AMI

Oxygen Analyzer Manual

Model 60 Probe

AMI, Garden Grove.

Contents

Preface

The AMI story

The AMI series of analyzers provide the latest in high-definition oxygen analysis. The series includes trace oxygen, percent oxygen and portable trace and percent oxygen models. All of them share the same basic design, using time proven oxygen sensors and advanced high definition electronics for noise and interference free performance. Certain aspects of the design are the subject of a patent, number 5,728,289.

AMI was formed by a group of analyzer professionals with over thirty years of experience between them. The company is dedicated to providing the very best and most cost effective solutions to the oxygen analysis problem with a range of analyzers.

Every effort is made to ensure that AMI products provide reliable, effective performance. However there are many pitfalls in achieving correct oxygen analysis, particularly at low ppm levels, and AMI stands ready to provide a complete solution to the analysis problem, from sample system design to on-site troubleshooting and problem analysis. Please feel free to call AMI for help should your results not meet your expectations.

Caution

Read and understand this manual fully before attempting to use the instrument. In particular understand the hazards associated with using flammable or poisonous gases, and associated with the contents of the sensor used.

Address

Advanced Micro Instruments.

12851 Western Ave Suite F

Garden Grove, CA 92841

The AMI Oxygen Probe Analyzer

Introduction

The Advanced Micro Instruments Oxygen Probe is designed for monitoring of oxygen content in a nitrogen or similar inert gas stream. It operates on a single range, normally 0-25% oxygen, and produces an output typically 0-2.5V DC over this range. It uses 24V DC power, and it provides a regulated 5VDC output as an auxiliary for low power devices such as LCD panel meters. No calibration is provided, calibration is performed by the host system to which it is attached.

Features:

- Compact size
- Single range operation
- Probe may be mounted up to 100ft from a suitable display unit.
- Air calibration, no zero or span gases required
- Virtually unaffected by hydrocarbons or other oxidizable gases
- High accuracy and fast response
- Backed by a two year warranty

Options:

- Analog voltage output from 0 - 10mV up to 0 - 2.5V

Oxygen sensor:

AMI uses an industry standard electrochemical sensor. This measures the concentration of oxygen in a gas stream, using an oxygen specific chemistry. It generates an output current in proportion to the amount of oxygen present, and has zero output in the absence of oxygen, thus avoiding any requirement to zero the analyzer. The cell is linear throughout its range. The span calibration may be performed using standard span gases or ambient air.

Percent level analyzers are routinely calibrated on air. Air has a reliable 20.94% oxygen in it, when dry. In the case of its use as an area monitor it is advisable to use a known high quality air supply for calibration since the room air may not contain 20.94% of oxygen!

Sensor Warranty:

The sensor is warranted to operate for a period determined by its class. If the sensor ceases to operate correctly before this time has elapsed, contact AMI for a return authorization for evaluation. If there is any evidence of defective material or workmanship the sensor will be replaced free of charge.

If the sensor has failed due to natural wear out mechanisms, it will be credited on a pro-rated basis to the purchase of a new sensor.

NOTE: Any evidence of abuse or physical damage, such as a torn membrane, will cause the failure not be regarded as a covered under the warranty.

Instrument Warranty:

Any failure of material or workmanship will be repaired free of charge for a period of two years from the original purchase (shipping date) of the instrument. AMI will also pay for one way shipment (back to the user).

This warranty does not cover the sensor, which is covered by its own warranty (see above).

Any indication of abuse or tampering will void the warranty.

Installation and Operation

Receiving the analyzer

Precaution

When you receive the instrument, check the package for evidence of damage and if any is found, contact the shipper.

Installation.

Location:

The unit is designed to be mounted on a suitable clip in a general purpose area. It is not suitable for installation in either a hazardous area though it may be mounted outdoors if the temperature range does not exceed the 0-45C for which it is rated. The cable supplied is two meters (rather over 6 ft) long.

Do not to mount it close to sources of electrical interference such as large transformers, motor start contactors, relays etc. Also avoid subjecting it to significant vibration. Make sure that the sensor cable does not run next to high-current cables, or AC cables. Preferably the sensor cable should be in its own conduit.

Avoid mounting it in such a way that it will be subject to rapid temperature changes. For example, do not mount it close to an outside door or air conditioning duct that will allow a sudden draft of cold or hot air to blow on it.

If used as an area monitor the probe should be mounted where it will sense a representative sample of the room air. If the room has no natural circulation, you may want to install a fan to make sure that there is some air movement. The nature of the possible asphyxiating gas also should affect its placement - if the danger is from a heavy gas such as CO_2 or SF_6, the sensor should be mounted low down so that it detects the gas before people start breathing it, while if the gas is light such as helium, the sensor should be mounted higher. Otherwise it should normally be mounted at head height.

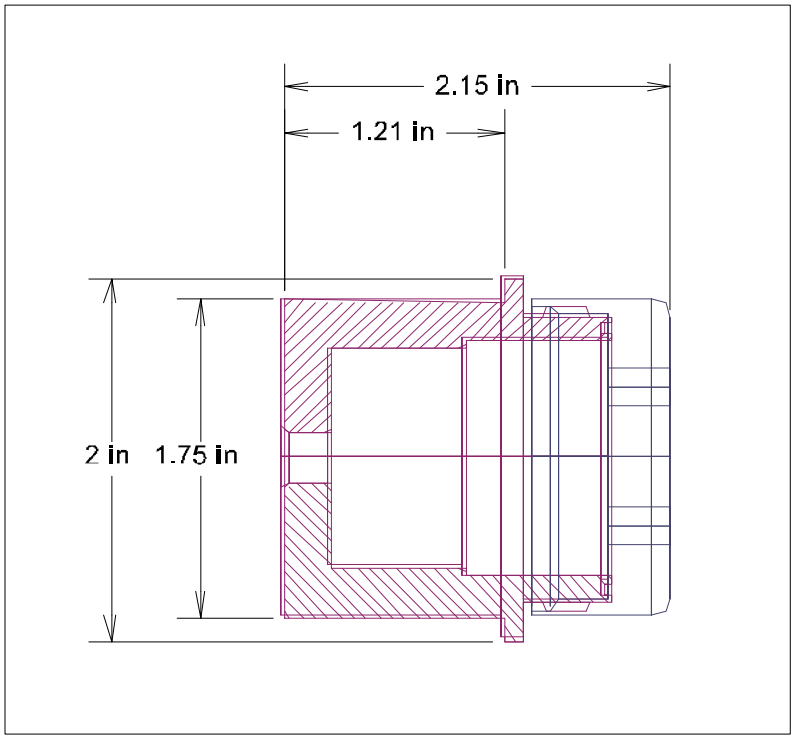

Figure 1. Probe dimensions Clip mounting holes are also shown.

Figure 2. Probe

Power supply connection:

The unit requires a DC power supply between about 7 and 30 volts, at about 5 mA. The supply should be free of high frequency noise - if it is derived from a switching power supply it is advisable to use a series inductor and parallel capacitors to filter it. It provides a regulated 5V DC output at up to 50 mA for external use.

Probe connection:

The probe is provided with a length of cable attached. If this length is not sufficient, an additional length may be added up to a distance of about 100ft. Make the connection in a suitable connection box. The cable used must be a pair of shielded twisted pairs, of any gauge from about 16AWG to about 26 AWG.

The wires are color coded, Brown being the positive power supply, Black the ground or return, White the voltage output and Blue the regulated 5V output.

Initial test:

Install the unit as desired, and connect it to some form of monitoring system. Install the oxygen sensor, making sure that it is the right way up.

Expose the unit to air, and calibrate the monitoring system to 20.94% oxygen (or equivalent nitrogen for nitrogen purity systems). The unit should be recalibrated after about one day, and thereafter at a rate determined by usage, though once a month is typical.

Output connections:

The voltage output circuit is capable of driving an input resistance of 10K Ohms or more. Lower input resistances will degrade the accuracy of the circuit.

Sample connection:

The sample may be introduced to either of the two barbed fittings on the cap of the unit. It may be desirable to provide a tee in the line for calibration - see the discussion below.

Sensor Installation:

Open the sensor unit cap, and unseal the sensor. Place the sensor inside the sensor unit in such a way that the electrodes on the sensor (the little circuit board with the central gold-plated disk, and annular gold-plated ring) are facing the connection springs within the sensor unit.

Operation

Calibration:

The sensor will stabilize within a few minutes, and it may be calibrated almost as soon as it has been installed.

No provision is made in the probe itself for calibration. It is expected that the display or monitoring device will perform this function. The output of the sensor will vary by about +/- 20% between units, in other words air will make the output come to somewhere between about 1.6V and 2.4V. The following section is intended to provide tips on performing calibration.

Make sure that the sensor is exposed to fresh ambient air, and adjust the gain in the monitoring unit until it reads 20.9%. If you are not sure that the air is indeed fresh, you should provide a sample of known oxygen level of around 20% to the sensor and adjust the gain until the display reads the contents of the span gas. A suitable way of doing this is to provide a "T" in the sample line, and flow span gas from a suitable cylinder through the "T".

Be absolutely sure that you are using at least a certified, and preferably a primary standard span gas supply as the span gas. Alternatively use known fresh air. So called "Manufactured air" or bottled compressed air often has an oxygen content that is significantly different from its label.

If the calibration is to be performed in software, bear in mind the following points.

1. The most common error is that the user attempts to span the system on an incorrect gas, often nitrogen. Some limitation must be made therefore in the permissible gain of the system so that this condition is detected. Typically the gain is allowed to vary no more than 25% between calibrations. However it is still possible for a calibration to be sufficiently in error that the system cannot be recalibrated again once it has been messed up. Therefore it must be possible to force a calibration no matter the apparent error.
2. The calibration routine should detect an excessive drift and delay calibration until the drift has stopped, or abort the process if no good reading can be obtained. This might happen because of an inadequate calibration gas flow, due perhaps to an empty cylinder.
3. If the sensor chosen has a time constant of 13 seconds, the calibration routine should allow at least 65 seconds for the reading to stabilize.
4. If the system performs an automatic calibration, some means of alerting the user to calibration failure must be made.

Maintenance and troubleshooting

Maintenance:

The AMI oxygen probe is virtually maintenance free other than for periodic calibration and occasional sensor replacement.

Periodic Calibration:

The probe system should be calibrated about once every three weeks to obtain the best accuracy. The sensor typically declines in sensitivity by about 1% per month, so a three weekly calibration is usually satisfactory. Use in a particularly aggressive environment may degrade the sensor faster: in this case calibrate more often.

Sensor Replacement:

This should be done on a regular schedule, rather than as a response to a dead sensor. See the chart below for recommended sensor replacement.

Sensor	Part number	Description	Expected life
T2	4SEN05	Trace oxygen - inert gas	9 months
T1	4SEN06	Trace oxygen - CO2 background	9 months
P1	**4SEN01**	**Percent oxygen - inert gas**	**9 months**
P2	4SEN03	100% oxygen - inert impurity	12 months
P3	4SEN04	Percent oxygen - CO2 background	9 months

Table 1. AMI sensor types

Sensor replacement cautions:

CAUTION: If using compressed air for cleaning, proper eye protection must be worn.

CAUTION: The sensor contains a caustic liquid. Do not allow this to come into contact with your skin. If it does, immediately flush the affected area with water for a period of at least 15 minutes. Refer to the Material Safety Data Sheet provided.

Dispose of leaking or used sensors in accordance with local regulations. Sensors usually contain lead which is toxic, and should generally not be thrown into ordinary trash. Refer to the MSDS to learn about potential hazards and corrective actions in case of any accident.

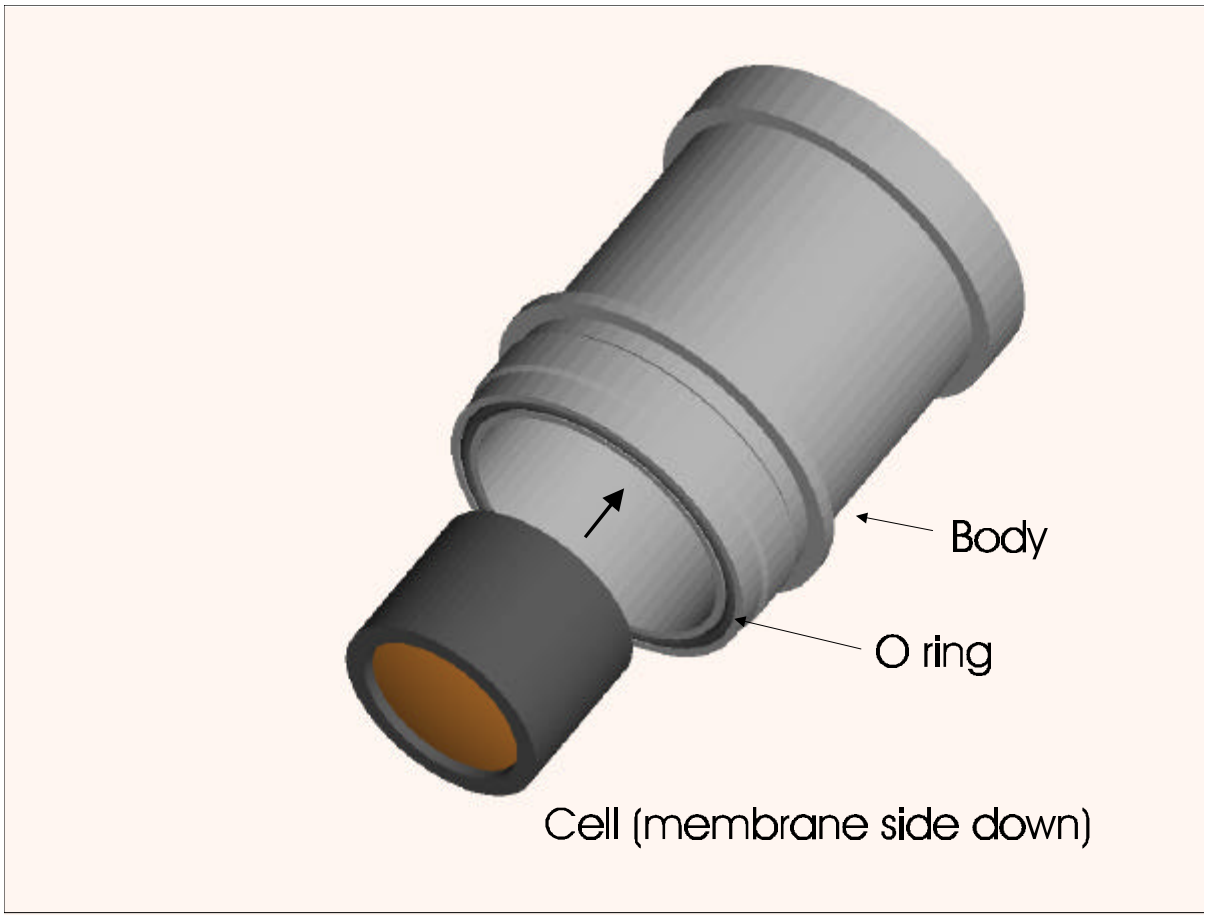

Figure 1. Inserting sensor in probe

Sensor replacement procedure:

The sensor is provided in a special sealed bag. Do not open this until you are immediately ready to install the sensor.

Before installing sensor, turn ON power.

1. Unscrew the sensor unit cap, being careful not to lose the O ring.
2. Carefully remove old cell.
3. Inspect the sensor unit cavity, and if any sign of moisture clean it out with a Q tip or similar. Make sure that the contact springs inside the sensor unit are intact. Be careful not to snag them with the Q tip.
4. Carefully open the bag using a pair of scissors or a knife. Make sure you don't cut yourself or stab the sensor! Make sure that there is no sign of any liquid in the bag, if so do not proceed, you need a new sensor. Be careful that you don't poke anything such as a fingernail through the membrane.
5. Remove the plug or other device that acts as a shorting clip. This may be found on the connection plate on the back of the sensor.
6. Slide the sensor into the sensor unit (gold plated contact side of sensor should be facing up touching the sensor unit contacts. The membrane side is covered by a convex gold plated mesh). Be careful not to touch the membrane while doing this - if the membrane is punctured the sensor must be replaced.
7. Verify that the sealing O ring is in place in the cell cap groove. Verify that the O ring and the cap are clean and free of any particulate deposits (dirt).
8. Carefully replace the cap, making sure that you do not cross thread it, and tighten firmly by hand. Do not over-tighten.
9. Allow the sensor to stabilize for a few minutes and then calibrate it preferably using known fresh air as the calibration gas.

Calibration:

For percent level analyzers, the sensor will stabilize within a few minutes, and it may be calibrated almost as soon as it has been installed.

1. Either expose the sensor unit to known good fresh air, or using a user-supplied valve, flow a known good span gas past the sensor.
2. If calibrating on air, adjust the system gain so that the reading on system display is 20.9%.
3. If using a calibration gas, read the value on the gas bottle label.
4. Adjust the system gain until the reading on the system display corresponds to the value on the gas bottle.

Periodic Calibration

You should calibrate the analyzer every three weeks until the expected end of life. At this point it is recommended that you replace the sensor, rather than try to eke the last few days of life from it. The sensor life typically ends when you run out of span adjustment.

Specifications and Disclaimer

Specifications:

Standard ranges:

Single range: 0 - 25%

Sensitivity: 0.5% of full scale

Repeatability: +/- 1% of full scale at constant temperature

Operating temperature: 5 - 45°C

Humidity: < 85%, non-condensing

Operational conditions: Pollution degree 2, Installation category I I.

Drift: +/- 1% of full scale in 4 weeks at constant temperature (dependent on sensor)

Expected cell life: 9 months.

Response times:

Percent: 90% of full scale < 7 seconds

Outputs: 0 - 2.5 VDC nominal (uncalibrated).

Power requirements: Between 7 and 30 VDC (nominally 24VDC) Less than 10 mA with no external draw from the 5V supply.

Dimensions: 2.15 Dia x 2" high (not including fittings or leads).

Weight less than 1 lb

Disclaimer

Although every effort has been made to assure that the AMI analyzers meet all their performance specifications, AMI takes no responsibility for any losses incurred by reason of the failure of its analyzers or associated components. AMI's obligation is expressly limited to the analyzer itself.

In particular, the AMI analyzer is designed for operation with non-flammable samples in a general purpose, i.e. non-hazardous area. Any damage resulting from its use in a hazardous area or with flammable or explosive samples is expressly the responsibility of the user.

The AMI analyzer is not designed as a primary safety device, that is to say it is not to be used as the primary means of assuring personnel safety. In particular it is not designed to act as a medical instrument, monitoring breathing air for correct oxygen concentration, and should not be used as such when it is the only safety device on the gas system.

Material safety data sheets (MSDS)

MSDS.1. Sensor type P1, P2, T2

MSDS.1.1. Product Identification

Product name: Oxygen sensor, class P1, P2, T2

Manufacturer: Advanced Micro Instruments

Address:

Phone: (714) 893-8024

Date of last revision: 4/27/00

Emergency phone number: (714) 893-8024

MSDS.1.2. Physical and chemical data

Composition:

The sensor body is made of polyethylene and glass-epoxy GR4 circuit board material, with a paper covering.

It contains the following substances:

Common name	Formula	Concentration	CAS number
Potassium hydroxide solution 15%	KOH	15%; 1-5ml	1310-58-3
Lead	Pb	pure, 3-20 g	7439-92-1

Character of individual components:

Component	KOH (pure)	Pb (pure)
Melting point/range	360°C	328°C
Boiling point/range	1320°C	1744°C
Specific gravity	2.04	11.34
pH	N/A	N/A
Solubility in water	Infinite	Insoluble
Appearance and odor	Odorless white or yellowish crystals	odorless gray metal

MSDS.1.3. Fire and explosion hazard data

Flash point: **N/A** **Flammable limit** **N/A** **LEL:** **N/A** **UEL** **N/A**

Extinguishing media: No special agents recommended.

Special fire fighting equipment: Wear NIOSH/OSHA approved self-contained breathing apparatus and protective clothing to prevent contact with skin and eyes.

Unusual fire and explosion hazards: Emits toxic fumes under fire conditions.

MSDS.1.4. Reactivity data

Stability: Stable

Incompatibilities: Aluminum, organic materials, acid chlorides, acid anhydrides, magnesium, copper. Avoid contact with acids and hydrogen peroxide > 52%

Hazardous decomposition byproducts: Toxic fumes

Hazardous polymerization: Will not occur

MSDS.1.5. Health hazard data

Primary route of entry:	Ingestion, eye/skin contact
Exposure limits:	OSHA PEL: 0.05 mg/cu. M. (Pb) ACG1H: 0.15 mg/m^3 Pb; 2 mg/m^3 KOH
Effect of overexposure: Ingestion:	May be fatal if swallowed. The electrolyte will cause a burning sensation; the lead will lead to symptoms such as loss of sleep, loss of appetite, metallic taste and fatigue.
Effect of overexposure: Eye:	The electrolyte is corrosive: it will produce a burning, soapy sensation, irritation or severe chemical burns.
Effect of overexposure: Dermal:	The electrolyte will cause a soapy, slippery feel, and eventually a burning sensation. It may cause irritation and chemical burns.
Effect of overexposure: Inhalation:	Inhalation of the electrolyte will cause severe irritation and chemical burns.
Signs/symptoms of exposure:	The electrolyte is harmful if swallowed, inhaled or absorbed through the skin. It is extremely destructive to the mucous membranes, stomach, mouth, upper respiratory tract, eyes and skin. The lead will lead to symptoms such as loss of sleep, loss of appetite, metallic taste and fatigue.
Medical conditions aggravated by exposure:	Persons with pre-existing skin disorders, eye conditions or impaired respiratory function may be more susceptible to these substances. Lead exposure may aggravate disease of the blood and blood forming organs, hypertension, kidney damage, nervous and possibly reproductive damage.
Carcinogenity:	IARC: lead is classified as a class 2B carcinogen - possibly carcinogenic to humans.
Other health hazards:	Lead is a chemical known to the state of California to cause birth defects or other reproductive harm.

MSDS.1.6. Emergency and first aid procedures

Eye contact: Flush eyes with water for at least 15 minutes and get immediate medical attention.

Skin contact: Wash affected area with plenty of water and remove contaminated clothing.

Ingestion: Give large amounts of cold water. Do not induce vomiting. Seek medical attention. Do not administer liquids to an unconscious person.

Inhalation: Liquid inhalation is unlikely. If it occurs, remove to fresh air and seek immediate medical attention.

MSDS.1.7. Handling information

NOTE: Oxygen sensors are sealed and under normal circumstances their contents do not present a health hazard. The following information is given as a guide in the event of a leak.

Hygienic practices:	Wash hands after handling
Protective clothing:	Rubber gloves, chemical splash goggles.
Clean up procedures:	Wipe down the area several times with a wet paper towel, using a fresh towel each time.
Protective measures during cell replacement:	Before opening the bag containing the sensor, check the sensor for leakage. If any is found, do not open the bag. If there is liquid around the sensor installed in the instrument, put on gloves and eye protection before removing it.
Disposal:	Must be in accordance with all applicable federal, state and local regulations. Both lead and potassium hydroxide are considered poisonous substances and are regulated under TSCA and SARA title III.
EPA waste number:	D008
California waste number:	181
DOT information:	RQ Hazardous Waste Solid N.O.S. (lead), 9, UN3077, PG III

NOTE: The above information is derived from the supplier's MSDS. This information is believed to be correct, but is not necessarily inclusive and should be used only as a guide. Advanced Micro Instruments. shall not be held liable for any damage arising out of using or abusing this product.

MSDS.2. Sensor type P3

MSDS.2.1. Product Identification

Product name:	Oxygen sensor, class P3
Manufacturer:	Advanced Micro Instruments
Address:	
Phone:	(714) 893-8024
Date of last revision:	4/27/00
Emergency phone number:	(714) 893-8024

MSDS.2.2. Physical and chemical data

Composition:

The sensor body is made of polyethylene and glass-epoxy GR4 circuit board material, with a paper covering.

It contains the following substances:

Common name	Formula	Concentration	CAS number
Potassium dibasic phosphate	$K_2HPO_4.3H_2O$	1.78% w/v	16788-57-1
Potassium bicarbonate	$KHCO_3$	5.11% w/v	298-14-6
Lead	Pb	pure	7439-92-1

Character of individual components:

Component	$KHCO_3$ (pure)	Pb (pure)	$K_2HPO_4.3H_2O$ (pure)
Melting point/range	100°C	328°C	Decomposes
Boiling point/range	N/A	1744°C	N/A
Specific gravity	2.17	11.34	1.24
pH	N/A	N/A	N/A
Solubility in water	Infinite	Insoluble	218 g/100 g H_2O @ 25°C
Appearance and odor	Odorless white crystals	odorless gray metal	Odorless, large white

melting crystal

MSDS.2.3. Physical hazards

Potential for fire and explosion:

The contents of the sensor are not flammable. There are no fire or explosion hazards associated with the sensor.

Potential for reactivity:

The sensor is stable under normal conditions of use. Avoid contact between the sensor electrolyte and strong acids.

MSDS.2.4. Health hazard data

Primary route of entry:	Ingestion, eye/skin contact
Exposure limits:	OSHA PEL: 0.05 mg/cu. M. (Pb)
Effect of overexposure: Ingestion:	The electrolyte is harmful if swallowed in large amounts
Effect of overexposure: Eye:	Avoid contact with eyes.
Effect of overexposure: Dermal:	Avoid contact with skin.
Effect of overexposure: Inhalation:	Unlikely, but avoid it anyway.
Signs/symptoms of exposure:	N/A
Medical conditions aggravated by exposure:	Persons with pre-existing skin disorders, eye conditions or impaired respiratory function may be more susceptible to these substances.
Carcinogenity:	IARC: lead is classified as a class 2B carcinogen - possibly carcinogenic to humans.
Other health hazards:	Lead is a chemical known to the state of California to cause birth defects or other reproductive harm.

MSDS.2.5. Emergency and first aid procedures

Eye contact: Flush eyes with water for at least 15 minutes and get immediate medical attention.

Skin contact: Wash affected area with plenty of water and remove contaminated clothing.

Ingestion: Give plenty of cold water. Do not induce vomiting. Seek medical attention. Do not administer liquids to an unconscious person.

Inhalation: Liquid inhalation is unlikely. If it occurs, seek immediate medical attention.

MSDS.2.6. Handling information

NOTE: Oxygen sensors are sealed and under normal circumstances their contents do not present a health hazard. The following information is given as a guide in the event of a leak.

Hygienic practices: Wash hands after handling

Protective clothing: Rubber gloves, chemical splash goggles.

Clean up procedures: Wipe down the area several times with a wet paper towel, using a fresh towel each time.

Protective measures during cell replacement: Before opening the bag containing the sensor, check the sensor for leakage. If any is found, do not open the bag. If there is liquid around the sensor installed in the instrument, put on gloves and eye protection before removing it.

Displosal: Must be in accordance with all applicable federal, state and local regulations.

EPA waste number: D008

California waste number: 181

DOT information: RQ Hazardous Waste Solid N.O.S. (lead), 9, UN3077, PG III

NOTE: The above information is derived from the supplier's MSDS. This information is believed to be correct, but is not necessarily inclusive and should be used only as a guide. Advanced Micro Instruments. shall not be held liable for any damage arising out of using or abusing this product.

MSDS.3. Sensor type T1

MSDS.3.1. Product Identification

Product name:	Oxygen sensor, class T1
Manufacturer:	Advanced Micro Instruments
Address:	
Phone:	(714) 893-8024
Date of last revision:	4/27/00
Emergency phone number:	(714) 893-8024

MSDS.3.2. Physical and chemical data

Composition:

The sensor body is made of polyethylene and glass-epoxy GR4 circuit board material, with a paper covering.

It contains the following substances:

Common name	Formula	Concentration	CAS number
Acetic acid	$HC_2H_3O_2$	5% w/v	64-19-7
Potassium acetate	$KC_2H_3O_2$	5% w/v	127-08-2
Lead	Pb	pure	7439-92-1

Character of individual components:

Component	$HC_2H_3O_2$ (99%+)	Pb (pure)	$KC_2H_3O_2$ (97%)
Melting point/range	16.6°C	328°C	292°C
Boiling point/range	118°C	1744°C	N/A
Specific gravity	1.05	11.34	1.57
pH	N/A	N/A	N/A
Solubility in water	Infinite	Insoluble	72% @ 25°C
Appearance and odor	Clear colorless solution with a strong vinegar-like odor	odorless gray metal	Odorless, large white melting crystal
Flash point	40°C	N/A	N/A
Autoignition temperature:	427°C	N/A	N/A

MSDS.3.3. Physical hazards

Potential for fire and explosion:

The contents of the sensor are not flammable. There are no fire or explosion hazards associated with the sensor.

Potential for reactivity:

The sensor is stable under normal conditions of use. Avoid contact between the sensor electrolyte and strong acids and oxidizing agents.

MSDS.3.4. Health hazard data

Primary route of entry:	Ingestion, eye/skin contact
Exposure limits:	OSHA PEL: 0.05 mg/cu. M. (Pb)
	ACGIH TLV: 0.15 mg/cu.m. (Pb)
	OSHA PEL: 10ppm (TWA) (Acetic acid)
	ACGIH TLV: 10ppm (TWA), 15 ppm (STEL) (Acetic acid)
Effect of overexposure: Ingestion:	The electrolyte could be harmful or fatal if swallowed
	Acetic acid Oral LD50 (RAT) = 3310 mg/kg
	Potassium acetate Oral LD50 (RAT) = 3.25 g/kg
Effect of overexposure: Eye:	The electrolyte is corrosive. Eye contact may lead to permanent loss of vision.
Effect of overexposure: Dermal:	The electrolyte is corrosive. Skin contact may lead to a chemical burn.
Effect of overexposure: Inhalation:	Unlikely, but avoid it anyway. Vapors are very irritating to eyes and nose.
Signs/symptoms of exposure:	Contact with skin or eyes will cause a burning sensation.
Medical conditions aggravated by exposure:	Persons with pre-existing skin disorders, eye conditions or impaired respiratory function may be more susceptible to these substances.
Carcinogenity:	IARC: lead is classified as a class 2B carcinogen - possibly carcinogenic to humans.
Other health hazards:	Lead is a chemical known to the State of California to cause birth defects or other reproductive harm. As the sensor is used, lead acetate is formed. Lead acetate is know to the State of California to cause cancer.

MSDS.3.5. Emergency and first aid procedures

Eye contact:	Flush eyes with water for at least 15 minutes and get immediate medical attention.
Skin contact:	Wash affected area with plenty of water and remove contaminated clothing.
Ingestion:	Give plenty of cold water. Do not induce vomiting. Seek medical attention. Do not administer liquids to an unconscious person.
Inhalation:	Liquid inhalation is unlikely. If it occurs, move to fresh air and seek immediate medical attention.

MSDS.3.6. Handling information

NOTE: Oxygen sensors are sealed and under normal circumstances their contents do not present a health hazard. The following information is given as a guide in the event of a leak.

Hygienic practices:	Wash hands after handling
Protective clothing:	Rubber gloves, chemical splash goggles.
Clean up procedures:	Wipe down the area several times with a wet paper towel, using a fresh towel each time.
Protective measures during cell replacement:	Before opening the bag containing the sensor, check the sensor for leakage. If any is found, do not open the bag. If there is liquid around the sensor installed in the instrument, put on gloves and eye protection before removing it.
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Glossary of Terms

Accuracy

A loose term. In general with analyzers when we use the word "accuracy" we really mean "repeatability", the degree to which an analyzer can repeat the same measurement reading on the same gas. All analyzers really compare the measured gas against a known standard, and the accuracy of their measurement is therefore dependent upon this standard.

Bulkhead

Refers to a method of mounting an analyzer where the back of the analyzer is mounted flush against a panel or wall, while the body of the analyzer extends out in front of it, like a box hung on a wall's surface rather than inset.

Come-down

A term referring to the operation of an analyzer reducing its reading from a high level to a low or zero level. For trace analyzers this can be quite long, as it can take a long time for the final traces of oxygen to diffuse out of the gas sampling system.

Electrochemical

A type of chemical reaction which produces an electrical current as part of the reaction. In this case, the oxygen sensors produce an electrical current in proportion to the amount of oxygen present at their membrane surface.

LCD

Liquid Crystal Display - a form of digital display suitable for reading in bright light conditions. The display degrades below about -20C and above about 60C.

Membrane

A thin layer of permeable material (normally Teflon or a similar flouro-carbon) that controls the rate of diffusion of oxygen into the electrochemical sensor. It also controls the rate of diffusion of electrolyte out of the sensor. If the membrane is torn the sensor must be discarded.

Output - voltage or current

An analog voltage or current proportional to the oxygen measurement as a percentage of range, suitable for driving a chart recorder or computer input. A current output is preferred as it is less subject to interference than a voltage signal.

Panel

A type of mounting where the analyzer is inserted into a vertical panel so that the face plate is visible on the panel, while the body of the analyzer extends behind it.

Process

Refers to the sample that is supposed to be analyzed. Typically an analyzer measures the product of a chemical or physical process, and this is generally referred to as the "Process"

Range

The operational range of measurement of the analyzer. This is set by its amplifier sensitivity. Oxygen levels higher than the range full-scale will not be measured accurately. Normally the analyzer should be measuring oxygen concentrations between 20 and 80 percent of its range.

Response

The response time of an analyzer is defined as the time taken to go from the beginning of a noticeable change to 90% of the final level. The beginning is often defined as 10% of the final level. This is also called the "t90" time. The transit time of the gas is not included in this measurement.

RFI

Radio Frequency Interference. All analog circuits are prone to interference from high lervel radio frequencies, and special precautions must be taken to prevent this. The quality of such design is referred to by the acronym EMC, or electromagnetic compatibility - the property of being compatible with any practical electromagnetic environment.

Span

To calibrate the upper end of the range of measurement, as opposed to the bottom end or zero. Generally this is done by exposing the sensor to a gas of known concentration, and making the analyzer read that value.

Trace

Low levels of, in this case, oxygen. This term is used to describe unwanted levels of oxygen as a contaminant, typically in the low ppm levels.