OPERATING INSTRUCTIONS FOR

Model 3110

Portable Trace & Percent Oxygen Analyzer

P/N M82155
12/05/11

DANGER

Toxic gases and or flammable liquids 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.

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.

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.

CAUTION: 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.

No Symbol

NOTE: Additional information and comments regarding a specific component or procedure are highlighted in the form of a note.

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.

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 TAI 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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DANGER
COMBUSTIBLE GAS USAGE
WARNING

This instrument is approved as an intrinsically safe gas analyzer for use in a Division 1 Group A-D hazardous area. Note that this approval does not apply to the non-conductive LCD window and micro-fuel cell. Also, although the analyzer is capable of being ranged up to 25% oxygen, the approval does not apply to oxygen exposure above 20.9%. This approval applies only to the equipment specified and installed in accordance with the information contained within this manual. 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 Introduction

The Teledyne Analytical Instruments (TAI) Model 3110 Portable Oxygen Analyzer is a portable, intrinsically safe oxygen analyzer capable of analyzing oxygen levels from 0-10 parts per million (ppm) oxygen to 25% oxygen (dependent on configuration). These units are rated as intrinsically safe and may be used in a Class I, Div 1, Group A-D hazardous environment. The instrument operates from internal rechargeable batteries and is supplied with a universal AC charge adapter. It features quick-disconnect fittings for sample connections and a rugged, lightweight housing with handle. This versatile instrument can be brought to the sample site and set up for analysis quickly and easily. Because of the intrinsically safe design, the instrument can be employed even in hazardous environments without compromise once calibrated. The Model 3110 incorporates a large standard feature list designed for versatile, accurate oxygen analysis for a wide range of applications. Figure 1-1 shows the standard Model 3110 Portable Trace Oxygen Analyzer.

The microprocessor based Model 3110 instrument provides one user settable analysis range in both trace and percent sensitivities. The range can be set from 0-10 ppm to 25% oxygen with lower ranges or percent sensitivity models available.

Sample oxygen is displayed on a 2-line 20 character alphanumeric LCD display mounted on the front panel. Four buttons are used to interface with the instrument and access all of the analyzer features.

Sample gas is introduced and vented via a pair of quick-disconnect fittings that feature integral shutoff valves which automatically close when the mating male fitting is withdrawn. The fittings are an integral part of the measuring cell manifold so that internal sample passage volume is at an absolute minimum.

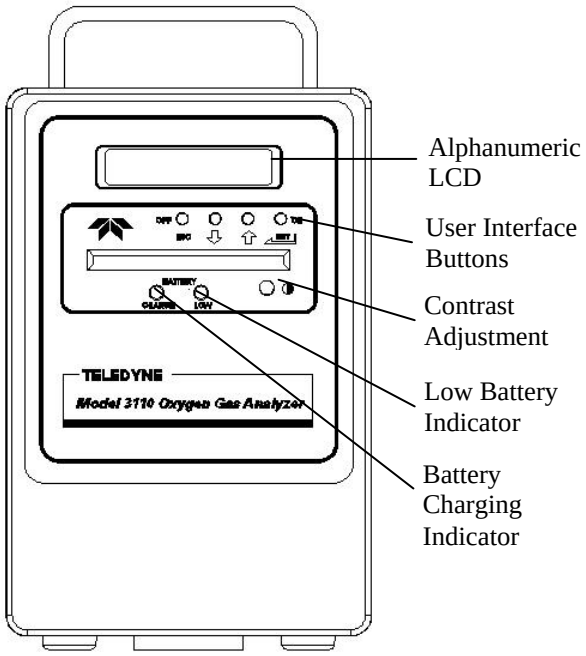

Figure 1-1: Model 3110 Portable Trace Oxygen Analyzer

1.2 Features

This instrument is designed to be versatile analytical instrument and to perform reliably and accurately in analyzing oxygen concentrations in gas mixtures from ppm levels through 25% oxygen. The following features are standard on the Model 3110:

- **Display:** A 2-line 20 character alphanumeric LCD on the front panel displays data and operational information through various screens. The contrast is adjustable for various lighting conditions.
- **Four-Button User Interface:** Operation is performed using the four front panel mounted buttons. These buttons are used to enter data, select items and move through operational screens that appear on the display.
- **Universal AC Charge Adapter:** The batteries can be recharged without removing them from the instrument. The charger operates over the range of 100-240 VAC.

- **LEDs:** Two front panel-mounted LEDs are used to indicate low battery condition and when the battery is recharging.
- **Contrast Control:** This feature allows the user to easily adjust the contrast of the display for optimum viewing under different lighting conditions. The adjustment is made using a front panel control dial.
- **Percent of Range Voltage Output:** A 0-1 VDC output is available that represents the percentage of the current analysis range.
- **Data Logger:** The optional built-in data logging feature allows the user to specify the time interval between data recording sets. The date, time, and oxygen concentration readings are stored in internal RAM at the user specified interval. The data set can be downloaded using the instrument's 9-pin serial interface.
- **Real-time Clock:** This feature allows the Model 3110 to date and time stamp the data set recorded on the data logger. It uses a 24 hour clock.
- **Quick Disconnect Fittings:** Dual self-sealing quick disconnect fittings are installed for easy sample connections.

1.3 Method of Analysis

The sample oxygen is measured by a unique electrochemical transducer which functions as a fuel cell; in this instance, the fuel is oxygen. Oxygen diffusing into the cell reacts chemically to produce an electrical current that is proportional to the oxygen concentration in the gas phase immediately adjacent to the transducer's sensing surface. The linear, but minute signal produced by the transducer from trace oxygen is amplified by a two-stage amplifier. Sensor output signal is digitized and fed to the microprocessor. Additional signal conditioning and temperature compensation are handled electronically and appropriate signals are directed to the display and output ports.

1.4 Micro-Fuel Cell

The micro-fuel cell (U.S. Pat. Nos. 3,767,552 and 3,668,101) is a sealed electrochemical transducer with no electrolyte to change or electrodes to clean. When the cell reaches the end of its useful life, it is thrown away and replaced. The life of the cell is warranted by TAI (see below).

The cell is specific for oxygen and is not sensitive to flowrate or reducing agents such as hydrocarbons, carbon monoxide, sulfur dioxide, etc. In the absence of oxygen, no current is produced; thus, no zeroing is required.

1.4.1 Cell Warranty

The Class B1, B2-C, A2C, B2C-XL, Insta-trace and NG series micro-fuel cells used in the Model 3110 carry a six (6) month warranty.

With regard to spare cells, service time starts when the cell is removed from its shipping package. You should stock only one spare cell per instrument at a time.

If a cell was working satisfactorily but ceases to function before the warranty period expires, you will receive credit on a pro-rated basis toward the purchase of a new cell.

If you have a warranty claim, 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 you.

WARNING: EVIDENCE OF DAMAGE DUE TO TAMPERING OR MISHANDLING WILL RENDER THE CELL WARRANTY NULL AND VOID.

The Model 3110 is rated as intrinsically safe and may be used in a Class I, Div 1, Group A-D hazardous environments.

This safety feature **does not** apply when the instrument is being charged with the 100- 240 VAC external charge adapter. The instrument should be removed from hazardous areas when the batteries are being charged.

Note: Do not use the analyzer when the battery level is low.

1.5 Accuracy and Response

The Model 3110 provides monitoring accuracies of ±2% of full scale or ±1 ppm, whichever is greater, at constant temperature.

With a sample flowrate of 1 SCFH, a 90% response can be achieved in 10 seconds when analyzing in the percent range. At the trace levels (ppm analysis), a 90% response can be realized in 60 seconds or less. The response time on the 3110 is limited by the filter setting.

1.6 Signal Output

This analyzer includes a 0-1 VDC output as standard. This signal is suitable for driving external devices that have an input impedance of 10,000 Ω or more. The signal output is available from a port on the rear panel.

1.7 Compact Packaging

The instrument is housed in 6 1/8" × 9 1/2" × 5 5/8" (156 × 241 × 143mm) aluminum case that is equipped with a carrying handle and foot pads.

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Installation

The Model 3110 Trace/Percent Oxygen Analyzer is designed to be portable and easy to setup and configure. To setup the analyzer:

- Read the manual
- Charge the batteries
- Install the sample and vent gas lines
- Install the trace sensor and purge the analyzer
- Install the percent sensor (no purging required)
- Set the sample gas flowrate
- Calibrate the analyzer

2.1 Charging the Batteries

The unit is powered by two intrinsically safe rated sub-C Ni-Cd batteries and is shipped with batteries fully charged. The batteries, however, will require periodic recharging. For recharging, access to an AC power source of 100 to 240 volt, 50/60 Hz will be required. The instrument should not be recharged in a hazardous area. Connect the universal AC charger adapter supplied with the instrument to the AC power outlet. Plug the other end of the charger into the port on the rear panel as shown in Figure 2-1. The green charge indicator LED should be illuminated to indicate that the unit is charging.

To fully recharge a set of batteries will take approximately 16 hours. The instrument should not be left on the charger for longer than 20 hours nor should the charger be left attached to the instrument when the unit is not charging. The Model 3110 cannot be operated while the battery charger is attached.

CAUTION: **DO NOT CHARGE THE BATTERY IN A HAZARDOUS AREA. THE INTRINSICALLY SAFE CLASSIFICATION OF THIS INSTRUMENT DOES NOT APPLY WHEN THE CHARGER IS ATTACHED TO THE INSTRUMENT. REMOVE THE INSTRUMENT TO A NON-HAZARDOUS AREA BEFORE CONNECTING THE BATTERY CHARGER TO THE INSTRUMENT.**

The unit can operate continuously for approximately 4 days on a set of fully charged batteries. If more frequent charging is required, the batteries are approaching the end of their useful life and should be replaced. See Battery Replacement in Section 4.3 of this manual.

A low battery condition is indicated by a blinking red Low Battery LED on the front panel. This will also cause the display to flicker along with the blinking LED due to the power drain and low battery condition. At this point the unit should be removed from service and the batteries recharged.

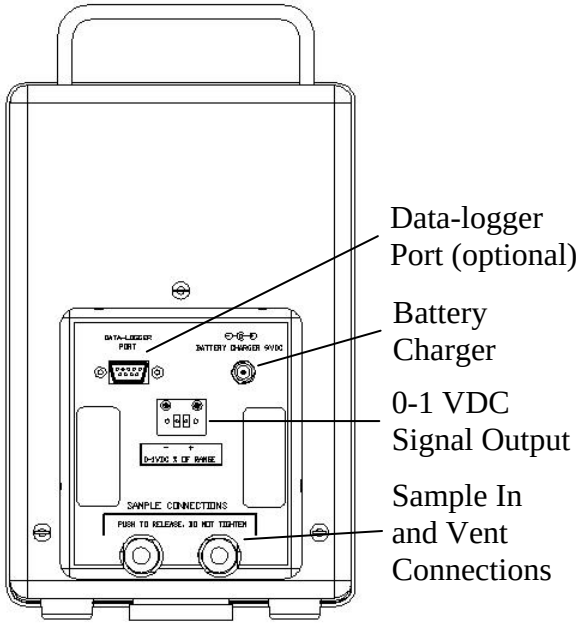


Figure 2-1: Model 3110 Rear Panel

2.2 Gas Connections

The customer must provide a means of controlling the pressure and flowrate of the applied gas. For positive pressure applications, TAI suggests a simple throttle valve installed in the sample line between the sample point and the analyzer. The flowrate should be limited to between 0.2 and 2.5 SCFH. The Sample In port is used for both sample and calibration gas. For sampling at atmospheric pressure, connect a pump and flow control valve **downstream** of the analyzer and draw (rather than push) the sample through the instrument.

IMPORTANT: IF A PRESSURE REGULATOR IS USED, IT MUST HAVE A METALLIC DIAPHRAGM. REGULATORS WITH ORGANIC OR PLASTIC DIAPHRAGMS ARE PERMEABLE TO OXYGEN AND, IF USED IN THE SAMPLING SYSTEM, WILL LEAD TO HIGH OXYGEN READINGS.

The instrument is shipped with a gas sampling and calibration kit. This includes a 12” piece of clear tubing with a quick disconnect line for use as a sample return or vent line plus two quick disconnect fittings to be installed on the sample and calibration lines. These fittings employ 1/4” tube fittings which can be removed to reveal a 1/8” NPT internal thread.

It is important in trace analysis applications to use metal for all wetted components of the sample system. This includes gas lines, filters, pump housing, diaphragms and any components in contact with the sample gas. Plastic tubing and parts can be used for percent analysis but will result in slow and inaccurate measurements at the ppm level.

There are two quick disconnect fittings installed on the rear panel for mating the instrument with the sample or calibration gas and the vent line. As shown in Figure 2-1, each fitting has a button which when depressed allows the rapid detachment of the gas line from the instrument. It is not necessary to press the button when inserting the line, just push the male fitting into the mating connector. When a line is removed, an internal seal prevents gas escape from the female sections of the fitting.

Note: To avoid pressurizing the sensor, the vent line should be installed first and removed last.

In setting up the sample lines, any valves used to set the sample flow or filters must be located on the Sample In line. Do not place any valves or restrictions on the vent line except as noted above for atmospheric pressure sampling when using a downstream pump. Doing so would increase the sensor operating pressure and result in inaccurate analysis.

For trace analysis applications, a flowmeter should be installed in the vent line but should not incorporate any control valves or restrictive devices. For percent measurement applications, flowmeters or rotameters (with or without control) valves can be placed upstream of the analyzer, i.e. on the Sample In line.

2.3 Sensor Installation

The Model 3110 can accept either a percent or trace analysis sensor. The procedure is similar for either sensor; however, a trace sensor requires that the instrument lines be immediately purged with zero gas after installing the cell.

2.3.1 Installing a Percent Sensor

To install a percent sensor:

1. Remove the cell holder cap from the bottom of the instrument.
2. Remove the sensor from its packaging.
3. Remove the shorting plug at the top of the sensor.
4. Place the sensor on the top of the cell holder cap with the concentric gold rings facing up.
5. Screw the cell holder cap and sensor into the bottom of the analyzer.

2.3.2 Installing a Trace Sensor

Prior to installing the trace sensor, make sure the analyzer is ready to purge with zero gas. Connect the vent line to the analyzer then connect the zero gas line to the sample in port. Set the zero gas flow rate to between 0.2 and 2.5 SCFH.

Prior to using any bottled gas for calibration or purge, it is good practice to bleed the regulator and sample line to remove any traces of trapped air. See Section 2.4.3 Bleeding the Regulator and Purging the Gas Line.

Once the vent and zero gas lines are attached and the lines are properly purged, proceed to install the trace sensor as follows:

1. Remove the cell holder cap from the bottom of the instrument.
2. Remove the outer packaging from the sensor.
3. While the sensor is still in its packaging, grip the shorting plug through the bag and remove it from the sensor.
4. Remove the packaging and rapidly place the sensor on the top of the cell holder cap with the concentric gold rings facing up.

5. Screw the cell holder cap and sensor into the bottom of the analyzer.

Note: Minimize the time the sensor is exposed to air.

6. Start the purge flow through the analyzer and purge overnight before calibrating the unit.

2.4 Calibration

Calibration involves using a span gas to calibrate the instrument. The proper span gas oxygen concentration depends on the range that the instrument will be used. The correct concentration should be 80-90% of the range used. For instance, if the analyzer is to be used on a range of 0-100 ppm oxygen, then a span gas should be prepared with 80-90 ppm oxygen in nitrogen. If the analyzer is going to be used on a percent range, acceptable accuracy may be obtained using air as a span gas.

2.4.1 Calibration Using Air for Percent Analysis

Note: Calibration requires a familiarity with the operational screens and general operation of the instrument. Read Chapter 3 to understand how to operate the instrument before proceeding with the calibration step.

To calibrate the instrument using ambient air as a span gas:

1. If not already powered up, press the ENTER key to turn the instrument on.
2. Set the filter to 1 or 2 on the filter screen.
3. Navigate to the *SPAN VALUE* screen and set the span to 20.9%. See Section 3.2.6.
4. Select the *SPAN* screen.
5. Install the vent and sample in lines in that order.
6. Remove the cell holder cap on the bottom of the instrument. This exposes the cell to air for calibration.
7. Replace the cell holder cap after a few seconds and observe the oxygen reading on the SPAN screen.
8. When the reading appears stable, select *SPAN: START*.
9. When the screen changes to *SPAN: FINISH*, select *SPAN: FINISH*.

10. Expose the cell holder to air again by removing the cell holder cap for a few seconds. Verify that the oxygen reading is 20.9%.

Once the cell holder cap is sealed, the sensor will slowly consume the trapped oxygen. You should notice that the on-screen oxygen reading should slowly decrease as the oxygen is consumed.

The instrument is now calibrated and you can remove the sample-in line and the vent line in that order.

2.4.2 Calibration Procedure for Trace Analysis

To calibrate the Model 3110 for trace oxygen measurements, the instrument must be fitted with a trace sensor. The instrument must also be purged overnight using a zero gas (a pure gas with no oxygen, typically O_2 free N_2) before calibrating.

To calibrate the analyzer for trace analysis:

1. Purge the analyzer overnight.
2. Purge the calibration gas sample line, regulator, and control valve. See Section 2.4.3.
3. Set the calibration gas flowrate to 1 SCFH.
4. Attach the vent line followed by the span gas line using the quick disconnect fittings.
5. Navigate to the SPAN VALUE screen (see Section 3.2.6) and set the span value to the known oxygen concentration in ppm of the span gas.
6. Observe the oxygen reading on the screen to determine when the reading has stabilized.
7. Navigate to the SPAN screen and select SPAN: START.
8. When the screen changes and displays SPAN: FINISH, select SPAN: FINISH to set the span.
9. Allow the span gas to flow for several minutes to verify the proper span setting.
10. Calibration is complete. Remove the span gas line first followed by the vent line.

2.4.3 Bleeding the Regulator and Purging the Gas Line

When using bottled gas (gas cylinder) as a calibration gas for trace analysis applications, the regulator and sample lines should be purged to

remove traces of trapped air. Otherwise, trapped air in the lines (especially between the regulator and cylinder) will cause the analyzer reading to slowly change over a period of hours.

To bleed the regulator and sample line:

1. Attach the regulator to the gas cylinder. Then attach a sample line with a flow control/shut off valve preferably at the far end of the sample line.
2. Open the shut off valve slightly, and then open the valve on the gas cylinder.
3. Adjust the regulator to the desired pressure (usually 5 psi) then close the cylinder valve.
4. Open the cylinder valve to pressurize the regulator fully then close the cylinder valve again.
5. Open the sample flow control valve and allow the gas to bleed down and vent to a safe area. Observe the secondary gauge (low pressure side) on the regulator. As the low pressure gauge starts to fall, close the sample flow control valve.
6. Repeat steps 4 and 5 seven (7) times.

The sample delivery system is now purged and ready for calibration or analysis. Keep the cylinder valve open to maintain system pressurization.

Note: Make sure there are no leaks in the sample line and regulator connections. Check also the cylinder connection for leaks.

2.5 Set the Sample Flowrate

Once the system has been calibrated, the instrument can be brought to the analysis site and the sample gas line can be connected to the unit. Using the quick disconnect fittings supplied, connect the vent line followed by the sample line to the rear panel. See Figure 2-1.

Once the sample gas is flowing, set the flow rate to 0.2-2.5 SCFH.

2.6 External Signal

A 0-1 VDC output signal is included with the Model 3110. When installed, the output signal represents the percentage of oxygen in the current range. For instance, if the range was set for 0 to 10 ppm, then 0.1

V would represent 1 ppm, 0.2V would be 2 ppm; 0.3V would be 3 ppm etc.

This output signal, when installed, is accessible from the rear panel.

Operation

The Model 3110 is supplied completely assembled and ready for use. The micro-fuel cell is supplied in a separate sealed bag, and in the case of trace sensors, was purged with an inert gas.

Turning the instrument on by pressing the ENTER key will power the display and show the power on screen briefly (if the display shows nothing or is very dark, adjust the contrast). The display will then change to indicate the oxygen concentration within the internal sample passageways if no sample line is attached.

Note: To extend cell life and minimize the time required to make the next analysis, the instrument should always be purged with an oxygen free inert gas prior to being taken out of service for standby or storage.

3.1 Front Panel Interface

The Model 3110 is controlled from the keys on the front panel and is shown in Figure 3-1. These keys are also used to setup the instrument for your application. The keys are:

- ENTER/ON
- ESC/OFF
- UP
- DOWN

3.1.1 ENTER Key

The ENTER key is context sensitive. It is used as follows:

- **Powering ON or OFF**—Pressing the ENTER key turns the power ON. The ENTER key is also used the power OFF from within the *POWER OFF* screen.
- **Enter SETUP**—In certain menus, pressing the ENTER key selects a setup screen for that particular function. Navigation arrows on the left and right of the bottom line identify these screens as setup screens by changing from UP/DOWN to LEFT/RIGHT. The setup screens also blink.

- **Select a value**—When multiple options or values exist for a function, pressing ENTER selects the currently displayed option.
- **Save changes**—If a value or option has been modified, pressing ENTER saves the change and brings you back to the previous screen.

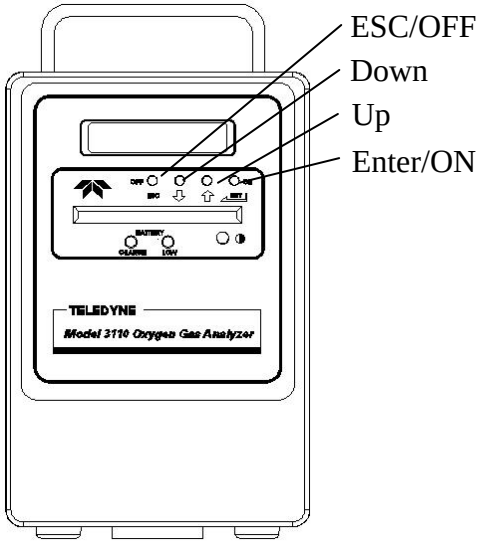


Figure 3-1: Front Panel Keys

3.1.2 ESCAPE Key

The Escape (ESC) key is used to exit a setup menu without saving any changes made to that screen. The values will revert to the last value saved for that entry.

3.1.3 UP/DOWN Keys

The UP/DOWN keys are used to:

- Navigate from one screen to another
- Toggle between multiple options within a menu
- Increment or decrement a value

3.2 Operation and Setup Screens and Menus

The Model 3110 operation and setup functions are arranged in a set of 15 menus. All but the *POWER ON* screen are accessible via the

UP/DOWN keys. Figure 3-2 shows the available menus and the sequence of screens when scrolling.

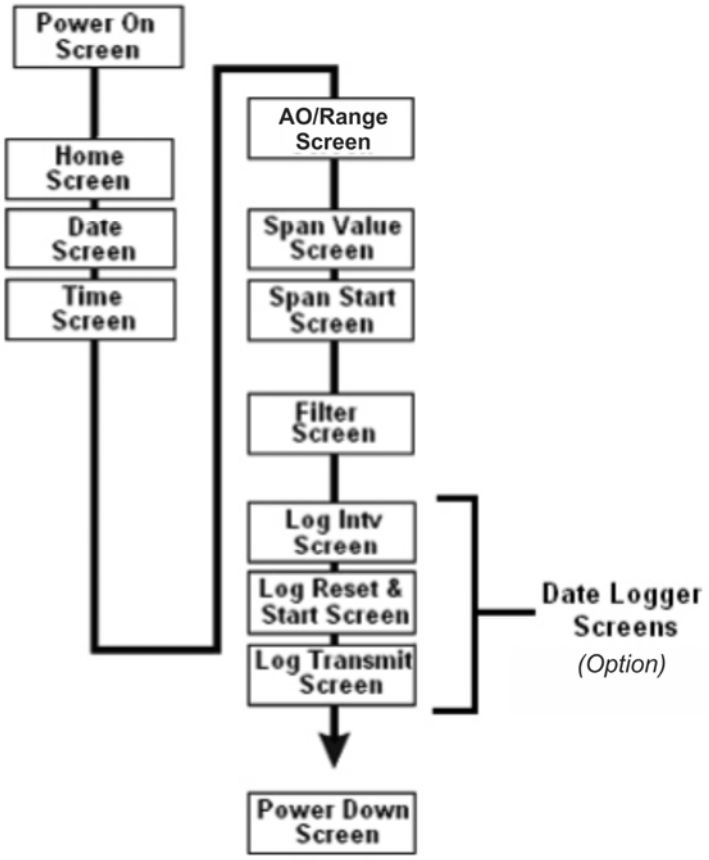


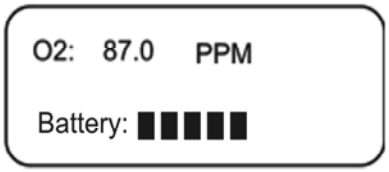
Figure 3-2: Available Menus and Their Sequence

3.2.1 POWER ON *Screen*

The *POWER ON* screen automatically appears on the display when the unit is first powered up. The display appears briefly and shows the model number and software version. After a few seconds the display reverts to the *HOME* screen.

3.2.2 HOME Screen

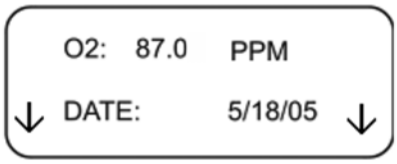
The HOME screen displays the oxygen concentration at the level of the current range (ppm or %). The concentration is shown in the upper line the current range is indicated on the second line.



Note: In almost all available screens, the first line displays the oxygen concentration.

3.2.3 DATE Screen

Use the UP/DOWN keys to navigate to the *DATE* screen. The second line of the *DATE* screen displays the current date and is used by the data logger for date stamping data records. The currently set date is displayed on the second line of the display.



To change the currently set date:

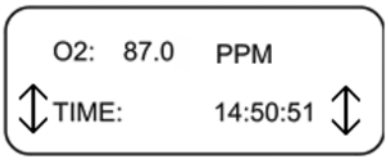
1. Press ENTER to enter the date setup function. Note the navigation arrows that appear on the left and right sides of the display change from UP/DOWN to pointing LEFT/RIGHT.
2. Use the UP/DOWN keys to alter the month. Then press ENTER. The cursor will move over to the next editable field.
3. Use the UP/DOWN keys to alter the day. Then press ENTER. The cursor will move over to the next editable field.
4. Use the UP/DOWN keys to alter the year. Then press ENTER.

5. Press ENTER again to save the current date and automatically return to the *DATE* screen.

At any time you can press the ESC key to abort the entry and return to the *DATE* screen.

3.2.4 TIME Screen

Use the UP/DOWN keys to navigate to the *TIME* screen. The second line of the this screen displays the current time in 24 hour military format. This information is used by the data logger for time stamping data records. The currently set time is displayed on the second line of the display.



To change the currently set time:

1. Press ENTER to enter the time setup function. Note the navigation arrows that appear on the left and right sides of the display change from UP/DOWN to pointing LEFT/RIGHT.
2. Use the UP/DOWN keys to alter the hour field. Then press ENTER. The cursor will move over to the next editable field.
3. Use the UP/DOWN keys to alter the minute field. Then press ENTER. The cursor will move over to the next editable field.
4. Use the UP/DOWN keys to alter the seconds field. Then press ENTER.
5. Press ENTER again to save the current time and automatically return to the *TIME* screen.

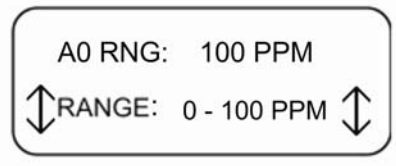
At any time you can press the ESC key to abort the entry and return to the *DATE* screen.

3.2.5 AO Rng Screen

In this screen, the user defines the analysis range which sets the scaling of the analog output to correspond to the range setting. For instance, if the range is set to 100 ppm then the 0-1 VDC output would track the concentration as follows:

Concentration (ppm)	Output (V)	Concentration (ppm)	Output (V)
0	0	60	0.6
10	0.1	70	0.7
20	0.2	80	0.8
30	0.3	90	0.9
40	0.4	100	1.0
50	0.5		

Use the UP/DOWN keys to navigate to the *AO RNG* screen and then press ENTER. The following screen appears:



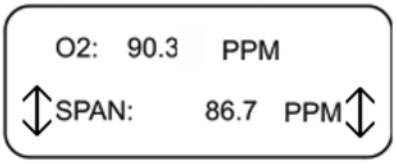
To define or change the range setting:

1. Use the UP /DOWN keys to change the range value. Press ENTER when the desired value is shown. The value will be accepted and the cursor will move to the next editable field (units).
2. Use the UP/DOWN keys to cycle between ppm and percent for units. Press ENTER to accept the displayed unit. The display will then return to the *HOME* screen.

Note: The range setting resolution is 0.1 PPM for trace analysis and 0.01% for percent analysis.

3.2.6 SPAN VALUE Screen

The *SPAN VALUE* screen displays the oxygen concentration of the span gas used for calibration. This is not a measured value; it is the known span gas concentration that is input to the analyzer by the operator.



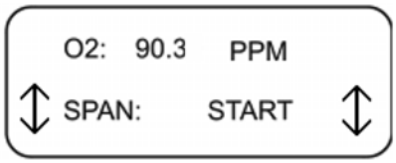
To change the span gas concentration:

1. Use the UP/DOWN keys to navigate to the *SPAN VALUE* screen. Then press ENTER to enter the setup screen.
2. Use the UP /DOWN keys to change the span value. Press ENTER to accept the displayed value and to return to the *SPAN VALUE* screen.

3.2.7 SPAN Screen

This screen is used to perform a span calibration on the Model 3110. The appropriate span value must have already been input to the instrument. See Section 3.2.6 for entering a span value into the analyzer.

CAUTION: THE CORRECT SPAN VALUE MUST BE ENTERED INTO THE INSTRUMENT THAT CORRESPONDS TO THE ACTUAL SPAN GAS USED. FAILURE TO ENTER THE PROPER VALUE WILL RESULT IN ERRONEOUS READINGS.

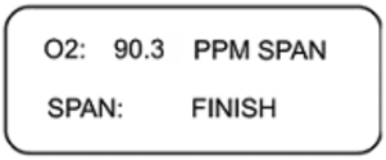


Note: The filter should be set to a low value to avoid errors during span setting. Allow the oxygen reading to become stable prior to setting the span.

To perform a span calibration:

1. Use the UP/DOWN keys to navigate to the *SPAN* screen. Then press ENTER to start the span calibration.

Once the span calibration has begun, the screen changes to reveal a span finish selection.

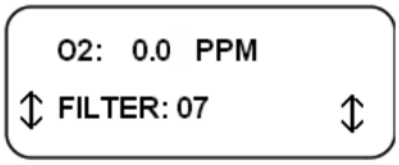


2. When the FINISH selection appears, press ENTER once the analyzer is providing a stable oxygen concentration on the span gas. This will end the span calibration. The analyzer will accept the calibration and return to the *HOME* screen.

Note: After successfully performing a span calibration, you are returned directly to the HOME screen rather than back to the previous menu.

3.2.8 Filter Screen

The 3110 includes user adjustable digital filter. The filter has settings 1-10. Setting 1 is the least amount of filtering and 10 is the highest level of damping. The filter is used to reduce the noise level of the O_2 readings. More filtering is required for lower trace ranges such as 10 ppm. Adding filtering will slow down analyzers response to changing O_2 levels. The lowest effective level of filtering should always be selected. The filter level should be lowered to 1 or 2 when setting the span to avoid delays. For a 0-10PPM range a filler setting or 6 or 7 should typically provide good results.



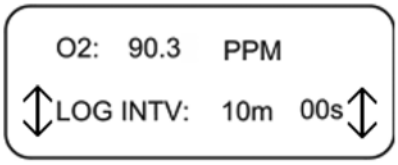
To use this feature:

1. Use the UP/DOWN keys to navigate to the *FILTER* screen. Then press ENTER to enter the setup screen.
2. Use the ENT/ON key to change the filter to the active mode. The arrows will point left and right and the filter setting will blink.
3. Use the UP/DOWN keys to select the desired setting.
4. Select the ENT/ON key to save the setting and to return to the non-active mode on the filter screen.

3.2.9 LOG INTV Screen (Optional)

This screen is for use with the data logger option only. It indicates the time interval between data samples taken by the data-logger. The interval

can be set between 1 second (00m 01sec) to 60 minutes (60m 00sec) in increments of 1 second.



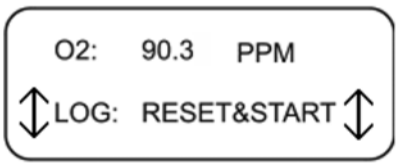
To change the interval between data samples:

1. Use the UP/DOWN keys to navigate to the *LOG INTV* screen. Then press ENTER to enter the setup screen.
2. Use the UP /DOWN keys to change the interval value. The value of the seconds will increase or decrease followed by the minutes. Press ENTER to accept the displayed value and return to the *LOG INTV* screen.

3.2.10 LOG RESET & START Screen (Optional)

Once a log interval has been input, the *LOG RESET & START* screen is used to start the data-logger.

The data logger has a 3200 record capacity and each record uses 10 bits of data. The data set is retained until it is reset by using the START RESET menu again. The data set can be downloaded using the LOG TRANSMIT screen (see Section 3.2.11).

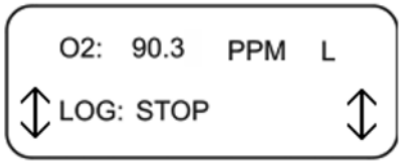


To start the data logger:

1. Use the UP/DOWN keys to navigate to the *LOG RESET & START* screen and press ENTER.
2. When the screen begins to blink press ENTER again to start the data logger. Once the data logger has started, the screen changes *RESET&START* to *STOP*. During logging a blinking “L” appears in the upper left corner of the screen.

To stop the data logger:

1. Press ENTER to stop the data logger and return to the *LOG RESET & START* screen.



3.2.11 LOG TRANSMIT Screen

Data can be downloaded to a computer using the 9-pin D-subminiature port and cable attached to a PC. The D-sub port accepts a standard data cable with a DB-9 connector. The computer must be able to accept data from a source with the following characteristics:

9600 baud

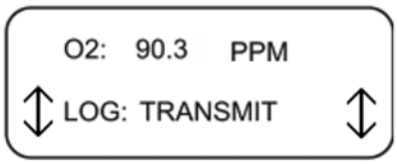
8 bit data

no parity

1 stop bit

no flow control

Refer to your computer manual for details on how to setup the RS-232 communications port on your computer.



To download a data log:

1. Use the UP/DOWN keys to navigate to the *LOG TRANSMIT* screen. Then press ENTER to enter the setup screen.
2. Press ENTER again to transmit the current data log.

Note: The data set will be transmitted each time you press the ENTER key. Use the ESC key to exit the LOG TRANSMIT

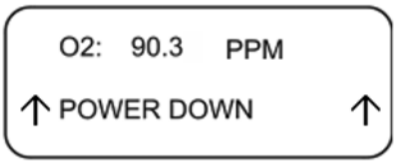
menu.

3. Press ESC to exit out of the *LOG TRANSMIT* screen and go to the home screen.

Note: The Date Log does not need to be stopped in order to transmit the date.

3.2.12 POWER DOWN Screen

This screen is used to power off the instrument. This can also be achieved by holding the ESC button for a few seconds.



To turn the analyzer off:

1. Use the UP/DOWN keys to navigate to the *POWER DOWN* screen. Then press ENTER.
2. Press ENTER again to turn the instrument OFF.

In a few seconds the analyzer will turn off.

Maintenance & Troubleshooting

4.1 Routine Maintenance

Other than replacing the sensor, there are no user-serviceable components within the instrument housing other than the cell holder O-ring. Routine maintenance consists of wiping down the instrument case, cleaning the screen and checking for leaks.

CAUTION: USING ABRASIVE CLEANSERS OR SOLVENTS WILL DAMAGE THE SCREEN. USE ONLY A MILD DETERGENT AND SOFT CLOTH WHEN REMOVING DIRT OR GREASE MARKS FROM THE SCREEN.

When cleaning the instrument case, do not flood with water or use harsh, abrasive or solvent cleansers. These cleansers will attack the LCD lens material as well as eventually wear off the silk-screened legends.

4.2 Opening the Instrument Case

CAUTION: DEPENDING ON THE APPLICATION, IT MAY BE NECESSARY TO PURGE THE INSTRUMENT THEN REMOVE THE INSTRUMENT TO A NON-HAZARDOUS AREA BEFORE OPENING THE INSTRUMENT CASE.

To open the enclosure:

1. Loosen (counter-clockwise) the three (3) ¼-turn screwdriver-type fasteners on the back of the outer enclosure.
2. Pull off the back section of the cover

4.3 Replacing the Battery

After many charge/recharge cycles of the battery, eventually the Ni-Cd batteries will have to be replaced. Usually, when the instrument requires more frequent charge cycles than before it is time to change the batteries. Refer to the Spare Parts Listing in the Appendix for the correct replacement battery. *Note: The batteries should only be replaced by a qualified technician.*

4.4 Battery Power Supply Service

The Model 3110 is designed to be intrinsically safe, and is designed for use only when **not** connected to the AC power line. TAI suggests that an overnight recharge be performed every few days for continuous use.

The low battery LED will begin to blink and the display will flicker when the batteries are getting low. At this point, the batteries should be recharged. To recharge the batteries, turn the instrument OFF (see Section 3.2.12. Remove the instrument to a safe non-hazardous location.

Note: Depending on the application, purging may be required before disconnecting the analyzer and moving it to a safe location.

Plug the AC charger into a suitable 100-240 VAC 50/60 Hz power source. Plug the other end of the charger cable into the port on the rear of the instrument. Figure 4-1 shows the AC charger port on the rear panel.

Note: During charging, the green battery charging indicator LED will illuminate.

When recharging is completed, unplug the unit from the AC outlet and disconnect the cable from the AC charger port.

Note: The analyzer cannot be turned on while the AC charger is attached.

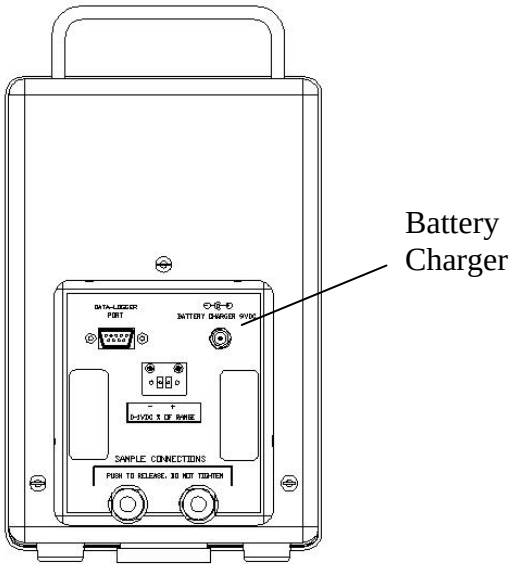


Figure 4-1: Battery Charger Port on the Model 3110

4.5 Cell Replacement

The characteristics of the micro-fuel cell are similar to those of a NiCad battery in that both provide an almost constant output through their useful life, and then fall off sharply towards zero at the end. If the sample being analyzed has a low oxygen concentration, cell failure will probably be indicated by the inability to properly calibrate the analyzer. You will find that very little span adjustment will be required to keep the analyzer calibrated properly during the duration of a given cell's useful life. If large span adjustments are required to calibrate the instrument, or calibration cannot be achieved within the range of the control, the cell should be immediately replaced. Refer to Section 4.4 before replacing the cell.

To offset the possibility of not having a replacement cell available when it is needed, TAI recommends that a spare cell be purchased shortly after the instrument is placed in service, and each time the cell is replaced thereafter.

The spare cell should be carefully stored in an area that is not subject to large variations in ambient temperature (75 °F nominal), and in such a way as to obviate any possibility of incurring damage. **Under no circumstances should you disturb the integrity of the cell package until the cell is to be actually used**. If the cell package is punctured and air permitted to enter, the cell will immediately start to react to the presence of oxygen.

CAUTION: THE MICRO-FUEL CELL CONTAINS KOH SOLUTION, WHICH IS CAUSTIC. SHOULD THE CELL RUPTURE, A LEAK MAY CAUSE INJURY. PLEASE REFER TO MATERIAL SAFETY DATA SHEET IN THE APPENDIX TO LEARN ABOUT POTENTIAL HAZARDS AND CORRECTIVE ACTION IN CASE OF ACCIDENT.

No tools are required to replace the cell in the instrument. Simply unscrew (counterclockwise) the plug at the bottom of the analyzer and the cell will drop out of the manifold cavity.

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.

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. Insert the cell and cap in the manifold cavity, and screw the cap back into place. Apply as much pressure as you can with your fingers, but use no tools.

After the cell has been installed, purge the instrument with an inert gas (or the sample), and then proceed as directed in section 3.1.1.

4.6 Cell Warranty

The majority of micro-fuel cells used in the Model 3110 carry a six-month warranty from date of service.

With regard to spare cells, service time starts when the cell is removed from its shipping package. The customer should stock only one spare cell per instrument at a time. Do not attempt to stockpile spare cells.

If the Model 3110 is used in trace analysis applications where CO_2 is a major component in the sample, the A2C micro-fuel cell should be used. At low CO_2 concentrations (1,000 PPM or less) the standard B2C cell performance will not be affected. Figure 4-2 shows the effects of CO_2 on the cell life of a Class B-2C cell.

If the analyzer is going to be used on percent ranges, a B-1 cell can be used. The B-1 sensor will provide better service life in percent applications.

WARNING: EVIDENCE OF DAMAGE DUE TO TAMPERING OR MISHANDLING WILL RENDER THE CELL WARRANTY NULL AND VOID.

4.7 Temperature Compensation

The micro-fuel cell has an inherent positive temperature coefficient. Compensation is performed internally by the microprocessor and needs no further adjustment.

Contact the factory if you suspect temperature related inaccuracies during monitoring and are operating within the instrument's temperature operation range.

4.8 Leak Testing

WARNING: IF A LEAK IS SUSPECTED IN THE UNIT, DO NOT ATTEMPT TO TIGHTEN THE DISCONNECT FITTINGS. THE FITTINGS ARE POTTED IN EPOXY AND TIGHTENING THEM WILL BREAK THE SEAL.

To check for leaks, TAI recommends one of the following procedures:

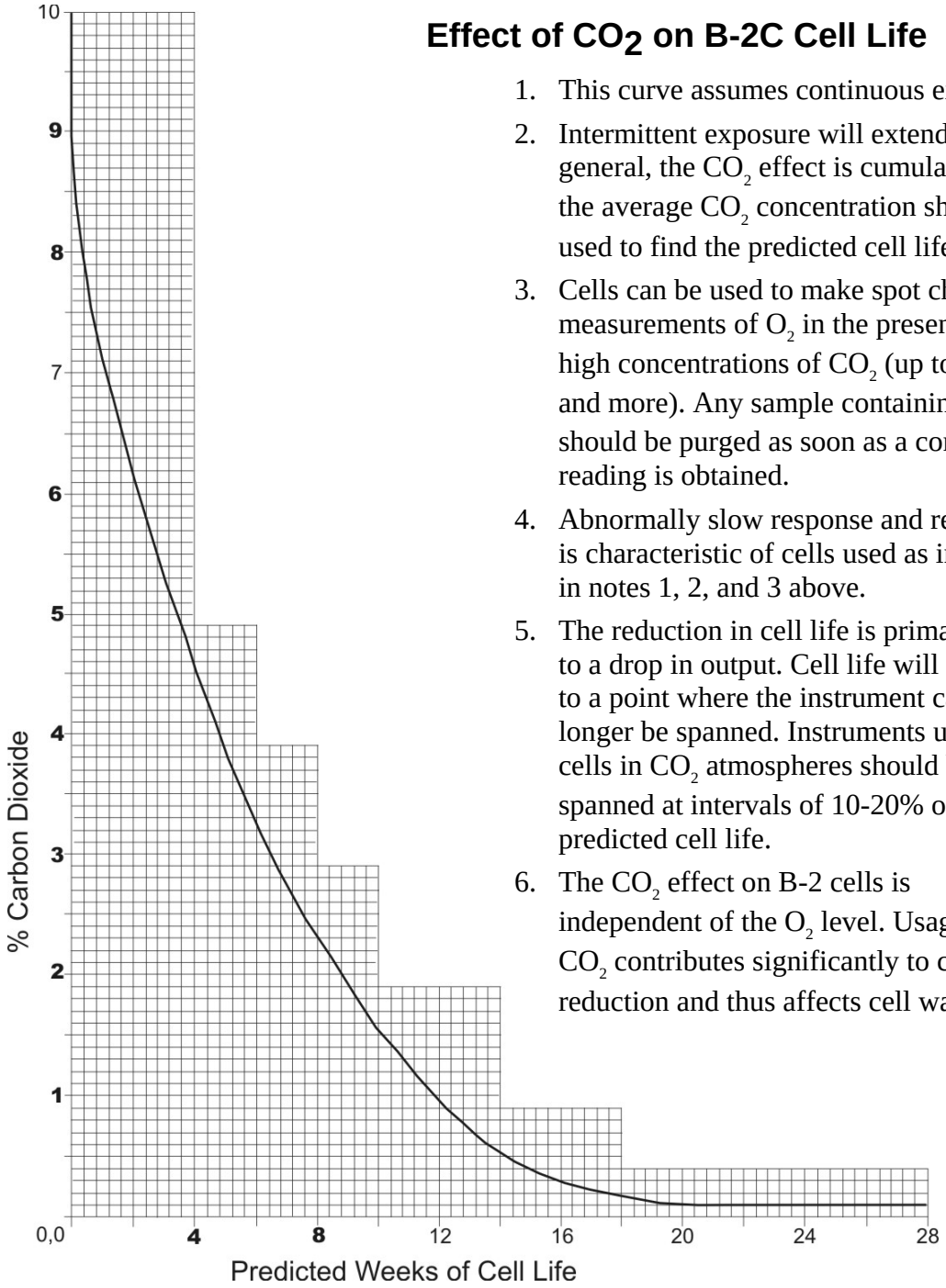
Procedure I:

1. Purge the instrument to as low a value as possible. Use a sensitive range for analysis for instance, 0-1% range Take note of the oxygen concentration.
2. Place the vent line in water and disconnect the sample.
3. Next, disconnect the vent line and use the same analysis range. The reading should not increase above the level to which you purged to.

Procedure II:

1. Purge the instrument with nitrogen at the sample port.
2. Note the reading once is has stabilized (at least 24 hours on the 0-10 PPM range) and at a flowrate of approximately 1 SCFH.
3. Increase the flowrate from 1 SCFH to 2 SCFH.

4. Note how much the reading has changed after a few minutes.
5. Reduce the flowrate to 0.5 SCFH.
6. Note how much the reading has changed.
7. The reading should change by less than 10% of the original value



Effect of CO_2 on B-2C Cell Life

1. This curve assumes continuous exposure.
2. Intermittent exposure will extend life. In general, the CO_2 effect is cumulative and the average CO_2 concentration should be used to find the predicted cell life.
3. Cells can be used to make spot check measurements of O_2 in the presence of high concentrations of CO_2 (up to 50% and more). Any sample containing CO_2 should be purged as soon as a constant reading is obtained.
4. Abnormally slow response and recovery is characteristic of cells used as indicated in notes 1, 2, and 3 above.
5. The reduction in cell life is primarily due to a drop in output. Cell life will reduce to a point where the instrument can no longer be spanned. Instruments using B-2 cells in CO_2 atmospheres should be spanned at intervals of 10-20% of the predicted cell life.
6. The CO_2 effect on B-2 cells is independent of the O_2 level. Usage in CO_2 contributes significantly to cell life reduction and thus affects cell warranty.

Figure 4-2: Effects of CO2 on B-2 Cell Life

Appendix

A.1 Specifications

Certification:	FM-approved, Intrinsically Safe, Class I Div 1 Group A-D T6
Micro-fuel Cell Class:	B-2C, B-1, A-2C, A-5, B-2CXL, A-2CXL, B-2C Insta-trace, A-2C Insta-trace, B-2CHS, A-2CNG
Ranges of Analysis:	1 user defined range 0-10 ppm to 0-25% (std 3110) 0-2 ppm to 0-25% (3110XL) 0-1% to 0-25% (3110P)
Accuracy:	±2% of scale or ±1 PPM (whichever is greater) at constant temperature; ±5% of reading or ±1 PPM (whichever is greater) over the operating temperature range.
Operating Temp. Range:	0°C to 40°C (32°F to 104°F)
Sample Temp. Range:	0-40°C
Sample Flow Rate:	0.5 – 2.5 SCFH
Recommended Span Gas:	Atmospheric air for percent analysis or 80-90% of range most likely to be used
Signal Output:	0-1 VDC
	Electrical safety parameters: Uo = 4.65 V, Io = 193.74 mA, Po = 225.2 mW, Co = 90 uF, Lo = 0.7 mH, Lo/Ro = 157.86 uH/Ohm
Dimensions:	10.9” x 6.2” x 5.2” deep
Weight:	4.4 lbs. (2.0 kg.)
Power Requirements:	100-240 VAC 47-63 Hz Charging Adapter

A.2 Spare Parts List

QTY	P/N	DESCRIPTION
1	O-165	Cell Cap O-Ring (standard)
2	B82162	Battery (must be installed by a qualified technician)
1	A761	Battery Charger, Universal
1	CP2487	2-pin 0-1 VDC Output Plug
1	A36289	Calibration Kit Std.
2	F1378	Fuse 200 mA (T)
1	C78853	Cell Cap with O-Ring (standard)
		* Micro Fuel Cell Options
1	C6689-B2C*	Micro-Fuel Cell, Class B-2C
1	C6689-B1	Micro-Fuel Cell, Class B-1
1	C6689-A2C	Micro-Fuel Cell, Class A-2C
1	C6689-A5	Micro-Fuel Cell, Class A-5
1	C6689-B2CXL	Micro-Fuel Cell, Class B-2CXL
1	B74033-A2CXL	Micro-Fuel Cell, Class A-2CXL
1	B71875	Micro-Fuel Cell, B-2C Insta-trace
1	B73016	Micro-Fuel Cell, A-2C Insta-trace
1	B73592	Micro-Fuel Cell, B-2CXL Insta-trace
1	B78640	Micro-Fuel Cell, Class B-2CHS
1	B76953	Micro-Fuel Cell, Class A-2CNG

A minimum charge of US$200.00 applies to spare parts orders.

IMPORTANT: Orders for replacement parts should include the model number, serial number, and range of the analyzer for which the parts are intended.

Orders should be sent to:

TELEDYNE ANALYTICAL INSTRUMENTS
16830 Chestnut Street
City of Industry, CA 91748
Phone: (626) 961-9221
FAX: (626) 961-2538
TWX: (626) 934-1651
or your local representative