

# Oxygen Analyzer Manual

## Model 201RSP



AMI, Costa Mesa, CA

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# 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 are also covered by a patent, number 7,316,768.

Please verify that the analyzer was not damaged in transit. If so please contact the shipper as well as AMI.

## 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.

## Address

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# Model 201RSP Oxygen Analyzer

## Introduction

The Advanced Micro Instrument Oxygen Analyzer Model 201R Series provides the latest in high precision oxygen measurement. It is designed for monitoring oxygen in trace (ppm) ranges in a non-hazardous area.

This manual is divided into two major sections: a quick reference section for experienced users, and a detailed exploration of all the many features of the analyzer for all users.

This manual covers software version 5.22.

## Features:

- Compact size
- Unique patented cell block
- Auto-ranging display with user-selectable output range
- Three customer-selected levels of security access settable via the RS232 interface.
- 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
- H<sub>2</sub>S resistant sensor up to 10ppm H<sub>2</sub>S
- Optional 500ppm H<sub>2</sub>S resistant sensor available
- Large liquid crystal display
- Bi-directional serial output with simple protocol
- Standard isolated 4-20mA output
- Two fully adjustable alarm relay contact closures 24VDC/230VAC 5A.
- User selectable alarm delay-on activation
- User selectable pulse drivers for latching-type solenoid valves
- Built-in data logging with real time clock
- Sample system for ambient pressure samples
- Includes high-quality pump
- Span solenoid valve
- Built-in data logging with real time clock
  - Logs oxygen, temperature, power supply voltages
  - Logs over-range spikes
- Automatic logging of low power, start up and calibration events
- USB connection for AMI provided software
- RS485 connection for ModBus™
- 90-240VAC operation

## **Oxygen sensor:**

AMI manufactures its own 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. 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.

## **Receiving the analyzer**

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

# Important:

*This section contains important information to do with safety and installation. Please don't skip it!*

## -----Points to consider first! -----

**Environment** – what is the temperature range going to be where the analyzer will be installed? If the temperature is going to go below freezing, you will need a heated version or to place it in a temperature controlled building. Also, make sure it won't get too hot in the summer – you may need to ventilate or even air condition a building. The standard (non-heated) temperature specification is 25°F to 115°F.

**Sample conditions** – if your sample is hot and wet, you will need to keep water from condensing in the sample line or analyzer. Contact AMI for advice. If the sample contains high amounts of CO<sub>2</sub>, it will be necessary to temperature control the analyzer so that the sensor doesn't explode like a can of soda on your car's dashboard in summer. Contact AMI for this one too.

**Sample pressure** – this analyzer is designed to work with ambient pressure samples, such as that from a glove box. As a result it draw the sample from the source through the sample line and then onto the sensor. The pressure drop across this line must be minimal – 1psig at the absolute most. If the line is long, use 3/8" or wider tubing.

**Power supply** – The unit contains a switching power supply that is insensitive to AC voltage or frequency changes over a wide range. It will work with any normal UPS system if desired.

**Electrical connections** - Following best electrical practices, run the analog output connections separately from the power and alarm connections. Modbus communications if used should be run with the analog output wiring, using twisted pair wires for both circuits. Run the alarm wires in the same conduit as the power wires.

**Solenoid valves** – if the analyzer is going to be used to control gas flow (such as to shut in contaminated gas) using solenoid valves, consider using latching type valves and the analyzer pulse feature so as to minimize power consumption, particularly if you are using a battery and inverter as the power supply. Standard solenoid valves require power to remain open (or closed), whereas latching valves require power only when changing their position. This conserves a lot of power.

**Span gas** –It is strongly suggested that you use room air to calibrate this unit. If you are going to use span gas to calibrate the analyzer as opposed to air, you will need to plumb a span gas tank to the span inlet on the back of the analyzer. When you do this, the line to the tank will be full of air. When you subsequently span the analyzer, oxygen from the air will have leaked into the span line potentially increasing its oxygen content. Wait until the reading has stabilized, and then adjust the span.



In addition, since the analyzer includes a pump, you have to take care that you do not pressurize the sensor with the span gas. It will be necessary to use a bypass valve and flow meter on the span inlet of the analyzer.

# Installation and Operation

## Receiving the analyzer

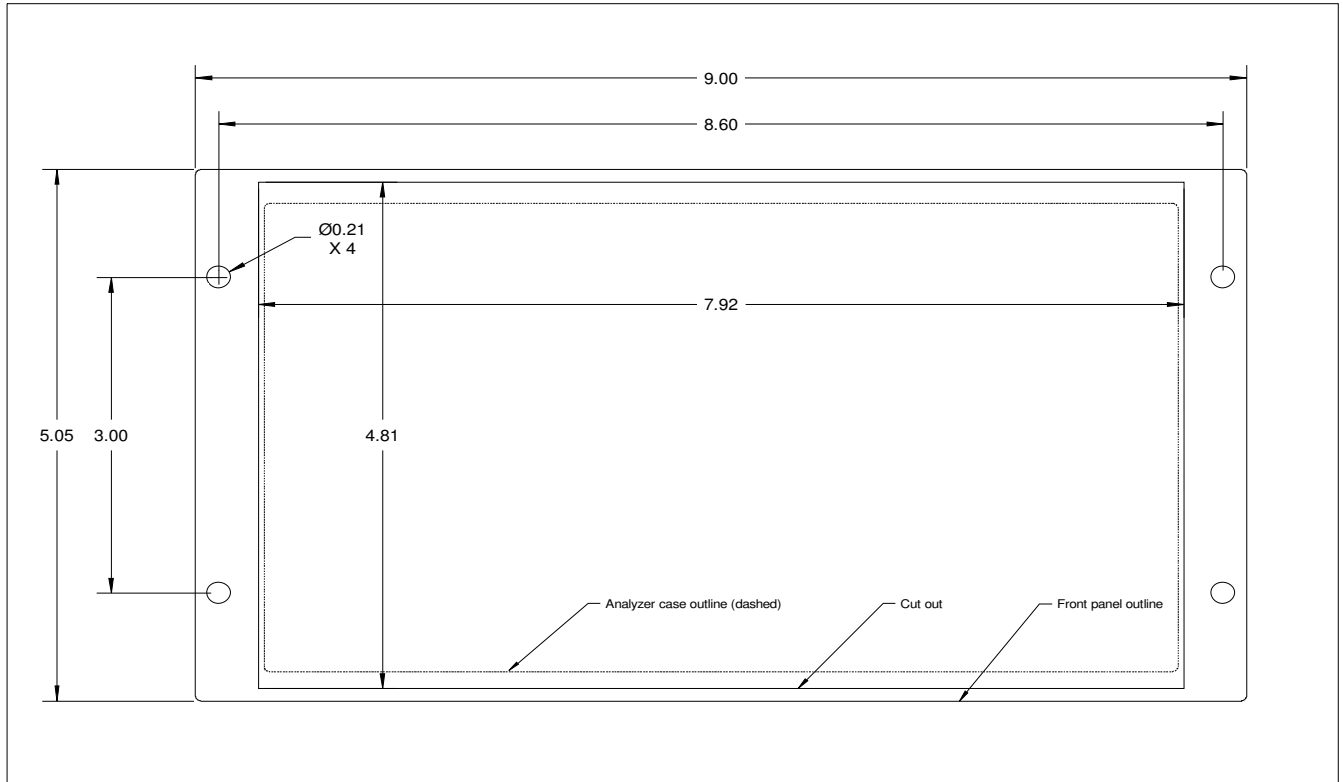
When you receive the instrument, check the package for evidence of damage and if any is found, contact the shipper.

## 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.

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 excessive vibration – anything worse than a truck may be problematical.



**Figure 1. Outline and Cut Out Drawing**

# Short-form Installation Procedure

1. Mount analyzer at a convenient eye level.
2. Deal with any potential condensation or liquid contamination issues.
3. Connect the sample line to the sample inlet port with ¼" tubing, either metal or a high quality plastic line. Don't use silicone tubing!.
4. Pressurize the sample line to between 1psig and 10psig).
5. Leak check every fitting and weld from the analyzer inlet to the sample tap.
6. Remove the pressure source from the sample line.
7. Connect vent line to outside or a suitable purge system, or back into the source if appropriate.
8. If using a span gas, connect it to the span port on the back of the analyzer. Include a bypass flow meter! See step 26 below.
9. Connect power, relay contacts, analog output and RS485 if desired. If using conduit, run the power and alarms in one conduit, and the analog output and RS485 in the other.
10. Turn on the analyzer with the switch on the power entry module on the back panel.
11. Adjust the sample flow to approximately 1 SCFH with the Flow control valve.
12. Allow the sample gas to purge the unit for a few minutes. Make sure the cell cap is in place.
13. If you are not using the advanced features, set up the alarms and the output range from the front panel of the analyzer.
14. Optional:
  - a. Connect the laptop, run the User Interface version III and verify all alarm, output and security settings.
  - b. Set the analyzer clock time, and click on "Clear Data Log".
  - c. Verify the output calibration .
    - i. Connect the analog output terminals to an appropriate measuring device – preferably the monitoring device you are going to be using with this analyzer.
    - ii. Arrange that you can readily see the reading given by this device.
    - iii. On the AMI User Interface, check the "Zero" check box under SETUP in the ANALYZER SETUP section.
    - iv. Observe the response of the monitoring device, and adjust the number in the Zero box until the monitoring device shows what it considers to be zero (which should correspond with 4mA).
    - v. Check the box marked "Full Scale" in the SETUP section, and adjust the number in the box next to it until the monitoring device shows full scale. This corresponds to 20mA.
    - vi. Check the "Mid Range" box and verify that the monitoring device shows mid scale.

- vii. Uncheck any boxes (if you forget, the analyzer will revert to its ordinary operation in ten minutes anyway).
15. Test the entire system, including anything controlled by the alarms or analog output, using a cell simulator (this is an optional device provided by AMI).
16. If not using span gas, press and hold the SPAN button on the front of the analyzer for 5 seconds until the LED turns blue. This will stop the sample flow.
17. Unscrew the cell cap, and install the oxygen sensor.
18. Remove the shorting tab on the sensor.
19. Optional: in the User Interface (version III) press the “NEW SENSOR” button, and record the sensor serial number.
20. If not using span gas, Stabilize for 45 seconds ONLY, adjust span to 20.9%. If it already shows 20.9%, press the UP arrow for a moment anyway (to tell the unit to switch back to sample gas).
21. If using span gas for calibration, stabilize the sensor by allowing sample (or zero) gas to flow at about 1 SCFH.
22. Replace the Cell cap and tighten it down (hand tight).
23. (If you are finished with setting it up) remove the USB connection cable.
24. If desired, span with known calibration gas.
  - a) Connect a regulator to span gas tank.
  - b) Shut off the regulator outlet valve and leak check all the tank fittings, gauges and packing glands with Snoop™ or equivalent liquid leak detector (not spray).
  - c) Connect a bypass flow meter and a series valve at the inlet of the span fitting. The analyzer’s pump will suck a sample out of this line, and you want the inlet pressure to be atmospheric. You can control the bypass flow with the valve while the analyzer is drawing its sample.
  - d) Flow calibration gas WHILE you are connecting the tubing to the span gas fitting. Allow the gas to purge through the fitting for about 20 seconds before you tighten it.
  - e) Tighten fitting on the span gas inlet.
  - f) Press the ALARM HOLD OFF button, and adjust the time displayed to a suitable value (typically 10 minutes).
  - g) Press and hold the SPAN button for 5 seconds until the LED turns blue.
  - h) Allow to stabilize for 2-5 minutes.
  - i) Verify that the analyzer reads within about 15% of the span gas value.
  - j) If so, adjust the analyzer span (see below) until it reads the span gas value.
  - k) Let it go back to normal operation (the “SPAN” flag goes out on the LCD display and the LED turns green), then press the UP arrow and note the number displayed (the “Calibration factor”).
  - l) Turn off the valve on the span gas tank (so it doesn’t all leak out).

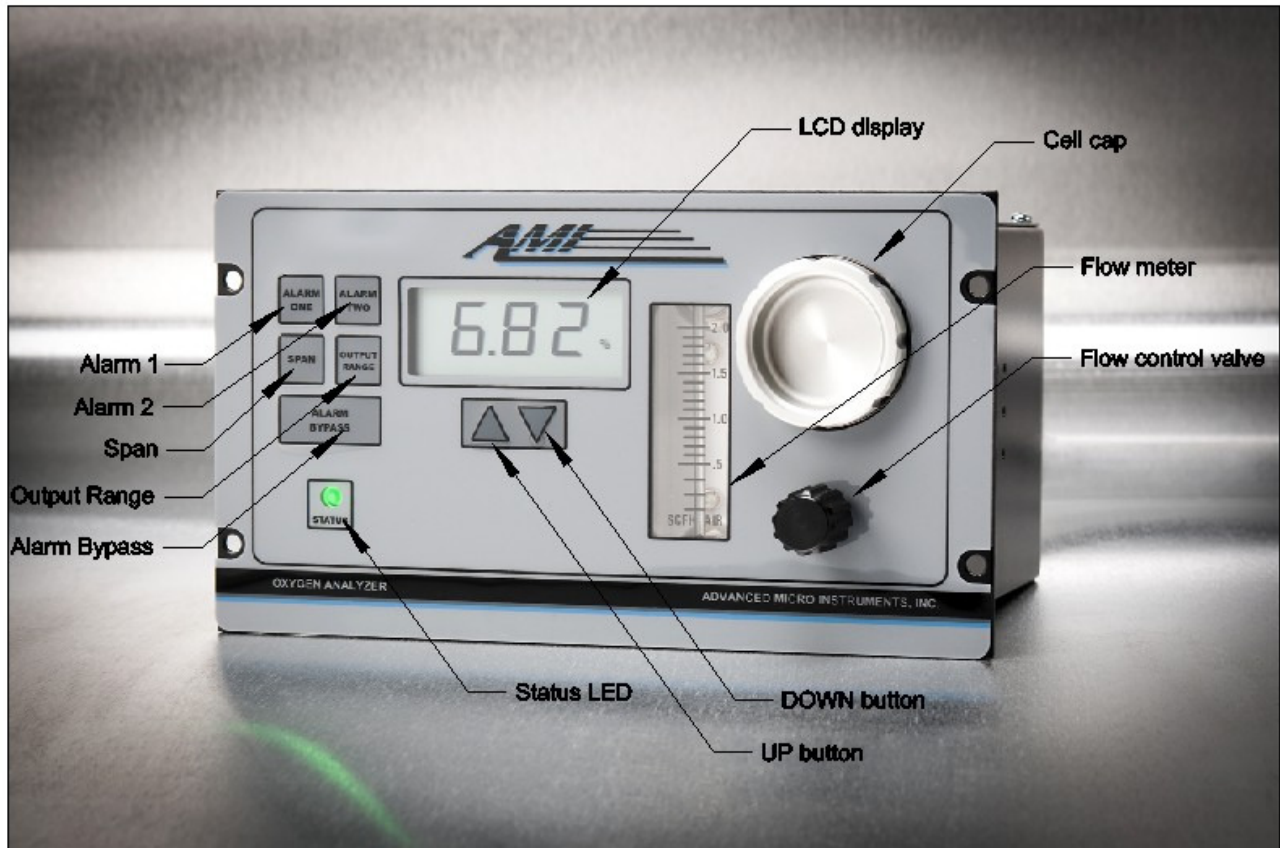
If the span gas reads worse than 15% wrong, something is wrong either with the gas, or with the plumbing (you have a leak) or some other error. See the troubleshooting section for some ideas about curing this.

## Laptop set up procedure:

1. Make sure the laptop has the FTDI driver installed.
  - a. Windows 7 will probably find the driver by itself, but XP probably won't.
  - b. Run the program called CDM20824\_Setup.exe which is either in the AMI CD, or can be downloaded from the FTDIchips.com site.
2. Install the AMI program if you haven't done so already.
3. Run the program.
4. On the User Interface screen, at the top, click the "Port" button. Note the ports listed.
5. **Make sure the analyzer is powered up**, and connect the USB cable to it.
  - a. **If you connect the cable without power to the analyzer, the port won't appear.**
6. On the User Interface screen, at the top, click the "Port" button again, and you should see an additional port. Select this port.
7. Let the program figure out how to talk to the analyzer, and watch it load up all the boxes with numbers or words.
8. If you want to name the analyzer, click on the "User ID:" box. A dialog box will come up, asking for a password. Use "AMI" (in capitals) as the password, and then write in up to 12 characters as a name for the analyzer.
9. Set up the output range, that is the range used by the analog output and the alarms to scale the output for your monitoring device.
10. Make sure the security settings are the way you want them.
11. Go through the analog output calibration procedure if desired.
12. Set up the alarms to work as you desire – see the alarm section below for details.
13. If you are installing the sensor, click on the New Sensor button and write in the serial number.
14. Check the analyzer date and time is correct (we set it up for Pacific Standard time, which may not be correct for you). You can send the computer time to the analyzer by clicking the Set Analyzer Time button.
15. Clear the stored data by clicking the "Clear Data" button in the DATALOG section on the right.

The following sections describe each of the above sections in more detail.

# Expanded Installation Procedure



**Figure 2. The 201RSP**

This section follows the format of the installation procedure above but with greatly expanded explanations and coverage of detail issues.

## **1. Mount analyzer at a convenient eye level.**

The basic analyzer is designed for operation between 25°F and 115°F. It is available with a heater, but this is intended only to stabilize its temperature if it to be measuring in pure CO<sub>2</sub>. The gas connections are made on the left side of the back of the analyzer, while the electrical connections are at the bottom of the back

The analyzer is intended to be mounted on a panel in a building.

If the analyzer is mounted in a building with other equipment, make sure it won't get too hot during the summer. The sensor will rapidly die in temperatures higher than 115°F. You may need to install ventilation or even air conditioning.

**2. Deal with any potential condensation or liquid contamination issues.**

If the sample may contain condensable liquids, they must be prevented from entering the analyzer. This analyzer is intended to work with clean dry samples only.

**3. Connect the sample line with ¼" tubing.**

Use a high quality tubing only to connect the sample to the analyzer. Most plastic tubing will be OK but do not use silicone tubing – the soft, easy to use stuff. It is remarkably permeable to oxygen and will give you incorrect readings. Normally ¼" tubing is adequate unless the sample run is very long and the source pressure low – in this case you may have to use wider tubing.

The analyzer contains three solenoid valves that control the gas flow. When turned off, the sensor is sealed off from the inlet and the exhaust. As soon as power is applied, the exhaust valve and the sample valve open. You can close the sample valve and open the span valve by pressing and holding the span button for five seconds. If you then touch either the up or down button, the analyzer will close the span valve and open the sample valve after another few seconds. Don't use the metering valve to shut off the flow (as it is a fine adjustment valve)!

**4. Pressurize the sample line to line pressure (1 – 10psig).**

The exact pressure doesn't matter – we want enough so that you can easily see leaks in the following step.

**5. Leak check every fitting and weld from the analyzer inlet to the sample tap.**

Use a liquid soap solution such as "Snoop™" or similar. Don't spray it on! You are looking for little bubbles that appear after a while, indicating a leak. Even the tiniest leak will allow oxygen to enter the gas stream, no matter what the pressure inside the line is. Check absolutely every possible source including welds, valve packing, fittings both around the tube and the nut, and anything else that might leak.

**6. Connect the vent line to outside or a suitable scavenging system, or if appropriate back to the source.**

It is important that you neither back-pressurize the sensor by restricting the exhaust flow, or that you pull a vacuum on it by directly connecting it up to a scavenging system. If you are measuring an inert gas, it is normally acceptable to vent the gas into the room (as long as you have some kind of ventilation!). If it is a flammable or otherwise hazardous gas, use a scavenging system that draws in room air along with the exhaust from the analyzer (putting an exhaust tube a foot or so up into a wider scavenging pipe works well). Allow the scavenging system to draw in room air along with the exhaust.

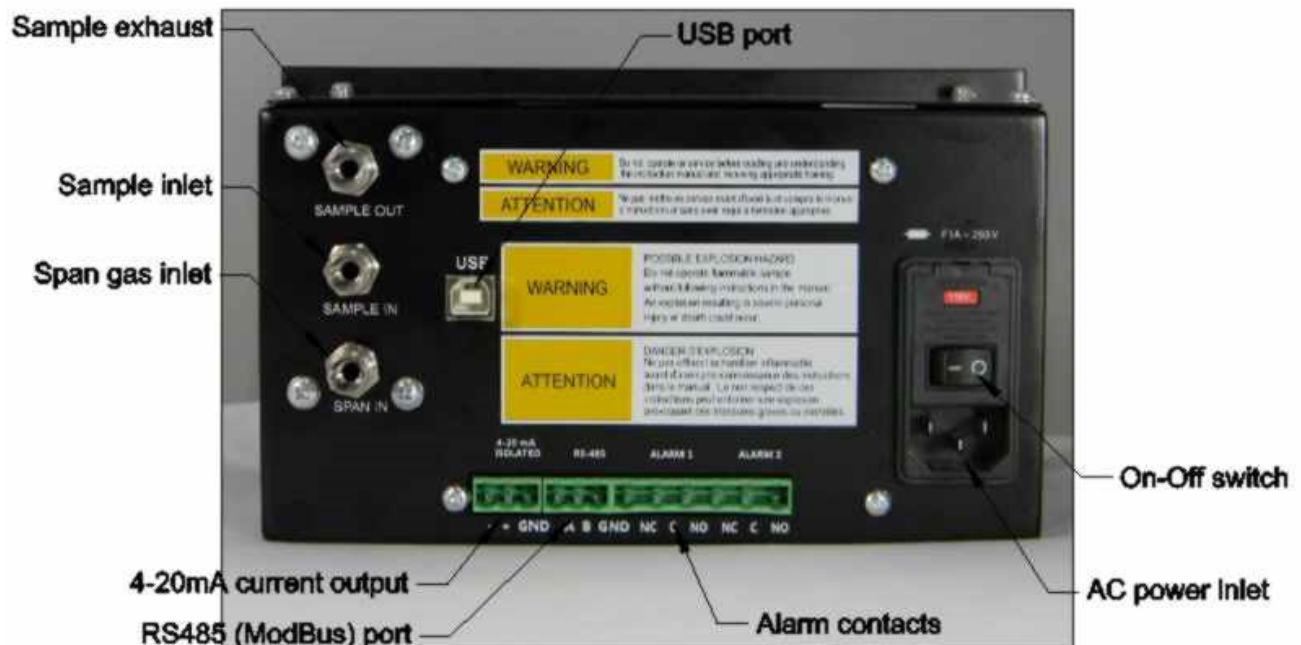
If using the analyzer with a glove box or similar device, it is often appropriate to return the sample to the source. Bear in mind that you might not want to do this if you intend to calibrate with air!



**7. Adjust the sample flow to approximately 1 SCFH with the Flow control valve located on the front panel.**

The Flow Control Valve is the metering valve on the right of the front panel. It is a sensitive needle valve – so don't try to use it to shut off the flow. Use the solenoid valves for this.

The exact flow rate is not important – 1 SCFH is half way up the flow meter, so is easy to see. You want the flow between about 0.5 SCFH and 2 SCFH at the maximum. Lower flows will result in longer response times, and possibly higher oxygen readings as minor leaks aren't diluted as much by the flow. Higher flow rates will tend to increase the pressure on the sensor which will increase the oxygen reading.



*Figure 3. The 201RSP back panel*

**8. Connect power, relay contacts, analog output and RS485 if desired. If using conduit, run the power and alarms in one conduit, and the analog output and RS485 in the other.**

The AC power uses a standard IEC connector like any desktop computer. Although the power entry module allows you to select the AC voltage, it is not necessary to do so as the switching power supply used has a very wide input range, and can handle voltages from 90 to 240VAC, and 50 and 60 Hz supplies.

The analog output – 4-20mA – is connected to the “+” and “-” symbols. This signal is isolated from ground. If the device to which you are connecting is also isolated from ground, make sure you ground the “-” connection at the analyzer. The terminal marked by the ground symbol may be used for this purpose, in

which case the output is no longer isolated. DO NOT GROUND BOTH ENDS! If you do so, you will generate a ground loop which will seriously upset the readings. Normally you would use the ground terminal for a shield. It is possible to use the AMI User Interface program on a laptop to calibrate the 4-20mA output to your monitoring device.

The two terminals marked A and B are for the RS-485 ModBus connection. This is not isolated from ground.

There are two alarm contacts. These are form C contacts. The NO and NC markings refer to the connections when the relay is unpowered. If the alarms are operated in "Failsafe" mode, the NC contact will be connected to the C contact either when the analyzer is in alarm or when power is removed.

Run the power and alarm wires through one conduit, and the analog output and RS485 lines through the other.

#### **9. Power up analyzer.**

When you do so, the LCD should light up in the right side enclosure, and the Status LED on the front panel should turn green. The solenoid valves will open allowing the sample to run through the analyzer. If the cell cap is not on it, you won't see any flow through the flow meter as all the flow will exhaust from the cell pocket in the front.

#### **10. If you are not using the advanced features, set up the alarms and the output range from the front panel of the analyzer.**

First choose the output range. This is the oxygen range that the analog output and alarms respond to. For example, if you use a range of 10% full scale, 20mA corresponds to 10%, and 4mA corresponds to zero. Use a range that gives you enough resolution to see normal behavior, but allows you to have reasonable alarm set points.

Set the range by pressing the OUTPUT RANGE button, and then scroll the number on the screen with the UP and DOWN arrows until it says what you want.

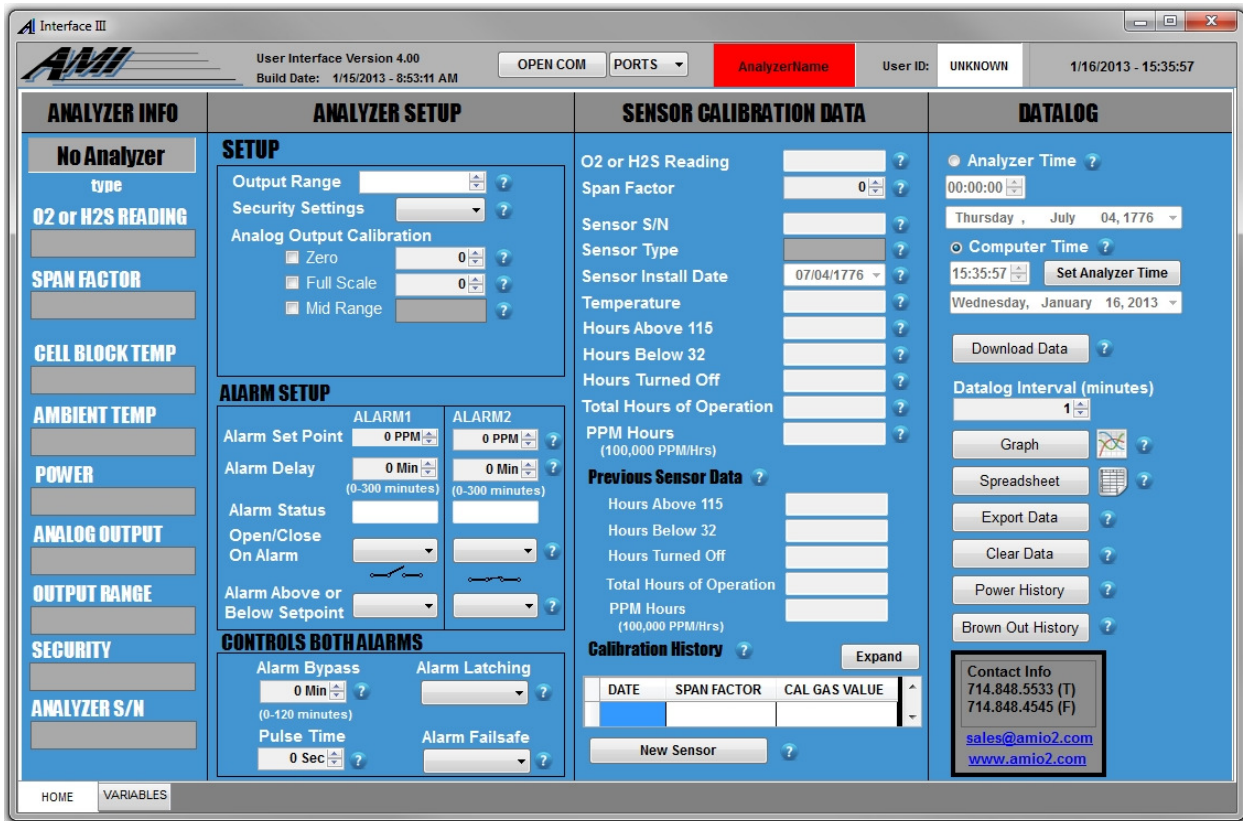
When you have set the output range, set the alarms. The alarm set point is shown as a ppm (or percentage) value, but it is internally stored as a percentage of the output range you just chose. If you change the range, the alarm set points will change along with it.

Note that this range has nothing to do with the measurement range of the analyzer. The analyzer LCD automatically scales its reading from 0.1% to 25%; it's only the analog output that gets scaled by the range, not the measurement.

If you want to set up other alarm features, such as whether the alarms latch or open or close on alarm, you have to use the laptop user interface program.

## 11. Optional:

This section talks about using the laptop to make more advanced choices.



**Figure 4. User interface initial screen**

- a. **Connect the laptop, run the User Interface version III and verify all alarm, output and security settings.**

Please see the chapter below about using the user interface for the details of this.

Note that you must have power on the analyzer before the laptop can find the communication port! Plug in a standard USB cable (such as the kind often used to connect a PC to a printer) to the port in the middle of the back of the analyzer. Select the comm port at the top of the screen, and click Open COMM. The program will figure out how to communicate to the analyzer, and fill in all the boxes once it connects.

- b. **Set the analyzer clock time, and click on “Clear Data Log”.**

The analyzer stores its readings for about two weeks for you to look at subsequently. It may have some readings stored from the check-out process, and these might confuse you when you subsequently view them. Also, we set it up on PST, and your time zone may be different. So set the time, and clear the data. In due course, click on the Download Data button to see the stored data.

**c. Verify the output calibration.**

You should only need to do this if your flow computer or similar monitoring device has an uncalibrated input.

- i. **Connect the analog output terminals to an appropriate measuring device – preferably the flow computer or similar monitoring device you are going to be using with this analyzer.**

You can simply use a multi meter connected to the output terminals. If so, make sure it is set correctly – don't use a voltmeter to measure current! Often people leave their meter in the current measurement position and the next time they measure a voltage they blow the current fuse. If this has happened, the meter won't measure current until you replace it.

- ii. **Arrange that you can readily see the reading given by this device.**
- iii. **On the AMI User Interface, check the "Zero" check box under SETUP in the ANALYZER SETUP section.**
- iv. **Observe the response of the monitoring device, and adjust the number in the box next to the Zero label until the monitoring device shows what it considers to be zero (which should correspond with 4mA).**
- v. **Check the box marked "Full Scale" in the SETUP section, and adjust the number in the box next to it until the monitoring device shows full scale. This corresponds to 20mA.**
- vi. **Check the "Mid Range" box and verify that the monitoring device shows mid scale.**
- vii. **Uncheck any checked box (if you forget, the analyzer will revert to its ordinary operation in ten minutes anyway).**

**12. Test the entire system, including anything controlled by the alarms or analog output, using a cell simulator.**

As an option, AMI can provide a "Cell Simulator" that mimics the operation of a sensor between 0-100ppm, so that you can verify that your control system or flow computer correctly reads the analyzer's output and responds correctly to the alarm contacts.

**13. Turn off the sample flow by closing the needle valve all the way**

You don't want to dilute the air under the sensor when you first place it in the analyzer. Don't tighten the needle valve or you will damage it – just turn it down until it stops.

**14. Unscrew the cell cap, and install the oxygen sensor.**

Unscrew the cap first. Open the sensor bag, remove the sensor by holding the little handle and immediately put it into the cell compartment, gold side up, and with the little metal tag on the side facing you. When it is in place, hold the sensor in place and pull out the tag. Do it in this order so that the sensor is always operating, eating up oxygen that gets in through its membrane. The length of time you take over this is critical in determining how long the sensor takes to get down to a low range.

Bear in mind that if you have returned the sample to the source, you will be flowing air into the source while you do this. You may want to temporarily exhaust the sample to room air, and connect it to the source when you are done with this procedure.

**15. Optional: in the User Interface (version III) press the “NEW SENSOR” button, and record the sensor serial number.**

You might just want to write it down. Note that you can read the serial number while the sensor is in place in its cell block pocket – don’t leave the sensor out while you write it down.

**16. Stabilize for 45 seconds ONLY, adjust span to 20.9%.**

It will take the sensor about 20 seconds to come to a reasonably stable reading, but give it 45 seconds to be sure. Don’t go over this time, even if the reading is still moving. The sensor is probably changing temperature a bit which affects its reading until it has equilibrated with the analyzer. You aren’t concerned with the utmost precision at this point, just a close-enough value. If you leave the sensor in air too long, it will take much longer to come down to low oxygen levels than you expect.

**17. Replace the Cell cap and tighten it down.**

Make sure you don’t cross thread it, and make sure it is tightened down firmly but not so much you will need a tool to undo it. There is no need to panic about getting it on fast, since the flow of sample gas will purge the sensor while you are working on it.

**18. Adjust the sample flow to 1 SCFH.**

The exact flow rate is not important.

**19. Purge with sample gas for half an hour, or until the oxygen reading has fallen to low ppm levels**

it should drop to less than 0.1% in less than a minute, if it has been installed properly, the temperature is above 50°F, and always assuming your sample has less than 0.1% of oxygen in it. (Cold temperatures cause the sensor to respond more slowly).

You may be required to perform a low level span – this means spanning the analyzer with a suitable span gas whose value is close to where the analyzer will be operating. If so, it is essential that the analyzer gets down to a lower value than the span gas value, or it will take forever to exponentially work its way down to the span gas reading.

Often this operation causes problems. For example, the span gas may be contaminated, or the regulator hasn’t been properly bled. A good first step is to simply run the span gas through the analyzer and see what it reads. If it is close to the correct value, you can go ahead and span it. If it isn’t, you MUST trouble shoot why not before you believe the span gas! The calibration you just did on air is going to be accurate to within about 2% of reading, probably, which is closer than many span gases!

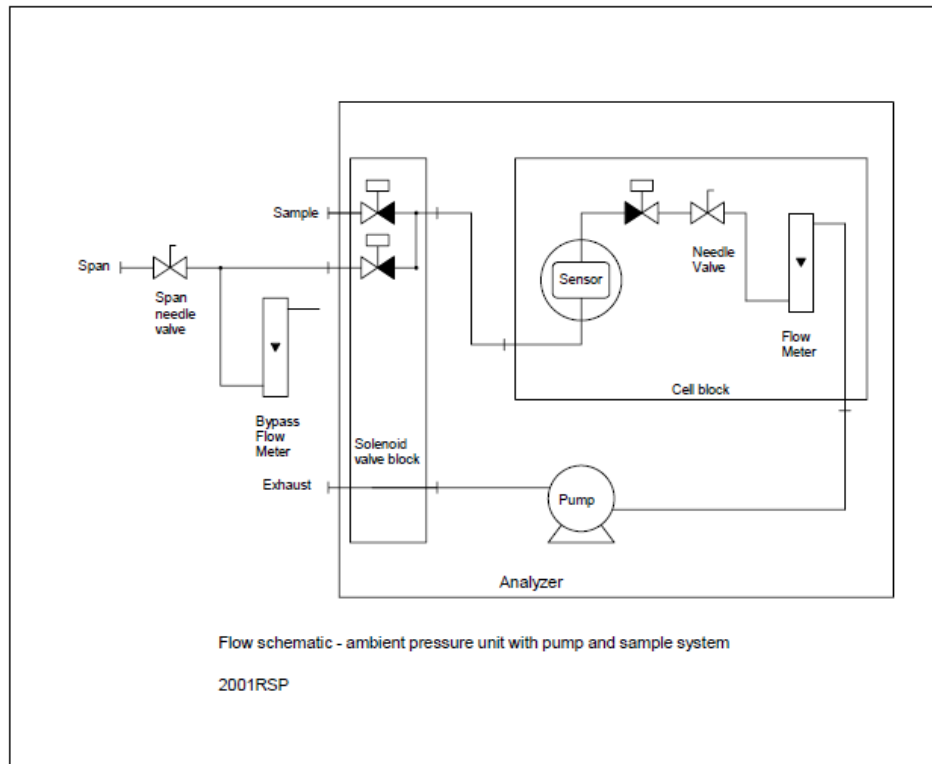
**20. If desired, span with known calibration gas.**

- a) **Connect a regulator to span gas tank.**
- b) **Shut off the regulator outlet valve and leak check all fittings, gauges and packing glands with Snoop™ or equivalent.**

Again, flow the liquid on, don’t spray it on. Make sure you check the regulator and tank valve as well.

- c) **Connect a bypass flow meter and a series valve at the inlet of the span fitting. The analyzer's pump will suck a sample out of this line, and you want the inlet pressure to be atmospheric. You can control the bypass flow with the valve while the analyzer is drawing its sample.**

Connect the span gas line to a needle valve, and then to a "T". Connect one arm of the T to the span inlet, and the other arm to the base of a flow meter. Use the needle valve to make sure that some minimal flow is flowing out of the flow meter while the analyzer is drawing its span gas from the T. In this way, the sensor sees the span gas at atmospheric pressure.



- d) **Flow calibration gas WHILE you are connecting the tubing to the span gas fitting. Allow the gas to purge around the fitting for about 20 seconds before you tighten it.**

If you are not going to leave the span gas tank permanently connected it is preferable to use the AMI special flexible non-diffusive tubing with its O-ring sealed fittings so that you don't destroy the span inlet fitting on the analyzer. This can be purchased from AMI as an option. Compression fittings can only take a few openings and closings before they cease to seal well enough for a trace oxygen analyzer. Otherwise use stainless steel tubing. Flow the gas through the tubing while you attach it to the span fitting: screw it on by one thread allowing the gas to escape around it, and after about 20 seconds tighten it up. This displaces the air from the fitting, meaning that you don't inject a slug of air onto the sensor and delay it coming to stability.

**e) Tighten fitting on the span gas inlet.**

Use Snoop™ or equivalent to leak check it.

**f) Press the ALARM HOLD OFF button, and adjust the time displayed to a suitable value (typically 10 minutes).**

Do this so you won't fire the alarms possibly causing all kinds of unnecessary havoc in your control system. Note that doing this will also hold the analog output at its last value.

**g) Press and hold the SPAN button for five seconds until the status LED turns blue.**

You will probably see the reading shoot up for a moment as the air in the span gas port is pushed past the sensor, then the reading will start to stabilize. Adjust the flow with the needle valve until it is 1 SCFH. Note that none of the front panel button will now affect the operation of the unit, other than the UP and DOWN arrows. Pressing either of these will cause the analyzer to drop out of the Span gas mode after five seconds.

**h) Allow to stabilize for 2-5 minutes.**

This will allow any residual air to be flushed out and the sensor to come to equilibrium.

**i) Verify that the analyzer reads within about 15% of the span gas value.**

If it doesn't, something is wrong. If the sensor reads very low, check it on air, and if that reading is also very low, replace the sensor (you shouldn't have to do this with a new sensor!) If the reading is too high, it is possible that your span gas is contaminated, or you have a leak, or you have made some kind of error. One thing to note is that if the analyzer temperature is very different from the sensor temperature when you put it in, the reading will be quite wrong until the sensor has had a chance to equilibrate. Increase the flow rate by doubling it, and see if the reading decreases after a few seconds. If the reading goes down with higher flow, you certainly do have a leak. You can also time how long it takes, which will give you an indication of where the leak is. The longer it takes for the flow change to affect the leak, the further from the analyzer is the leak source. Fix it by using Snoop and try again.

**j) If so, adjust the analyzer span until it reads the span gas value.**

Press the SPAN button. The SPAN flag should appear on the LCD. Press the UP or DOWN arrow buttons until the reading is correct. After a few seconds the SPAN flag will go out and the analyzer will accept the new calibration. This automatically turns off the span gas solenoid and turns on the sample solenoid.

**k) Let it go back to normal operation (the "SPAN" flag goes out on the LCD display), then press the UP arrow and note the number displayed (the "Calibration factor").**

You can use this to get an idea of the remaining cell life in the future. The analyzer also stores the calibration values in memory so you can view the history later. When the sensor is new it will have a Calibration factor (also called Span factor) of about 450. As it gets used up, this number will have to increase when you span the analyzer until it gets up to around 950 or so (the Calibration factor doesn't increase by itself, it only does so when you span the analyzer). You will probably see the span factor remain fairly constant, then suddenly change. When it does so it means that you will need a new sensor soon. The sensor behaves rather like a NiCd battery – it is stable until suddenly it starts to fail.

The analyzer is now set up and calibrated. It is normally good practice to give it a day or two and recheck the calibration.



## Interconnections:



Figure 5. Back panel of the 201RSP.

## Alarm connections:

The alarm connections are single pole double throw relays, i.e. Form C contacts. They may be programmed to go into alarm mode either above or below a set point, to open (the normally closed) contacts or close them, and to either latch or not latch, that is, go back out of alarm when the oxygen level returns below (or above) the set point or else wait until the operator presses the “ALARM ACKNOWLEDGE” button on the front panel. 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.

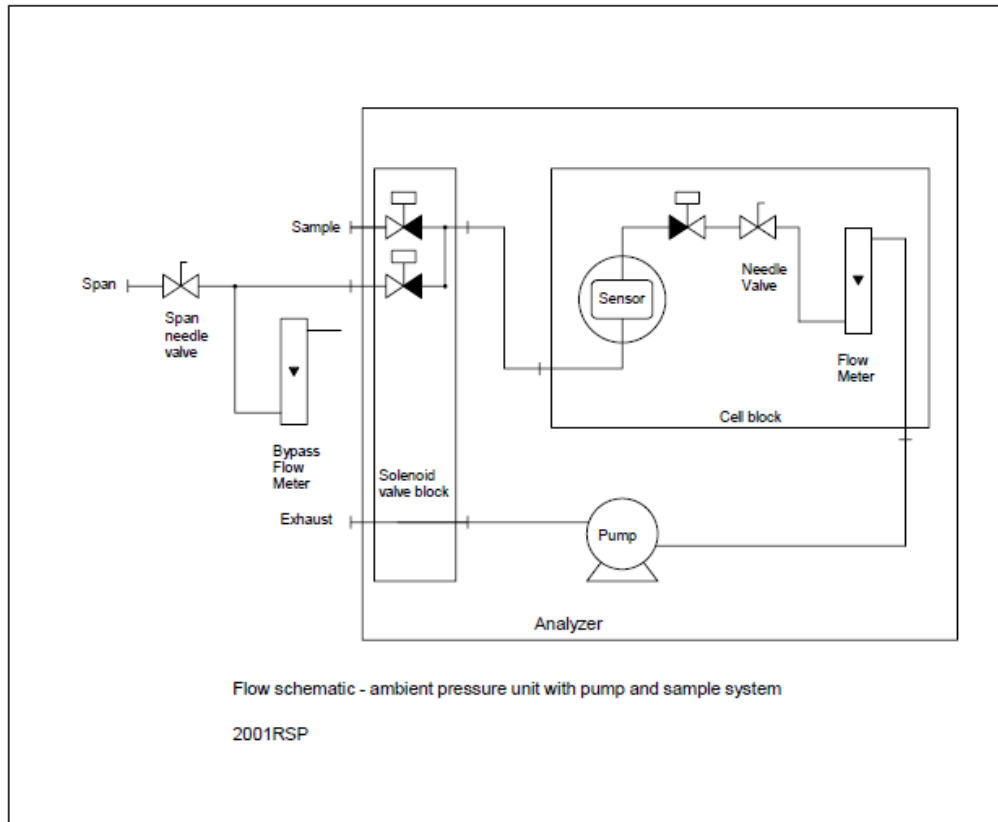
Using AMI software you can force the output to 4mA (zero output), 12mA (half scale) or 20mA (full scale), and calibrate these values so as to get the most accurate possible transfer of information to a recording or computing device. If you forget to reset them the unit will automatically return to its normal operation after ten minutes.

### **Serial connections:**

The 201RSP provides two serial connections – a USB port that can talk to a standard PC running the AMI User Interface software, and an RS485 connection that supports the standard ModBus protocol. The unit detects the presence of a USB connection, and disables the RS485 connection if one is detected. This allows you to leave it connected to the RS485 loop while you configure it with the AMI program.

For details see the chapters below.

## Sample Handling:



**Figure 6 Flow Schematic of the 201RSP.**

This analyzer expects to see ambient inlet pressure. It contains an integral needle valve and flowmeter for controlling and observing the sample flow. It also contains solenoid valves that seal off the sensor when power fails, and also that can select between the sample and a span calibration gas.

The span gas should be at the same pressure as the sample – i.e. ambient pressure. See the diagram above for how to accomplish this. The idea is that when you span the analyzer you flow some span gas out of the bypass flow meter so that the inlet to the analyzer is at ambient pressure. If you don't do this, the pump will fight the span tank regulator and you may have a random pressure on the sensor, which will ruin the calibration, and possibly the sensor as well. Make sure that you turn off the span gas cylinder valve when you are not using it – otherwise you may lose all the span gas if you have a tiny leak in the system somewhere.

The exhaust should be vented to atmosphere or to atmospheric pressure, or back to the source if it is something like a glove box. The oxygen reading will be affected if the pressure the sensor sees is not atmospheric.

The front panel LED will change from green to red if the unit goes into alarm. If the alarm hold off button is then pressed, the LED will turn yellow and the alarm relays will go into their non-alarm state. If the SPAN button is held for five seconds, the span solenoid will activate and the LED will change color to blue, and flash on and off, indicating that the unit is in span mode. If it goes into alarm while in span mode, the LED will flash between red and magenta (a blue/red combination). If the unit is put into leak-check mode (via the User Interface) the LED will flash yellow. It can only come out of leak check mode either by waiting for 8 hours or by the appropriate command from the user interface.

## 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 0-10%, and the alarms to be say 4.0% and 5.0% (i.e. 40% and 50% of range), activating above set point. If the oxygen level actually is 2.5%, the display will show 2.50%, and the output signal will be at 25% of full scale. If the oxygen level becomes 20.0%, the display will show 20.0%, but the 4-20mA output will be saturated, and the alarms will both be activated.

If you now manually change the output range to 0-25%, the reading will stay at 20.0%, the 4-20mA output will go to 80% of scale, and the alarms will de-activate, since they now correspond to 10% and 12.5%, i.e. still 40% and 50% of range. However if the alarms were set to latch, you would have to acknowledge them by pressing the ALARM ACKNOWLEDGE button before they would de-activate.

The unit provides a number of adjustments and controls through the front panel, and many more are available through the user interface program.

The analyzer is actually made with two processors which communicate to each other over a one-wire protocol internally. The analysis unit 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.

### Security:

Through the user interface, three levels of security can be set. These are: No security (all front panel controls are active), Span (only the span control and the ALARM ACKNOWLEDGE (ALARM SILENCE/SEQUENCE TIME) button are allowed to operate), and Full security (only the ALARM

ACKNOWLEDGE (ALARM SILENCE/SEQUENCE TIME) button performs a function; other buttons will show settings but won't allow them to be changed). If the front panel controls don't seem to work, use the AMI User Interface to change the security settings.

## 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	0-1%, 0-5%, 0-10%, 0-25%. 0-1000ppm and 0-100% are options.
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### 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.

### 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 (if security allows) from the front panel. All the other alarm configuration settings can only be changed with the AMI User Interface program.

## 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 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. If security is set, nothing will happen. In this case use the AMI User Interface program to change the security level, or directly change the alarm set point.

## 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. During this time the LED will glow yellow, rather than red. If the alarms are programmed to latch, pressing this button will also unlatch them (and stop them from alarming again for the hold off period).

If the security setting allows it, the alarm hold off time can be adjusted by pressing the UP or DOWN arrow buttons.

## Calibration (Spanning)

The model 201RSP 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. Adjust this with the regulator on the span gas bottle (which should be set to about 10psig).

If the span gas value is such that it will cause the alarms to activate, press the ALARM ACKNOWLEDGE button to preemptively silence them. You may want to extend the alarm hold off 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 immediately flow zero or sample gas by opening the appropriate valve.

#### SPAN GAS CALIBRATION

1. Make sure that you have a span gas connected to the span inlet on the back of the unit, and that the span gas bottle valve is on and the pressure set to a reasonable value (typically 10psig).
2. Press and hold the SPAN button for five seconds. The span valve will be activated, and the LED on the front will flash blue. Release the button, and wait until the reading has stabilized. Then adjust the UP or DOWN buttons to make the analyzer reading match the span gas value. Once you have touched these buttons, after five seconds the span gas valve will shut off and the sample valve will turn on, and the LED will change back to green (or red if it is in alarm).
3. If not using the span gas valve feature in the 201RSP, press the span button momentarily (so that the unit shows its "SPAN" flag) and let it go, and then press and hold the UP or DOWN button until the reading matches the span gas value, or if using air, 20.9%. The LED will remain green during this procedure.

## 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! If the unit is equipped with a heater, the temperature will of course be higher than ambient once the ambient temperature has dropped below 50F.

## Alarm Functionality:

The model 201RSP has two alarms, with two associated relays. As shipped, these are set to operate as high alarms (they go into alarm if the oxygen level goes above the set point), and set to failsafe mode (i.e. unpowered on 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, and the LED will change color to red.

Using the analyzer front panel you can change the alarm set points (if security allows), but you cannot change any of the other settings.

If you want to change how they work, you must use the AMI user interface to configure them.

The alarm function and the relay function are programmed independently: you can have either alarm go into alarm mode above or below set point, and you can have the relays associated with each alarm operate in the failsafe mode (i.e. unpowered in alarm) or not.

You can set them to reset automatically, or else to latch, so that an operator has to press the “ALARM ACKNOWLEDGE (or ALARM SILENCE/SEQUENCE TIME)” button to reset them; you can set them to wait for a period of time before they go into alarm, and you can even set them so that one relay pulses open or closed when either alarm is triggered, while the other pulses open or close when the alarms are reset, either automatically or by the operator.

Each alarm can be programmed so that an alarm occurs if the oxygen level goes above the set point, or alternatively below the set point. In either case the oxygen level will have to go a bit further the other way back for the alarm to reset – in other words it has hysteresis of about 3% of range. For example, if the alarm is a high alarm set to go off at 10% on the 25% output range, when the oxygen level gets to 10% the alarm will trigger (assuming no time delay). When the oxygen level subsequently drops, it will have to drop to below 9.7% for the alarm to deactivate.

A time delay may be programmed for each alarm, in minutes. The oxygen level has to be beyond the set point for the entire time of the delay, and then once the delay is up the alarm will activate. If the level goes back to the non-alarm area during the delay time, the delay will be reset and it will start again the next time the level moves into the alarm region.

The alarms may also be programmed to latch, that is, once they have gone into alarm they won't drop back out until someone presses the ALARM ACKNOWLEDGE button. At that point they will immediately drop out of alarm, and stay that way for the entire hold off period, or the alarm delay period, whichever is longer, even if the oxygen level is beyond the alarm set point.

The ALARM ACKNOWLEDGE button will immediately cancel an alarm state.

The final option is that the relays may be set to pulse mode. This is done by selecting a non-zero pulse time (in seconds) on the user interface.

If the pulse time is set to some number of seconds, when the unit goes into alarm, alarm 1 relay will change state (to the alarm state as programmed) for that number of seconds, and then change back again. When the unit goes out of alarm, either because the oxygen level has dropped out of the alarm region or someone



has pressed the ALARM ACKNOWLEDGE button, alarm 2 relay will change state to its alarm position (open or closed) for the same time, and then it will drop out.

The purpose of this is to drive latching solenoid valves that require a pulse of current one way to set them, and then a reverse pulse of current to reset them.

The alarm hold off period may be set by the front panel, or the user interface, and by default is one minute. The alarm hold off is triggered whenever the ALARM ACKNOWLEDGE button is pressed

# Communications

## Basics

The 201RSP supports both a USB link to a local PC, and RS485 over a network. Only one of these can be active at a time, and the unit automatically turns off the RS485 if it detects a computer plugged into the USB connection. Therefore the PC connection over the USB has priority.

The USB connection supports the proprietary AMI protocol, and AMI provides a program on a CD that interfaces with the analyzer. Alternatively it is possible for someone familiar with communications on a PC to directly use the protocol.

The RS485 port supports ModBus RTU at 9600 baud.

## USB communication:

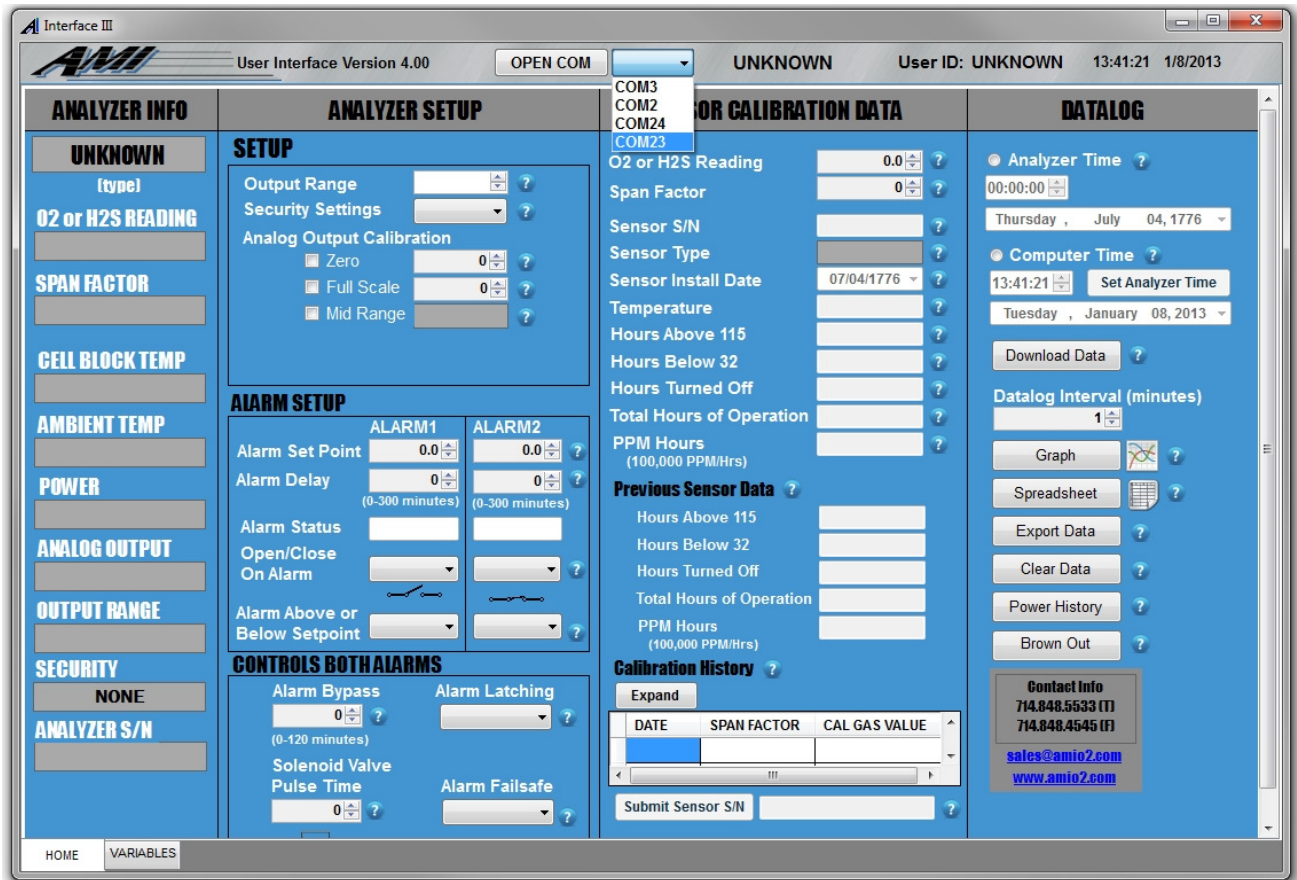
The USB port is located on the cover panel in the explosion proof enclosure, and is provided as a type B USB connector. It uses a standard cable such as are often used to connect PCs to printers.

Through the USB interface you can operate the analyzer from your PC, and you can set up its internal parameters to your liking. The USB communication runs at 57600 baud.

The RS-485 Modbus™ connection is disabled whenever the USB connector is plugged in (at both ends).

- We recommend that you use the AMI communication program for reading from and setting up the analyzer.
- Use the Version 3 or later program (identifiable by having a blue background to its main screen). It supports the new analyzer features mentioned below.

## Communication program:



**Figure 7. User interface initial screen**

The program will come up, and once you click the “Port” button (next to the OPEN COMM button at the top) will show a screen as above. Select the appropriate port, click “Open Com” and the program will automatically select the appropriate baud rate and determine the kind of analyzer present.

The ports available will be shown. Depending on your particular computer, the port may be anything. If there are more than one available, you may have to try them all until you get the one that works.

Note that if the analyzer loses power, you will have to restart the AMI program as the USB chip will have to restart.

Once the program has connected, it will automatically fill in the various boxes with values it gets from the analyzer.

You can change values by writing in the new value and pressing ENTER (on the keyboard), or by clicking the appropriate button or scroll button. The program will send the values down to the analyzer, and after a little, read the value back to make sure it “took”. If it didn’t for some reason, the value will change back to whatever the analyzer actually has. Don’t try to change many settings simultaneously, as the analyzer may get confused. Give each one a second or so to take. This is particularly true of the alarm configuration settings.

### **Top section:**

This shows the version of the user interface, the user ID (which can be set as desired by clicking on it) and the time and date.

### **Analyzer Info Section:**

These boxes are populated by the program from data provided by the analyzer. (Earlier versions of the analyzer will not provide all the data it expects, so some boxes might be blank if you use this interface with legacy units).

The analyzer model code will be shown at the top of this section.

The current oxygen reading will be shown in the “Reading” text box. The span factor will be shown below that. The cell block temperature will be shown immediately below in the box marked “Cell block temp”. This temperature only goes down to 25F (below that point the sensor won’t work properly anyway).

The power supply voltage is shown in the box marked “Power”, and the type of analog output that the unit was originally configured with shown below that (this will always be 4-20mA). The output range is shown, and also the security setting and the analyzer serial number.

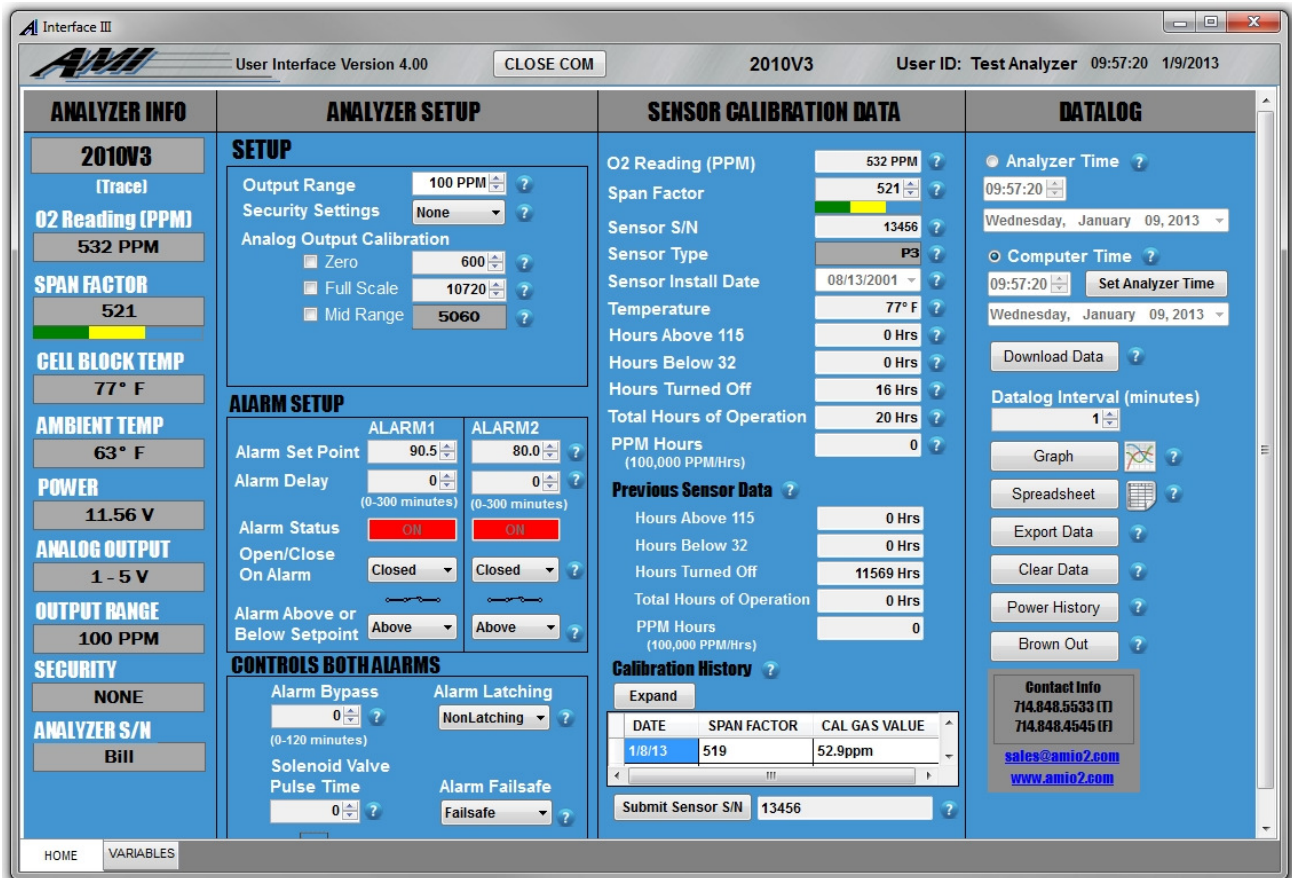


Figure 8. User interface screen showing analyzer with alarms

## Analyzer Setup Section:

The top section of this group should be setup first.

First, set the desired output range. The alarms are referenced to the output range, so if you set them first, and then set the range, you will have to reset the alarms.

Select the security level desired. You can choose between none, (a user can adjust any of the front panel controls), span only (in which case he can span the unit, but not set alarms, the output range or the alarm time out) and full, in which case he can look at the settings but not change any of them.

When initially configuring the analyzer, or installing it, it is useful to be able to calibrate the analog output against the measuring device you connect it to. You can do this using the Analog output calibration. To calibrate the analog output, you will need to have a meter set up for measuring current.

1. Select "Zero" by clicking in the appropriate radio button.

2. Press the Refresh button.
3. Measure the output you actually get, and adjust the number that appears in the “Adjustment” box until it is correct –4mA. You can either click on the UP or DOWN arrows, or else write a whole new value into the box, pressing Enter on the keyboard when you are done. This value is normally about 680.
4. Select “Fullscale” by clicking on that radio button.
5. Press the Refresh button.
6. Measure the output you actually get, and adjust the number that appears in the “Adjustment” box until the output is indeed full scale, 20mA. This number will be somewhat over 10,000.
7. Select “Zero” again and verify that the zero is still OK, and if not adjust the adjustment value again.
8. If you have changed the zero, recheck the full scale value again.
9. Keep doing this until both ends are correct. Normally only one adjustment is needed.
10. Select the Mid scale radio button, and verify that you either have 12mA.
11. Select “Oxygen reading” to go back to the natural output of the analyzer. If you forget to do this it will go back to the oxygen reading anyway after ten minutes.

Set the alarm set points for each alarm in the text boxes provided. The program converts the values from the analyzer (which are percent of range) into absolute values. Over-write them with the value you want, and press ENTER on the keyboard to send it down to the analyzer. For example, if you expect the oxygen values to vary between 0 and 10% of oxygen, set the Output Range to 10%. If the alarm set point should be 5% oxygen, write into one of the alarm Set Point boxes “5.0%” and press Enter. Alternatively you can scroll the value with the up and down arrows.

Set the Alarm Delay to the delay time you want. This is in minutes, and is independent for the two alarms. This is the time the analyzer will wait after the alarm set point has been reached, before it actually fires the relay (this time is reset to zero if the unit goes out of alarm again before the relay has had a chance to respond).

Set the relay to open or close on alarm, and the alarm to occur above or below the set point. If above the set point, the alarm will be triggered when the oxygen value becomes higher than the set point, whereas if below it will be out of alarm above the set point and in alarm below it.

The remaining settings are common to both alarms.

The “Alarm Bypass” is the time in minutes that the analyzer will bypass its alarm once the ALARM HOLD OFF button is pressed. The least value for this setting is 0, but in fact if the button is pressed the analyzer will hold the alarms off for a minimum of ten seconds.

The “Solenoid Valve Pulse Time” should be set to zero if you don’t want to use the pulse feature. If you do, set this to a suitable number in seconds – 15 seconds is normally OK – to drive a latching solenoid valve. When going into alarm, alarm relay 1 will pulse closed (or open) for six seconds, and when coming out of alarm, alarm relay 2 will pulse for six seconds. This is true no matter whether it is alarm 1 or alarm 2 that goes into alarm: but both alarm 1 and alarm 2 have to be out of alarm for the alarm relay 2 to pulse.

If set to “Latching”, the alarms will stay triggered until someone presses the ALARM HOLD OFF button on the analyzer. If set to “non-latching”, they will reset themselves when the oxygen level has gone back to the non-alarm state, above or below set point (and hysteresis) as appropriate.

Alarm failsafe will cause the analyzer to attempt to set the alarms to the alarm state when it detects a power failure, or when the power supply voltage it measures drops below 8.5 Volts. If the unit is DC powered from a battery and solar panel combination, this setting will cause the analyzer to go into alarm when the battery dies. On the other hand, if the unit is AC powered, or the DC power fails instantly, it probably will not have a chance to fire the relays (since they need power to operate!)

## **Sensor Calibration Data:**

This section shows information about the sensor. The Oxygen reading is repeated, and can be changed by adjusting the span factor, just as if the unit is calibrated via the front panel.

The sensor information is read only – although you can submit a sensor serial number at the bottom of this section when you insert a new sensor.

When you put in a new sensor, you can place the sensor in the analyzer and flow gas over it while you read its serial number. Click on the NEW button, and make sure the box marked reset sensor is checked (otherwise you will just change the serial number, but not tell the analyzer that the sensor is new). The analyzer will record the date, and start timing various things about the new sensor, and it will copy these timings over to the previous sensor fields so that you can see how the last one did.

The analyzer records the total time that the sensor has been installed (actually, since you told it that there was a new sensor), the length of time that this sensor has seen temperatures over 110°F or below 32°F, the number of hours that the analyzer has been unpowered, and the ppm hours (in units of 100,000 ppm hours). If the sensor is only exposed to low ppm levels, this number may stay at zero for a very long time! The reason for recording the length of time the analyzer was unpowered is that of course it can’t tell how much oxygen the sensor was exposed to during that time.

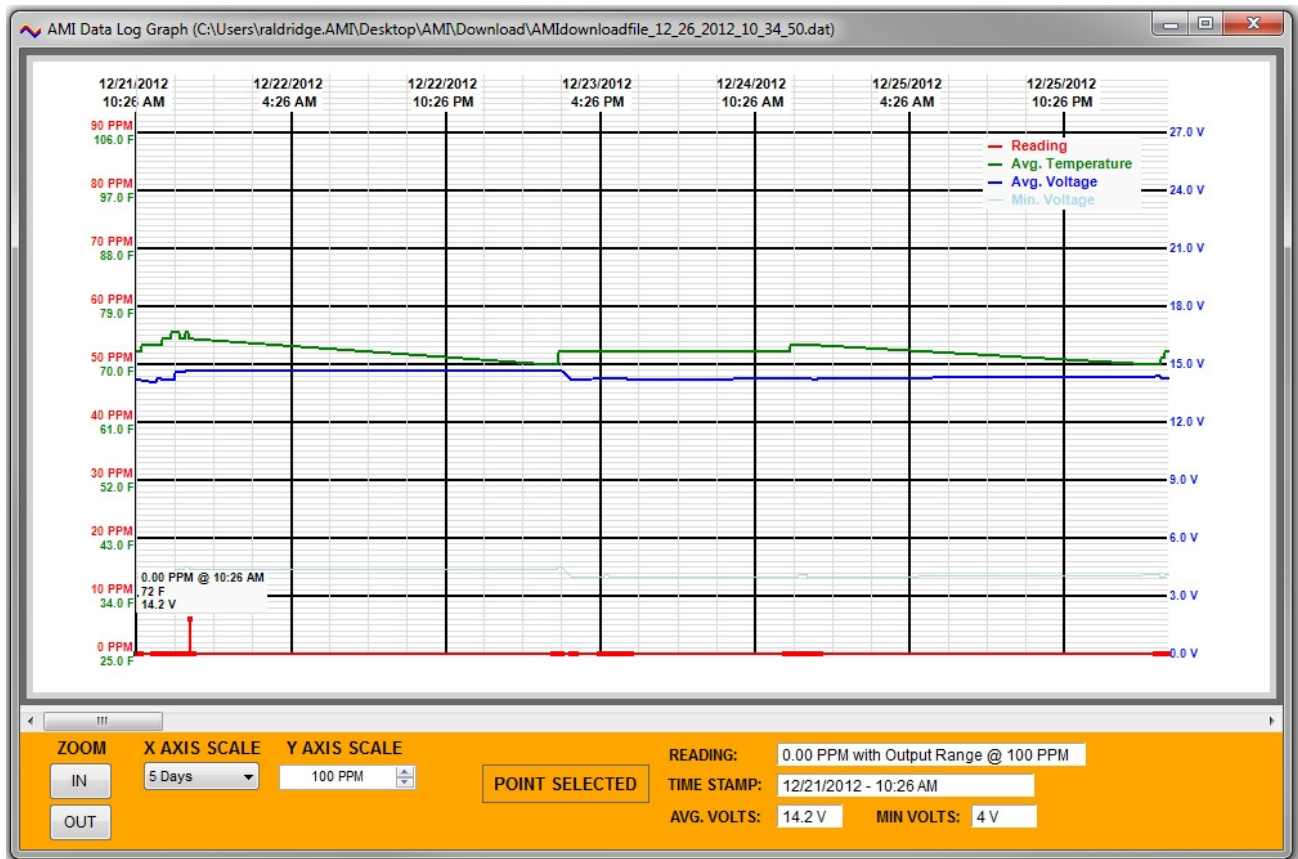
This section also shows the data from the last sensor prior to the most recent one, so you can compare how well they are doing.

This section also shows the calibration history of the analyzer. It records the date, the span factor when the calibration is finished, and the oxygen reading at that time, which was presumably the oxygen level of the span gas used. If you perform another calibration on the same day, it will overwrite the one you just did, but

if you do it on the next day or later, it will regard the latest calibration as a new one, and roll the previous one down to the previous record. It stores in this way five calibrations.

This means that if you attempt to calibrate the unit, but can't, so you replace the sensor and do it again on the same day, the analyzer will only record the latest calibration of the new sensor.

## Data Logging



**Figure 9. User interface datalog chart**

The program shows what the analyzer thinks is the current time and date, and also what your computer thinks is the current time and date. You can send the computer time and date to the analyzer by clicking on the "Set Analyzer Time" button. If you change the time and date, you may want to click the Clear Data button so the software doesn't get confused by later times being earlier than earlier times!

The analyzer logs data at a rate set by the "Datalog Interval" box. If this is set to zero, logging will actually occur at ten second intervals. Typically this interval will be set to 1 minute. The unit is capable of storing about 21000 data points, corresponding in this case to 21000 minutes, or rather more than 14 days. Setting the interval to 4 minutes will allow it to store over two months of data. The oxygen reading is averaged for the logging period, and stored as a percentage of the current output range, with a resolution of 1% of the output range. If the reading goes above the output range limit, it will be stored as a percentage of the next



range but one up, i.e. ten times the current range (unless the output range is 25%). Every 32 data points, various internal parameters including the time and date are stored as well. If the memory capacity is exceeded, the unit will overwrite the oldest data and keep on storing data in a circular fashion so that always the most recent set of data points can be retrieved.

Note that since the unit only stores the output range every 32 data points, if you change the output range this won't be recorded until the next time it stores this value, but the reading of course will change immediately. This means that there will be up to 32 data points with apparently the wrong value stored. We recommend that if you do change the output range you clear the data so that no confusion can arise.

You can download the stored data by pressing the "Download Data" button. It may take a couple of minutes to get it all, and the progress of this process is shown in a color bar, in traditional Windows style, though unlike most Windows programs the length of the bar does in fact correspond with the amount of data already retrieved.

Once the data is retrieved, it will be displayed in tabular form. It is automatically saved as an Excel™ compatible "CSV" format for subsequent analysis, so when you press the graph button the program opens a dialog box which allows you to graph any of the stored files – the latest one will of course be the most recent one. Double click it and the graph will appear. In the graph display you can zoom into data by clicking the "Zoom In" button, and zoom out by clicking the "Zoom out" button.

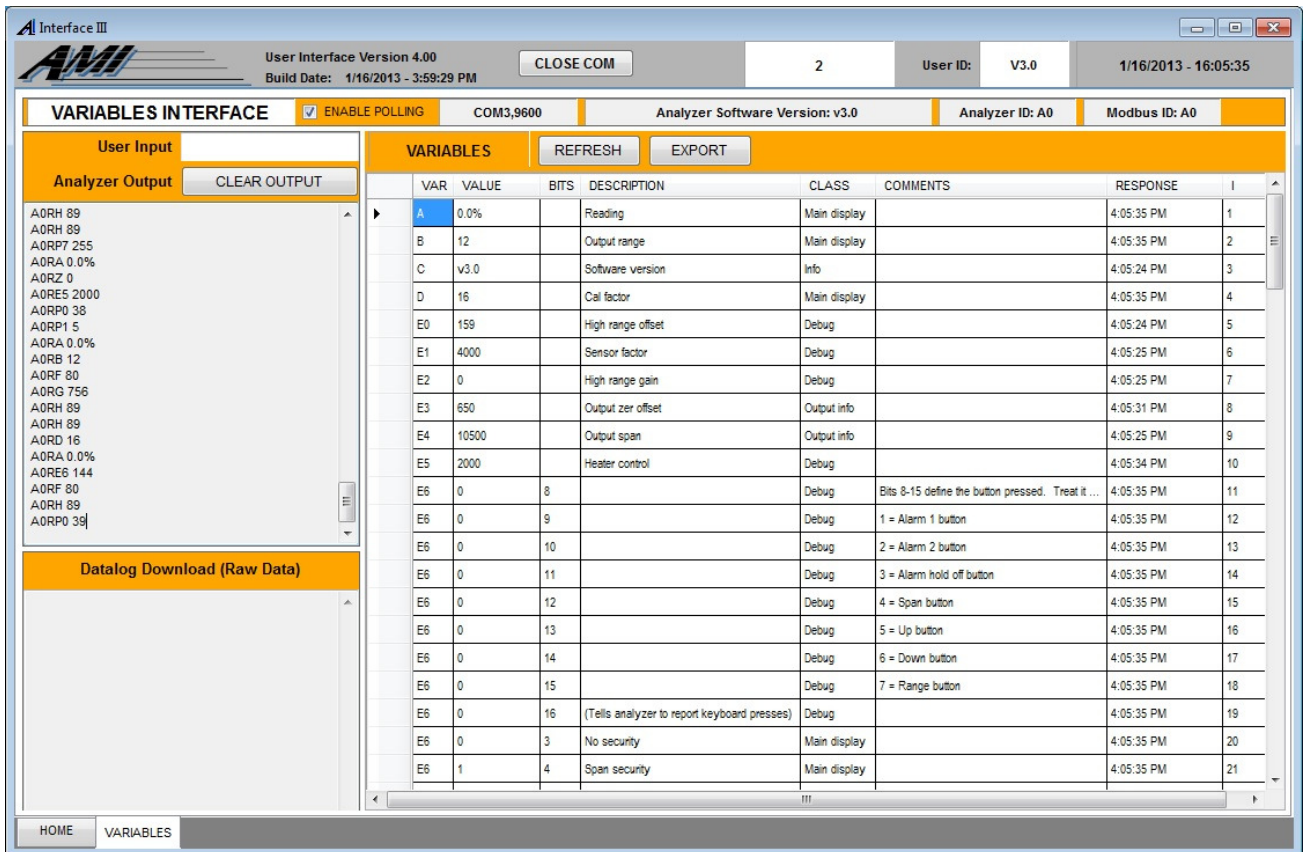
The analyzer can be left to overwrite the old data by itself, or else it can be told to start again at the beginning by pressing the "Clear Data" button.

The chart shows the oxygen reading, the average power supply voltage, the minimum power supply voltage over each 32 data points, and the average temperature.

#### Power and Brownout history

The analyzer stores the times it was powered up, and records how many memory errors it ran into when it did so. (It can't store times it lost power!) The last ten times it was powered up can be displayed by clicking the "Power History" button. The first column shows the number of data errors it saw, and this should always be "00". If it isn't it implies that there is something wrong with the hardware and the unit should be returned to AMI for repair. (The unit stores its configuration data in four separate locations, so that any one memory error won't affect its operation).

The "Brown Out" button shows times the power supply voltage dropped below 8.5V and came back above that point again. This is useful in debugging the battery and solar panel power circuits often used in the field.



**Figure 10. User interface Variables Screen**

## Variables:

This screen shows the internal operation of the analyzer, together with the operation of the communication program. It allows you to interrogate the analyzer for a particular variable manually, but normally this is not necessary. When the analyzer is first connected, the program will fill up all the variables in the list and will then poll a subset of them regularly. If desired the “REFRESH” button will cause the program to update every variable.

Mostly this screen is used for troubleshooting.

## RS-485 Modbus Introduction:

The Modbus™ protocol was invented in the 70's by Modicon Corporation, and placed in the public domain. It is managed by the Modbus Organization. It is probably the most common industrial communication protocol. It allows a single master computer to talk with up to 254 slaves over a number of hardware connections, including RS-485 which is the one we use.

It uses two possible means of communicating, ASCII or RTU, of which we use the RTU version since it is quite a bit more efficient. Each session consists of a command string sent out by the master to which the slave may or may not respond.

There are a number of possible commands, and each may have a number of possible parameters. These include reading and writing single bits (called "coils" in Modbus terminology), reading and writing certain 16 bit registers, and a set of diagnostic commands. The registers are separated into two types – "Input registers" and "Holding registers".

"Input registers" contain data that comes into the device, and cannot be modified, such as the temperature. They are read with command 4.

"Holding registers" contain configuration data, and may be both read and written to with commands 3, 6 and 16. **They can only be written to if coil 24 is set to ON first.**

In our case, "coils" can be read and written individually, or else treated as a bit map in some of the holding registers, whatever is more convenient.

**To write into any holding register or coil, coil 24 MUST be set first.** If you don't do this you will get error messages. This coil is reset upon power failure, so it is as well to set it every time you attempt to write into the analyzer.

## RS-485 Modbus Communication:

### Overview:

Version 3 of the 201RSP analyzer supports the Modbus™ RTU protocol over an RS-485 link. This can be permanently wired up. The RS-485 link is disabled whenever the USB connection is attached, so that it doesn't need to be disconnected and the USB communication won't interfere with the network traffic on the RS-485 bus.

The protocol supports all of the standard Modbus™ commands, but the unit has to be set so as to allow writing of variables before it will accept the "forcing" commands. This can be done over Modbus™ as well as over the USB interface. Note that only Modbus™ RTU is supported, not Modbus™ ASCII.

The RS-485 connection is via a similar Phoenix connector as that used to wire up the analog output on the back panel. It shares a ground with the analog output shield. The signal is NOT isolated from ground, so it may be necessary to insert galvanic isolators if ground loop issues arise.

The analyzer address is by default 17, but it is located in register 254 and can be changed over the Modbus if coil 24 is set. Alternatively it can be changed as desired using the USB program.

### Commands:

Command	Registers	Notes
1 – Read coils	0-24	Corresponds to some holding registers, except #24 which is the write enable bit.
3 – Read holding registers	0-255	Equivalent to all the AMI protocol variables, except the datalog download which is not available through Modbus™.
4 – Read input registers	0-5	The parameters including oxygen measured by the analyzer
5 – Force single coil	0-24	Not all coils are writable. #24 when set allows any other coil or register to be forced.
6 – Preset single register	2-39	If enabled, allows writing to most of the registers within the range of 2-39
7-Read exception status		Reports the alarm flags
8 - Diagnostics		Supports sub-functions 1,2,4,and 10-16.
15 – force multiple coils	0-24	Writes into any writable coil. If a non-writable one is included, the command fails at that point, and an "invalid address" error message is returned.
16 – Preset multiple registers	2-39	Writes into any set of writable registers. If a non-writable one is included, the command fails at that register, and an "invalid address" error message is returned.
17 – Report id		Reports a string corresponding to the serial number, as ASCII, packed two

		characters per byte.
--	--	----------------------

## The Oxygen Reading:

The oxygen reading from the analyzer can be obtained in two ways. Since Modbus supports 16 bit registers, and the full range of oxygen from 0.1ppm to 1,000,000 ppm is considerably greater than this, the reading is reported as a percentage of a range. This range is different for the input registers from that for the holding registers, i.e as reported by command 4 (input) or 3 (holding).

In the case of the **input** registers (command 4), register 0 reports a percentage value multiplied by 10 (i.e. 100% of range would be 1000). The range it is a percentage of is given in register 1: this can have values of 1, 10, 100, 1000, 10001, 10010, and 10100. The values up to 1000 correspond to ppm numbers - e.g. if the reading in register 0 is 234, and the number in register 1 is 100, the actual reading is 23.4ppm, i.e. 23.4% of 100ppm.

If the value in register 0 is still 234, but the value in register 1 is 10010, the reading is 23.4% of 10%, i.e. 2.34% oxygen. The value in both of these registers is dynamic – that is, they change automatically to keep the oxygen reading properly scaled. It would be necessary to read both input registers to interpret the reading. Note that this range is calculated by the processor in the analyzer – it has no relationship to the physical measuring hardware.

Alternatively, the **holding** registers 0 and 1 can be used with command 3. In this case, the value in the holding register 0 is again the percent of the range in holding register 1, but now holding register 1 contains the output range full scale value in a similar fashion to input register 1. This register can have the values 1, 5, 10, 50, 100, 500, 1000, 5000, 10001, 10005, 10010, 10025, and 10100, where once again the values greater than 10000 correspond to percent ranges (minus the 10000, i.e. 10005 means 5%, 10010 means 10% and so on).

This (holding register) reading does not scale automatically – it tracks what the analog output signal does. It will saturate at 125% of the range. Once the output range has been set, it is no longer necessary to read that as well as the 0 register.

## Other readings:

The input registers also hold values corresponding to the cell block temperature the power supply voltage, and if present, the barometric pressure. Temperatures are in degrees Fahrenheit, and the voltage is in tens of millivolts, i.e. 1234 means 12.34 volts.

Also, a series of informational registers show the life (so far) of the sensor. The first value is the total time in hours since the analyzer was told that the sensor was installed; the second shows the number of million ppm-hours that the analyzer knows it has seen. Note that this value is affected by the time the unit was powered down, since during that time the sensor might have been exposed to oxygen but of course the analyzer can't tell. In order to help with this fact, one of the registers shows the number of hours that the

analyzer was powered down during this time. Two other registers show the number of hours that the sensor saw temperatures below 32F or above 110F.

Finally, the user info is shown in the last several registers.

## Input Registers

Input register		Variable name	AMI address	Typical value	Min value	Max value
0		Reading	(A)	1000	0	10000
1		Measuring range		100	1	10100
2		Sensor temperature	T0	75	0	140
3		Power section temperature	T1	75	0	140
4		Power supply voltage	T3	120	0	3000
5		Ambient pressure	T2	0		
6		Sensor life in hours	U0			
7		Sensor life in million ppm-hours	U1			
8		Sensor life above 110F	U2			
9		Sensor life below 32F	U3			
10		Sensor life powered off	U4			
11		Last sensor life hours	U5			
12		Last sensor life million ppm-hours	U6			
13		Last sensor life above 110F	U7			
14		Last sensor life below 32F	U8			
15		User info byte 0	L2.0			
16		User info byte 1	L2.1			
17		User info byte 2	L2.2			
18		User info byte 3	L2.3			
19		User info byte 4	L2.4			
20		User info byte 5	L2.5			
21		User info byte 6	L2.6			
22		User info byte 7	L2.7			
23		User info byte 8	L2.8			
24		User info byte 9	L2.9			
25		User info byte 10	L2.10			
26		User info byte 11	L2.11			

## Holding registers

Register	Writable?	Variable name	AMI address	Typical value	Min value	Max value
0	N	Reading		1000	0	10000
1	N	PPM or percent		100	1	10100
2		Output range	B	4	0	13
3		Span factor	D	2000		
4		High range offset	E0	3950		
5		Sensor factor	E1	16		
6		High range gain	E2	1000		
7		Output zero offset	E3	811		
8		Output full scale span	E4	9986		
9		Heater control	E5	681		
10		Special flags	E6	8		
11		Alarm 1 set point	F	800	0	1000
12		Alarm 2 set point	G	900	0	1000
13		Alarm state	H			
14		Alarm hold off time	Z	60		
15		Alarm 1 delay	X	0		
16		Alarm 2 delay	Y	0		
17		Pulse time	W	0	0	600
18		Log period	P7	1	0	60
19	N	Log data position	Q		0	30000
20		Sequence time				
21	N	Sensor temperature	T0	75		
22	N	Last invalid address				
23		Error flags	I			
24	N	Power temperature	T1	75		
25	N	Not supported	T3	1440		
26		Seconds	P0		0	59
27		Minutes	P1		0	59
28		Hours	P2		0	12
29		Day of week	P3		0	6
30		Day of month	P4		1	31
31		Month	P5		1	12
32		Year	P6		0	99
33	N	Serial number 0	L0			
34	N	Serial number 1				
35	N	Serial number 2				
36	N	Serial number 3				
37	N	Serial number 4				
38	N	Serial number 5				
39	N	Serial number 6				
40	N	Software revision 0	C			
41	N	Software revision 1				
42	N	Software revision 2				
254		Modbus address	N1	17		



Holding registers can be written to unless they have an N in the Writeable column above. Coil 24 must be set for this to be enabled. Please be extremely careful about setting any of these registers. If you get it wrong the analyzer may behave in unpredictable ways.

If you write into more than one register at once, using command 16, but there is an error – perhaps you attempt to write into a non-writable one, or use a value outside the acceptable range - the procedure will stop at that register and return an error message. It will place in register 22 the address of the register that failed. This means that the command succeeded in all prior register writes. It will not attempt to continue past the failed write. Any further error will overwrite this register (22) with the latest error.

#### Higher Registers:

The registers above 42 report the various logging features of the analyzer. These are reported as ASCII characters packed 2-to-a-word in contiguous registers from 43 upwards to 253. The final entry in each set is a zero (0x00) in a word – the only time 0x00 will appear since all the other characters are ASCII. If the length of the entry is shorter than the maximum allowed, the rest of the entry (after the zero) might be random gibberish and should be ignored.

The span history is located in registers 44 through 54, then 55 through 65, then 66 through 76, then 77 through 87, and then 88 through 98.

The span history is structured as dd:mm:yy-XXX-YYYppm, with the number of X's and Y's varying. XXX is the span factor after the span, and YYY is the span gas used as read by the analyzer – for example, if the analyzer is spanned to 80.0ppm gas, this value will be 80.0ppm. If it was spanned on air, to 20.90%, this value would be 20.9%. A total of five such sets of data are stored, the most recent being the first set. Month and day are stored as either single or double digits, so make sure you delimit the values with the colons and dashes.

The start up history continues above that, but as this contains an odd number of characters words are shared between two adjacent entries. This is structured as hh:dd:mm:yy-XX again with either single or double digits for the hh, dd, and mm entries. The XX gives the number of memory errors encountered during the start up (the analyzer stores critical values four separate times, and takes a majority vote if any of them don't match the others).

Ten sets are stored, the most recent being first.

Above register 175 can be found the Low Power entries, occupying ten registers each.

These report the times that low power (below 8.5V) was detected, and when normal power was restored (above 10V). These records are structured Lo:hh:dd:mm:yy, and OK:hh:dd:mm:yy respectively. A total of ten records are stored, usually five of each.

In every case, nonsense values may be present if the unit hasn't had that number of experiences. If so the colons won't be present in the strings.

None of these higher registers may be written into.

## Coils

Coil	Name	Meaning if set (1)	Meaning if reset (0)
0	Force output to zero	Output = 4mA or 1V	Output normal if 1 and 2 are 0
1	Force output to mid-scale	Output = 12mA or 3V	Output normal if 0 and 2 are 0
2	Force output to full scale	Output = 20mA or 5V	Output normal if 1 and 2 are 0
3	Set full security if 4 set	Span security if 4 = 1,	Secure
4	Set span security if 3 reset	Span Security if 3 = 1	No security if 3 = 1
5	Percent unit selection	Standard 210	2010BR if 5,6,7 = 0
6	Low range 210	210 with 0-1000ppm	2010BR if 5,6,7 = 0
7	High range 210	210 with 100%	2010BR if 5,6,7 = 0
8	Alarm 1 state	In alarm	Out of alarm
9	Alarm 1 high/low selection	Alarms above set point	Alarms below set point
10	Alarm 1 operation	Closes in alarm	Opens in alarm
11	Failsafe selection	Attempts to alarm if power fails	Doesn't.
12	Alarm 2 state	In alarm	Out of alarm
13	Alarm 2 high/low selection	Alarms above set point	Alarms below set point
14	Alarm 2 operation	Closes in alarm	Opens in alarm
15	Alarm latch selection	Alarms latch	Alarms automatically reset
16	Error – invalid output range	1 = error	No error
17	Error – failed initialization	1 = error	No error
18	Error – Span value out of range	1 = error	No error
19	N/A		
20	Error – Invalid alarm set point	1 = value over 1000	No error
21	Error - memory failure	Non-volatile storage failed	No error
22	Error – lost contact with Analysis section	Internal electronic problem	No error
23	Error – over-range	Reading greater than output range maximum	No error
24	Allow writing into analyzer	Enables writing	Disables writing

For example, to rest latched alarms, set coil 24, reset coil 15, wait for a second or so, then set coil 15.

## Diagnostic Functions

The diagnostic functions 0,1,2,4,10,11,12,13,14,15, and 16 are supported.

Note that each counter will count up to 65535, but won't go any higher. They can be reset to zero with the 10 command.

Function	Command (without CRC)	Action	Notes
0	11 08 00 00	Echo message	Returns the exact same message.
1	11 08 00 01	Restart communication	Restarts from a previous 4 command
2	11 08 00 02	Return error byte	Returns same as holding register 23
4	11 08 00 04	Listen only mode	Stops the analyzer from responding to anything.
10	11 08 00 0A	Clear all diagnostic counters	Clear each of the diagnostic counters to zero
11	11 08 00 0B	Total message count	The total number of messages seen by the analyzer
12	11 08 00 0C	CRC error count	Number of CRC errors seen by the analyzer
13	11 08 00 0D	Exception count	Number of invalid Modbus commands
14	11 08 00 0E	Number of slave messages	Number of messages the analyzer has returned
15	11 08 00 0F	Number of no responses	Number of messages addressed to the analyzer that it did not respond to
16	11 08 00 10	Number of NAK responses	Number of messages with incorrect parameters (such as invalid registers or out-of-bounds values) seen by the analyzer

# Maintenance and troubleshooting

## Maintenance:

The model 201RSP 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.

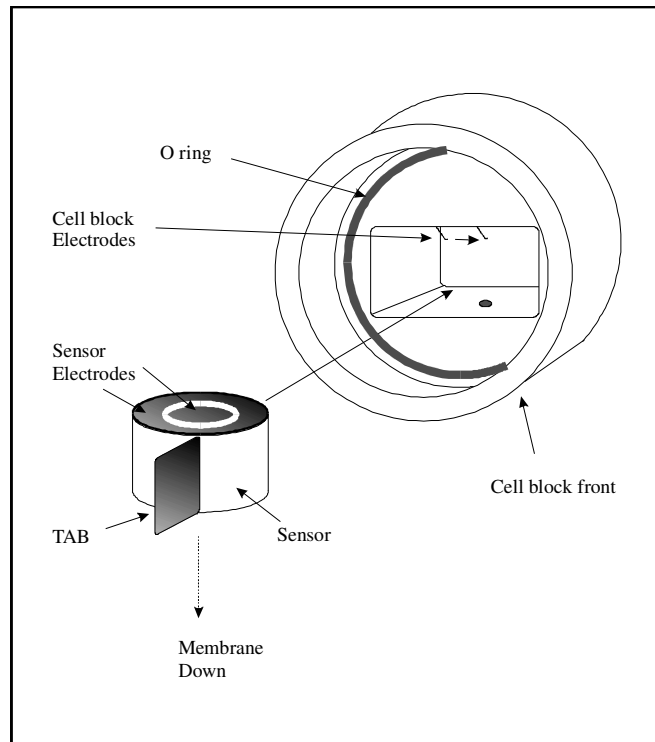
Sensor	Part number	Description	Expected life
P2	4SEN03-1	0-50% in inert gas background	12-15 months
P3	4SEN04	0-25% in CO2 containing background	9 -12 months
P4	4SEN08	0-100% in inert gas background	18 months in air
P5	4SEN19	P-3 with up to 500ppm H2S in background	9-12 months

**Table 1. AMI percent sensor types**

## Sensor replacement cautions:

**CAUTION:** The sensor contains an acid or alkaline 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 11. Inserting sensor in cell block**

# 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 fuses in the power entry module are not blown. If they are, it indicates that something has gone seriously wrong. Only replace them with 1A fast blow fuses – if these blow, return the unit to AMI for repair. Don't put nails in there!.

### ***Analyzer reads too low***

1. Sensor is not calibrated. Flow span gas through it and span the analyzer until the analyzer reads appropriately.
2. Span gas was not bypassed so the analyzer was spanned incorrectly. Bypass the span gas as suggested earlier in this manual.
3. If you still cannot adjust the span enough, replace the sensor.
4. If the new sensor still reads too low, check its calibration with air and read the span gas - the span gas may be incorrect.
5. If the sensor seems to die quickly, it may be getting poisoned by acid or sulfur bearing gases such as H<sub>2</sub>S. Use the H<sub>2</sub>S resistant T-4 sensor.
6. 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 - 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/span 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 in all the ranges - 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 boards!

NOTE: Almost always, high oxygen readings are due to leaks. Oxygen in the air is under a partial pressure of about 5 psia at sea level, and thus will force its way into minute leaks, no matter what the internal pressure of any other gas may be. 3000 psig nitrogen or other gas lines look like a vacuum to oxygen! This always surprises people who have not experienced it.

---

### ***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.
4. Verify that the unit is set to the correct output. Remove the output board cover and verify that the jumpers are in the correct positions (on the left for current output, on the right for voltage output). If not, place them correctly.

### ***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 alarms are configured correctly, using a PC or similar communication device.
4. Verify the alarm delay time with the PC.
5. 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!

### ***Analyzer refuses to accept front panel settings***

1. Using the RS-232 interface, verify that the security is set the way you want it.

### ***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](mailto:sales@AMIO2.com).



# Specifications and Disclaimer

## Specifications:

201R Series Standard ranges:

0 – 1%, 0 – 5%, 0 – 10%, 0 – 25%

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); -25°C to +45°C (-13°F to 113°F) with optional heater

Maximum inlet pressure: 15 psig

Humidity: < 85%, non-condensing

Operational conditions: Pollution degree 2, Installation category II.

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 seconds (P2 sensor):

Outputs: 4-20mA isolated.

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

Power requirements: 90-240VAC <10W.

Absolute Maximum Power voltage 264VAC 60Hz.

Overall dimensions: 9" w x 5" h x 7" d

Mounting hole dimensions: 7.92" w x 4.81" h

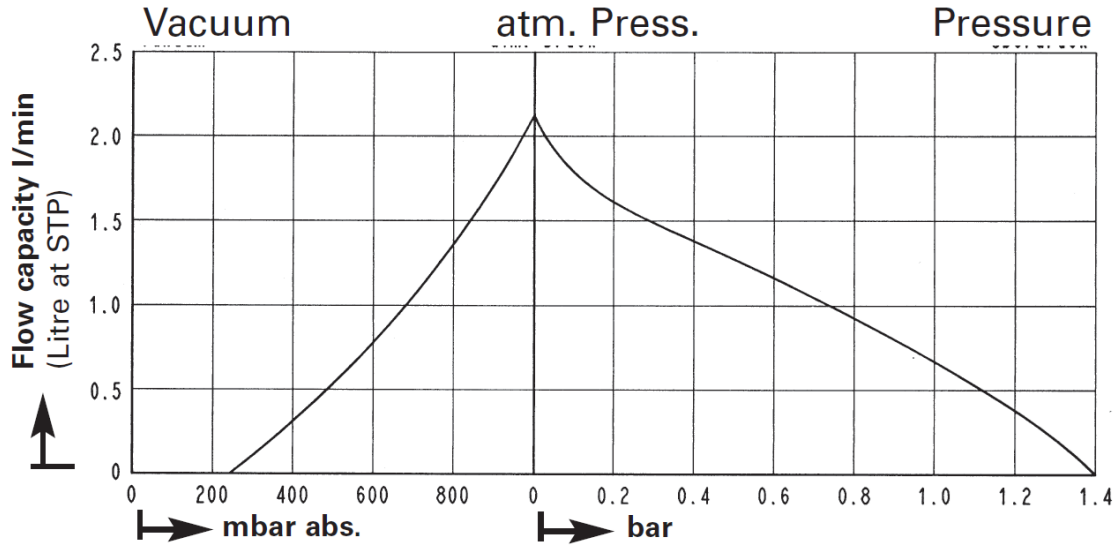
Weight 10 lbs

**To be installed only in installation (overvoltage) category I or II.**

**Pump Performance:**

Free Flow Rate :  $\geq 4.4$  scfh (2.1 L/min)

Max Pressure: 20 psig (1.4 barg)



## 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.

# AMI<sup>®</sup> WARRANTY & SUPPORT

## LIMITED WARRANTY/DISCLAIMER

The warranty period is **TWO YEARS** for the Analyzer. Any failure of material or workmanship will be repaired free of charge for that specified period from the original purchase (shipping date) of the instrument. AMI will also pay for 1-way ground shipment back to the customer.

The warranty period for the electrochemical oxygen sensor is 6 months.

The warranty period for the electrochemical H<sub>2</sub>S sensor is 6 months.

The warranty period for the zirconium oxide sensor is 2 years.

Any indication of abuse or tampering of the instrument will void the warranty.

### **Receiving the Analyzer**

When you receive the instrument, check the package for evidence of damage and if any is found contact the shipper. Although every effort has been made to assure that the Analyzer meets all performance specifications, AMI takes no responsibility for any losses incurred by reason of the failure of this analyzer or associated components. AMI's obligation is expressly limited to the Analyzer itself.

EXCEPT FOR THE FOREGOING LIMITED WARRANTY, AMI MAKES NO WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, AS TO THE NON-INFRINGEMENT OF THIRD-PARTY RIGHTS, MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE. IF APPLICABLE LAW REQUIRES ANY WARRANTIES WITH RESPECT TO THE SYSTEM, ALL SUCH WARRANTIES ARE LIMITED IN DURATION TO TWO (2) YEARS FROM THE DATE OF DELIVERY.

## LIMITATION OF LIABILITY

IN NO EVENT WILL AMI BE LIABLE TO YOU FOR ANY SPECIAL DAMAGES, INCLUDING ANY LOST PROFITS, LOST SAVINGS, OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES, EVEN IF THE COMPANY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, OR FOR ANY CLAIM BY ANY OTHER PARTY.

## LIMITATION OF REMEDIES

AMI's entire liability and your exclusive remedy under the Limited Warranty (see above) shall be the replacement of any Analyzer that is returned to the Company and does not meet the Company's Limited Warranty.

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