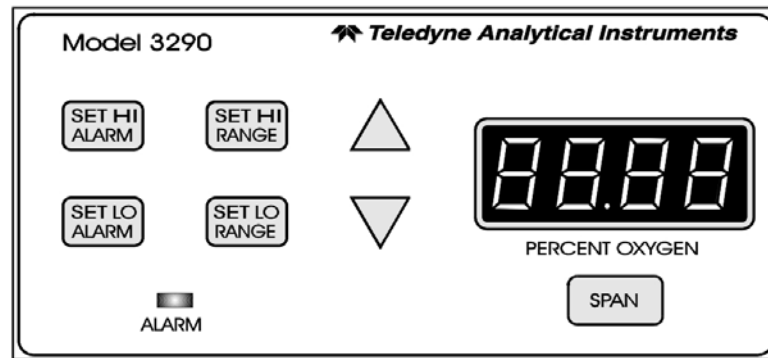

OPERATING INSTRUCTIONS FOR

Model 3290

Percent Oxygen Analyzer



P/N M64643
8/10/11



DANGER



Depending upon your application, toxic gases may be present in this monitoring system.

Personal protective equipment may be required when servicing this instrument.

Hazardous voltages exist on certain components internally which may persist for a time even after the power is turned off and disconnected.

Only authorized personnel should conduct maintenance and/or servicing. Before conducting any maintenance or servicing, consult with authorized supervisor/manager.

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Warranty

This equipment is sold subject to the mutual agreement that it is warranted by us free from defects of material and of construction, and that our liability shall be limited to replacing or repairing at our factory (without charge, except for transportation), or at customer plant at our option, any material or construction in which defects become apparent within one year from the date of shipment, except in cases where quotations or acknowledgements provide for a shorter period. Components manufactured by others bear the warranty of their manufacturer. This warranty does not cover defects caused by wear, accident, misuse, neglect or repairs other than those performed by TI/AI or an authorized service center. We assume no liability for direct or indirect damages of any kind and the purchaser by the acceptance of the equipment will assume all liability for any damage which may result from its use or misuse.

We reserve the right to employ any suitable material in the manufacture of our apparatus, and to make any alterations in the dimensions, shape or weight of any parts, in so far as such alterations do not adversely affect our warranty.

Important Notice

This instrument provides measurement readings to its user, and serves as a tool by which valuable data can be gathered. The information provided by the instrument may assist the user in eliminating potential hazards caused by his process; however, it is essential that all personnel involved in the use of the instrument or its interface, with the process being measured, be properly trained in the process itself, as well as all instrumentation related to it.

The safety of personnel is ultimately the responsibility of those who control process conditions. While this instrument may be able to provide early warning of imminent danger, it has no control over process conditions, and it can be misused. In particular, any alarm or control systems installed must be tested and understood, both as to how they operate and as to how they can be defeated. Any safeguards required such as locks, labels, or redundancy, must be provided by the user or specifically requested of TI/AI at the time the order is placed.

Therefore, the purchaser must be aware of the hazardous process conditions. The purchaser is responsible for the training of personnel, for providing hazard warning methods and instrumentation per the appropriate standards, and for ensuring that hazard warning devices and instrumentation are maintained and operated properly.

Teledyne Instruments/Analytical Instruments, the manufacturer of this instrument, cannot accept responsibility for conditions beyond its knowledge and control. No statement expressed or implied by this document or any information disseminated by the manufacturer or its agents, is to be construed as a warranty of adequate safety control under the user's process conditions.

Specific Model Information

Instrument Serial Number: _____

Instrument Range: _____

Background Gas: _____

Span Gas: _____

Safety Messages

Your safety and the safety of others is very important. We have provided many important safety messages in this manual. Please read these messages carefully.

A safety message alerts you to potential hazards that could hurt you or others. Each safety message is associated with a safety alert symbol. These symbols are found in the manual and inside the instrument. The definition of these symbols is described below:



GENERAL WARNING/CAUTION: Refer to the instructions for details on the specific danger. These cautions warn of specific procedures which if not followed could cause bodily injury and/or damage the instrument.



WARNING: HOT SURFACE WARNING: This warning is specific to heated components within the instrument. Failure to heed the warning could result in serious burns to skin and underlying tissue.



WARNING: ELECTRICAL SHOCK HAZARD: Dangerous voltages appear within this instrument. This warning is specific to an electrical hazard existing at or nearby the component or procedure under discussion. Failure to heed this warning could result in injury and/or death from electrocution.



Technician Symbol: All operations marked with this symbol are to be performed by qualified maintenance personnel only.

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



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

Percent Oxygen Analyzer

This manual provides information designed to guide you through the installation, calibration operation and maintenance of your new analyzer. Please read this manual and keep it available.

Occasionally, some instruments are customized for a particular application or features and/or options added per customer requests. Please check the front of this manual for any additional information in the form of an Addendum which discusses specific information, procedures, cautions and warnings that may be peculiar to your instrument.

Manuals do get lost. Additional manuals can be obtained from TI/AI at the address given in the Appendix. Some of our manuals are available in electronic form via the internet. Please visit our website at: www.teledyne-ai.com.

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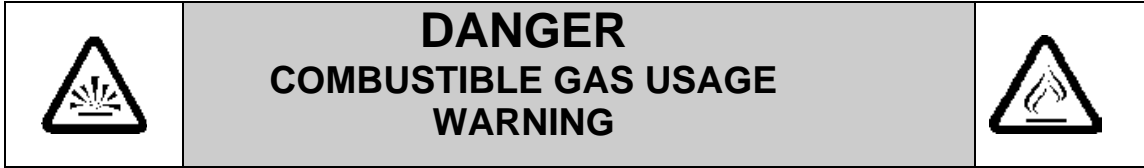
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Percent Oxygen Analyzer

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This is a general purpose instrument designed for use in a non-hazardous area. It is the customer's responsibility to ensure safety especially when combustible gases are being analyzed since the potential of gas leaks always exist.

The customer should ensure that the principles of operating this equipment are well understood by the user. Misuse of this product in any manner, tampering with its components, or unauthorized substitution of any component may adversely affect the safety of this instrument.

Since the use of this instrument is beyond the control of Teledyne Analytical Instruments, referred as TAI, no responsibility by TAI, its affiliates, and agents for damage or injury from misuse or neglect of this equipment is implied or assumed.

Introduction

1.1 Overview

The Teledyne Analytical Instruments (TAI) Model 3290 is a microprocessor-based percent oxygen analyzer for real-time measurement of the percent of oxygen in inert gases, or in a wide variety of gas mixtures. It features simple operation, fast response, and a compact, rugged construction. Typical applications of the Model 3290 are monitoring nitrogen generators and inert gas blanketing applications.

1.2 Main Features of the Analyzer

The main features of the analyzer include:

- High resolution, accurate readings of oxygen content from 0-1 % through 0-25 %. Large, bright, light-emitting-diode (LED) meter readout.
- Simple pushbutton controls.
- Nylon cell holder.
- Advanced E-2 oxygen sensor for percent analysis, has a two-year warranty on the standard cell and an expected lifetime of four years.
- Unaffected by oxidizable gases.
- Fast response and recovery time.
- Microprocessor based electronics: 8-bit CMOS microprocessor with on-board RAM and 16 KB ROM.
- Two user selectable ranges (from 0-1 % through 0-25 %, optional 0-100%) allow best match to user's process and equipment.
- Air-calibration range for convenient spanning at 20.9 %.

- User selectable autoranging feature, which allows the analyzer to automatically select the proper preset range for a given measurement. The analyzer can also be manually locked on a fixed analysis range.
- Two concentration alarms with adjustable setpoints.
- Sensor failure alarm.
- Optional RS-232 serial digital port for output of concentration and range data to a computer, terminal, or other digital device.
- Three analog outputs: two for measurement (0–10 VDC, and negative ground 4–20 mA DC) and one for range identification (0-10 VDC).
- Compact and rugged control unit with flush-panel case. Designed for indoor use. Front panel NEMA-4 rated.
- External probe can be located 6 feet (1.83 meters) or more away, depending on the existing electromagnetic noise level.

1.3 Front Panel Description

All controls and displays except the power switch are accessible from the front panel. See Figure 1-1. The front panel has seven pushbutton membrane switches, a digital meter, and an alarm indicator LED for operating the analyzer. These features are described briefly here and in greater detail in Chapter 4, *Operation*.

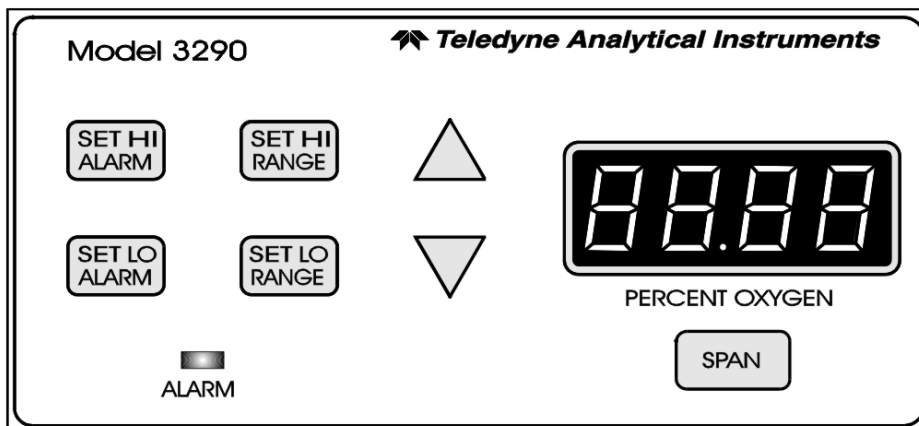


Figure 1-1: Front Panel

Function Keys: Five pushbutton membrane switches are used to select the function performed by the analyzer:

- **Set HI Alarm** Set the concentration ABOVE which an alarm activates.
- **Set LO Alarm** Set the concentration BELOW which an alarm activates.
- **Set HI Range** Set the high analysis range for the instrument (up to 0-25 %).
- **Set LO Range** Set the low analysis range for the instrument (down to 0-1 %).
- **Span** Span calibrate the analyzer.

Data Entry Keys: Two pushbutton membrane switches are used to manually change measurement parameters of the instrument as they are displayed on the LED meter readout:

- **Up Arrow** Increment values of parameters upwards as they are displayed on the LED readout.
- **Down Arrow** Increment values of parameters downwards as they are displayed on the LED readout.

Digital LED Readout: The digital display is a LED device that produces large, bright, 7-segment numbers that are legible in any lighting environment. It has two functions:

- **Meter Readout:** As the meter readout, it displays the oxygen concentration currently being measured.
- **Measurement Parameters Readout:** It also displays user-definable alarm setpoints, ranges, and span calibration point when they are being checked or changed.

1.4 Rear Panel Description

The rear panel contains the electrical input and output connectors. Separate rear panel illustrations are shown in Figure 1-2 for the AC and DC powered versions of the instrument. The connectors are described briefly here and in detail in Chapter 3 *Installation* of this manual.

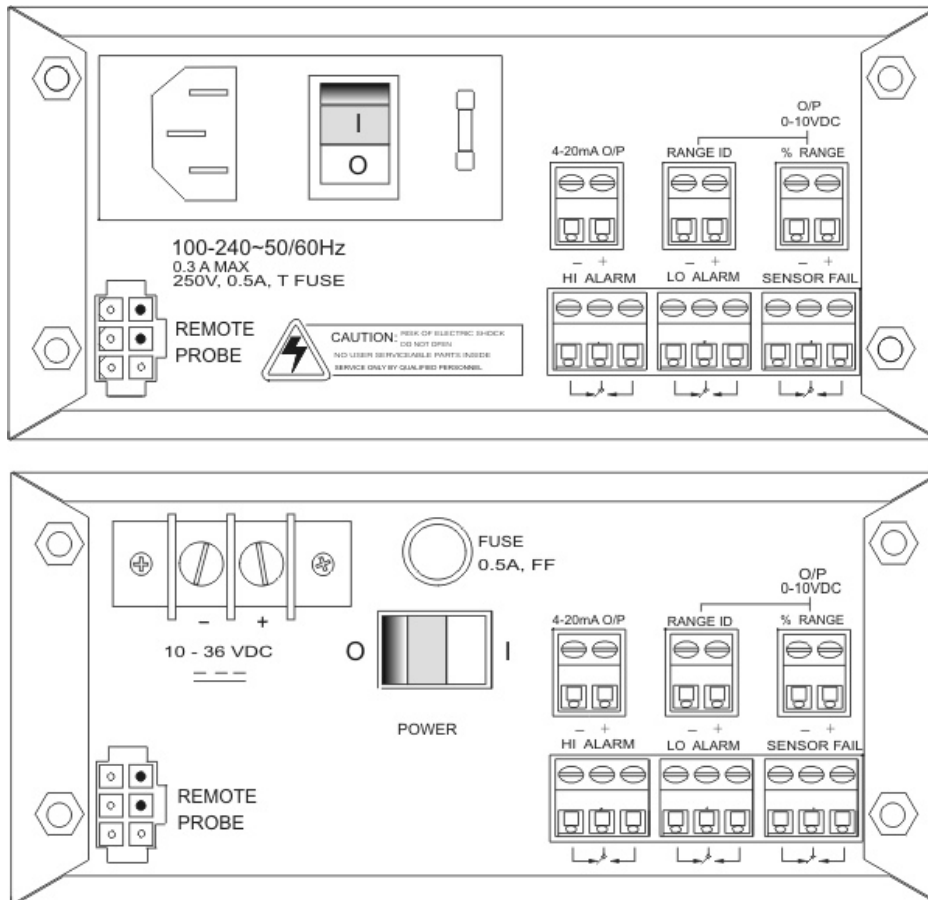


Figure 1-2: Rear Panel (AC and DC versions)

- **Power Connection** *AC version:* 100–240 VAC, at 50/60 Hz. The connector housing includes the fuse holder and the power switch. *DC version:* Requires between 10 and 36 VDC.

Fuse Holder: Replacing the fuse is described in Chapter 5, *Maintenance*.

I/O Power Switch: Turns the instrument power ON (I) or OFF (O).

- **Analog Outputs** 0–10 VDC concentration output.
0–10 VDC range ID (or optional overrange) output.
4–20 mA DC concentration output, negative ground.
- **Alarm Connections** HI Alarm, LO Alarm, and Sensor Failure Alarm connections.
- **RS-232 Port (Option)** Serial digital output of concentration and range signals.
- **External Probe** Connects to the Remote Probe or remote Analysis Unit.

Operational Theory

2.1 Introduction

The analyzer is composed of two subsystems:

1. Analysis Unit with Oxygen Sensor
2. Control Unit with Signal Processing, Display and Controls

The Analysis Unit is designed to accept the sample gas and direct it to the sensitive surface of the oxygen sensor. The oxygen sensor is an electrochemical galvanic device that translates the amount of oxygen present in the sample into an electrical current.

The Control Unit processes the sensor output and translates it into electrical concentration, range, and alarm outputs, and a percent oxygen meter readout. It contains a micro-controller that manages all signal processing, input/output, and display functions for the analyzer.

2.2 Oxygen Sensor

2.2.1 Principles of Operation

The oxygen sensor used in the Model 3290 is a micro-fuel cell designed and manufactured by TAI. It is a sealed, disposable electrochemical transducer.

The active components of the oxygen sensor, also referred to as the sensor cell or just cell, are a cathode, an anode, and the 15% aqueous KOH electrolyte for the typical oxygen sensor in which they are immersed. The cell converts the energy from a chemical reaction into an electrical potential that can produce a current in an external electrical circuit. Its action is similar to that of a battery.

There is, however, an important difference in the operation of a battery as compared to the oxygen sensor or micro-fuel cell. In the battery, all reactants are stored within the cell, whereas in the micro-fuel cell, one of the reactants (oxygen) comes from outside the device as a constituent of the sample gas being analyzed. The oxygen sensor is

therefore a hybrid between a battery and a true fuel cell; where in a true fuel cell all of the reactants are stored externally.

2.2.2 Anatomy of the Oxygen Sensor

The oxygen sensor is made of extremely inert plastic (which can be placed confidently in practically any environment or sample stream). It is effectively sealed, though one end is permeable to oxygen in the sample gas. At the permeable end a screen retains a diffusion membrane through which the oxygen passes into the cell. At the other end of the cell is a connector. The connector mates with a miniature phone jack that provides electrical connection to the Control Unit.

Refer to Figure 2-1, *Basic Elements of a Oxygen Sensor*, which illustrates the following internal description.

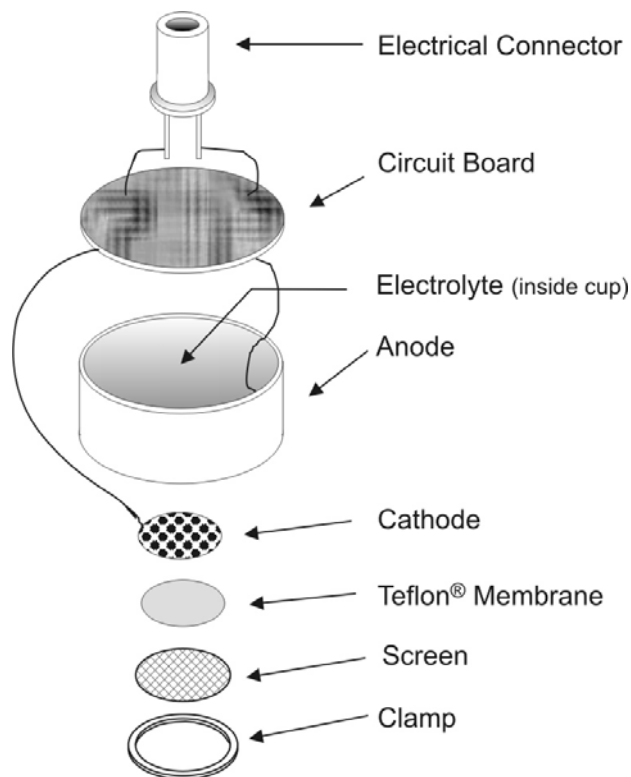


Figure 2-1: *Basic Elements of the Oxygen Sensor (not to scale)*

At the sensing end of the cell is a diffusion membrane, whose thickness is very accurately controlled. Near the diffusion membrane lies the oxygen sensing element—the cathode.

The anode structure is larger than the cathode. It is made of lead and is designed to maximize the amount of metal available for chemical reaction.

The space between the active elements is filled by a structure saturated with electrolyte. Cathode and anode are wet by this common pool. They each have a conductor connecting them, through some electrical circuitry, to one of the external contacts in the connector receptacle, which is on the top of the cell.

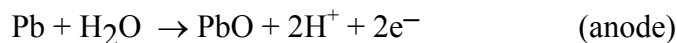
2.2.3 Electrochemical Reactions

The sample gas diffuses through the Teflon[®] membrane. Any oxygen in the sample gas is reduced on the surface of the cathode by the following HALF REACTION:



(Four electrons combine with one oxygen molecule—in the presence of water from the electrolyte—to produce four hydroxyl ions.)

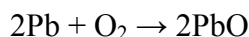
When the oxygen is reduced at the cathode, lead is simultaneously oxidized at the anode by the following HALF REACTION:



Two electrons are transferred for each atom of lead that is oxidized. TWO ANODE REACTIONS balance one cathode reaction to transfer four electrons.

The electrons released at the surface of the anode flow to the cathode surface when an external electrical path is provided. The current is proportional to the amount of oxygen reaching the cathode. It is measured and used to determine the oxygen concentration in the gas mixture.

The overall reaction for the fuel cell is the SUM of the half reactions above, or:



These reactions will hold as long as no gaseous components capable of oxidizing lead are present in the sample. The only likely components are the halogens—iodine, bromine, chlorine and fluorine.

The output of the fuel cell is limited by (1) the amount of oxygen in the cell at the time and (2) the amount of stored anode material.

In the absence of oxygen, no current is generated.

2.2.4 The Effect of Pressure

In order to state the amount of oxygen present in the sample as a percentage of the gas mixture, it is necessary that the sample diffuse into the cell under constant pressure.

The sensing technology deployed in the Model 3290 is an electrochemical oxygen sensor which is a partial pressure device. Any changes in the vent pressure of the unit will affect the pressure of the sample the sensor sees. This will influence the output of the sensor according to Dalton's Law of partial pressures. Therefore changes in barometric pressure should be considered in critical applications.

As the pressure changes, the rate that oxygen reaches the cathode through the diffusing membrane will also increase. The electron transfer, and therefore the external current, will increase, even though the proportion of oxygen has not changed.

For a sensor vented to the atmosphere, the displayed oxygen value will vary in direct proportion to the barometric pressure (absolute atmospheric pressure). For example, if the analyzer is calibrated with air at 20.9% oxygen at an ambient atmospheric pressure of 14.3 psia (0.986 bar), and then the atmospheric pressure increases to 14.5 psia (1.000 bar), the displayed value for air will be 21.2% oxygen. Ideally, the analyzer should be calibrated when the atmospheric pressure is in the middle of the normal barometric pressure range for the location and the temperature is also in the middle of the normal operating ambient temperature range.

Fortunately, Dalton's Law confirms that every gas in a mixture contributes the same pressure to the mixture that it would exert if it were alone in the same amount in that same volume. This means that as long as the total pressure of the sample remains constant, the mixture can change, but the diffusion of the oxygen will be affected only by the concentration of the oxygen.

For this reason, the sample system supplying sample gas to the cell should be designed to keep the pressure on the diffusion membrane constant.

2.2.5 Calibration Characteristics

Given that the total pressure of the sample gas at the surface of the oxygen sensor input is constant, a convenient characteristic of the cell is that the current produced in an external circuit of constant impedance is directly proportional to the rate at which oxygen molecules reach the cathode, and this rate is directly proportional to the concentration of oxygen in the gaseous mixture. In other words it has a linear characteristic curve, as shown in Figure 2-2. Measuring circuits do not have to compensate for non-linearities.

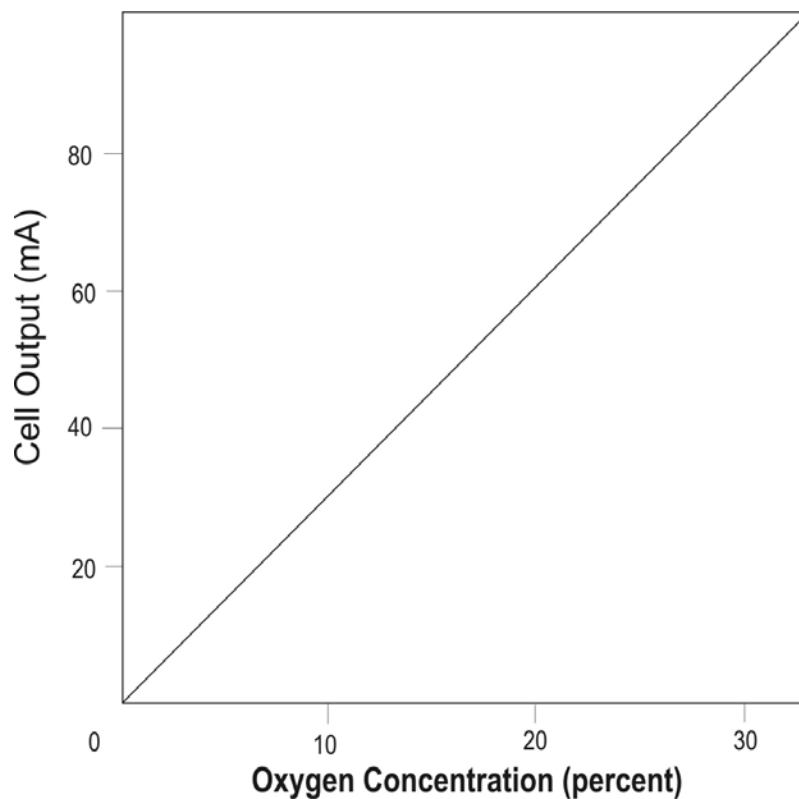


Figure 2-2: Input/Output Curve for a Typical Oxygen Sensor

In addition, since there is zero output in the absence of oxygen, the characteristic curve has an absolute zero. The cell itself does not need to be zeroed.

2.3 Electronics

2.3.1 General

The signal processing uses an Intel[®] micro-controller with on-board RAM and ROM to control all signal processing, input/output, and display functions for the analyzer. System power is supplied from a universal power supply module designed to be compatible with most international power sources.

The power supply circuitry is on the Power Supply PCB, which is mounted vertically, just behind the rear panel of the Control Unit.

The signal processing electronics including the temperature compensated amplifier, micro-controller, analog to digital and digital to analog converters are located on the Main PCB, which is mounted vertically, just behind the front panel of the Control Unit.

2.3.2 Signal Processing

Figure 2-3 is a block diagram of the signal processing electronics described below.

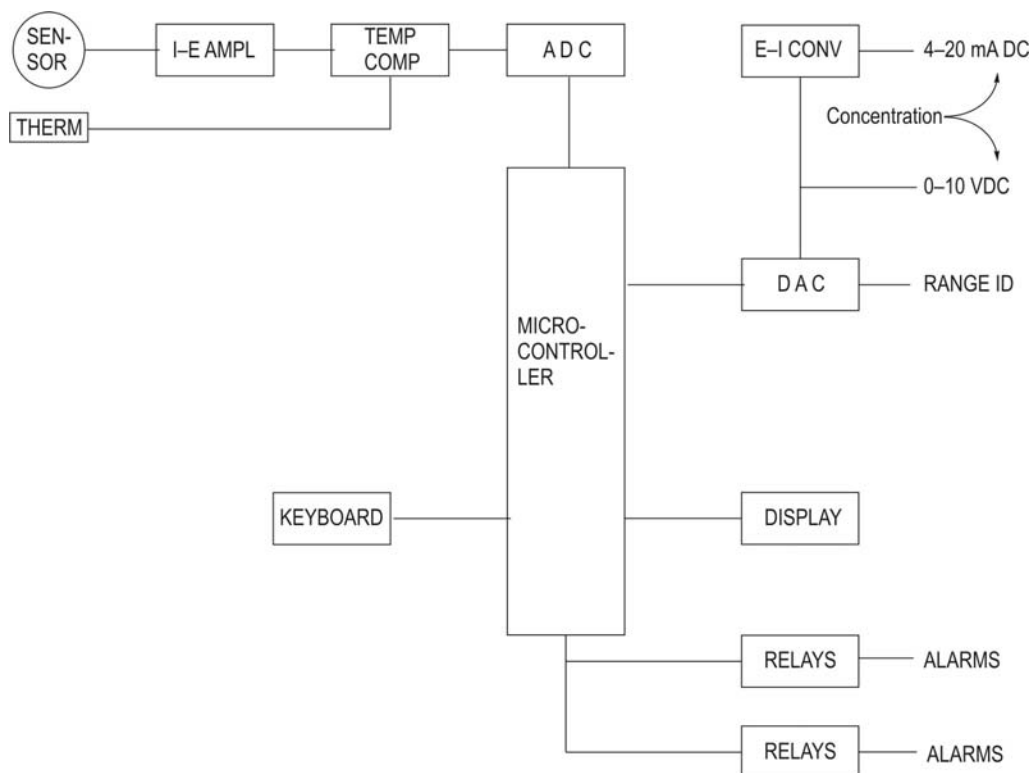


Figure 2-3: Block Diagram of the Signal Processing Electronics

In the presence of oxygen the cell generates a current. A current to voltage amplifier (I-E AMPL) converts this current to a voltage.

The second stage amplifier (TEMP COMP) supplies temperature compensation for the oxygen sensor output. The temperature compensation amplifier incorporates a thermistor (THERM) that is physically located in the cell block for the typical oxygen sensor. The thermistor is a temperature dependent resistance that changes the gain of the amplifier in proportion to the temperature changes in the block. This change is inversely proportional to the change in the cell output due to the temperature changes. As a result there is negligible net change in the signal due to temperature changes once the sensor comes to equilibrium. See *Specifications* in the Appendix.

The output from the temperature compensation amplifier is sent to an analog to digital converter (ADC), and the resulting digital concentration signal is sent to the micro-controller.

The digital concentration signal along with input from the front panel buttons (KEYBOARD) is processed by the micro-controller, and appropriate output signals are directed to the display, alarm relays, and the optional RS-232 output. The same digital information is also sent to a 12-bit digital to analog converter (DAC) that produces the 0-10 VDC analog concentration signal and the 0-10 VDC analog range ID output. A current to voltage converter (E-I CONV) produces the 4-20 mA DC analog concentration signal.

Installation

Installation of the analyzer includes:

1. Unpacking the system.
2. Mounting the Control Unit, external sample block, and oxygen sensor.
3. Making the electrical connections.
4. Making the gas connections.
5. Testing the installation.

CAUTION: READ THIS CHAPTER IN ITS ENTIRETY BEFORE INSTALLING THE UNITS.



FOR INDOOR USE ONLY.

THE SAMPLE MUST BE FREE OF ENTRAINED SOLIDS OR WATER.

THE SENSOR ELECTROLYTE IS CAUSTIC. DO NOT ATTEMPT TO OPEN IT. LEAKING OR EXHAUSTED CELLS SHOULD BE DISPOSED OF IN ACCORDANCE WITH LOCAL REGULATIONS. REFER TO THE MATERIAL SAFETY DATA SHEET IN THE APPENDIX OR ADDENDUM.

ANY DAMAGE OR SCARRING OF THE DELICATE PERMEABLE MEMBRANE ON THE SENSING END OF THE CELL WILL REQUIRE CELL REPLACEMENT. PREVENT CONTACT WITH MEMBRANE BY ANY SOLID OBJECT.

3.1 Unpacking the Analyzer

As soon as you receive the instrument, carefully unpack and inspect Control Unit, External Probe, and any included accessories for damage. Immediately report any damage to the shipping agent. The analyzer is shipped with all the materials you need to install and prepare the system for operation.

CAUTION: **DO NOT DISTURB THE INTEGRITY OF THE CELL PACKAGE UNTIL THE CELL IS TO ACTUALLY BE USED. IF THE CELL PACKAGE IS PUNCTURED AND AIR IS PERMITTED TO ENTER, CELL LIFE WILL BE COMPROMISED.**



3.2 Location and Mounting

3.2.1 Control Unit Installation

The 3290 Control Unit is designed to be panel-mounted in a general purpose, indoor area, away from moisture and the elements. The unit should be installed at viewing level in a sheltered area.

CAUTION: **FOR THE DC POWERED VERSION, THE CONTROL UNIT CHASSIS MUST BE ISOLATED FROM THE INPUT POWER GROUND.**



Refer to the Outline diagram C-64771 for the physical dimensions of the analyzer.

3.2.2 External Probe Installation

The External Probe can be installed in the process any reasonable distance from the Control Unit. The nominal maximum is 6 ft (1.83 meter), but the distance can be more, depending on the level of electromagnetic noise in the operating environment.

The standard Model 3290 includes the External Probe unit depicted in the Final Assembly, Dwg C-64643, and the Analysis Unit (probe) Outline, Dwg B-57335. Dimensions are also given in *Specifications* in the Appendix.

For special applications, the type of External Probe unit supplied may vary depending on the specific process. With these systems, specific installation and interconnect information is given in a separate probe manual or in an addendum to this manual depending on the model External Probe used. The addendum will reference the specific Outline and Interconnection Drawings in the Drawings section of this manual, and provides any other appropriate information.

For special applications the oxygen sensor may also be of a different type than the standard E-2 sensor. If this is the case, the pertinent cell specifications will be given in the addendum.

3.2.3 Installing the Oxygen Sensor

The oxygen sensor is included as a separate item. It must be installed prior to instrument use. The standard instrument is shipped with an E-2 oxygen sensor. Some units on special request are fitted with the optional C-5 or C-5F oxygen sensor. The installation procedure is different for these cells. See Section 5.2.4.

Once the cell is expended, or if the instrument has been idle for a lengthy period, the oxygen sensor will need to be replaced.

To install or replace the oxygen sensor, follow the procedures in Chapter 5, *Maintenance*.

3.3 Electrical Connections

Figure 3-1 shows the two alternate Model 3290 rear panels. The difference between them is the power connections. The first illustration shows the AC powered version, and the second illustration shows the DC powered version. Both versions have identical connections for the External Probe, the alarms, and for both digital and analog concentration outputs. For detailed pinouts, see the wiring/interconnection drawings in the Drawings section at the rear of this manual.

Primary Input Power (AC version): The power cord receptacle, fuse block and Power switch are located in the same assembly. A 6-foot (1.83 meter), standard AC power cord is supplied with the Control Unit. Insert the female plug end of the power cord into the power cord receptacle.

The universal power supply allows direct connection to any 100-240 VAC, 50/60 Hz power source. The fuse block, to the right of the

power cord receptacle, accepts a 5 x 20 mm, 0.5 A, time-lag (T) fuse. (See Fuse Replacement in Chapter 5, Maintenance.)

The power switch is located at the right within the power source input receptacle assembly.

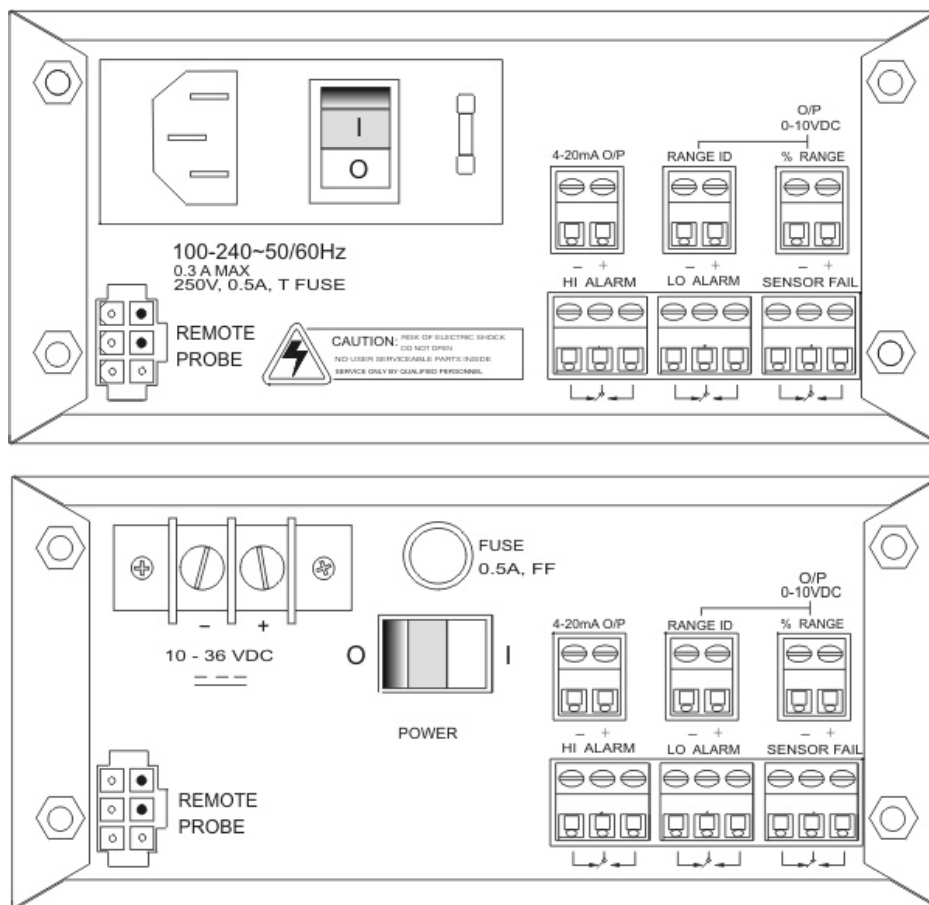


Figure 3-1: Rear Panel Electrical Connectors for AC & DC Units

Primary Input Power (DC version): The 10–36 VDC power is connected via the + and – terminals in the upper left corner of the panel. The fuse receptacle, to the right of the power terminal strip, holds a 0.5 A, very quick acting fuse. (See *Fuse Replacement* in Chapter 5, *Maintenance*.)

The Power switch is located below the fuse receptacle.

CAUTION: INSERT THE STRIPPED TIPS OF WIRES ENTIRELY INTO THE TERMINAL BLOCKS. DO NOT LEAVE EXPOSED WIRE OUTSIDE OF THE HOLES IN THE BLOCKS.



CAUTION: THE CONTROL UNIT CHASSIS MUST BE ISOLATED FROM THE GROUNDING SYSTEM OF THE DC INPUT POWER.



Analog Outputs: There are three DC output signal connectors with screw terminals on the panel. There are two wires per output with the polarity noted. See Figure 3-1. The outputs are:

0–10 V % Range: Voltage rises with increasing oxygen concentration, from 0 V at 0 percent oxygen to 10 V at full scale percent oxygen. (Full scale = 100% of programmed range.)

0–10 V Range ID: 3.33 V = Low Range, 6.66 V = High Range, 10 V = Air Cal Range.

4–20 mA % Range: Current increases with increasing oxygen concentration, from 4 mA at 0 percent oxygen to 20 mA at full scale percent oxygen. (Full scale = 100% of programmed range.)

Alarm Relays: The three alarm-circuit connectors are screw terminals for making connections to internal alarm relay contacts. There is one set of contacts for each type of alarm. Contacts are Form C, with normally open and normally closed contact connections capable of switching up to 0.5 ampere at 125 VAC into a resistive load.

The alarm relay circuits are designed for failsafe operation, meaning the relays are energized during normal operation. If power fails the relays de-energize (alarms activated).

The contact connections are indicated diagrammatically on the rear panel as Normally Closed, Common, and Normally Open. Figure 3-2 explains how these act in failsafe operation.

The specific descriptions for each type of alarm are as follows:

- HI Alarm** Configured as high alarm (actuates when concentration is above threshold). Can be set anywhere between 1 and 25 %, but must be set ABOVE the threshold set for the LO Alarm.
- LO Alarm** Configured as low alarm (actuates when concentration is below threshold). Can be set anywhere from 1 to 25 %, but must be set BELOW the threshold set for the HI Alarm.
- Sensor Fail** Actuates when the output of the oxygen sensor falls below the pre-programmed level, typically 0.05%..

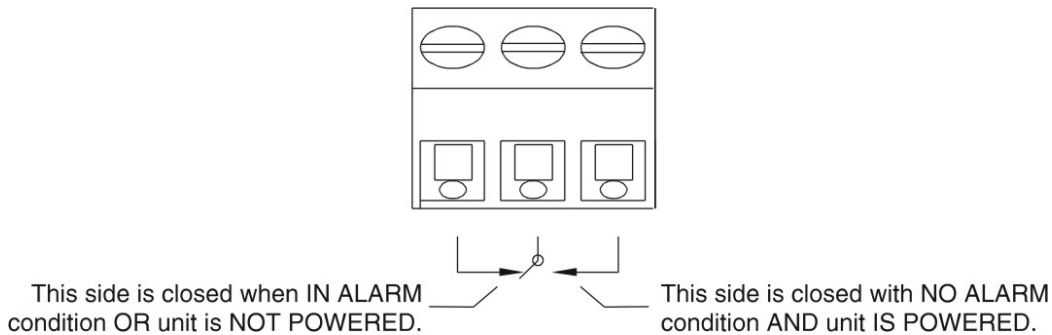


Figure 3-2: Contact Identification for FAILSAFE Relay Operation

Optional RS-232 Port: The digital signal output is a standard RS-232 serial communications port used to connect the analyzer to a modem or other digital device. Only the output mode is implemented in this instrument. The data is concentration information in serial digital form.

The RS-232 protocol allows some flexibility in implementation in the choice of values for certain parameters. Table 3-1 lists the RS-232 values required by the Model 3290 implementation.

Note: The RS-232 port is an optional feature and is not present on all instruments.

Table 3-1: Required RS-232 Data Format

Parameter	Setting
Baud	2400
Byte	8 bits
Parity	none
Stop Bits	1
Message Rate	2 per second

External Probe: The receptacle for the analysis unit cable is located in the lower left-hand corner of the rear panel. The 6-pin Minifit connector is keyed to fit only one way into the receptacle. Do not force it in. The other end of the cable is made of four separate wires. These should be connected to the terminal strip on the analysis unit as follows:

Red:	#1	
Black:	#2	
Green:	#3	} The green and white connectors can be interchanged, but be consistent.
White:	#4	

Refer to the Final Assembly, Dwg. C-64643.

3.4 Gas Connections

Gas connection instructions depend on the specific External Probe used and any special requirements of the process being monitored.

The standard Model 3290 External Probe has inlet and outlet fixtures only. Calibration gases must be tee'd into the sample inlet through appropriate valves. ¼ inch tube fittings are used. For metric installations, ¼ inch to 6 mm adapters are supplied.

In general, sample flow and pressure must not create significant backpressure past the sensor. For the standard probe, set the pressure to achieve a 2 SCFH flowrate.

The pressure required will depend on the sampling system. When venting into a constant pressure, such as the atmosphere, controlling input pressure is simple. If you are venting into a system of varying pressure, then some form of pressure regulation is required. Refer to Section 2.2.4 *The Effect of Pressure* for more information.

3.5 Installation Checklist

Before connecting the instrument to the power source and turning it on, make sure you have:

- Correctly installed the Sample and Exhaust gas lines
- Opened the isolation valves
- Checked for leaks
- Set the sample pressure to achieve a 2 SCFH flowrate.

Once the above checks have been made, you can connect to the power source. The instrument is now ready for operation.

Operation

4.1 Introduction

Once the analyzer has been mounted, the gas lines connected and the electrical connections made, the Analyzer can be configured for your application. This involves setting the system parameters:

- Defining the user selectable analysis ranges.
- Setting alarm setpoints.
- Calibrating the instrument.

All of these functions are performed via the front panel controls, shown in Figure 4-1.

Analyzing for the percent oxygen level in the gas passing through the cell block is the default mode of operation. As long as no front panel buttons are being pressed, the Analyzer is analyzing.

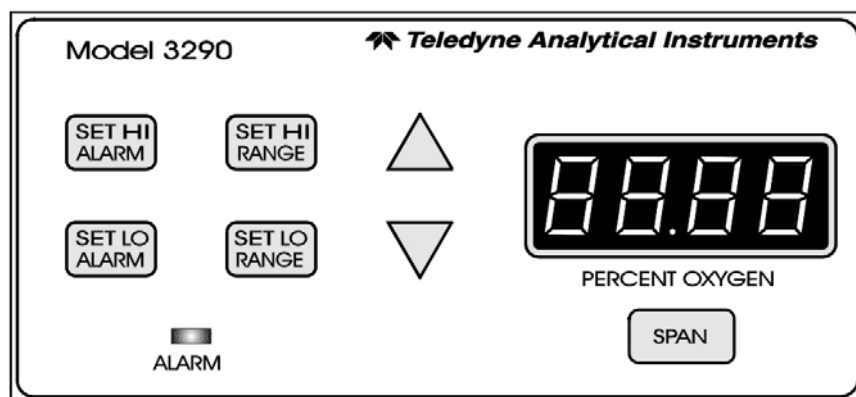


Figure 4-1: Front Panel Controls and Indicators

4.2 Using the Function and Data Entry Buttons

When no buttons on the Analyzer are being pressed, the instrument is in the Analysis mode. It is monitoring the percent of oxygen in the sample gas that is flowing through the remote probe.

When one of the function buttons is being pressed, the Analyzer is in the Setup mode or the Calibration mode.

The 4 Setup function buttons on the analyzer are:

- SET HI ALARM
- SET LO ALARM
- SET HI RANGE
- SET LO RANGE

The Calibration mode button is:

- SPAN

The data entry buttons (Δ and ∇) increment the values displayed on the PERCENT OXYGEN meter while one of the function buttons is being held down.

- Δ : Increments the displayed value upwards.
- ∇ : Increments the displayed value downwards.

Any of the functions can be selected at any time by holding down the appropriate button.

Each function will be described in the following sections. Although the operator can use any function at any time, the order chosen in this manual is appropriate for an initial setup.

4.3 Setting the Analysis Ranges

The two user definable analysis ranges are both capable of being adjusted from 0-1% to 0-25% oxygen concentration. When in the auto ranging mode, regardless of the user-defined values that have been set, the analyzer will automatically switch from the LO range to the HI range when the oxygen concentration reaches 100% of the LO range fullscale value, and will switch back to the LO range when the oxygen concentration reaches 85% of the LO range fullscale value.

Note: The HI Range value MUST be set at a higher value than the LO Range value.

4.3.1 HI Range

Setting the HI Range fullscale value defines the LEAST sensitive analysis range to be used. To set the HI Range:

1. Press the SET HI RANGE function button once.
2. Immediately (within 5 seconds) press either the Δ or ∇ button to raise or lower the displayed value, as required, until the display reads the desired fullscale percent value.

4.3.2 LO Range

Setting the LO Range fullscale value defines the MOST sensitive range to be used. To set the LO Range:

1. Press the SET LO RANGE function button once.
2. Immediately (within 5 seconds) press either the Δ or ∇ button to raise or lower the displayed value, as required, until the display reads the desired fullscale percent value.

4.4 Setting the Alarm Setpoints

The alarm setpoints can be adjusted over the full range of the analyzer (0-25% oxygen content). They are set as a percent of oxygen content, so that an alarm set to indicate 9.6 on the display will activate at 9.6% O₂ on any O₂ range.

Note: The HI Alarm setpoint MUST be set at a higher alarm setpoint than the LO Alarm setpoint.

4.4.1 HI Alarm

Setting the HI Alarm sets the concentration ABOVE which the HI Alarm will activate. To Set the HI Alarm:

1. Press the SET HI ALARM function button once.
2. Immediately (within 5 seconds) press either the Δ or ∇ button to raise or lower the displayed value, as required, until the display reads the desired percent concentration.

4.4.2 LO Alarm

Setting the LO Alarm sets the concentration BELOW which the LO alarm will activate. To set the LO Alarm:

1. Press the SET LO ALARM function button once.
2. Immediately press either the Δ or ∇ button to raise or lower the displayed value, as required, until the display reads the desired percent concentration.

4.4.3 Sensor Fail Alarm

The SENSOR FAIL alarm is factory preset in the instrument software at 0.05%. It cannot be changed by the user. It is a low O₂ alarm and triggers when the O₂ level is below this level of 0.05% O₂.

Teledyne incorporates a low O₂ alarm to indicate sensor failure, since for a percent O₂ sensor, the most common failure mode is depletion of the lead anode over time and O₂ exposure, which results in a zero or near zero signal from the sensor.

Should this alarm trigger, the ALARM Indicator below the SET function buttons will blink, and the alarm relay contact dedicated to this function will change state.

4.5 Selecting a Fixed Range or Autoranging

The Model 3290 can operate in fixed high, fixed low, or autoranging mode. To change modes:

1. Press and then release the SET HI RANGE and the SET LO RANGE buttons simultaneously.
2. Immediately (within 5 seconds) press either the Δ or ∇ button until **Auto**, **Lo**, or **Hi** displays on the LCD, as desired.

After about three seconds, the analyzer resumes monitoring in the selected range mode.

4.6 Calibration

Preliminary—If not already done: Power up the Analyzer and allow the LED reading to stabilize. Set the Alarm setpoints and the analysis ranges to the desired values.

Procedure:

1. Expose the sensor to ambient air or instrument grade air (20.9% oxygen). Allow time for the sampling system to purge and the analyzer to achieve equilibrium.

Note: Teledyne recommends not to use breathing air cylinders as a calibration source since the oxygen concentration has been found to vary between 19.5-23.5% oxygen. Always refer to the analysis certificate supplied with the gas cylinder and use the analyzed concentration for the calibration value. This will ensure the maximum accuracy for the analyzer.

Note: If the analyzer goes overrange, the display will go blank and the front panel ALARM Indicator, beneath the SET function buttons, will blink. Hold down the SPAN button until the ALARM Indicator stops blinking.

2. Press the SPAN button once.
3. Immediately (within 5 seconds) press either the Δ or ∇ button until the display is stable and reads 20.9%.

The unit is now calibrated.

Note: The alarms will be disabled for about 25 seconds after the SPAN button is released. Disabling the alarms allows air to be purged from the sample system without tripping any alarm set below span (20.9%). Do not attempt to adjust any alarm setpoints while the alarms are disabled during the 25-second period.

Maintenance

Aside from normal cleaning and checking for leaks at the gas connections, the Model 3290 should not require any maintenance beyond replacement of expended sensors, and perhaps a blown fuse. Routine maintenance includes occasional recalibration, as described in Chapter 4, *Operation*.

5.1 Replacing the Fuse

5.1.1 AC Powered Units

When a fuse blows, check first to determine the cause, then replace the fuse using the following procedure:

1. Disconnect the AC power and place the power switch located on the rear panel in the **O** position. Remove the power cord from the receptacle.
2. The fuse receptacle is located in the power cord receptacle assembly in the upper left-hand corner of the rear panel. See Figure 5-1.

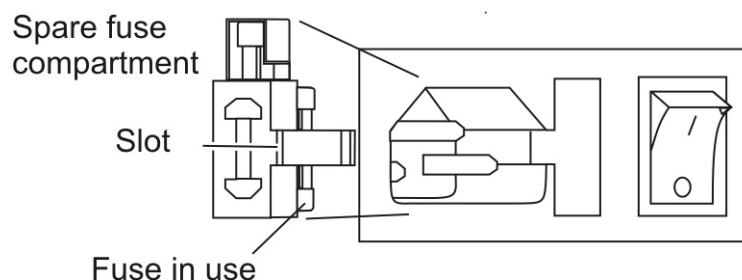


Figure 5-1: AC Fuse Replacement

3. Insert a small flat-blade screwdriver into the slot in the receptacle wall nearest the fuse and gently pry open the fuse receptacle. The fuse holder will slide out. The fuse in use is visible in the clip. To open the spare fuse compartment, push on one end until it slides out.
4. Remove the bad fuse and replace it with a 5×20 mm 0.5 A, 250 VAC, time lag (T) fuse (P/N F1128) for AC units.
5. Replace the fuse holder into its receptacle, pushing in firmly until it clicks.
6. Restore power to the analyzer.

5.1.2 DC Powered Units

In units with DC power, the fuse is located on the rear panel above the ON/OFF switch.

1. Place the power switch on the rear panel to the O position.
2. Open the fuse holder by unscrewing and removing the cap marked FUSE.
3. The fuse is located inside the receptacle, not inside the cap. Both terminals are on the same end of the fuse. Pull straight out without twisting to remove the old fuse from the receptacle, and replace it with a 0.5 A, 125 VDC, very quick acting (FF) microfuse (P/N F51).
4. Replace the cap by screwing it back into the receptacle.
5. Turn the instrument back on.

5.2 Sensor Installation or Replacement

5.2.1 When to Replace a Sensor

The characteristics of the oxygen sensor show an almost constant output through their useful life, and then fall off sharply towards zero at the end. Normally, very little adjustment will be required to keep the analyzer calibrated properly during the duration of a cell's useful life.

If the sample being analyzed has a low oxygen concentration, cell failure will probably be indicated by the inability to properly calibrate the analyzer. If large adjustments are required to calibrate the

instrument, or calibration cannot be achieved within the range of the $\Delta\nabla$ buttons, the cell may need replacing. Read the section *Cell Warranty Conditions*, below, before replacing the cell.

In addition, if the front panel Percent Oxygen Meter displays “0.00” when the unit is plugged in, and the power switch is in the ON position, the sensor needs to be replaced.


IMPORTANT: *After replacing the oxygen sensor, the analyzer must be recalibrated. See Calibration in Chapter 4.*


5.2.2 Ordering and Handling of Spare Sensors

To have a replacement cell available when it is needed, TAI recommends that one spare cell be purchased shortly after the instrument is placed in service, and each time the cell is replaced.

Note: *Do not stockpile cells. The warranty period starts on the day of shipment. For best results, order a new spare cell when the current spare is installed.*

The spare cell should be carefully stored in an area that is not subject to large variations in ambient temperature (75° F, 23.9°C nominal), and in such a way as to eliminate the possibility of incurring damage.

CAUTION:  **DO NOT DISTURB THE INTEGRITY OF THE CELL PACKAGE UNTIL THE CELL IS TO ACTUALLY BE USED. IF THE CELL PACKAGE IS PUNCTURED AND AIR IS PERMITTED TO ENTER, CELL-LIFE WILL BE COMPROMISED.**

CAUTION:  **THE SENSOR USED IN THE MODEL 3290 USES ELECTROLYTES WHICH CONTAIN SUBSTANCES THAT ARE EXTREMELY HARMFUL IF TOUCHED, SWALLOWED, OR INHALED. AVOID CONTACT WITH ANY FLUID OR POWDER IN OR AROUND THE UNIT. WHAT MAY APPEAR TO BE PLAIN WATER COULD CONTAIN ONE OF THESE TOXIC SUBSTANCES. IN CASE OF EYE CONTACT, IMMEDIATELY FLUSH EYES WITH WATER FOR AT LEAST 15 MINUTES. CALL PHYSICIAN. (SEE APPENDIX OR ADDENDUM, MATERIAL SAFETY DATA SHEET—MSDS).**

5.2.3 Removing the Oxygen Sensor

No tools are required to replace the cell in the instrument for either the standard E-2 sensor or the optional C-5 or C-5F sensors.

To remove a spent or damaged E-2 oxygen sensor:

1. Disconnect the Power Source from the Unit.
2. Unplug the connector from the spent cell.
3. Remove the spent cell by unscrewing it, counterclockwise, from the cell block.
4. Dispose of the cell in a safe manner, and in accordance with local laws.


Depending on the application, some units are shipped with the C-5 or C-5F oxygen sensor. The procedure for installing the cell is different for these sensors. If your instrument is equipped with a C-5 or C-5F oxygen sensor:

To remove a C-5 or C-5F sensor:

1. Disconnect power to the analyzer.
2. Remove probe assembly from sensor manifold.
3. Unscrew (counterclockwise) the cap at the bottom of the sensor holder and the cell will drop out of the cavity.
4. Dispose of the spent cell in a manner consistent with local and federal guidelines.

5.2.4 Installing the Oxygen Sensor

To install a new E-2 oxygen sensor:

CAUTION:  **DO NOT SCRATCH, PUNCTURE, OR DAMAGE THE SENSING MEMBRANE OF THE OXYGEN SENSOR. DAMAGE TO THE MEMBRANE WILL REQUIRE REPLACEMENT OF THE OXYGEN SENSOR.**

1. Disconnect power to the analyzer.
2. Remove the new oxygen sensor from its protective bag, being careful not to lose the O-ring at the base of the threaded portion of the cell.
3. Replace the cell on the cell holder by screwing it clockwise into the cell block until it is held firmly in the socket.

4. Insert the cell block electrical connector plug into the socket in the sensor in such a way that the sensing membrane is facing down to facilitate water evaporation away from the sensing membrane and that any bubbles that form will migrate away from the sensing cathode due to gravity effects.
5. Reconnect power to the instrument.

To install a new C-5 or C-5F sensor:

1. Disconnect power to the analyzer.
2. Remove the new cell from its package, and carefully remove the shorting clip. Do not touch the silver-colored sensing surface of the cell, as it is covered with a delicate Teflon[®] membrane that can be ruptured in handling.
3. Place the cell on the end of the cell holder cap so that the sensing surface of the cell is in contact with the cap and the electrical contact plate end of the cell is facing upwards. The sensing membrane should face downward to facilitate water evaporation away from the sensing membrane and any bubbles that form will migrate away from the sensing cathode due to gravity effects.
4. Screw the cap back into place. Apply as much pressure as you can with your fingers, but use no tools. Then insert the probe with the new cell into the manifold cavity.
5. Reconnect power to the instrument.

5.2.5 Cell Warranty Conditions

The E-2 oxygen sensor is the typical cell used in the Model 3290. This cell is a long life cell and is warranted for 2 years (under specified operating conditions—see Appendix) from the date of shipment. Note any Addenda attached to the front of this manual for special information applying to your instrument. Some instruments are shipped with a C-5 or C-5F cell. These sensors are used in applications requiring extended cell lifetime in air or long lifetime in the presence of CO₂. These cells carry a 6 months warranty.

With regard to spare cells, warranty period begins on the date of shipment. The customer should stock only one spare cell per instrument at a time. Do not attempt to stockpile spare cells.

If a cell was working satisfactorily, but ceases to function before the warranty period expires, the customer will receive credit toward the purchase of a new cell.

With any warranty claim, the customer must return the cell in question to the factory for evaluation. If it is determined that failure is due to faulty workmanship or material, the cell will be replaced at no cost to the customer.

Note: Evidence of damage due to tampering or mishandling will render the cell warranty null and void.

Appendix

A.1 Specifications

Ranges: Two user selectable % ranges can be set between 1% and 25 % O₂ plus fixed 0-25% cal range. (Optional 0-100% range is available. Consult factory.)
Standard ranges configured as 0-3% and 0-10%.

Sensor: E-2 Oxygen Sensor (standard)
C-5, C-5F Oxygen Sensor (optional)

Signal Output: Voltage: 0–10 VDC, negative ground
Current: 4-20 mA, negative ground

Range ID: 0-10 VDC

Display: Light emitting diode.

Alarms: One high alarm relay, adjustable; one low alarm relay, adjustable; one sensor failure relay. (All are failsafe.)

System Operating Temp: 32-122°F (0-50 °C)

Accuracy: ±2% of full scale at constant temperature and pressure
±5% of full scale through operating temperature range once temperature equilibrium is reached and at constant pressure

Response Time: 90% in less than 20 seconds at 77°F (25 °C)

System Power Requirements: AC (100 to 240 VAC, 50/60 Hz), or DC (10-36 VDC, 15 W); user specified

Power Consumption: 70 Watts

System Enclosure: *Panel Mount:* 2.81" H × 6.0" W × 2.87" D
(71.4 mm × 152.4 mm × 72.9 mm)
Face Plate: 3.75" H × 7.0" W (95.3 mm H
× 177.8 mm W)

Sensor Type: E-2 (typical)
C-5, C-5F (optional)

Analysis Unit: 4.0" H × 6.0" W × 2.5" D
(101.6 mm × 152.4 mm × 63.5 mm)

A.2 Spare Parts List (Standard Version)

QTY.	P/N	DESCRIPTION
1	C-65220	PC Board, Main
1	C-64586	PC Board, Power Supply
1	C-57283-E2	E-2 Oxygen Sensor
1	A33748	Thermistor Assembly
4	F-1128	Fuse (AC), ½A, 250 VAC
4	F-51	Fuse (DC), ½A, 125 VDC
1	A-64678A	Probe to Analyzer Cable, 6 ft

IMPORTANT: *Orders for replacement parts should include the part number and the model and serial number of the system for which the parts are intended.*

Send orders to:

Teledyne Analytical Instruments
16830 Chestnut Street
City of Industry, CA 91749-1580

Telephone: (626) 934-1500
TWX: (910) 584-1887 TDYANYL COID
Fax: (626) 961-2538

or your local representative.

A.3 Drawing List (Standard Version)

C-64771	Outline Diagram
C-64643	Final Assembly (and interconnection diagram)
C-64773	Control Unit Assembly
C-65946	Analysis Unit Assembly

A.4 Miscellaneous

The symbol: ~ is used on the rear panel of the Model 3290 to signify volts alternating current (VAC).