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Quality Management System

- ▶ MDD/93/42 EEC, Annex II
- ▶ ISO 13485:2003
- ▶ ISO 9001:2008



**Instructions
for Use**

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Analytical Industries Inc.
2855 Metropolitan, Pomona, CA 91767 USA.
Tel: 909-392-6900, Fax: 909-392-3665
Email: Divea11@a111.com, Web: www.a111.com

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Palm CO
Carbon
Monoxide
Analyzer



Table of Contents

1	Introduction	1
	1.1 Indications for Use	1
2	General Safety Warnings	2
3	Start-up	4
	3.1 Contents of Shipping Container	4
	3.2 Controls	4
	3.3 Bump Testing	4
4	Calibration	5
	4.1 Zero Calibration	5
	4.2 Span Calibration	6
	4.3 Calibration Log	7
5	Operation	8
	5.1 Principle of Operation	8
	5.2 Application Considerations	8
	5.3 Sampling	9
6	Maintenance	9
	6.1 Cleaning Instructions	9
	6.2 Battery Replacement	9
	6.3 CO Sensor Replacement	11
	6.4 Reassembly Checklist	12
	6.5 Storage	12
7	Spare Parts & Optional Accessories	12
8	Troubleshooting	13
9	Warranty	14
10	Safety Data Sheet (SDS)	15
	10.1 Disposal	15
11	Specification	16
12	Quality Control & Calibration Certification	17

1 Introduction

Congratulations on your purchase. These Instructions for Use describe the precautions, set-up, operation, maintenance, and specifications of the Palm CO Carbon Monoxide Analyzer.



This symbol means CAUTION – Failure to read and comply with the Instructions for Use could damage the device and possibly jeopardize the well being of the user.



Users must read the following statements as they are essential to reducing the risk of use error due to ergonomic features of the device or the environment in which the device is intended to be used. In order to obtain optimum performance, the operation of the device must be performed in accordance with these 'Instructions for use'.

Note: Analytical Industries Inc. cannot warrant any damage resulting from the misuse, unauthorized repair or improper maintenance of the device.

Prior to shipment, every device is thoroughly tested at the factory and documented in the form of a Quality Control Certification that is included in the Instructions for Use supplied with every device.

For future reference in the event you need to contact the factory, we suggest the serial number of the analyzer be recorded below:

Serial Number: _____

1.1 Indications for Use

The Palm CO Carbon Monoxide Analyzer is intended to measure and display the concentration in the range of 0 to 25 PPM of carbon monoxide in compressed breathing air tanks, intended for scuba diving. It provides continuous, fast, reliable, and accurate carbon monoxide measurements.

2 General Safety Warnings



ALWAYS follow the statements below as they are essential to reducing the risk of use error .

- ALWAYS have knowledgeable personnel who have read, understand and agree to follow the Instructions for Use operate the device.
- ALWAYS retain the Instructions for Use for future reference.
- ALWAYS follow Instructions for Use. Failure to do so may cause the device to fail and void the warranty.
- ALWAYS inspect the device and accessories before sampling gas & ensure:
 - (a) there is no evidence of physical damage
 - (b) the sensor (particularly the sensing surface) is dry
 - (c) the accessories and options specified in **Section 7** are present
- ALWAYS follow the general calibration guidelines:
 - (a) use a known source of DRY carbon monoxide span gas at least every 3 months
 - (b) recalibrate when the temperature or pressure of the operating environment changes beyond $\pm 10^{\circ}\text{C}$
 - (c) recalibrate after the battery or carbon monoxide sensor has been replaced
- ALWAYS clean the device and accessories in accordance with **Section 6.1**. Failure to do so may lead to inaccurate readings, damage to the sensor, and void warranty.
- ALWAYS replace the batteries according to **Section 6.2**.
- ALWAYS replace and install Carbon monoxide sensor according to **Section 6.3**.
- ALWAYS contact the factory if you are in doubt while troubleshooting.



NEVER operate the device in any manner described below. Doing so may compromise the safety of divers.

- DO NOT use if reading is unstable or any malfunction is suspected.
- DO NOT use while 'ERR' or 'bA' messages are displayed on the LCD.
- DO NOT use near equipment capable of emitting high levels of electromagnetic radiation (EMI) or radio frequency interference (RFI).
- DO NOT use if device is exposed to extreme conditions, particularly the LCD display or sensor. Conditions include, but are not limited to pressure, liquid submersion, heat, cold, or excessive sunlight beyond the device's storage temperature range for extended periods of time (refer to **Section 8**).
- DO NOT use outside of the parameters specified in **Section 11** particularly at flow rates greater than 10 liters per minute - the backpressure generated produces erroneously high carbon monoxide readings.
- DO NOT attempt to sterilize, autoclave, liquid sterilize, immerse in any liquid or expose the device or accessories to steam, ethylene oxide or radiation sterilization.
- DO NOT open the main compartment of the device, except to change the integral carbon monoxide sensor or batteries.
- DO NOT open the carbon monoxide sensor or probe the sensing surface, refer to **Section 10** in the event the sensor should leak and someone comes in contact with electrolyte.
- DO NOT allow the device or carbon monoxide sensor to be serviced, repaired or altered by anyone except knowledgeable personnel that are familiar with the product's Instructions for Use
- DO NOT use another manufacturer's sensor inside this analyzer: The design of the electronics is intended for only the Analytical Industries Inc. OSV-22-AF carbon monoxide sensors. Use of a different carbon monoxide sensor may result in an erroneous carbon monoxide reading.

3 Start-Up

3.1 Contents of Shipping Container

The contents include:

- ▶ Palm CO Carbon Monoxide Analyzer
- ▶ A-3388 Adapter, Dome to Sensor
- ▶ Instructions for Use

A zero and span calibration is performed at the factory which is documented by the Quality Control & Calibration Certification, **Section 12**, shipped with every Palm CO. The batteries and carbon monoxide sensor are installed at the factory so the Palm CO is ready for immediate use.

Inspect the box and contents for shipping damage. If any component appears damaged, do not attempt to operate the device and contact the manufacturer immediately, **Section 9**.

3.2 Controls

The analyzer employs a micro-processor that is controlled by three (3) pushbuttons located on the keypad on the front cover.

- ▶ **CAL** (↑) initiates calibration mode and adjusts the reading upward while in calibration mode.
- ▶ **POWER** (⏻) turns the power ON/OFF.
- ▶ **ZERO** (↓) adjusts the reading downward while in calibration mode.

3.3 Bump Testing: Prerequisite Gas Tests Prior to Start-Up and Use



Bump testing is recommended before each use of the Palm CO analyzer. To conduct the test, one exposes the sensor to a gas mixture of known carbon monoxide concentration and ensures that the response is within ± 3 PPM of carbon monoxide in bump gas.

Due to transportation regulations, we recommend obtaining a bump gas of 10 PPM carbon monoxide balance air from local sources.



The device should **NEVER** be bump tested with a gas containing more than 25 PPM carbon monoxide concentration.



3.3.1 Bump Test Procedure

1. Set up sampling system according to the figure below.
2. Turn on the analyzer.
3. Flow the bump test gas.
4. Wait for the analyzer's reading to stabilize on the LCD
5. Verify the reading is within ± 3 ppm of the CO concentration of the bump gas. If it is not, refer to **Section 8 Troubleshooting**.



4 Calibration

4.1 Zero Calibration

Performing a zero calibration before every use is not necessary.

Once the **POWER** (⏻) key is pressed and power is applied, allow the reading to stabilize for 10-15 minutes in air. The analyzer will display a reading of 0 PPM in a clean source of ambient air. However, if the analyzer reading is not 0 PPM:

- ▶ The most common reason is the analyzer is not located in a clean source of ambient air which can be remedied by moving to another location.
- ▶ If the analyzer is located in a clean source of ambient air and the display reads 1-2 PPM, it is possible the sensor has drifted slightly which can be remedied by performing a "zero calibration" as described below.
- ▶ If the analyzer displays a reading greater than 2 PPM, a problem is indicated. In view of the low threshold for CO, the analyzer design has equally tight limits which considers the initial factory zero calibration. Performing another in this situation would likely display an "ERR" result. **The recommendation here is to contact the factory for assistance.**

5 Operation

5.1 Principle of Operation

The device utilizes an electrochemical carbon monoxide sensor intended to measure carbon monoxide levels in gas streams. Carbon monoxide, diffusing into the sensor through a gas permeable barrier, reacts chemically at the sensing electrode to produce an electrical current output proportional to the carbon monoxide concentration in the gas phase.

A battery powered state-of-the-art micro-processor converts the sensor's signal output, which represents the partial pressure of carbon monoxide in the gas stream being analyzed. The resulting carbon monoxide reading is displayed by an easy to read screen that has a resolution of 1 PPM carbon monoxide.

5.2 Application Considerations

5.2.1 Effect of Temperature

At constant temperature, the sensor's electrical current signal varies linearly with carbon monoxide concentration. Over the temperature range of 0-40°C, the output varies approximately $\pm 10\%$ from its value at 20°C. For this reason, it is highly recommended that the analyzer be calibrated at a temperature close to that of the environment in which it is intended to be used.

5.2.2 Effect of Pressure

The electrochemical sensor measures the partial pressure of carbon monoxide in a gas stream to which it is exposed. The sensor is accurate at any pressure within the rated range of 80-120 kPa, provided the ambient pressure is constant during sampling and calibration.

5.2.3 Effect of Humidity

Changes in humidity will produce transients in sensor output that last for about ten minutes. Therefore, it is recommended that at least ten minutes be provided before taking measurements after a sudden humidity change, which may occur if the analyzer is removed from a sealed bag of different humidity than the ambient environment or a dramatic change in the weather. It is not necessary that the analyzer be powered on during this period.

5.2.4 Effect of Electromagnetic Radiation

Tested over a 26 MHz to 1000 MHz electromagnetic field, the analyzer is susceptible at all frequencies tested except those between 930 and 990 MHz. Never operate the analyzer near equipment capable of emitting high levels of electromagnetic radiation. Do not continue to operate the analyzer if the reading becomes unstable.

5.3 Sampling Procedure

1. Assure that the analyzer is calibrated, giving a stable reading, and is in sampling mode. Note: Sampling mode is the default screen. Nothing needs to be done to get to this screen, assuming you are out of all menus and modes.
2. Open the gas tank until you hear a slight 'hissing noise'
3. Hold the hole at the bottom of the black dome adaptor firmly against the tank's gas outlet.
4. Ensure there is a good connection between the dome adaptor and the gas tank to prevent ambient air from leaking into the gas being measured.
5. Once the sensor is exposed to the gas stream, allow the reading to stabilize as displayed by the LCD.

6 Maintenance

6.1 Cleaning Instructions

Clean the device only when needed. The carbon monoxide sensor and accessories can be cleaned with a soft cloth dampened with either water or mild isopropyl alcohol solution (70% isopropyl alcohol solution in water). Allow the components to air-dry after cleaning.

6.2 Battery Replacement

The Palm CO Carbon Monoxide Analyzer is powered by two 1.5V AA alkaline batteries with an approximate life of 450 hours.

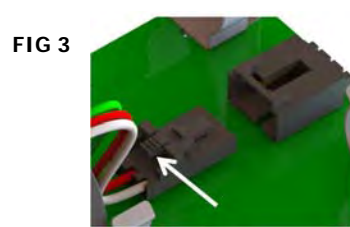
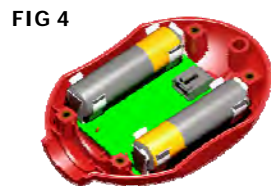
The LDC displays a low battery indicator 'bA' when the battery falls below the necessary voltage for reliable operation of the analyzer, **FIG 1**. The batteries are located in the top section or front of the analyzer and secured by terminals mounted directly on the PCB assembly.



FIG 1

6.2.1 Procedure:

1. Place the analyzer face down on a flat surface and remove the four (4) Phillips screws from the rear of the enclosure, **FIG 2**.
2. To access the interior of the analyzer, locate the black sealing gasket and pull the farthest edge of the upper section upwards 90°, **FIG 2 arrow**.
3. Separate the enclosure by disconnecting the CO sensor, **FIG 3**:
 - ▶ Locate the sensor cable connector.
 - ▶ Press down on the latch arm, see arrow in **FIG 3**.
 - ▶ Pull back on the male connector attached to the sensor cable from the female connector attached to the PCB assembly.
4. With the battery section separated and still facing down, **FIG 4**, remove a battery by grasping the middle of the battery and gently pull straight up.
5. Assure the battery contacts are clean. Clean with mild alcohol as required.
6. Install the new battery:
 - ▶ Register the battery's positive (+) terminal with the corresponding (+) battery symbol printed on the PCB Assembly.
 - ▶ Align the battery over the terminal clip mounted on the PCB Assembly
 - ▶ Press down until the battery snaps into place, **FIG 4**.
7. Repeat steps 3-7 with the remaining battery.
8. Reassemble the device by reversing steps 3, 2, 1.
9. Calibrate the device after replacing the batteries (refer to **Section 4**).



10

6.3 Carbon Monoxide Sensor Replacement



DO NOT attempt to open or probe sensor. In event the sensor leaks, refer to the Safety Data Sheet in **Section 10**.

6.3.1 Procedure

1. Place the analyzer face down on a flat surface and remove the four (4) Phillips screws from the rear of the enclosure, **FIG 2**.
2. To access the interior of the analyzer, locate the black sealing gasket and pull the farthest edge of the upper section upwards 90°, **FIG 2 arrow**.
3. Separate the enclosure by disconnecting the CO sensor, **FIG 3**:
 - ▶ Locate the sensor cable connector.
 - ▶ Press down on the latch arm, see arrow in **FIG 3**.
 - ▶ Pull back on the male connector attached to the sensor cable from the female connector attached to the PCB assembly.
4. Remove the carbon monoxide sensor, **FIG 5**:
 - ▶ Lift up the rear of the sensor, where the connector wires are attached.
 - ▶ Pull the front end of the sensor out of the retaining collar, **arrow**, molded into the gasket that seals the two sections of the enclosure.
5. Install the new carbon monoxide sensor:
 - ▶ Locate the registration slot pointed to by the arrow **circled in FIG 6** molded into the inside of the enclosure.
 - ▶ Align the wires at the rear of the sensor over the slot, **do not insert**.
 - ▶ Insert the front of the sensor into the molded collar, **arrow FIG 5**, and push until the shoulder aligns with the front edge of the collar.
 - ▶ Ensure the wires are aligned with the registration slot **FIG 6** and gently press down on the rear of the sensor until the sensor is seated.
6. Connect the CO sensor (reverse step 3).
7. Reassemble the device (reverse steps 2 & 1)
8. Calibrate the device after replacing the CO sensor (refer to **Section 4**).

FIG 6

11

6.4 Reassembly Checklist

To ensure proper operation after replacing the sensor or batteries check that:

- ▶ The overview of the Palm CO Analyzer reassembly, **FIG 7**, is followed.
- ▶ The batteries are secured in the terminal clip, **FIG 4**.
- ▶ The shoulder at the front end of the sensor is aligned with the front edge of the molded collar, **FIG 5**.
- ▶ The molded collar with the sensor installed is installed behind the retainer tabs of the enclosure, **FIG 8**.
- ▶ The rear end of the sensor and it's connecting wires are not bent or bound when closing up the enclosure and tightening the Phillips screws, **FIG 6** and **FIG 7**.
- ▶ The sealing gasket is registered onto the 4 pegs molded into the bottom section of the enclosure **FIG 7**.

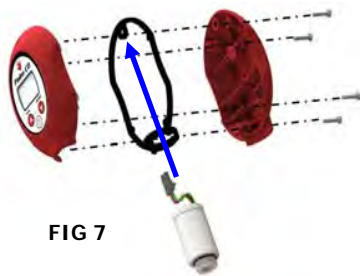


FIG 7



FIG 8

6.5 Storage

Store the device by turning the power OFF. Do not store in extreme temperature, pressure, or humidity.

7 Spare Parts & Accessories

Spare Parts

OSV-22-AF Carbon Monoxide Sensor
 BATT-1008 Battery 1.5V AA Alkaline
 A-1199 Rev F1 PCB Assembly
 A-3388 Adapter, Dome to Sensor

Optional Accessories

GAS-1035 Bump Gas (Section 3.3)
 A-3671 Adapter, BC with Restrictor
 HRWR-1157 Screwdriver
 HRWR-1158 Lanyard

8 Troubleshooting

If the recommended corrective action does not resolve the problem return the device to the factory for service.

Symptom	Corrective Action
Device appears to be physically damaged	▶ Turn device ON & calibrate – if it passes calibration, then proceed
No display when analyzer is turned ON	▶ Replace batteries ▶ Check battery polarity ▶ Check and/or clean battery contacts
'bA' displayed when analyzer is turned ON or in use	▶ Replace battery and calibrate device
Unable to match reading to calibration gas in calibration mode	▶ Replace sensor if nearing end of its useful life
No response to keypad	▶ Replace battery
Cannot turn device OFF	▶ Calibration routine in process—press ON/OFF (Ⓞ) again
Bump test failure, or reading displayed by LCD does not change when carbon monoxide level changes	▶ Replace sensor if nearing end of its useful life
After calibration, analyzer reading drifts more than 2% over 8 hours	▶ Replace sensor if nearing end of its useful life
Reading does not stabilize or fluctuates erratically	▶ Relocate analyzer away source of RF or electromagnetic radiation emissions. Wait 5 minutes, then repeat calibration ▶ Replace sensor, repeat calibration

9 Warranty

Coverage

Under normal operating conditions, the analyzer and sensors are warranted to be free of defects in materials and workmanship for the period specified in the current published specifications. To make a warranty claim, you must return the item properly packaged and postage prepaid to:

Analytical Industries Inc.
2855 Metropolitan Place
Pomona, Ca 91767 USA
T: 909-392-6900, F: 909-392-3665
E: diveaii@aii1.com, W: www.aii1.com

Analytical Industries in their sole discretion shall determine the nature of the defect. If the item is determined to be eligible for warranty we will repair it or, at our option, replace it at no charge to you. If we choose to repair your item, we may use new or reconditioned replacement parts of the same or upgraded design. This is the only warranty we will give and it sets forth all our responsibilities, there are no other express or implied warranties.

The warranty begins with the date of shipment from Analytical Industries Inc., is limited to the first customer who submits a claim for a given serial number which must be in place and readable to be eligible for warranty and will not extend to more than one customer or beyond the warranty period under any conditions.

Exclusions

This warranty does not cover normal wear and tear; corrosion; damage while in transit; damage resulting from misuse or abuse; lack of proper maintenance; unauthorized repair or modification of the analyzer; fire; flood; explosion or other failure to follow the Owner's Manual.

Limitations

Analytical Industries Inc. shall not be liable for losses or damages of any kind; loss of use of the analyzer; incidental or consequential losses or damages; damages resulting from alterations, misuse, abuse, lack of proper maintenance; unauthorized repair or modification of the analyzer.

Service

Contact us between 8:00am and 5:00pm PST Monday thru Thursday or before 12:00pm on Friday. Trained technicians will assist you in diagnosing the problem and determining the appropriate course of action.

10 Safety Data Sheet (SDS)

Product name	Electrochemical Galvanic Fuel Cell Carbon Sensor
Exposure	Sealed device with protective coverings, normally no hazard
Ingredients	Carcinogens - none; Sulfuric Acid (H ₂ SO ₄)
Properties	Completely soluble in H ₂ O; evaporation similar to H ₂ O
Flash Points	Not applicable, non-flammable
Reactivity	Stable; avoid strong acids, emits fumes when heated
Health Hazard	<ul style="list-style-type: none">▶ H₂SO₄ entry via ingestion - harmful or fatal if swallowed;▶ Eye - corrosive, possible loss of vision;▶ Skin contact - corrosive, possible chemical burn.▶ Liquid inhalation is unlikely.
Symptoms	Eye contact - burning sensation; skin contact - slick feeling
Protection	Ventilation - none; eye - safety glasses; hands - gloves
Precautions	Do not remove membrane or plastic coverings; do not probe with sharp objects; avoid contact with eyes, skin and clothing.
Action H ₂ SO ₄ Leak	Use rubber gloves, safety glasses and H ₂ O and flush all surfaces repeatedly with liberal amounts of H ₂ O

10.1 Disposal

Carbon monoxide sensors and batteries should be disposed of in accordance with local regulations for batteries.



WEEE regulations prohibit electronic products from being placed in household trash bins.

Electronic products should be disposed of in accordance with local regulations.

11 Specifications



Analytical Industries Inc.

Technical Specifications

Accuracy:	± 2 PPM
Analysis:	0-25 PPM carbon monoxide (CO)
Application:	Check carbon monoxide concentration in compressed air tanks
Calibration:	Certified span gas mixture of carbon monoxide concentration between 10-20 PPM with balance air
Connections:	Dome adapter; option BC adapter with restrictor
Controls:	Soft touch keypad for ON/OFF and Calibration
Dimensions:	2.72" x 4.1" x 1.35"; weight 7 oz. (196 grams)
Display:	2 digit LCD 1.1" x .625"; resolution 1 PPM CO
Flow Sensitivity:	None between 0.2 to 10 liters per minute
Humidity:	Non-condensing 15-90% RH
Pressure:	Ambient 80-120 kPa
Power:	(2) 1.5V AA alkaline batteries; 450 hrs of use
Response Time:	90% of final FS reading in 30 seconds
Sensor Model:	OSV-22-AF Carbon Monoxide Sensor
Expected Sensor Life:	24 months
Storage Temp.:	3° to 35°C (37.4°F to 95°F) for 6 mos in original sealed shipping package
Temp. Range:	0° to 50°C (32°F to 122°F)
Warm-up Time:	60 seconds
Warranty:	12 months analyzer and sensor



Palm CO **Carbon** **Monoxide** **Analyzer**

User friendly interface
One touch zero or span calibration
Accurate reliable results
No maintenance

Assembled under a certified
Quality Management System

Analytical Industries Inc.

12 Quality Control & Calibration Certification

Customer: _____		Date: _____		
Order No. _____			Pass Y/N Initial / Date	
Model: Palm CO Carbon Monoxide Analyzer		S/N _____		
Sensor: OSV-22-AF Carbon Monoxide Sensor		S/N _____		
Electronics: A-1199 Rev F1 PCB Assembly Main		Version _____		
Accessories: Manual, Instructions for Use BATT-1008 Battery, 1.5V AA (Qty 2) A-3388 Adapter, Dome to Sensor _____				
QC Test:		Expected Value	Observed Value	Initial / Date
	1) LCD displays	2 digits		
	2) Default reading in air	0 PPM \pm 4 PPM		
	3) Reading in air after zero calibration in air	0 PPM \pm 1 PPM		
	NOTE: Add "with ____ PPM CO span gas" after steps 4-7			
	4) Reading before span calibration . . .	____ PPM \pm 5 PPM		
	5) Reading after span calibration . . .	____ PPM \pm 1 PPM		
	6) Reading in air after span calibration . . .	____ PPM \pm 1 PPM		
	7) Reading 24 hours after span calibration . . .	____ PPM \pm 2 PPM		
	8) Visual spot check that reading does not fluctuate during above tests	\pm 1 PPM		
	9) LCD displays low battery warning	BA		
10) Overall inspection for physical defects				
Options:	P/N _____	Qty _____		
	P/N _____	Qty _____		
	P/N _____	Qty _____		
Other:	Spare Parts: P/N _____	Qty _____		
	Spare Parts: P/N _____	Qty _____		
	Spare Parts: P/N _____	Qty _____		
Delivery:	1 of _____, ship by _____			