INSTRUCTION MANUAL

Model 200B

miniPID Fast Response Miniature Photo-Ionization Detector

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1.0 Introduction

The miniPID fast-response photo-ionization detector combines small size, fast response, and high sensitivity in an easy-to-use, competitively priced package. The sensor has a true frequency response of 330 Hz with a 10-90% rise time of 0.6 msec. The detection limit is 100 ppb (parts per billion) propylene gas in air and the full-scale measurement range is 500 ppm (parts per million). The miniPID has been designed to provide high frequency concentration measurements in wind tunnels, test chambers and in the atmosphere.

1.1 Operating Principle

Inside the miniPID photo-ionization detector (PID) a gas or vapour sample is exposed to high intensity ultraviolet light that ionizes the molecules of chemical substances. Ions are collected on positive and negative electrodes within the detector cell creating a current proportional to the contaminant concentration. Ionization depends on the minimum energy needed by a molecule to produce ions and this energy (ionization potential) is different for each chemical substance. The molecules of most permanent gases (including the constituents of air: nitrogen, oxygen, carbon dioxide, argon, etc.) are not ionized, as they require a photon energy level higher than that generated by the lamp. Molecules having ionization energy levels below the lamp energy (10.6 eV) are the ones that are ionized. Appendix C contains a list of the ionization potentials of many common substances.

Since the PID is sensitive to any gas with an ionization potential below 10.6 eV, the output of the device should be viewed as an expression of the total ionizables present. Because of this, the accuracy of the miniPID is dependent on the presence of interference gases.

1.2 Instrument Description

The instrument consists of a sensor head with mounting rod, interconnection cable, controller and a power cord. Also included in the shipping package are this instruction manual and some tools.

Sensor Head

The sensor head contains the ultra violet (UV) lamp, lamp drive electronics, sample inlet, detection cell, and a pre-amplifier.

The high energy UV lamp ionizes gases and vapours that enter the detection cell. The lamp is electrode less and uses radio frequency (RF) excitation that is generated by the lamp drive electronics enclosed within the sensor head. The sample enters the detection cell through a 5.7-cm (2.25") long inlet needle that has a 0.076-cm (0.030") inside diameter. The length of the inlet was chosen to place the sampling point well away from potential flow disturbances caused by the case of the sensor head. The inlet diameter was chosen to maximize frequency response and spatial resolution. The detection cell and pre-amplifier are built into the end of the case and convert gas concentration to a voltage signal. The sensor head case is anodized aluminum and measures 2.54cmx5.1cmx7.6cm (1"x2"x3").

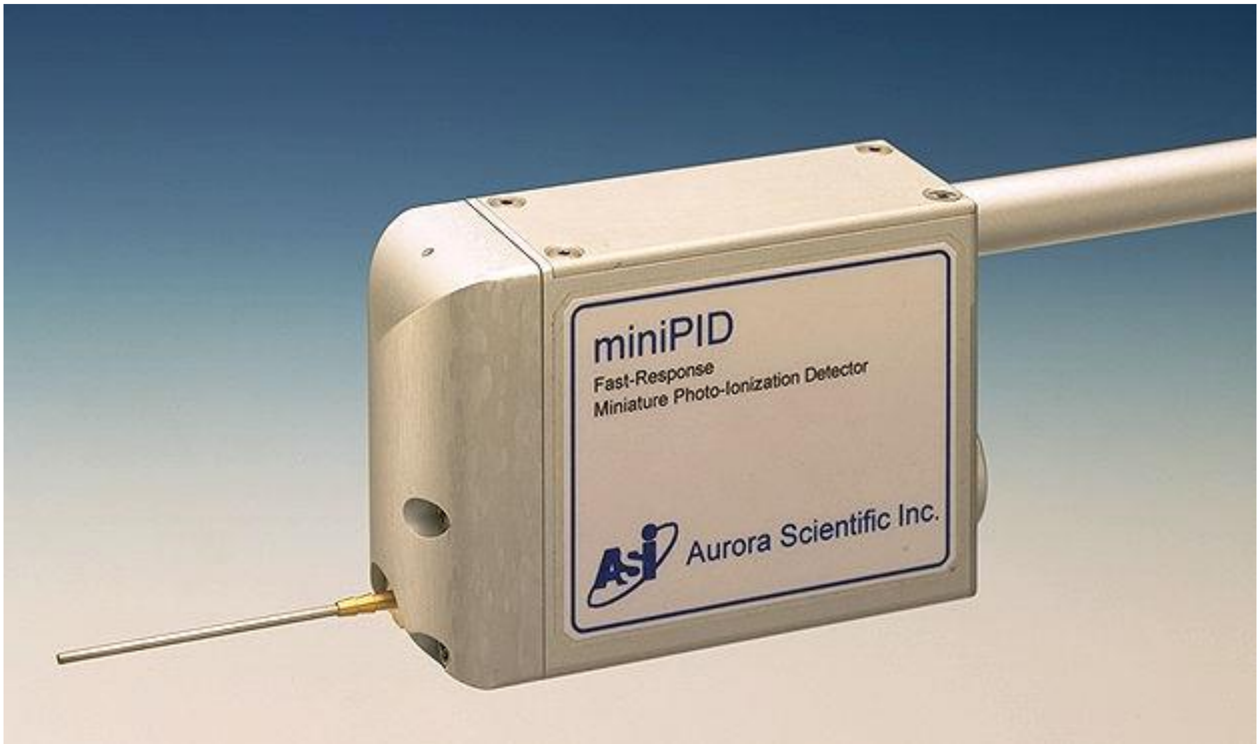

Photo 1 miniPID Sensor Head

Mounting

A 0.95 cm (0.375") diameter by 24.4 cm (10") long mounting tube is attached to the miniPID sensor head and can be used to hold the sensor in the desired position using standard laboratory retort stands and clamps (see drawing # MP-ASM2 in Appendix A). The mounting tube contains electrical connections and the suction tube and should not be removed from the sensor head. Removal of the mounting rod will result in damage to the sensor.

Interconnection Cable

The interconnection cable consists of a power cable, a signal cable, and a suction tube all contained within a woven nylon jacket and terminated with connectors on each end. The cable is 305 cm (120") long to allow the controller to be mounted outside of a wind tunnel or test chamber.

Controller

The controller contains the sample pump, power supplies, lamp control circuitry, zero and gain circuitry and an anti-aliasing filter. The front panel of the controller has switches to control instrument power, pump flow, and gain range selection. A potentiometer is also mounted on the front panel for zeroing the voltage output. LED status lights are provided that indicate power on, lamp on, and pump on. A logarithmic LED bar-graph signal meter with a 90 dB range is included to provide a real-time indication of signal level. The connections to the sensor head both electrical and air suction are also on the front panel. The controller is half rack in size and can be mounted in a standard 19” rack by using an Aurora Scientific Inc. half-rack adapter. AC power enters on the back panel of the controller. Also on the back panel is the sample pump outlet connection.

Power Supply

The power supply is built into the controller and is set for the line input voltage of the researcher's country. Ensure that the line input power matches the tag on the back of the instrument.

2.0 Sensor Setup and Use

1) Using the mounting tube and a standard lab clamp, or other user supplied clamp, mount the sensor head in the desired location with the inlet needle either facing into the flow or perpendicular to the flow (see photo 1 below for an example of a mounting technique). The miniPID will operate in any orientation but care should be taken to protect the instrument from rain or moisture, excessive dust or dirt, and mechanical shock. The sensor has not been designed for continuous exposure to weather.

Photo 2 **miniPID** sensor in use at Prof. Ring Carde's lab,
Dept. of Entomology, University of California, Riverside.

2) Plug the power cord into an AC power socket and into the back of the miniPID controller. Plug the sensor cable and sample hose into the front of the miniPID controller and into the sensor head. Tighten the connector screws on the DB-9 connector used on the front panel of the controller. Loose connections can greatly increase sensor noise.

3) Connect a data acquisition computer, a voltmeter, an oscilloscope, or a chart recorder to the BNC "Signal Out" connector on the controller front panel. Because of the wide dynamic range and fast response of the sensor, it is recommended that a 16-bit analog-to-digital converter (ADC) be used to digitize the output signal. The ADC should be set to unipolar input with a 0 to +10 volt range. The output of the miniPID controller is filtered through an 8^{th} order Butterworth low-pass anti-aliasing filter. The cut-off frequency of this filter is shown on the Calibration and Data Sheet provided with the instrument. It is recommended that the ADC sampling

frequency be set to at least 4 times the cut-off frequency of the low-pass filter. Over sampling is crucial if aliasing of the data is to be avoided.

4) Turn the power switch "ON". The pump will start immediately but the UV lamp may take up to 1 minute to light. Monitor the "Lamp" LED on the controller front panel. If this LED does not light within 3 minutes switch the power off, wait about 2 minutes and then try again. If the lamp does not light after repeated attempts then consult the troubleshooting and maintenance section of this manual. Once the UV lamp is lit allow the sensor to warm up for at least 30 minutes before taking data.

5) When the sensor has warmed up set the controller gain switch to the desired gain range. Also set the pump switch to the desired inlet flowrate. The flow rates corresponding to the three positions of the switch can be found on the miniPID data sheet included with the instrument.

6) With the sensor drawing clean air, adjust the "Zero" potentiometer to give a small positive output (100 to 500 mV). This offset voltage will ensure that the sensor output stays above 0 volts in the event of sensor drift due to changes in background gas concentration, temperature, or humidity. Note: the LED bar-graph meter has been adjusted at the factory so that a positive output of about 100 mV is required to illuminate the first LED. Thus an easy method for adjusting the sensor to a small offset value is to adjust the "Zero" knob until only a few LEDs of the bar-graph meter are illuminated.

7) Release the tracer gas and observe the signals on the LED bar-graph meter. Adjust the tracer flow rate or increase the gain of the sensor until signals can be seen which illuminate most of the LEDs. A red LED is included at the high end of the meter range to indicate signals that exceed 10 volts. If the red LED turns on then either reduce the gain setting on the controller front panel or adjust the source strength of the tracer gas. The bar-graph meter is logarithmic and covers the 90 dB range of a 16-bit ADC. The 30 dB point on the scale corresponds to 10 mV, the 60 dB point to 316 mV, and the 90 dB point to 10 volts.

8) It is normal for the output of the miniPID to drift slightly with time. This drift occurs mainly in the sensor head circuitry and therefore it is amplified at the higher two gain settings available on the controller front panel.

9) It is normal for the sensor head to become slightly warm to the touch.

10) The as-shipped configuration of the miniPID Controller has the sample air exit the controller through a stainless steel muffler (located on the controller rear panel). In some cases it may be preferable to have the air exit in a different location, for example within the test chamber. For this situation remove the muffler (using a 5/16" wrench) and mount the 1/8" tube connector supplied with the instrument. Use a 1/4" OD by 1/8" ID vinyl tube to connect the exhaust fitting to the test chamber.

At this point the miniPID should be set up and ready for use. It is recommended that the sensor be calibrated before the start of a series of tests and then once every 30 hours of use. If the sensor is used to detect very high gas concentrations or is used in dirty environments more frequent calibration may be required. See the chapter 3 for more information on calibration.

2.1 Choice of Tracer Gas

Several experimenters have used propylene as a tracer gas especially in outdoor trials. Propylene was chosen because it is inexpensive, available in liquid form (which allows large volumes to be released without requiring a large number of high pressure cylinders), non-toxic, EPA approvals for outdoor dissemination can be obtained, and the sensor is reasonably sensitive to it.

CAUTION - If pure propylene is to be used as a tracer then proper safety procedures must be in place as propylene is an explosive gas.

Depending on your specific experiment, it may be advantageous to look into using other tracer gases. Isobutylene is a good choice for a wind tunnel experiment because the ionization potential is lower than for propylene which results in a higher output for a given gas concentration. Appendix C provides a list of common substances and their ionization potentials. Any substance with an ionization potential less than 10.6 eV can be measured using the miniPID sensor.

If problems are experienced in the wind tunnel with the sensor over ranging, it may be advantageous to purchase a gas mixture consisting of tracer gas mixed with air instead of using a pure tracer. The other major advantage of using a gas mixture is that the mixture can be purchased with a concentration below the lower explosive limit of the gas. This provides a much greater level of safety since, under normal conditions; the concentration can never rise to explosive levels.

Aurora Scientific Inc. recommends that air/gas mixtures below the explosive limit of the gas always be used for wind tunnel and other indoor experiments.

3.0 Calibration

The miniPID detector should be calibrated once every 30 hours of operation. The calibration is affected by lamp output, detection cell cleanliness, and pump flow rate. Therefore, in addition to routine calibration, the detector must also be calibrated after replacement, removal, or cleaning the lamp, after cleaning the detection cell and after cleaning or replacing the pump.

The presence of UV absorbers (such as water vapour, and oxygen) will have a small effect on the detector output and calibration. It is recommended that the detector be calibrated using the background gas present during testing. In most applications the detector will be used to measure tracer gas concentration in air. If the sensor is to be used to measure contaminants in some other background gas ensure that the sensor is calibrated using the test background gas.

3.1 Calibration Techniques

The output of the miniPID sensor can be accurately modelled using a 2nd order polynomial of the form

$$C = a_1V^2 + a_2V + a_3$$

where C is the concentration in ppm
V is the output voltage from the controller in volts
and a_1,a_2,a_3 are the coefficients of a least squares polynomial fit to the calibration data.

Because of the slight non-linearity in the output it is important that a multi-point calibration be used. This calibration can be performed by delivering several known concentrations of tracer gas to the sensor and then recording the output. This procedure is repeated for the three gain settings of the instrument. A 2nd order polynomial is then fit to the output versus concentration data to yield the calibration equation. A preliminary calibration was performed at the factory and the results are shown on the miniPID Calibration Sheet included with the instrument.

Several different calibration techniques will be described in the following sections but they all involve delivering a known concentration of gas to the sensor at a prescribed flow rate. It is important that the flow rate of the calibration gas is about 1.1 times the inlet flow rate of the sensor and that a slightly oversize tube is used to deliver the calibration gas to the sensor inlet needle. It is suggested that a 1/16"-1/8" ID vinyl tube be used to deliver the calibration gas to the inlet needle. Insert the needle 1/4"-1/2" into the end of the vinyl tubing but do not attempt to seal the tube to the inlet needle. It is critical that the sensor draw the calibration gas from the delivery tube at atmospheric pressure. If the calibration flow is less than the sensor inlet flow then the sensor will draw in surrounding air and the concentration will be diluted (this results in an output which is lower than it should be). If the calibration flow is significantly greater than the inlet flow, or the delivery tube fits tightly on the inlet needle, then the sensor inlet will become pressurized resulting in a greater mass of material being drawn into the sensor (this results in an output value which is greater than it should be).

3.1.1 Calibrated Gas Mixtures Technique

Gas product suppliers, such as Matheson Gas Products and Scott Specialty Gases, can supply high-pressure cylinders containing calibrated mixtures of tracer gas and air. Purchase several different calibrated gas mixtures, regulators, a flow meter, and a needle valve. The calibrated gas mixtures can be delivered directly to the sensor inlet via a regulator and flow control needle valve. The flow meter, a simple rotameter is sufficient, allows the calibration flow rate to be set at 1.1 times the sensor sample flow rate. Perform the following procedure to calibrate the sensor.

1) Turn on the sensor and allow it to warm up.
2) Select the gain range of interest.
3) Deliver zero air (air with very low concentrations of hydrocarbons in it) to the sensor inlet needle at a flow rate 1.1 times the sensor suction flow rate.
4) Zero the sensor (remember to leave a small positive offset on the output signal).
5) Record the output voltage.
6) Deliver a low gas concentration to the sensor and record the voltage.
7) Repeat step (6) with successively higher calibration gas concentrations.
8) Plot the voltage versus concentration and fit a 2nd order polynomial to the data.
9) Repeat the calibration procedure for each gain range.

3.1.2 Simple Gas Mixing Technique

When a multipoint calibration of more than 3 or 4 points is required then it is more cost effective to create your own concentrations by diluting calibrated gas mixtures with zero air. A simple dilution system can be constructed using a gas proportioning rotameter system (commercially available from Omega, Matheson Gas Products, etc.) and selected calibrated gas concentrations. A gas proportioning rotameter consists of two flow meters, two needle valves and a mixing tube. The calibration is performed by mixing zero air with a calibrated gas mixture to produce any desired concentration between zero concentration and the concentration of the calibrated mixture. For example mixing zero air and 100 ppm tracer in air will allow you to generate any concentration between 0 and 100 ppm (within the tolerance of the rotameters). Note that the total flow must be maintained at about 1.1 times the inlet flow rate of the sensor. Also note that this method is a volumetric mixing operation and therefore the pressures and temperatures of the two gases must be the same in order to maintain accuracy. Use the calibration procedure outlined in section 3.1.1.

3.1.3 Mass Flow Meter Gas Mixing Technique

The best method for generating many different concentrations of tracer in air is to use two mass flow controllers to perform a mass mixing of zero air and a calibrated gas mixture. This method is similar to that described in 3.1.2 except the mass flow controllers will compensate for changes in inlet temperature and pressure. Electronic control modules are available to automate the mixing process. The calibration procedure remains the same as outlined in section 3.1.1.

Aurora Scientific Inc. can supply any of the above calibration systems. Please contact us with your requirements.

4.0 Maintenance and Troubleshooting

4.1 Pump

A rotary vane sample pump is mounted inside the controller. Because the pump flowrate affects the sensor calibration, the flowrate should be checked periodically. A rotameter with a 0 to 2 SLPM (standard litres per minute) range can be attached to the miniPID inlet needle using a short length of 1/16" ID vinyl tubing and some 1/16" OD Teflon tubing (a short length of each was supplied with the instrument). Connect the miniPID needle to the top of the rotameter (normal exit of the meter) and leave the bottom port of the rotameter open. Ensure a gas tight connection between the rotameter and the miniPID inlet needle. Also ensure that any valves attached to the rotameter are wide open. Turn on the miniPID controller and observe the flow rate indicated on the rotameter. If there is no flow or the measured flow rate is significantly less than the as-shipped flow rate (listed on the miniPID Data Sheet) then perform the following checks.

1) Check that the "Pump" LED on the controller is illuminated and that you can hear the pump running.
2) Check that the quick-connect on the front of the controller, which connects the sample tube to the controller, is fully mated. Likewise check the quick-connect at the sensor head and ensure it is fully mated.
3) Disconnect the rotameter from the miniPID inlet needle and the sample tube from the miniPID sensor head. Attach the rotameter to the sample tube and check the flow rate. If the flow rate is okay then the miniPID inlet needle has become clogged. To clean the inlet needle, **remove it** from the sensor head and clean it with a fine wire and compressed air. Visually check that the needle is clear and re-attach it to the sensor. Recheck the flow rate through the sensor head to confirm correct operation. The inlet needle diameter is smaller than any of the internal passages in the sensor head and therefore a blockage is most likely to occur in the needle.
4) If during step (3) it is found that the flow rate is not okay when the sensor head is removed, then disconnect the sample line from the quick-connect fitting at the controller and attach the rotameter. If the flow is okay without the long sample line in place then check to see if the sample line is pinched, crushed, or blocked. Ensure that the sample line is not bent around a sharp corner. It is very unlikely that the line could become blocked since the miniPID inlet needle has a smaller diameter than the sample tube.
5) If step (4) shows that the sample line is okay then the problem is with the pump itself. In this case return the controller to Aurora Scientific Inc. for repair. Do not attempt to open the controller and replace the pump. **HIGH VOLTAGE is present inside the controller.**

The sensor should be re-calibrated if the sample flowrate changes.

4.2 UV Lamp Cleaning, Tuning and Replacement

4.2.1 Lamp Removal and Cleaning

Shut off the sensor and unplug the power cable and the vinyl sample tube from the sensor head prior to lamp removal or cleaning.

The UV lamp can be removed by unscrewing the large screw cap found on the miniPID sensor head. Ensure that you do not drop the lamp when removing it. This can result in lamp failure. Also make certain that the lamp compression spring is not lost.

If successive calibrations show a decrease in signal output for a given calibration concentration, then it is most likely that the lamp is dirty. To clean the lamp, remove the lamp and inspect the flat face for dirt. This face can be cleaned with a soft cloth. If the dirt will not easily wipe off, then dampen the cloth with methanol and wipe the surface again. Do not use other solvents since they can be detected by the sensor and will result in a very large signal offset. Ensure that the lamp face is free of dirt and fingerprints before replacing it in the sensor head. The sensor **must** be re-calibrated after lamp removal or cleaning.

4.2.2 Lamp Tuning

A lamp-tuning adjustment is available in the miniPID controller. A potentiometer (labelled PT1) is located on the main controller circuit board near the centre of the circuit board. The run voltage may need adjustment from time to time as the lamp and other electronic components age.

Adjusting the Lamp Run Voltage

The lamp run voltage should be adjusted any time you detect a drop in signal output and cleaning the lamp and detection cell does not return the signal to the original level shown in the miniPID data sheet provided with the instrument. If you believe that the lamp run voltage needs to be adjusted then use the following procedure.

CAUTION

HIGH VOLTAGES ARE PRESENT WITHIN THE CONTROLLER.
Ensure the controller is switched OFF and the AC power
is unplugged BEFORE opening the controller.

1) Remove the top cover from the miniPID controller. To do this locate and remove the Philips head screw located at the back top of the controller. Slide the top cover backwards and off of the controller. This will expose the controller circuit board.
2) Locate the potentiometer labelled PT1 near the centre of the circuit board. You will need a small blade-type screwdriver to adjust a potentiometer.
3) **An 800VDC power supply is located on the circuit board just to the left of the potentiometer that you need to adjust. Be extremely careful not to touch any components or traces on the circuit board during this tuning procedure. Also**

avoid touching the power supply located at the back of the controller box as AC voltages are present at this power supply.

4) Attach the sensor head to the controller. Attach the AC power cord to the controller. Turn on the instrument and allow it to warm up for 30 minutes.
5) Connect a voltmeter or other voltage-recording device (oscilloscope, chart recorder, A/D system, etc.) to the Signal Output BNC connector on the front of the miniPID controller.
6) Use the Zero knob on the front panel of the controller to set the output signal level to about 100 mV (set the zero level when the sensor is drawing clean air).
7) Supply a steady source of calibration gas to the inlet of the sensor head at a flowrate at least 1.1 times the inlet flowrate. Ensure that the calibration gas is delivered to the inlet using a small diameter tube that is larger than the outside diameter of the inlet needle and also ensure that the tube does not fit snugly on the inlet tube of the sensor (we don't want to pressurize the inlet). We recommend using a mixture of 100-ppm calibration gas in zero air as the gas source.
8) Monitor the output signal level while you slowly turn the Lamp Run Voltage potentiometer (PT1). A setting of the potentiometer can be found that will result in a peak in the output signal. Turning the pot in either direction from this point will cause an output signal decrease. Turn the pot in both directions to determine the location that maximizes the output signal.
9) Once tuned, turn off the instrument, remove the AC power cord and then put the lid back on the controller ensuring that the screw on the back panel is tightened.

4.2.3 Lamp Replacement

If repeated attempts to light the UV lamp fail and lamp tuning does not help, or if the lamp glows with an orange colour, then the lamp requires replacement. Replacement lamps are available from Aurora Scientific Inc. The sensor **must** be re-calibrated after lamp replacement.

4.3 Detection Cell Cleaning

CAUTION

HIGH VOLTAGE (800VDC) IS PRESENT WITHIN THE DETECTOR CELL.
Ensure the controller is switched OFF and the sensor head is UNPLUGGED BEFORE detection cell cleaning.

Under normal operation the detection cell in the miniPID sensor will require cleaning about once a month and more often if the sensor is used in dusty environments. There is no inlet filter on the miniPID and therefore dirt can accumulate within the detection cell. An easy method for monitoring the dirt accumulation in the detection cell and on the lamp face is to use the results of successive calibrations. If the calibration values get progressively lower for a given calibration gas concentration then this is a good indication that the detection cell and lamp require cleaning.

Shut off the sensor, unplug the AC power from the controller and also unplug the sensor cable between the head and the controller. Also unplug the vinyl sample tube from the sensor head.

Remove the lamp from the sensor head (see section 4.2.1). Obtain a can of compressed air that has a small diameter plastic delivery tube on it. A recommended product is "Aero Duster" (available from Miller-Stephenson Chemical Company, product number MS-222N) or a similar product such as "Dust Off" (available at most camera stores). Look into the end of the lamp cavity and note the stainless steel plate at the far end that has a 1mm wide slot cut in it. Insert the delivery tube of the Aero Duster into the lamp cavity and position it near the slot.

CAUTION: Wear adequate eye protection while cleaning the detection cell.

Actuate the nozzle on the Aero Duster and blow off the dust accumulated within the slot. Remove the inlet needle from the sensor head and use the Aero Duster to blow out any accumulated dust in the needle. After cleaning replace the lamp and re-calibrate the sensor.

Under no circumstances should you attempt to disassemble the detector head. The detector and pre-amplifier are located beneath the rounded front end of the sensor head. There are four socket head cap screws holding this cover in place. Removing these screws and the detector cover will void the warranty.

4.4 Troubleshooting

The following troubleshooting information can be used to solve most common problems encountered with the miniPID sensor.

Table 4.1 Troubleshooting Table

Problem	Recommended Action
miniPID controller does not switch ON, "Power" LED does not light.	1. Ensure AC power cord is firmly plugged into the wall receptacle and the receptacle on the back of the controller. 2. Ensure the power switch is in the ON position. 3. Ensure the line voltage is correct. 4. Ensure the power source you plugged the power supply into is energized. 5. Check the fuse located inside the drawer in the power entry module on the back panel. Note a spare fuse is supplied in the drawer. 6. Unplug the controller from the AC power and then remove the top cover from the controller. Check that the internal power wires are attached to the circuit board. The power wires are red, black and blue and end in a white connector that must be firmly attached to the mating connector on the circuit board.
UV lamp does not switch on, "Lamp" LED does not light.	1. Ensure the sensor cable is plugged securely into the front of the controller and into the miniPID sensor head. 2. Ensure that a UV lamp is present in the sensor head and the lamp screw cap is on. 3. Ensure that the "Power" switch on the controller is in the ON position and that the "Power" LED is lit. 4. The UV lamp can take up to 2 minutes to light especially if the unit has not been turned on for a while. 5. If the UV lamp has not lit after about 3 minutes, switch the controller power OFF, wait about 1 minute, and then switch the controller power back ON. 6. If repeated attempts to turn on the UV lamp fail then replace the lamp. If the new lamp does not light then contact Aurora Scientific Inc. for assistance.
Pump does not run, "Pump" LED does not light.	1. Ensure the sensor cable is plugged securely into the front of the controller and into the miniPID sensor head. 2. Turn off the controller, unplug the AC cord from the back of the controller and remove the top cover. Check that the pump connector is attached to the main circuit board. The pump connector is a two pin brown connector that mates with a brown connector on the board. 3. Touch the pump motor to see if it is hot. If it is and you can't hear the pump running then the rotor inside the pump is probably broken and needs repair. Contact Aurora Scientific Inc. for assistance.

Correspondence

Table 4.1 Troubleshooting Table (continued)

Problem	Recommended Action
Pump runs but no air is sucked into inlet needle.	1. Ensure sample tube quick-connector is fully mated on front of the controller. 2. Ensure sample tube is attached to the sensor head. 3. Check the inlet needle for blockages (see section 4.1 for procedure). 4. Check the sample line between the controller and the sensor head for a pinched or crimped hose.
UV lamp is on and pump is on but the sensor does not respond to gas concentrations	1. Check that the pump is drawing air into the sensor head inlet needle (see previous troubleshooting information on pump). 2. Switch the controller to a higher gain setting. 3. Ensure that the tracer in use has an ionization potential of 10.6 eV or less (see Appendix C for ionization potentials of common compounds). 4. Ensure that the concentration of the tracer gas delivered to the sensor is greater than 100-ppb propylene equivalent. 5. If using calibration gas standards ensure that the flow rate of the calibration gas to the sensor is about 1.1 times the sensor inlet flow rate.
Sensor operates correctly but the signal output has a positive voltage offset.	1. Ensure the sensor is operating in a clean environment with no background ionizable material present. 2. Rotate the "Zero" knob counter-clockwise to reduce the offset.
Sensor operates correctly but the signal output has a negative voltage offset.	1. Ensure the pump is operating correctly and that there is the correct flow into the inlet needle. 2. Rotate the "Zero" knob clockwise to increase the offset.
Output signal from the controller is noisy.	1. Because the sensor has very fast response it is able to track concentration fluctuations in the atmosphere that may appear to be "noise". Evaluate sensor noise with a steady flow of calibration gas or with the suction tube disconnected from the sensor head. 2. If the background noise is above the typical noise level (2 mV on the 1x gain range) then clean the lamp and the detection cell. Re-tune the lamp by adjusting the lamp run voltage.

4.5 Technical Assistance

Technical assistance is available by regular mail, email, phone, or fax. Use the information below to contact Aurora Scientific Inc.

Address: Aurora Scientific Inc.
miniPID Technical Assistance
360 Industrial Pkwy. S. Unit 4
Aurora, Ontario, CANADA
L4G 3V7
Phone: 1 905 727-5161
Toll Free: 1 877 878-4784
FAX: 1 905 713-6882
E-mail: info@AuroraScientific.com
Web site: www.AuroraScientific.com

5.0 Warranty

Products manufactured by Aurora Scientific Inc. (ASI) are guaranteed to the original purchaser for a period of three (3) years. Under this warranty, the liability of ASI is limited to servicing, adjusting and replacing any defective parts that are of ASI manufacture. ASI is not liable to the customer for consequential or other damages, labour losses or expenses in connection with or by reason of the use or inability to use the products manufactured by ASI. Guarantee of parts and components not manufactured by ASI shall be the same as the guarantee extended by the manufacturer of such components or parts. Where possible such parts returned to ASI will be sent to the manufacturer for credit or replacement. Ultimate disposition of these items will depend upon the manufacturer's decision. All shortages must be reported within ten (10) days from receipt of shipment.

Except where deviations are specified in literature describing particular products, the limited warranty above is applicable to all ASI products, provided the products are returned to ASI and are demonstrated to the satisfaction of ASI to be defective.

Transportation costs of all products returned to ASI must be borne by the customer and products must be returned to ASI within three years after delivery to the original purchaser. ASI cannot assume responsibility for repairs or changes not authorized by ASI or damage resulting from abnormal or misuse or lack of proper maintenance.

Repair or service work not covered under the limited warranty will be billed at current service rates. ASI will provide its customers warranty service expedited by premium-time, work overtime, Saturday, Sunday or holiday at the customer's option. When the customer authorizes premium-time work, charges will be 50% above the standard rate.

ASI will also make available warranty service at the customer's location; provided the customer elects to pay all travel time and expenses.

NO EXPRESS WARRANTIES AND NO IMPLIED WARRANTIES WHETHER FOR MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR USE, OR OTHERWISE OTHER THAN THOSE EXPRESSLY SET FORTH ABOVE WHICH ARE MADE EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, SHALL APPLY TO PRODUCTS SOLD BY ASI, AND NO WAIVER, ALTERATION OR MODIFICATION OF THE FOREGOING CONDITIONS SHALL BE VALID UNLESS MADE IN WRITING AND SIGNED BY AN EXECUTIVE OFFICER OF ASI.

Appendix A Assembly Drawings

Drawing #	Title
MP-ASM1	miniPID Assembly - Exploded View
MP-ASM2	miniPID Assembly - Mounting Configuration
AS20003	Silkscreen of miniPID Controller Circuit Board

Appendix B miniPID Specifications

Detector:	Photo ionization, with a 10.6eV, RF-excited, electrode less discharge tube	
Frequency Response:	330 Hz (@ the -3 dB point)	
Detection Limit:	100 ppb (propylene)	
Operating Concentration Ranges:	Low Gain	0 - 500 ppm
	Med. Gain	0 - 100 ppm
	High Gain	0 - 50 ppm
Precision:	5% of the current reading or 0.5 ppm whichever is greater	
Gas Sampling Rate:	High: 1250 SCCM, Med: 950 SCCM, Low: 750 SCCM	
Operating Humidity Range:	0 to 95% RH (non-condensing)	
Operating Temperature Range:	32°F to 105°F (0°C to 40°C)	
Dimensions		
Sensor Head:	3.0" (7.6 cm) long, 2.0" (5.1 cm) wide, 1.0" (2.5 cm) thick.	
Controller:	3.5" (9 cm) high, 8.4" (21 cm) wide (1/2 rack), 10" (25 cm) deep.	
Weight		
Sensor Head:	0.38 lbs. (0.17 kg).	
Controller:	6.4 lbs. (3.0 kg).	
Power:	120VAC ±10%, 50/60Hz, 0.5A max. 100, 220 and 240VAC optional	

Appendix C Compounds Detectable with the miniPID Sensor