miniPID

200C

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1 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 50 ppb (parts per billion) propylene gas in air and the full-scale measurement range is 600 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 and electrons are collected on 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 A contains a list of the ionization potentials of many common substances.

Figure 1 200C Controller

Figure 2 200C miniPID Sensor Short Mount

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.

Figure 3 200C miniPID Sensor Long Mount

2 Quick Start Guide

This quick start guide will provide you with basic information that will allow you to get your new 200C miniPID up and running as quickly as possible.

2.1 Package Contents

The 200C miniPID was shipped in a single box. Unpack the box and check the contents against the list provided below. If there are any issues with what you received, please contact Aurora Scientific as soon as possible.

Item	*Description*
200C Controller	Main controller including power supply pre-set to the power used in your country, suction pump, control electronics, and a 2U, ½-rack, rack-mountable enclosure.
251A 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.
200C-S or 200C-L Sensor Head	The sensor head contains the ultra violet (UV) lamp, lamp drive electronics, sample inlet, detection cell, and a pre-amplifier.
200C Series Accessories	Accessories include power cord, tubing, fittings, and some tools.

Table 1 Items included with a 200C Series Force Transducer

For further description of the components of the system, see Section 3.1.

2.2 First Time Operation of the 200C miniPID

1. The sensor head can be configured with a short or long mount. The short mount includes a side plate that includes ¼-20 tapped holes in two directions (this is the same thread that is used on cameras). The tapped holes can be used to attach the head to experimental apparatus or to a standard camera tripod. The long mount includes a rear plate with a ¼-20 tapped hole and a rod with a ¼-20 threaded end. The rod can be screwed into the rear plate and then a standard lab clamp, or other user supplied clamp, can be used to grasp the rod, and thereby 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 this 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. **Note: The sensor has not been designed for exposure to weather.**

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 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 1,000Hz. It is recommended that the ADC sampling frequency be set to at least 4 times the cut-off frequency of the low-pass filter (4,000Hz sampling frequency). Over sampling is crucial if aliasing of the data is to be avoided.

*Photo 1 miniPID sensor in use at Prof. Ring Carde's lab,
Dept. of Entomology, University of California, Riverside.*

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 Pump switch to the High flow rate setting and ensure the Flow Adjust knob is fully closed (turned fully clockwise). This will provide the maximum flow rate and the fastest response for the instrument.

6. With the sensor drawing clean air, depress the Zero pushbutton to zero the output. The zero procedure takes a few seconds and when it is complete the Zero LED will light. Note: the instrument has been adjusted at the factory so that the zero LED is illuminated green if the output is within 50mV of zero.

7. Release a tracer gas and observe the signals on the front panel LED indicator. Adjust the tracer flow rate or sensor flow rate until signals can be seen which illuminate most of the LEDs. An Offscale red LED is included next to the meter to indicate signals that exceed 10 volts. If the red LED turns on, then lower the source strength of the tracer gas until it turns off. Note: if the tracer gas is release into free air, then the miniPID output will appear very unstable (rapidly increasing and decreasing signal that may appear to be noise), this is normal as the instrument is measuring

the high frequency concentration fluctuations in the dispersing plume of tracer gas. For the purposes of determining correct operation, or for calibration, it is recommended that the tracer be delivered to the head through a 1/8” ID tube placed loosely over the inlet needle on the head. This ensures no entrainment of air in the tracer gas and therefore no concentration fluctuations.

8. It is normal for the output of the miniPID to drift slightly with time. This drift occurs mainly in the sensor head circuitry.

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 exiting 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 accessories. Use a 1/4" OD by 1/8" ID vinyl tube to connect the exhaust fitting to the test chamber or other location where you want the flow to exit to.

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 chapter 4 for the calibration procedure.

3 General Operating Procedure

3.1 Description of System Components

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 0.84mm (0.033") inside diameter. The length of the inlet was chosen to place the sampling point well away from potential flow disturbances caused by flow over 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 2.54cm x 5.1cm x 7.6cm (1" x 2" x3 ").

Mounting

The 200C miniPID is offered in two variants, differing only in the way they are mounted to the experimental setup. The long version includes a 0.95cm (0.375") diameter by 15cm (6") long mounting rod which attaches to the rear of the miniPID sensor head and can be used to hold the sensor in the desired position using standard laboratory retort stand and clamp. The short mount includes a side plate that includes ¼”-20 tapped holes in two directions (this is the same thread that is used on cameras). The tapped holes can be used to attach the head to experimental apparatus or to a standard camera tripod.

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 305cm (120") long which allows the controller to be mounted outside of a wind tunnel or test chamber as required.

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, zero the instrument, and set the pump flowrate. A single push of the Zero push button will zero the output of the instrument to 0.00±0.05V. LED status lights are provided that indicate power on, lamp on, sensor zeroed and output Offscale. A series of LEDs is included to provide a real-time indication of signal level. The connections to the sensor head both electrical and air suction are on the front panel. Also included is a flow adjust knob that opens a valve to lower the pump flowrate for either of the two pump flowrates (High or Low). This valve provides very precise control of the flowrate through the sensor head. In experiments where the flowrate through the sensor must be tightly controlled a combination of pump flow switch setting and valve setting will allow the experimenter to achieve any flowrate in the range 300-1500 SCCM. 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.

3.2 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 many high-pressure cylinders), is non-toxic, has EPA approvals for outdoor dissemination, 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 greater level of safety since, under normal conditions, the concentration can never rise to explosive levels.

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

3.3 Troubleshooting

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

Table 3.2 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 and replace it if blown. 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 purple 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 cannot be heard running.	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 connector that mates with a two-pin connector on the circuit 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 may be jammed or broken and the pump will need repair. Contact Aurora Scientific Inc. for assistance.

Table 3.2 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 quick connector is attached to the sensor head. 3. Check the inlet needle for blockages (see section 4.1 for procedure). 4. Disconnect the sample line at the head and check for flow at the connector. If there is no flow then the sample line between the controller and the sensor head is blocked or damaged, check 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. 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). 3. Ensure that the concentration of the tracer gas delivered to the sensor is greater than 100ppb propylene equivalent. 4. 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. 5. With the sensor on, remove the lamp screw and look into the lamp cavity, the lamp should be glowing a purple colour, if the lamp is not on or the colour is orange, then the lamp needs replacement.
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. Press the "Zero" pushbutton to zero the sensor.
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. Press the "Zero" pushbutton to zero the sensor.
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 (delivered directly to the inlet needle through a 1/8” ID tube that is placed loosely over the inlet needle) or with the suction tube disconnected from the sensor head. 2. If the background noise is above the typical noise level (2 mV) then clean the lamp and the detection cell. Re-tune the lamp by adjusting the lamp run voltage.

Technical support is available by regular mail, email, phone, or fax. See Chapter 5.3 for technical support contact information.

4 Calibration, Instrument Tuning and Maintenance

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 affect 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

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 a1, a2, a3 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. 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 1.6mm (1/16") ID tube be used to deliver the calibration gas to the inlet needle. Insert the needle 6-12mm (1/4"-1/2") into the end of the 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 which results in an output value which is greater than it should be. Thus it is critical to measure the inlet flowrate of the sensor before calibration and then set the flowrate of the calibration gas to ~1.1X the sensor flowrate.

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. 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.
3. Zero the sensor.
4. Record the output voltage.
5. Deliver a low gas concentration to the sensor and record the output voltage.
6. Repeat step (5) with successively higher calibration gas concentrations. It is recommended to calibrate the sensor over the expected range of concentrations expected during the experiment. For more accurate calibration we suggest a minimum of 4 data points be collected (including the zero value).
7. Plot the voltage versus concentration and fit a 2nd order polynomial to the data. To eliminate the zero offset we suggest that the zero-output voltage be subtracted from all measurements prior to fitting the polynomial.

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). At the factory we use three calibrated gas mixtures plus zero air to perform calibrations. The concentrations we use are 10, 100 and 1000ppm propylene in zero air. Due to accuracy limitations of the rotameters, we typically don’t attempt to reduce the concentration to less than 20% of the nominal concentrations (i.e., for the 100ppm cylinder we would set concentrations in the range of 20ppm to 100ppm during a calibration). For concentrations less than 20ppm we would switch to the 10ppm mixture. Likewise for concentrations above 100ppm, we would use the 1000ppm mixture in the range of 200ppm to 1000ppm. Note that the total flow must be maintained at approximately 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 4.1.2 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 4.1.1.

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

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 Lamp Run) 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 the controller. This will expose the controller circuit board.
2. Locate the potentiometer labelled PT1 Lamp Run 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 AC power cord to the controller. Avoid touching the power supply located at the back of the controller box as AC voltages are present at this power supply.
4. 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 Out BNC connector on the front of the miniPID controller.
6. Use the Zero pushbutton on the front panel of the controller to zero the output signal level (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 ensure that the tube does not fit snugly on the inlet tube of the sensor (you 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 Maintenance

4.3.1 Pump

A rotary vane 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 liters 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 in the accessories kit). 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 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.

4.3.2 Detection Cell Cleaning

CAUTION

HIGH VOLTAGE (600VDC) 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, is to use the results of successive calibrations. If the calibration gets 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.

5 Performance Guarantee, Technical Support, Warranty and Repair Information

Aurora Scientific is dedicated to providing you with products that allow you to meet your research goals. For this reason, we offer a performance guarantee, technical support and a new product warranty. Our performance guarantee ensures you purchase the correct instrument for your research. 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 Aurora Scientific 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.

5.1 Performance Guarantee

Our performance guarantee states: if for any reason a new product does not meet your research needs then you can return it to Aurora Scientific for exchange or a full refund. The performance guarantee only applies to new products and must be exercised within 60 days of receipt of the instrument.

5.2 Technical Support

Technical assistance is always free and will be available for the life of your product. Please don't hesitate to contact us if you have any technical support issues. Contact us by telephone, email, fax, or regular mail.

5.3 Technical Support Contact Information and Return Shipping Addresses

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Email (all Aurora Scientific Offices): techsupport@aurorascientific.com
Web Site: www.AuroraScientific.com

Europe
Aurora Scientific Europe
Landscape House, Landscape Road
Churchtown, Dublin
D14 A6P3 Ireland
Attn: RMA Returns
Tel: +353-1-525-3300
Fax: +353-1-443-0784

Asia, Australia, New Zealand
Aurora Scientific Asia
Unit B, 10/F
Charmhill Centre
50 Hillwood Road
Tsimshatsui, Kowloon, Hong Kong
Attn: RMA Returns
Tel: +852-3188-9946
Fax: +852-2724-2633

Distributors
Japan
Kantoh Electronics Co., Ltd.
1-25-14, Nakacho, Meguro-ku
Tokyo, 153-0065, Japan
Tel: +81-03-5773-5028
Fax: +81-03-5773-5029
Email: info@Kantoh-elec.co.jp
Web site: http://www.kantoh-elec.co.jp

5.4 Warranty

Products manufactured by Aurora Scientific Inc. are guaranteed to the original purchaser for a period of three (3) years. Under this warranty, the liability of Aurora Scientific is limited to servicing, adjusting and replacing any defective parts that are of Aurora Scientific manufacture. Aurora Scientific 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 Aurora Scientific.

Guarantee of parts and components not manufactured by Aurora Scientific shall be the same as the guarantee extended by the manufacturer of such components or parts. Where possible such parts returned to Aurora Scientific 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 Aurora Scientific products, provided the products are returned to Aurora Scientific and are demonstrated to the satisfaction of Aurora Scientific to be defective.

Transportation costs of all products returned to Aurora Scientific must be borne by the customer and products must be returned to Aurora Scientific within three years after delivery to the original purchaser. Aurora Scientific cannot assume responsibility for repairs or changes not authorized by Aurora Scientific 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 AURORA SCIENTIFIC INC, AND NO WAIVER, ALTERATION OR MODIFICATION OF THE FOREGOING CONDITIONS

SHALL BE VALID UNLESS MADE IN WRITING AND SIGNED BY AN EXECUTIVE OFFICER OF AURORA SCIENTIFIC INC.

5.5 Returning Products to Aurora Scientific for Repair

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

1. Obtain a Return Material Authorization number (RMA#).

Contact our technical support department to obtain an 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.

Asia, Australia and New Zealand Clients: no customs documents are required, skip to step 4 and ship to Aurora Scientific Asia.

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 300B Muscle Lever System, Serial Number 1111), 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.

Asia, Australia and New Zealand Clients: ship your instrument to Aurora Scientific Asia in Hong Kong.

Canadian, USA and all other Clients: ship your instrument to Aurora Scientific in Ontario, 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 email us the purchase order at your earliest convenience.

6 Specifications

Model #	200C
Resolution [ppb][1] (propylene)	50.0
Maximum Concentration [ppm][2] (propylene)	625
Output[3] [V] (@100ppm propylene)	2.00 ± 0.25
Rise Time[4] [millisecond]	1.00
Impulse Frequency Response[5] [Hz]	330
Precision [%]	5
Sampling Flowrate[6] [SCCM][7]	High: 1500 - 700 Low: 900 - 300
Suction Inlet Tube Diameter [mm]	0.84
Detector Technology	Photoionization
Lamp Type	10.6 eV, RF-excited UV Electrodeless Discharge
General Specifications	
Operating Temperature [°C]	10 – 40
Operating Humidity [%RH]	0 to 80 (non-condensing)
Power Required	100, 120, 220, 240 VAC, 50/60 Hz. available
Power Consumption [W]	20
Controller Weight [kg]	3.1
Head Weight [g]	170
Head Dimensions [cm]	2.5W x 7.6L x 5.1H
Controller Dimensions [cm]	21W (1/2 rack mount) x 25D x 9H (2U)

[1] Parts per billion
[2] Parts per million
[3] Head warmed up and stabilized (30 minutes) at room temperature.
[4] 1 to 99%; Flow Adjust valve fully closed, and flow switch set to high.
[5] -3dB point
[6] Flow Adjust valve Closed - Open
[7] Standard Cubic Centimeters per Minute

7 Appendix A - 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	Diethylamine	8.01
Chloromethylethyl Ether	10.08	Diethylamino Ethanol	8.58
Chloromethylmethyl Ether	10.25	Diethyl Ether	9.53
1-Chloro-2-Methylpropane	10.66	Diethyl Ketone	9.32
1-Chloropropane *	10.82	Diethyl Sulfide	8.43
2-Chloropropane *	10.78	1,2-Difluorobenzene	9.31
3-Chloropropene	10.04	1,4-Difluorobenzene	9.15
2-Chlorothiophene	8.68	Difluoromethylbenzene	9.45
o-Chlorotoluene	8.83	Diiodomethane	9.34
m-Chlorotoluene	8.83	Diisobutyl Ketone	9.04
p-chlorotoluene	8.70	Diisopropylamine	7.73
o-Cresol	8.48	1,1-Dimethoxyethane	9.65
m-cresol	8.48	Dimethoxymethane	10.00
p-Cresol	8.48	Dymethylamine	8.24
Crotonaldehyde	9.73	Dimethylaniline	7.13
Cumene (Isopropylbenzene)	8.75	2,3-Dimethylbutadiene	8.72
Cyanoethene *	10.91	2,2-Dimethylbutane	10.06
Cyanogen Bromide *	10.91	2,3-Dimethylbutane	10.02
3-Cyanopropene	10.39	2,2-Dimethylbutan-3-one	9.18
Cyclobutane	10.50	3,3-Dimethylbutanone	9.17
Cyclohexane	9.98	2,3-Dimethyl-2-Butene	8.30
Cyclohexanol	10.00	Dimethyl Disulfide (DMDS)	8.46
Cyclohexanone	9.14	Dimethyl Ether	10.00
Cyclohexene	8.95	3,5-Dimethyl-4-Heptanone	9.04
Cyclo-Octatetraene	7.99	1,1-Dimethylhydrazine	8.88
Cyclopentadiene	8.55	2,2-Dimethyl-3-Pentanone	8.98
Cyclopentane	10.52	2,2-Dimethylpropane	10.35
Cyclopentanone	9.26	Dimethyl Sulfide (DMS)	8.69
Cyclopentene	9.01	Di-n-Propylamine	7.84
Cyclopropane	10.06	Di-n-Propyl Disulfide	8.27
2-Decanone	9.40	Di-n-Propyl Ether	9.27
Dibromochloromethane	10.59	Di-i-Propyl Ether	9.20
1,1-Dibromoethane	10.19	Di-n-Propyl Sulfide	8.30
Dibromomethane	10.49	Epichlorohydrin	10.60
1,2-Dibromopropane	10.26	Ethane *	11.65
Dibutylamine	7.69	Ethanethiol (Ethyl Mercaptan)	9.29
1,2-Dichlorobenzene	9.07	Ethanol	10.62
1,1-Dichloroethane *	11.06	Ethanolamine	9.87
1,2-Dichloroethane *	11.04	Ethene (Ethylene)	10.52
1,1-Dichloroethene	10.00	Ethyl Acetate	10.11
cis-1,2-Dichloroethene	9.65	Ethylamine	8.86
trans-1,2-Dichloroethene	9.66	Ethyl Amyl Ketone	9.10
Dichloromethane *	11.35	Ethylbenzene	8.76
1,2-Dichloropropane *	10.87	Ethyl Bromide	10.29
1,3-Dichloropropane *	10.85	Ethyl Butyl Ketone	9.02
1,1-Dichloropropanone	9.71	Ethyl Chloroacetate	10.20
2,3-Dichloropropene	9.82	Ethyl Disulfide	8.27
Dicyclopentadiene	7.74	Ethyl Ethanoate	10.10
Diethoxymethane	9.70	Ethyl Ether	9.41

Ethylene Chlorohydrin	10.90	Isobutyl Ethanoate	9.95
Ethylene Dibromide (EDB)	10.37	Isobutyl Formate	10.46
Ethylene Oxide	10.56	Isobutyl Mercaptan	9.12
Ethyl Formate	10.61	Isobutyl Methanoate	10.46
Ethyl Iodide	9.33	Isobutyraldehyde	9.74
Ethyl Isothiocyanate	9.14	Isopentane	10.32
Ethyl Methanoate	10.61	Isoprene	8.85
Ethyl Methyl Sulfide	8.55	Isopropyl Acetate	9.99
Ethyl Propanoate	10.00	Isopropyl Alcohol	10.16
Ethyl Trichloroacetate	10.44	Isopropylamine	8.72
mono-Fluorobenzene	9.20	Isopropylbenzene	8.75
mono-Fluoroethene	10.37	Isopropyl Ether	9.20
mono-Floromethanal	11.40	Isovaleraldehyde	9.71
Fluorotribromomethane	10.67	Ketene	9.61
o-Fluorotoluene	8.92	Mesitylene	8.40
m-Fluorotoluene	8.92	Mesityl Oxide	9.08
p-Fluorotoluene	8.79	Methyl Acetate	10.27
Furan	8.89	Methylamine	8.97
Furfural	9.21	Methyl Bromide	10.53
n-Heptane	10.07	2-Methyl-1,3-Butadiene	8.85
2-Heptanone	9.33	2-Methylbutanal	9.71
4-Heptanone	9.12	2-Methylbutane	10.31
n-Hexane	10.18	2-Methyl-1-Butene	9.12
2-Hexanone	9.44	3-Methyl-1-Butene	9.51
1-Hexene	9.46	3-Methyl-2-Butene	8.67
Hydrogen Selenide	9.88	Methyl n-Butyl Ketone	9.34
Hydrogen Sulfide	10.46	Methyl Butyrate	10.07
Hydrogen Telluride	9.14	Methyl Chloroacetate	10.35
Iodobenzene	8.73	Methylchloroform *	11.25
1-Iodobutane	9.21	Methylcyclohexane	9.85
2-Iodobutane	9.09	Methylcyclohexanol	9.80
Iodoethane (Ethyl Iodide)	9.33	Methylcyclohexanone	9.05
Iodomethane (Methyl Iodide)	9.54	4-Methylcyclohexene	8.91
1-Iodo-2-Methylpropane	9.23	Methylcyclopropane	9.52
1-Iodopentane	9.19	Methyl Dichloroacetate	10.44
1-Iodopropane	9.26	Methyl Ethanoate	10.27
2-Iodopropane	9.17	Methyl Ethyl Ketone	9.53
o-Iodotoluene	8.62	Methyl Ethyl Sulfide	8.55
m-Iodotoluene	8.61	2-Methyl Furan	8.39
p-Iodotoluene	8.50	Methyl Iodide	9.54
Isoamyl Acetate	9.90	Methyl Isobutyl Ketone	9.30
Isoamyl Alcohol	10.16	Methyl Isobutyrate	9.98
Isobutane	10.57	Methyl Isopropyl Ketone	9.32
Isobutanol	10.47	Methyl Mercaptan	9.44
Isobutyl Acetate	9.97	Methyl Methacrylate	9.74
Isobutyl Alcohol	10.47	2-Methylpentane	10.12
Isobutylamine	8.70	3-Methylpentane	10.08
Isobutylbenzene	8.68	2-Methylpropanal	9.74
Isobutylene	9.43	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
m-Xylene	8.56
p-Xylene	8.45
2,4-Xylidine	7.65
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	Vinyl Ethanoate	9.19
2,2,4-Trimethyl Pentane	9.86	Vinyl Fluoride	10.37
2,2,4-Trimethyl-3-Pentanone	8.82	Vinyl Methyl Ether	8.93
n-Valeraldehyde	9.82	o-Vinyl Toluene	8.20
Vinyl Acetate	9.19	o-Xylene	8.56
Vinyl Bromide	9.80	m-Xylene	8.56
Vinyl Chloride	10.00	p-Xylene	8.45
4-Vinylcyclohexene	8.93	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.