Aurora Scientific Inc.

INSTRUCTION MANUAL

Model
201A Portable miniPID

July 15, 2012, Revision 1

Aurora Scientific Inc.
360 Industrial Parkway South, Unit 4
Aurora, Ontario, Canada L4G 3V7
Toll Free: 1-877-878-4784
Telephone: 1-905-727-5161
Facsimile: 1-905-713-6882
Email: info@AuroraScientific.com
Web site: www.AuroraScientific.com

*** WARNING ***

**This product contains Lithium-Ion battery packs.
These batteries must be handled properly
during use, charging and storage.**

**SAFE OPERATING PROCEDURES AND PROPER USE
OF THE EQUIPMENT ARE THE RESPONSIBILITY
OF THE USER OF THIS SYSTEM.**

**Aurora Scientific Inc. provides information on its
products and associated hazards, but it assumes no
responsibility for the after-sale operation and safety practices.**

**ALL PERSONNEL WHO WORK WITH OR IN THE VICINITY OF
THIS EQUIPMENT MUST UNDERSTAND THE PROPER
USE AND SAFETY PRECAUTIONS TO PROTECT
THEMSELVES AGAINST POSSIBLE SERIOUS
AND/OR FATAL BODILY INJURY.**

TABLE OF CONTENTS

TABLE OF FIGURES

1.0 Battery Safety, Fuses, and Precautions

Aurora Scientific Inc. provides information on its products and associated hazards, but it assumes no responsibility for the after-sale operation and safety practices.

This product contains lithium-ion batteries. These batteries require extra care to ensure safety and longevity. Please read the following sections carefully and follow the recommendations provided. Please contact Aurora Scientific Inc. if you have any questions or concerns. Under normal circumstances, and when used correctly, these batteries will provide safe and reliable power.

1.1 Precautions

- Do not leave the battery pack in direct sunlight for extended periods of time.
- Do not charge the Lithium-Ion battery pack while unattended.
- Do not subject the battery pack to strong impacts or shocks.
- Do not expose the battery to water or salt water, or allow the battery to get wet.
- Do not disassemble or modify the battery. The battery contains safety and protection devices which, if damaged, may cause the battery to generate heat, rupture or ignite.
- Do not place the battery on or near fires, stoves, or other high temperature locations.
- Never short circuit, reverse the polarity, disassemble, damage or heat the battery pack over 100ºC (212ºF). If an exposed lithium battery does start on fire, it will burn even more violently if it comes into contact with water or even the moisture in air.
- DO NOT THROW WATER ON A BURNING LI-ION BATTERY! Use an appropriate fire extinguisher.

1.2 Charging

Note: Do not charge the Lithium-Ion battery pack while unattended.

1. Plug in the charger to an appropriate AC power source. Note: Only use the 18.5V Lithium-Ion Smart Charger provided with the product to charge the batteries.
2. Unplug the power cable connecting the battery pack to the controller.
3. Ensure the switch on the battery pack is in the middle position “Run miniPID”
4. Connect the battery charger to the battery pack.
5. Toggle the switch on the battery pack to the upper position “Battery 1”. The LED on the charger should turn red to indicate that the battery is charging. If the LED does not turn red then see section 1.3 to ensure that the battery fuse is not blown.
6. When the LED on the charger turns green the battery is charged. This should take between 2 and 4 hours depending on the state of charge.
7. Toggle the switch to “Battery 2” and again wait for it to finish charging.

1.3 Fuses

When the battery charger is connected to a battery that has a blown fuse the LED will stay green. This can be misleading because it appears that the battery is charged when in reality the charger is simply displaying that it has power. Here is how to differentiate between a blown fuse and a charged battery.

Blown fuse: With the charger connected and the switch toggled to one of the batteries, the light will be green.

Charged battery: With the charger connected and the switch toggled to one of the batteries the light will also be green. The difference is that when you switch back to “Run miniPID” the light will flash red for a very short period of time. Try this a few times. If this red flash is not visible, the fuse may be blown.

Fuse Replacement Procedure

1. Determine which fuse is blown using the above method.
2. Unplug the charger/power cable from the battery pack.
3. Remove the #1 Philips head screw from the lid at the rear of the box.
4. Slide the lid back and off of the box.
5. Behind the battery at the rear of the box there are two yellow fuse holders. The one with red wires is “Battery 1” the one with black wires is “Battery 2”. See Figure 1 for a picture.
6. Grab both ends of the yellow fuse holder and pull apart. The connector should come apart and the fuse can be removed and inspected.
7. If the filament (wire) in the fuse is not connected the fuse must be replaced.
8. Replace the fuse (use 2A fast acting, ¼” diameter x 1-¼” long AGC glass tube fuse) and push the fuse holder back together.
9. Place the fuse holders back behind the battery, make sure all wires are tucked inside the case, then close and secure the lid.

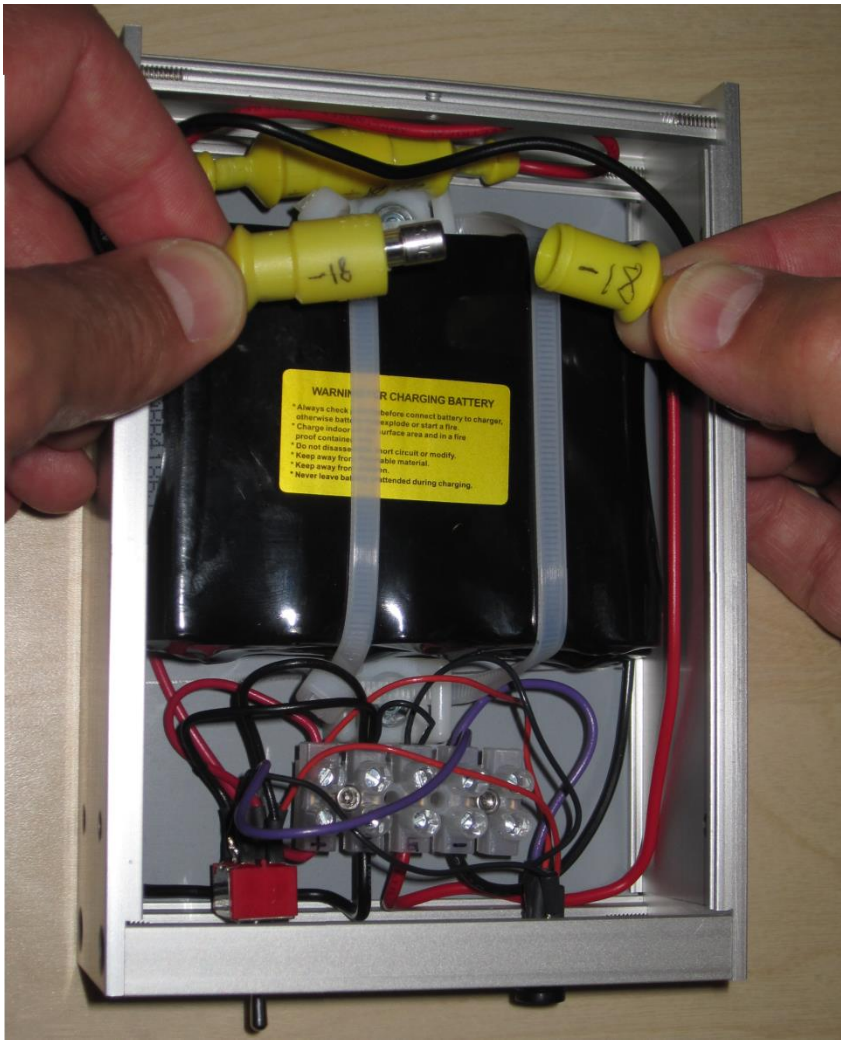

Figure 1 Opening the battery fuse holder

1.4 Storage and Maintenance

Similar to other types of rechargeable batteries, lithium ion batteries also loose charge capacity over time. Although this is unavoidable there are ways to reduce this loss and extend the life of the battery. If the battery is not going to be used for a period greater than four weeks then the following storage guidelines should be considered.

- Store the battery at around 40% charge level, this is ideal but does not need to be exact.
- Store at a low temperature around 4ºC (40ºF). The refrigerator provides good storage, as long as the temperature does not go below 0ºC (32ºF).
- Never discharge the battery fully.
- Always charge at least once per year to prevent over discharging.

Additionally, in general use charging the batteries early and often will help extend their life. Unlike other rechargeable batteries that should be fully drained and fully charged, Li-Ion batteries prefer short cycles.

2.0 Introduction

The portable 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 portable miniPID has been designed to provide high frequency concentration measurements not only in wind tunnels, test chambers and in the atmosphere, but in the field. By providing the functionality of the 200B miniPID in a scaled down, more efficient package and combined with a lightweight lithium-ion battery pack, this product is more versatile and field ready.

2.1 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.

2.2 Instrument Description

The instrument consists of a sensor head, interconnection cable, controller, battery pack and battery to controller power cord. Also included in the shipping package are this instruction manual, a Li-Ion battery charger with power cord 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 electrodeless 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").

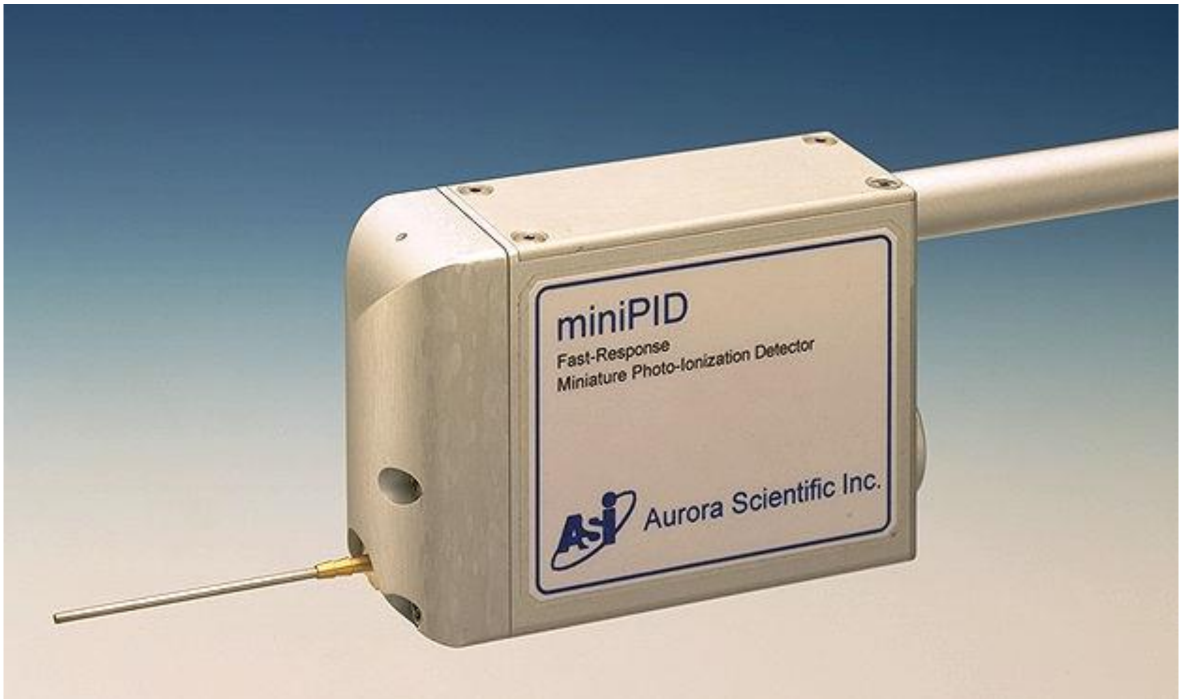

Figure 2 miniPID Sensor Head

Mounting

The sensor can be mounted using the connector tube at the rear of the sensor. This can be secured using a standard laboratory retort stand with clamp or a user supplied clamp. Alternatively Aurora Scientific Inc. has an optional top cover which contains two threaded mounting holes the same as found in the bottom of cameras, one hole is drilled vertically and the other horizontally. This makes the sensor easily mountable on a standard camera tripod. A drawing of this cover is shown in Appendix A. Contact Aurora Scientific Inc. for more details of this threaded mounting cover.

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 and gain range selection. A potentiometer is also accessible from the front panel for zeroing the voltage output. An LED status light indicates power on. Two additional LED lights are used to indicate that the sensor is off scale. The top LED shows the sensor output is above 10V while the bottom LED shows the sensor output is below 0V. The electrical and air suction connections to the sensor head attach to the front panel. The controller is quarter rack in size and can be mounted in a standard 19” rack using an optional rack adapter available from Aurora Scientific Inc. On the back there is a DC power connector that connects to the battery pack. Also on the back panel is the sample pump outlet connection.

Battery Pack

The portable miniPID controller is powered by a lithium-ion battery pack which will power the instrument for up to six hours. The battery pack is housed in an identically sized enclosure, making them easily stackable. More information on the battery pack is provided in section 1.0

3.0 Sensor Setup and Use

Caution: Do not use until you have read the safe use and handling of Li-Ion batteries presented in Section 1 of this manual. All personnel using this equipment must be trained in the safe use and handling of Li-Ion batteries. Lithium-Ion batteries can be hazardous if not handled properly.

1. Fully charge the battery pack before using. See section 1.2 for details of the proper charging procedure.

2. 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. Figure 3shows an example of a mounting technique using the 200B miniPID. 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.

Figure 3 miniPID sensor in use at Prof. Ring Carde's lab, Dept. of Entomology, University of California, Riverside.

3. Connect the battery pack to the controller using the supplied cable. Plug the sensor cable and sample hose into the sensor head and into the miniPID controller. Tighten the connector screws on the DB-9 connector used on the front panel of the controller. Loose connections can increase sensor noise.

4. 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 8th 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.

5. 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.

6. When the sensor has warmed up set the controller gain switch to the desired gain range (either 1X or 10X).

7. With the sensor drawing clean air, adjust the "Zero" potentiometer to give a small positive output (100 to 500 mV). Note: the –Offscale LED will light whenever the sensor output is less than about 100mV. Therefore an easy method of setting the zero is to turn the potentiometer until the –Offscale LED just starts to light. Once you are at this point then turn the potentiometer clockwise about ½ turn. This will provide a small offset voltage which 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.

8. Release the tracer gas and observe the output signal. There are +Offscale and –Offscale LED indicators that provide a visual clue that the sensor output is off scale either above 10V or below 0V. Adjust the gain so that the signals do not go off scale. If the red +Offscale LED turns on then either reduce the gain setting on the controller front panel or reduce the source strength of the tracer gas.

9. 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 gain setting available on the controller front panel.

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

11. The as-shipped configuration of the miniPID Controller has the sample air exit the controller through a muffler located on the rear panel of the controller. In some cases it may be preferable to have the air exit in a different location, for example plumbed back into a 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 4 for more information on calibration.

3.1 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 low pressure 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 the 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.

4.0 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 effect 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.

4.1 Calibration Techniques

The output of the miniPID sensor can be accurately modeled 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 should be repeated for the two 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" to 1/8" ID vinyl tube be used to deliver the calibration gas to the inlet needle. Insert the sensor inlet needle 1/4" to 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).

4.1.1 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.

4.1.2 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 4.1.1.

4.1.3 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 section 4.1.2 except that mass flow controllers are used because they 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 4.1.1.

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

5.0 Maintenance and Troubleshooting

5.1 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 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.

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

5.2 UV Lamp Cleaning, Tuning and Replacement

5.2.1 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.

5.2.2 Lamp Tuning

A lamp-tuning adjustment is available in the miniPID controller. A potentiometer (labeled 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 SENSOR HEAD.
Ensure the controller is switched OFF and 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 labeled PT1 near the centre of the circuit board. You will need a small blade-type screwdriver to adjust a potentiometer.
3) Attach the sensor head to the controller. Attach the power cord to the controller. Turn on the instrument and allow it to warm up for 30 minutes.
4) 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.

5) 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).
6) 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.
7) 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 the output signal to decrease. Turn the pot in both directions to determine the location that maximizes the output signal and then leave it at the point that provides the maximum output signal.
8) Once tuned, turn off the instrument, remove the power cord and then put the lid back on the controller ensuring that the screw on the back panel is tightened.

5.2.3 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.

5.3 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 cleaning the detection cell.

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. To maximize frequency response 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.

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

Shut off the sensor, unplug the power from the controller and 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 5.2.1). 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 narrow slot cut in it. Insert the delivery tube of the Aero Duster into the lamp cavity and position it near the slot. Actuate the nozzle on the Aero Duster and blow out the slot to remove any accumulated dust.

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.

5.4 Troubleshooting

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

Table 5.1 Troubleshooting Table

Problem	Recommended Action
miniPID controller does not switch ON, "Power" LED does not light.	1. Ensure the power switch is in the ON position. 2. Ensure the switch on the battery pack is at “Run miniPID” 3. Ensure the battery pack is charged 4. Check the fuse in the battery pack. See Section 5. 6. 1.3 Fuses 7. Unplug the controller from the battery 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 violet 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, the lamp screw cap is on and the compression spring is between the screw cap and the lamp. 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, cannot be heard.	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.

Table 5.1 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 5.1 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. Turn the "Zero" potentiometer 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. Turn the "Zero" potentiometer 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.

6.0 Technical Support, Warranty and Repairs

Aurora Scientific Inc. is dedicated to providing you with products that allow you to meet your research goals. For this reason technical assistance is always free and will be available for the life of your product. If you do have a problem with a product then please know that all ASI products are covered by a three year warranty covering both parts and labour. If you need to return a product to us for repair then consult the final section of this chapter for returns information.

6.1 Technical Support

Please don't hesitate to contact us if you have any technical support issues. Contact us by telephone, email, fax, or regular mail.

Address: Aurora Scientific Inc.
Technical Support
P.O. Box 2724
Richmond Hill, Ontario, CANADA
L4E 1A7

Phone: 1 905 727-5161
Toll Free: 1 877 878-4784 (North America)
FAX: 1 905 713-6882
E-mail: TechSupport@AuroraScientific.com
Web site: www.AuroraScientific.com

6.2 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 after 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.

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.

6.3 Returning Products to Aurora Scientific Inc. for Repair

There are a few simple steps that must be completed before returning your product to Aurora Scientific Inc.

1. Obtain a Return Material Authorization number (RMA#).
Contact our technical support department to obtain a RMA #. We require the serial number of the product along with your contact information, i.e. your name, institution, phone number and email address.

2. Package your instrument.
Use the original packaging materials if available. If you do not have original packaging then ensure that the product is wrapped in bubble pack and placed in a sturdy corrugated cardboard box. If you are returning a force transducer please place the transducer head in the plastic protective box and then wrap the plastic box in bubble pack and place it in a small cardboard box which can then be placed in the larger box along with the electronics. For force transducer repairs we require both the transducer head and the control electronics. Please don't send the power cord. When returning a muscle lever system wrap the motor in bubble pack and place it along with the lever arm in a small cardboard box and then place that box in the larger shipping container along with the controller. For muscle lever repairs we require the motor, lever arm, motor cable and control electronics. Please don't send the power cord.

3. Prepare Customs documents.
Canadian Clients: no customs documents are required, skip to step 4.
European Clients: no customs documents are required, skip to step 4 and ship to Aurora Scientific Europe.
USA and Rest of the World Clients: You must include a Commercial Invoice (CI) with the shipment. Please click this link to download a blank CI.
You can also prepare the commercial invoice yourself instead of using the downloadable form. Print the document on your company's letterhead and include the following information: Date, Shipper's Name, Address and Phone Number (your company information), Consignee's Name, Address and Phone Number (Aurora Scientific Inc. is the

Consignee), Country of Origin of Goods (this will be Canada if you purchased the instrument from Aurora Scientific or USA if your product was purchased from Cambridge Technology), Conditions of Sale (include the following statement: GOODS RETURNING TO FACTORY FOR REPAIR, TEMPORARY IMPORT), Number of Packages (normally 1), Description of Goods (e.g. Model 200B miniPID, Serial Number 200111), Quantity of Each Item (normally 1) and Value for Customs Purposes (the original purchase price of the instrument).
Place three (3) copies of your CI in an envelope and mark the outside CUSTOMS PAPERS ENCLOSED. Attach the envelope to the outside of the box.

4. Choose a shipper and prepare the waybill.
European Clients: ship your instrument to Aurora Scientific Europe in Dublin, Ireland.
All other Clients: ship your instrument to Aurora Scientific Inc. in Aurora, ON, Canada.
You may ship your instrument back to us via the courier of your choice or via parcel post. If possible we prefer that you ship via FedEx. You are responsible for both the shipping and brokerage charges so please mark the waybill accordingly. Please don't ship freight collect. Shipments sent freight collect will be received but you will be invoiced for the shipping charges when your instrument is returned.

5. Prepare and send a purchase order.
After we receive the instrument we will evaluate it and contact you with the estimated repair cost. We require a purchase order before we can repair and return your instrument. Please fax or email us the purchase order at your earliest convenience.

Return Shipping Address:

All countries outside of Europe	**Europe**
Aurora Scientific Inc. 360 Industrial Parkway S., Unit 4 Aurora, Ontario, CANADA L4G 3V7 Attn: RMA Returns Tel: +1-905-727-5161	Aurora Scientific Europe Hilton House 3 Ardee Road Rathmines, Dublin 6, Ireland Attn: RMA Returns Tel: +353-1-525-3300

Appendix A Optional Mount Drawing

Figure 4 Optional Sensor Mount

This optional mount replaces the top cover as seen in Figure 2. The mount features 2 threaded holes on different axes. The holes are ¼-20, the same as is used on cameras, which allows the sensor to be mounted on a standard camera tripod. Please contact Aurora Scientific Inc. if you would like further information.

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
	High Gain	0 - 50 ppm
Precision:	5% of the current reading or 0.5 ppm whichever is greater	
Gas Sampling Rate:	1250 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:	1.75" (4.5 cm) high, 4.25" (10.5 cm) wide (1/4 rack), 6" (15 cm) deep.
Battery:	1.75" (4.5 cm) high, 4.25" (10.5 cm) wide (1/4 rack), 6" (15 cm) deep.

Weight

Sensor Head:	0.38 lbs. (0.17 kg).
Controller:	1.4 lbs. (0.65 kg).
Battery:	2.0 lbs. (0.9 kg).

Battery:	+/-18.5 VDC, Li-Ion
Fuse:	2A, fast acting, ¼”x1-¼” AGC glass tube fuse
Battery Charger:	Type: 18.5 V Li-Ion Smart Charger Input: 100-240VAC, 50/60Hz Output: 21 VDC @ 1.5A Max

Appendix C Compounds Detectable with the miniPID Sensor

Compound	Ionization Potential (eV)	Compound	Ionization Potential (eV)
Acetaldehyde	10.21	n-Butanal	9.83
Acetic Acid	10.37	s-Butanal	9.73
Acetone	9.69	n-Butane	10.63
Acetylene*	11.41	n-Butanol	10.04
Acrolein	10.10	s-Butanol	10.23
Acrylonitrile	10.91	t-Butanol	10.25
Allene	9.83	2-Butanone	9.53
Allyl Alcohol	9.67	1-Butene	9.58
Allyl Chloride	10.20	cis-2-Butene	9.13
Aminoethanol	9.87	trans-2-Butene	9.13
2-Amino Pyridine	8.34	n-Butyl Acetate	10.01
Ammonia	10.15	s-Butyl Acetate	9.91
Aniline	7.70	t-Butyl Acetate	9.90
Arsine	9.89	n-Butyl Alcohol	10.04
Benzaldehyde	9.53	n-Butylamine	8.71
Benzene	9.25	s-Butylamine	8.70
Benzenethiol	8.33	t-butylamine	8.64
Bromobenzene	8.98	n-Butylbenzene	8.69
1-Bromobutane	10.13	t-Butylbenzene	8.68
2-Bromobutane	9.98	Butyl Cellusolve	8.68
1-Bromobutanone	9.54	n-Butyl Mercaptan	9.15
1-Bromo-2-Chloroethane	10.63	t-Butyl Mercaptan	9.03
Bromoethane	10.28	p-tert-Butyltoluene	8.35
Bromoethene	9.80	1-Butyne	10.18
Bromoform	10.48	2-Butyne	9.85
1-Bromo-3-Hexanone	9.26	n-Butyraldehyde	9.83
Bromomethane	10.53	Carbon Disulfide	10.13
Bromomethyl Ethyl Ether	10.08	Carbon Tetrachloride *	11.28
1-Bromo-2-Methylpropane	10.09	Chloroacetaldehyde	10.16
2-Bromo-2-Methylpropane	9.89	Chlorobenzene	9.07
1-Bromopentane	10.10	1-Chloro-2-Bromoethane	10.63
1-Bromopropane	10.18	1-Chlorobutane	10.67
2-Bromopropane	10.08	2-Chlorobutane	10.65
1-Bromopropene	9.30	1-Chlorobutanone	9.54
2-Bromopropene	10.06	1-Chloro-2,3-Epoxypropane	10.60
3-Bromopropene	9.70	Chloroethene	10.00
2-Bromothiophene	8.63	2-Chloroethoxyethene	10.61
o-Bromotoluene	8.79	1-Chloro-2-Fluorobenzene	9.16
m-Bromotoluene	8.81	1-Chloro-3-Fluorobenzene	9.21
p-Bromotoluene	8.67	cis-1-Chloro-2-Fluoroethene	9.87
1,3-Butadiene	9.07	trans-1-Chloro-2-Fluoroethene	9.87
2,3-Butadione	9.23	Chloroform *	11.37

o-Chloroiodobenzene	8.35	Dicyclopentadiene	7.74
Chloromethylethyl Ether	10.08	Diethoxymethane	9.70
Chloromethylmethyl Ether	10.25	Diethylamine	8.01
1-Chloro-2-Methylpropane	10.66	Diethylamino Ethanol	8.58
1-Chloropropane *	10.82	Diethyl Ether	9.53
2-Chloropropane *	10.78	Diethyl Ketone	9.32
3-Chloropropene	10.04	Diethyl Sulfide	8.43
2-Chlorothiophene	8.68	1,2-Difluorobenzene	9.31
o-Chlorotoluene	8.83	1,4-Difluorobenzene	9.15
m-Chlorotoluene	8.83	Difluoromethylbenzene	9.45
p-chlorotoluene	8.70	Diiodomethane	9.34
o-Cresol	8.48	Diisobutyl Ketone	9.04
m-cresol	8.48	Diisopropylamine	7.73
p-Cresol	8.48	1,1-Dimethoxyethane	9.65
Crotonaldehyde	9.73	Dimethoxymethane	10.00
Cumene (Isopropylbenzene)	8.75	Dymethylamine	8.24
Cyanoethene *	10.91	Dimethylaniline	7.13
Cyanogen Bromide *	10.91	2,3-Dimethylbutadiene	8.72
3-Cyanopropene	10.39	2,2-Dimethylbutane	10.06
Cyclobutane	10.50	2,3-Dimethylbutane	10.02
Cyclohexane	9.98	2,2-Dimethylbutan-3-one	9.18
Cyclohexanol	10.00	3,3-Dimethylbutanone	9.17
Cyclohexanone	9.14	2,3-Dimethyl-2-Butene	8.30
Cyclohexene	8.95	Dimethyl Disulfide (DMDS)	8.46
Cyclo-Octatetraene	7.99	Dimethyl Ether	10.00
Cyclopentadiene	8.55	3,5-Dimethyl-4-Heptanone	9.04
Cyclopentane	10.52	1,1-Dimethylhydrazine	8.88
Cyclopentanone	9.26	2,2-Dimethyl-3-Pentanone	8.98
Cyclopentene	9.01	2,2-Dimethylpropane	10.35
Cyclopropane	10.06	Dimethyl Sulfide (DMS)	8.69
2-Decanone	9.40	Di-n-Propylamine	7.84
Dibromochloromethane	10.59	Di-n-Propyl Disulfide	8.27
1,1-Dibromoethane	10.19	Di-n-Propyl Ether	9.27
Dibromomethane	10.49	Di-i-Propyl Ether	9.20
1,2-Dibromopropane	10.26	Di-n-Propyl Sulfide	8.30
Dibutylamine	7.69	Epichlorohydrin	10.60
1,2-Dichlorobenzene	9.07	Ethane *	11.65
1,1-Dichloroethane *	11.06	Ethanethiol (Ethyl Mercaptan)	9.29
1,2-Dichloroethane *	11.04	Ethanol	10.62
1,1-Dichloroethene	10.00	Ethanolamine	9.87
cis-1,2-Dichloroethene	9.65	Ethene (Ethylene)	10.52
trans-1,2-Dichloroethene	9.66	Ethyl Acetate	10.11
Dichloromethane *	11.35	Ethylamine	8.86
1,2-Dichloropropane *	10.87	Ethyl Amyl Ketone	9.10
1,3-Dichloropropane *	10.85	Ethylbenzene	8.76
1,1-Dichloropropanone	9.71	Ethyl Bromide	10.29
2,3-Dichloropropene	9.82	Ethyl Butyl Ketone	9.02

Ethyl Chloroacetate	10.20
Ethyl Disulfide	8.27
Ethyl Ethanoate	10.10
Ethyl Ether	9.41
Ethylene Chlorohydrin	10.90
Ethylene Dibromide (EDB)	10.37
Ethylene Oxide	10.56
Ethyl Formate	10.61
Ethyl Iodide	9.33
Ethyl Isothiocyanate	9.14
Ethyl Methanoate	10.61
Ethyl Methyl Sulfide	8.55
Ethyl Propanoate	10.00
Ethyl Trichloroacetate	10.44
mono-Fluorobenzene	9.20
mono-Fluoroethene	10.37
mono-Floromethanal	11.40
Fluorotribromomethane	10.67
o-Fluorotoluene	8.92
m-Fluorotoluene	8.92
p-Fluorotoluene	8.79
Furan	8.89
Furfural	9.21
n-Heptane	10.07
2-Heptanone	9.33
4-Heptanone	9.12
n-Hexane	10.18
2-Hexanone	9.44
1-Hexene	9.46
Hydrogen Selenide	9.88
Hydrogen Sulfide	10.46
Hydrogen Telluride	9.14
Iodobenzene	8.73
1-Iodobutane	9.21
2-Iodobutane	9.09
Iodoethane (Ethyl Iodide)	9.33
Iodomethane (Methyl Iodide)	9.54
1-Iodo-2-Methylpropane	9.23
1-Iodopentane	9.19
1-Iodopropane	9.26
2-Iodopropane	9.17
o-Iodotoluene	8.62
m-Iodotoluene	8.61
p-Iodotoluene	8.50
Isoamyl Acetate	9.90
Isoamyl Alcohol	10.16
Isobutane	10.57
Isobutanol	10.47
Isobutyl Acetate	9.97
Isobutyl Alcohol	10.47
Isobutylamine	8.70
Isobutylbenzene	8.68
Isobutylene	9.43
Isobutyl Ethanoate	9.95
Isobutyl Formate	10.46
Isobutyl Mercaptan	9.12
Isobutyl Methanoate	10.46
Isobutyraldehyde	9.74
Isopentane	10.32
Isoprene	8.85
Isopropyl Acetate	9.99
Isopropyl Alcohol	10.16
Isopropylamine	8.72
Isopropylbenzene	8.75
Isopropyl Ether	9.20
Isovaleraldehyde	9.71
Ketene	9.61
Mesitylene	8.40
Mesityl Oxide	9.08
Methyl Acetate	10.27
Methylamine	8.97
Methyl Bromide	10.53
2-Methyl-1,3-Butadiene	8.85
2-Methylbutanal	9.71
2-Methylbutane	10.31
2-Methyl-1-Butene	9.12
3-Methyl-1-Butene	9.51
3-Methyl-2-Butene	8.67
Methyl n-Butyl Ketone	9.34
Methyl Butyrate	10.07
Methyl Chloroacetate	10.35
Methylchloroform *	11.25
Methylcyclohexane	9.85
Methylcyclohexanol	9.80
Methylcyclohexanone	9.05
4-Methylcyclohexene	8.91
Methylcyclopropane	9.52
Methyl Dichloroacetate	10.44
Methyl Ethanoate	10.27
Methyl Ethyl Ketone	9.53
Methyl Ethyl Sulfide	8.55
2-Methyl Furan	8.39
Methyl Iodide	9.54
Methyl Isobutyl Ketone	9.30

Methyl Isobutyrate	9.98
Methyl Isopropyl Ketone	9.32
Methyl Mercaptan	9.44
Methyl Methacrylate	9.74
2-Methylpentane	10.12
3-Methylpentane	10.08
2-Methylpropanal	9.74
2-Methylpropane	10.56
2-Methyl-2-Propanol	9.70
2-Methylpropene	9.23
Methyl n-Propyl Ketone	9.39
Methyl Styrene	8.35
Napthalene	8.10
Nitric Oxide	9.25
Nitrobenzene	9.92
p-Nitrochlorobenzene	9.96
5-Nonanone	9.10
3-Octanone	9.19
4-Octanone	9.10
1-Octene	9.52
cis-1,3-Pentadiene	8.59
trans-1,3-Pentadiene	8.56
n-Pentanal	9.82
n-Pentane	10.53
2,4-Pentanedione	8.87
2-Pentanone	9.39
3-Pentanone	9.32
1-Pentene	9.50
Perfuoro-1-Heptene	10.48
n-Perfuoropropyl Iodide	10.36
n-Perfuoropropyl-Iodomethane	9.96
n-Perfuoropropyl-Methyl Ketone	10.58
Phenol	8.69
Phenyl Ether	8.09
Phenyl Isocyanate	8.77
Phosphine	9.96
Pinene	8.07
Propadiene	10.19
n-Propanal	9.95
Propane *	11.07
1-Propanethiol (n-Propyl Mercaptan)	9.20
n-Propanol	10.51
Propanone	9.69
Propene	9.73
Prop-1-ene-2-ol	8.20
Prop-2-ene-1-ol	9.67
Propionaldehyde	9.98
n-Propyl Acetate	10.04
n-Propyl Alcohol	10.51
n-Propylamine	8.78
n-Propylbenzene	8.72
Propylene	9.73
Propylene Imine	8.76
Propylene Oxide	10.22
n-Propyl Ether	9.27
n-Propyl Formate	10.54
Propyne	10.36
Pyridine	9.32
Styrene	8.47
Tetrachloroethylene (PCE)	9.32
Tetrafluoroethene	10.12
Tetrahydrofuran	9.54
Thioethanol	9.29
Thiomethanol	9.44
Thiophene	8.86
1-Thiopropanol	9.20
Toluene	8.82
o-Toluidine	7.44
Tribromoethene	9.27
1,1,1-Trichlorobutanone	9.54
1,1,1-Trichloroethane *	11.25
Trichloroethylene (TCE)	9.45
Trichloromethyl Ethyl Ether	10.08
Triethylamine	7.50
1,2,4-Trifluorobenzene	9.37
1,3,5-Trifluorobenzene	9.32
Trifluoroethene	10.14
1,1,1-Trifluoro-2-Iodoethane	10.10
Trifluoroiodomethane	10.40
Trifluoromethylbenzene	9.68
Trifluoromethylcyclohexane	10.46
1,1,1-Trifluoropropene	10.90
Trimethylamine	7.82
2,2,4-Trimethyl Pentane	9.86
2,2,4-Trimethyl-3-Pentanone	8.82
n-Valeraldehyde	9.82
Vinyl Acetate	9.19
Vinyl Bromide	9.80
Vinyl Chloride	10.00
4-Vinylcyclohexene	8.93
Vinyl Ethanoate	9.19
Vinyl Fluoride	10.37
Vinyl Methyl Ether	8.93
o-Vinyl Toluene	8.20

o-Xylene	8.56	n-Valeraldehyde	9.82
m-Xylene	8.56	Vinyl Acetate	9.19
p-Xylene	8.45	Vinyl Bromide	9.80
2,4-Xylidine	7.65	Vinyl Chloride	10.00
Trifluoroethene	10.14	4-Vinylcyclohexene	8.93
1,1,1-Trifluoro-2-Iodoethane	10.10	Vinyl Ethanoate	9.19
Trifluoroiodomethane	10.40	Vinyl Fluoride	10.37
Trifluoromethylbenzene	9.68	Vinyl Methyl Ether	8.93
Trifluoromethylcyclohexane	10.46	o-Vinyl Toluene	8.20
1,1,1-Trifluoropropene	10.90	o-Xylene	8.56
Trimethylamine	7.82	m-Xylene	8.56
2,2,4-Trimethyl Pentane	9.86	p-Xylene	8.45
2,2,4-Trimethyl-3-Pentanone	8.82	2,4-Xylidine	7.65

* Using an 11.7 eV lamp instead of the standard 10.6 eV lamp may enhance the sensitivity of the miniPID sensor to these compounds.

Many compounds, not appearing in this list, that have an ionization potential of 10.6 eV or less may also be detectable.

Some of the ionization potential data is from Photovac Inc. Technical Bulletin No. 11.

Ionization potentials for several other compounds can be found in Ionization Potential and Appearance Potential Measurements, 1971-1981, R. D. Levin and S. G. Lias, National Bureau of Standards, Washington, D.C., October 1982.