OPERATING & SERVICE INSTRUCTIONS FOR

MX300

PORTABLE OXYGEN MONITOR

TYPE B APPLIED PART:

$$\mathsf{C}\mathsf{E}\ _{0086}$$

Equipment provides a degree of protection against electric shock, particularly regarding—

- Allowable Leakage Current
- Reliability of the protective earth connection (if present).

Teledyne Analytical Instruments   i

Warranty

Teledyne warrants that the goods are free from defects of material and of construction for a period of 2 years (or less, as the case may be, with consumables) from the date of shipment from Teledyne. The liability of Teledyne, if any, shall be limited solely to the replacement or repair of the goods, and shall not include shipping costs or other incidental damages as defined in Section 2-715 of the U.S. Uniform Commercial Code.

Teledyne cannot warrant any damage resulting from unauthorized repair, misuse, improper maintenance, negligence, or other events not caused by Teledyne or our goods.

CAUTION: *FEDERAL LAW RESTRICTS THIS DEVICE TO SALE BY OR ON THE ORDER OF A PHYSICIAN.*

The device has been tested to the standard required by the European Community for CE making, EN/IEC60601-1-2. The device performed within the requirements of the applicable standard.

Magnetic Field Immunity Datasheet				
X or A Normal Performance within specification limits				
	Induce magnetic field strength for continuous fields			
	Level 1	Level 2	Level 3	Level 4	Level 5
	1 A/m	3 A/m	10 A/m	30 A/m	100 A/m
X Axis		X			
Y Axis		X			
Z Axis		X			

About This Manual

This Manual describes the installation, configuration, operation and maintenance instructions for Model MX300 Portable Oxygen Monitor.

This Manual contains Cautions, Warnings, and Notes to ensure safe and efficient performance of the Monitor.

For convenience with operating and maintaining your Monitor, this manual includes Specifications, Troubleshooting and Maintenance Spare Parts sections.

How To Use This Manual

This manual is designed to walk you through the initial set-up of the MX300 Portable Oxygen Monitor. After you have used it to initially commission your Monitor, it becomes a quick reference guide to help you with specific questions or operating challenges.

Before operating the Monitor for the first time, you are advised to read and familiarize yourself with the contents of this manual.

Safety Messages

Your safety and the safety of others are very important. Please carefully read and understand the Caution, Warning and Notes found in several places in the manual.

CAUTION: *THE MONITOR SHOULD ONLY BE USED FOR THE PURPOSES AND IN THE MANNER DESCRIBED IN THIS MANUAL.*

IF YOU USE THE MONITOR IN A MANNER OTHER THAN THAT FOR WHICH IT WAS INTENDED, UNPREDICTABLE BEHAVIOR COULD RESULT POSSIBLY ACCOMPANIED WITH HAZARDOUS CONSEQUENCES.

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Introduction

The Teledyne Analytical Instruments MX300 Oxygen Monitor, hereinafter referred to as MX300 or Monitor, is a portable monitor designed to analyze oxygen concentration in medical gas mixtures. The Monitor is equipped with oxygen concentration alarms. Oxygen analysis is linear across the single range of 0-100% using Teledyne's class R17MED oxygen sensor.
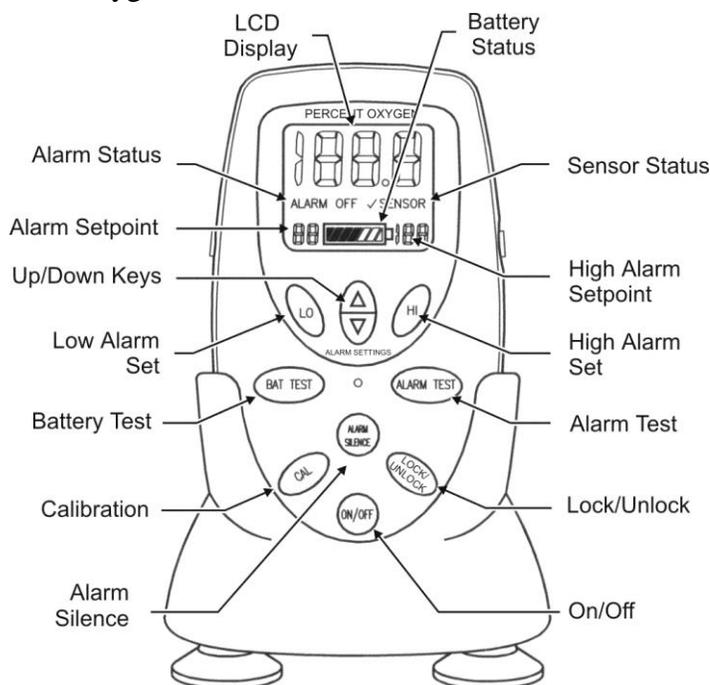
Figure 1-1: MX300 Front View

The MX300's liquid crystal display (LCD) consists of up to 3.5 characters plus a decimal point indicator capable of displaying up to 105%. An integral battery life indicator is displayed continuously on the MX300.

The Monitor is powered by three AA alkaline batteries and is designed to operate for 2000 hours on a single set of batteries in a Non-alarm State.

A sensor failure alarm is incorporated which warns the user if the sensor signal is lost or low. When this occurs, the √SENSOR display and a visual green light will flash, and the alarm buzzer will activate.

This alarm condition is also triggered when the oxygen concentration at the point of analysis falls below 18% (Reference: ISO 7767 standard). For safety reasons, when any of the above referenced conditions occur, the alarm buzzer cannot be silenced until the alarm condition is resolved.

CAUTION: *DURING NORMAL USE, ALARM CONDITIONS SHOULD NOT BE OVERRIDDEN BY ACTIONS SUCH AS HOLDING THE ALARM SILENCE KEY DEPRESSED OR REMOVING THE BATTERIES. THE CAUSE FOR THE ALARM CONDITION SHOULD FIRST BE RESOLVED.*

CAUTION: *WHILE HOLDING DOWN THE ALARM SILENCE KEY MAY MOMENTARILY SILENCE THE ALARM BUZZER ACTIVATED BECAUSE OF REASONS MENTIOEND ABOVE, AUDIBLE ALARM WILL RETURN UPON DISENGAGING THE ALARM SILENCE KEY. HOLDING THE KEY FOR LONGER DURATIONS WILL INITIATE THE "STUCK KEY" ALARM, WHICH CAN BE DEACTIVATED ONLY VIA REMOVING THE BATTERIES FROM THE ANALYZER. ANALYZER SHOULD BE RECALIBRATED UP ON REPOWERING. .*

The MX300 Monitor incorporates a dual concentration alarm with individual user-defined set points. The set points are displayed on the lower portion of the LCD display with the low alarm set point appearing at the lower left and the high alarm appearing on the lower right of the display. The alarm circuit provides both an audible and a visual alarm.

When the oxygen concentration reaches levels beyond the pre-set alarm limits, the following will occur:

1. If the HI alarm is triggered because of monitored oxygen level exceeding the high alarm set point, the green light display will flash and the alarm buzzer will activate. The alarm buzzer can be silenced by pressing the Alarm Silence key.

   NOTE: IF THE ALARM CONDITION IS NOT CORRECTED WITHIN ABOUT 115 SECONDS, THE ALARM BUZZER WILL REACTIVATE. PRESSING THE ALARM SILENCE KEY AGAIN WILL SILENCE THE ALARM BUZZER ONCE AGAIN FOR ABOUT 115 SECONDS, WITH THE BUZZER REACTIVATING IF THE ALARM CONDITIONS PERSIST.

2. If the LO alarm is triggered because of monitored oxygen level falling below the low alarm set point, the green light display will flash and the alarm buzzer will activate.

   NOTE: IF THE LOW ALARM CONDITION IS TRIGGERED WITH THE OXYGEN LEVEL STAYING ABOVE THE SAFETY LIMIT OF 18%, THE ALARM BUZZER CAN BE DEACTIVATED BY PRESSING THE ALARM SILENCE KEY. IF ALARM CONDITION IS NOT CORRECTED WITHIN ABOUT 115 SECONDS, THE ALARM BUZZER WILL REACTIVATE. PRESSING THE

ALARM SILENCE KEY AGAIN WILL SILENCE THE ALARM BUZZER ONCE AGAIN FOR ABOUT 115 SECONDS, WITH THE BUZZER REAACTIVATING IF THE ALARM CONDITIONS PERSIST.

NOTE: IF THE LOW ALARM CONDITION IS TRIGGERED WITH THE OXYGEN LEVEL FALLING BELOW 18%, THE √SENSOR SIGN WILL FLASH ALONG WITH THE GREEN LIGHT, AND THE BUZZER WILL ACTIVATE.   IN THIS CONDITION, THE ALARM BUZZER CANNOT BE SILENCED. WHILE HOLDING DOWN THE ALARM SILENCE KEY MAY MOMENTARILY SILENCE THE ALARM BUZZER, AUDIBLE ALARM WILL RETURN UPON DISENGAGING THE ALARM SILENCE KEY. HOLDING THE KEY FOR LONGER DURATIONS WILL INITIATE THE "STUCK KEY" ALARM, WHICH CAN BE DEACTIVATED ONLY VIA REMOVING THE BATTERIES FROM THE ANALYZER. ANALYZER SHOULD BE RECALIBRATED UP ON REPOWERING.

1.1 Features

The following features are standard on the MX300 Monitor:

- Large easy to read 3½-digit LCD (see options)
- Automatic LCD back lighting upon key press
- Microprocessor controlled
- Up/Down control keys on the front panel
- Sensor fail/disconnect alarm indicator (audible and visual)
- Two adjustable concentration alarms with user-defined set points
- Alarm Silence key
- 2000 operating hours from 3 AA alkaline batteries
- Battery status indicator
- Battery test function
- Stand for upright tabletop deployment
- Rugged high impact ABS plastic construction
- Splash resistant case.
- Long life class R17MED sensor
- 0-1 VDC digital output (optional RS-232)
- FDA 510(k) market clearance

1.2 Options

The following options are available for the MX300 Monitor:

- A-Option—2½-digit LCD instead of 3½-digit

NOTE: CONTACT FACTORY FOR MODIFYING YOUR MONITOR FOR 2½-DIGIT LCD. FOR RS-232 RECONFIGURATION, SEE SECTION 2.1.5.

- B-Option—RS 232 digital output instead of 0-1VDC
- Universal Pole Mounting Clamp (P/N CP 2345)
- V-Mount Pole Clamp (P/N CP 2344)
- V-Mount Wall Adapter P/N B 647)
- 0-1 VDC Interface Cable (P/NB-75554)
- RS 232 Interface Cable (P/N B-75555)

1.3 Applications

The MX300 Monitor is intended for continuously measuring the concentration of oxygen in gas mixtures used in applications such as Anesthesia gas delivery and Respiratory care, and is intended for adult, pediatric and neonatal populations.

1.4 Operation Summary

The MX300 Monitor uses Teledyne Analytical Instruments' Patented R17MED oxygen sensor. The sensor output is used to determine the oxygen gas concentration. The data from the sensor is compared to the alarm values set by the user, and activates the audible and visual alarms if the oxygen level crosses the threshold values. Sensor fail/disconnect alarm is incorporated in the Monitor to warn the user of a sensor problem. The√SENSOR indicator is illuminated on the LCD and the audible and visual alarms are activated whenever a fault is detected.

The Class R17MED oxygen sensor is a disposable sensor. The sensor has a cathode (sensing electrode), an anode (counter electrode), and a compatible electrolyte, and is packaged in a small plastic sensor body. Oxygen entering the sensor reacts with the anode and a proportional current is collected at the cathode, which is then converted into a digital signal and displayed on the LCD screen on the Monitor.

Used with the R17MED sensor is a removable plastic diverter. This diverter is used to facilitate the transport of gas mixtures through the sensor. The diverter, packaged separately when shipped, is necessary when the tee adapter is used to sample gas flowing through a tube.

The diverter is not necessary and should not be used when the sensor is placed directly in a chamber, or when the sensor is used in confined volume analysis, such as incubators and inhalation tents.

The audio alarm is used for both the concentration alarms and the sensor-disconnect alarm. The user can manually bypass the concentration alarm for a set amount of time. Pressing the ALARM SILENCE key will provide an audible alarm override for 115 seconds. After that, if the alarm condition still prevails, the audible alarm will resume. The ALARM SILENCE key can also be used to interrupt the sensor-disconnect audible alarm.

⚠ **CAUTION STATEMENTS:**

> THE R17MED SENSOR CONTAINS A CAUSTIC ELECTRO-LYTE AND LEAD. DO NOT TRY TO OPEN THE SENSOR ASSEMBLY. CHECK THE SENSOR PERIODICALLY FOR LEAKS. IF THE SENSOR IS LEAKING, REPLACE IT. DO NOT TRY TO REPAIR IT. CONTACT YOUR DISTRIBUTOR OR TELEDYNE FOR THE MATERIAL SAFETY DATA SHEET RELATED TO HANDLING AND DISPOSAL OF THE SENSOR.

> THE R17MED SENSOR CONTAINS A CAUSTIC ELECTRO-LYTE, AND IN THE EVENT OF A LEAK, THE ELECTROLYTE MAY ATTACK CERTAIN MATERIALS IT IS EXPOSED TO, SUCH AS ALUMINUM. USE PRECAUTION IN YOUR CHOICE OF INTERFACE MATERIALS.

> REMOVE AND SAVE THE DIVERTER WHEN THE SENSOR IS USED IN CONFINED VOLUME APPLICATIONS.

> THE MX300 OXYGEN MONITOR, R17MED OXYGEN SENSOR AND ASSOCIATED HARDWARE ARE INTENDED FOR USE AS SECONDARY DEVICES TO VERIFY THE CONCENTRATION OF OXYGEN IN GAS MIXTURES. DO NOT USE THESE DEVICES AS PRIMARY LIFE-SUPPORT OR PRIMARY MONITORING DEVICES.

> THE INFORMATION OBTAINED FROM THE MX300 SHOULD NEVER BE USED TO ADJUST A LIFE-SUPPORT SYSTEM. IT SHOULD ONLY BE USED AS AN INDICATION THAT THE LIFE SUPPORT SYSTEM OR DEVICE IN THE BREATHING SYSTEM THAT MX300 IS BEING USED WITH MAY REQUIRE SERVICE AND/OR CALIBRATION.

Operating Instructions

Notes:

> *Upon receipt, INSPECT THE ENTIRE UNIT FOR ANY DAMAGE. Check the unit and all included accessories for broken or loose parts. If damaged, DO NOT USE. Notify the shipper, your distributor or Teledyne Analytical Instruments.*
>
> *This equipment is internally powered using 3 AA batteries.*
>
> *The LOCK/UNLOCK key helps prevent accidental change to the calibration set point. At least two keys must be pressed in order to modify the critical calibration set point value.*
>
> *If the keys are unlocked and no keys are pressed, the Monitor will revert to the locked mode within nine seconds.*
>
> *The ALARM SILENCE key and the BAT TEST key continue to operate normally when the lock feature is activated.*

2.1 Setup

To use your MX300 Monitor, first install the batteries, then install the oxygen sensor and then, calibrate the Monitor using the steps outlined in section 2.1.4.

2.1.1 Sensor Installation or Replacement

Note: Install the R17MED oxygen sensor before using the MX300 oxygen Monitor.

1. Remove the new sensor from its protective bag. Inspect the sensor for damage or electrolyte leakage.

Warning: *The sensor has a caustic electrolyte. Do not use a damaged or leaking sensor. Do not let the electrolyte come in contact with the skin. If it does, flush affected area with water. Do not attempt to open or repair the sensor.*
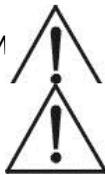
Warning: *The sensor also contains lead. Leaking or exhausted sensors should be handled and disposed of in accordance with local regulations.*

W *The MX300 oxygen Monitor, R17MED oxygen sensor, and associated hardware are non-sterile devices. Autoclaving or other chemical cleaning may damage the Monitor and the sensor.*

2. Plug one end of the coiled cable into the receptacle on the back of the R17MED sensor and secure it in place with the capture nut located at the base of the connector. See Figure 2-1.
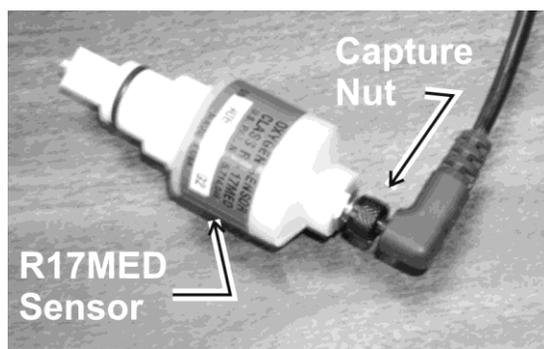
Figure 2-1: Installing the R17MED Sensor

3. Plug the other end of the cable into the receptacle located on the side of the unit and secure it using the capture nut. See Figure 2-2.
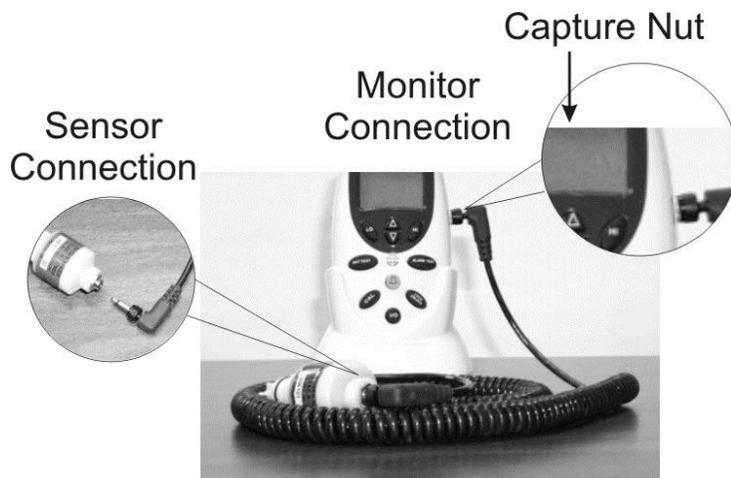
Figure 2-2: Sensor Cable Connection to Monitor

Note: *Cable shown is for illustration purposes only.*

Note: *Do not use the plastic flow diverter with the R17MED sensor when the sensor is used for diffusion sampling (such as with oxygen tents, incubators, etc.). When the sensor is used with a Tee Adapter, such as in a breathing system, the diverter must be used as shown in Figure 2-3.*
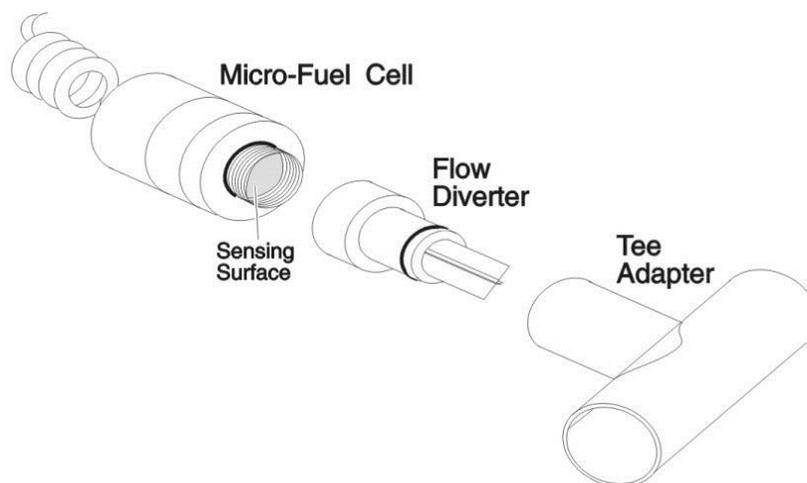
Figure 2-3: Mounting the Sensor in the Tee Adapter

2.1.2 Mounting

The MX300 can be mounted in several ways depending on the optional equipment ordered at the time of purchase. See Section 1.3.

2.1.2.1 V-Mount Adapter Installation

The V-Mount Adapter consists of a matching plastic plate with integral V-grooves that attach to the rear of the Monitor.
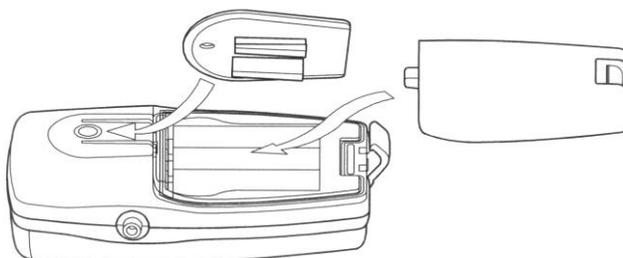
Figure 2-4: V-Mount Adapter Installation

To install V-Mount Adapter, remove the battery compartment door by prying up the hinged latch at the bottom of the cover, then slide the adapter plate into grooves provided in rear case. Replace the battery compartment door and secure door latch. See Figure 2-4.

Note: The door latch is a tight fit onto the battery cover. Use a coin to gently pry up the

latch.

2.1.2.2 Universal Mounting Clamp Installation

The optional Universal Mounting Clamp comes with a 1/4-20 screw for securing the clamp to the rear of the Monitor. A threaded brass insert is installed on the back of the Monitor for this purpose. See Figure 2-5.
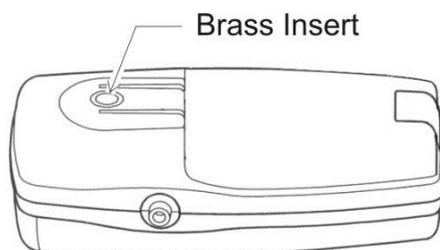
Figure 2-5: Brass Insert for Universal Mounting Clamp

2.1.3 Battery Installation

Note: Three "AA" alkaline batteries must be installed in the unit before the Monitor will operate. The unit must be recalibrated and HI/LOW alarm set points must be reset to desired values whenever new batteries are installed.

To install the batteries:

1. Turn the unit off (if it is on).

2. Hold the Monitor face down in the palm of your hand. Use a coin to pry up the latch that secures the battery compartment door. Remove the battery compartment door.

CAUTION: IMPROPER INSTALLATION OF THE BATTERIES MAY RESULT IN DAMAGE TO THE UNIT AND BATTERIES.

Note: Use alkaline batteries only. Other battery types will produce erroneous battery test readings.

3. Install 3 "AA" alkaline batteries into the holder as shown in Figure 2-6. Each battery has its own slot. To insure proper polarity, place the bottom (flat) or negative end of the battery in the end of the holder marked "–". Place the top (button) or positive end of the battery in the end of the holder marked "+". Do this for each battery.
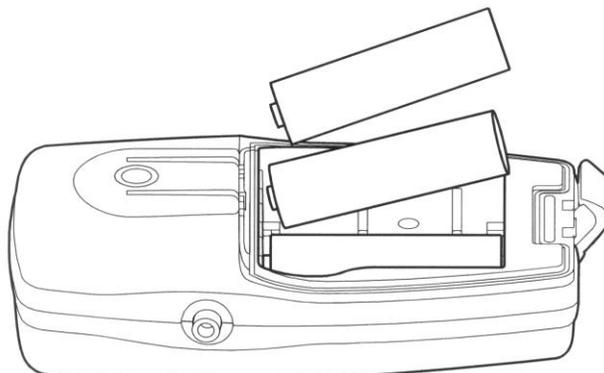
Figure 2-6: Installing Batteries

4. Re-install the battery compartment door. When the unit is first turned on, the screen will momentarily display all LCD segments. During this period, diagnostic tests are being conducted to ensure that the circuits are functioning correctly. The unit will activate the audible and visual alarms for about 1 second. The LCD will flash continuously indicating the unit is in the unlocked position ready for calibration.

Note: When batteries are first installed or power is lost for any reason, the Monitor defaults to the calibration mode. All keys except the CAL and ON/OFF (I/O) keys will be inoperable until a successful calibration is achieved.

5. Note the battery display located below the oxygen readout display. It continuously shows a bar graph of the remaining life to the batteries. Using new batteries will illuminate all 5 segments from the left to the right end of the bar. The bar graph indicator is continuously on when the Monitor is powered on.

2.1.4 Calibration

The MX300 should be calibrated before each use and every 8 hours to maintain accuracy.

When batteries are removed for any reason or when new batteries are installed, the Oxygen Monitor defaults to the calibration mode with the LCD display flashing 00.0. Only the CAL and ON/OFF (I/O) keys are functional at this point. Reset the alarm set points after calibrating the Monitor.

Note: For first time and for routine maintenance calibrations, make sure that the sensor and sensor cable are installed correctly before attempting to calibrate the Monitor.

Figure 2-7: Calibration Sequence

To calibrate the Monitor (See Figure 2-7):

1. Turn the unit on by pressing the ON/OFF (I/O) key.

2. Check the batteries by pressing the BAT TEST key.

3. If the LCD is not flashing, press the LOCK/UNLOCK key to unlock the keys. LCD will flash indicating that changes can be made to the settings. If the batteries have just been installed the LCD will flash 00.0

4. As with most oxygen monitors, the highest level of accuracy is achieved when calibration is conducted using 100% oxygen. After installing the flow diverter as noted in Section 2.1.1, insert the sensor into the plastic tee and connect to a supply of pure dry oxygen flowing at 1-2 liters per minute.

Note: An accessory calibration assembly (P/N C53790) is available from Teledyne for use with the R17MED sensor

5. Wait about 20 seconds to ensure that the sample line is completely purged with the calibration gas. Press the CAL key. The LCD will count down from 9 to 0. The Monitor electronics will measure the sensor output during this countdown to determine the gas concentration and selects the calibration range of either 100% or 20.9%. When the calibration is complete, the LCD will display the gas value.

Note: At the end of the calibration countdown, the Monitor will display a solid number, indicating acceptance of the calibration value. No further user action is required. If the LOCK/UNLOCK key is still pressed, the display will start blinking, allowing the recalibration. If this LOCK/UNLOCK key-press is in error, either press the key once more or allow the software to revert to the locked mode automatically, which will occur within nine seconds of not pressing any functional keys. Once the Monitor reaches the locked mode, press the LOCK/UNLOCK key and press the CAL key to repeat calibration.

Note: The MX300 can only be calibrated using certified medical grade 100% oxygen or ambient level air (20.9% Oxygen). Improper calibration or use of other gas con-

centrations will either activate the √ SENSOR indicator or render the Monitor to assume that the gas delivered for calibration was 100% Oxygen. This latter behavior of the Monitor, which is common across other peer group Monitors, would introduce significant error in analysis. Hence, use only certified medical grade 100% Oxygen gas or ambient level air (20.9% Oxygen) to calibrate your Monitor.

6. Remove the sensor from the oxygen supply and confirm the LCD reads less than 22% in room air. It is not necessary for it to read exactly 20.9%.

7. It is important to perform the calibration carefully and thoroughly, using calibration gases that are free from contaminates. The accuracy of the Monitor is only as good as the accuracy of calibration gases used and the accuracy of the procedure used to calibrate the Monitor.

Note: A single point air calibration is not recommended unless the sensor can be exposed to a known source of fresh outdoor air. Hospital room air may often have oxygen at above normal ambient levels of 20.9%, which will introduce errors in the calibration. Air calibration should only be used for analyzing oxygen levels between 21% and 40% and should never be used where a high degree of accuracy is needed.

Note: Never calibrate the unit in humidified gas, as water vapor makes the oxygen concentration appear lower than it really is. See Section 2.3.1: Humidity.

8. Adjust alarm set points to desired level according to the procedures in Section 2.1.4.

9. The Monitor is now ready for use.

2.1.5 Alarms

Note: Before attempting to change the alarms it is necessary to unlock the control keys by pressing the LOCK/UNLOCK key. When pressed the display will start flashing.

To set the alarms on the MX300 Monitor (see Figure 2-8):

1. To set the HI alarm: Press the HI ALARM SET key once. Press the UP and DOWN arrow key until the desired value is displayed in the lower right corner of the display.

Note: The HI alarm may be defeated by setting the HI alarm limit one step above 100%. The HI alarm setting will display "- -" to show that it is disabled. The LO alarm is still functional.

2. To set the LO alarm, press the LO ALARM SET key once. Press the UP and DOWN arrow key to select a value. A built-in safety feature will not allow you to select a LO alarm value less than 18%.
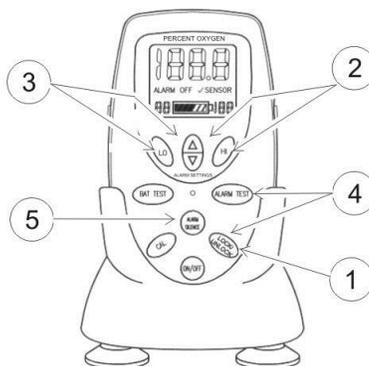
Figure 2-8: Setting the Alarms

Note: *The MX300 Portable Oxygen Monitor is designed to prevent crossing of HI/LO alarm settings. If you attempt to set the LO alarm higher than the HI alarm, it will push the HI alarm setting up as you continue to rise the LO alarm set point. This also applies when attempting to set the HI alarm lower than the LO alarm.*

3. To test the alarms, unlock the controls by pressing the LOCK/UNLOCK key and then press ALARM TEST key. The Lo alarm followed by the HI alarm will blink and the audible visual alarm will are activated for about 1 second.

4. To silence the alarm buzzer for 115 seconds press the alarm silence key (flashing red indicator light). Buzzer cannot be silenced when the monitor registers oxygen l at falls below 18%.

5. To disable the high alarm set the high alarm set point above 100%.

Note: *When HI alarm is disabled (set point above 100%) the set point is shown as two dashes "- -". The LO alarm setting is not affected.*

2.1.6 Output 0-1 VDC or RS232

The MX300 Portable Oxygen Monitor comes with optional 0-1 VDC and RS232 signal outputs for use with compatible external recording, indicating or computing equipment.

An optional 0-1 VDC Interface Cable (P/N B-75554) is available from Teledyne for accessing the voltage output.

To connect the Monitor to an analog recording/indicating device:

1. Insert one end of the interface cable into the output port on the side of the Monitor. See Figure 2-9.

2. Insert the other end into the analog recorder/indicator device equipped to handle a 0-1 VDC signal.

When properly calibrated, the output signal generated by the Monitor is linear and proportional to the oxygen concentration.

If you requested Option-B (RS 232 digital output) at the time of purchase, a digital RS 232 signal is output from the output port shown in Figure 2-9. Use the optional RS 232 Interface Cable (P/N B-75555) available from Teledyne for connection to a standard RS 232 port on a computer or other suitably equipped digital device.

CAUTION: *MX300 MONITOR SHOULD ONLY BE CONNECTED TO AN*
                 EN60601-1/IEC60606-1 APPROVED DEVICE.
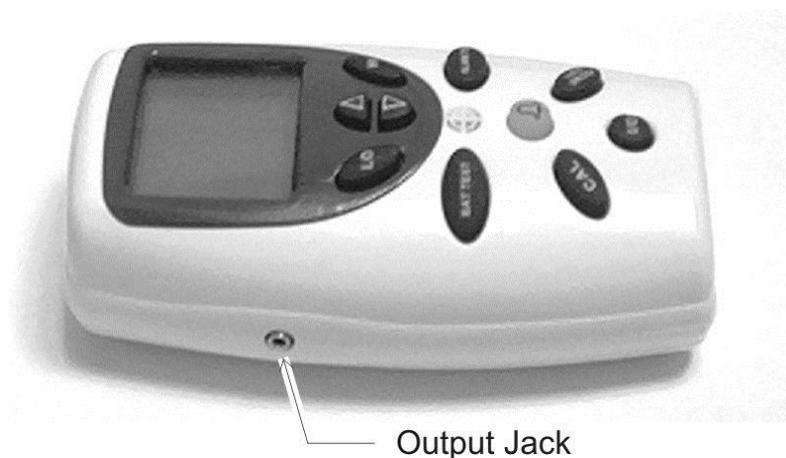
Figure 2-9: 0-1 VDC or RS 232 Digital Output Port

RS232 signal output has been tested with Windows Hyperterminal. The setup changes with different windows versions. If software other than windows Hyper-Terminal is used, consult with factory.

Windows 95 version
Baud:	2400
Data:	7
Parity:	ODD
Stop bit:	1
Flow control:	NONE

Windows 98, Windows 2000 and Window XP version:
Baud:	2400

Data: 8
Parity: ODD
Stop bit: 1
Flow control: NONE

2.2 Operation

2.2.1 Procedure

Note: Prior to every use, always test the batteries, check the sensor for any leaks or damage, check the calibration and the alarm set points.

The MX300 Monitor can be used to measure a gas mixture for oxygen in two basic modes:

- In the inhalation side of breathing system upstream of any antibacterial filters, humidifiers and other such medicating devices.

- In confined volumes such as in incubators or tents.

When analyzing for oxygen in breathing systems, the flow diverter must be used. The diverter should be screwed onto the threaded front end of the R17MED sensor. A tee adapter (plastic, P/N A268, or metal, P/N A283) should be placed into the breathing loop, and the above sensor assembly plugged into the tee adapter. See Figure 2-3.

CAUTION: *CHECK THE BREATHING SYSTEM FOR LEAKS. BE CERTAIN THAT THE SYSTEM DOWNSTREAM OF THE SENSOR DOES NOT PRO-DUCE ANY BACKPRESSURE OR RESTRICTION TO FLOW. ERRORS IN READINGS WILL RESULT IF THIS IS NOT FOLLOWED.*

THE OXYGEN SENSOR IS A NON-STERILE DEVICE AND SHOULD BE USED IN CONJUCTION WITH AN ANTI-BACTERIAL FILTER. AL-

WAYS INSTALL THE SENSOR ON THE INSPIRED LINE AHEAD OF FILTERS, HUMIDIFIERS AND MEDICATING DEVICES. NEVER IN-STALL THE SENSOR IN A LOCATION THAT WILL EXPOSE THE SENSOR TO PATIENTS' EXHALED BREATH OR SECRETIONS UN-LESS YOU INTEND TO DISPOSE OF THE SENSOR AND FLOW ADAPTER AFTER USE.

When monitoring for oxygen in confined volumes such as incubators, hoods, etc., the flow diverter must be removed from the R17MED sensor so that it does not interfere with the rapid exchange of gases to and from the sensing surface of the sensor. Failure to remove the diverter in these applications may adversely affect the response time of the sensor.

The R17MED sensor can be placed or hung inside incubators, tents, etc. When it is necessary to thread the cable through a small hole in order to gain access to the inside of a chamber, the cable should be disconnected at the sensor, threaded through the hole, and reconnected inside the chamber.

2.3 Factors Affecting Sampling Accuracy

2.3.1 Humidity

Humidity does not directly affect the accuracy of the sensor's measurement. However, when a nebulizer or other device is used to increase moisture levels in gas mixtures, the moisture actually dilutes the mixture. This dilution effect decreases the oxygen concentration. Your portable oxygen Monitor accurately measures the decreased oxygen concentration.

As with all diffusion based oxygen sensors, excessive condensation on the sensing surface of the R17MED will block the diffusion of oxygen to the sensor, rendering it inoperative. We recommend installing the sensor on the dry side of the breathing system at all times.

2.3.2 Temperature

The R17MED oxygen sensor compensates for ambient temperature changes in the range of 0–40°C (32–104°F). Since the thermistor that compensates for these changes is located in the rear of the sensor assembly, it is important that gas mixtures, flowing over the front of the sensor, be at room temperature, which is assumed to the temperature around the rear of the sensor. Reading errors may occur if gases at higher temperature from devices such as heated humidifier are used to measure oxygen with R17MED oxygen sensor.

A small thermal tracking error may be encountered in applications where the entire sensor assembly is placed in the gas mixture to be analyzed (such as in the incubators). Holding the sensor in your hand for more than a few minutes can also affect the temperature tracking which appears as a slow drift on the LCD.

No adjustments should be made during this period since this error will be eliminated when both the thermistor and sensing electrode have had sufficient time to come to thermal equilibrium. This can take up to 2 hours.

2.3.3 Pressure

Virtually all gas sensors and monitors measure the partial pressure of the gas that they sample. The only time that these monitors can accurately read percentages is when the total pressure does not vary over time between calibrations and use. For this reason it is important to calibrate the MX300 Oxygen Monitor (with R17MED oxygen sensor) at regular intervals. It is recommended that the Monitor be calibrated prior to each use or every 8 hours, and at the same pressure the monitor normally operates after calibration. If the gas being monitored flows through some length of tubing, use similar tubing/apparatus and same pressure/flow rates when calibrating the Monitor.

When a ventilator is a part of the breathing system, the alternating "breathing" pressure cycles generated by the ventilator will be sensed as pressure pulses by the sensor, and over time, such pulses manifest as pressure increases in the fast-reacting sensors such as R17MED. This perceived pressure increase results in correspondingly higher oxygen reading. While the concentration of oxygen is not changing, it is the total pressure that is increasing producing a corresponding increase in the partial pressure of oxygen.

2.3.4 Discrepancy in Readings

When a discrepancy in oxygen readings is detected, the Monitor's readings should be verified by checking the MX300 battery condition and calibration using 100% oxygen. If the Monitor can be calibrated, the unit is assumed to be in good working order. If, after reinstalling the unit, the discrepancy in oxygen readings persists, the problem is most likely elsewhere in the breathing system. Resolve the cause(s) for the discrepancy before using the Monitor. The troubleshooting section of this manual may provide additional assistance in locating the problem.

2.3.5 Anesthetic Gases

2.3.5.1 Gases That MAY INDUCE Reading Error

When using the R17MED sensor in the presence of anesthetic gases, the oxygen reading may fall (see Table below). The magnitude of this error will depend upon the level of oxygen and the duration of exposure.

The anesthetic agents listed in the following table (Halothane, Enflurane, Isoflurane, Sevoflurane, and Desflurane) were vaporized into a stream of 30% oxygen / 70% nitrous oxide, and the resulting drops in oxygen level after an exposure of approximately two hours were noted.

Exposures in excess of two hours may produce slightly greater errors. The errors listed are typical for all oxygen sensors such as the R17MED. Exposing the sensor to air or gases that do not contain anesthetic agents for a period of time equal to or greater than the exposure interval will eliminate the reading error in most cases.

Table 2-1: Oxygen Reading Error in a Mixture of Anesthetic Gas

Gas or Vapor Level		
(Balance: Mixture of 30% O2 / 70% N2O, except where noted)		
Gas or Vapor	**Test Level**	**Oxygen Reading Error**
Helium	50%, balance O2	0%
Nitrous Oxide	80%, balance O2	0%
Carbon Dioxide	10%, balance O2	0%
Halothane	4%	< 1.5% O2 *
Enflurane	5%	< 1.5% O2 *
Isoflurane	5%	< 1.5% O2 *
Sevoflurane	5%	< 1.5% O2 *
Desflurane	15%	< 1.5% O2 *

* Errors are approximate and may vary based on exposure times and concentrations.

These performances meet or exceed the requirements of ISO 7767: 1997 (E).

CAUTION: THE MX300 SHOULD NOT BE USED IN THE PRESENCE OF FLAMMABLE ANESTHETICS SUCH AS DIETHYL ETHER OR CYCLOPROPANE.

CAUTION: THE MONITOR, THE OXYGEN SENSOR AND ASSOCIATED HARDWARE ARE NON-STERILE DEVICES. DO NOT AUTOCLAVE THE MONITOR OR SENSOR, AS THIS WILL DAMAGE THE EQUIPMENT.

2.3.5.2 Care After Use in Nitrous Oxide

CAUTION: THE R17MED SENSOR SHOULD NOT BE LEFT IN NITROUS OXIDE MIXTURES ANY LONGER THAN NECESSARY.

After exposure to nitrous oxide mixtures, the sensor should be left in 100% oxygen overnight (e.g., left in a breathing system that has been flushed with pure oxygen). If this is not practical, when using the tee, remove the plastic flow diverter and leave the sensor in room air. If the oxygen reading continues to drop after each use in nitrous oxide, the sensor should be removed from service. If the sensor can no longer be calibrated or if there is any sign of electrolyte leakage, the sensor should be disposed of in accordance with local regulations and the Material Safety Data Sheet (MSDS) available through Teledyne.

2.3.6 Cleaning

The MX300 and R17MED sensor are non-sterile devices.

The oxygen monitor, oxygen sensor, and sensor interconnection cable may be cleaned by wiping the surfaces with isopropyl alcohol or a mild cleaning solution.

When cleaning, do not allow liquids or moisture to enter the Monitor or sensor internal cavities. Do not expose the electrical connections to the cleaning solution. Do not immerse the Monitor, oxygen sensor or sensor interconnection cable in water or any other liquid.

Do not expose the Monitor, oxygen sensor and interconnection cable to steam, ethylene oxide, or radiation sterilization.

After cleaning, ensure that all surfaces are dry and the Monitor is properly calibrated before using the Monitor.

2.4 Dos and Don'ts

– DO –

- Read and understand the manual before using the Monitor
- Calibrate every 8 hours or before every use.
- Visually inspect the sensor for leakage before each use.
- Calibrate using 100% oxygen and check in air.
- Check the HI and LO alarm settings prior to each use.
- Test batteries regularly and replace when battery indicator shows low battery (no bars)
- Keep the Monitor, sensor and connections dry, or on the dry side of the breathing system.
- Recalibrate after replacing the batteries.
- Recalibrate after replacing the sensor.
- Use only alkaline batteries.

- Ensure that the R17MED sensor is properly connected to the Monitor.
- Always use the plastic flow diverter when using the tee adapter.
- Remove and save the plastic flow diverter when using the sensor in non-flowing applications
- Perform alarm test before each use (press the ALARM TEST key).
- Use only isopropyl alcohol or mild detergent, if cleaning is required,

– DON'T –

- Use this Monitor if you suspect any malfunction.
- Use the Monitor in the presence of flammable gases.
- Use anything but alkaline batteries.
- Autoclave or freeze the sensor or Monitor.
- Open or try to repair a leaking or broken sensor.
- Immerse the unit or sensor in any liquid.
- Pass hot or cold gas mixtures over the sensor.
- Expose the unit to devices that produce high levels of radio, short wave, microwave, x-ray, or high frequency interference.
- Use cleaning agents or liquids in the cable receptacles or around the battery compartment.
- Place the unit in a water vapor-saturated environment.
- Expose the LCD to excessive sunlight.
- Expose the unit to a condensing water environment such as a mist tent.

Service Instructions

3.1 General Service Information

Without access to special probes and test equipment, troubleshooting and repair of the board or its components are not feasible. A factory replacement of the entire PC board is recommended if necessary.

With the exception of replacing the sensor or batteries, there are no user-serviceable components inside the unit. If a problem arises that cannot be corrected by recalibration, changing the batteries or replacing the sensor as described in this manual, the unit must be sent back to the factory for repair or replacement. Contact your local Representative or see Section 3.11 for instructions on obtaining a Return Merchandise Authorization (RMA) number before sending a unit back to Teledyne for repair.

3.2 Overall Maintenance

The MX300 Monitor requires very little maintenance, other than calibration, checking the batteries and sensor. Occasional cleaning of the plastic surface can be done with isopropyl alcohol. There are no user-serviceable components within the Monitor.

3.3 Battery Maintenance

DO: Test batteries regularly. (Replace immediately when all battery strength indicator bars are missing).

DO: Always use alkaline batteries.

DO: Recalibrate after replacing batteries.

The MX300 Monitor has a battery strength indicator that continuously displays the approximate amount of useful life remaining on the set of installed batteries. Excessive alarm activation will drain the batteries faster. The minimum detectable change in battery voltage corresponds to an increment of about 50 hours, meaning that the battery voltage reading may not change for several hours at a time.

If the Monitor is not used for a period of 30 days or more, the batteries should be removed from the Monitor.

3.4 Sensor Maintenance

DO check the sensor for damage or leaks before use.

DON'T immerse the R17MED sensor in liquid.

DON'T autoclave the R17MED sensor.

DON'T open or try to repair the sensor.

Before every use, the sensor, cable and connections should be checked. Check the sensor for leaks and condensation. Check the cable for splitting or cracked insulation. Make sure the connections are tight and dry.

In the event that the sensor has been damaged, consult the Material Safety Data Sheet in the Appendix for handling guidelines.

3.5 Calibration

Incorrect readings can often be traced to improper calibration. The MX300 should be calibrated before each use and every 8 hours to maintain accuracy. It must be calibrated whenever new sensor or batteries are installed. Calibration using methods other than described in section 2.1.4 will lead to improper operation.

Whenever new batteries are installed or removed for any reason, the Monitor defaults to the calibration mode with the LCD display flashing 00.0. Only the CAL and ON/OFF (I/O) keys are functional at this point.

3.6 Alarms

To set the alarms on the MX300 Monitor, refer to Section 2.1.4.

3.7 Factors Affecting Sampling Accuracy

Refer to Section 2.3 of this manual.

3.8 Troubleshooting

The MX300 Oxygen Monitor provides a variety of built-in safety features that prevent its use when a fault is detected. When a unit displays the message $\sqrt{}$ SENSOR and sounds the audible and visual alarm continuously, it is an indication of a faulty connection between the sensor and the unit or an expired or faulty sensor. It also indicates when oxygen concentrations are below 18%.

For assistance with troubleshooting, see Table 3-1.

Table 3-1 Troubleshooting

Symptom	Why	What To Do
New sensor responds slow or drifts.	If the sensor is new and was just removed from its sealed bag it may need to run for several hours.	A) Wait 1–2 hours and recalibrate.

Symptom	Why	What To Do
Sensor will not read below 22 % after calibration in 100% O2.	Calibration in 100% was invalid or the room air enriched with excess oxygen.	A) Recalibrate using dry gas B) Make sure that at least 6" (30 cm.) of tubing is attached to the exhaust side of the tee adapter to prevent back filling. O2 flow rate should not exceed 5 l/min. C) Oxygen concentration at the sensor is significantly higher than 21%. Take the Monitor to a well-ventilated area and check the reading again. D) Try calibrating with a known good sensor, and if this fails, contact customer support.
The sensor does not react to changes in oxygen concentration, or the readings are unstable and drifting.	Water may have condensed on the sensing surface. Electrical interference is disrupting the electronics	A) Remove the sensor from tee adapter and unscrew the plastic flow diverter. Using absorbent tissue or cotton swab, gently wipe off sensing surface inside threaded portion of sensor assembly. Do not damage the sensing surface, and do not leave any tissue/swab residue on the sensing membrane. B) Relocate unit away from sources of electrical noise such as cauterizing equipment and two-way radios.
The display is flashing √ SENSOR	The unit has detected a fault in the signal from the sensor. Sensor has expired. The sensor has been exposed to a gas containing less than 18% oxygen.	A) Check sensor cable connections to ensure they are completely inserted into the mating connector and the capture nut is firmly in place. B) Expose the sensor in 100% O2 and check calibration. C) The sensor output has fallen to a level where it is no longer usable. Replace sensor.

Symptom	Why	What To Do
The oxygen reading fluctuates or appears to be incorrect.	The sample pressure may be changing.	A) During calibration, make sure there is no restriction on exhaust side of sensor. If the reading changes with flow, the sensor is pressurized or there may be a leak in the system. B) If a high degree of accuracy is desired, or the concentration of O2 being analyzed is in excess of 40%, calibration with 100% is recommended. C) If humidified gas is used to ventilate the patient, water vapor actually dilutes the gas. See Section 2.3. . D) If a blender is used, check its calibration.
The unit has stopped working and the LCD is displaying alphanumeric characters.	The MX300 unit is equipped with an electronic "watch dog," which analyzes the circuitry within the unit for potential faults and renders the unit inoperable until the condition is corrected. (See Watch dog section) Several conditions can activate the "watch dog." Dropping the unit, poor battery connections, and radio frequency interference are the most common causes. See the watch dog section for additional information	A) Disconnect the batteries and inspect the contacts for corrosion. Reconnect the batteries. If the unit functions properly, calibrate the unit and reset the alarm values. B) Try a new set of batteries. C) Increase the distance between the unit and any source of radio frequency interference. The sensor cable is a prime source of pickup as it can act like an antenna. Relocate the sensor cable and if possible change its coiled length to "de-tune" its antenna effect. Placing the cable in a different position may also help.
No display.	A) Batteries expired. B) Bad battery connection.	A) Check/replace batteries. B) Check battery connections. C) Calibrate.

Note: In the event that none of these procedures produces desired results, remove the batteries and return the unit to Teledyne for repair.

3.9 Watchdog

The MX300 is equipped with a watchdog circuit that continuously analyzes the electronics for proper operation. If the watchdog detects a failure, one of the codes in Table 3.3 will appear on the LCD.

The error codes can appear on the LCD when batteries are first installed, during normal operation or if the unit is subjected to shock. In some cases, an additional digit is used in the error code to supply additional information. For example, the error code 6 and 7 are followed by another digit listed as (N) in Table 3.2. The error code 65 would indicate that a key is stuck and this key is the Silence key.

In addition to supplying visual error codes, the audio device will beep a number of times to indicate the general error in case the display is not functional.

Note: *To reset the watchdog error code, remove one battery for 5 seconds and replace. If the error persists, contact your local representative or Teledyne for assistance.*

Table 3.2 Error Codes

Error Code	Audio Beeps	Error
Indeterminate	2	The watchdog timer has timed out indicating a serious software error
30	3	Analog output is different from the expected value. May indicate a shorted or over-loaded analog output or a failure of the analog to digital converter or digital to analog converter circuit.
50	5	The ADC circuit failed during POST.
6 (5)	6 (There is no indication of which key is stuck)	A stuck key has been detected. The second digit example (5) on the display shows which key is stuck: 0 - Low Alarm 1 - Batt 2 - Cal 3 - Up 4 - Down 5 - Silence 6 - High Alarm 7 - Alarm Test 8 - Key Lock

7(2)	7 (There is no indication of the type of DAC failure)	A failure has occurred during the automatic calibration of the digital to analog converter (DAC) circuit. The second digit example (2) shows the type of digital to analog failure. 0 - Measurement 1 - High Test 2 - Low Test 3 - Offset Cal 4 - Gain Cal

3.10 Other Problems with the Monitor

Most other problems arise from either mechanical damage to the Monitor or electronic component failure.

Repair or troubleshooting the PCB or individual components on the board is not feasible. Under most circumstances, a replacement of the entire PC Board is recommended. If the repair diagnosis indicates problem with the PCB, the Monitor must be returned to the factory for PCB replacement.

3.11 Return Authorization for Service

For any service beyond sensor and battery replacement, the Monitor must be returned to the factory. A return merchandise authorization (RMA) number must be obtained from Teledyne Analytical Instruments prior to returning the Monitor for service. You can request a RMA number via email by contacting us at:

tetci_customerservice@teledyne.com

You can also contact us at the address below.

Customer Service Department
TELEDYNE Analytical Instruments

16830 Chestnut Street
City of Industry, CA 91749-1580 USA

Phone (626) 934-1500, Fax (626) 961-2538

Or via the web at: www.teledyne-ai.com

Appendix

A.1 Specifications

Range:	0-100% oxygen
Accuracy:	$\pm$2% of full scale (at constant temperature and pressure)
Response Time:	90% in less than 6 seconds at 25 °C
Battery Life:	Approximately 2000 hours of continuous use in non-alarm condition
System Power:	3 AA alkaline batteries.
Sensor Type:	Class R17MED
Expected Life:	36 months in air at 25°C, Atmospheric Pressure and 50% Relative Humidity. (~7.5 months under similar conditions when continuously exposed to 100% oxygen)
Dimensions:	2.5" W $\times$ 1.25" D $\times$ 4.5" H (66 mm x 33-mm $\times$ 111.5 mm)
Sensor Cable:	Retracted: 2 ft / Extended: 10 ft.
Storage Temp.	10-30°C (continuous), 5-50°C (Intermittent)
Operating Temp:	0-40°C
Alarm ranges:	HI - 19 to 100%; LO - 18 to 99 %
Alarm accuracy:	Alarm thresholds are digitally stored and alarm affectivity is digitally compared against the value calculated by the microprocessor. Hence, the accuracy of the alarms is the same as the accuracy of the unit as specified above.

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A.2 Spare Parts List

QTY	PART NO	DESCRIPTION
1	C43690-R17MED	Micro-Fuel Cell R17MED with flow diverter P/N A50057
3	B99	"AA" size alkaline battery
1	C74721	Cable assembly
1	A268	Tee adapter (22 mm)

A.3 Optional Accessories

1	A50057	R17MED flow diverter
1	CP2345	Universal Pole Mounting Clamp
1	CP2344	"V" mount Pole Clamp
1	B647	"V" mount Wall Adapter
1	A51589	Sensor adapter cap, female (22 mm)
1	A51588	Sensor adapter cap, male (22 mm)
1	C53790	Calibration assembly
1	A284	Universal adapter set for pediatric circuits (15mm)
1	A274	Tee adapter, autoclavable
1	A283	Tee adapter, metal
1	B75554	0-1 VDC Interface Cable
1	B75555	RS 232 Interface Cable

Schematics are available on request.

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A minimum charge is applicable to spare parts orders.

Note: *Orders for replacement parts should include the part number (if available) and the model and serial number of the Monitor for which the parts are intended.*

Orders should be sent to:

TELEDYNE Analytical Instruments
16830 Chestnut Street
City of Industry, CA 91749-1580
Phone (626) 934-1500, Fax (626) 961-2538
Web: www.teledyne-ai.com
Or your local representative.