed during a Probe Alarm Condition. |
| RAM DATA INVALID<br>RE-INITIALIZING | Oximeter memory has been erased. Trend Data is lost. Unit automatically reinitializes and is ready for use. |

| MESSAGE | DESCRIPTION |
|---|---|
| S | Displayed next to the plethysmographic waveform when the Oximeter is in the Slow Response Mode (12 second averaging). |
| SLOW RESPONSE SELECTED | Displayed momentarily when the Slow Response Mode has been selected. |
| SYSTEM OPERATIONAL | Displayed after the diagnostic self-test upon power up, indicating the Oximeter passed all performance tests. |
| TREND MODE SELECTED | Displayed momentarily when the TREND key is depressed during an Alarm Condition except a NO PROBE or PROBE OFF condition. |
| TREND OUTPUT MODE START CHART RECORDER HIT TREND KEY TO START OUTPUT | Displayed momentarily when the Oximeter is ready to output the Trend Data. |

## 3.5 Alarm Messages

Alarm Messages appear on the Graphic Display alerting the user to conditions which need immediate attention. Check the patient and the Oximeter whenever any alarm condition occurs. In a situation where an $SaO_2$ or Pulse Rate limit is violated, only the Digital Display is affected.

3.5.1 The **PATIENT ALARM LIMIT CONDITION** occurs when the Oximeter detects conditions affecting patient status. Trend Data is collected during a Patient Alarm Limit Condition, and the alarm can be silenced for 2 minutes.

When this alarm condition occurs:

1. An alarm tone sounds,
2. The red alarm light flashes,
3. The violated alarm limit flashes on the Digital Display,
4. The out-of-range SaO2 or Pulse Rate reading flashes on the Digital Display.

**IMPORTANT**: If pulse rate drops to 20 BPM or less, or if the Signal Strength Indicator remains at 1 pixel for 5 seconds or more, or if the quality of the signal is so low that valid saturation and pulse rate readings cannot be obtained, both $SaO_2$ and Pulse Rate readings will be dashed. Concurrently, if either (or both) of the Low Pulse Rate or Low $SaO_2$ alarms are enabled, an alarm tone sounds, the red alarm light flashes, and the violated limit(s) flash on the Digital Display.

3.5.2 The **PROBE ALARM CONDITION** occurs when the Oximeter detects conditions affecting the probe or its placement or probe failure. Trend Data is collected during a Probe Alarm Condition, but the readings are set to zero. Alarms can be silenced for 2 minutes.

When this alarm condition occurs:

1. An alarm tone sounds,
2. The red alarm light flashes,
3. An Alarm Message appears on the Graphic Display,
4. Dashes appear on the Digital Display.

Depressing the Alarm Silence key in the case of a PROBE OFF or NO PROBE alarm will silence the audible alarm until either the specific alarm condition is remedied, a different alarm condition is detected, or a different message is displayed on the Front Panel (other than Trend).

3.5.3 During the **DEVICE FAILURE ALARM CONDITION** the Oximeter is not functional and the Trend Data is NOT collected. The alarm still can be silenced for 2 minutes.

In the case of RECHARGE BATTERY and POWER SUPPLY FAILURE the Oximeter automatically shuts off approximately 10 seconds after the message appears on the Graphic Display.

In the case of PROBE OR CIRCUIT FAILURE or A/D CONVERTER FAILURE, the Oximeter will alarm at volume 10 and then will shut down.

3.5.4 Message Descriptions / Troubleshooting Guide

WHENEVER **ANY** OF THE FOLLOWING MESSAGES APPEAR, YOU SHOULD:

* Turn the unit off, and

* Have the unit serviced

---

ANALOG SYNCHRONIZATION ERROR, SERVICE UNIT

CHARGING CIRCUIT FAILURE, SERVICE UNIT

MICRO-PROCESSOR ERROR, SERVICE UNIT

MICRO-PROCESSOR INTERRUPT ERROR, SERVICE UNIT

POWER SUPPLY FAILURE, SERVICE UNIT

RAM CHECK ERROR, SERVICE UNIT

RAM TEST ERROR HIGH BYTE, SERVICE UNIT

RAM TEST ERROR HIGH & LOW BYTES, SERVICE UNIT

RAM TEST ERROR LOW BYTE, SERVICE UNIT

RAM TEST ERROR TREND CHECKSUM, SERVICE UNIT

ROM TEST ERROR HIGH BYTE, SERVICE UNIT

ROM TEST ERROR HIGH & LOW BYTES, SERVICE UNIT

ROM TEST ERROR LOW BYTE, SERVICE UNIT

STACK ERROR PLEASE NOTE CONDITIONS AND SERVICE UNIT

SYSTEM ERROR X, PLEASE NOTE ERROR CODE AND SERVICE UNIT (X represents an alphanumeric value)

TEST SIGNAL DC REFERENCE ERROR, SERVICE UNIT

VOLTAGE REFERENCE FAILURE, SERVICE UNIT

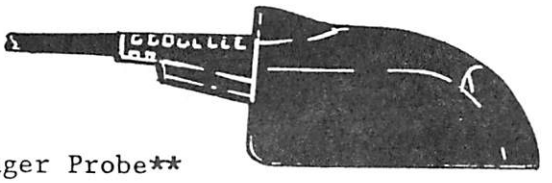
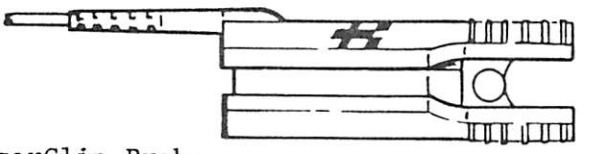
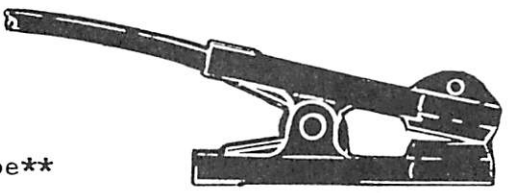
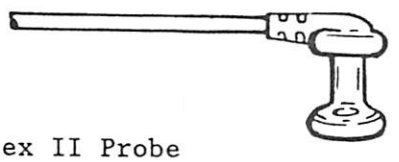
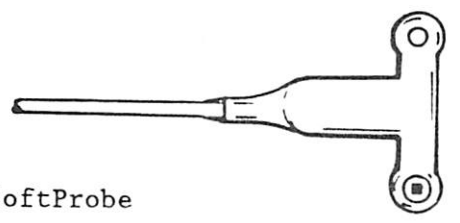
When any of the following messages appear, the user should take appropriate action as shown in the PROBABLE REMEDY column:

| ALARM MESSAGE | POSSIBLE CAUSES | PROBABLE REMEDY |
|---|---|---|
| A/D CONVERTER FAILURE, SERVICE UNIT (NOTE: unit alarms at Vol. 10 for 2 seconds, then shuts off) | Device unable to complete Analog to Digital conversion. | Have unit serviced. |
| CALIBRATE UNIT ADJUST POT AT BOTTOM HOLE VALUE = 0 ± .1 HIT WAVEFORM TO END | Calibration out of range after the Oximeter runs diagnostic self-test | See Calibration procedure, Section 2.3 |
| CANNOT IDENTIFY PROBE (SEE MANUAL) | Oximeter cannot identify the probe connected to it | Check probe model number (see Section 4.1.1), or replace probe. |
| INSUFFICIENT LIGHT DETECTED, CHECK PROBE SITE | 1. Dirt on the probe emitter or detector | 1. Clean the probe |
| | 2. Test site is dirty | 2. Clean the site |
| | 3. Misaligned or malpositioned probe | 3. Reposition the probe or select an alternate test site |
| | 4. Insufficient amount of light penetrating tissue sample | 4. Reposition the probe or select an alternate test site |
| | 5. Fingernail polish present | 5. Remove polish or use ear probe |
| | 6. Dark skin pigmentation | 6. Select an alternate test site |
| | 7. Detector failure | 7. Replace probe |

| ALARM MESSAGE | POSSIBLE CAUSES | PROBABLE REMEDY |
|---|---|---|
| NO PROBE CONNECTED TO UNIT | 1. May be incorrect probe model number | 1. Check the probe model number (see Section 4.1.1) |
| | 2. Probe not plugged in or not fully inserted into probe connector | 2. Insert probe plug into probe connector |
| PLUG UNIT INTO WALL OUTLET TO RECHARGE BATTERY | Battery unable to supply proper operating voltage; Unit shuts off automatically in about 10 seconds | Recharge battery (see Section 5.2) or operate from AC mains power |
| PROBE OR CIRCUIT FAILURE, REPLACE PROBE OR SERVICE UNIT (NOTE: unit alarms at Volume 10 for 2 seconds, then shuts off) | 1. Broken probe cable wire; in-operative LEDs; probe has failed | 1. Replace probe |
| | 2. Oximeter's probe circuitry has failed | 2. Have unit or probe serviced |
| PROBE OFF PATIENT (NOTE: this may not occur with the Flex II Probe or SoftProbe) | 1. Probe is off patient | 1. Attach probe to patient |
| | 2. Too much light is detected by probe photodetector | 2. Shield probe site from ambient light |
| | 3. Extremely thin tissue at test site | 3. Select an alternate test site |
| | 4. Artificial nail tips or long fingernails present | 4. Do NOT attempt to remove the nail; select an alternate test site |

## 4.1 Probe Selection

### 4.1.1 Probe Identification

| PROBE | PART NUMBER (cable length) |
|---|---|
|  Finger Probe** | BX#8122-005 (12 FT / 3.66 m)<br>BX#8122-001 ( 8 FT / 2.44 m) |
|  FingerClip Probe | BX#8124-001 (12 FT / 3.66 m)<br>BX#8124-002 ( 8 FT / 2.44 m) |
|  Ear Probe** | BX#8122-003 ( 8 FT / 2.44 m) |
|  Flex II Probe | BX#8122-007 (12 FT / 3.66 m)<br>BX#8122-006 ( 8 FT / 2.44 m) |
|  SoftProbe | BX#8123-001 (Neonatal - 8 FT)<br>BX#8123-003 (Pediatric - 8 FT) |

** **INCOMPATIBLE PROBES:** Although identical looking, probes with Identification Numbers 8102-XXX or 8117-XXX (with X representing an alphanumeric value) are NOT compatible with this Oximeter.

## 4.1.2 Determining Which Probe to Use

| PROBE | PATIENT POPULATION | RECOMMENDED USE | SUGGESTED SITE |
|---|---|---|---|
| Finger<br>or<br>FingerClip | Large child to Adult | * Routine monitoring | Any finger large enough to cover the detector |
| Ear | Child to Adult | * Stress and exercise testing<br>* Sleep studies<br>* Significant hand or finger motion | Ear lobe large enough to cover the detector & emitter. Use of the stabilizer recommended. |
| Flex II | Neonate to Adult | * Long-term monitoring<br>* Test sites are difficult to find on ear or finger<br>* In a transport situation | Neonate to Child - foot, palm, ankle, or thumb<br>Adult - thumb, finger, or toe |
| SoftProbe | Neonate to Adult | * Long-term monitoring<br>* Routine monitoring | Neonatal Probe -- foot or hand<br>Pediatric Probe -- thumb, toe, or finger |

NOTE: See Section 4.3 for Attaching / Removing probes.

## 4.2 Connecting / Disconnecting Probes to the Oximeter

**CAUTIONS** Use ONLY the Ohmeda probes and cables specified in Section 4 with this oximeter. Otherwise, equipment damage may result.

Do NOT apply tension to the probe cable. Probe damage may result.

* **CONNECTING** Insert the probe plug into the probe connector until an audible "click" is heard.

* **DISCONNECTING** Push down on the connector release button and pull the probe plug away from the receptacle.

NOTE: Use of the discontinued Probe Extension Cable #0380-1500-001 (BX#7000-083) is NOT recommended.

## 4.3 Attaching / Removing Probes

### 4.3.1 Ear Probe

**WARNINGS** PATIENT SAFETY: Prolonged monitoring or patient condition may require changing the probe site periodically. Move the probe if there is any sign of skin irritation or impaired circulation. Check the probe site at least every four hours.

DATA VALIDITY: Excessive ambient light, excessive motion, low perfusion, or electrical interference at the probe site may cause erroneous readings. To ensure accuracy, check for adequate signal strength and a repeatable pulsatile waveform.

**CAUTION** Do NOT apply tension to the probe cable. Probe damage may result.

1. Clean the surface of the probe before and after each patient use. (See Section 5.1.2)

2. Massage the ear lobe with an isopropyl alcohol (70%) pad, or rubefacient cream** for 20-30 seconds to increase perfusion. Strong vasodilator cream such as nitroglycerin paste is NOT recommended.

3. Center the ear probe with the rounded emitter (light source) side toward the head on the lower, fleshy part of the lobe. Be certain that the detector window is fully covered by the tissue and NOT exposed to light in the room, otherwise a poor signal results.

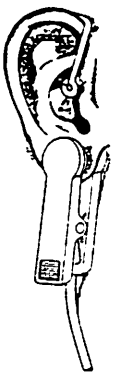


Figure 23.

Placement of Ear Probe on the Ear Lobe (side view)

** An agent that causes reddening of the skin by producing local vasodilation; such agents may be bought over-the-counter and should contain 10-30% Methyl Salicylate and 2-10% Menthol.

4. Do NOT position the ear probe where cartilage is present nor should it press against the side of the head. Use the ear probe stabilizer to position and secure the probe on the patient. Adhesive disks (see Section 4.3.3 B) may be used to additionally secure the probe.

5. To determine if the probe is attached correctly and the display data is verifiable, see the Signal and Data Validity Section. (See Section 3.2)

### 4.3.2 Finger Probe and FingerClip Probe

**WARNINGS** PATIENT SAFETY: Prolonged monitoring or patient condition may require changing the probe site periodically. Move the probe if there is any sign of skin irritation or impaired circulation. (**FINGER PROBE:** Check the probe site at least every four hours. **FINGERCLIP PROBE:** Change the probe site at least every four hours.)

DATA VALIDITY: Excessive ambient light, excessive motion, low perfusion, or electrical interference at the probe site may cause erroneous readings. To ensure accuracy, check for adequate signal strength and a repeatable pulsatile waveform.

DATA VALIDITY: An inflated blood pressure cuff on the same limb as the probe will cause erroneous readings. Select another site.

**CAUTION** Do NOT apply tension to the probe cable. Probe damage may result.

**Proper coverage of the photodetector is essential. Use the finger which best covers the photodetector and seats properly in the lower half of the probe housing.**

If the patient has long fingernails, or is wearing fingernail polish or artificial (cosmetic) fingernails:

* choose a different probe test site, or
* remove the fingernail polish or artificial fingernail

1. Clean the surface of the probe before and after each patient use. (See Section 5.1.2)

2. To attach either of these probes, insert the patient's finger into the probe housing until it touches the raised finger stop inside the probe. Be certain that the surface of the finger covers the detector window on the lower inside surface of the probe. The hand should be relaxed.
NOTE: The probe may be additionally secured by taping the cable to the back of the hand.

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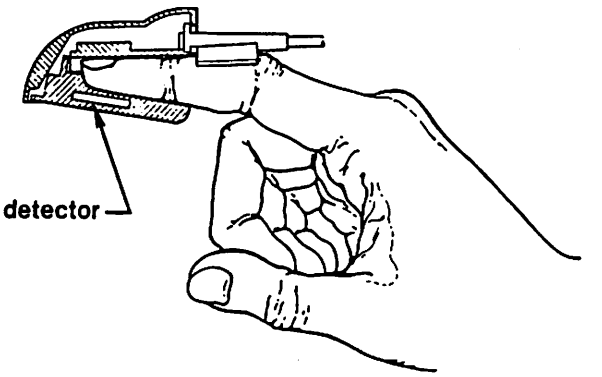



Figure 24.

Correct
Finger Probe
Attachment

---

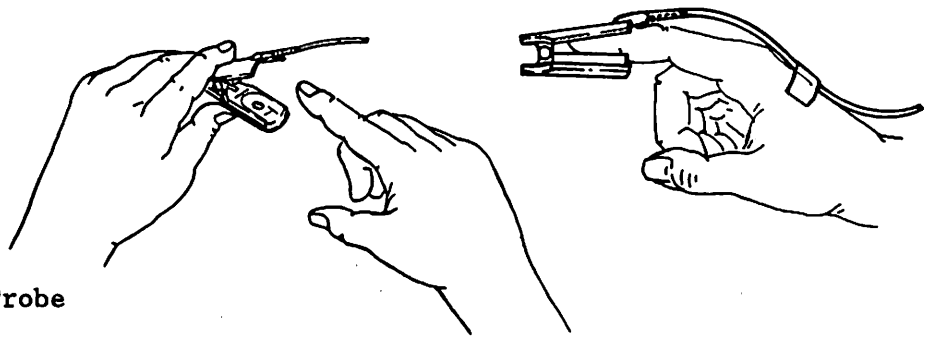


Figure 25.

Correct
FingerClip Probe
Attachment

---

3. To determine if the probe is attached correctly and the display data is verifiable, see the Signal and Data Validity Section. (Section 3.2)

### 4.3.3 Flex II Probe

**WARNINGS** PATIENT SAFETY: Exercise extreme care to assure continued circulation distal to the probe site after application.

PATIENT SAFETY: Prolonged monitoring or patient condition may require changing the probe site periodically. Move the probe if there is any sign of skin irritation or impaired circulation. **Change** the probe site at least every four hours.

DATA VALIDITY: Excessive ambient light, excessive motion, low perfusion, or electrical interference at the probe site may cause erroneous readings. To ensure accuracy, check for adequate signal strength and a repeatable pulsatile waveform.

DATA VALIDITY: An inflated blood pressure cuff on the same limb as the probe will cause erroneous readings. Select another site.

**CAUTION** Do NOT apply tension to the probe cable. Probe damage may result.

**IMPORTANT:** When attaching the probe to the patient, minimal pressure should be applied to the test site. THIS IS OF PARTICULAR CONCERN WITH NEONATAL APPLICATION.

Patient Sites for Monitoring:

Choice of probe site will vary depending on the size of the patient and site availability. Any site that gives a verifiable signal may be used.

For neonatal or pediatric use, some suggested sites are the palm of hand, sole of foot, ankle, calf and forearm. Additional choices in larger patients are the big toe, thumb and outer aspect of the foot proximal to the little toe.

Adult sites include the fingers, thumbs, or toes.

application procedures start on next page ---

A -- Flex II Probe Neonatal Application:

1. Clean the surface of the probe before and after each patient use. (See Section 5.1.2)

2. OPTIONAL: Apply Adhesive Disks (see page 4-9).

3. Place the detector side (cable side) of the probe on the bottom of the foot, and then place the emitter side on top of the foot.

   Ensure that the detector and emitter are opposite of each other.

   Ensure the detector is flush against the test site and is fully covered by skin tissue.

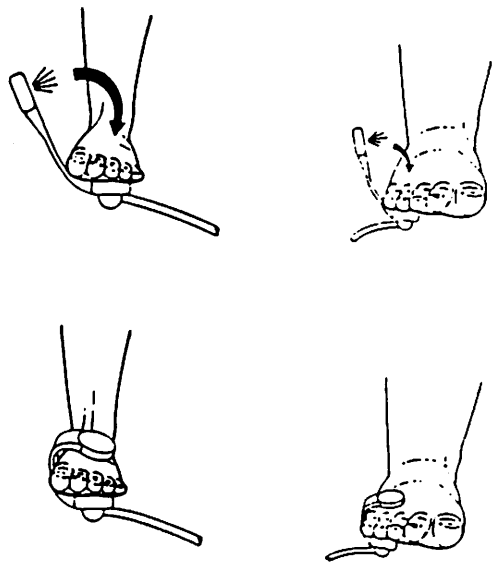


Figure 26. Flex II Probe Attachment (Neonatal)

For best signal strength:

* place the probe close to the toes

* for extremely small feet, place the probe toward the heel to ensure that the detector is fully covered by tissue

4. Apply a wrapping of your choice once around the foot. DO NOT RESTRICT CIRCULATION.

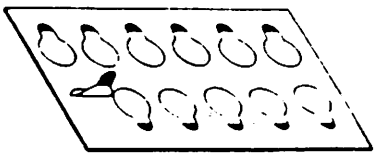
5. The probe can be further isolated from patient motion by taping the cable to the patient approximately 3 to 6 inches away from the probe head. DO NOT RESTRICT CIRCULATION.

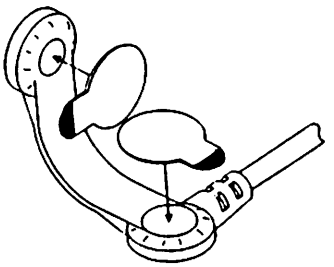
6. To determine if the probe is attached correctly and the data is verifiable, see the Signal and Data Validity Section. (See Section 3.2)

B -- Adhesive Disks (**OPTIONAL**):

**WARNING** PATIENT SAFETY: Where patients skin is fragile and/or sensitive to adhesive tape, the Adhesive Disks should NOT be used.

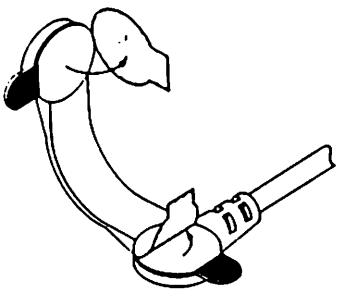
The Adhesive Disks are an optional item for use with some Ohmeda Biox Pulse Oximeter Probes. They may accomplish easy initial placement and enable a flush patient/probe interface.





Place one Adhesive Disk over the probe emitter and another over the probe detector.

Make sure the colored tab does not cover the emitter or detector surface.



Remove the paper cover from the Adhesive Disks.

Figure 27. Adhesive Disk Application

After monitoring, remove the Adhesive Disks, if used, from the probe. The Adhesive Disk is intended for one time use only. Apply new Adhesive Disks to the probe with each successive use.

C -- Flex II Probe Adult Application:

1. Clean the surface of the probe before and after each patient use. (See Section 5.1.2)

2. Select a test site that will ensure proper coverage of the photodetector.

3. To determine if the probe is attached correctly and the display data is verifiable, see the Signal and Data Validity Section (Section 3.2).

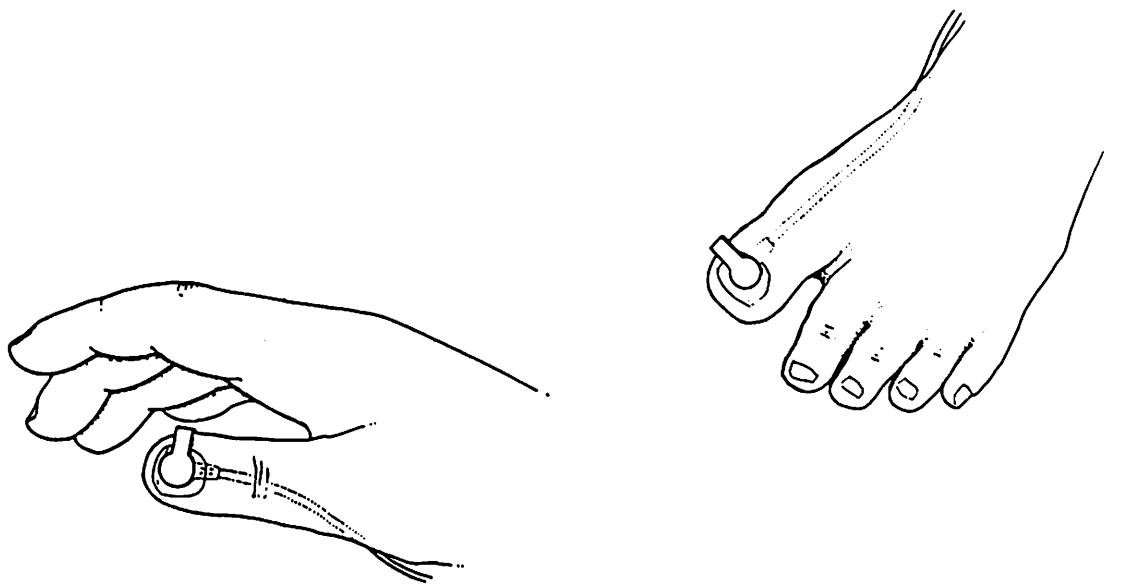


Figure 28. Flex II Probe Attachment (Adult)

### 4.4.4 SoftProbe

**WARNINGS**

DATA VALIDITY: An inflated blood pressure cuff on the same limb as the probe will cause erroneous readings. Select another site.

DATA VALIDITY: Excessive ambient light, excessive motion, low perfusion, or electrical interference at the probe site can result in the display of invalid data.

PATIENT SAFETY: Exercise extreme care to assure continued circulation distal to the probe site after application.

PATIENT SAFETY: Prolonged monitoring or patient condition may require changing the probe test site periodically. Move the probe if there is any sign of skin irritation or impaired circulation. Change the probe site at least every four hours.

PATIENT SAFETY: If a probe is damaged in any way, discontinue use immediately.

**CAUTION**

Do NOT apply tension to the probe cable. Probe damage may result.

The Neonatal and Pediatric SoftProbes are recommended for routine and long-term monitoring. The positioning circles on the tape indicate the position of the probe's optical components.

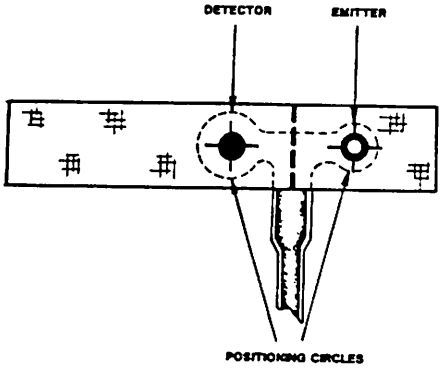



Figure 29. SoftProbe

Suggested sites:

For the Neonatal SoftProbe -- foot or hand
For the Pediatric SoftProbe -- finger, thumb, or toe

A - Application Procedure:

1. Peel the backing from the tape/probe head.

2. For best signal quality, select a site that allows positioning of the detector (solid circle on the tape) on a fleshy area. The cable should extend up the limb.

3. Apply the probe, being careful not to restrict circulation as you wrap the tape around the site. IF APPLYING TO A DIGIT, POSITION THE PROBE SO THAT THE TAPE WRAPS AROUND THE SIDE -- NOT OVER THE TIP -- OF THE DIGIT. The circles on the tape should be positioned opposite each other.

   IMPORTANT: When attaching the probe to the patient, minimal pressure should be applied to the probe site.

Figure 30. SoftProbe Attachment

4. The probe can be further isolated from patient motion by taping the cable to the patient approximately 3 to 6 inches away from the probe head. DO NOT RESTRICT CIRCULATION.

5. Connect the SoftProbe to the Oximeter. To ensure a good signal, check for adequate signal strength and a repeatable pulsatile waveform.

B - Tape Replacement:

1. Carefully remove the used tape from the probe head.

2. Apply new tape to the back (flattest side) of the probe, with the solid circle centered on the larger (detector) end of the probe head.

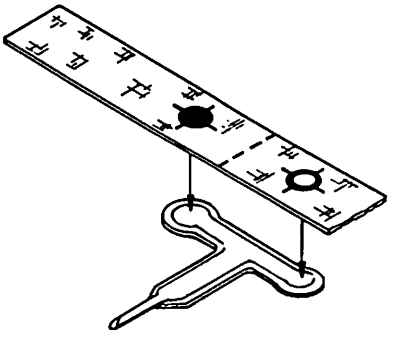


Figure 31.

## 5.1 Cleaning

**WARNING** ELECTRICAL SHOCK AND FLAMMABILITY HAZARD: Always turn the Oximeter off and disconnect it from AC mains power before cleaning.

**CAUTION** Do NOT autoclave or pressure sterilize this Oximeter. Do NOT soak or immerse this Oximeter in any liquid. Do NOT gas sterilize this Oximeter. Damage to the equipment will result.

### 5.1.1 Oximeter

The outer surface of the Oximeter can be cleaned with a soft cloth dampened in a mild soap and water solution or isopropyl alcohol (70%). Ensure that the Oximeter is unplugged prior to cleaning and the unit is completely dry before use.

Do not touch, press or rub the display panel with abrasive cleaning compounds, instruments, brushes, rough surface materials or make any contact with anything that can scratch the panel.

Do not use organic solvents containing acetone to clean the display panel. Use a cotton swab saturated with 70% isopropyl alcohol and gently wipe the panel.

### 5.1.2 Probes

**CAUTION** Do NOT soak or immerse the probes in any liquid solution. Do NOT autoclave probes. **EXCEPTION:** All but the connector-end of the SoftProbe may be immersed in the recommended disinfectants.

A - Surface Cleaning (ALL PROBES): To clean probes after each patient use:

* Disconnect the probe from the patient and the Oximeter.
* Clean with a soft cloth using a mild soap and water solution, or an isopropyl alcohol (70%) swab.
* Allow the probe to dry completely before returning it to operation.

B - Disinfecting (SOFTPROBE): The head and cable ONLY may be disinfected by immersion in glutaraldehyde (e.g., Cidex) or bleach. The parts of the probe coming in contact with the patient must be thoroughly rinsed to remove any residue.

C - Ethylene Oxide Exposure (ALL PROBES): None of the probes will be harmed by exposure to an ethylene oxide mixture at 120-130° F (49-54° C).

**CAUTION** Improper exposure to ethylene oxide may result in probe damage. Follow ethylene oxide instructions exactly.

D - Ethylene Oxide Sterilization (SOFTPROBE): In its original unopened, undamaged package, the SoftProbe may be ETO sterilized, following the recommended specifications below:

**WARNING** PATIENT SAFETY: Follow ethylene oxide instructions exactly when sterilizing the SoftProbe. Improper aeration may result in chemical burns or chemical sensitivity.

---

STERILANT [12% ETO / 88% Freon (w/w)]

1. Initial Vacuum -- 25 in. Hg
2. Humidify to 80%,
   Dwell for 30 minutes
3. Sterilant Injection Time -- 5 minutes
4. Dwell -- 4 hours, 54° C (130° F) , 8 PSIG
5. Post Vacuum -- 25 in. Hg

**[CARDBOARD SHIPPING BOX MUST BE REMOVED PRIOR TO AERATION]**

6. Aerate -- 24 hours at 54° C (130° F),
   1 air exchange/minute

---

## 5.2 Recharging the Battery

**CAUTION** Do NOT turn the Oximeter on after the RECHARGE BATTERY Alarm condition is displayed without first connecting it to AC mains power. Damage to the lead-acid battery may result.

Low Battery (LO BT) Indicator: Appears when the battery is at 5% charge/discharge capacity

The recharging times and capacity proportions are:

* 80% capacity - recharges in approximately 4 hours
* 100% capacity - recharges in approximately 16 hours

When charged to full capacity, the battery provides approximately 1.5 hours of continuous operation.

When the Alarm Message RECHARGE BATTERY appears on the Graphic Display, the audible alarm sounds and the Oximeter automatically shuts off in approximately 10 seconds. Plug the Oximeter into AC mains power.

NOTE: The Oximeter will redisplay the RECHARGE BATTERY Alarm Message and automatically turn off again. Should the Oximeter be continually powered on in this condition, battery damage may result.

NOTE: DURING THE RECHARGING PROCESS THE OXIMETER MAY BE OPERATED WHEN IT IS PLUGGED INTO AC MAINS POWER.

Under normal conditions, the battery lasts for several hundred "charge-discharge" cycles. To obtain maximum battery life, recharge the Oximeter whenever it is not in use. The battery will not overcharge.

## 5.3 Storage

It is suggested that the Oximeter and probes be stored at temperature ranges from -20° C (-4° F) to 60° C (140° F). At temperature extremes, the LCD read-out may exhibit reduced contrast, ghosting or darkening. When returning from temperature extremes, allow the Oximeter to stabilize before use.

## 6.1 Repair Policy

**CAUTION** Repairs should only be undertaken or attempted by Ohmeda-trained service personnel.

Do NOT use malfunctioning equipment. Make all necessary repairs, or have the equipment serviced by Ohmeda Service Personnel. Replace damaged parts with components manufactured or sold by Ohmeda. After repair, test the equipment to ensure that it is functioning properly and complies with the manufacturer's published specifications.

To ensure full reliability, have all repairs and service done by an Authorized Ohmeda Service Representative. If this cannot be done, replacement and maintenance of those parts listed in the manual may be undertaken by a competent, trained individual having expertise in the repair of devices of this nature.

## 6.2 Obtaining Service

PLEASE CLEAN CONTAMINATED OR DIRTY EQUIPMENT BEFORE RETURNING.

| | |
|---|---|
| **Hospitals and Clinics (USA)** | Contact the nearest Ohmeda Regional Service Office as listed on the back cover of this manual. |
| **Home Health Care Accounts (USA)** | Contact Ohmeda - Boulder at 1-800-652-2469. Do NOT return equipment without first getting a Return Authorization Number. |
| **PROBES ONLY (all USA accounts)** | Contact Ohmeda - Boulder Customer Service at 1-800-652-2469. |
| --- | |
| **Outside the USA** | Contact the nearest Ohmeda Representative or office listed on the back cover of this manual. |

**Shipping:** Package the equipment securely in the original shipping container (if possible) and ship it prepaid. Enclose with the equipment:

* A letter describing in detail any difficulties experienced and the repairs felt necessary
* Warranty information -- copy of invoice or other applicable documentation must be included
* Ship to and bill to information
* Purchase order number
* Person (name, telephone number, or telex number & country) to contact for functional questions

## 6.3 Accessories

The following accessories may be ordered through Ohmeda.
(NOTE: Outside of the USA, use the BX number.)

**Headband**
0380-1500-002
(BX#7900-045)

**Adhesive Disks**
**(package of 10 sheets)**
0380-1500-082
(BX#8122-500)

**Ear Probe Stabilizer**
(Package of 10)
0380-1500-003
(BX#8102-007)

**Cable Clip, Adhesive Back**
**(Package of 2)**
0380-0100-001
(BX#6303-007)

**3700 Operating/Maintenance Manual (w/binder)**
0380-0900-001
(BX#1118-300)

**3700 Service Manual (w/binder)**
0380-0900-002
(BX#1118-302)

**Traceability Registration Card (Warranty Card)**
0380-0900-027
(BX#1000-246)

**Finger Probe (8 FT/2.44 m)**
0380-1000-019
(BX#8122-001)

**Finger Probe**
(12 FT/3.66 m)
0380-1000-023
(BX#8122-005)

**Ear Probe (8 FT/2.44 m)**
0380-1000-021
(BX#8122-003)

**Flex II Probe**
**(8 FT/2.44 m)**
0380-1000-080
(BX#8122-006)

**Flex II Probe**
**(12 FT/3.66 m)**
0380-1000-081
(BX#8122-007)

**FingerClip Probe**
**(8 FT/2.44 m)**
0380-1000-043
(BX#8124-002)

**FingerClip Probe**
**(12 FT/ 3.66m)**
0380-1000-023
(BX#8124-001)

**SoftProbe (Pediatric)**
**Single:** 0380-1000-048
(BX#8123-001)

**Box of 6:** 0380-1000-052
(BX#8123-010)

**SoftProbe (Neonatal)**
**Single:** 0380-1000-049
(BX#8123-003)

**Box of 6:** 0380-1000-051
(BX#8123-009)

A/D CONVERTER
FAILURE,
SERVICE UNIT

ALARM VOLUME
HOLD KEY TO SET,
VOLUME LEVEL IS #

ANALOG
SYNCHRONIZATION
ERROR,
SERVICE UNIT

BATTERY IN USE

BT

**CALIBRATE UNIT**
ADJUST POT AT BOTTOM
HOLE TO VALUE = 0 ± .1
HIT WAVEFORM TO END

CANNOT IDENTIFY
PROBE
(SEE MANUAL)

CHARGING CIRCUIT
FAILURE,
SERVICE UNIT

F

FAST RESPONSE
SELECTED

INSUFFICIENT LIGHT
DETECTED,
CHECK PROBE SITE

INTERFERENCE
DETECTED,
$SaO_2$ & PULSE RATE
MAY BE INVALID

LO
BT

LO QUALITY SGNL

MICRO-PROCESSOR
ERROR,
SERVICE UNIT

MICRO-PROCESSOR
INTERRUPT ERROR,
SERVICE UNIT

N

NO PROBE
CONNECTED TO UNIT

NORMAL RESPONSE
SELECTED

OHMEDA-BIOX
3700/3710
REVISION:X
SYSTEM CHECK

OUTPUTTING TREND,
TIME REMAINING X:XX
HIT TREND KEY
TO END OUTPUT

PLEASE PLUG UNIT
INTO WALL OUTLET
TO DETERMINE
LINE FREQUENCY

PLUG UNIT INTO
WALL OUTLET
TO
RECHARGE BATTERY

POWER SUPPLY
FAILURE,
SERVICE UNIT

PREVIOUS TREND
DATA AVAILABLE

PROBE OR CIRCUIT
FAILURE
REPLACE PROBE OR
SERVICE UNIT

PROBE OFF
PATIENT

PULSE VOLUME
HOLD KEY TO SET,
VOLUME LEVEL IS #

PULSE WAVEFORM
SELECTED

RAM CHECK
ERROR,
SERVICE UNIT

RAM DATA INVALID,
RE-INITIALIZING

RAM TEST ERROR
HIGH BYTE,
SERVICE UNIT

RAM TEST ERROR
HIGH & LOW BYTES,
SERVICE UNIT

RAM TEST ERROR
LOW BYTE,
SERVICE UNIT

RAM TEST ERROR
TREND CHECKSUM,
SERVICE UNIT

ROM TEST ERROR
HIGH BYTE,
SERVICE UNIT

ROM TEST ERROR
HIGH & LOW BYTES,
SERVICE UNIT

ROM TEST ERROR
LOW BYTE,
SERVICE UNIT

S

$SaO_2$ & PULSE ANALOG
OUTPUT = # VOLTS
WAVEFORM: NEXT TEST,
TREND: QUIT

SLOW RESPONSE
SELECTED

STACK ERROR,
PLEASE NOTE
CONDITIONS AND
SERVICE UNIT

SYSTEM ERROR X
PLEASE NOTE
ERROR CODE AND
SERVICE UNIT

SYSTEM
OPERATIONAL

TEST SIGNAL
DC REFERENCE
ERROR,
SERVICE UNIT

THANK YOU
UNIT MAY NOW RUN
ON BATTERY

TREND OUTPUT MODE,
START CHART RECORDER
HIT TREND KEY
TO START OUTPUT

TREND MODE
SELECTED

VOLTAGE REFERENCE
FAILURE,
SERVICE UNIT

## APPENDIX B: REFERENCES


Barker, SJ, Ph.D., M.D.; Tremper, KK, Ph.D., M.D.; Hufstedler, S, M.D.; Hyatt, J; Zaccari, J. "The Effects of Carbon Monoxide Inhalation on Noninvasive Oxygen Monitoring" Anesthesia Analg, Vol 65:S12, 1986.

Barker, SJ, Ph.D., M.D.; Tremper, KK, Ph.D., M.D.; Hufstedler, S, M.D.; Hyatt, J; Zaccari, J. "Effects of Methemoglobinemia on Pulse Oximetry and Mixed Venous Oximetry" Anesthesiology Supp., Vol. 67:3A, 1987.

Scheller, MS, M.D.; Unger, RJ, M.D. "The Influence of Intravenously Administered Dyes on Pulse Oximetry Readings" Anesthesiology, Vol 65:A161, 1986.

Shippy, Merrill B., BS RRT; Petterson, Michael T., BA RRT CCPT; Whitman, Robert A., BA RRT CCPT; Shivers, Constance R., BA. "A Clinical Evaluation of the BTI Biox II Ear Oximeter" Respiratory Care, Vol 29:730, 1984.

Sidi, A, M.D.; Rush, WR, B.A.; Paulus, DA, M.D.; Gravenstein, N, M.D.; Davis, RF, M.D. "Effect of Fluorescein, Indocyanine Green, and Methylene Blue on the Measurement of Oxygen Saturation by Pulse Oximetry" Anesthesiology, Vol 65:A132, 1986.

## APPENDIX C: CONNECTION WITH CHART RECORDERS, POLYGRAPHS, AND OTHER RECORDING EQUIPMENT

### C.1 Interfacing With Analog Recording Devices

**WARNING** ELECTRIC SHOCK HAZARD: Measure the leakage current whenever an external device is connected to either the analog or digital ports. Forward and Reverse Polarity: 100 microamperes maximum.

**CAUTION** Connect only a high impedance device (1K Ohm or higher) to the analog output jacks. Improper loading will upset the correspondence between the measured voltage and the intended output voltage.

It is possible to interface the Ohmeda Biox 3700 Pulse Oximeter with any analog recording device capable of accepting the 0 to 1 volt signal outputs representing the oxygen saturation and Pulse Rate. This is done through the mono mini-phone output jacks on the rear panel of the Ohmeda Biox 3700 Pulse Oximeter. The jacks are wired as follows:

jack tip (input connector tip) = signal
jack base (input connector base) = signal ground

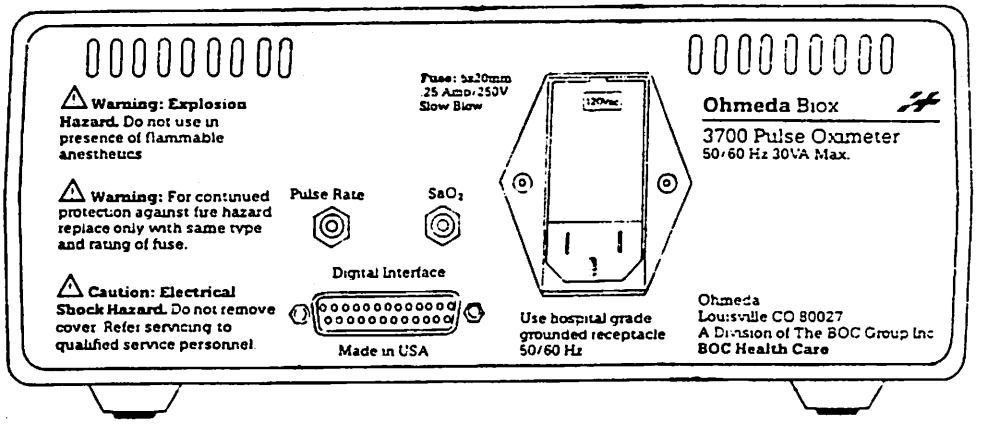



Figure 9. Rear Panel

NOTE: Ensure that there is a tight connection between the output jack and the Oximeter connector.

If using a recorder other than Ohmeda's, please contact the recorder's manufacturer for input connections and calibration instructions.

## APPENDIX C: CONNECTION WITH CHART RECORDERS, POLYGRAPHS, AND OTHER RECORDING EQUIPMENT

The Ohmeda Biox Model 0001 Single Channel or the Model 0003 Dual Channel Strip Chart Recorder connects directly to either of the analog output jacks. To connect the Ohmeda Biox Recorders with the Ohmeda Biox 3700 Pulse Oximeter, use the following procedure.

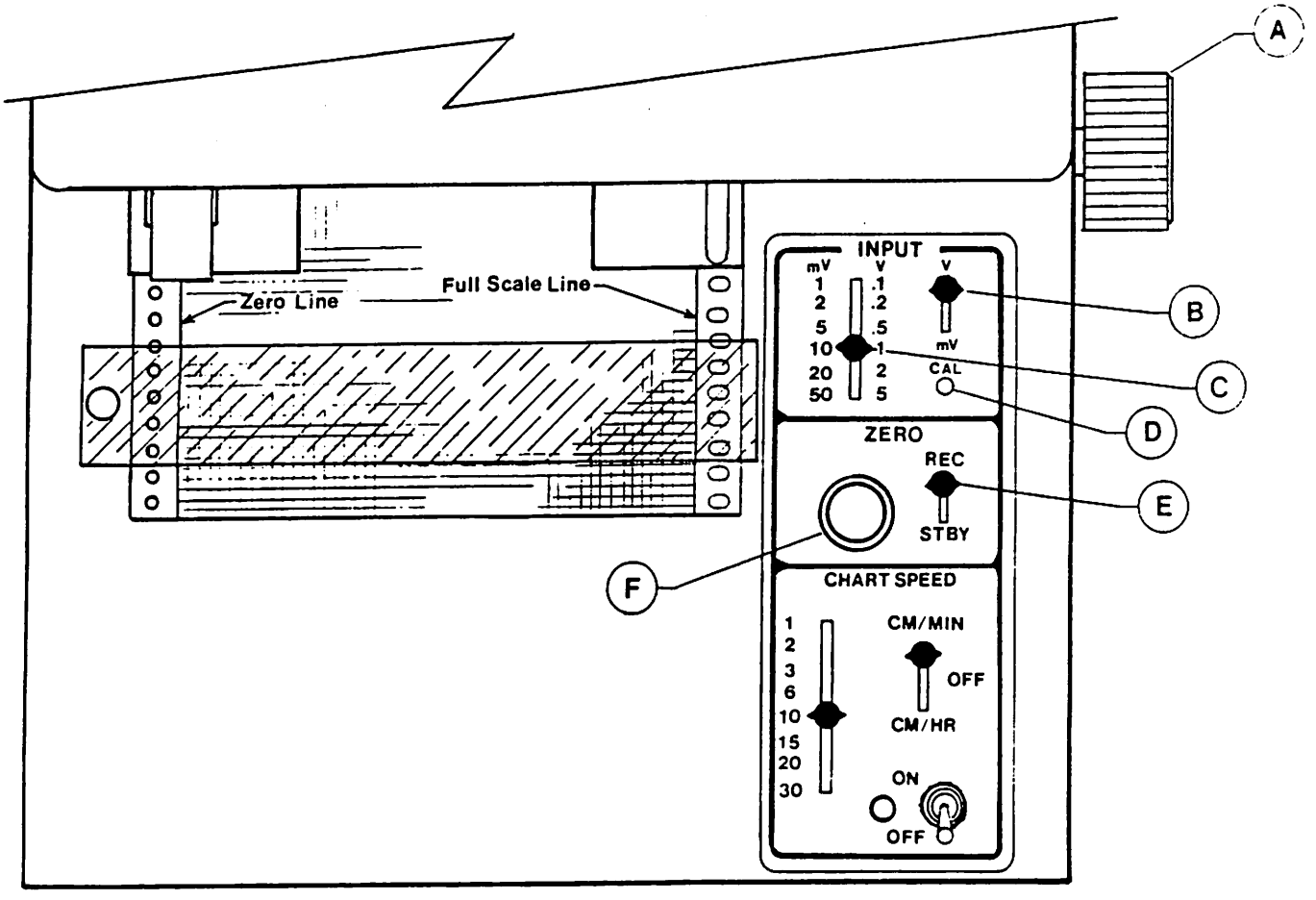



Figure 32. Ohmeda Chart Recorder Control Panel

## APPENDIX C: CONNECTION WITH CHART RECORDERS, POLYGRAPHS, AND OTHER RECORDING EQUIPMENT

### C.2 Ohmeda Single or Dual Chart Recorder Connection

#### C.2.1 Connecting to Oximeter

1. Using the knob **A** on the side of the recorder, advance the chart paper until the numbers are visible.

2. Locate the positive (+) and negative (-) input signal connections on the rear of the chart recorder. Using a small flat blade screwdriver (supplied with the Ohmeda Chart Recorder):

   * Connect the clear wire tab to the positive (+) input signal connection.

   * Connect the black wire tab to the negative (-) input signal connection.

3. Connect the plug end of the shielded chart recorder cable into the rear panel of the Oximeter at the $SaO_2$ jack or Pulse Rate jack (depending on which data is to be output). Ensure that the plug is firmly connected to the Oximeter.

4. Locate the input voltage selection switches on the chart recorder control panel.

   * Push the mV/V Switch **B** to the V (volt) setting

   * Set the Numerical Slide Switch **C** to the 1 V (One volt) setting

   * Set the REC/STBY Switch **E** to REC (Record)

5. Turn on the Chart Recorder.

C.2.2 Calibration

**NOTE: Make sure Oximeter is OFF before starting this procedure.**

1. To enter the User Calibration Mode, press and hold the Low $SaO_2$ down arrow key on the Oximeter front panel and turn the Oximeter on. The following Status Message momentarily appears on the Graphic Display:

OHMEDA-BIOX
3700/3710
REVISION:X
SYSTEM CHECK

NOTE: X represents an alphanumeric value of the software revision level.

Next, the following Status Message appears on the Graphic Display:

$SaO_2$ & PULSE ANALOG
OUTPUTS = 0 VOLTS
WAVEFORM: NEXT TEST,
TREND: QUIT

**IMPORTANT: If this Status Message does not appear, turn the Oximeter off, and repeat step #1.**

2. Adjust the Zero Control Knob **F** on the control panel of the chart recorder to set the pen to zero line on the recorder paper. The chart recorder pen should move across the recorder paper towards the zero line.

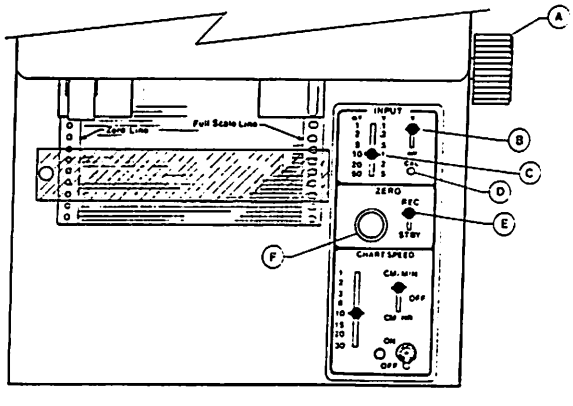



Figure 32.

Ohmeda Chart Recorder Control Panel

3. Depress the WAVEFORM key on the Oximeter. The Status Message which appears on the Graphic Display is:

$SaO_2$ & PULSE ANALOG
OUTPUTS = 1 VOLT
WAVEFORM: NEXT TEST,
TREND: QUIT

The chart recorder pen should move across the recorder paper from the Zero line to approximately the full scale line.

4. Adjust the calibration (CAL) potentiometer **D** on the chart recorder control panel with a small flat blade screwdriver (supplied with the Ohmeda Chart Recorder) to set the pen to full scale on the recorder paper (100% $SaO_2$ or 250 BPM).

NOTE: The screwdriver supplied with the Ohmeda Chart Recorder has various size blades stored in the handle. Pull the screwdriver handle off to locate the blades. The largest blade should be used to calibrate the recorder.

5. Depress the WAVEFORM key on the Oximeter. The following Status Message appears on the Graphic Display:

**CALIBRATE UNIT**
ADJUST POT AT BOTTOM
HOLE TO VALUE = 0 ± .1
HIT WAVEFORM TO END

The chart recorder pen should move across the recorder paper from the full scale line to the zero line. Wait a few seconds for the reading on the Oximeter Digital Display to stabilize.

* Verify that the Oximeter Digital Display reads zero (0.0 ± .1). If the Digital Display does not read zero (0.0 ± .1) refer to the Calibration Procedure in this manual (See Section 2.3).

6. Depress the WAVEFORM key to return to the Status Message OHMEDA-BIOX 3700/3710 REVISION:X SYSTEM CHECK. The chart recorder should be calibrated to the Oximeter and ready for use.

## APPENDIX C: CONNECTION WITH CHART RECORDERS, POLYGRAPHS, AND OTHER RECORDING EQUIPMENT

### C.3 Analog Output -- Real Time

During normal operation, the $SaO_2$ and Pulse Rate values are continuously sent to the analog outputs on the Oximeter rear panel.

Zero volts represents:

$SaO_2$ = 0% (indicates error)
Pulse Rate = 0 BPM (indicates error)

1 volt represents:

$SaO_2$ = 100%
Pulse Rate = 250 BPM

During the real time analog output of data, the LO QUALITY SGNL condition is represented by a tick mark. This happens for both the $SaO_2$ and the Pulse Rate output. Instead of going to zero when LO QUALITY SGNL occurs, a three percent spike (tick mark) below the current reading and lasts for 1/3 second for $SaO_2$, and an eight BPM spike (tick mark) drop below the current reading lasts for 1/3 second for Pulse Rate.

The tick mark appears simultaneously with the display of the LO QUALITY SGNL message. If the LO QUALITY SGNL is continuous, the tick mark occurs every 15 seconds thereafter. During errors other than LO QUALITY SIGNAL, both analog outputs are at zero volts.

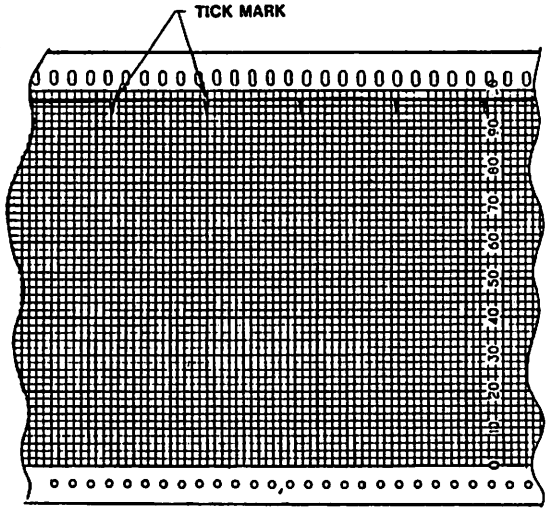



Figure 33. Chart Paper with Tick Mark

## APPENDIX C: CONNECTION WITH CHART RECORDERS, POLYGRAPHS, AND OTHER RECORDING EQUIPMENT

### C.4 Analog Output -- Trend Data

1. **Calibrate the chart recorder with the Oximeter** (see Section C.2.2).

2. Determine which of the two Trend Data options listed below you wish to output:

   **Option 1:** **View the Trend Data Buffer of $SaO_2$ and Pulse Rate since the last time the Oximeter was turned on.**

   * Turn the Oximeter on to access Option 1.

   **Option 2:** **View the full eight hours of Trend Data.**

   * To access Option 2 and restore the previous Trend Data, press the $SaO_2$ TREND 20/60 key while turning the unit on. The message "PREVIOUS TREND DATA AVAILABLE" should appear on the Graphic Display.

3. To enter the Trend Output Mode, press the $SaO_2$ TREND 20/60 key for three seconds. The following Status Message appears on the Graphic Display:

   TREND OUTPUT MODE,
   START CHART RECORDER
   HIT TREND KEY
   TO START OUTPUT

4. Press the $SaO_2$ TREND 20/60 key to start outputting the full eight hours of the Trend Data buffer continuously. One hour of Trend Data is output approximately every minute. During this time the Graphic Display should read:

   OUTPUTTING TREND,
   TIME REMAINING: X:XX
   HIT TREND KEY
   TO END OUTPUT

This Status Message is updated approximately every second to inform the operator of the hours and minutes of Trend Data remaining. This feature allows the user to select a particular section of Trend Data to be output.

After the data is output, the Oximeter returns to the previous display. The Trend Data is still in memory and can be output again.

NOTE: Eight hours of Trend Data is output in approximately eight minutes.

## APPENDIX D: COMPUTER INTERFACE

### D.1 Digital Interface

**CAUTION** Connect only a high impedance device (1K Ohm or higher) to the analog output jacks. Improper loading will upset the correspondence between the measured voltage and the intended output voltage.

**Requirements:** Connect the oximeter only to computers, display terminals, and printers with:

- an RS-232C interface
- the capability to accept ASCII formatted data at a baud rate of 1200.

**Notes:** To Output Trend Data to a printer, the printer must have a 48K buffer (printer speed dependent).

When the Oximeter is connected to RS-232C devices, $SaO_2$ and Pulse Rate readings and alarm conditions are transmitted and updated every two seconds.

The settings on the terminal or equipment must be:

- 1200 Baud
- 7 Bit Data
- Odd Parity
- 1 Stop Bit

**RS-232C Interface Cable:** Configure the RS-232C Interface Cable as described below:

| Connector wiring | | |
|---|---|---|
| | Pin 1 | Chassis Ground |
| | Pin 2 | Oximeter Receives Data |
| | Pin 3 | Oximeter Transmits Data |
| | Pin 7 | Signal Ground |

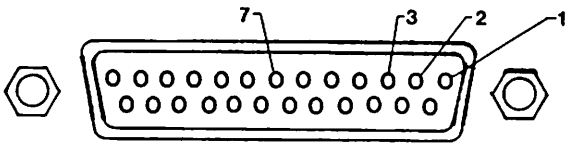



Figure 34. Digital Interface Connector (located on the Oximeter rear panel)

## D.2 Guidelines

**IMPORTANT:** **Read this guideline and the sections of the manual which are referenced before attempting computer interface with the Ohmeda Biox 3700 Pulse Oximeter.**

| | | |
|---|---|---|
| REQUIREMENTS | Determine if the computer or terminal can be connected to the Ohmeda Biox 3700 Pulse Oximeter. | See Digital Interface Section |
| SET-UP | Connect the Ohmeda Biox 3700 Pulse Oximeter to a computer or terminal. | See Digital Interface Section |
| PROGRAMMING | Program the computer or terminal to communicate with the Ohmeda Biox 3700 Pulse Oximeter. | See Manual Section: Programming the IBM PC to Communicate with the Ohmeda Biox 3700 Pulse Oximeter. |
| IMPLEMENTING | If in DOS and if the program has been saved, type BASICA 3700COM (Make sure you are in the correct directory.) | See Manual Section: Programming the IBM PC to Communicate with the Ohmeda Biox 3700 Pulse Oximeter. |
| APPLICATIONS | For further information on:<br><br>Auto-Output Mode<br>Trend-Output Mode<br>Waveform Mode<br><br>Slave Mode<br>Control Mode | See Communication Section |

## D.3 Example of Connection to an IBM PC

In this example, we will connect the Ohmeda Biox 3700 Pulse Oximeter to an IBM PC.

(IBM and IBM PC are registered tradenames of International Business Machines Corporation).

EQUIPMENT NEEDED:

* A board for the IBM that supports Serial Communication with the same serial port connections as the Ohmeda Biox 3700 Pulse Oximeter.

* Male (DB-25P) to Female (DB-25S) Interface Cable.

PROCEDURE:

1. On the Ohmeda Biox 3700 Pulse Oximeter rear panel, locate the Digital Interface Connector.

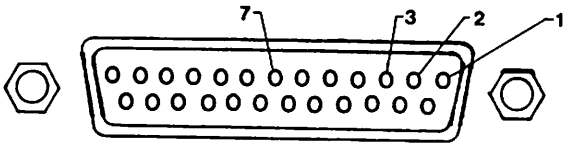



Figure 34. Digital Interface Connector

2. Connect the Male (DB-25P) end of the RS-232C Interface Cable to the Oximeter Digital Interface Connector.

3. On the rear panel of the IBM PC, locate the RS-232C Interface Connector.

4. Connect the Female (DB-25S) end of the RS-232C Interface Cable to the IBM PC 232C Interface Connector.

5. Ensure that the RS-232C Interface Cable is securely connected on both ends.

6. Proceed to next section: Programming the IBM PC to Communicate with the Ohmeda Biox 3700 Pulse Oximeter.

## D.4 Programming an IBM PC to Communicate with an Ohmeda Biox 3700 Pulse Oximeter*

Before proceeding with this section, ensure that the Ohmeda Biox 3700 Pulse Oximeter is connected to the IBM PC as described in the Digital Interface Section.

In order to program the IBM PC, an understanding of some key aspects about how the computer works is suggested. You will find the following concepts and commands helpful (Refer to documentation supplied with the IBM PC for this information):

* Use of the keyboard especially:


CAPS LOCK

BACKSPACE

SHIFT


ESCAPE

ENTER



CTRL BREAK

* The BASIC Program Editor
* SAVE
* RUN
* LIST

---

* Ohmeda provides this section as a sample for general information only. Ohmeda is not responsible for any changes IBM makes to their product. For specific information on other computer systems, refer to the system's manual or the manufacturer.

D.4.1 Entering IBM BASIC

**NOTE: It is important to use capital letters as they are shown in this procedure.**

1. Press POWER/STANDBY to turn the Oximeter on.

2. Insert the DOS disk and turn on the computer. Ensure that BASICA is available.

3. A prompt should appear on the computer screen within a minute. The prompt may vary due to which default drive is being used. The prompt may look like:

   A>

4. Type BASICA after the prompt. The computer screen should look like the following:

   A>BASICA

5. Press ENTER

6. The BASIC Language Sign-On Message should appear on the computer screen. For example, the message may look like the following:

   IBM Personal Computer Basic
   Version D3.10 Copyright IBM Corp 1981, 1985
   61310 bytes free

In the next section is a sample program which may be run on the IBM PC to communicate with the Ohmeda Biox 3700 Pulse Oximeter. Before typing the program, here are some Helpful Hints to review:

To Correct a MINOR typing mistake:

* Use the BACKSPACE key to back up to the mistake
* Type the correct character
* Press the ENTER key after the correction has been made

To Correct a MAJOR typing mistake:

* Put the cursor at the beginning of the line you want to correct
* Press the ESCAPE key -- the line is erased
* Retype the line
* Press the ENTER key after the line has been entered

D.4.2 Sample Program

1. Type the following program (line 1Ø through line 8Ø) exactly as it appears -- including spaces. Remember to enter the line number. Press ENTER after each line entered.

IMPORTANT: The symbol "O" denotes the capital letter O.
The symbol "Ø" denotes the number zero.
Use capital letters except as shown.

**The 3700 -- IBM PC Communication Program**

```
1Ø KEY OFF: SCREEN Ø,Ø: CLS: ON ERROR GOTO 2Ø
15 OPEN "COM1: 12ØØ,O,7,1,CS,DS,CD" AS #1
2Ø B$ = INKEY$: IF B$ = "" THEN 6Ø
25 B=ASC(B$): IF B=7 THEN END
3Ø IF B>96 AND B <123 THEN B=B-32
35 B$=CHR$(B): PRINT #1,B$;
4Ø IF B=27 THEN C$="ESC "
45 IF B=8 THEN C$=LEFT$(C$,LEN(C$)-1)
5Ø IF B>27 THEN C$=C$+B$
55 LOCATE 25,1,Ø: PRINT C$,,;
6Ø IF EOF(1) THEN 2Ø
65 A$=A$+INPUT$(LOC(1),#1)
7Ø L=INSTR(1,A$,CHR$(13)): IF L=Ø THEN 2Ø
75 LOCATE 24,1,Ø: PRINT LEFT$(A$,L);
8Ø A$ = RIGHT$(A$,LEN(A$)-L): GOTO 2Ø
```

**Output to Printer:**

To output to a printer through the computer add

```
: LPRINT LEFT$(A$,L);
```

to line 75 so it reads:

```
75 LOCATE 24,1,Ø; PRINT LEFT$(A$,L);: LPRINT LEFT$(A$,L);
```

Note: To output Trend Data to a printer, the printer must have a 48K buffer (printer speed dependent).

2. Carefully check the program (line by line) on the computer screen to see that is has been entered correctly. If all the information is correct, go to the next step to save the program.

3. Save the program in a file named 3700COM.BAS by typing:

   SAVE"3700COM.BAS"

   Press ENTER

4. Type RUN

   Press ENTER

5. If the previous steps have been performed correctly, the Ohmeda Biox 3700 Pulse Oximeter should be communicating with the IBM PC in the Auto-Output mode. (The oximeter must be turned on.)

   One line of data is output to the computer screen every two seconds. The message should look like the following:

   :SaO2=XXX PR=XXX

6. Proceed to Section D.5, Communication, which discusses how to use the different modes.

## D.4.3 Program Troubleshooting Guide

| Symptom | Action |
|---|---|
| Computer screen blank or no data displayed after typing RUN | 1. Ensure that the RS-232C Interface Cable is securely connected.<br>2. Press CTRL - BREAK simultaneously<br>3. Type LIST and press ENTER<br>4. Examine program line by line |
| Syntax errors or other errors | 1. Type LIST and press ENTER<br>2. Examine the program line referenced for mistakes. |

**NOTE:** Once the program has been saved, it does not need to be retyped each time the Computer Interface is used.

To run the program from the DOS prompt, type:

BASICA 3700COM

Then press ENTER.

## D.5 Communication

The Ohmeda Biox 3700 Pulse Oximeter has the capability of two-way communication with terminals. Most of the controls on the Front Panel can be operated remotely by using an RS-232C input device.

This section discusses:

* how the Ohmeda Biox 3700 Pulse Oximeter communicates with computers
* how the computers communicate with the Ohmeda Biox 3700 Pulse Oximeter

It also describes the five modes of operation:

* Auto-Output Mode - (Default Mode) Real time data output to the computer.
* Output Trend Mode - Trend data stored in the Oximeter's memory is output to the computer.
* Waveform Mode - Real time data output in graphic format (Requires a graphics program for the computer).
* Slave Mode - Stops Auto-output. Displays on command $SaO_2$, pulse rate, and Oximeter status.
* Control Mode - Allows the user to send the Oximeter commands from the computer.

In order to use these modes:

* the Ohmeda Biox 3700 Pulse Oximeter must be connected to the computer or terminal (as described in the "Digital Interface" Section)
* the computer or terminal must be programmed (as described in the "Programming the IBM PC to Communicate with the Ohmeda Biox 3700 Pulse Oximeter" Section)

It is **IMPORTANT** to remember:

* to use capital letters, as shown in the manual
* to refer to the Troubleshooting Table at the end of this section if necessary

### D.5.1 Auto-Output Mode

**Entering** This is the default mode. If you have completed programming the IBM PC as described in Section D.4, you have already seen the Auto-Output Mode. It is present when the Oximeter begins communication with a computer, and is the mode the Oximeter returns to when exiting from other modes.

**Enabling** One line of data is output to the terminal every two seconds. The message looks like the following:

:SaO2=XXX PR=XXX

If the following messages appear on the Graphic Display, they also appear on the terminal following the message shown above:

CANNOT IDENTIFY PROBE (SEE MANUAL)

INTERFERENCE DETECTED. $SaO_2$ & PULSE RATE MAY BE INVALID

NO PROBE CONNECTED TO UNIT

INSUFFICIENT LIGHT DETECTED, CHECK PROBE SITE

PROBE OFF PATIENT

LOW QUALITY SIGNAL

**Exiting** Hold down CTRL, then depress G. The program stops running.

To exit BASICA, type:

SYSTEM

Then press ENTER.

D.5.2 Trend-Output Mode

This mode allows up to eight hours of Trend Data to be output to a printer or a terminal through the digital output. (NOTE: 8 hours of Trend Data is output in approximately 8 minutes.)

* To output the Trend Data to a chart recorder, refer to the section titled "Analog Output of Trend Data"

* To output the full eight hours of Trend Data you must restore the previous Trend Data (otherwise you will only output the Trend Data from the current Power On)

  To restore the previous Trend Data for the full eight hours of output, turn the Oximeter off and depress the $SaO_2$ TREND 20/60 key while turning the Oximeter on. The following Status Message should appear on the Oximeter Graphic Display:

  PREVIOUS TREND
  DATA AVAILABLE

**Entering** Hold the Oximeter $SaO_2$ TREND 20/60 key for approximately three seconds or until this Status Message appears on the Oximeter Graphic Display:

TREND OUTPUT MODE
START CHART RECORDER
HIT TREND
TO START OUTPUT

The following message should appear on the computer screen at the same time:

OHMEDA BIOX 3700/3710 PULSE OXIMETER
TREND DATA OUTPUT
12 SECONDS PER DATA POINT

NOTE: This mode can also be entered by using the Control Mode, as described in Section D.5.5

**Enabling** Depress the Oximeter SaO2 TREND 20/60 key a second time to start the Trend-Output. The data is output to the computer screen in the following format:

**POWER ON**
SaO2=XXX PR=XXX
SaO2=XXX PR=XXX YY

YY is representative of a two letter error code as defined below:

| Error | Description |
|---|---|
| NP | No Probe |
| IN | Interference Detected |
| PO | Probe Off Patient |
| IL | Insufficient Light |
| ID | Cannot Identify Probe |
| LQ | Lo Quality Signal |

:SaO2=--- PR=--- dashes are used when the calculated $SaO_2$ and Pulse Rate are considered invalid.

When an error code is displayed, the $SaO_2$ and Pulse Rate values are dashed, except for LO QUALITY SIGNAL, in which case the $SaO_2$ and Pulse Rate values may be displayed or dashed.

* This Status Message Appears on the Oximeter Graphic Display:

OUTPUTTING TREND
TIME REMAINING: X:XX
HIT TREND KEY
TO END OUTPUT

The Oximeter Status Message is updated approximately every second to inform the operator of the hours and minutes of Trend Data remaining.

* When the Trend Data is being output, messages which appear on the Oximeter Graphic Display do NOT appear on the computer terminal

* No new Trend Data is collected during Trend Output and the $SaO_2$ and Pulse Rate values on the Oximeter Digital Display are dashed

**Exiting** To exit the Trend Output Mode while data is being output, press the Oximeter $SaO_2$ TREND 20/60 key.

* After the Trend Data is output, the Oximeter returns to the previous display and the Auto-Output Mode automatically resumes. The Trend Data is still in memory and can be output again without turning the Oximeter on and off again.

(NOTE: No other modes can be activated through the Computer Interface while in the Trend Output Mode; only the Trend Output exit command is recognized)

### D.5.3 Waveform Mode

This mode is useful for devices or programs designed for graphically displaying the information. (NOTE: The BASIC program listed in Section D.4.2 does not have the capacity to keep up with this mode.) When the Waveform Mode is enabled:

* No other output modes can be enabled

* The Oximeter only acknowledges the command to exit the Waveform Mode

**Entering and Enabling** Using a computer or terminal, press

ESCAPE CL ENTER

(See Section D.5.6 describing the Control Mode)

Waveform: Waveform information is representative of the photoplethysmographic signal. It corresponds directly with the Oximeter Graphic Display. It is sent as two ASCII numeric bytes followed by a carriage return. Waveform data is sent on 1/30 second intervals in 60 Hz Mode (1/25 second intervals, 50 Hz).

XX: where XX is from 00 to 31 inclusive
(XX is 00 when an error condition exists)

Signal Strength Indicator (SSI):

SSI information is representative of the overall signal quality and is sent as an 'S' and two ASCII numeric bytes followed by a carriage return. SSI data is sent every second.

SXX: where XX is from 00 to 31 inclusive
(XX is 00 when an error condition exists)

Saturation and Pulse Rate:

Saturation and Pulse Rate information is representative of the displayed saturation and Pulse Rate as determined by the Oximeter. The formats are shown below. $SaO_2$ and Pulse Rate data is sent every two seconds.

:SaO2=XXX PR=XXX where XXX in the Saturation field is from 0 to 100, and XXX in the Pulse Rate field is from 0 to 255. This format is used when the readings are considered valid.

:SaO2=--- PR=--- dashes are used when the calculated Saturation and Pulse Rate are considered invalid.

:SaO2=XXX PR=XXX YY XXX will be dashes except for LO QUALITY SIGNAL when numbers or dashes may be displayed. YY is representative of a two digit error code as defined below.

| Error Code | Description |
|---|---|
| 06 | No Probe Connected To Unit |
| 08 | Interference Detected, SAO2 And Pulse Rate May Be Invalid |
| 10 | Probe Off Patient |
| 12 | Insufficient Light Detected, Check Probe Site |
| 13 | Cannot Identify Probe (See Manual) |
| 14 | Lo Quality Signal |

**Exiting** Press ESCAPE CM ENTER

The Oximeter re-enters the Auto-Output Mode.

### D.5.4 Slave Mode

Use this mode with either a computer or terminal connection. When entered, this mode stops continuous data output from the Oximeter, i.e., the $SaO_2$ and Pulse Rate limits and readings are output for viewing only when requested.

**Entering** Using a computer or terminal, press (IN SUCCESSION)

ESCAPE S

Stops continuous data output from the Oximeter

**Enabling** Press (IN SUCCESSION) ESCAPE ?

$SaO_2$, Pulse Rate and high and low $SaO_2$ and Pulse Rate limits are displayed -- The data is output once on the computer screen in the following format:

:XXX XXX XXX XXX XXX XXX

with each set of numbers representing $SaO_2$, Pulse Rate, Low $SaO_2$ Alarm Limit, High $SaO_2$ Alarm Limit, Low Pulse Rate Alarm Limit, and High Pulse Rate Alarm Limit, respectively.

**NOTE:** While in the Slave Mode, the Oximeter does not acknowledge any commands that it does not recognize. When incorrect commands are sent to the Oximeter, the computer displays WHAT? and beeps, then waits for a familiar command.

**Exiting** Press (IN SUCCESSION) Escape X

The Oximeter automatically returns to the Auto-Output Mode & data resumes being output to the computer

### D.5.5 Control Mode

This mode allows the user to send the Oximeter commands.

**Entering and Enabling** Entering and enabling this mode are done simultaneously. The Control Mode can only be used in the Auto-Output or Slave Modes and returns to the Auto-Output or Slave Modes after the command is completed. Enabling the Control Mode changes the Oximeter parameters without touching the Front Panel. WHile in the Control Mode, the changes also appear on the Oximeter.

If you want to change any of the items in the table below, you need to press:

ESCAPE C CAPITAL LETTER PARAMETER ENTER

| | |
|---|---|
| A = Alarm Silence | (no parameter) |
| B = $SaO_2$ Low Alarm Limit | (50% - 100%) |
| C = $SaO_2$ High Alarm Limit | (70% - 100%) |
| D = Pulse Rate Low Alarm Limit | (40-200 BPM) |
| E = Pulse Rate High Alarm Limit | (70-250 BPM) |
| F = Fast Response Mode | (no parameter) |
| G = Slow Response Mode | (no parameter) |
| H = Pulse Volume | (zero-10) |
| I = Alarm Volume | (1-10) |
| J = Start Trend Output | (no parameter) |
| K = Stop Trend Output | (no parameter) |
| L = Start Waveform | (no parameter) |
| M = Stop Waveform Mode | (no parameter) |
| N = Normal Response Mode | (no parameter) |

**EXAMPLE:** Suppose you want to change the Oximeter Pulse Volume setting to one. You need to:

* Use the Table to determine which capital letter corresponds with the Pulse Volume. (The letter H corresponds with the Pulse Volume.)

* Use the Table to determine if the Pulse Volume can be set to one. (The parameter for the Pulse Volume is zero to ten. Therefore, the Pulse Volume can be set to one.)

* Therefore, to change the Pulse Volume to 1, press (IN SUCCESSION)

  ESCAPE CH1 ENTER

  If the information has been entered correctly, the Pulse Volume should change.

**The following information is important to know when using the Control Mode:**

Parameters — To set an alarm limit or pulse volume to off, input Ø (zero) as the parameter.

If no parameter needs to be input, press ENTER after the capital letter entered.

The "%" and "BPM" MUST NOT be entered with the parameter for $SaO_2$ and Pulse Rate limits.

The $SaO_2$ alarm limits change in steps of 1 (one). The Pulse Rate alarm limits change in steps of 5 (five).

WHAT? — The message WHAT? appears on the computer screen along with an audible beep (ASCII Ø7) if:

* the Oximeter does not recognize a letter or parameter field

* a parameter has been omitted

**NOTE:** If you have entered data incorrectly or are not getting an expected response, press the ENTER key a few times to clear the buffer.

Trend Output — When J (start Trend output) is selected, the Trend Data is output in the same format as the Trend-Output Mode.

To restore the previous Trend Data for the full eight hours of output, turn the Oximeter off and depress the $SaO_2$ TREND 20/60 key while turning the Oximeter on.

Starting Trend Output with the Control Mode or the Oximeter front panel can only be done while in the Auto-Output or Slave Modes.

**Exiting** — The Control Mode automatically returns to the Auto-Output or Slave Modes after the information has been entered into the computer. If you want to change another item in the box above, press:

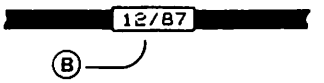
ESCAPE C CAPITAL LETTER PARAMETER ENTER

### D.5.6 Communication Troubleshooting

| SYMPTOM | ACTION |
|---|---|
| Unable to enter a mode | . Ensure that CAPS LOCK key is in upper case position |
| Auto-Output Mode does not return after a Trend Output | . You might be in the Slave Mode<br>. Press ESCAPE X if you wish to return to the Auto-Output Mode |

This product is sold by Ohmeda under the warranties set forth in the following paragraphs. Such warranties are extended only with respect to the purchase of this Product directly from Ohmeda's Authorized Dealers as new merchandise and are extended to the first Buyer thereof, other than for resale.

For a period of three (3) years from date of shipment this Product, other than its expendable parts, is warranted to be free from functional defects in materials and workmanship and to conform to the description of the Product contained in this operating manual and accompanying labels and/or inserts, provided that same is properly operated under conditions of normal use, that maintenance and service is performed and that replacements and repairs are made in accordance with the instructions provided. This same warranty applies to all probes as follows: The Date Code Tag (B) located on the cable identifies the month and year that the warranty period begins (**Removal of this tag voids the warranty**). The period extends for 12 months from this date for Ear, Finger, and FingerClip Probes; 3 months for Flex II Probes. The SoftProbe carries an out-of-box failure warranty only.




The foregoing warranties shall not apply if the Product has been repaired other than by Ohmeda or in accordance with written instructions provided by Ohmeda, or altered by anyone other than Ohmeda, or if the Product and/or probe have been subject to misuse, negligence, or accident.

Ohmeda's sole and exclusive obligation and Buyer's sole and exclusive remedy under the above warranties is limited to repairing or replacing, free of charge, at Ohmeda's option, a Product, which is telephonically reported to the Ohmeda Regional Office and which, if so advised by Ohmeda, is thereafter returned with a statement of the observed deficiency, not later than seven (7) days after the expiration date of the warranty, to Ohmeda (Louisville) during normal business hours, transporting charges prepaid and which, upon Ohmeda's examination, is not found to conform with the above warranties. OHMEDA SHALL NOT BE OTHERWISE LIABLE FOR ANY DAMAGES INCLUDING BUT NOT LIMITED TO INCIDENTAL DAMAGES, CONSEQUENTIAL DAMAGES OR SPECIAL DAMAGES.

THERE ARE NO EXPRESS OR IMPLIED WARRANTIES WHICH EXTEND BEYOND THE WARRANTIES HEREINABOVE SET FORTH. OHMEDA MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE PRODUCT OR PARTS THEREOF.

OHMEDA

THE BOC GROUP

# Biox 3700/3700e Pulse Oximeter

## Service Manual

L&SP 7105

# Important

This manual is subject to periodic review, update, and revision. Customers are cautioned to verify that the manual's information applies to the software and hardware present in the equipment.

This product performs as described in this manual, and in accompanying labels and/or inserts, when assembled, operated, maintained, and repaired in accordance with the instructions provided.

This product must be cleaned and checked periodically. Do not use a defective product. Parts that are broken, missing, plainly worn, distorted, or contaminated should be replaced immediately. If repair or replacement become necessary, call or write to request service advice from the nearest Ohmeda Regional Service Center (listed on the back cover). Do not repair this product or any of its parts other than in accordance with written instructions provided by Ohmeda and by Ohmeda-trained personnel.

The product must not be altered without the prior written approval of Ohmeda's Safety Department. The user of this product shall have the sole responsibility for any malfunction that results from improper use, faulty maintenance, improper repair, unauthorized service, damage, or alteration by anyone other than Ohmeda.

The safety, reliability, and performance of this device can only be assured under the following conditions:

- If the device has been used according to the accompanying operating instructions.
- If fittings, extensions, readjustments, changes, or repairs have been carried out by Ohmeda's authorized agents.
- If it is used in buildings that have ground equalization wiring that complies with relevant IEC or local standards and regulations (ETL, UL, CSA, PSI, TUV, etc.).



Text revised August 1996

## 4/Messages and Troubleshooting



## 5/Repair Procedures



## 6/Parts and Illustrations

# 1/Overview

This manual provides instructions for servicing the Ohmeda Biox 3700 or 3700e Pulse Oximeter, Revision M and above. This chapter contains:

- A general description of the oximeter.
- Oximeter specifications and options.
- Precautions, including specific warnings and cautions, you must follow when servicing the monitor.
- Safety procedures you must follow when handling equipment that may be contaminated and when making repairs.

## 1.1 General Description

The Ohmeda Biox 3700 or 3700e Pulse Oximeter is a stand-alone, noninvasive, arterial oxygen saturation monitor. Ear, finger, and flex probes connect the monitor to the patient, giving continuous oxygen saturation ($SpO_2$) and pulse rate readings.

The oximeter measures a patient's arterial oxygen saturation and pulse rate by measuring the absorption of selected wavelengths of light. The light generated in the probe passes through the tissue and is converted into an electronic signal by the probe's photodetector. The electronic signal passes to the oximeter and is amplified. Analog and digital signal processing convert the light intensity information into $SpO_2$ values. Two liquid crystal displays (LCDs) present patient data and status information. The digital LCD shows the patient's $SpO_2$ and pulse rate and the graphic LCD shows the plethysmographic waveform trend data, and status and alarm messages.

**Note:** For a detailed description of the unit's components, key functions, general operating guidelines, chart recorder connection, and computer interface, see the *Ohmeda Biox 3700/3700e Pulse Oximeter Operator's Manual.* For information on probe or sensor application and cleaning see the instructions for the appropriate probe or sensor.

# 1.2 Specifications

Unless otherwise indicated, all specifications are nominal and are subject to change without notice.

## 1.2.1 Physical

### Dimensions

Height: 10.16 cm (4.0 in)
Width: 25.40 cm (10.0 in)
Depth: 28.70 cm (11.3 in)
Weight: 3.86 kg (8.5 lb)

### Front panel

Display: Seven-segment liquid crystal display (LCD) and dot matrix LCD
Probe connector: Hypertac 9-pin, injection-molded polycarbonate

### Rear panel connectors

Analog output: ⅛" mini phone jack
Digital output: 25-pin "D" socket
Ground equalization: DIN 42-801

### Fuses

100V/120V: Dual 5x20mm T 0.25A / 250V
220V/240V: Dual 5x20mm T 0.25A / 250V

### Power input connector

IEC 320: 125 V, 15 A
250 V, 6 A

## 1.2.2 Accuracy

### $SpO_2$

Range: 0 to 100%

| Range | Accuracy (1 Standard Deviation) | Data points |
|---|---|---|
| 90 to 100% | 1.5% | 183 |
| 80 to 89.9% | 2.1% | 197 |
| 60 to 100% | 2.4% | 616 |
| Below 59.9% | unspecified | |

Accuracy measurements are statistically derived and correlated to simultaneous arterial blood gases measured on an IL-282 co-oximeter.

### Pulse Rate

Range: 40 to 235 BPM
Display Range: 0 to 255 BPM
Accuracy: ±1.7% of current reading (assuming a constant pulse rate)

## 1.2.3 Alarm Limits

**$SpO_2$ alarm limit range**

High = 70 to 100%,
Low = 50 to 100%.

**Pulse rate alarm limit range in beats per minute (BPM):**

High = 70 to 250 BPM
Low = 40 to 200 BPM
0 (zero) to 255 BPM will display; 0-20 BPM will appear as dashes; above 235 BPM, the data may be invalid

## 1.2.4 Default settings

| Parameter | Default Setting | Range |
|---|---|---|
| High $SpO_2$ Limit | OFF (appears as: - - -) | 70% to 100% |
| Low $SpO_2$ Limit | 85% | 50% to 100% |
| | (90% at software revision 22 or lower) | |
| High Pulse Rate | OFF (appears as: - - -) | 70 to 250 BPM* |
| Low Pulse Rate | OFF (appears as: - - -) | 40 to 200 BPM |
| | (50 BPM at software revision 22 or lower) | |
| Alarm Volume | 4 | 1 to 10 |
| Pulse Volume | 4 | OFF to 10 |
| Response Time | S | S, N, F |
| | N at software revision 22 or lower) | |
| Alarm Filter | ON | OFF, ON |

* BPM = Beats-Per-Minute

## 1.2.5 Audible alarms

Setting levels available:
- $SpO_2$ - 1 through 10
- Pulse - Off through 10

Frequency = 400 to 800 Hertz
Intensity at 1-meter distance:
- Volume setting of 1: 55 decibels (minimum)
- Volume setting of 10: 75 decibels (maximum)

## 1.2.6 Environmental

### Temperature

Operating Range: 0° to 50°C (32° to 122°F)
Storage Range: -20° to 60°C (-4° to 140°F)

> **Note:** At temperature extremes, the liquid crystal display may show reduced contrast, ghosting, or darkening. When returning from temperature extremes, allow the oximeter temperature to stabilize before use.

### International Electrotechnical Commission classifications

*Type of protection against electric shock:* Class I/Internal electrical power source

*Degree of protection against electric shock:* Type BF

*Degree of protection against ingress of liquids*: Ordinary

*Mode of operation:* Continuous

*Recommended methods of sterilization or disinfection:* See section 1.4.1 in this manual and the instructions for the probe you are using for recommended procedures for cleaning this equipment.

*Degree of safety of application in the presence of a flammable anesthetic mixed with air or with oxygen or nitrous oxide:* Equipment not suitable for use in the presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide.

## 1.2.7 Electrical

### General

Input voltage (minimum and maximum) for stable operation:

| Range | Operation |
|---|---|
| 90 to 110 V | 100 V |
| 108 to 132V | 120 V |
| 198 to 242 V | 220 V |
| 216 to 264 V | 240 V |

Current: Normal draw, approximately 0.2 A at 100/120 V or 0.1 A at 220/240 V
Power: 100, 120, 220, 240 V (single phase)
Frequency: Limits = 47 to 63 Hz
Patient isolation from power input:
20 MW, 2500 V RMS at 60 Hz (EarProbe, FingerProbe, and Flex II probe to third wire ground)
Chassis breakdown voltage: 1500 V RMS at 60 Hz
Ground resistance: <0.1 Ω
Leakage current, forward and reverse polarity: 50 µA maximum

### Battery

1, 4-cell pack
Sealed lead-acid
Operation time: 1.5 hours typical with all functions operating
Recharging time: 80% capacity = approx. 4 hours.
100% capacity = approx. 16 hours
Voltage: 8 V, 2.5 amp-hours
Charge life: several hundred charge/discharge cycles
Constant voltage charger: 9.35 to 9.40 V

### Power cord

Type: 16 AWG, 3-conductor jacketed, SJT gray, 10 feet
Voltage and current rating: 6 A, 250 V or 15 A, 125 V

### Power consumption (25 watts typical)

| | Output | $SpO_2$ | Pulse rate |
|---|---|---|---|
| Analog | Voltage | 0V/1V = 0% - 100% | 0V/1V = 0-250 BPM |
| | Impedance | 300 Ω | 300 Ω |
| Digital | Voltage | RS-232C compatible | |
| | Impedance | RS-232C compatible | |

### Analog Output

Current: 3 milliamperes (at full scale output)
Connector type: ⅛" miniature phone jack
Mating Connector Plug: ⅛" miniature phone plug
Connector polarity: tip = signal (+); sleeve = ground (-)

### Serial Output

Number of bits per character: 7
Parity: odd
Number of stop bits: 1
Connector type: 25-pin standard D, female
Connector pin functions:
1 = chassis ground
2 = receive data by the oximeter
3 = transmit data from the oximeter
7 = signal ground

### Probes and sensors

Refer to the instructions for the probe or sensor you are using.

# 1.3 Precautions

Two types of precautions appear in this manual: warnings and cautions.

## 1.3.1 Warnings

A **WARNING** indicates the possibility of injury to the patient or operator.

Handle the monitor with care. Improper handling can cause damage or inaccurate results.

**Failure of operation**

If the oximeter fails any part of the preoperative checkout procedures, calibration, or current leakage test, remove it from operation until qualified service personnel have corrected the situation.

The oximeter is a microprocessor-based device designed to immediately shut down if the microprocessor fails. This prevents the possible display of erroneous information. No alarms forewarn this action.

**Data validity**

Calibration is verified during powerup. Do **not** operate the oximeter unless it is properly calibrated or inaccurate patient readings will result.

Excessive ambient light, excessive motion, low perfusion, or electrical interference at the probe site may cause erroneous readings.

To prevent erroneous readings, do not use an inflated blood pressure cuff on the same limb as the oximeter probe.

To prevent inaccurate patient readings, the digital voltmeter used in reference voltage test procedures must be accurately calibrated.

On units with software revision 23 or higher, the low quality signal indicator no longer appears. It is strongly recommended that the user monitor the plethysmographic waveform and signal strength indicator to make the determination that the data being presented are valid.

**Electrical shock and flammability hazard**

To protect against fire hazard, replace only with fuses of the same type and local line voltage rating.

Disconnect the power supply from the unit before starting fuse replacement.

**Explosion hazard**

Do not use the oximeter in the presence of flammable anesthetics or other flammable substances.

### Electrical shock hazard

This equipment must be properly grounded.

- Connect this equipment only to a three-wire, grounded, hospital-grade receptacle. The three-connector plug must be inserted into a properly wired three-wire receptacle; if a three-wire receptacle is not available, a qualified electrician must install one in accordance with the governing electrical code.
- Do not under any circumstances remove the grounding connector from the power plug.
- Do not use extension cords or adapters of any type. The power cord and plug must be intact and undamaged.
- If there is any doubt about the integrity of the protective earth conductor arrangement, operate the monitor on internal battery power until the AC mains protective conductor is fully operational.

To prevent injury,

- Before servicing or cleaning the monitor, turn the unit off and disconnect the power cord from the AC power supply.
- Do not touch any exposed wiring or conductive surface while the cover is removed. The voltage present when electrical power is connected to the monitor can cause serious injury or death.
- Never wear a grounding wrist strap when working on an energized oximeter.

Measure the oximeter's leakage current whenever an external device is connected to either the analog or serial port. Leakage current must not exceed 50 microamperes.

Because the unit is not grounded when it is operated on battery power, do not connect any equipment to the signal input/output ports on the rear panel unless the unit is connected to the AC mains power supply.

### Battery replacement

Unauthorized personnel should not attempt to install, connect, or replace the oximeter's battery.

- Removing the cover and/or faulty battery connections could be hazardous and will void the warranty.
- Reversing the battery connections could result in injury and will permanently damage the circuitry.
- If trained technical personnel are not available, call Ohmeda for assistance.
- For proper operation, replace only with an Ohmeda battery.
- To prevent failure of the 2 amp fuse on the power supply board, do not cross battery connections

**Patient safety**

Do not, under any circumstances, perform any testing or maintenance on the oximeter or probe when it is being used to monitor a patient.

To prevent patient injury or equipment damage, use only oximeter probes identified for this monitor (see the instructions for the probe you are using).

If a probe is damaged in any way, discontinue use immediately.

Prolonged monitoring or patient condition may require periodically changing the probe test site. To reduce the risk of blistering, skin erosion, or ischemic skin necrosis, change the probe site as specified in the user instructions for the probe you are using. If any evidence of the above conditions appears prior to the specified time period (for example, discoloration or reddening), change the probe site immediately.

To avoid any possibility of patient discomfort or injury during magnetic resonance imaging,

- Do not allow the oximeter probe cable to come in contact with the patient's body; keep the cable off of the patient or place a blanket or other insulating material between the patient and the probe cable.
- Position the oximeter probe and probe cable as far from the center of the magnetic field as possible.

The correct use of the oximeter is to measure only arterial oxygen saturation ($SpO_2$) and pulse rate.

- A pulse oximeter does not measure respiration and under no circumstances should be used as a substitute for an apnea monitor.
- The oximeter must not be used as the primary monitor for infants being monitored for apnea, either in the hospital or in the home setting. It measure $SpO_2$ and pulse rate, and only in conjunction with other appropriate monitoring techniques.
- A pulse oximeter is often used during sleep studies with adults, but must be used only to gather information regarding $SpO_2$ and pulse rate during these studies.
- A pulse oximeter is to be used only by or on the order of medically trained personnel.

Refer to the instructions for the probe or sensor you are using for detailed warning information.

### 1.3.2 Cautions

A **CAUTION** indicates a condition that may lead to equipment damage or malfunction.

Federal law in the U.S.A. and Canada restricts the sale of this device by or on the order of a licensed medical practitioner.

Always make sure the monitor is set up to operate at the AC power supply voltage present at the "wall" receptacle.

Avoid storing the oximeter and probes at temperatures below -20° C (-4° F) or above 60° C (140° F).

To prevent damage to the lead-acid battery, do not turn the monitor on after the Recharge Battery alert message appears without first plugging it into the AC power supply.

To prevent improper loading, which upsets the correspondence between the measured voltage and the intended output voltage, connect only a high impedance device (1K Ω or higher) to the analog output.

**Static sensitivity**

The oximeter's electronic components are susceptible to damage by electrostatic discharge. When disassembling the unit,

- Work at a static-control workstation and wear a static-control wrist strap to discharge accumulated static charges from you and any tool you use.
- Use nonconductive tools.
- Handle circuit boards (replacement and defective) by their nonconductive edges. Use anti-static containers to transport them.

Detailed information for more extensive repairs is included in the service manual solely for the convenience of users having proper knowledge, tools, and test equipment, and for service representatives trained by Ohmeda.

Refer to the instructions for the probe or sensor you are using for detailed caution information.

**Cleaning**

- Do not autoclave, pressure sterilize, or gas sterilize this oximeter.
- Do not soak or immerse the monitor in any liquid.
- Use the cleaning solution sparingly. Excessive solution can flow into the monitor and cause damage to internal components.
- Do not touch, press, or rub the display panel with abrasive cleaning compounds, instruments, brushes, rough-surface materials, or bring it into contact with anything that could scratch the panel. Do not use petroleum-based or acetone solutions, or other harsh solvents to clean the display panel.

# 1.4 Safety procedures

**WARNINGS:**

**Patient safety—Do not, under any circumstances, perform any testing or maintenance on the oximeter or probe when it is being used to monitor a patient.**

**Electrical shock hazard—Before cleaning or repairing the oximeter, always turn it off and unplug it from the AC power supply.**

**Read** and follow **each step** of all test and repair procedures to ensure their proper and safe completion. Give special attention to all WARNINGS and CAUTIONS.

**Before you start** any procedure that involves disassembly of the oximeter, be sure to

- Power off and disconnect the unit for the AC power supply.
- Clean the unit--see section 1.4.1.
- Disconnect the probe from the unit.

**After repairs are complete,**

- Test the unit as directed in each procedure to verify that it is functioning properly.
- Complete the "Preoperative checklist" in 2/Operations in the *Ohmeda Biox 3700/3700e Operator's Manual.*

## 1.4.1 Cleaning the monitor

**You must clean the oximeter,**

- Before you start any test or repair procedure that involves disassembly of the monitor.
- Before you send it to Ohmeda for repair.

**Equipment**

- Safety eyeglasses or face guard.
- Disposable latex-based gloves.
- Paper towels.
- Cool, liquid cleansing agent, such as 70% isopropyl alcohol or equivalent.

**CAUTION: Cleaning**

- Do not autoclave, pressure sterilize, or gas sterilize this oximeter.
- Do not soak or immerse the monitor in any liquid.
- Use the cleaning solution sparingly. Excessive solution can flow into the monitor and cause damage to internal components.
- Do not touch, press, or rub the display panel with abrasive cleaning compounds, instruments, brushes, rough-surface materials, or bring it into contact with anything that could scratch the panel. Do not use petroleum-based or acetone solutions, or other harsh solvents to clean the display panel.

**To clean the oximeter,**

1. Wash your hands before you handle the unit.
2. Wear safety eyeglasses and disposable latex gloves.
3. Disconnect the probe from the unit.
4. Spray a solution of cool, liquid cleansing agent on a paper towel and use it to wipe the surface of the unit.
5. Let the oximeter stand for 3 minutes, then dampen a clean paper towel with water and wipe the surface of the unit.

   **Note:** Wait for the oximeter's surface to dry before handling.
6. Discard the used paper towels and gloves as you would potentially contaminated waste materials.
7. Wash your hands.

# 2/Theory of Operation

This chapter provides the

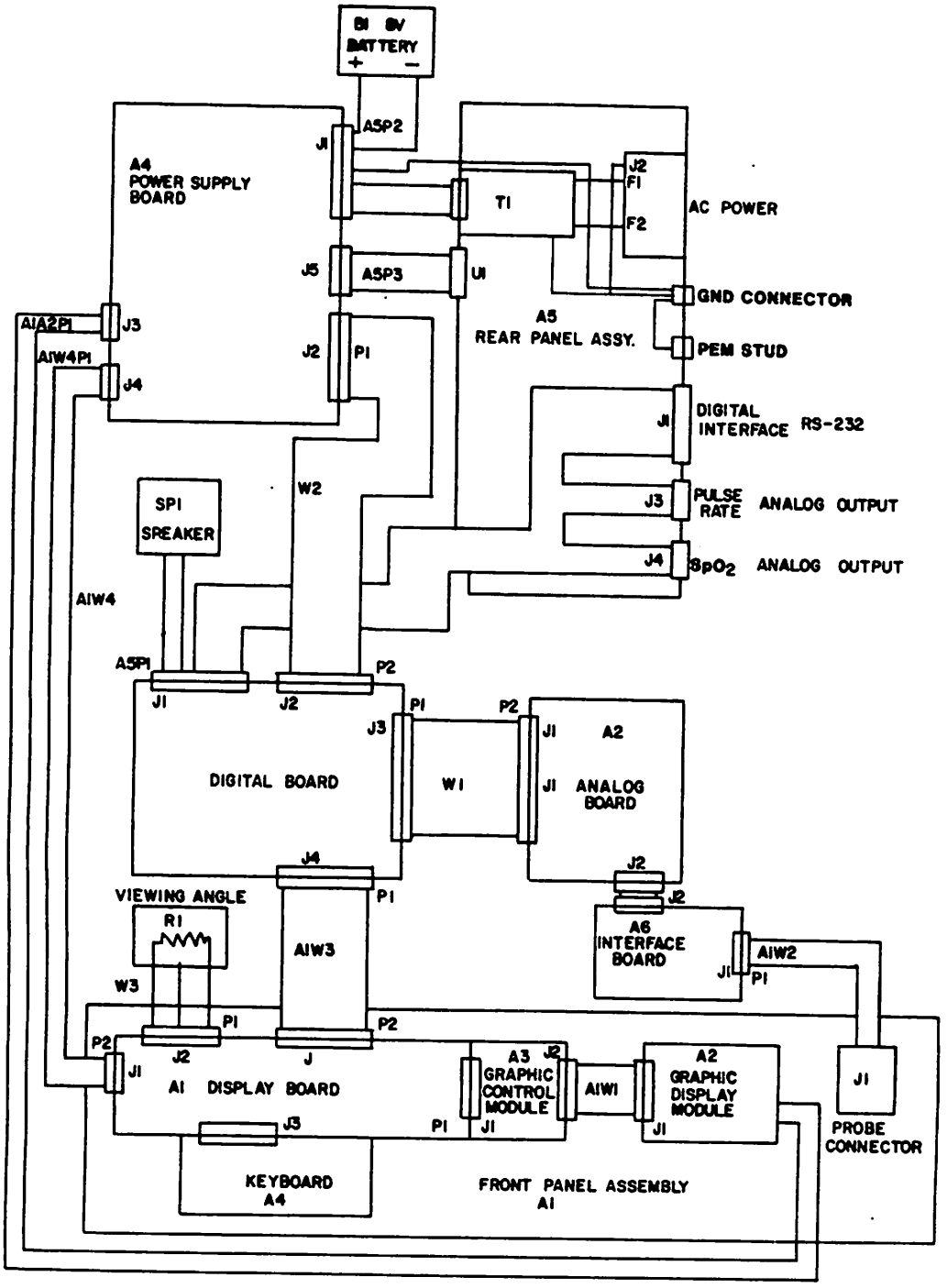
- Block interconnect diagram
- Front panel diagram
- Rear panel diagram
- Interconnect cables diagram
- Theory of operation for the
  - Power supply board
  - Digital board
  - Display board
  - Analog board

This chapter supplies basic circuitry information and is not intended to be an exact representation of the product.

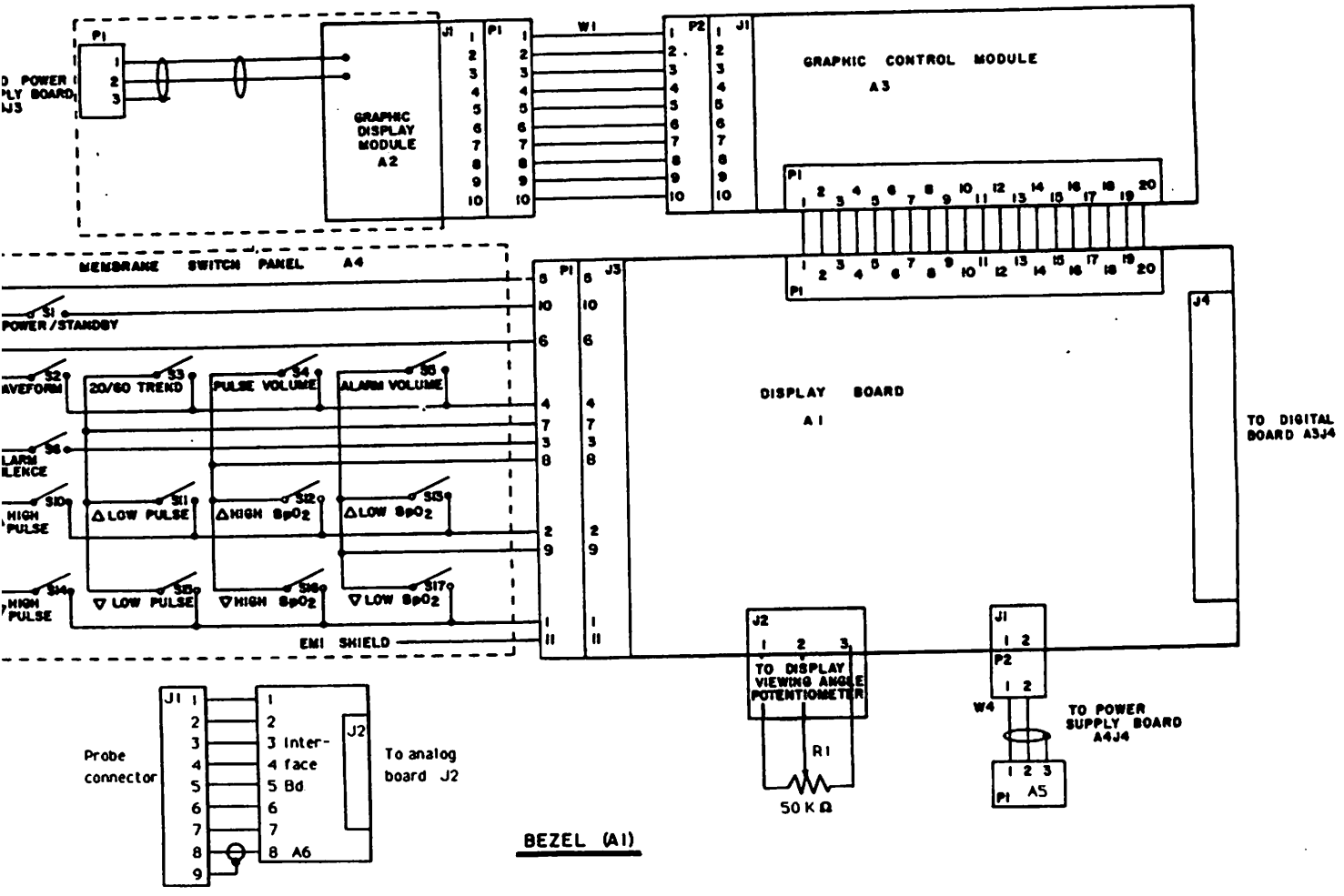
The reference designators used in these circuit theories are found in 6/Illustrated Parts List.

**Note:** All resistors are ¼ Watt 5% unless otherwise noted.

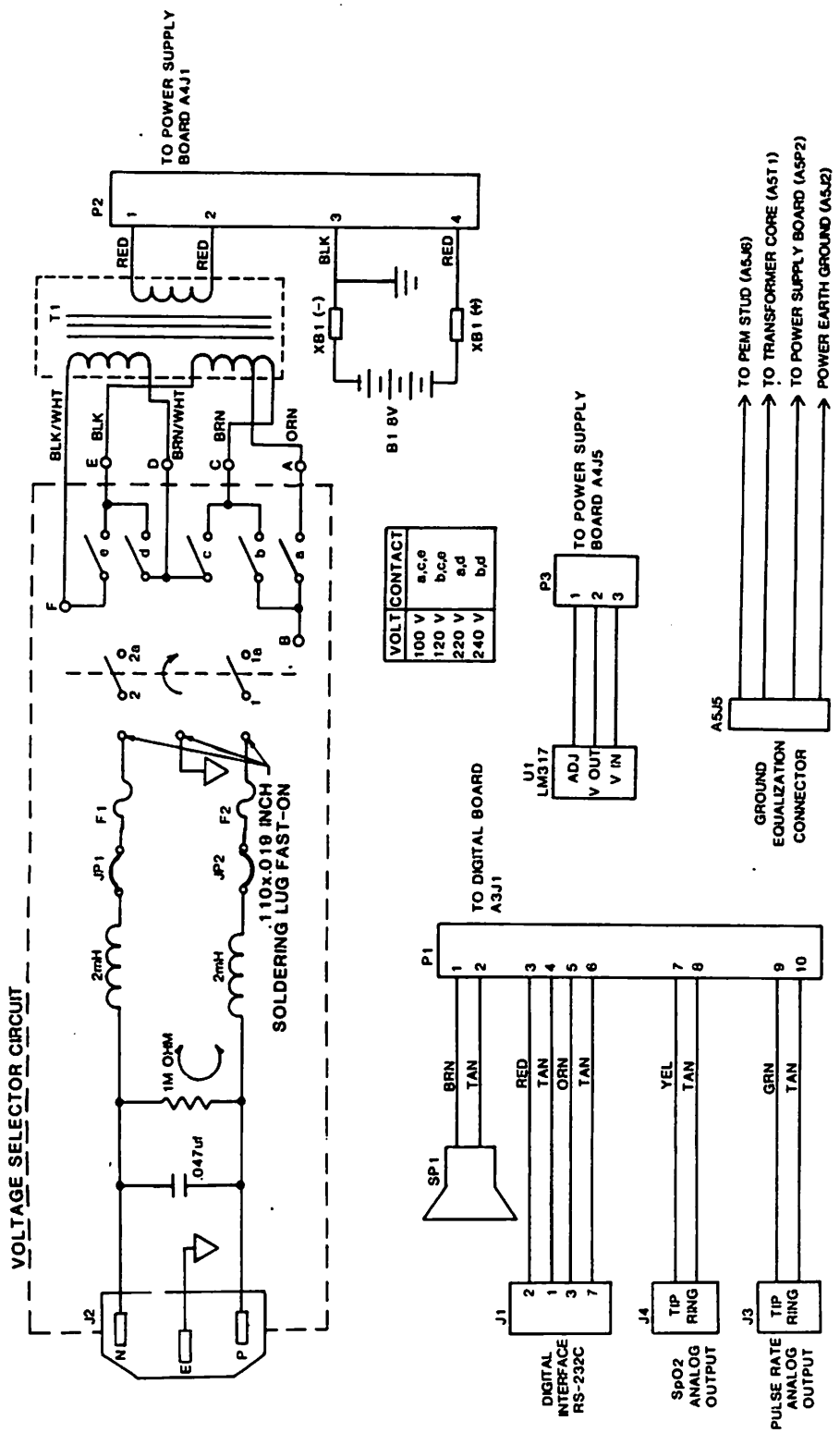
# 2.1 Block interconnect diagram



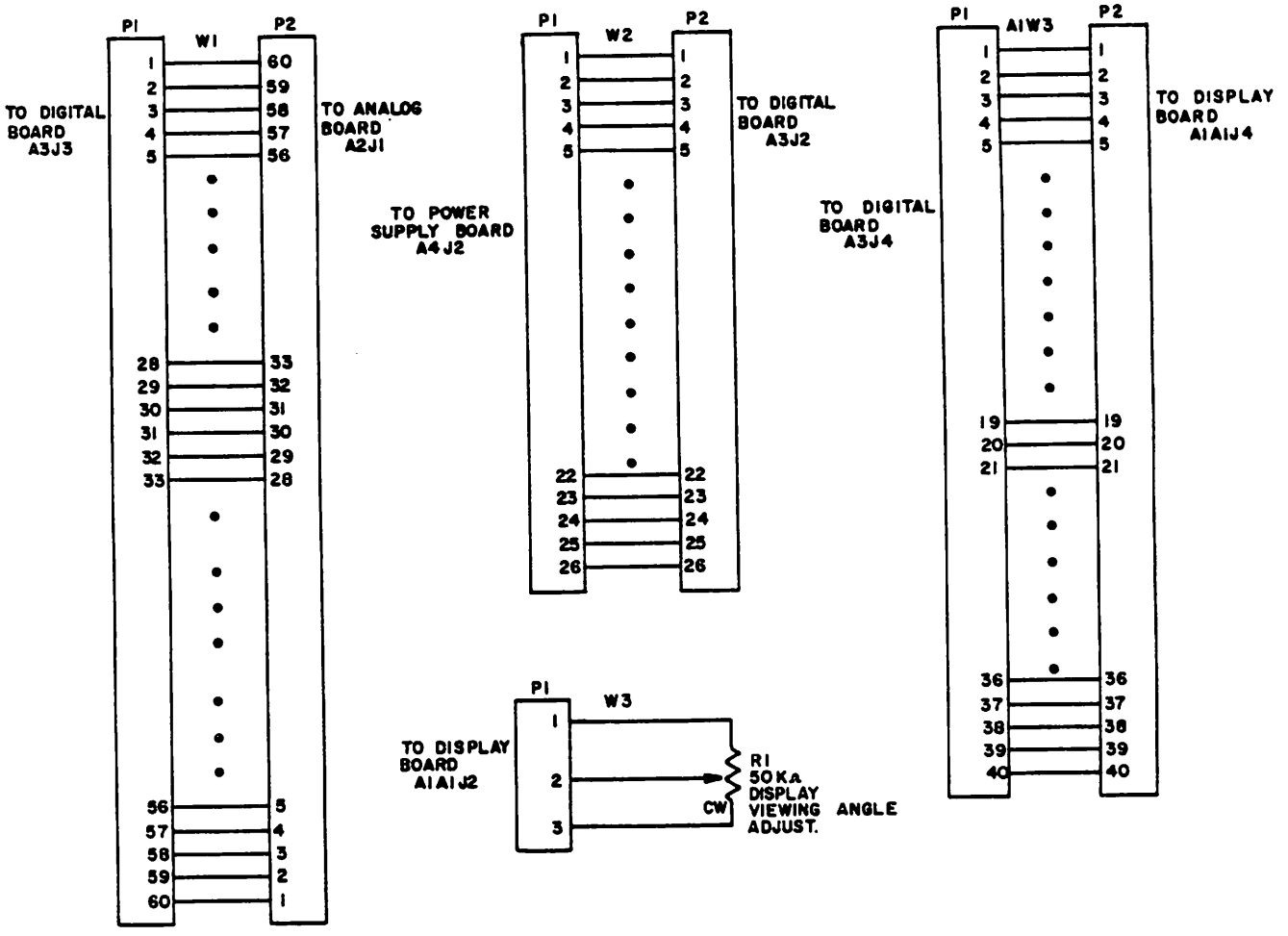
# 2.2 Front panel diagram



# 2.3 Rear panel diagram



# 2.4 Interconnect cables diagram



# 2.5 Power supply board

### AC power conversion

When the oximeter is plugged into AC power and the Power/Stndy switch is in the On position, the output from the transformer is rectified by a full wave bridge rectified (CR1), smoothed by filter capacitors C1 and C2, and regulated by a 3-terminal regulator (connected to J5). This power passes through Schottky blocking diode CR11 to operate the unit.

### Battery charging circuit

The same regulator that supplies power to the unit is also used to charge the battery. Resistors R3 and R4 and potentiometer R5 set the output voltage of the regulator. The power to charge the battery passes through a current limiting resistor (R27) and a Schottky blocking diode (CR12).

The battery-charging voltage is set for 9.35 to 9.40 volts.

Three Schottky diodes (CR10, CR11, CR12) set up the blocking of current so the battery charges while the unit is operating. When the unit is not plugged in, the relay (K1) shorts out one diode (CR10). this guarantees that the unit has enough overhead voltage from the battery to drive the regulators (U12, U13, U15, U16, U17).

### On/Off circuit

The battery or battery-charging circuit supplies power to the power on/off control circuit and the RAM standby regulator through diode CR18. When the oximeter is turn on, the initial surge of current to charge capacitances on the boards causes a sudden drop in the supply voltage at the cathode of CR11. CR18 and capacitor C4 prevent this spike from affecting the power on/off control circuit.

The power on/off control circuit operates in one of two different modes (3700 or 3710) depending on the position of switch SW1.

In 3700 mode, power to the unit is controlled by a single momentary contact switch (Power/Stndby), which toggles power on and off. If SW1 is erroneously placed in the 3710 position in a 3700 or 3700e oximeter, the Power/Stndby key has no function. Connecting the 3700 or 3700e oximeter to AC power turns it on and disconnecting it turn it off, but it will not operate on battery power.

With SW1 in the 3700 position, U18-2 is held low, which causes the SET input of flip-flop U9B to be held low. J2-12 (COM/OFF) is also held low and serves as the common return for the Power/Stndby switch. Resistor R46 pulls U18-8 high, which disables this input as a reset to flip-flop U9B.

Pressing the Power/Stndby switch momentarily ground J2-10 (PWR/STBY). During the power on sequence the power sensing circuit (transistors Q3 and Q4 and resistors R30 and R29) keeps the RAM

disable signal (RAM DIS-) low until the +5V power supply voltage is above the turn on threshold of Q3, which is high enough to enable the RAM without losing information.

Pressing Power/Stndby a second time toggles U9B and starts the following sequence of operations:

- The Q output of U9B goes low, causing the inverter output (U8-6) to go high. This signal (OFF) informs the microprocessor that power is being turned off, allowing time to clean up the RAM and turn the unit off. Also, as the Q- output of U9B goes high, a fail-safe timer starts. The fail-safe timer consists of capacitor C9, resistor R9, diode CR7 and gate U7C. If the microprocessor fails to do so, this circuit turns the unit off by generating a reset pulse to U9A approximately 130 milliseconds after U9-12 goes high.
- The microprocessor turns the unit off by ceasing to reset the watchdog timer on the digital board. The signal SHUTDOWN goes high (Q2-GATE), which resets flip-flop U9A and de-energizes the relay K2.

## 2.5.1 Power regulating circuits

### RAM standby circuit

The micro power regulator (U6) supplies power to the RAM while the unit is off. Resistors R6 and R7 set the output voltage of U6 to 4 volts, which passes through the diode (CR5) to the RAM. The RAM sees approximately 3.4 volts; it needs only 2.4 volts to retain its contents.

### Positive 5-volt circuit

When the power turns on, relay K2 connects the battery voltage to the regulator circuits U12, U13, U15, J16, and U17. U12 supplies +5 volts to the digital board and supplies 5 volts to Schottky diode (CR9), which supplies power to the RAM on the digital board.

### Positive V circuit

Regulator (U13) provides +5 volts for the analog circuitry.

### Negative V and positive/negative -15 V

The switching regulators U15, U16, and U17 generate -5 volts for the analog circuitry, and 15 volts for the D/A converter and bugger amplifier on the analog board.

### Power fail circuit

Comparators U11-C and U11-D detect when one of the four analog supplies (+V, -V, +15V, or -15V) fails. If one of these voltages drops below half of its normal voltage, the power fail signal goes low. The processor detects this signal and displays a POWER SUPPLY FAILURE message momentarily and automatically turns the oximeter off.

### Low battery detection circuit

Comparators U11A and U11B sense the state of discharge of the battery. Reference diode U10 provides an accurate reference for the comparators. Resistor-divider network R21, R16, and R20 sets the voltage levels for the comparators to determine the battery's condition.

Comparator U11B senses when the battery voltage drops below 7.3 volts. The output of this comparator (U11-2, LOW BATT) informs the microprocessor that the charge on the battery is getting low. The unit then displays the LO BT message.

Comparator U11A senses when the battery voltage drops below 7.0 volts. The output of this comparator (U11-1, RECHG) informs the microprocessor that the battery is fully discharged. The unit then replaces the waveform display with the RECHARGE BATTERY message for 15 seconds and then cycles itself off.

**CAUTION:** To prevent damage to the lead-acid battery, do not turn the monitor on after the RECHARGE BATTERY alert message appears without first plugging it into the AC power supply.

### Electroluminescent (EL) panel driver

**The following description applies to display board 6050-0003-302, or higher:**

This version of the display board has an LED backlight that is powered off of +5V. It does not require a cable connection to J2.

**The following description applies to display board A118-004, Rev V, or lower:**

A counter circuit synchronizes the EL panel driver to the system clock. The 3.6864 mHz clock feeds counter (U14). The Q13 output of U14 (450 Hz) drives transistor Q6, which drives the transformer T1. This transformer converts 5 volts to approximately 120 volts AC, which powers the EL panels.

The circuit consisting of Q5, R32, R34, C22, C28, and CR15 acts as a fail-safe circuit to protect Q6 and T1. As long as the 3.6864 mHz clock is functioning, it is coupled through capacitor C28 to the gate of Q5. This turns Q5 on and discharges capacitor C22.

If the 3.6864 mHz clock stops functioning, resistor R34 pulls the gate of Q5 low, which turns Q5 off. This allows capacitor C22 to charge to +5 volts through resistor R32, which resets counter U14.

### Line frequency detector circuit

15 volts AC from the power transformer goes to resistor R1 and an optoisolator (U1). This puts out a line frequency signal referenced to circuit ground. This signal goes through Schmitt trigger U2A and then to 2 flip-flops (U3A, U3B), a gate (U2B), and an inverter (U8A). This circuit generates a single pulse 4.34 microseconds wide, synchronized to the

power line, which feed the reset on the counter circuit (U5, U4). The counters U4 and U5 have a 3.6864 mHz clock and are reset periodically based on the power line frequency.

The output is coded into 2 bits (FREQ 0 and FREQ 1). The diode, resistor, and capacitor networks (CR8-R11-C8 and CR6-R10-C7) act as retriggerable one shots that go high with a pulse at U4-3 or U4-5 and stay high as long as pulses occur more often than approximately every.1 second. If the power line frequency is greater than 225 Hz (e.g., 400 Hz), the counter is always reset before the first bit of the second stage (U4-3) gets set. This gives a code at FREQ 0, FREQ 1 of 00.

If the power line frequency is between 56 Hz and 225 Hz (e.g., 60 Hz), then U4-3 gets set once every 4 to 18 milliseconds, but U4-5 never gets set. This gives a code at FREQ 0, FREQ 1 of 10.

If the power line frequency is between 19 Hz and 56 Hz (e.g., 50 Hz), then U4-3 and U4-5 both get set. This gives a code at FREQ 0, FREQ 1 of 11.

If the power line frequency is zero Hz (e.g., operating on battery power). the counter is never reset. This allows the counter outputs U4-6 and U4-5 to get set, and feed back through gates U2D and U2C to disable the second stage of the counter. At the time that the counter is disabled, the output U4-3 is low. This gives a code at FREQ 0, FREQ 1 of 01.

## 2.6 Digital board

### Crystal oscillator

The master clock for the oximeter is generated by the crystal oscillator circuit, U27A, Y1, R10, C19, and C20, which oscillates at 3.6864 mHz.

### Power ON reset

The circuit C1, R1, CR1, U1A, U1B, and U1C generates a reset signal at power up, holding the processor reset until the power supply voltages stabilize. The reset signal is also sent to the watchdog timer, the interrupt latch, and the serial communication interface.

### Watchdog timer

The circuit U4, U2B, U3C, C2, R2, and R3 is a fail-safe timer circuit that turns the oximeter power off if the microprocessor fails. The analog board generates a signal (WCLK, J3-16), which clocks counter U4. The frequency of WCLK is 960 Hz when operating the oximeter for 60 Hz power and 800 Hz when operating the oximeter from 50 Hz power. The microprocessor sets and clears bit 2 on the output port U11-17, to reset U4. This signal is AC coupled to the counter U4 through C2 and U3C. Resistor R2 sets the ground reference for the input (pin 10) to U3, and R3 provides current limiting for the input protection diode inside U3-10. If U4 is not reset before the counter output Q7-4 goes high, then flip-flop U2B gets set and the signal SHUTDOWN is sent to the power supply board, causing the oximeter power to be turned off. Upon powerup, the power on reset circuit resets counter U4 and flip-flop U2B.

### Microprocessor

The master controller is a Z8002 microprocessor (U6) with a 16-bit, multiplexed address/data bus. The microprocessor performs all control functions in the oximeter and calculates $SpO_2$ and pulse rate.

### Address latch

U7 and U16 make up the address latch, which demultiplexes the address from the address/data bus. The address strobe (AS) from the microprocessor (U6 pin 26) clocks the address into the latch. Inverter U23A inverts the AS to the correct sense for use by the address latch.

### Interrupt latch

Flip-flop U2A latches the nonvectored interrupt (NVI) from the analog board until the microprocessor acknowledges its occurrence, at which time it resets the interrupt latch by clearing and then setting bit 3 of output latch U11-16. Upon powerup, the power on reset circuit resets the interrupt latch. The two resets are or'ed by gate U1D.

### ROM

The read-only memory (ROM), U9 and U18, contains the master program for controlling the oximeter and calculating $SpO_2$ and pulse rate.

### Data RAM

Random-access memory (RAM), U8 and U17, stores $SpO_2$ and pulse rate trend data, system flags, and other data.

### Address decoding

Decoders U22 and U28 and gates U3A and U3B perform decoding of memory addresses for ROM and RAM.

U22 decodes byte-word instructions and enables the appropriate half of U28, which in turn enables the appropriate half of the 16-bit-wide memory. When a memory request (MREQ) occurs, U28 enables either ROM or RAM. If address bit 15 is low, ROM is enabled; if address bit 15 is high, RAM is enabled.

Gates U3A and U3B disable RAM (U8 and U17) when address bit 14 is high.

The ROM address space is from hexadecimal (hex) memory address 0000 to 7FFF.

RAM is divided into two section : RAM and memory-mapped input/output (I/O). RAM address space is from hex address 8000 to BFFF. Memory-mapped I/O address space is from hex address C000 to C01D.

U30 and U31 decode the addressing for the memory-mapped I/O. Memory-mapped I/O addresses with pin numbers for U30 and U31 and a brief description are as follows:

| Hex address | IC and pin # | Function |
|---|---|---|
| C000 | U31 - 15 | Input data from serial interface |
| C003 | U31 - 14 | Output control of AC and DC gain, test mode, and sample frequency |
| C008 | U31 - 13 | Input A/D converter data, output A/D control |
| C00C | U31 - 12 | Output alarm light, interrupt reset, watchdog reset, DAR |
| C010 | U31 - 11 | Output analog multiplexer control and keyboard scan |
| C014 | U31 - 10 | Output Red LED intensity |
| C018 | U31 - 9 | Output IR LED intensity |
| C01C | U31 - 7 | Output data to serial interface |
| C001 | U30 - 15 | Output to D/A converter for analog pulse rate |
| C005 | U30 - 14 | Input keyboard scan, line frequency, A/D status and data valid |
| C009 | U30 - 13 | Unused |
| C00D | U30 - 12 | Output $SpO_2$ display data |
| C011 | U30 - 11 | Output pulse rate |
| C015 | U30 - 10 | Output $SpO_2$ and pulse rate display control |
| C019 | U30 - 9 | Unused |
| C01D | U30 - 7 | Input serial interface status |

Decoder U29 performs address decoding for nonmemory-mapped I/O. The I/O addresses with pin numbers for U20 and a brief description are as follows:

| Hex address | IC and pin # | Function |
|---|---|---|
| 0 | U29 - 15 | Output to D/A converter for analog SpO2 |
| 3/13 | U29 - 14 | Output data/control to graphic display |
| 5 | U29 - 13 | Output audio frequency data |
| 7 | U29 - 12 | Input power supply status |
| 9 | U29 - 11 | Unused |
| B | U29 - 10 | Unused |
| D | U29 - 9 | Output audio volume data |
| F | U29 - 7 | Unused |

### Serial communication port

This port is an RS-232C-compatible interface consisting of the UART (U10), a baud-rate generator circuit (U25, U24D, and U32A), a line-receiver circuit (R4, R5, R7, CR2, and Q1), and a line-driver circuit (U5, R6, and C12).

The baud-rate generator counts the 3.6864 mHz system clock (U25-10) down to 19.2 kHz at U32-5, which is 16 times the serial interface baud rate of 1200.

The line-receiver circuit translates the RS-232C signal (which has a voltage swing range of ±3 volts to ±12 volts) to a logic-level signal, which feeds into the UART (U10-20).

The line-driver circuit translates the logic-level signal from the UART (U10-25) into a RS-232C-compatible signal level, which swings ±5 volts.

The microprocessor controls the UART and memory-mapped I/O. the microprocessor reads the UART status at hex memory address C01D, outputs UART transmit data at hex memory address C01C, and reads input data received by the UART at hex memory address C000. The microprocessor acknowledges received data by clearing and then setting bit 1 of memory-mapped output port U11-18, which is at hex memory address C00C.

### Input and output ports

U11, U19, and U26 are memory-mapped output ports that perform the following functions:

U11 hex address C00C

| Bit | Pin # | Function |
|---|---|---|
| 0 | 19 | Unused |
| 1 | 18 | DAR data acknowledge reset to UART |
| 2 | 17 | Watchdog timer reset |
| 3 | 16 | Interrupt latch reset |
| 4 | 15 | Alarm LED control |
| 5 | 14 | Unused |
| 6 | 13 | Unused |
| 7 | 12 | Unused |

## U19 hex address C004

| Bit | Pin # | Function |
|---|---|---|
| 0 | 19 | FREQ OUT; controls sampling frequency on analog board |
| 1 | 18 | TEST; controls test signal for self-test mode |
| 2 | 17 | A— |
| 3 | 16 | B— Controls AC gain on analog board |
| 4 | 15 | C— |
| 5 | 14 | A— |
| 6 | 13 | B— Controls DC gain on analog board |
| 7 | 12 | C— |

## U26 hex address C010

| Bit | Pin # | Function |
|---|---|---|
| 0 | 19 | A— |
| 1 | 18 | B— Controls analog multiplexer input |
| 2 | 17 | C— to A/D converter on analog board |
| 3 | 16 | D— |
| 4 | 15 | A— |
| 5 | 14 | B— Output drive |
| 6 | 13 | C— for scanning keyboard |
| 7 | 12 | D— |

## U20 hex address C005 (memory-mapped input port)

| Bit | Pin # | Function |
|---|---|---|
| 0 | 2 | FREQ 1 along with FREQ 0—power line frequency |
| 1 | 3 | ADSTS A/D converter status input |
| 2 | 4 | DATVAL data valid signal from analog board |
| 3 | 5 | FREQ 0 along with FREQ 1—power line frequency |
| 4 | 6 | A— |
| 5 | 7 | B— Inputs for |
| 6 | 8 | C— scanning keyboard |
| 7 | 9 | D— |

U12 hex I/O address 7 (nonmemory-mapped input port)

| Bit | Pin # | Function |
|---|---|---|
| 0 | 2 | Unused |
| 1 | 3 | Unused |
| 2 | 4 | Unused |
| 3 | 5 | Unused |
| 4 | 6 | PWRFAIL—power supply failure |
| 5 | 7 | OFF—unit is being turned off |
| 6 | 8 | RCHG—battery should be recharged |
| 7 | 9 | D— |

### Analog outputs

The SpO2 analog output circuit consists of a 10-bit D/A converter (U21), an output amplifier (U15) with a short-circuit protection resistor (R8), a high-frequency roll-off capacitor (C14), and an input-protection diode (CR5). CR3 and CR6 protect U21 from latch-up failure during powerup.

U21, a multiplying D/A converter, multiplies the reference input voltage (-VRED, pin 3) by -n/1024, where n is the decimal equivalent of the 10-bit binary number loaded into the holding register inside U21 at hex I/O address 0.

The SpO2 analog output is set to 1.00 volt full scale, representing 100% saturation.

The heart rate analog output circuit consists of an 8-bit D/A converter (U13), an output amplifier (U14) with a short-circuit protection resistor (R9), a high-frequency roll-off capacitor (C13), and an input-protection diode (CR4). U13, a multiplying D/A converter, multiplies the reference input voltage (-VREF, pin 15) by -n/256, where n is the decimal equivalent of the 8-bit binary number loaded into the holding register inside U13 at hex memory address C001

The full-scale output voltage of 1.00 volt represents a heart rate of 250 beats per minute.

### Audio output

The audio output amplifier (U33) is a current buffer amplifier with unity voltage gain. The input to U33 is AC coupled through capacitor C22 and the output is AC coupled through capacitor C28. This output drives an 8-Ω speaker mounted inside the oximeter bottom case.

# 2.7 Front panel assembly

The front panel assembly contains the graphic display, the graphic module interface, the display board, and the membrane switch panel.

### Graphic display/graphic module interface

The graphic display and the graphic module interface connect through a 10-conductor ribbon cable and operate as a unit. The graphic module interfaced to the microprocessor at hex I/O address 3 for data and 13 for control.

### Display board

This board provides the interface connections from the digital board (J4) to the membrane switch panel (J3) and to the graphics module interface (P1). It contains the numeric display (DSP1) and the visible alarm indicator (DSP2) with associated circuitry.

The numeric display is an 18-digit triplexed liquid crystal display (LCD). The LCD contains 6 large digits (.5 inch high): 3 each to display $SpO_2$ and pulse rate, and 12 small digits (.18 inch high), 3 each to display alarm limits for low $SpO_2$, high $SpO_2$, low pulse rate, and high pulse rate.

Display drivers (U1 and U2) control the multiplex timing and voltage levels driving the display. U1 controls the 9 digits associated with the pulse rate, and U2 controls the 9 digits associated with $SpO_2$. The microprocessor writes data into the display driver holding registers at hex memory address C00D for the pulse rate display driver. When the microprocessor writes to hex memory address C015, the display driver holding register data is transferred to the appropriate data register and decoder in both display drivers.

The display drive voltages, which control the viewing angle of both the graphic and numeric displays, are generated by dual operational amplifier U3, resistors R1 and R2, and potentiometers R3 and display contrast adjust (located under the right side of the front panel). The display contrast adjust potentiometer (R5, W3R1) controls both of the display drive voltages. R3 serves as a balance control, affecting only the display drive voltage for the graphic display.

The visual alarm indicator is a red light emitting diode (LED) light bar (DSP2) with three LEDs. Bit 4 of output port U11, located on the digital board, controls field effect transistor (FET) Q1, which turns on the indicator. Resistors R4 and R6 set the current flowing through the LEDs in the indicator.

### Membrane switch panel

This panel consists of the Power/Stndy switch, with two separate connections (power/standby and com) and 13 other front panel switches arranged in a 4 x 4 matrix (SWOA - SWOD and SWIA - SWID), as follows:

| | SWOA | SWOB | SWOC | SWOD |
|---|---|---|---|---|
| SWI D | Waveform | Alarm silence | ▲ High pulse | ▼ High pulse |
| SWI C | $SpO_2$ Trend 20/60 | unused | ▲ Low pulse | ▼ Low pulse |
| SWI B | Pulse volume | unused | ▲ High $SpO_2$ | ▼ High $SpO_2$ |
| SWI A | Alarm volume | unused | ▲ Low $SpO_2$ | ▼ Low $SpO_2$ |

The membrane switch panel also contains a conductive layer for shielding against electromagnetic interference (EMI) and electrostatic discharge (ESD).

## 2.8 Analog board

### Probes/sensors

The probe contains a red LED, and infrared LED, a silicon photodetector, and a resistor that identifies the relationship between the wavelengths of the red and infrared LED.

### Timing control

The frequency divider circuit, consisting of counters U5 and U6 and multiplexer U8, controls the frequency of the timing control for the analog circuitry.

When the unit is operating on 60 Hz power, the microprocessor sets FREQ OUT (U8-10 and U11) low. This selects the Q3 output of U5 (U5-7) to pass through switch A of U8 to the reset input of U5 (U5-15), and selects the Q5 output of U6-1 to pass through switch B of U8 to reset input of U6 (U6-15), which sets U5 to divide by 3 and U6 to divide by 5.

The frequency divider circuit therefor divides the 3.6864 mHz input clock (U5-14) by 15 to produce an output clock frequency of 245.76 kHz at U6-2.

When the unit is operating on 50 Hz power, the microprocessor sets FREQ OUT high, which sets U5 to divide by 2 and U6 to divide by 9. In this case, the frequency divider circuit divides the input clock by 18 to produce an output clock frequency of 204.8 kHz.

The master timing information for controlling the analog circuitry is contained in a ROM (U10). Counter U9 accepts the output clock from U6-2 and sequentially addresses the ROM to access the timing

information. The output clock from U6-2 loads the timing information from the ROM into data register U11, which prevents extraneous transitions of the ROM outputs from being propagated through to the analog circuitry.

### Reference voltages

Reference diode U36 generates a stable reference voltage of 1.235 volts. Resistor R56 sets the bias current for U36. Dual amplifier U35 uses the stable reference voltage from U36 to generate two stable reference voltages of -1 volt (-VREF, U35-1) and +1 volt (+VREF, U35-7).

Resistors R55 and R51 and potentiometer R52 set the gain of amplified U35A, and R52 adjusts the output to -1 volt. Precision resistors R53 and R54 set the gain of amplifier U35B to -1 volt, which produces an output voltage of +1 volt.

### LED drive

The circuitry that provides the drive current for the probe LEDs consists of U25, U27B, Q4, R48, and associated circuitry for driving the red LED, and U19, U27A, Q3, R22, and associated circuitry for driving the infrared LED.

The microprocessor loads an 8-bit binary decimal equivalent of the 8-bit number into the holding register within the multiplying D/A converter U26 to set the drive current for the red LED. Amplifier U27B converts the current output of U19 into a voltage at the emitter of transistor Q4. This voltage appears across resistor R48, which sets a constant current drawn through the collector of Q4 and the red LED in the probe.

The current through the red LED is determined by the relationship:

$$I_{LED} = \frac{VREF}{R48} \times \frac{N}{256}$$

where VREF = 1 volt, R48 = 8.25 Ω, and N is the binary number that the microprocessor loads into U26.

The maximum drive current for the red LED is set when N = 255. This current is 120 milliamperes, or 40 milliamperes when driving a SoftProbe or Easy Probe. **Note:** The addition of the upgrade interface board restricts the current of either of these probe to a maximum of 45 milliamperes should a failure of software or hardware occur elsewhere within the unit.

Switch A of multiplexer U32 turns the red LED drive on and off. The timing signal from U11-13 controls the switch. The duty cycle of this timing signal is approximately ⅓.

The infrared LED is controlled in the same manner as the red LED. The maximum drive current for the infrared LED is 60 milliamperes. The timing signal from U11-15 controls switch B of multiplexer U32 to turn the infrared LED on and off. The duty cycle of this timing signal is also approximately ⅓. The timing of the two LED drive signals is such that each LED is turned on for ⅓ of the time and they are both off for ⅓ of the time.

### LED drive monitor

Switch C of U32 samples the voltage at the cathode of the red LED when it is on (controlled by signal RLT at U32-9). Capacitor C40 stores this voltage for measurement by the A/D converter U12. Switch A of U33 and capacitor C41 sample the voltage at the cathode of the red LED when it is off (controlled by signal IRLT at U33-11). Similarly, switches B and C of U33 and capacitors C38 and C39 sample the voltages at the cathode of the infrared LED when it is on and off.

### Photodetector preamplifier

Amplifier U39, with feedback resistor R66, generates a voltage from the current produced by the photodiode in the probe. This signal passes through switch C of multiplexer U38.

### Calibration test signal

Multiplexer U38 controls the selection of the calibration test signal to be injected into the signal path. Amplifiers U25A and U25D, and associated circuitry, generate a 3 Hz sine wave at U25-1. Amplifier 25A, with input resistor R18 and feedback capacitor C23, is an integrator. The output of the integrator feeds back to its input through a two-pole, low-pass, active filter consisting of R14, C24, R13, C22, and U25B. Resistor R17 and diodes CR5 and CR6 limit the voltage swing of the signal fed back through the low-pass filter.

Amplifier U25B and multiplexer U38 accept the 3 Hz sine wave and generate a test signal that simulates the output of the photodetector preamplifier.

The reference voltage (+VREF) feeds input resistor R19 to produce a DC voltage at the output of amplifier U25B-7. The 3 Hz oscillator U25-1 feeds input resistor R15, which adds about .75% modulation to the output of amplifier U25B.

When the signal IR (U38-11) goes high, switch A of multiplexer U38 places resistor R11 in parallel with input resistor R15. This increases the amplitude of the modulation on the output of amplifier U25B to 1.5%.

When the red and infrared diodes are on, switch B of multiplexer U38 passes the output of amplifier U25B through to the Y input of switch C (U38-3). When the signal DK (U38-10) goes high, switch B of U38 selects ground to be passed through the Y input of switch C.

This calibration signal emulates a photodetector preamplifier output that represents a known oxygen saturation and a pulse rate of 150 to 210 beats per minute. The microprocessor checks the calibration of the oximeter by setting the signal TEST (U38-9) high. This selects the calibration signal to be passed through switch C of multiplexer U38 in place of the photodetector preamplifier output.

The signal from U38 pin 4 passes through a switched low-pass filter consisting of resistor R69; capacitors C66, C67, and C68; multiplexer U41; and amplifier U40. This filter is essentially three separate single-pole filters that are time multiplexed into the same signal path. Resistor R69 is a part of all three filters. Switch C of multiplexer U41 selects capacitor C67 to filter during the dark time (control signal DK at U41-9). Switch A of U41 selects capacitor C68 to filter during the red light time (red LED is on, control signal RLT at U41-11). Switch B of U41 selects capacitor C66 to filter during the infrared light time (infrared LED is on, control signal IRLT at U41-10).

With the multiplexing timing considered, the filter has an equivalent pole at approximately 10 Hz, which serves to suppress high-frequency interference that comes in through the photodetector preamplifier. Amplifier U40 acts as a buffer to prevent loading of the filter.

### Ambient light cancellation

Capacitor C55 and switch A of multiplexer U30 remove the effects of ambient light from the photodetector signal. Resistor R77 adds offset to the photodetector and assists in ambient light rejection. When the signal DK goes high, switch A of U30 connects one end of C55 to ground. This causes capacitor C55 to charge to the difference between ground and the voltage level of the input signal (U40-6) during the dark time (when both LEDs are off). When the signal DK goes low, the voltage across C55 is subtracted from the input signal as it passes through C55 to the input of amplifier U37.

### DC gain

Under microprocessor control, analog multiplexer U34 selects one of the seven resistors (R57 through R63) or an open circuit (U34-13) to combine with feedback resistor R39 to set the gain of amplifier U37. The nominal gains selectable are:

| Input number | Input control A | B | C | Nominal gain |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 2 |
| 2 | 0 | 1 | 0 | 3 |
| 3 | 0 | 1 | 1 | 5 |
| 4 | 1 | 0 | 0 | 9 |
| 5 | 1 | 0 | 1 | 17 |
| 6 | 1 | 1 | 0 | 33 |
| 7 | 1 | 1 | 1 | 66 |

### DC separator

When signal RLT at U31-11 goes high, switch A of U31 passes the red component of the signal from U37 through to the low-pass filter consisting of R75 and C29. The equivalent pole of this switched filter is at approximately 0.4 Hz, which passes only the DC component of the signal. Amplifier U17 passes the red DC signal (RDC) to the multiplexer U13-15 so it can be measured by the A/D converter U12.

The infrared DC component is separated in a similar manner by switch C of multiplexer U30, low-pass filter R76 and C31, and amplifier U18. Amplifier U18 passes infrared DC signal (IRDC) to the multiplexer U13-12 so it can be measured by the A/D converter U12.

### Low-pass filter

The amplified signal from U37 passes through a switched low-pass filter consisting of resistor R37, switch B of U30, switch C of U22, capacitors C30 and C42, and amplifier U29. Since the DC components have been separated and measured previously, it is not necessary to filter the dark time. Switch B of U30 and capacitor C30 filter the signal during the red LED on time, and switch C of U22 and capacitor C42 filter the signal during the infrared LED on time. Amplifier U20 buffers the signal to prevent loading by further stages of filtering.

### DC stripper (high-pass filter)

The switched high-pass filter, consisting of switches B and C of U31, capacitors C32 and C33, and resistor R12, removes the DC signal components from amplifier U29. Switch B of U31 and capacitor C32 pass the pulsatile signal component from amplifier U29 during the red LED on time. Switch C of U31 and capacitor C33 pass the pulsatile signal component from amplifier U29 during the infrared LED on time.

### AC gain

Under microprocessor control, analog multiplexer U23 selects one of seven resistors (R30 through R36) or an open circuit (U23-13) to combine with feedback resistor R11 to set the gain of amplifier U24. The nominal gains selectable are:

| Input number | Input control A | B | C | Nominal gain |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 9 |
| 2 | 0 | 1 | 0 | 17 |
| 3 | 0 | 1 | 1 | 33 |
| 4 | 1 | 0 | 0 | 66 |
| 5 | 1 | 0 | 1 | 128 |
| 6 | 1 | 1 | 0 | 256 |
| 7 | 1 | 1 | 1 | 525 |

### Red/infrared separator

Switches A and B of U22 separate the red and the infrared pulsatile signals into two independent channels. Resistor R10 and capacitors C18 and C14 also serve as parts of two third-order, low-pass filters in separating the signals. Switch A of U22 passes the red pulsatile signal through to C18; switch B of U22 passes the infrared pulsatile signal through to C14.

The red pulsatile signal passes through the two third-order, low-pass, active filters consisting of resistors R10, R7, and R6; capacitors C18, C13, and C12; and amplifier U15A. The infrared pulsatile signal passes through the third-order, low-pass, active filter consisting of resistors R10, R9, and R8; capacitors C14, C17, and C16; and amplifier U15B.

### Calibration

Amplifier U21B compensates for gain differences between the red and infrared signal paths by adjusting the gain in the infrared signal.

### Sample and hold

Sample-and-hold circuits U14 and U16 sample the red and infrared pulsatile signals simultaneously so that they can be measured by the A/D converter U12. Signal S/H at U14-8 and U16-8 controls the timing of pulsatile signal sampling at a rate synchronous to the power-line frequency. This sampling frequency helps to suppress interference generated from sources connected to line power such as room lighting.

### Probe identification

Amplifier U25C, with feedback resistor R40, generates a voltage proportional to the identification resistor contained in the probe. This voltage passes through a low-pass filter (R64, C62) to the input of analog multiplexer U20 to be measured by the A/D converter U12.

### Analog multiplexer

Analog multiplexers U13 and U20 select one of the 16 analog signals to be measured by the A/D converter U12. Amplifier U28 buffers the signal selected.

### A/D converter

U12 is a 12-bit, successive-approximation-type analog to digital converter. The microprocessor uses the A/D converter to make all necessary analog measurements. The microprocessor commands the A/D converter to take a measurement by writing to hex memory address C008, and reads the results of the measurements from the same memory address.

### Interference detection

The circuit described below detects the presence of most interfering signals that may affect the accuracy of the oximeter or otherwise interfere with its operation.

Switch A of U42 samples the output of the photodetector preamplifier U39 during the time that the red LED is on. Resistor R70 and capacitor C63 delay the rising edge of control signal RLT, which controls switch A of U42. Diode CR8 prevents the falling edge from being delayed. Capacitor C64 and resistor R72 allow high frequencies to pass and hold the DC level stable at U42-13 when switch A is off. High-pass filter C65, R71C37, R28 removes any DC component from the inter allows high-frequency interference to pass while blocking out lower frequency signals.

U43 amplifies the high-frequency interference signal to a level that can be measured easily. High-pass filter C37, R28 removes any DC component from the interference signal. Diode CR4 rectifies the interference signal and places the peak voltage on capacitor C36. Resistor R68 helps to smooth the peak-to-peak variations in the interference. Resistor R29 slowly bleeds the charge off C36 so that the voltage on C36 returns to zero when interference is no longer present. The interfering signal is therefore converted to a DC voltage on C36 that is proportional to the amplitude of the signal. Analog multiplexer U20 passes this voltage to the A/D converter for measurement. The microprocessor declares that interference is detected when the voltage on C36 is greater than approximately 600 millivolts.

**Audio frequency control**

The circuit consisting of D/A converter U2, dual amplifier U1, and associated circuitry generate an audio frequency signal that is used to drive the speaker. The microprocessor controls the frequency of this signal by loading an 8-bit number into the holding register of U2 at hex I/O address 05. The frequency is approximately:

$$f = \frac{n}{1024RC} = \frac{n}{.22528}$$

where n is the decimal equivalent of the 8-bit number loaded into U2, R is the full-scale resistance of the D/A converter U2, and C is the capacitance of C1 (.022 µf).

The integrator U1B outputs a triangular waveform that swings between +VREF and -VREF.

**Audio volume control**

The audio signal volume is controlled by the programmable gain amplifier consisting of D/A converter U3, amplifier U4A, and feedback resistor R3. the microprocessor controls the amplifier gain by loading an 8-bit number into the holding register of U3. The amplifier gain (G) is approximately:

$$G = \frac{3n}{256}$$

where n is the decimal equivalent of the 8-bit number loaded into U3. The output of U4A feeds the audio power amplifier on the digital board.

# 3/Test and Calibration

This chapter provides procedures to

- Verify that the oximeter and its keys are functioning properly.
- Access and verify user calibration mode.
- Access diagnostics mode and perform the various circuit and functionality tests accessible in that mode.
- Test leakage current and ground resistance.

**WARNINGS: Patient safety**

- **Do not, under any circumstances, perform any testing or maintenance on the oximeter or probe when it is being used to monitor a patient.**
- **To prevent patient injury or equipment damage, use only oximeter probes identified for this monitor (see the instructions for the probe you are using).**
- **If a probe is damaged in any way, discontinue use immediately.**
- **If the oximeter fails any part of the functional, calibration, or leak tests, remove it from operation until qualified service personnel have corrected the situation.**

## 3.1 Functionality test

1. Plug the oximeter into the AC power supply.
2. Connect a probe to the oximeter.
3. Place the probe on your finger.
4. Press Power/Stndby to turn the oximeter on.
5. If necessary, adjust the display with the contrast adjust thumb wheel.
6. Verify
   a. The alarm light flashes and the alarm beeps.
   b. Figure 8's appear on the digital display.

c. OHMEDA
3700/3710/3700e
Revision: X
SYS AND CAL CHECK

appears on the graphic display. (X represents the alphanumeric value of the currently installed software level)

d. SYSTEM OPERATIONAL appears.

e. That there is a strong signal and a good waveform.

f. That verifiable readings appear on the digital display. See "Signal and data validity" in 2/Operations of the Operator's manual.

7. Unplug the oximeter from the AC power supply and verify that BT appears on the graphic display..

8. Plug the oximeter back into the AC power supply and verify that BT no longer appears on the display.

9. Verify, in the following order, that the front panel keys function properly.

$SpO_2$ Trend 20/60 displays the trend graph and toggles between 20- and 60-minute trend graph displays.

Wave Form restores the plethysmographic waveform.

Pulse Volume adjusts the volume setting for the pulse tone.

Alarm Volume adjusts the volume setting for the audible alarms.

Low $SpO_2$ raises or lowers the low $SpO_2$ alarm limit.

High $SpO_2$ raises or lowers the high $SpO_2$ alarm limit.

Low Pulse raises or lowers the low pulse rate alarm limit.

High Pulse raises or lowers the high pulse rate alarm limit.

10. Verify that the patient alarms are functional.

a. Set the high and low $SpO_2$ and pulse rate alarm limits beyond the readings.

b. Make sure the alarm tone sounds and that the violated alarm limit and reading flash on the digital display.

**Note:** A delay in the audible alarm and red alarm light may occur for low $SpO_2$ when the alarm filter is active.

11. Press and verify that
    a. Alarm silence temporarily silences all audible alarms for 120 seconds and changes the flashing red alarm light to a steady red light.
    b. Wave Form (hold for 3 seconds to enter each mode) puts the oximeter into Fast and then Slow response mode, and that F and then S appear for their respective modes.

## 3.2 User calibration mode

**To access and verify calibration mode,**

1. Press Low $SpO_2$ ▼ and Power/Stndby simultaneously.
2. Verify that
    a. The alarm light flashes and the oximeter beeps.
    b. Figure 8's appear on the digital display.
    c. The OHMEDA 3700/3710/3700e... message appears.
    d. After which the following message appears:

```
SpO2 & PULSE ANALOG
  OUTPUTS = 0 VOLTS
WAVEFORM: NEXT TEST,
     TREND: QUIT
```

3. Press Wave Form. The following message appears:

```
SpO2 & PULSE ANALOG
  OUTPUTS = 1 VOLTS
WAVEFORM: NEXT TEST,
     TREND: QUIT
```

4. Press Wave Form. The following message appears:

```
** CALIBRATE UNIT **
ADJUST POT AT BOTTOM
 HOLE TO VALUE = 0 ± .1
 HIT WAVEFORM TO END
```

5. To return to operation, press Wave Form one more time.

# 3.3 Diagnostics mode procedures

This section covers

- Accessing diagnostics mode.
- Verifying $SpO_2$ and Pulse Rate output-port voltage.
- Adjusting the calibration pot.
- Performing the following tests:
  - ROM
  - Power-source frequency
  - Digital-interface circuit
  - Graphic- and digital-display circuits
  - Audio-tone circuit
  - Volume-control circuit
  - $SpO_2$ D/A converter ramp
  - Pulse rate and LED D/A converter ramp
  - R/IR ratio/phase
  - Probe identification
  - RAM
  - Watchdog timer

**Equipment required**

- Digital multimeter - Fluke 8022B or equivalent
- Small, flat-blade screwdriver - plastic or nonconductive
- Chart recorder - Ohmeda 0001 or equivalent
- DB 25P shorting plug with pins 2 and 3 connected
- Ohmeda FingerProbe

**To access diagnostics mode,**

1. Plug the oximeter into the AC power supply.
2. Press Alarm Volume and Power/Stndby simultaneously.
3. Verify that
   a. The alarm light flashes and the oximeter beeps.
   b. Figure 8's appear on the digital display.
   c. The OHMEDA 3700/3710/3700e... message appears.

**Important**

If at any time during the following tests the oximeter does not operate as describe, refer to 4/Messages and Troubleshooting for additional information.

## 3.3.1 $SpO_2$ and pulse rate analog outputs

**WARNINGS:**

- **Data validity—To prevent inaccurate patient readings, the digital voltmeter used in reference voltage test procedures must be accurately calibrated.**
- **Electric shock hazard—Because the unit is not grounded when it is operated on battery power, do not connect any equipment to the signal input/output ports on the rear panel unless the unit is connected to the AC main power supply.**

**CAUTION:** To prevent improper loading, which upsets the correspondence between the measured voltage and the intended output voltage, connect only a high impedance device (1 KΩ or higher) to the analog output.

This test provides zero and full-scale voltages at the analog output ports so a chart recorder connected to the analog output ports can be calibrated.

1. After accessing diagnostics mode (section 3.3), the following message appears:

   SpO2 & PULSE ANALOG
   OUTPUTS = 0 VOLTS
   WAVEFORM: NEXT TEST,
   TREND: QUIT

2. Use the digital voltmeter (DVM) to check for 0 ± .010 Vdc at both $SpO_2$ and Pulse Rate ports on the rear panel.
3. Press Wave Form and verify that the message now shows that OUTPUTS = 1 VOLT.
4. Use the DVM to verify that 1.000 ± .010 Vdc appears at the $SpO_2$ and pulse rate output ports on the rear panel.

   Do not adjust R52 on the analog board while monitoring the $SpO_2$ output port voltage. Adjust R52 while monitoring $V_{ref}$, NOT the $SpO_2$ analog port. $V_{ref}$ is available only at the board level (at U35, pin 1 or C60 +side) and, if necessary, should be adjusted to 1.010 ± 0.005 Vdc.

5. Use the DVM to verify that 1.00 ± .025 Vdc appears at the Pulse Rate output port on the rear panel.
6. Press Wave Form to proceed to the next test.

### 3.3.2 Calibration test

1. The message on the display should be

   ** CALIBRATE UNIT **
   ADJUST POT AT BOTTOM
   HOLE TO VALUE = 0± .1
   HIT WAVEFORM TO END

2. After the oximeter has stability for 10 seconds, verify that the digital display reads 0.0 ± 0.1. If it does not,

   a. Locate the calibration access hole on the bottom of the oximeter.

   b. Locate the calibration potentiometer (an adjustment screw) that is directly inside the oximeter (R25 on the analog board).

   c. Use a small, flat-blade, plastic or nonconductive screwdriver to turn the potentiometer slowly in either direction. Watch the calibration reading on the digital display.

      Continue turning until the reading is 0.0 (±0.1)—wait for it to stabilize.

3. Press Wave Form to proceed to the next test.

### 3.3.3 ROM test

This test verifies the ROM contents against a checksum that is stored in ROM.

1. The message on the display should be:

   ROM TEST
   IN PROCESS

2. Verify that the following message appears after a few seconds:

   ROM TEST OK

3. Press Wave Form to proceed to the next test.

### 3.3.4 Power source frequency test

1. The message on the display should be:

   FREQUENCY DETECTED =
   XX HERTZ
   WAVEFORM: NEXT TEST,
   TREND: QUIT

   **Note:** XX will be 50, 60, or 400, depending on local frequency.

2. Unplug the oximeter and verify that BATTERY appears as the detected frequency.

3. Plug the oximeter in again and press Wave Form to proceed to the next text.

### 3.3.5 Digital interface circuit test

1. The message on the display should be:

   UART LOOP TEST

   STATUS: OPEN LOOP

   WAVEFORM: NEXT TEST,

   TREND: QUIT

   The message will flicker.

2. Connect a DB 25P shorting plug to the RS-232C serial connector. This connects pin 2 to pin 3.
3. Verify that the following message appears:

   STATUS: OPERATIONAL

4. Remove DB 25P and then press Wave Form to proceed to the next test.

### 3.3.6 Graphic display test

1. The message on the display should be:

   GRAPHIC DISPLAY TEST

   WAVEFORM: NEXT TEST,

   TREND: QUIT

2. Verify that the following occurs:
   a. The graphic display fills with a row of black pixels, moving from top to bottom.
   b. When the display is filled with the black pixels, a row of blank or transparent pixels fills the display, moving from top to bottom.
   c. The test repeats until you press the Wave Form or $SpO_2$ Trend 20/60 key.
3. Press Wave Form to proceed to the next text.

### 3.3.7 Digital display test

1. The message on the display should be:

   NUMERIC DISPLAY TEST

   WAVEFORM: NEXT TEST,

   TREND: QUIT

2. Verify that the following occurs:

   a. On the digital display, the number .8 (decimal point eight) scrolls from left to right across the $SpO_2$ and pulse rate readings, and the number 8 (eight, no decimal) scrolls across the $SpO_2$ and pulse rate limits.

   b. The digital display (readings and limits) then counts from 0 to 9, -, E, H, L, P, and blank, with all decimal points in the readings turned on.

   c. The test repeats until you press the Wave Form or $SpO_2$ Trend 20/60 key.

3. Press Wave Form to proceed to the next text.

### 3.3.8 Speaker pitch test

1. The message on the display should be:

   SPEAKER PITCH

   TEST

   WAVEFORM: NEXT TEST,

   TREND: QUIT

2. The speaker tone pitch increases in ten steps.

3. The test repeats until you press the Wave Form or $SpO_2$ Trend 20/60 key.

4. Press Wave Form to proceed to the next text.

### 3.3.9 Speaker volume test

1. The message on the display should be:

   SPEAKER VOLUME

   TEST

   WAVEFORM: NEXT TEST,

   TREND: QUIT

2. The speaker volume increases in ten steps, first at one frequency and then at another.

3. The test repeats until you press the Wave Form or $SpO_2$ Trend 20/60 key.
4. Press Wave Form to proceed to the next text.

## 3.3.10 $SpO_2$ D/A converter ramp test

**CAUTION:** To prevent improper loading, which upsets the correspondence between the measured voltage and the intended output voltage, connect only a high impedance device (1 KΩ or higher) to the analog output.

1. The message on the display should be:

SpO2 D/A CONVERTER
RAMP TEST
WAVEFORM: TEXT TEST,
TREND: QUIT

2. Connect a chart recorder to the $SpO_2$ output port on the rear panel of the oximeter (for more details, see Appendix B in the Operator's manual).
3. Verify that the chart recorder shows a linear ramp output from zero to full scale.

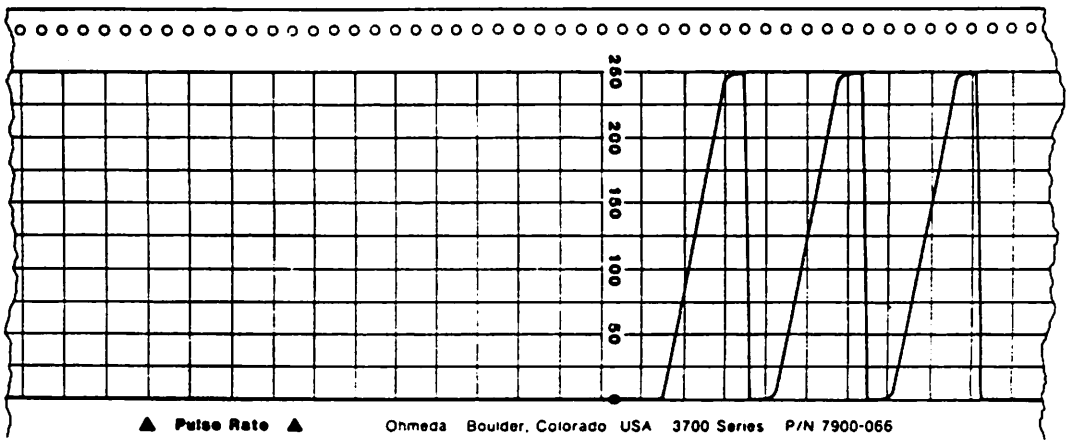



**Figure 3-1.** Chart recorder linear ramp output.

4. Press Wave Form to proceed to the next text.

## 3.3.11 Pulse rate and LED D/A converter ramp test

**CAUTION:** To prevent improper loading, which upsets the correspondence between the measured voltage and the intended output voltage, connect only a high impedance device (1 KΩ or higher) to the analog output.

1. The message on the display should be:

OTHER D/A CONVERTERS
RAMP TEST
WAVEFORM: NEXT TEST,
TREND: QUIT

2. Connect a chart recorder to the Pulse Rate output port on the rear panel of the oximeter (for more details, see Appendix B in the Operator's manual).
3. Verify that the chart recorder shows a linear ramp output from zero to full scale. See Figure 3-1.
4. Connect the FingerProbe to the oximeter.
5. Verify that the red LED in the FingerProbe is lit, slowly gets brighter, goes out, and then repeats.
6. Press Wave Form to proceed to the next text.

### 3.3.12 DC gain, AC gain, and A/D converter tests

These tests are for manufacturing purposes only; you bypass each one.

1. When you see DC GAIN TEST NOW TESTING STAGE #..., press Wave Form **before** a number appears on the digital display to bypass this test.
2. When you see AC GAIN TEST NOW TESTING STAGE #..., press Wave Form **before** a number appears on the digital display to bypass this test.
3. When you see A/D CONVERTER TEST..., press Wave Form **before** a number appears in the $SpO_2$ reading position on the digital display to bypass this test.

### 3.3.13 R/IR ratio/phase test

This test measures the phase difference of the calibration signal between the red and infrared channels.

1. The message on the display should be:

   DFT TEST

   SPO2=RATIO PR=PHASE

   WAVEFORM: NEXT TEST,

   TREND: QUIT

2. The digital display shows
   - A red to infrared amplitude ratio of .50 ± .05 in the $SpO_2$ reading position.
   - A phase difference of 0 ± 1 in the Pulse Rate reading position.
   - A calibration signal frequency reading of 30 ± 5 in the low $SpO_2$ Alarm Limit position.
3. Press Wave Form to proceed to the next text.

### 3.3.14 Probe identification test

1. If no probe is plugged into the oximeter, the message reads

   CANNOT IDENTIFY
   PROBE
   WAVEFORM: NEXT TEST,
   TREND: QUIT

**Or**

If a probe is plugged into the oximeter, the message reads

PROBE IDENTIFIED

WAVEFORM: NEXT TEST,
TREND: QUIT

and the bin number appears in the digital display.

2. Press Wave Form to proceed to the next text.

### 3.3.15 RAM test

**Important**

Running the RAM test erases any existing trend data and frequency information in memory.

1. The message on the display should be:

   RAM TEST --- DATA
   WILL BE DESTROYED!
   WAVEFORM: SKIP TEST,
   TREND: START

2. To retain the trend and frequency information, press Wave Form.

   The oximeter skips this test and proceeds to the next one.

**Or**

a. To start the RAM test, press $SpO_2$ Trend 20/60.

   Within a few seconds the RAM TEST OK message appears.

b. Press Wave Form to proceed to the next text.

### 3.3.16 Watchdog timer test

This test verifies that the processor shuts the unit down properly.

1. The message on the display should be:

   WATCHDOG TIMER

   TEST

   WAVEFORM: SKIP TEST,

   TREND: POWER DOWN

2. Press $SpO_2$ Trend 20/60

The oximeter turns off. All diagnostics tests have been completed.

## 3.4 Leakage current and ground resistance test

Perform this test

- Whenever an external device is connected to the analog or serial port.
- After you have performed any service on the oximeter.

**WARNING: Electric shock hazard—Measure the oximeter's leakage current whenever an external device is connected to either the analog or serial port. Leakage current must not exceed 50 microamperes.**

1. With the power cord connected **only to the oximeter**, measure the resistance from the power plug ground prong/connector to all exposed metal on the chassis. The measured resistance must not exceed 0.1 Ω.
2. Measure the leakage current of the oximeter following the instructions supplied with the leakage current tester. The leakage current must not exceed 50 microamperes in any mode.
3. Record the results. for reference in future resistance/leakage tests. A significant change may indicate a pending failure.

# 4/Messages and Troubleshooting

This chapter provides

- A chart of the messages that may appear on the oximeter: the message, the possible cause(s), the recommended action(s).
- Troubleshooting tables to help you solve diagnostics test and operational problems.

## 4.1 Messages

**Note:** Diagnostics mode messages are not included here. See section 4.2, Troubleshooting.

| Message | Possible cause(s) | Recommended action(s) |
|---|---|---|
| A/D CONVERTER FAILURE, SERVICE UNIT | Oximeter unable to complete the analog-to-digital conversion. Oximeter alarms at volume 10 for 2 seconds and then shuts down. | Replace analog board. |
| ALARM VOLUME HOLD KEY TO SET, VOLUME LEVEL IS # | Appears when you press the Alarm Volume key. # represents the current level set. | Hold key down until desired volume level appears. |
| ALARM FILTER OFF | Appears briefly when the Alarm silence key is held or three seconds to deactive the alarm filter. | No action required. |
| ALARM FILTER ON | Appears briefly when the Alarm silence key is held down for three seconds to activate the alarm filter. | No action required. |
| ALL MUTE | Appears when the all mute feature is activated. | No action required. (Press once to deactivate.) |
| ANALOG SYNCHRONIZATION ERROR, SERVICE UNIT | Oximeter unable to synchronize with the analog circuitry. | Replace analog board. |
| BATTERY IN USE | Appears briefly during power-up when the oximeter is operating on battery power. | No action required. |
| BT | Appears next to the waveform when the oximeter is operating on batter power. | No action required. |

| Message | Possible cause(s) | Recommended action(s) |
|---|---|---|
| **CALIBRATE UNIT** ADJUST POT AT BOTTOM HOLE TO VALUE = 0 ± .1 | Appears after initial self-test if oximeter is out of specification. | Calibrate the unit. See "User calibration mode" in chapter 3. |
| CALIBRATION PASSED SYSTEM OPERATIONAL | Appears after initial self-test when the oximeter has passed all performance tests. | No action required. |
| CANNOT IDENTIFY PROBE (SEE MANUAL) | Oximeter can't identify the connected probe. | Replace probe; see probe instruction sheet.<br>If condition persists, reseat probe connector and/or connections to the analog board.<br>If condition persists, replace analog board. |
| CHARGING CIRCUIT FAILURE, SERVICE UNIT | Battery charger/regulator is defective. | Perform the battery charger circuit adjustment. If condition persists, replace regulator. |
| | Battery is defective. | Check that battery voltage is above 7.3V after 1 hour of battery operation. Replace if defective. |
| | Oximeter's internal circuitry has failed. | Replace power supply board. |
| CHECK PROBE SITE | Appears when $SpO_2$ readings may be invalid due to motion or incorrect probe site or placement. | For either cause, reposition or relocate probe. |
| | Appears during Stage 3 alarm condition. | |
| F | Appears next to the waveform when the oximeter is in Fast response mode (3-second averaging). | No action required. |
| FAST RESPONSE SELECTED | Appears briefly when the Wave Form key is held for 3 seconds to select Fast response mode. | No action required. |
| INSUFFICIENT LIGHT DETECTED, CHECK PROBE SITE | Dirt on the probe emitter, probe detector, or at test site. | Clean the probe. Clean the test site. |
| | Misaligned or poorly positioned probe. | Reposition the probe or select another test site. |
| | Insufficient light penetrating tissue site. | Reposition the probe or select another test site. |
| | Fingernail polish present. | Remove polish or use the EarProbe. |
| | Dark pigmentation. | Select another test site. |
| | Detector failure. | Replace probe. If condition persists, replace analog board. |

| Message | Possible cause(s) | Recommended action(s) |
|---|---|---|
| INTERFERENCE DETECTED, SpO2 & PULSE RATE MAY BE INVALID | Appears when the signal is too erratic to be processed.<br><br>Response mode time period required for the message to appear:<br><br>Slow 24 seconds<br>Normal 24 seconds<br>Fast 12 seconds | No action required.<br><br>May be caused by strong radio frequency (RF) interference possibly generated by electrocautery.<br><br>If condition persists, check and, if necessary, replace analog and/or digital board. |
| LO BT | Appears beside the waveform when approximately 5 minutes of battery operation remain. Does not appear when viewing a trend graph. | Within 5 minutes, put the oximeter in Off/Standby mode and plug it into the AC power supply to recharge the battery. |
| LO QUALITY SGNL (software revision T through 22 only) | Probe off patient.<br><br>Perfusion insufficient for valid readings.<br><br>Motion at probe site, electrical noise, or incorrect probe placement. | Reattach the probe.<br><br>Check patient and oximeter setup.<br><br>Check patient and oximeter setup. |
| MICRO-PROCESSOR ERROR, SERVICE UNIT | Appears during initial self-test if oximeter is not operating correctly. | Replace digital board. |
| MICRO-PROCESSOR INTERRUPT ERROR, SERVICE UNIT | Microprocessor has received an illegal interrupt. | Replace digital board. |
| N | Appears next to the waveform when the oximeter is in Normal response mode (6-second averaging). | No action required. |
| NO PROBE CONNECTED TO UNIT | Probe not fully inserted into the probe connector.<br><br>May be an incorrect probe.<br><br>Defective probe jack. | Insert probe plug into the connector.<br><br>Refer to the instructions for the probe you are using.<br><br>Check probe connector and connections to analog board. If necessary, replace analog board. |
| NO PULSE | Appears when the bar graph shows a signal strength at 1 pixel or less for 5 seconds or more, or when the pulse rate readings are less than or equal to 20 bpm for 5 seconds or more. | Check attachment and placement of probe.<br><br>Have patient remain as motionless as possible.<br><br>Perfuse probe site and reattach the probe.<br><br>Select another probe site. |
| NORMAL RESPONSE SELECTED | Appears briefly when you've selected Normal response mode. | No action required. |

| Message | Possible cause(s) | Recommended action(s) |
|---|---|---|
| OHMEDA-BIOX<br>3700/3710/3700e<br>REVISION: X<br>SYS AND CAL CHECK | Appears briefly when you power on the oximeter. X represents the current software revision level. | No action required. |
| OUTPUTTING TREND,<br>TIME REMAINING X:XX<br>HIT TREND KEY<br>TO END OUTPUT | Appears while the oximeter is outputting trend data through the $SpO_2$, pulse rate, analog, or serial ports | No action required. Time remaining, X:XX, represents both the hours and minutes of trend data left to be output and the minute and seconds it will take to complete the output. (1 hr = 1 minute) |
| PLEASE PLUG UNIT<br>INTO WALL OUTLET<br>TO DETERMINE<br>LINE FREQUENCY | Appears at power-up when the oximeter has lost battery-packed RAM and is operating on battery power. | Put the oximeter in Off/Standby mode and plug it into the AC power supply. |
| PLUG UNIT INTO<br>WALL OUTLET<br>TO<br>RECHARGE BATTERY | Battery unable to supply sufficient power. Unit will automatically shut off in 10 seconds. | Put the oximeter in Off/Standby mode and plug it into the AC power supply. |
| POWER SUPPLY<br>FAILURE,<br>SERVICE UNIT | The oximeter's power supply has failed. Unit will automatically shut off in 10 seconds. | Check voltage at J2-5.<br>If < 2.5 Vdc, replace power supply board.<br>If ≥ 2.5 Vdc, replace digital board. |
| PREVIOUS TREND<br>DATA AVAILABLE | Appears when Trend key is held down while you're turning on the oximeter so you can view or output previous trend data. | No action required. |
| PROBE OFF<br>PATIENT<br>Note: This message may not appear if you're using the Flex II, EasyProbe, or SoftProbe. | Probe is off patient.<br>Too much light detected by the probe's photodetector.<br>Extremely thin tissue at the probe site.<br>Artificial nail tips or long fingernails present. | Reattach the probe.<br>Shield the probe from ambient light.<br>Find another probe site.<br>Do **not** attempt nail removal. Find another probe site. |
| PROBE OR CIRCUIT<br>FAILURE<br>REPLACE PROBE OR<br>SERVICE UNIT | Broken probe cable wire or inoperative LEDs; probe has failed. Oximeter's probe circuitry has failed. Oximeter alarms at volume 10 for 2 seconds and then shuts down. | Replace probe.<br>If condition persists, replace analog board . |
| PULSE VOLUME<br>HOLD KEY TO SET,<br>VOLUME LEVEL IS # | Appears when you press the Pulse Volume key. # represents the current level set. | Hold down the key until the desired volume level appears. |

| Message | Possible cause(s) | Recommended action(s) |
|---|---|---|
| PULSE WAVEFORM SELECTED | Appears briefly when you press the Wave Form key during a probe alarm condition. | No action required. |
| RAM CHECK ERROR, SERVICE UNIT | Appears when a periodic check has found an error during monitoring. | Replace digital board. |
| RAM DATA INVALID, RE-INITIALIZING | The oximeter's memory erased; trend data is lost. The unit reinitializes automatically and is then ready for use. | No action required. |
| RAM TEST ERROR HIGH BYTE, SERVICE UNIT | Appears after the initial self-test if a RAM failure exists. | Replace digital board. |
| RAM TEST ERROR HIGH & LOW BYTES, SERVICE UNIT | Appears after the initial self-test if a RAM failure exists. | Replace digital board. |
| RAM TEST ERROR LOW BYTE, SERVICE UNIT | Appears after the initial self-test if a RAM failure exists. | Replace digital board. |
| RAM TEST ERROR TREND CHECKSUM, SERVICE UNIT | Appears after the initial self-test if a RAM failure exists. | Replace digital board. |
| ROM TEST ERROR HIGH & LOW BYTES, SERVICE UNIT | Appears after the initial self-test if a ROM failure exists. | Replace digital board. |
| ROM TEST ERROR LOW BYTE, SERVICE UNIT | Appears after the initial self-test if a ROM failure exists. | Replace digital board. |
| S | Appears next to the waveform when the oximeter is in Slow response mode (12-second averaging). | No action required. |
| SLOW RESPONSE SELECTED | Appears briefly when you hold the Wave Form key for 3 seconds to enter the Slow response mode. | No action required. |
| STACK ERROR, PLEASE NOTE CONDITIONS AND SERVICE UNIT | Appears when a periodic check of system stack area during monitoring indicates a problem. | Replace digital board. |
| SYSTEM ERROR X PLEASE NOTE ERROR CODE AND SERVICE UNIT | Appears when a periodic check of software and hardware during monitoring has found a problem. X represents an error code number. | Note the error #. Turn unit off. Call Ohmeda for service information (see back cover of this manual). |

| Message | Possible cause(s) | Recommended action(s) |
|---|---|---|
| TEST SIGNAL<br>DC REFERENCE<br>ERROR,<br>SERVICE UNIT | Appears during the initial self-test if a hardware problem exists. | Replace analog board. |
| THANK YOU<br>UNIT MAY NOW RUN<br>ON BATTERY | Appears after you've plugged the oximeter into the AC power supply in response to the RECHARGE BATTERY message. | No further action required. |
| TREND MODE<br>SELECTED | Appears briefly when you press the Trend key during an alarm condition (exception: No Probe or Probe Off alarms). | No action required. |
| TREND OUTPUT MODE,<br>START CHART RECORDER<br>HIT TREND KEY<br>TO START OUTPUT | Appears briefly when the oximeter is ready to begin trend data output. | Press Trend to begin output. |
| VOLTAGE REFERENCE<br>FAILURE,<br>SERVICE UNIT | Appears during monitoring if a hardware problem exists. | Replace analog board. |

## 4.2 Troubleshooting

When you encounter problems during a diagnostics test or procedure, use Figure 4-1 to locate the possible cause(s).

When an oximeter condition that may not produce a message arises, use Figure 4-2 to locate the possible cause(s).

| Diagnostic | Inter-connect Cable | On/Off switch/ fuse/line filter/ transformer | Battery | Power supply board | Analog board | Digital board | Front panel | Calibra-tion | Probe |
|---|---|---|---|---|---|---|---|---|---|
| Analog output = 0 V | X | | | X | X | X | | X | |
| Analog output = 1 V | X | | | X | X | X | | X | |
| Calibration | | | | X | X | X | | X | |
| ROM TEST | | | | | | X | | | |
| Frequency detected | X | X | | X | | X | | | |
| UART loop | X | | | | | X | | | |
| Graphic display | X | | | | | X | X | | |
| Numeric display | X | | | | | X | X | | |
| Speaker pitch | X | | | | X | X | | | |
| Speaker volume | X | | | | X | X | | | |
| $SpO_2$ D/A | X | | | | | X | | | |
| Other D/A | X | | | | X | X | | | |
| Ratio phase | | | | | X | | | | |
| Probe ID | X | | | | X | | | | X |
| RAM data | | | | X | | X | | | |
| Watchdog timer | | | | X | X | X | | | |

**Figure 4-1.** Diagnostics troubleshooting

| Symptom | Inter-connect Cable | On/Off switch/ fuse/line filter/ transformer | Battery | Power supply board | Analog board | Digital board | Front panel | Calibra-tion | Probe |
|---|---|---|---|---|---|---|---|---|---|
| Will not power up on battery | X | | X | X | | X | | | |
| Will not power up on AC | X | X | | X | | X | | | |
| Backlight not lit | X | | | X | | X | X | | |
| Inaccurate readings | | | | | X | X | | X | X |
| Interference detected | | | | | X | X | | | |
| Insufficient light | X | | | | X | | | | X |
| Visual alarm failure | X | | | | | X | X | | |

**Figure 4-2.** System troubleshooting

# 5/Repair Procedures

This chapter provides

- Service and repair policy
  - Obtaining technical assistance and service
  - Packaging and return procedure
- Instructions for frequently used procedures:
  - Removing the cover
  - Removing the front panel assembly
  - Attaching the front panel assembly
  - Installing the cover
- Remove and replace procedures:
  - Front panel
  - Board set
  - Battery
  - Probe connector
  - Software EPROMs
- Adjusting the battery charging circuit
- Adjusting the display contrast
- Measuring the power supply

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**Important**

While performing the following procedures, refer to the end of this chapter, "5.7 Oximeter assembly information," for oximeter illustrations and reference designators.

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**Note:** To clean the oximeter, recharge the battery, or replace a fuse, refer to 4/Maintenance and Service in the *Ohmeda Biox 3700/3700e Operator's Manual.*

# 5.1 Service and repair policy

Warranty repair and service must be performed by an Ohmeda Service Representative or at the Ohmeda Service and Distribution Center. When Ohmeda's warranty is not applicable, repairs are made at Ohmeda's current list price for replacement parts plus a reasonable labor charge.

Do not use malfunctioning equipment. Make all necessary repairs or have the unit repaired by an Ohmeda Service Representative.

Parts listed in this manual may be repaired or replaced by a competent, trained person who has experience in repairing devices of this nature. We recommend that you use only replacement parts manufactured or sold by Ohmeda.

**CAUTIONS: Service**

- Only competent individuals trained in the repair of this equipment should attempt to service it.
- Detailed information for extensive repairs is included in this manual solely for the convenience of users having proper knowledge, tools, and test equipment, and for service representatives trained by Ohmeda.

## 5.1.1 Obtaining technical assistance and service

**Inside the USA**—Contact Ohmeda Technical Support, which is listed on the back cover.

**Outside the USA**—Contact the nearest Ohmeda Representative or office listed on the back cover.

## 5.1.2 Packaging and return procedure

If the oximeter is to be sent to Ohmeda, **please clean** the unit as described in section 1.4 of this manual, using the safety procedures specified. Be sure the unit is **thoroughly dry** before you pack it for shipment.

To return the oximeter to Ohmeda, wrap it in a plastic bag and package it securely (in the original shipping container if possible). Enclose the following items in the package:

1. A letter describing the problem in detail.
2. Warranty information (you must include a copy of the invoice or other applicable documentation).
3. Purchase order number to cover repairs if out of warranty or for tracking purposes if within the warranty period.
4. "Ship To" and "Bill To" information.
5. Person to contact for questions (country, name, and telephone/Telex/fax number.

**After calling,**

**Inside the USA**—ship the oximeter prepaid to:

Ohmeda Service and Distribution Center
7750 The Bluffs NW
Austell, GA 30001

**Outside the USA**—send the oximeter to your local authorized service office as shown on the back cover of this manual.

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**Important:** Upon receipt of a repaired monitor, complete the Functionality Test to verify proper operation of the oximeter—see section 3.1.

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## 5.2 Frequently used procedures

Most repairs require the use of certain procedures, such as the removal and subsequent installation of the cover. To avoid unnecessary repetition, the procedures are included here; references to them are provided where appropriate.

### Equipment and tools

- Phillips screwdriver, #2

**WARNING: Electric shock hazard**

- **Before service or cleaning the oximeter, turn the unit off and disconnect the power cord from the AC power supply.**
- **Do not touch any exposed wiring or conductive surface while the cover is removed. The voltage present when electrical power is connected to the oximeter can cause serious injury or death.**
- **Never wear a grounding wrist strap when working on an energized oximeter.**

**CAUTION: Static sensitivity**

- Work at a static-control workstation and wear a static-control wrist strap to discharge accumulated static charges from you and any tool you use.
- Use nonconductive tools.
- Handle circuit boards (replacement and defective by their nonconductive edges. Use anti-static containers to transport them.

### 5.2.1 Removing the cover

1. Turn the oximeter off and disconnect it from the AC power supply.
2. Disconnect any probe from the oximeter.
3. To remove the cover,
   a. Turn the unit upside down.
   b. Remove the four #6-32 x 2⅛" Phillips-head screws.
   c. Turn the unit right side up.
   d. Press gently on the sides of the cover and lift it off.

### 5.2.2 Removing the front panel

1. Turn the oximeter off and unplug it from the AC power supply.
2. Remove the oximeter cover—see section 5.2.1.
3. While being very careful not to pull on any wires, lift the front panel off the oximeter.
4. To remove the front panel from the oximeter, disconnect the following components:
   a. This step **only** for display board A118-004, Rev V, or lower:
      — Graphic display module connector A1A2P1 from connector A4J3 on the power supply board (top board in the board set).
      — Display board connector A1W4 from connector A4J4 on the power supply board.

   **Display board versions 6050-0003-302 and A118-004, perform these steps:**
   b. Ribbon cable A1W3 (pull back the latches) from connector A3J4 on the digital board (middle board).
   c. Probe cable A1W2 from connector J1 on the interface board (small printed circuit board in front of the board set).
   d. Cable W3 from connector clip A1A1J2 on the display board (on front panel).
5. Place the front panel aside.
6. Gently pull straight back on the interface board until connector J2 (on the rear side) unplugs from the connector on the bottom of the analog board (bottom board of board set).
7. Loosen the nylon screw on the plastic mounting bracket enough to remove the bracket and circuit board from the chassis boss; set aside.

### 5.2.3 Replacing the front panel

1. To install the interface board,
   a. Slide the plastic mounting bracket over the chassis boss on the front left side of the unit with connector J1 on the interface board at the top, facing away from the board set.
   b. Insert connector J2 (on the rear of the board) into the empty connector on the bottom of the analog board (bottom board of board set).
   c. Tighten the nylon screw on the plastic mounting bracket so that the bracket is snug against the boss.
   d. Plug probe cable A1W2 into J1 at the top of the interface board.
2. Connect the following:
   a. Cable W3 to connector clip A1A1J2 on the display board (on front panel).
   b. Ribbon cable A1W3 to connector A3J4 on the digital board (middle board).
   c. This step **only** for display board A118-004, Rev V or lower:
      — Connector A1W4 to A4J4 on the power supply board (top board).
      — Connector A1A2P1 to connector A4J3 on the power supply board.
3. Align and place the front panel on the oximeter assembly.
4. Make sure all connectors are snug and no loose hardware is inside the chassis.
5. To replace the oximeter cover, see section 5.2.4.

### 5.2.4 Installing the cover

1. Verify that
   - The front panel is placed properly on the front of the oximeter chassis—see section 5.2.3.
   - The battery is connected securely—see section 5.6.

**WARNING: Electric shock hazard**

- **Do not touch any exposed wiring or conductive surface while the cover is removed. The voltage present when electrical power is connected to the oximeter can cause serious injury or death.**
- **Never wear a grounding wrist strap when working on an energized oximeter.**

2. Before verifying operation, place the oximeter cover carefully over the chassis.
3. Press Power/Stndby and verify that the displays are lit.

**Note:** If the battery was not disconnected or was disconnected for less that 2 minutes, the messages in steps 4 and 5 may not appear.

4. Verify that the following sequences of messages appears:

   OHMEDA-BIOX

   3700/3710/3700E

   REVISION: X

   SYS AND CAL CHECK

   RAM DATA INVALID

   RE-INITIALIZING

   PLEASE PLUG UNIT

   INTO WALL OUTLET

   TO DETERMINE

   LINE FREQUENCY

5. Plug the oximeter into the AC power supply and verify that the follow message appears:

   THANK YOU

   UNIT MAY NOW RUN

   ON BATTERY

6. Finally, verify that the initial OHMEDA 3700/3710/3700E... sign-on message appears followed by

   SYSTEM OPERATIONAL

7. Turn the oximeter off and unplug it from the AC power supply.
8. Remove the loosely placed cover.
9. Place the cover so the slits on the rear fit over the rear panel.
10. Check for pinched cables; make certain everything is secure inside the chassis.
11. To attach the cover,
    a. Turn the oximeter upside down.
    b. Loosely screw in the four #6-32 x 2⅛" Phillips-head screws into the chassis.
    c. Tighten the screws until snug—**do not overtighten**.
    d. Turn the oximeter right side up.

12. Perform the leakage current and ground resistance test—see section 3.4.
13. Before using the oximeter for patient monitoring, always perform the functionality test—see section 3.1.

## 5.3 Remove and replace procedures

This section covers removing and replacing the following oximeter components for repair, replacement, or maintenance:

- Front panel
- Board set
- Battery
- Probe connector

### 5.3.1 Front panel

**Disassembly**

1. Remove the oximeter cover—section 5.2.1.
2. Remove the front panel assembly—section 5.2.2.
3. Remove the following sets of screws:
   - — Four #4-40 x ¼" Phillips-head screws from the graphic display module, A1A2.
   - — Two #2-56 x f" Phillips-head screws from the graphic module interface, A1A3.
   - — Four #4-40 Phillips-head screws from the display board, A1A1.
4. Remove the 10-pin, 1-row ribbon cable assembly A1W1 from
   - — Graphic display module A1A2
   - — Graphic module interface A1A3..
5. Lift the graphic module interface from the display board (A1A1).
6. Unplug ribbon cable A1A4P1 from the display board.
7. Remove the display board.
8. Remove the graphic display module.

The front bezel (A1A4) and the probe cable assembly (A1W2) are all that should remain on the front panel.

### Reassembly

1. Clean the back of the display windows with isopropyl alcohol. Remove any lint or dust from the windows.
2. To attach the graphic display module (A1A3) to the front panel, loosely screw in four #4-40 x ¼" screws. Tighten screws until snug but **not** overtight.
3. To attach the display board (A1A1) to the front panel, loosely screw in four #4-40 x ¼" screws. Tighten screws until snug but **not** overtight.
4. To attach the graphic module interface (A1A3) to the graphic display module (A1A2), loosely screw in the two #2-56 x ¾" screws. Tighten screws until snug but **not** overtight.
5. Reconnect the 10-pin, 1-row ribbon cable assembly A1W1 to the
   - — Graphic module interface (A1A3).
   - — Graphic display module (A1A2).
6. Reconnect ribbon cable A1A4P1 to the display board (A1A1).

## 5.3.2 Board set

This procedure accesses the board set so you can remove and replace the power supply, digital, and/or analog board.

### Disassembly

1. Remove the oximeter cover—see section 5.2.1.
2. Remove the front panel assembly—see section 5.2.2.
3. Disconnect the following power supply board connectors (top board):
   - — A4J1 (near the transformer)
   - — A4J2 (on the right side of the board near the battery). Pull the cable back towards the rear panel.
   - — A4J5 (near the middle of the board).
4. Disconnect and remove the interface board.
5. Disconnect cable assembly W1 from connector A3J3 (near the battery) on the digital board (middle board).
6. Disconnect cable assembly W1 from connector A2J1 on the analog board (bottom board).
7. Loosen the four #6-32 x 1¼" Phillips-head screws (item 15) holding the board set.
8. Remove only **three** of the screws and washers, leaving the lower right-corner screw attached **loosely** in the board set.

9. Disconnect connector A3J1 (between the transformer and connector A4J2) on the digital board.
10. Remove the fourth screw and washer from the lower right corner.
11. Lift the board set (3 boards and 2 shields) from the chassis.

**Reassembly**

1. Reconnect cable assembly W1 to connector A2J1 on the analog board.
2. Place the shield plate (item 26) in the chassis.
3. With the component side **down**, place the analog board (A2) on top of the shield plate in the chassis.

   The 60-pin connector socket and cable (W1) should be on the right side.
4. Place the other shield plate (item 10) on the backside of the analog board.
5. With the component side **up**, place the digital board (A3) on top of the shield plate.
6. Reconnect W1 to A3J3 on the digital board.
7. Reconnect A5P1 from the rear panel to A3J1 on the digital board.
8. Reinstall the interface board.
9. Attach the front panel—see section 5.2.3.
10. Install the cover—see section 5.2.4.

## 5.3.3 Probe connector

**Additional tool required:**

- Probe socket wrench (0380-0100-254) or needle-nose pliers.

**Disassembly**

1. Remove the oximeter cover—see section 5.2.1
2. Remove the front panel—see section 5.2.2.
3. Use the probe socket wrench (or needle-nose pliers) to loosen the nut holding the cable to the back of the front panel.
4. Remove the nut and the O-ring from the probe socket.
5. Disconnect the probe cable from the interface board at A6J1.
6. From the front of the panel, pull out the old probe socket and cable.

### Reassembly

1. Remove the nut and O-ring from the new probe connector.
2. From the front of the panel, insert the new probe socket and cable assembly into the probe connector hole on the front panel.
3. From the back of the panel, slide the O-ring and then the nut over the probe connector cable.
4. Reconnect the probe cable to the interface board at A6J1.
5. Use the probe socket wrench (or needle-nose pliers) to tighten the nut onto the back of the probe socket. Tighten the nut ¼ to ½ turn past the point of contact with the fully seated O-ring.

   Optional: Only RTV silicone rubber materials are recommended for use as supplemental nut-locking adhesives.
6. Reattach the front panel—see section 5.2.3
7. Install the cover—see section 5.2.4.

## 5.3.4 Battery

**WARNINGS: Battery replacement**

- **Faulty battery connections could be hazardous and will void the warranty.**
- **Reversing the battery connections could result in injury and will permanently damage the circuitry.**
- **If trained technical personnel are not available, call Ohmeda for assistance.**
- **For proper operation, replace only with an Ohmeda battery.**

### Disassembly

1. Remove the oximeter cover—see section 5.2.1.
2. Remove the front panel—see section 5.2.2.
3. Locate battery (B1).
4. Disconnect the red cable from the positive (+) battery terminal and the black cable from the negative (-) battery terminal.
5. Remove the 2 (6-32 x 1/4") Phillips-head screws securing the battery strap to the lower chassis. Set aside for reinstallation.
6. Remove the old battery.

### Reassembly

1. Place the new battery into the chassis.

   Be sure the positive (+) side of the battery is toward the rear panel.
2. Use the 2 screws you remove earlier to secure the battery strap to the lower chassis.

**WARNINGS:**

- **Reversing the battery connections could result in injury and will permanently damage the circuitry.**
- **To prevent failure of the 2-amp fuse on the power supply board, do not cross the battery connections.**

3. Reconnect the red cable to the positive (+) battery terminal and the black cable to the negative (-) terminal.
4. Reattach the front panel—see section 5.2.3.
5. Install the cover—see section 5.2.4.

### 5.3.5 Software

**Additional tools required:**

Small, flat-blade screwdriver or an IC extractor tool

**EPROM removal**

1. Remove the cover—see section 5.2.1.
2. Locate the battery (B1).
3. Disconnect the red cable from the positive (+) battery terminal and the black cable from the negative (-) battery terminal.
4. Disconnect the following power supply board connectors:
   - — A4J1 (near the transformer)
   - — A4J2 (on the right side of the board near the battery). Pull the cable back towards the rear panel.
   - — A4J3 (near the front of the board).
   - — A4J4 (near the front of the board)
   - — A4J5 (near the middle of the board).
5. Remove the 4 (6-32 x 1¼) Phillips-head screws (item 15) holding the board set. Set aside for reinstallation.
6. Lift the power supply board from the board set.
7. Locate the EPROMS (U9 and U18) on the digital board—if necessary, refer to the digital board assembly diagram, section 6.5.1. To remove each EPROM,
   a. **Digital board Rev M and lower:** Insert a small, flat-blade screwdriver into the latch on the socket holding the EPROM. Gently pull back on the screwdriver until the EPROM releases from the socket.

      **Digital board Rev N or higher:** Use the IC extractor tool, or pry the EPROM out of the socket by gently twisting up and out with a flat-blade screwdriver.

### EPROM replacement and reassembly

The replacement EPROMS must be inserted as follows:

| EPROM | Revision | Socket |
|---|---|---|
| 6050-0003-107 | 23 and higher | U9 HI |
| 6050-0003-103 | 23 and higher | U18 LO |
| T118-012 | T through 22 | U9 HI |
| T118-013 | T through 22 | U18 LO |
| T118-001 | M only | U9 HI |
| T118-013 | M only | U18 LO |

**Digital board Rev M and lower:** The notch on the EPROM must be at the same end of the socket as the latch. Do not release the socket locking mechanism prior to installing the EPROM.

**Digital board Rev N or higher:** The notch on the EPROM must match the notch on the socket.

1. Insert each new EPROM into the correct socket and press firmly. The socket normally offers high resistance to the EPROM.

   Make sure that all the pins are in the socket and that none are bent.

2. Place the power supply board on the digital board.

   Connector A3J2 must be toward the rear panel with the two large capacitors on the left.

3. Use the 4 screws you removed earlier to screw into the board set.

4. Reconnect the following power supply board connectors:

   — A5P2 from the transformer to A4J1.

   — W2 to A4J2.

   — A1W2 to A4J3.

   — A1W4 to A4J4.

   — A5P3 to A4J5.

**WARNINGS:**

- **Reversing the battery connections could result in injury and will permanently damage the circuitry.**
- **To prevent failure of the 2-amp fuse on the power supply board, do not cross battery connections.**

5. Reconnect the red cable to the positive (+) battery terminal and the black cable to the negative (-) terminal.

6. Install the cover—see section 5.2.4.

# 5.4 Adjusting the battery charging circuit

**Additional equipment required:**

- 470 Ω ± 5% ¼ watt resistor
- Digital voltmeter (DVM), 0 - 20 Vdc scale

**Always use insulated tools when adjusting the oximeter's internal controls.**

1. Remove the cover—see section 5.2.1.
2. Locate the battery (B1).
3. Disconnect the red cable from the positive (+) battery terminal and the black cable from the negative (-) battery terminal.
4. Connect the red and black cables to a 470 Ω ± 5% ¼ watt resistor.
5. Connect a DVM across the resistor to monitor the DC voltage present.

**WARNING: Electric shock hazard**

- **Do not touch any exposed wiring or conductive surface while the cover is removed. The voltage present when electrical power is connected to the oximeter can cause serious injury or death.**
- **Never wear a grounding wrist strap when working on an energized oximeter.**

**CAUTION: Static sensitivity**

- Work at a static-control workstation and wear a static-control wrist strap to discharge accumulated static charges from you and any tool you use.
- Use nonconductive tools.

6. Plug the oximeter in the AC power supply.
7. If the unit is on after plugging it in, press Power/Stndby to turn it off. **The oximeter is still energized.**
8. Adjust R5 on the power supply board so that the voltage displayed on the DVM is between 9.35 and 9.40 volts.
9. Disconnect the oximeter from the AC power supply.
10. Disconnect the 470 Ω ± 5% ¼ watt resistor and the DVM.

**WARNINGS:**

- **Reversing the battery connections could result in injury and will permanently damage the circuitry.**
- **To prevent failure of the 2-amp fuse on the power supply board, do not cross battery connections.**

11. Reconnect the red cable to the positive (+) battery terminal and the black cable to the negative (-) terminal.
12. Install the cover—see section 5.2.4.

# 5.5 Adjusting the display contrast

1. Remove the cover—see section 5.2.1.

**WARNING: Electric shock hazard**

- **Do not touch any exposed wiring or conductive surface while the cover is removed. The voltage present when electrical power is connected to the oximeter can cause serious injury or death.**
- **Never wear a grounding wrist strap when working on an energized oximeter.**

**CAUTION: Static sensitivity**

- Work at a static-control workstation and wear a static-control wrist strap to discharge accumulated static charges from you and any tool you use.
- Use insulated tools.

2. Plug the oximeter into the AC power supply and make sure the unit is on.
3. Connect the test leads of the DVM between J2 pin 3 of the display board and U3 pin 7. Adjust the viewing angle pot (just below the right side of the front panel) for a DVM reading of 2.0 ± 0.1 Vdc.
4. Connect the leads between J2 pin 3 (black wire) of display board and U3 pin 1 on the display board.
5. Adjust R3 on the display board for a DVM reading of approximately
   - A118-004, Rev V or lower only: 3.0 Vdc and then adjust the intensity to match the displays.
   - 6050-0003-302 or higher only: 2.3 Vcd and then adjust the intensity to match the displays.
6. Verify that the viewing angle of both displays track together as you adjust the Contract Adjust thumbwheel.
7. Power off the unit and unplug it from the AC power supply.
8. Install the cover—see section 5.2.4.

# 5.6 Measuring the power supply

**Additional equipment required:**

- Digital voltmeter (DVM)

1. Remove the oximeter cover—see section 5.2.1.

**WARNING: Electric shock hazard**

- **Do not touch any exposed wiring or conductive surface while the cover is removed. The voltage present when electrical power is connected to the oximeter can cause serious injury or death.**
- **Never wear a grounding wrist strap when working on an energized oximeter.**

2. Connect the DVM + to J2, pin 4, and the DVM common to J2, pin 25.

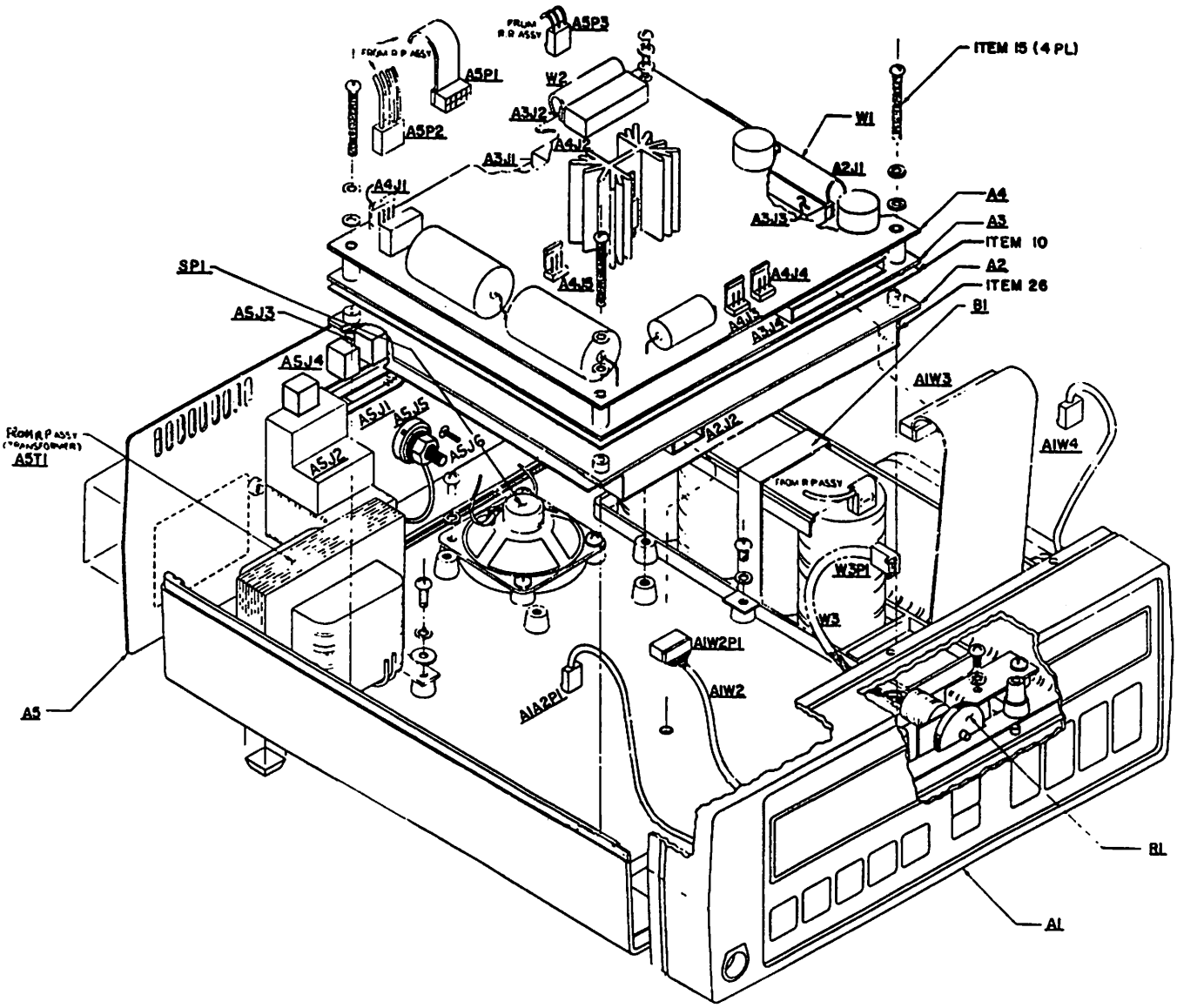
3. Verify that the +V RAM standby voltage is 2.4 to 4.5 Vdc.
4. Plug the unit in and turn it on.
5. Connect a DVM to the following points and verify that the voltage is as shown.

| DVM | | | |
|---|---|---|---|
| + | common | Voltage reading | Supply name |
| J2-4 | J2-25 | 4.75 to 5.25 Vdc | +V RAM |
| J2-13 | J2-25 | 4.75 to 5.25 Vdc | +5V |
| J2-23 | J2-25 | 4.75 to 5.25 Vdc | +V |
| J2-21 | J2-25 | -4.75 to -5.25 Vdc | -V |
| J2-17 | J2-25 | 14.25 to 15.75 Vdc | +15V |
| J2-19 | J2-25 | -14.25 to -15.75 Vdc | -15V |

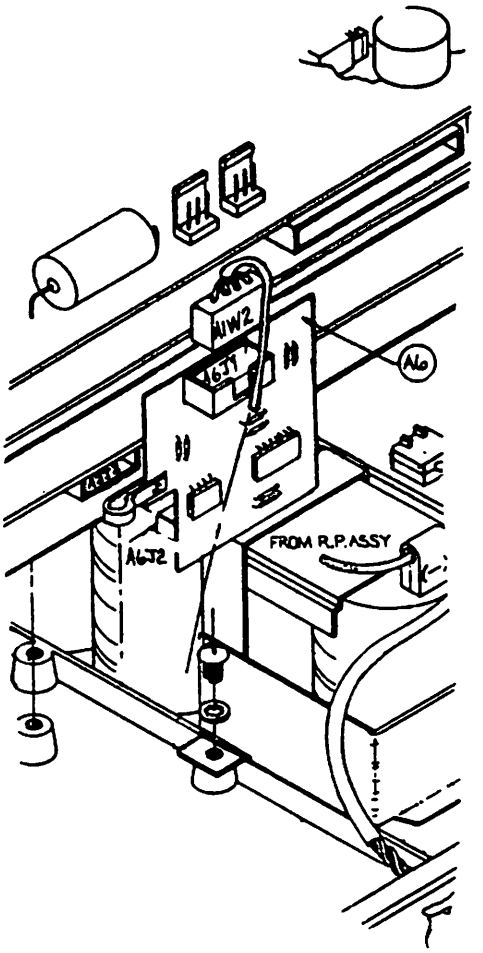
6. Install the cover—see section 5.2.4.

# 5.7 Oximeter assembly information

## 5.7.1 Oximeter assembly illustration



## 5.7.2 Interface board connections—close view



## 5.7.3 Reference designators

| Reference | Description | Connects to |
|---|---|---|
| **A1** | **Front panel assembly** | |
| A1A1 | Display board assembly | |
| A1A1J1 | E.L. backlight connector | A1W4 |
| A1A1J2 | Viewing angle adjust connector | W3P1 |
| A1A1J3 | Keyboard connector | A1A4P1 |
| A1A1J4 | Digital board interface connector | A1W3 |
| A1A1P1 | Graphic control interface | A1A3J1 |
| A1A2 | Graphic display module | |
| A1A2J1 | Graphic control interface | A1W1 |
| A1A2P1 | E.L. panel backlight | A4J3 |
| A1A3 | Graphic control module | |
| A1A3J1 | Digital control interface | A1A1P1 |
| A1A3J2 | Graphic display interface | A1W1 |
| A1A4 | Keyboard | A1A1J3 |
| A1A4P1 | Keyboard connector | A1A1J3 |
| A1W1 | Cable assembly | A1A2J1 to A1A3J2 |
| A1W2 | Cable assembly | A1W2J1 (probe) to A2J2 |
| A1W3 | Cable assembly | A1A1J4 to A3J4 |
| A1W4 | Cable assembly | A1A1J1 to A4J4 |
| **A2** | **Analog board assembly** | |
| A2J1 | Digital board interface | W1 |
| A2J2 | Probe interface | A6J2 |
| **A3** | **Digital board assembly** | |
| A3J1 | Analog outputs, digital interface, speaker | A5P1 |
| A3J2 | Power supply board connector | W2 |
| A3J3 | Analog board interface | W1 |
| A3J4 | Display board interface | A1W3 |

| Reference | Description | Connects to |
|---|---|---|
| **A4** | **Power supply board assembly** | |
| A4J1 | AC power and battery | A5P2 |
| A4J2 | Digital board interface | W2 |
| A4J3 | Graphic E.L. backlight | A1A2P1 |
| A4J4 | Digital display E.L. backlight | A1W4 |
| A4J5 | Voltage regulator connector | A5P3 |
| **A5** | **Rear panel assembly** | |
| A5J1 | Digital interface connector | |
| A5J2 | AC power input connector | A5J5, A5T1 |
| A5J3 | Pulse rate analog output connector | |
| A5J4 | SpO2 analog output connector | |
| A5J5 | Ground equalization connector | A5T1, A5J2, A5P2, A5J6 |
| A5J6 | Rear panel ground | A5J5 |
| A5P1 | Analog output, digital interface, speaker | A3J1 |
| A5P2 | Transformer secondary | A4J1, A5J5 |
| A5P3 | Voltage regulator output | A5V1 to A4J5 |
| A5T1 | Power transformer | A5J5, A5J2, A5P2 |
| A5V1 | Voltage regulator | A1J1 |
| **A6J1** | **Probe cable interface connector** | A1W2 |
| **A6J2** | **Analog board connector** | A2J2 |
| **B1** | **8-volt battery** | |
| **SP1** | **Speaker** | A5P1 |
| **W1** | **Cable assembly** | A2J1 to A3J3 |
| **W2** | **Cable assembly** | A3J2 to A4J2 |
| **W3** | **Cable assembly** | A1A1J2 to R1 |

# 6/Parts and Illustrations

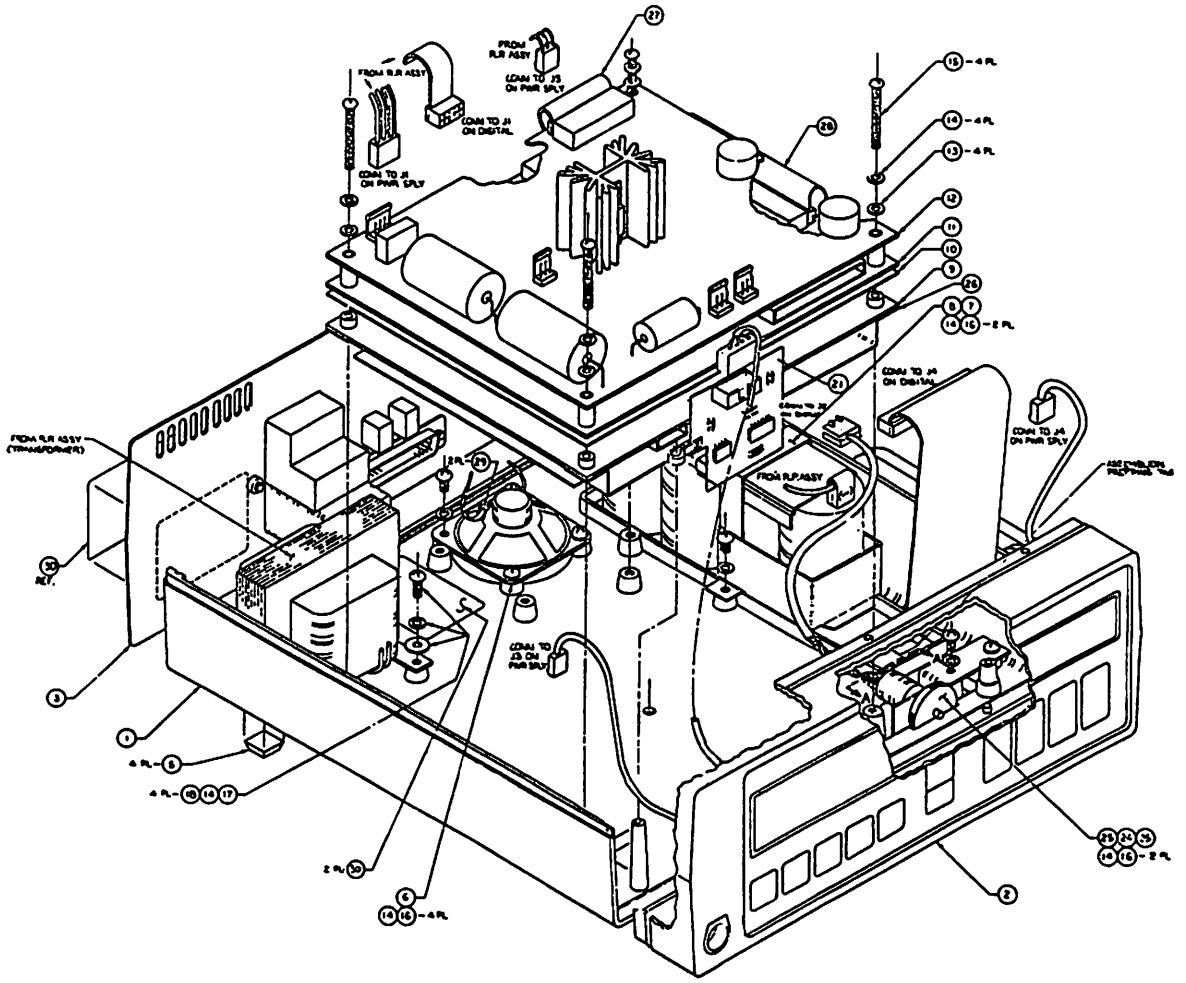
The following components are covered in this chapter:



**Note:** Only those items in the parts lists that appear with stock numbers may be ordered through Ohmeda or an authorized representative.

# 6.1 Oximeter assembly

## 6.1.1 Oximeter assembly illustration



## 6.1.2 Oximeter assembly parts list

Two models of the unit exist (the upper and lower housings for these two versions are **not** interchangeable).

The older version has a handle that swings down to become a tilt stand or that can be used to hang the unit from a bed rail. You must order **Kit, housing, 3700/3700e, side handle (p/n 6050-0002-900)** to replace the housings for this model. The kit contains all the necessary parts to replace both housings, converting the unit to a side-handle version.

The newer version has a carrying handle on the side of the unit and a separate bail rod for tilting the unit. You may order the kit (6050-0002-900) to replace both housings, or you may order them separately as necessary from the parts list below.

| Item # | Description | Part number |
|---|---|---|
| 1 | Housing, lower, 3700/3700e (side handle/bail rod model) (6050-0002-900 ⊃ | 6050-0002-825 → 69.00 |
| 2 | Assy, front panel, 3700 (A1), top view | 0380-0800-086 |
| | Assy, front panel, 3700e (A1), top view | 0380-0700-050 |
| 3 | Assy, rear panel 3700 (A5) | 0380-0800-021 |
| | Assy, rear panel, 3700e (A5) | 0380-0700-051 |
| not shown | Handle strap (side handle model) | 0380-1500-093 |
| not shown | Handle end caps, white (side handle model) | 0380-1500-118 |
| not shown | Bail rod (side handle model) | 0380-0100-283 |
| not shown | Mounting foot, bail rod (side handle model) | 0380-0100-284 |
| 5 | Rubber foot, adhesive backed | 0279-0109-300 2.00 |
| 6 | Speaker, 8 Ω (SP1) | 0279-0101-300 |
| 7 | Battery strap | 0279-0110-300 |
| 8 | Battery, 8 volt (B1) | 0279-0102-300 |
| 9 | Assy, analog board (A2) | 0279-0147-300 |
| 10 | Shield plate | 0279-0165-300 |
| 11 | Assy, digital board, Rev M only | 0279-0150-300 |
| | 3700e German (A3) | 0380-0500-068 |
| 11A | Assy, digital board, Rev P and above (A3) (SoftProbe/EasyProbe compatible) | 0380-0500-018 |
| 12 | Assy, power supply board (A4) | 0279-0154-300 |
| 13 | Washer, #6, flat, nylon | 0380-0100-097 |
| 14 | Washer, #6, internal star | 0380-0100-094 |
| 15 | Screw, #6-32 x 1.25", PPH | 0380-0100-074 |
| 16 | Screw, #6-32 x .25", PPH | 0380-0100-067 |
| 17 | Screw, #6-32 x .375", PPH | 0380-0100-068 |
| 18 | Washer, #6 flat | 0380-0100-093 |
| 21 | Assy, PCB, 30-bin upgrade | 0380-0500-024 |
| 22 | Case screw, #6-32 x 2.125", PPH (not shown) | 0279-0103-300 |
| not shown | Housing, upper, 3700/3700e (side handle/bail rod model) | 6050-0002-823 |
| 24 | Contrast adjust thumbwheel | 0279-0116-300 |

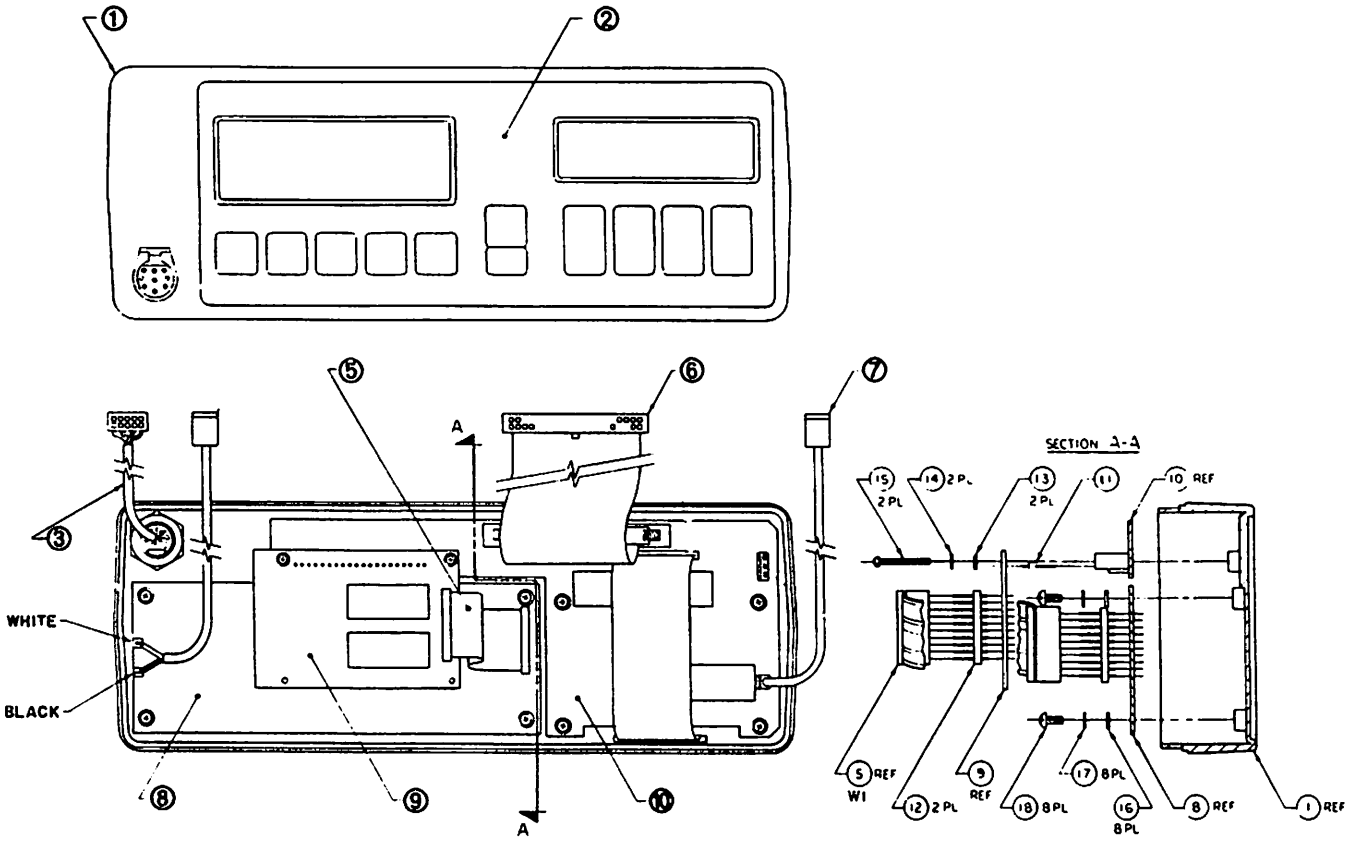
| Item # | Description | Part number |
|---|---|---|
| 25 | Bracket, thumbwheel | 0279-0111-300 |
| 26 | Shield plate | 0279-0166-300 |
| 27 | Assy, ribbon cable, 26 pin, 2.5" | 0279-0105-300 |
| 28 | Assy, ribbon cable, 60 pin, 2.5" | 0279-0106-300 |
| 29 | Shrink tubing, clear ⅛: dia. | |
| 35 | Cable assy., w/trimming pot, 3 cond, 12" | 0279-0107-300 |
| | Retainer, battery, 3 axis | 0380-0100-257 |
| | Label, Graphic display | 0380-0900-064 |

## 6.1.3 Oximeter assembly service kits

| Description | Part number |
|---|---|
| Kit, software only, revises to Rev. M only | 0380-0800-044 |
| Kit, current software only, for Rev. P or higher units | |
| English | 6050-0003-139 |
| French | 6050-0003-140 |
| German | 6050-0003-141 |
| Spanish | 6050-0003-142 |
| Kit, upgrade, current software and PCA, for pre-rev P units; upgrades to 30-bin and latest software | |
| English | 6050-0003-224 |
| French | 6050-0003-225 |
| German | 6050-0003-222 |
| Spanish | 6050-0003-223 |
| Kit, bottom view to top view, repl. | 6050-0002-828 |
| Kit, housing, 3700/3700e, side handle/bail rod model | 6050-0002-900 |
| Kit, display, TV, 30 bin upgrade (PCA, front panel, EPROM) | 0380-0800-027 |
| Front panel, Svc, 3700 | 0380-0800-086 |
| Front panel, Svc, 3700e | 0380-0700-050 |
| Rear panel, Svc, 3700 | 0380-0800-121 |
| Rear panel, Svc, 3700e | 0380-0700-051 |

# 6.2 Front panel assembly

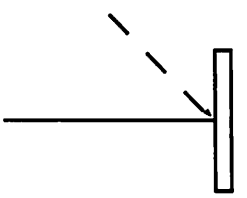
## 6.2.1 Front panel assembly illustration



## 6.2.2 Front panel assembly parts list

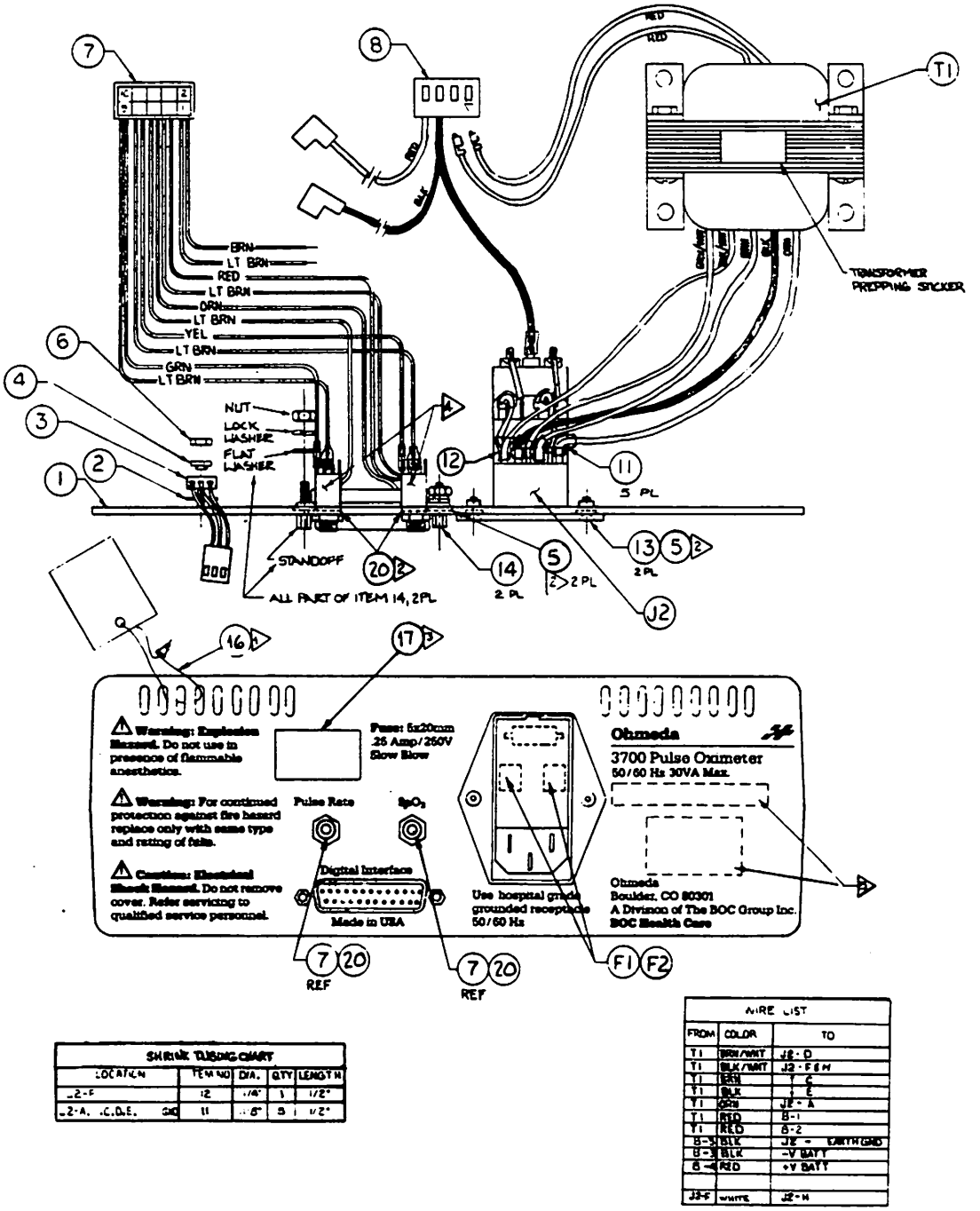
| Item # | Description | Part number |
|---|---|---|
| 1 & 2 | Assy, bezel, 3700, w/membrane | 0380-0700-028 |
| | Assy, bezel, 3700e, English, w/membrane | 0380-0100-298 |
| | Assy, bezel, 3700e, German, w/membrane | 0380-0100-301 |
| 3 | Cable assy, probe, black, Rev. M only | 0279-0136-300 |
| | Cable assy, probe, white, SoftProbe/EasyProbe, Rev. P and above | 0380-0600-095 |
| 5 | Assy, ribbon cable, 10 pin, 1 row | 0279-0134-300 |
| 6 | Assy, ribbon cable, 40 pin, 8" | 0279-0133-300 |
| 7 | A118-004, Rev V or lower only: Cable assy, 2 cond. shield, w/plugs | 0279-0135-300 |
| 8 | Display, LCD graphics, top view* 6050-002-828 | ~~0380-0300-458~~ |
| 9 | Graphic module interface | 0279-0132-300 |
| 10 | Assy, display board, top view* | 0279-0140-300 |
| 13 | Washer, #2 flat, nylon | 0279-0167-300 |
| 14 | Washer, #2, internal star | 0380-0100-088 |
| 15 | Screw, #2-56 x .75, PPH | 0380-0100-057 |
| 16 | Washer, #4 flat, nylon | 0380-0100-089 |
| 17 | Washer, #4 internal star | 0380-0100-090 |
| 18 | Screw, #4-40 x .25, PPH | 0380-0100-062 |

***Top view** is for use in an oximeter (product code FMA or FMU) that the observer views from **above the direct line of sight.**



# 6.3 Rear panel assembly

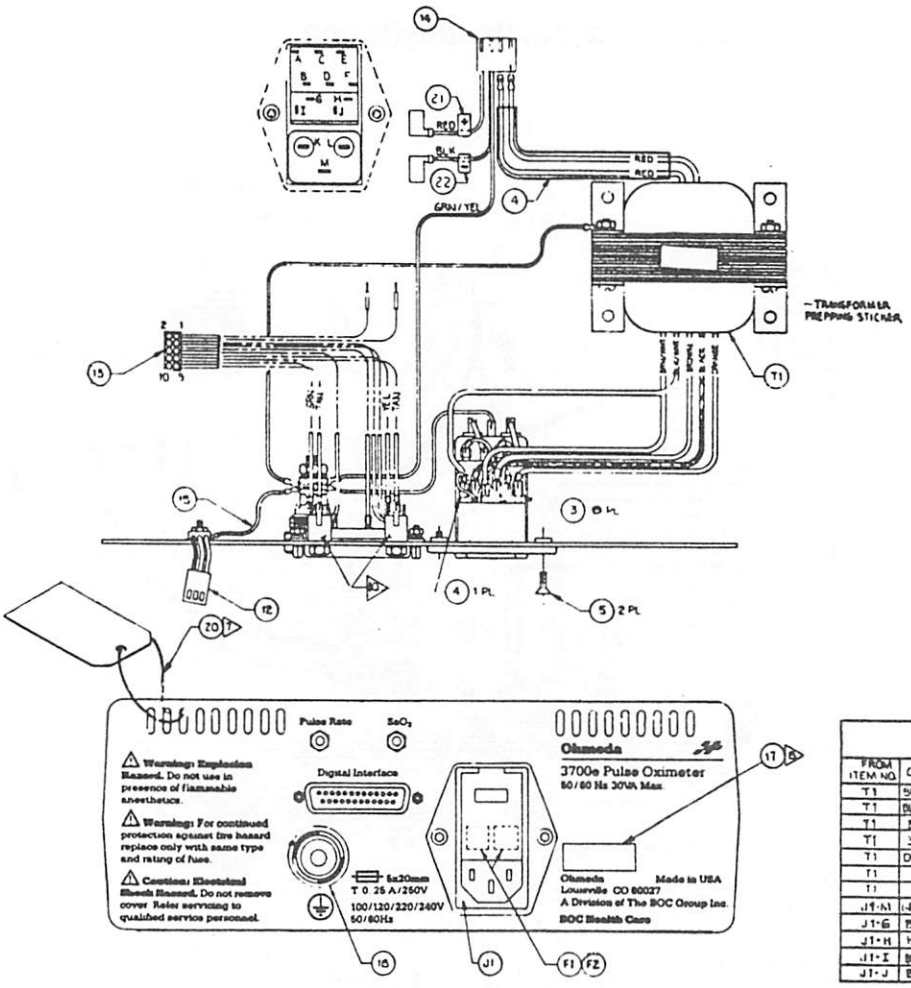
## 6.3.1 3700 rear panel assembly illustration




| SHRINK TUBING CHART | | | | |
|---|---|---|---|---|
| LOCATION | ITEM NO | DIA. | QTY | LENGTH |
| J2-F | 12 | 1/4" | 1 | 1/2" |
| J2-A, C, D, E, G&D | 11 | .5" | 5 | 1/2" |

| WIRE LIST | | |
|---|---|---|
| FROM | COLOR | TO |
| T1 | BRN/WHT | J2-D |
| T1 | BLK/WHT | J2-F & H |
| T1 | BRN | J2-C |
| T1 | BLK | J2-E |
| T1 | ORN | J2-A |
| T1 | RED | B-1 |
| T1 | RED | B-2 |
| B-3 | BLK | J2-G EARTH GND |
| B-3 | BLK | -V BATT |
| B-4 | RED | +V BATT |
| | | |
| J2-F | WHITE | J2-H |

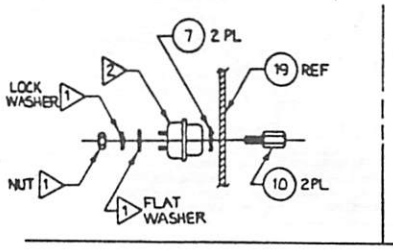
## 6.3.2 3700e rear panel assembly illustration



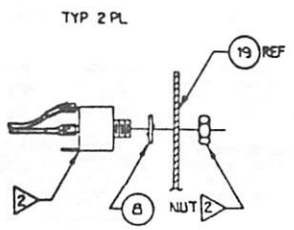

WIRE LIST

| FROM ITEM NO. | COLOR | TO ITEM NO. | TUBING ITEM NO. | LENGTH |
|---|---|---|---|---|
| T1 | GRN/YLW | J1-D | 3 | ½" |
| T1 | BLK/WHT | J1-P | 4 | ½" |
| T1 | BROWN | J1-C | 3 | ½" |
| T1 | BLACK | J1-E | 3 | ½" |
| T1 | ORANGE | J1-A | 3 | ½" |
| T1 | RED | 14-1 | — | — |
| T1 | RED | 14-2 | — | — |
| J1-M | GRN/YEL | 18 | — | — |
| J1-G | BROWN | J1-B | 3 | ½" |
| J1-H | BLUE | J1-F | 4 NST | — |
| J1-I | BROWN | J1-K | 3 | ½" |
| J1-J | BLUE | J1-L | 3 | ½" |

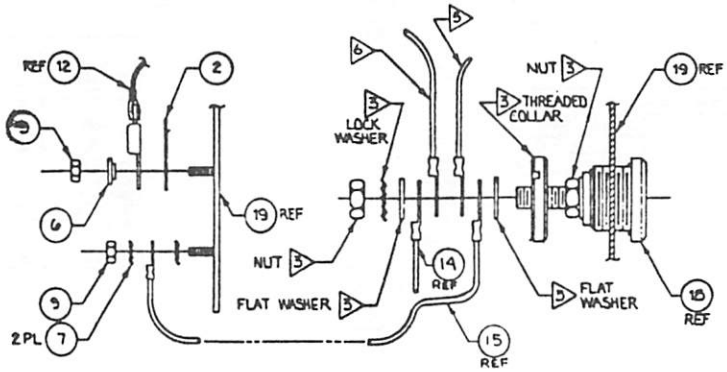
Digital interface




Analog output




Voltage regulator




Ground equalization

## 6.3.3 3700 rear panel assembly parts list

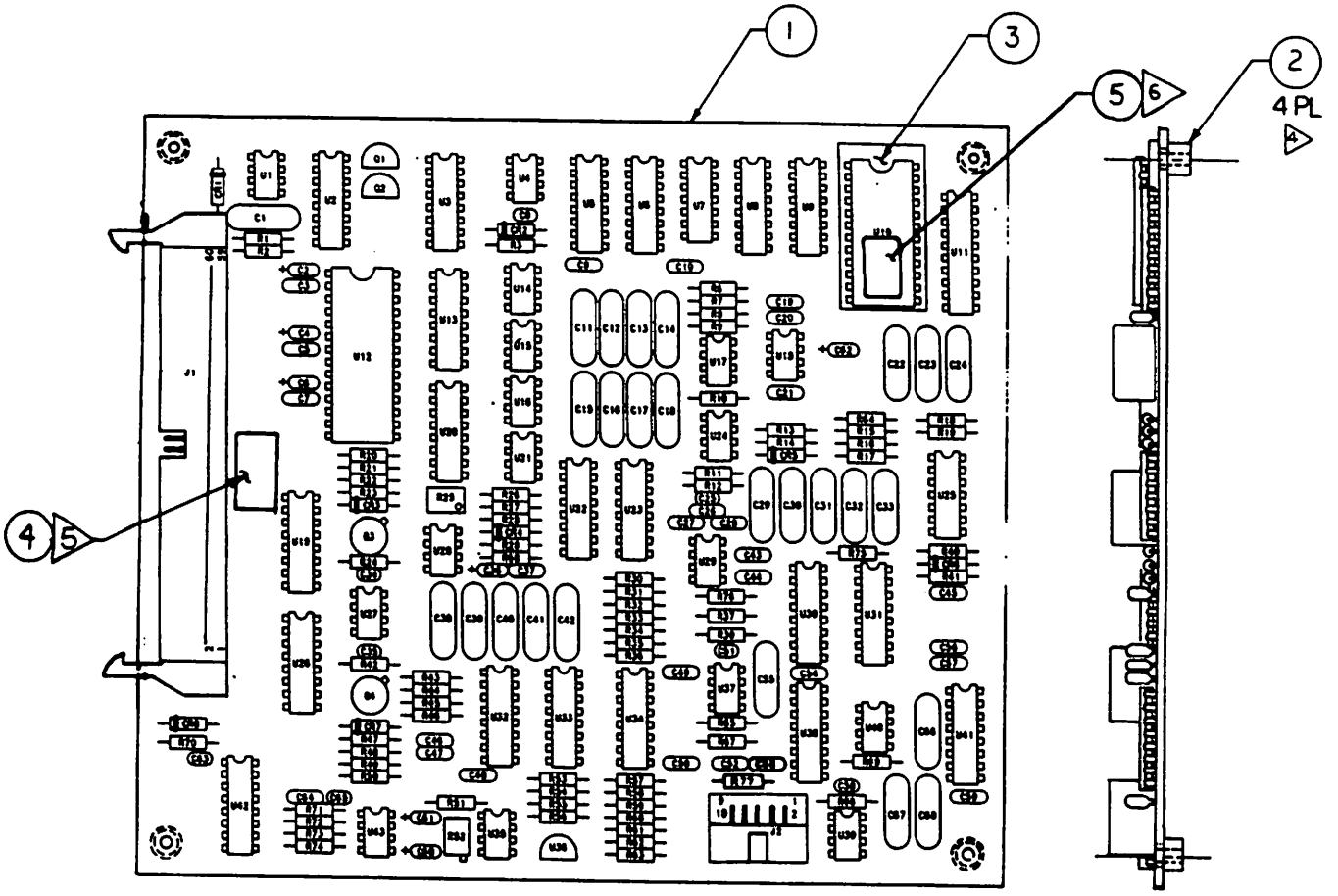
| Item # | Description | Part number |
|---|---|---|
| 1 | Panel, rear, model 3700, English | 0380-0700-026 |
| | French | 0380-0500-075 |
| 2 | Thermal pad (3223-07FR-54) | 0380-0100-041 |
| 3 | Cable assy, regulator | 0380-0600-083 |
| 4 | Washer, insulating, shoulder | 0380-0100-086 |
| 5 | Washer, #4 external star | 0380-0100-091 |
| 6 | Nut, #4-40 hex | |
| 7 | Cable assy, output | 0380-0600-077 |
| 8 | Cable assy, battery 3700/3710 | 0380-0600-086 |
| 9 | Pin, conn 18-22 AWG, box type | 0279-0122-300 |
| 10 | Wire, PVC stranded, 20 AWG, blk | |
| 12 | Shrink tubing, clear ¼" dia. | |
| 13 | Screw, #4-40 x .375 soc flt blk | 0380-0100-063 |
| 14 | Screw lock assy | 0380-0100-121 |
| 20 | Washer, ¼" internal lock | 0380-0100-100 |
| F1/F2 | Fuse, .25 amp, 250V, Slow-blo | 0279-0168-300 |
| J2 | Pwr line filter, w/volt select | 0279-0117-300 |
| T1 | XFMR, MLT PRMY to 13.8 Vdc @1.5A | 0380-1500-163 |

## 6.3.4 3700e rear panel assembly parts list

| Item # | Description | Part number |
|---|---|---|
| 1 | Pin conn, 18-22 AWG, box type | 0279-0122-300 |
| 2 | Thermal pad (3223-07FR-54) | 0380-0100-041 |
| 3 | Shrink tubing, clear d" dia. | |
| 4 | Shrink tubing, clear c" dia. | |
| 5 | Screw, #4-40 soc flt blk | 0380-0100-063 |
| 6 | Washer, insulating, shoulder | 0380-0100-086 |
| 7 | Washer, #4 external star | 0380-0100-091 |
| 8 | Washer, ¼" internal lock | 0380-0100-100 |
| 9 | Nut, #4-40 hex, 3/16 dr | |
| 10 | Screw lock assy. | 0380-0100-121 |
| 12 | Cable assy, regulator | 0380-0600-083 |
| 13 | Cable assy, output | 0380-0600-077 |
| 14 | Cable assy, battery int'l | 0380-0600-117 |
| 15 | Cable assy, rear panel, ground | 0380-0600-118 |
| 18 | Connector, ground equalization | 0380-0100-308 |
| 19 | Panel, rear 3700e, English | 0380-0700-043 |
| | German | 0380-0700-056 |
| | Spanish | 6050-0002-456 |
| 20 | Cable tie, 3" | 0380-0100-116 |
| F1/F2 | Fuse, .25 amp, 250V, Slow-blo | 0279-0168-300 |
| J2 | Pwr line filter, w/volt select | 0380-0200-192 |
| T1 | XFMR, MLT PRMY to 13.8 Vdc @1.5A | 0380-1500-163 |

# 6.4 Analog board assembly

## 6.4.1 Analog board assembly diagram




## 6.4.2 Analog board reference designators

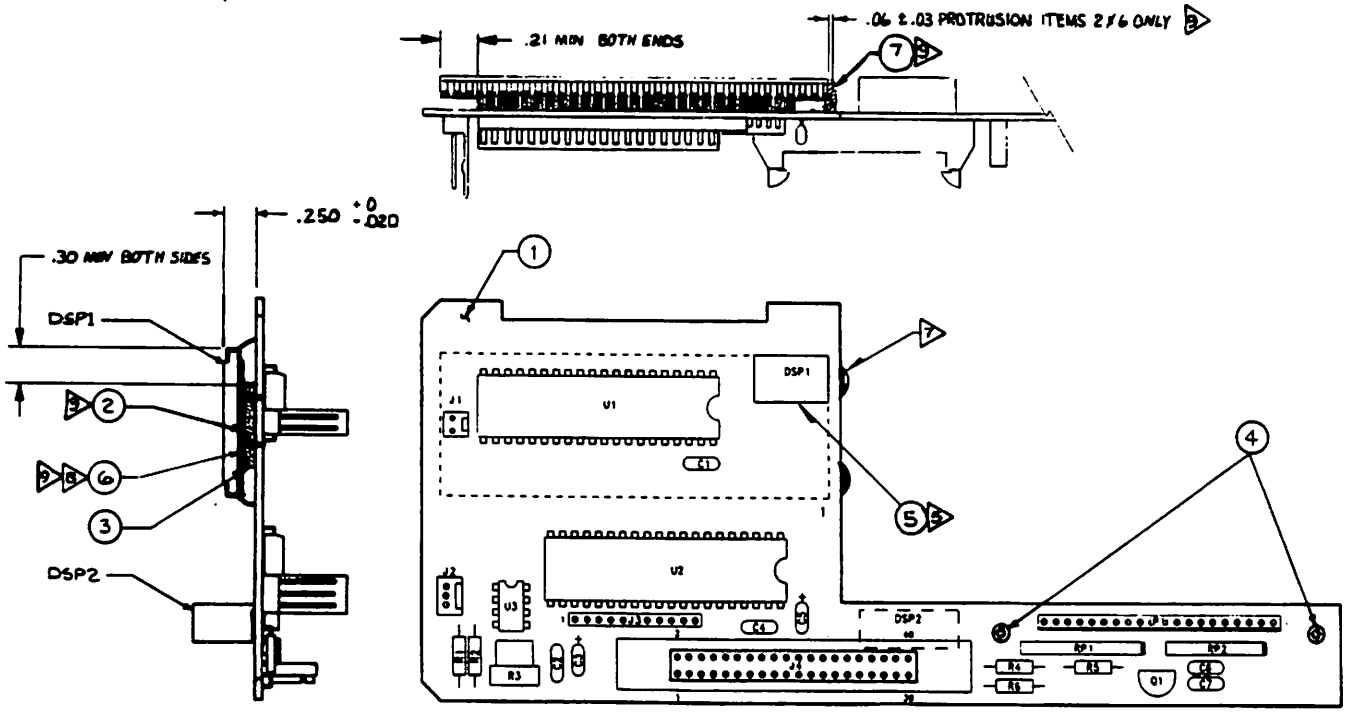
| Ref. designation | Description |
|---|---|
| **Resistors** | |
| R1, R2, R27 | 10K ¼W 1% |
| R3 | 20K ¼W 1% |
| R6. R8 | 40.2K ¼W 1% |
| R7, R9, R75, R76 | 562K ¼W 1% |
| R10 | 23.2K ¼W 1% |
| R11, R15, R16, R39, R58, R66 | 1M ¼W 1% |
| R12 | 215K ¼W 1% |
| R13, R14 | 150K ¼W 5% |
| R17, R44 | 2K ¼W 5% |
| R18 | 24K ¼W 5% |
| R19 | 3.9K ¼W 5% |
| R20, R21 | 49.9 Ω ¼W 1% |

| Ref. designation | Description |
|---|---|
| R22 | 16.5 Ω ¼W 1% |
| R23, R47 | 33K ¼W 5% |
| R24, R28, R42, R49, R50, R71 | 10K ¼W 5% |
| R25 | Pot, trimming, 1K Ω |
| R26 | 10.5K ¼W 1% |
| R29 | 51K ¼W 5% |
| R30, R61 | 30.9K¼W 1% |
| R31, R60 | 124K ¼W 1% |
| R32, R63 | 61.9K ¼W 1% |
| R33, R62 | 15.4K ¼W 1% |
| R34 | 3.92K ¼W 1% |
| R35 | 1.91K ¼W 1% |
| R36 | 7.87K ¼W 1% |
| R37, R69 | 21.5K ¼W 1% |
| R40, R53, R54 | 50K 1/20W 1% |
| R41 | 4.75K ¼W 1% |
| R43, R45, R46, R68, R72, R73 | 1K ¼W 5% |
| R48 | 8.25 Ω ¼W 1% |
| R51 | 75K ¼W 1% |
| R52 | Pot, trimming 10K Ω |
| R55 | 100K ¼W 1% |
| R56 | 18K ¼W 5% |
| R57 | 249K ¼W 1% |
| R59 | 499K ¼W 1% |
| R64, R70 | 100K ¼W 5% |
| R65 | 10 Ω ¼W 5% |
| R67 | 15 Ω ¼W 5% |
| R74 | 5.11K ⅛W 1% |
| R77 | 392K ¼W 1% |
| **Capacitors** | |
| C1, C12, C16 | (Matched sets) 25V, 022µf tested |
| C2, C4, C6, C60, C61 | Tant EL, 25V 20% 10µf |
| C3, C5, C7, C9, C10, C19, C20, C21, C26, C27, C28, C37, C43, C44, C45, C46, C47, C48, C49, C50, C52, C53, C54, C56, C57, C59, C64 | MCER.20 50V 20% .1µF |
| C8 | MCER 50V 5% 15pf |
| C11, C15 | 25V 5% .047µf |
| C13, C17, C32, C33 | Polyester 63V .47µf |
| C14, C18, C30, C42, C66, C67, C68 | Polyester 25V .22µf |
| C22, C23 | Polyester 63V 5% .47µf |
| C24, C29, C31, C55 | Polyester 25V 5% .22µf |

| Ref. designator | Description |
|---|---|
| C25, C51, C58 | MCER 50V 5% .001µf |
| C34, C35 | MCER 50V 5% 100pf |
| C36, C62 | Tant EL 25V 20% 1µf |
| C38, C39, C40, C41 | Polyester 100V 5% .1µf |
| C63 | MCER 50V 5% .001µf |
| C65 | MCER 50V 5% 470pf |
| **Transistors** | |
| Q1 | VN0104N3, N-FET |
| Q2 | VP010N3, P-FET |
| Q3, Q4 | 2N2222, NPN |
| **Diodes** | |
| CR1, CR2, CR3, CR4, CR7 | 1N6263 |
| CR5, CR6, CR8 | 1N914 |
| **Integrated circuits** | |
| U1, U4, U21 | IC dual Jfet-Input op-amp 082C |
| U2, U3, U19, U26 | IC CMOS 8-bit Mult DAC 7524 |
| U5, U6 | IC HCMOS decade counter divider 74HC4017 |
| U7 | IC HCMOS hex inverter, TTL THR 74HCT04 |
| U8, U22, U30, U31, U32, U33, U38, U41, U42 | IC CMOS triple 2-1 analog Mux 4053B |
| U9 | IC HCMOS counter 14-it 74HC4020 |
| U10 | EPROM, sequence program 3700/3700e |
| U11 | IC octal D-type flip-flop 74 HCT574 |
| U12 | IC A/D converter 12-bit 574 |
| U13, U20, U23, U34 | IC CMOS 8-to-1 analog Mux 4051B |
| U14, U16 | IC mono sample and hold 398 |
| U15, U27 | IC dual op-amp LM358 |
| U17, U18, U24, U29, U37, U40 | IC ultra-low offset op-amp OP-07CP |
| U25 | IC quad low power op-amp |
| U28, U39 | IC mono JFET-input op-amp 356 |
| U35 | IC dual JFET-input op-amp 082B |
| U36 | LM 385 B-1.2V |
| U43 | IC JFET-input wide-band op-amp 357 |
| **Misc.** | |
| Item 1 | PCB, analog, 3700/3700e |
| Item 2 | Standoff, .143 ID x .125 L |
| Item 3 | Socket, 24-pin, Dip |
| Item 4 | Label, .75" x .25" |
| Item 5 | Label, EPROM sequence, 3700/3700e |
| J1 | Header, 90 deg, lock, 4-wall, 60-pin |
| J2 | Header, 90 deg, shrouded, 10-pin |

# 6.6 Display board assembly

## 6.6.1 Display board diagram

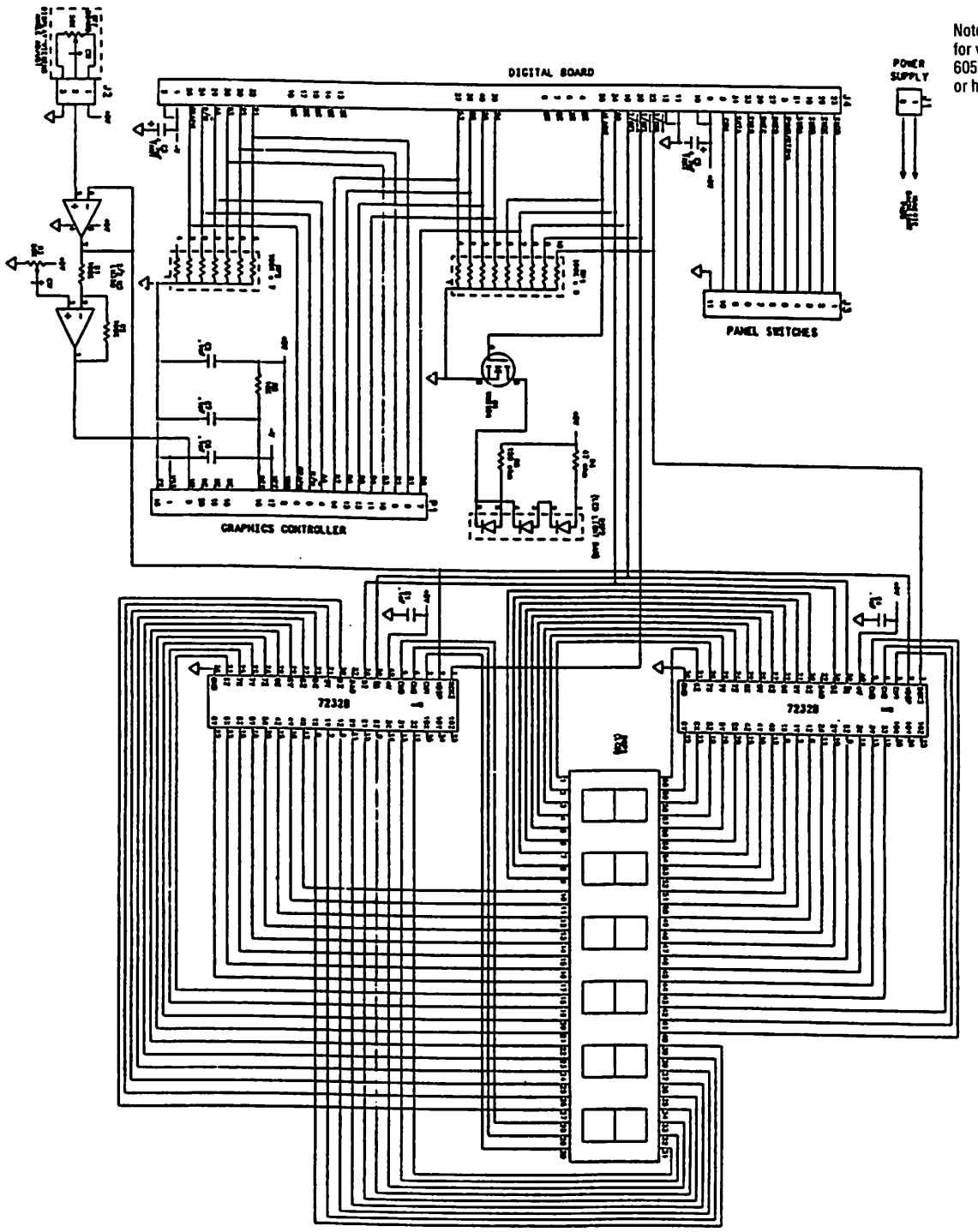



## 6.6.2 Display board reference designators

| Ref. designator | Description |
|---|---|
| **Resistors** | |
| R1, R2 | 100K ¼W 5% |
| R3 | Pot, trimming 50K Ω ¾ turn |
| R4 | 47 Ω ¼W 5% |
| R5 | 10K ¼W 5% |
| R6 | 150 Ω ¼W 5% |
| RP1 | R-Pak, 100K x 9 (10-pin) |
| RP2 | R-Pak, 100k x 7 (8-pin) |
| **Capacitors** | |
| C1, C2, C4, C6, C7 | 50V 20% .1µf |
| C3, C5 | 25V 20% 4.7 µf |
| **Transistors** | |
| Q1 | VN0104N3, N-FET |
| **Integrated circuits** | |
| U1, U2 | Display drive LCD 7232BF |
| U3 | IC dual op-amp LM358 |
| **Displays** | |
| DSP1 | LCD display, top view |
| DSP2 | Red LED, light bar |

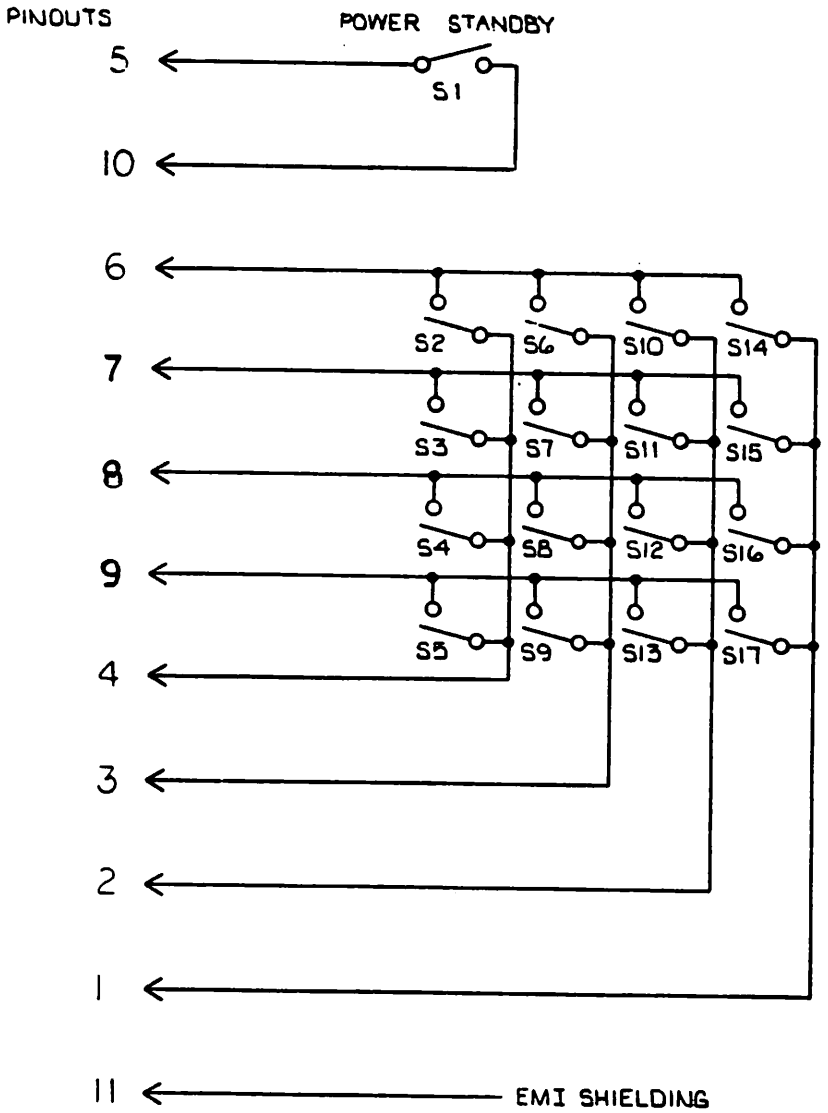
| Ref. designator | Description |
|---|---|
| **Misc.** | |
| Item 1 | PCB, display, 3700/3700e |
| Item 2 | Panel, luminous/LED backlight, 3.15 x .98 |
| Item 3 | Foam spacer, display panel |
| Item 4 | Standoff, .116 ID x .500 L |
| Item 5 | Label, .75" x .25" |
| Item 6 | Filter, display, yellow-green |
| Item 7 | Adhesive, RTV, clear |
| J1 | Header, straight locking, 2-pin |
| J2 | Header, straight locking, 3-pin |
| J3 | Header, straight, 11-pin |
| J4 | Header, straight, lock 4-wall, 40-pin |
| P1 | Socket, Sip connector 20-pin |

## 6.6.3 Display board schematic




Note: Not used for version 6050-0003-302 or higher

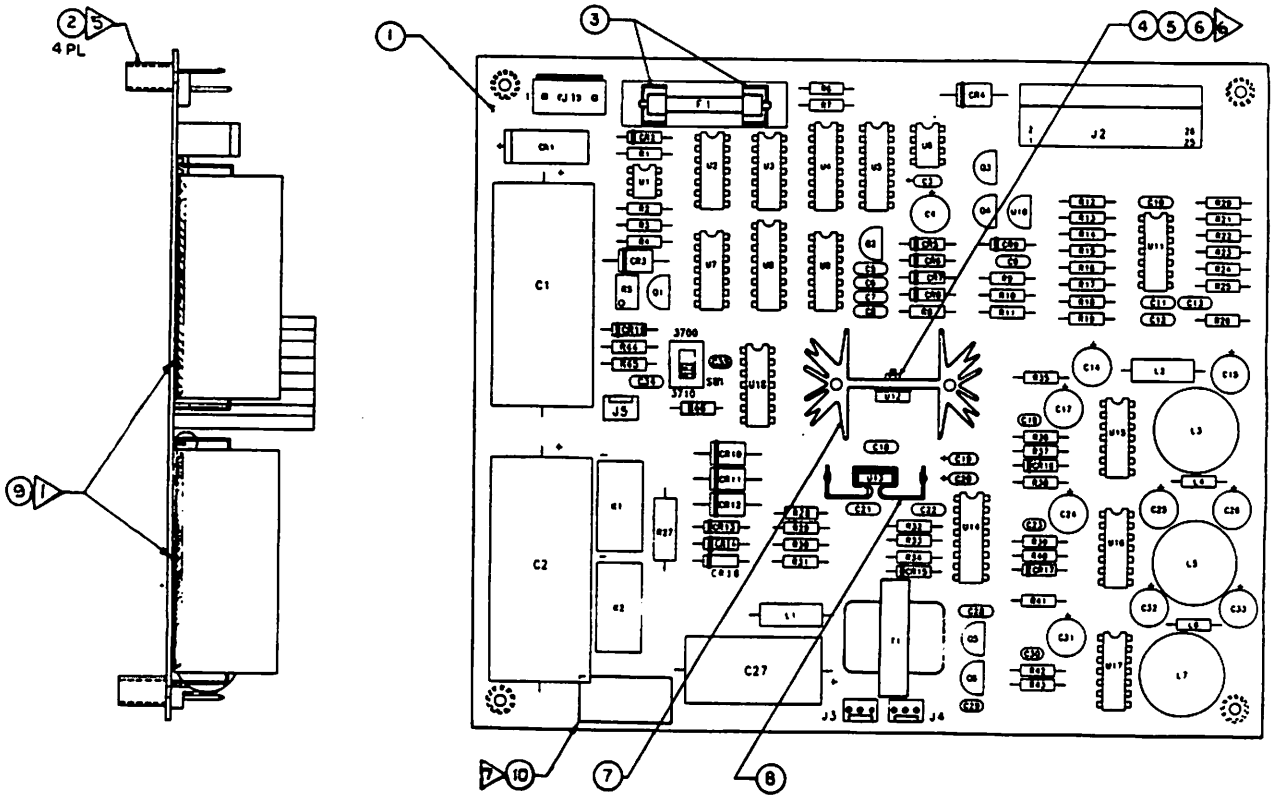
## 6.6.4 Membrane panel switch schematic




| SWITCH | NOMENCLATURE |
|---|---|
| S1 | POWER STANDBY |
| S5 | ALARM VOLUME |
| S3 | 20/60 TREND |
| S4 | PULSE VOLUME |
| S2 | WAVE FORM |
| S6 | ALARM |
| S13 | △ LOW SpO2 |
| S17 | ▽ LOW SpO2 |
| S12 | △ HIGH SpO2 |
| S16 | ▽ HIGH SpO2 |
| S11 | △ LOW PULSE |
| S15 | ▽ LOW PULSE |
| S10 | △ HIGH PULSE |
| S14 | ▽ HIGH PULSE |
| S7 | ——— |
| S8 | ——— |
| S9 | ——— |

# 6.7 Power supply board

## 6.7.1 Power supply board diagram



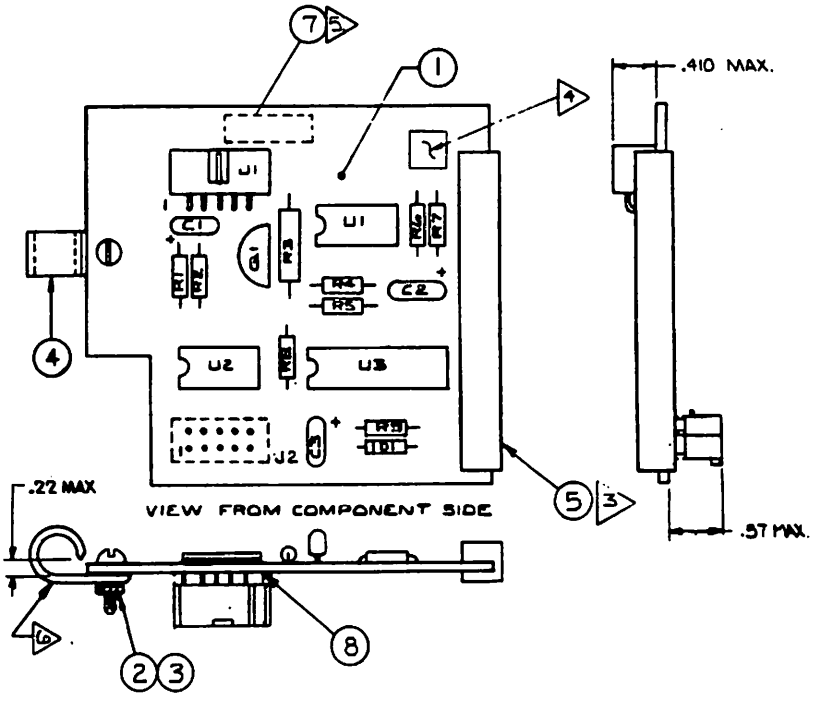

## 6.7.2 Power supply board reference designators

| Ref. designator | Description |
|---|---|
| **Resistors** | |
| R1, R2 | 2K ¼W 5% |
| R3 | 243 Ω ¼W 1% |
| R4, R40, R42 | 1.40K ¼W 1% |
| R5 | Pot, trimming, 500 Ω |
| R6 | 680K ¼W 5% |
| R7 | 330K ¼W 5% |
| R8, R12, R17, R18, R25, R28, R32, R34 | 100K ¼W 5% |
| R9, R10, R11, R29, R30, R45, R46 | 2M ¼W 5% |
| R13 | 46.4K ¼W 1% |
| R14 | 332K ¼W 1% |
| R15 | 69.8K ¼W 1% |
| R16 | 511 Ω ¼W 1% |
| R19 | 124K ¼W 1% |

| Ref. designator | Description |
|---|---|
| **Resistors, cont'd** | |
| R20 | 10.2K ¼W 1% |
| R21 | 49.9K ¼W 1% |
| R22 | 15K ¼W 1% |
| R23, R24 | 10M ¼W 5% |
| R26 | 267K ¼W 1% |
| R27 | 2.2 Ω 3W 1% |
| R31 | 10K ¼W 5% |
| R33 | 24K ¼W 5% |
| R35, R38, R41 | 1 Ω ⅛W 5% |
| R36 | 1.50K ¼W 1% |
| R37 | 4.75K ¼W 1% |
| R39, R43 | 16.2K ¼W 1% |
| R44 | 470K ¼W 5% |
| **Capacitors** | |
| C1, C2 | Alum EL 25V +50-20% 4700µf |
| C3, C19, C20 | Tant EL 25V 20% 10µf |
| C4, C14, C15, C17, C24, C25, C26, C31, C32, C33 | Alum EL 25V, Rad lead, 100µf |
| C5, C6, C7, C8, C9, C11, C12, C13, C18, C21, C22, C28, C34 | MCER 50V 20% .1µf |
| C10, C29 | MCER 25V 20% .01µf |
| C16, C23, C30 | MCER 50V 5% 220pf |
| C27 | Alum EL 16V +50-20% 1000µf |
| C35 | MCER, 50V 5% .001µf |
| **Transistors** | |
| Q1, Q2, Q3, Q4, Q5 | VN0104N3, N-FET |
| Q6 | VN0206N3 N-FET |
| **Relays** | |
| K1, K2 | 9V, DPDT 2 amp |
| **Fuses** | |
| F1 | 2 amp, fast-act, instrumentation |
| **Diodes** | |
| CR1 | Rectifier, 3N254, full wave bridge, 100V |
| CR2, CR5, CR6, CR7, CR8, CR15, CR18 | 1N914 |
| CR3, CR10, CR11, CR12 | 1N5820 3amp Schottky |
| CR4 | Transzorb P6KE6.8 |
| CR9, CR16, CR17 | 1N5817 1 amp Schottky |
| CR13, CR14, CR19 | 1N4001 50V 1 amp |
| **Integrated circuits** | |
| U1 | 255 Optoisolator |
| U2, U7, U18 | IC CMOS quad 2-input Nand Schmitt 409 |
| U3, U9 | IC CMOS dual D flip-flop 4013B |
| U4 | IC CMOS dual binary counter 4520B |
| U5, U14 | IC HCMOS ounter 14-bit 74HC4020 |
| U6 | IC CMOS POS volt regulator 7663 |
| U8 | IC CMOS hex interting buff 4049UB |
| U10 | IC voltage reference 1.235V LM385 |
| U11 | IC quad differential comp 339 |
| U12, U13 | IC 3 term +5 volt regulator 7805 |

# 6.8 Interface board

## 6.8.1 Interface board diagram




## 6.8.2 Interface board reference designators

| Ref. designator | Description |
|---|---|
| **Resistors** | |
| R1, R4 | 2K ⅛W 1% |
| R2, R8 | 590K ⅛W 1% |
| R3 | 2 Ω 1W 1% |
| R5, R7 | 10K ⅛W 1% |
| R6 | 20K ⅛W 1% |
| R9 | 200K ⅛W 5% |
| **Capacitors** | |
| C1, C3 | Tant EL 25V 20% 10µf |
| C2 | MCER 50V 20% .1µf |
| **Transistors** | |
| Q1 | VN0206N3 N-FET |
| **Diodes** | |
| D11 | N914 |
| **Integrated circuits** | |
| U1 | IC low power comparator LM393N |
| U2 | Op-amp ICL7612 |
| U3 | HCMOS dual D-type flip-flop 74HC74 |

| Ref. designator | Description |
|---|---|
| **Misc.** | |
| Item 1 | PCB, upgrade interface board |
| Item 2 | Screw, #6-32 x .375 Steel round nylon |
| Item 3 | Nut, #6-32 hex nylon |
| Item 4 | Cable clamp, 5/16" nylon |
| Item 5 | Extrusion, rubber |
| Item 6 | Adhesive, RTV, clear |
| Item 8 | Spacer, connector, 10-pin |
| J1 | Header, 90 deg shrouded, 10-pin |
| J2 | Socket, 10-pin, center key |

## 6.8.3 Interface board schematic