AMI

Oxygen Analyzer Manual
Model 201LC

AMI, Costa Mesa, CA

Contents

Preface

The AMI story

The AMI series of analyzers provide the latest in high-definition oxygen analysis. The series includes trace (ppm) and percent models in several configurations. All of them share the same basic design approach, using AMI-manufactured oxygen sensors and advanced high definition electronics for noise and interference free performance. Several aspects of the design are the subject of patents, number 5,728,289 and 6,675,629; the sensors have a patent pending.

AMI specializes in oxygen analysis only , so as not to dilute its expertise by trying to cover too many other fields. As a result AMI analyzers are more advanced and have more features than competitive models.

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

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Model 201LC Series Oxygen Analyzer

Introduction

The Advanced Micro Instrument Oxygen Analyzer Model 201LC provides the latest in low-cost high precision oxygen measurement.

This manual covers software version 1.0.

Features:

- Compact size
- Unique patented cell block
- Auto-ranging display with user-selectable output range
- Front panel sensor access
- Optional air or span gas calibration, no zero gases required
- Virtually unaffected by hydrocarbons or other oxidizable gases
- High accuracy and fast response
- Large liquid crystal display
- Backed by a two year warranty (excluding sensor)
- Standard isolated 4-20mA output
- Two fully adjustable alarm relay contact closures 24VDC/230VAC 5A.

Oxygen sensor:

AMI manufactures its own electrochemical sensor. It 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. Unlike competitive sensors, the AMI sensor is made using a high capacity metallic body that provides long life with about twice the active ingredients of conventional sensors, but without compromised come-down time.

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.

NOTE: Any evidence of abuse or physical damage, such as a torn membrane, will void 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

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

Do not install the sensor until the analyzer is completely installed, the gas lines are plumbed and the electrical connections are all made; and sample or a suitable low oxygen level gas such as nitrogen or a low level span gas is ready to flow into it.

Installation.

Location:

The unit is designed to be mounted in a panel in a general purpose area. It should be mounted at a suitable viewing level. Refer to the drawing (figure 1) showing the analyzer dimensions. It is not suitable for use in a hazardous area or with flammable gases.

Although the unit is RFI protected, 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.

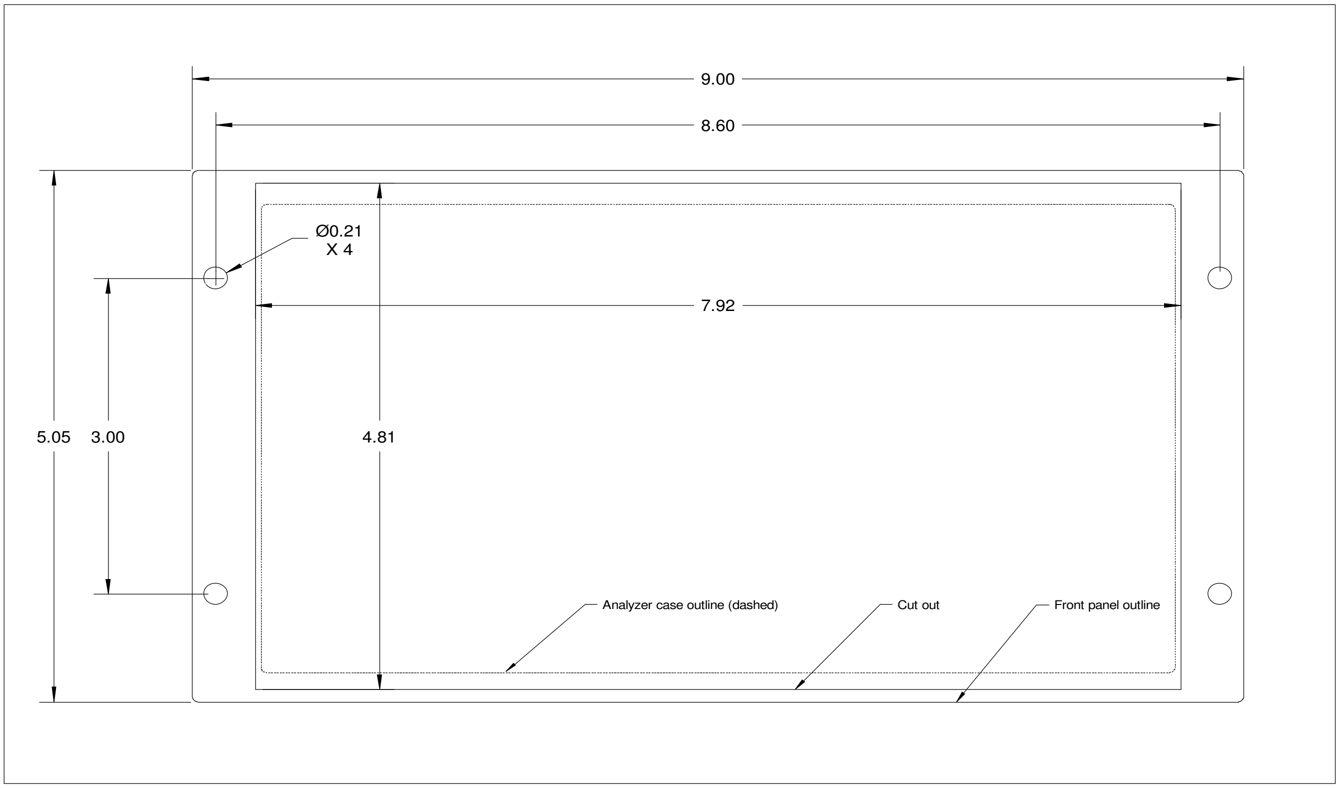

Figure 1. Outline and Cut Out Drawing

Connect gas and power lines:

Do not install the sensor until the gas lines have been connected and the electrical connections made.

Install the unit, and connect the sample gas lines, power and appropriate alarm and output connections. Connect the sample gas line to the fitting on the rear panel using the ¼" compression fittings provided, and the exhaust line to a suitable vent.

Sample gas:

The sample gas inlet pressure should be between 1-40psig.

Span gas:

Span gas (if desired) must be provided by a user-supplied valve.

Exhaust:

The exhaust line may be left open, or vented to a suitable vent. If used with a scavenging system, use a large diameter pipe (for example, ½" pipe) as the input to the scavenging system, and allow the ¼" vent to terminate a little way inside this larger line without sealing it. The scavenging system will then draw in room air along with the sample, while leaving the exhaust at atmospheric pressure.

Power connections:

The 201LC is designed to be operated from a 24V power supply only. Use a suitable wall adapter, or other kind of stable DC power supply. Make sure the ground is connected to a real ground – otherwise you may experience excessive noise and RFI interference.

Interconnections:

Figure 2. Back panel of the 201LC.

Alarm connections:

The alarm connections are single pole double throw relays, i.e. Form C contacts. They are normally preset to operate as high alarms, failsafe, with no alarm delay, though they can be supplied with other settings. By failsafe is meant that the relays are powered when NOT in alarm, so that if power fails, they indicate an alarm condition. The contacts can handle AC or DC voltages, and can carry up to 5A of current for a resistive load. Inductive loads such as solenoid valves should be “snubbed” – we suggest that you connect diodes or Zener diodes or “Transzorbs” directly across them to absorb the inductive spike. Do not connect them across the relay terminals on the analyzer, since the resultant current loop will transmit a lot of RFI that could upset sensitive devices nearby.

Output connections:

This unit is equipped with an isolated 4-20mA output. It is capable of driving a 600 Ohm load and will saturate at more than 125% of the nominal full scale range.

Serial connections:

No serial connection is provided on this analyzer.

Sample Handling:

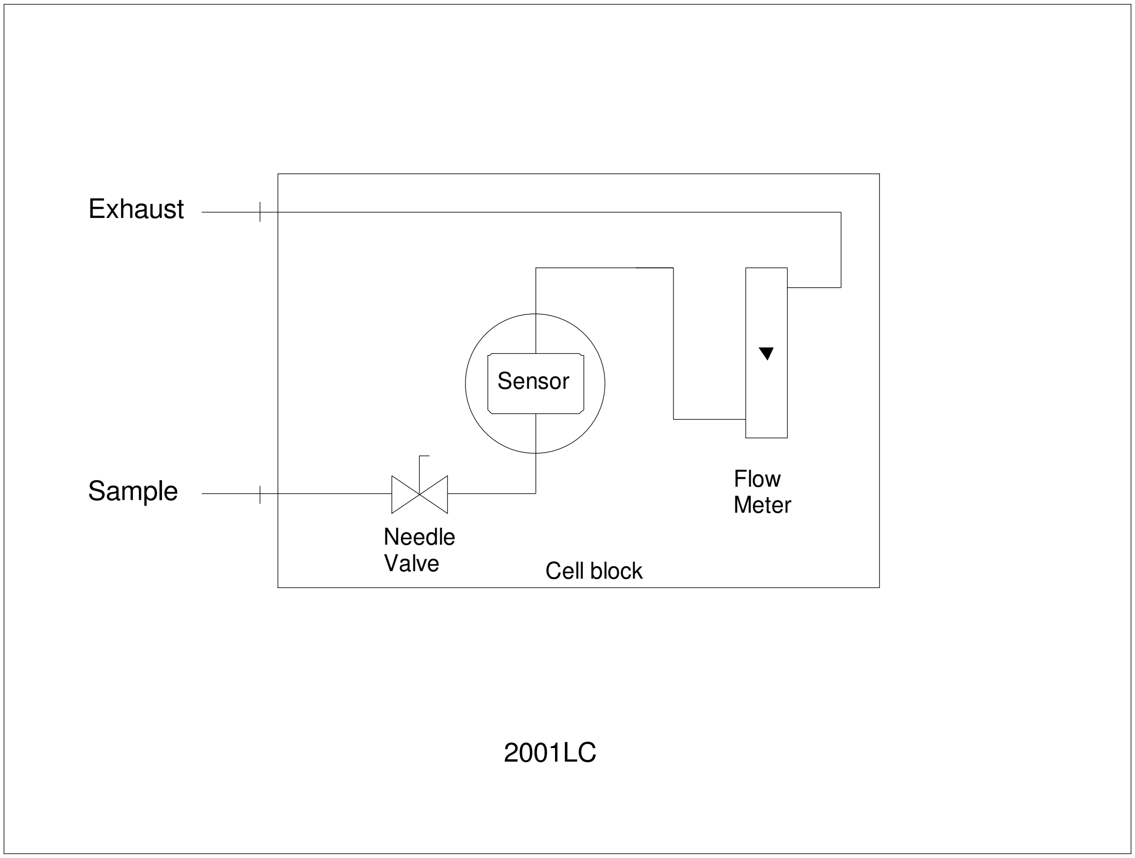

Figure 3 Flow Schematic of the 201LC

The analyzer expects to get a sample of gas at a pressure between 1 and 40psig. A built-in needle valve and flowmeter allow the user to control flow to 1SCFH with any pressure within this range. Higher pressure applications, or varying pressure applications, will need a regulator to control pressure. The analyzer is not sensitive to flow changes between about 0.2SCFH and 5 SCFH, but it is sensitive to back pressure changes (changes in exhaust pressure).

The flowmeter is mounted on the exhaust so that the oxygen reading is not affected by potential leaks around the flowmeter tube.

Sensor Installation:

The sensor is supplied sealed in a barrier bag. When you are ready to place it in the analyzer, open the bag and rapidly place the sensor in its compartment, sensing side down. If desired, rapidly calibrate it on air, and then flow a low oxygen level gas over the sensor until it has come down to its operating range

Operation

General Description:

This series of analyzers is designed to be as simple to operate as possible. The analyzer displays the oxygen level in appropriate units on the LCD, automatically adjusting its sensitivity as required. Meanwhile the analog output and the alarms are set on a single (user selectable) range.

For example, you can set the analog output to correspond to 0-1%, and the alarms to be say 0.4% and 0.5% (i.e. 40% and 50% of range), activating above set point. If the oxygen level actually is 0.25%, the display will show 0.25%, and the output signal will be at 25% of full scale. If the oxygen level becomes 2%, the display will show 2.00%, but the 4-20mA output will be saturated, and the alarms will both be activated.

If you now manually change the output range to 0-10%, the reading will stay at 2.00%, the 4-20mAoutput will go to 20% of scale, and the alarms will de-activate, since they now correspond to 4.0% and 5.0%, i.e. still 40% and 50% of range.

The analyzer uses a very high definition ADC to measure the oxygen signal as well as a temperature signal. Since it is so precise, it measures the full range of oxygen values with no gain change required.

Front Panel Controls:

The controls all work the same way. You press the function you want for a second, and let go, and the display will show the value corresponding to that function, for about 3 seconds. For example, if you press the OUTPUT RANGE button for a second, the display will show the full scale output range. You can change this value (if the security setting allows) by then pressing the UP or DOWN arrow button within about three seconds. You can either press this once for a small change, or you can hold it down , in which case the number will change slowly at first, and then faster. If you overshoot your target, press the other button to go back, and the display will again start moving slowly. If you release any of the buttons, or don't press the UP or DOWN buttons for three seconds, the unit will cycle back into normal operation and store the new value.

Output Ranges

The output range is the range to which the 4-20mA analog output signal and the alarm settings correspond.

Output ranges	(optional) 0-1000ppm, (optional)0-5000ppm, 0-1%, 0-5%, 0-25%, (optional) 0-100%

View Output Range

Press the OUTPUT RANGE button on the front panel for a second, and let go. The display will show the full scale value of the output range for about three seconds, and then change back to the oxygen reading. According to the option programmed into the unit, it will display the percentage output ranges allowed as shown above.

Change Output Range

Press the OUTPUT RANGE button for a second and let go. While the output range value is displayed (you have approximately three seconds), press the UP or DOWN arrow buttons to change it. The output range will change to whatever you want. Simply leave it or select another function and the range will be stored and the system updated. You will note that if this results in an alarm change, the alarms will change as soon as the unit starts showing the reading again. If the output range does not change, the security level must be set to full or span only security. In this case change the security level with the laptop and the AMI User Interface program.

Alarm Set Points

The alarm set points can be viewed and changed from the front panel.

View Alarm Set Points

Press either of the ALARM SET POINT buttons and let go. The alarm set point will be displayed for about 3 seconds, and the then the display will revert to the oxygen reading. The set point shown relates to the current output range. If you change the output range, the alarm set point will change to a new value which is the same percentage of the new output range. For example, if the output range is 100ppm, you can set an alarm set point to be half way up, i.e. 50ppm of oxygen. If you then change the output range to 500ppm, the alarm set point will remain half way up the new range, and be displayed as 250ppm.

Change Alarm Set Points

Press one or the other ALARM SET POINT button for a second, and let go. While the alarm set point is showing, press either the UP or DOWN arrow button and hold it until the value is what you want. The numbers will scroll slowly at first and then speed up: if you press the other button, or release and re-press the one you are using, the number will start going slowly again.

Alarm Hold Off

Press the ALARM HOLD OFF button for a second and release it. The display will show the alarm hold off time in minutes, and if the analyzer was indicating an alarm, it will be turned off and held off for the period of the alarm hold off time. The alarm hold off time can be adjusted by pressing the UP or DOWN arrow buttons.

Calibration (Spanning)

The model 201LC may be calibrated using air as the span gas, or else using a lower level gas closer to the measurement range. It is not necessary to zero the analyzer. Spanning is normally performed somewhere between once a month and once every three months, depending on the level of accuracy required.

Do not attempt to span with a gas less than 20% of the range to be used, as the span errors multiply and your results will be less accurate. Make sure that the flow rate of span gas is the same as that of the process gas, unless you use air as the span gas by opening the cell compartment.

If the span gas value is such that it will cause the alarms to activate, press the ALARM button to preemptively silence them. You may want to extend the alarm hold of time to cover the length of time you will be spanning!

AIR CALIBRATION

1. Shut down the sample gas flow, either by closing an external valve, or closing the internal flow valve.
2. Open the cell cap, and blow a little compressed air under the cell. Don’t use your breath as it contains less than 20.9% oxygen!

3. Press the span button momentarily, and adjust the reading up or down with the UP or DOWN arrows until it reads 20.9%.
4. Close the cell cap, and flow zero or sample gas by opening the valve.

SPAN GAS CALIBRATION

1. Flow sample or zero gas through the unit until it is reading a value below the span gas value. If the sensor is newly installed, allow the reading to come down to at least one tenth the span gas value; if it has been looking at a sample gas of roughly the span gas value for more than a few hours, this step is unnecessary. The idea is to make sure that any dissolved oxygen left in the sensor has had a chance to be depleted.
2. Using an external selection valve, introduce a span gas into the cell compartment. Flow it at 1SCFH, or at any rate the same flow as the sample gas.
3. Allow the reading to stabilize. This will take only a minute or so, but you may want to leave it for five minutes to be sure.
4. Press the SPAN button, and then adjust the reading with the UP or DOWN arrow until it says the same as the marking on the tank.
5. After a few seconds, the SPAN flag will go off and the new calibration value will be stored.
6. Using the external valve, allow sample gas to flow again.

Verify Span Factor:

The analyzer features a “Span Factor” display to help you determine the state of the sensor. As the sensor ages, its output decreases gradually, and therefore the span factor has to be turned up during calibration to compensate.
Press and release the UP button while the unit is showing its reading to view the span factor. The factor corresponds to the setting of a traditional ten turn span pot with a turns counter dial on it.
The setting should be between 300 and 600 for a new sensor. When you calibrate the analyzer, check this value before and after the calibration. You should see that the value goes up slowly over the life of the sensor. When the value has gotten up to 1000, the sensor has reached the end of its life and should be replaced. Also, if the value suddenly jumps, it indicates that the sensor is getting close to the end of its life.

Read the Temperature:

Press the DOWN arrow button. The display will show the temperature of the cell block in degrees Fahrenheit. The value is limited to 25F at the lowest, and about 120F at the highest. Values outside this range will damage the sensor

Alarm Functionality:

The model 201LC series has two alarms, with two associated relays. Normally, these are set to operate as high alarms (they go into alarm if the oxygen level goes above the set point), and to close their associated relays upon alarm. Their time delay is set to zero, and they do not latch (unless specifically requested otherwise). An Alarm state is indicated by the word “ALARM” appearing on the display.

Using the analyzer front panel you can change the alarm set points, but you cannot change any of the other settings. If you want them to operate below alarm set point, to latch, or to operate in a pulse mode, you have to order the analyzer set up that way. In this case contact the factory.

Maintenance and troubleshooting

Maintenance:

The model 201LC is virtually maintenance free other than for periodic calibration and occasional sensor replacement.

Periodic Calibration:

The analyzer should be calibrated about once every month to obtain the best accuracy. The sensor typically declines in sensitivity by about 1% per month, so a monthly 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 based on the Span Factor feature, rather than as a response to a dead sensor. See the chart below for recommended sensor replacement.

Sensor	Part number	Description	Expected life
P2	4SEN03-1	0-50% Percent oxygen - inert gas	9 to 12 months
P3	4SEN04	0-25% Percent oxygen - CO2 background	9 to 12 months
P4	4SEN08	100% oxygen - inert impurity	6 to 9 months

Table 1. AMI percent sensor types

Sensor replacement cautions:

CAUTION: The sensor contains a caustic or acid liquid. If there is any sign of a liquid in the cell compartment, do not allow it 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.

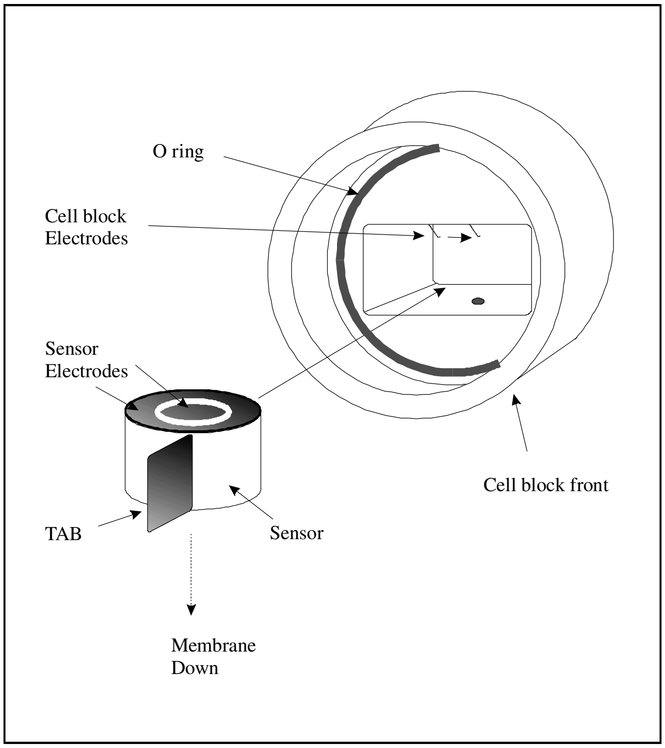

Figure 4. Inserting sensor in cell block

Sensor replacement procedure:

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

Before installing sensor, make sure the power is ON.

1. Press the ALARM ACKNOWLEDGE.
2. Turn the gas flow down to zero on the flowmeter.
3. Unscrew the cell block cap, being careful not to lose the O ring.
4. Carefully remove old cell by pulling the tab on the label.
5. Inspect the cell block cavity, and if any sign of moisture clean it out with a Q tip or similar. Make sure that the contact springs inside the block are intact. Be careful not to snag them with the Q tip.
6. 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 (such as dirt).
7. Carefully open the bag using a pair of scissors or a knife. Make sure you don't cut yourself or stab the sensor! In the rare event that the sensor has leaked there will be 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.
8. Don't pull out the shorting tab yet!
9. Holding the sensor by its tab, membrane side down, slide it into the cell block (gold plated contact side of sensor should be facing up touching the cell block contacts. Make sure the tab is pointing towards the outside so you can pull it out!
10. When the sensor is pushed in all the way, pull out the shorting tab.
11. Let the reading stabilize and adjust it after a minute to 20.9%.
12. Turn up the flow of zero (or sample) gas.
13. Carefully replace the cap, making sure that you do not cross thread it, and tighten firmly by hand. Do not over-tighten.
14. Make sure the zero or sample gas flow is set to 1 SCFH.
15. Let the reading come down to a low level, and then if desired, calibrate it using a span gas.

O rings

The O rings used are all Buna N type. Replacements are available from AMI . The following lists all the O rings used in the model 201LC Series.

Position	**O ring number**
Cell cap	1ORG01
Flow meter seal	1ORG07

Troubleshooting

All oxygen applications

Analyzer does not power up.

1. Check that the power is connected correctly, and the switch on the power entry module is on.
2. Check that the power supply voltage is 24VDC only.

Analyzer reads too low

1. Sensor is not calibrated. Flow span gas through it and span the analyzer until the analyzer reads appropriately.
2. If you cannot adjust the span enough to accomplish this, replace the sensor.
3. If the new sensor still reads too low, check its calibration with air and read the span gas - the span gas may be incorrect.
4. If the sensor seems to die quickly, it may be getting poisoned by acid or sulfur bearing gases such as H_2S. These should be scrubbed from the sample stream by a scrubber.
5. Verify that the cell block connectors are in fact making contact with the cell. Clean them gently with a Q tip, and bend them slightly straighter so that they make a good contact. Once this is done the cell should have some resistance to being removed from the block.

Analyzer reads too high

1. Verify that there is no flow restriction in the vent line of the analyzer.
2. Increase the flow rate through analyzer by increasing the sample pressure - if the reading goes down it indicates a leak in the incoming sample line or the cell block. Use “Snoop™” or equivalent to check all the fittings back to the gas source.
3. Leak test all external fittings with “Snoop™” soap solution or equivalent.
4. Verify that the gas flow rate is correct. (0.1 to 2 SCFH)
5. Oxygen diffusion can be a serious problem. Verify that no plastic tubing or other plastic components are used in a trace gas system, including diaphragms of pressure regulators, packing of valves etc. For percent applications, similar problems may be experienced with silicone tubing. Use Teflon™ or Tygon™ or similar high quality tubing.
6. Verify the analyzer calibration using air as the span gas.
7. Flow zero gas through the analyzer for a while until the reading is stable: shut off the incoming flow with the sample valve and then immediately seal the vent tightly with a tube plug or equivalent (don’t pressurize the cell!). Monitor the reading and see if it increases significantly over a 5 minute period. Such an increase indicates a leak in the cell block or internal sample system.
8. Remove the cell (and short it out!) and verify that the analyzer reads zero - if not, there is moisture or corrosion between the sensor contacts in the cell block; clean the contacts and the area around them with isopropyl alcohol, dry with dry compressed air or nitrogen, then replace the cap on the cell block again. Pressurize the system to no more than 10 psig and leak check all the fittings and tubing including the sensor block penetrations such as the sensor wire seals (nylon plugs and epoxy seals on the top of the cell block).

NOTE: Be careful not to get soap solution on the PC board!

Analyzer reads zero

1. Verify that the sensor is in the correct position, not upside down. If it is upside down, verify that the membrane has not been punctured - i.e. there is no sign of electrolyte on the surface, and if not, put it back the right way up. If you have left it this way for a while, it may take several hours to recover to a low reading.
2. Verify that the cell block contacts are touching the sensor. Pull the sensor tab, and the contact should hold the sensor with a gentle force. If not, the contacts may be bent. If they have been bent too much, remove the sensor and gently bend them back so that they can again make contact.
3. Make sure that the gold plated contact wires are clean. If not, gently clean them with a Q tip or an eraser. Do not use an abrasive cleaner, as it will remove the gold plating.
4. Check the output of the sensor with a DVM configured to measure current. Connect its leads to the two gold rings on the back of the sensor - the center is ground. The output should be around 150 to 750 micro Amps in air. This will take a few minutes to stabilize as the sensor consumes oxygen dissolved in its electrolyte. Replace the sensor if it does not read this amount. See sensor replacement instructions under Maintenance.

No voltage or current output to recording device

1. Verify that the output wires are properly stripped and connected.
2. Verify the connections on the output terminal block.
3. Verify that the output connections are not shorted all the way back to the recording device. Disconnect the wires from the analyzer and use an ohmmeter to check for shorts or opens.

No output alarm indication

1. Verify the alarm set points are correct - press the appropriate switch on the front panel, and check the displayed reading on the LCD for correct setting.
2. Verify that the connections on the terminal block are properly stripped and correct.
3. Verify that the output connections are not shorted all the way back to the recording device. Disconnect the wires from the analyzer and use an ohmmeter to check for shorts or opens.

Incorrect readings

1. Verify that there are no leaks in the system.
2. Verify that the span gas bottle is correctly marked by comparing its reading when the analyzer has been spanned on air to what it actually says.
3. If spanning on air, verify that the air source is free of water vapor (humid air will contain about 3% less oxygen than expected, depending on temperature), and that bottle air does actually contain 20.9% oxygen. Manufactured air often does not!

Still no correct operation

1. Call AMI at 714 848 5533, and ask for Technical assistance.
2. Or contact us by email at sales@AMIO2.com.

Specifications and Disclaimer

Specifications:

201LC Series Standard ranges:

0 – 1%, 0 – 5%, 0 – 10%, 0 –25%

Optional ranges (contact factory) 0-1000ppm, 0-5000ppm, 0-100%

Sensitivity: 0.5% of full scale

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

Operating temperature: 5°C to +45°C (41°F to 113°F)

Humidity: < 95%, 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 to 2 years.

Response times:

90% of full scale in less than 10 sec

Output: 4-20mA isolated.

Alarm contacts: 230/117VAC @ 5A, or 28VDC @ 5A, resistive

Power requirements: 24VDC <10W.

Absolute Maximum Power voltage 28VDC

Overall dimensions: 9” w x 95” h x 3” d

Mounting hole dimensions: 7.92” w x 4.81” h

Weight 5 lbs

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.

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)

Sensor type P2, T1

Product Identification

Product name:	Oxygen sensor, class P1, P2, T1
Manufacturer:	Advanced Micro Instruments
Address:	
Phone:	(714) 848-5533
Date of last revision:	11/08/2004
Emergency phone number:	(714) 848-5533

Physical and chemical data

Composition:
The sensor body is made of metal and glass-epoxy GR4 circuit board material, with a Mylar 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

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.

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

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.

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.

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.

Sensor type T2

Product Identification

Product name:	Oxygen sensor, class T2
Manufacturer:	Advanced Micro Instruments
Address:	
Phone:	(714) 848-5533
Date of last revision:	11/08/2004
Emergency phone number:	(714) 848-5533

Physical and chemical data

Composition:

The sensor body is made of metal and glass-epoxy GR4 circuit board material, with a Mylar 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
Auto ignition temperature:	427°C	N/A	N/A

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.

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.

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.

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.
EPA waste number:	D008
California waste number:	181
DOT information:	RQ Hazardous Waste Solid N.O.S. (lead), 9, UN3077, PG III

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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. In the case of the microprocessor based 2001/201 analyzers, normally refers to the range to which the analog output corresponds.

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 level 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.

RS-232

"Recommended Standard (no.) 232" – a rather non-standard description of the simplest way of allowing two computers or a computer and another device such as a printer, to talk to each other.

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.

Index