

INSTRUCTION MANUAL

TED 200-T OXYGEN MONITOR

I. INTRODUCTION

The TED 200-T is an easy-to-use, cost-effective Portable Oxygen Monitor that provides fast and accurate oxygen analysis and alarm capability. Because it is microprocessor-based, the TED 200-T has a unique combination of features and functions that makes it ideal for use in respiratory therapy, anesthesiology, neonatal care, and other medical applications.

The TED 200-T's long list of features includes:

- Large high-contrast liquid crystal display (LCD)
- Fast response
- Operator-initiated pushbutton calibration
- Automatic diagnostics
- Dual alarms
- Red LED and audible alarm indicators
- Unique alarm test
- Tamper-resistant key operation
- "Smart" memory
- Word prompts for key functions
- Long battery life
- User-friendly design
- Rugged construction
- 24 month warranty (TED 200-T exclusive of sensor)

The TED 200-T uses Teledyne's Class T-7 Micro-Fuel Cell oxygen sensor. The T-7 represents a new class of sensor that features:

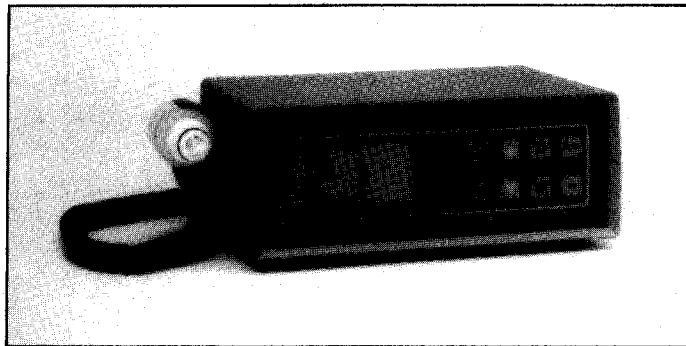
Fast response. 90% full scale response in less than 10 seconds (6-8 seconds typical) at 5 liters/minute flow rate.

Long life. Designed to provide over 10 months life in 100% oxygen (equivalent to 48 months of life in room air).

Small size. Fits easily into incubators and other medical equipment (a T-adapter is included with the TED 200-T).

Maintenance-free operation. The T-7 is easily replaced requiring no electrodes to clean or membranes and electrolyte to replace.

One year limited warranty. Backed by Teledyne's 20 years experience with electrochemical oxygen sensors.



TED 200-T

A. MAIN FEATURES

1. The TED 200-T is equipped with a safety feature that prevents the user from inadvertently interrupting continuous O₂ monitoring. The TED 200-T is designed to require two (2) key strokes in succession when using the "CAL", "ALARM TEST", and "ON/OFF" keys. If one of these keys is pressed only once, the TED 200-T will wait 5 seconds and then return to normal operation.
2. When the "CAL" key is pressed twice the TED 200-T detects whether the sensor is in AIR or 100% O₂. It then calibrates itself to the appropriate gas.
3. The HI/LO ALARM set points are adjustable in increments of 1% O₂. They appear on the display and are set by pressing the "SET HI ALARM" or "SET LO ALARM" key and then pressing the UP or DOWN arrow keys. If the HI ALARM setting exceeds

100% the word "OFF" will be displayed and "ALARM DEFEATED" will flash. If the O₂ level is above the HI ALARM or below the LO ALARM set point, the TED 200-T will display a flashing red light and sound a pulsating alarm.

4. The "ALARM SILENCE" key overrides the audible alarm. To override the audible alarm press this key once for 30 seconds, twice for 90 seconds, three times for 180 seconds, and four times to discontinue the override.
5. The TED 200-T warns of a low battery condition when its batteries need to be replaced. Pressing the "BATT. TEST" key displays the battery life remaining in hours. When the batteries become depleted, the TED 200-T will cease displaying an O₂ reading, and will eventually turn itself off completely. (See Section VIII).

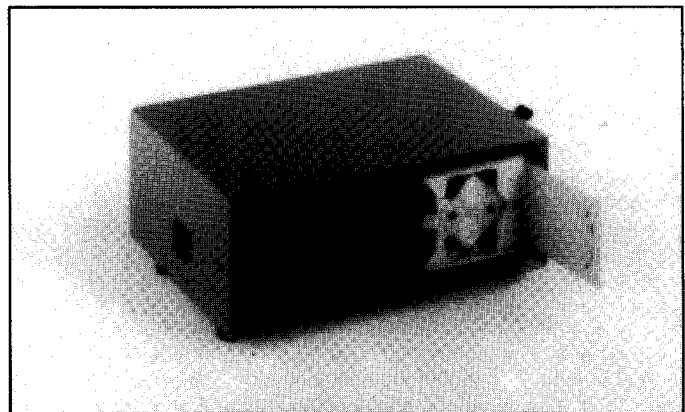
II. SET UP

NOTE: UPON RECEIPT, INSPECT THE ENTIRE UNIT FOR DAMAGE. IF DAMAGE IS FOUND, NOTIFY THE SHIPPER. CHECK UNIT, AND INCLUDED ACCESSORIES, FOR BROKEN OR LOOSE PARTS.

A. BATTERY INSTALLATION OR REPLACEMENT

NOTE: Four "AA" alkaline batteries must be installed in the unit before the TED 200-T can be operated.

1. Turn the unit off.
 2. Pull open the battery compartment door from left to right.
 3. Remove the battery holder and take out the batteries, if present. **NOTE:** Use alkaline batteries only, other types will give erroneous "BATT TEST" readings and reduce battery life.
 4. Install 4 "AA" alkaline batteries, observing proper polarity. The use of carbon zinc batteries is not recommended.
- WARNING:** If the batteries are installed improperly, damage to the circuitry may occur causing the batteries to become hot and battery life to shorten.
5. Replace the battery holder.
 6. Close the compartment door.



Battery Compartment

B. SENSOR INSTALLATION OR REPLACEMENT

NOTE: The Micro-Fuel Cell (T-7) must be connected to the sensor cable before the TED 200-T can be operated.

CAUTION: Do not autoclave the sensor. Recommended storage temperature is 10-30° C (50-86° F).

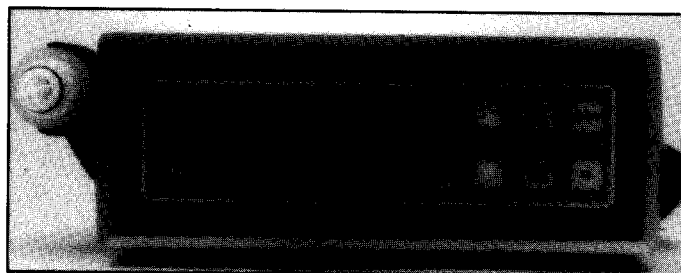
1. Remove the new sensor from its protective bag.
2. Plug one end of the coiled cable jack into the telephone jack receptacle, located on the base of the T-7 sensor, observing key orientation.

3. Plug the other end of the coiled cable receptacle into the right side panel of the TED 200-T, observing key orientation.
4. A T-adapter is available for installing the sensor in breathing circuits. To install the sensor in the T-adapter, screw on the flow diverter and insert the holder into the adapter until it is seated.

NOTE: If the instrument is used for diffusion sampling (e.g. incubators, oxygen tents, etc.) the flow diverter should be removed from the T-7 sensor to maximize response characteristics.

III. OPERATING INSTRUCTIONS

1. Make sure the T-7 Micro-Fuel Cell is properly connected to the cable.
2. Make sure the sensor cable is plugged into the receptacle on the right side of the TED 200-T. No warm-up period is required. The unit may be used immediately after connecting the sensor to the unit.
3. Turn the unit on by pressing the "ON/OFF" key once. **NOTE:** If new batteries have just been installed the display will flash "AIR CAL". HI alarm will read 100%; LO alarm will read 17%. The oxygen value will be blank on the display until the unit is calibrated.
4. Place the sensor in room air (uncontaminated with excess oxygen or other gases) with the flow diverter removed. Press the "CAL" key once (twice after initial calibration). **NOTE:** It is very important that air calibration is performed every time a sensor is installed on the TED 200-T. The microprocessor cannot perform its task properly without this data. After 10 seconds a reading of 21 will be displayed. "CAL IN 100%" will flash for a period of 5 seconds during which time the reading of 21 persists. Set the LO and HI alarm limits to 17 and OFF respectively (refer to Step 5 below). Replace the flow diverter and using the T-adapter, flow 100% oxygen over the sensing surface of the T-7 sensor assembly and allow the reading to stabilize. If the reading is other than 100, press the "CAL" key twice. After 15 seconds a reading of 100 will be displayed.
5. To set the HI alarm press the "SET HI ALARM" key. Press the "UP" or "DOWN" keys (within 5 sec.) for desired value. **NOTE:** If the HI alarm value exceeds 100%, the display will show "OFF" and flash "ALARM DEFEATED." Follow same procedure to set the LO alarm using "SET LO ALARM" key. **NOTE:** The TED 200-T is designed to prevent crossing of HI/LO alarm settings. If you try to make the LO alarm higher than the HI alarm, it will push the HI alarm setting up as you continue to raise the LO alarm set point (this also applies when setting the HI alarm lower than the LO alarm).
6. To test the alarms, press the "ALARM TEST" key twice. The display will show "ALARM TEST." The O₂ reading on the display will sequence to the HI alarm value and activate the audible/visual alarm (1-2 sec.). It will then sequence down to the LO alarm value and activate the audible/visual alarm (1-2 sec.).
7. To override the audible alarm, press the "ALARM SILENCE" key (press once for 30 sec.; twice for 90 sec.; three times for 180 sec.; four times to discontinue override). The display will flash "ALARM SILENCE" and then countdown the remaining alarm silence time. The unit will continue monitoring and displaying the O₂ concentration.
8. To check the batteries, press the "BATT TEST" key once. The display will show "BATTERY HRS LEFT" (up to a maximum of "999" hrs) of remaining battery life. **NOTE:** The TED 200-T is designed to automatically (once per hr.) check its battery life. **NOTE:** When setting the HI/LO alarms or checking the batteries, the unit will freeze the O₂ reading momentarily. This is completely normal.
9. The TED 200-T is now ready for use. **NOTE:** To turn the unit off, press the "ON/OFF" key twice.



TED 200-T Keyboard Panel

IV. INSTALLATION TIPS

1. Water Condensation.

As with all oxygen sensors, excessive condensation on the sensing surface will block the diffusion of oxygen to the sensor, making it inoperative. TED recommends installing the sensor on the dry side of the breathing circuit. If this is not possible, install the sensor holder at a 45° angle from vertical, which minimizes condensation of water on the sensing surface. The sensor should be removed from the breathing circuit periodically (once every 2-3 hrs.), dried and calibration checked to assure that communication with the sensing surface is not blocked by excessive water condensate.

The TED 200-T includes a T-Adapter for mounting the sensor in a standard 22 mm circuit as shown in Figure 1. Optional adapters are available.

2. Pressure Effects.

The effect of PRESSURE is a trait common to virtually all electrochemical sensors used in medical oxygen analyzers. Because sensors measure the partial pressure of oxygen, it is normal for them to respond to changes in total pressure. For example, a positive pressure cycle of 100 cm of water will produce a 10.6% change in the oxygen reading. For a 50% O₂ mixture, that means a positive pressure of 100 cm of water will result in a reading of 55.3% O₂. The sensor will approach this reading (55.3% O₂) depending upon the response time of the sensor and the duration of the pressure pulse. A fast responding sensor, such as the T-7, will track pressure transients more than slower responding sensors.

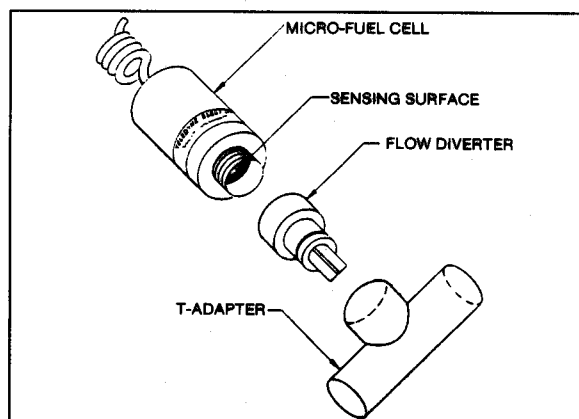


Figure 1. Mounting of Sensor in T-Adapter

V. PRECAUTIONS

1. Do not autoclave or gas sterilize any part of the TED 200-T. Refer to "Disinfecting and Sterilization" for recommended methods.
2. The TED 200-T should not be used in the presence of flammable gases or vapors.
3. The T-7 sensor contains a caustic mixture, which is harmful if touched, inhaled, or swallowed. In case of eye contact, immediately flush eyes with water for at least 15 minutes. Call a physician. Material Safety Data Sheets (MSDS) are available from TED.

The TED 200-T is equipped with an electronic "watch dog." The purpose of this feature is to monitor the circuitry within the unit for potential faults. When a fault is detected, the "watch dog" is programmed to immediately activate the alarm and disable all key functions. The "watch dog" and alarm can only be reset by disconnecting the batteries.

CORRECTIVE ACTION:

A) There are a number of conditions other than faults which can activate the "watch dog." Dropping the unit, poor battery connections, and Radio Frequency Interference (RFI) are the most common causes. If the unit has been dropped, it may have produced a momentary open circuit in the battery or circuit connections activating the "watch dog." Disconnect the batteries and inspect contacts for corrosion and damage. Reconnect battery and calibrate the instrument. If the unit appears to function properly, check alarm functions and settings. Return to service. If the unit continues to alarm or is non-operable return the unit for repair.

B) The TED 200-T has been hardened against RFI commonly produced by cauterizing machines. Older machines produce very strong RFI signals which may find their way into the unit through the sensor cable which acts as an antenna. These signals can interfere with the microprocessor and activate the "watch dog."

This difficulty can be corrected by increasing the distance between the source of RFI and the monitor. Relocating the sensor cable and changing its extended length is also very helpful in eliminating this condition.

6. SYMPTOM: No response when pushing a keyboard pad button. All other functions appear normal.

CORRECTIVE ACTION:

A) Some TED 200-T keypads require two (2) successive strokes within a 5 second period for activation. Refer to Section I - "Main Features."

NOTE: In the event none of the above steps produce the desired results, remove the batteries and return the unit to TED.

IX. SPECIFICATIONS

Range:	0-100%
Accuracy:	± 1% of full scale at constant temperature
Response Time:	90% in less than 10 sec. (typically 6-8 sec.) at 77° (25° C)
Display Resolution:	Nearest whole number
Calibration Time:	@ 21% 10 sec. @ 100% 15 sec.
Battery Life:	Approximately 1,200 hrs. continuous use in a non-alarm condition using 4 "AA" alkaline batteries.
Expected Sensor Life:	Up to 10 months in 100% oxygen (equivalent to 48 months in room air).
Dimensions:	7"W x 5"D x 2-1/2"H
Weight:	Less than 2 lbs.
Cable Length:	Retracted 2 ft. (0.6 meters) Extended 10 ft. (3 meters)
Storage Temp.:	0-50° C (Recommended Temp. 10-30° C)
Operating Temp.:	10-40° C
Alarms Indicators:	Audible/Visual

Audio: Pulsating 5-1 KHZ tone @ 70 to 90 DBA, 50% duty cycle.
Visual: Red high-brightness LED.
RFI Hardened

Interferent Gases & Vapors:

Interferent	Volume % Dry	Interference Equivalent in Percentage O ₂
Helium	80%	< 1%
Nitrous Oxide	80%	< 1%
Diethyl Ether	10%	< 1%
Carbon Dioxide	10%	< 1%
Halothane	6%	-1.8%
Enflurane	5%	-1%
Isoflurane	5%	-1.8%
Methoxyflurane	1%	-1%

X. SPARE PARTS LIST

QTY	PART NO.	DESCRIPTION
1	A-51327	Micro-Fuel Cell - T-7
4	B99	"AA" Size Alkaline Battery
1	B384	Battery Holder
1	C885	Cable Assembly
1	B-34102	Mounting Clamp
1	A268	T-Adapter, (22 mm)

XI. OPTIONAL ACCESSORIES

QTY	PART NO.	DESCRIPTION
1	A-51589	Adapter - T-7, female (22 mm)
1	A-51588	Adapter - T-7, male (22 mm)
1	A274	T-Adapter, re-usable (22 mm)

XII. WARRANTY

Teledyne warrants that the goods are free from defects of material and of construction for a period of 2 years from the date of shipment from Tele dyne. The Class T-7 Micro-Fuel Cell is warranted for one year from the date of shipment from Teledyne. The liability of Teledyne, if any, shall be limited solely to the replacement and 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.

This warranty is null and void if any goods are subjected to misuse, negligence, accident, or repairs other than those performed by Teledyne or an authorized service center.

FCC STATEMENT

This equipment generates and uses radio frequency energy, and if not installed and used in strict accordance with the manufacturers instruction manual, may cause interference to radio and TV communications. It has been type tested and certified to comply with the limits for a Class A, and exceeds limits for a Class B, computing device pursuant to Subpart J of FCC Rules, which are designed to provide reasonable protection against such interference when installed in a commercial and residential environment. Operation of this equipment in a residential area may cause interference, in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

NOTE: The above statement is required by the FCC for any device that incorporates microprocessors.

 **TELEDYNE ELECTRONIC DEVICES**

4. The TED 200-T has been hardened against electrosurgical equipment emitting RFI. However, nearby operation of equipment such as high frequency, short-wave, or micro-wave apparatus may interfere with the proper functioning of the TED 200-T.

VI. STERILIZATION OF SENSOR AND CABLE

The T-7 sensor and interconnecting cable may be gas sterilized using low temperature ethylene oxide. A vacuum must not be drawn on the sensor during the sterilization process. The TED 200-T unit should NOT be sterilized. The surface of the case may be wiped with isopropyl alcohol and allowed to air dry.

WARNING: The sensor must never be immersed in any sterilizing or other solutions, autoclaved, or subjected to high temperatures or vacuums.

VII. BATTERY LIFE

The TED 200-T calculates battery life by measuring the voltage from the batteries once an hour, and extrapolating from the known relationship between voltage and life remaining of an alkaline cell.

The voltage changes slowly, and the minimum detectable change corresponds to a time increment of about 50 hours. The computer interpolates between changes according to how long it has been on since the last time the battery voltage changed. NOTE: There may not be any change in the battery life for several hours.

This calculation is based on the normal current drain of the system (which is very low). If the alarms go off, or the keys are pressed many times, the high current drain of the red LED and the beeper will drain the batteries faster than usual, and the hours left will drop rapidly. NOTE: The battery hours left is only a guide. When the battery voltage becomes low a "LOW BATTERY" message will flash on the display until the batteries are replaced. If the batteries are not replaced when the remaining hours reach 24 hours, the computer will blank the screen, displaying "LOW BATTERY" with a pulsating beep and flashing LED. If the unit is left on, it will eventually turn itself off completely. In order to use the TED 200-T again, the batteries will have to be replaced and the unit MUST be recalibrated (see Section III - Step 4).

The expected life of a new set of batteries, with no alarms occurring, will be approximately 1200 hours. Hours remaining above 999 are shown as 999.

VIII. TROUBLESHOOTING

The TED 200-T provides a variety of built-in safety features which prevents using the instrument when a fault or incorrect procedure is detected. When a unit repeatedly displays "RECAL," "REPLACE SENSOR," "SEE TROUBLESHOOT," alarms continuously, or refuses to turn on, it may be an indication of an erroneous calibration, moisture or pressure interference or a faulty component. To determine where the difficulty lies, refer to the following guidelines.

1. SYMPTOM: New sensor does not calibrate in air. Display is flashing "RECAL," "REPLACE SENSOR," or "SEE TROUBLESHOOT" message after second attempt to calibrate.

CORRECTIVE ACTION:

- A) A new sensor must be allowed to stabilize prior to calibration.
- B) Oxygen concentration at this sensor is significantly higher than 21%. Take the instrument to a well ventilated area and repeat calibration.

2. SYMPTOM: Unit successfully calibrated at 21%, but will not calibrate at 100%. Display is flashing "RECAL," "REPLACE SENSOR," or "SEE TROUBLESHOOT."

CORRECTIVE ACTION:

- A) The sensor must be allowed to stabilize in 100% oxygen before calibration is attempted. Wait 1-2 minutes or until the oxygen concentration reading is stable, push the "CAL" key twice, and wait for calibration sequence to complete.

- B) Oxygen concentration at the sensor is less than 100% or the sensor is pressurized by the calibration gas. If calibration is performed by passing 100% oxygen by the sensor, make sure that at least 12" (30 cm.) of tubing is attached to the exhaust side of the T-adapter to prevent backfilling with air. The flow rate of oxygen should not exceed approximately 5 liters per minute. Extremely high flow rates or small diameter vent tubing may produce significant back pressures resulting in erroneous high readings. Humidifiers, nebulizers, or similar devices must be turned off or removed from the calibration circuit to prevent dilution of the gas with water vapor. Check for leaks or open circuits.

If calibration is done by placing the sensor in a bag or container, wait until the reading stabilizes before attempting calibration. Depending on the size of the container, it may take up to 5 minutes to completely purge the vessel with oxygen.

3. SYMPTOM: The TED 200-T does not react to changes in oxygen concentration, or the readings are unstable and drifting.

CORRECTIVE ACTION:

The above condition is typical of all oxygen sensors when they become flooded with water or patient secretions. Remove the sensor from the T-adapter and unscrew the flow diverter. Using absorbent tissue or a cotton swab, gently wipe off the sensing surface (inside the threaded portion of the sensor assembly). The reading should be stable, and the unit should respond instantly to changes in oxygen. Gently blowing on the sensor is a simple, but effective test to determine responsiveness.

NOTE: If at all possible, the sensor should be installed on the dry side of circuit to prevent flooding. If this is not practical, make sure the sensor is installed at a 45° angle from vertical with the sensor holder at the top of circuit facing down. This reduces the flooding effects.

4. SYMPTOM: Oxygen reading fluctuates or appears to be incorrect.

CORRECTIVE ACTION:

- A) Like all oxygen sensors, the T-7 cell detects the changes in partial pressure of oxygen. Unlike older slower sensors, the T-7 sensor's fast response allows the monitor to track the changes in pressure during normal inspiratory/expiratory cycles of the ventilator.

If you double the pressure at the sensor you will double the oxygen reading. During calibration make sure there are no restrictions on the exhaust side of the sensor. Excessive gas flow can also produce back pressure, which can lead to incorrect readings. The sensor should not be affected by changes in flow rate. If the reading changes with flow, the sensor is pressurized or there is a leak in the system. See Section IV - Pressure Effects."

- B) If a high degree of accuracy is desired, or the concentration of oxygen is in excess of 50%, calibration with 100% oxygen is recommended.

- C) If humidified gas is used to ventilate the patient, water vapor actually dilutes the gas, which in turn translates into lower oxygen readings. This is normal. Hot or warm gas mixtures should not be passed over the sensing end of the sensor assembly. The gas mixture should be brought to room temperature prior to passing the mixture over the sensor. Errors in temperature compensation may be produced if the front and rear of the sensor assembly are at different temperatures.

- D) If a blender is used, its calibration should be verified.

5. SYMPTOM: Unit appears to have a momentary condition which causes alarms to be activated; unit cannot be silenced and all keys are non-functional.