## O2100C Oxygen Measurement Module

The O2100C module measures the partial pressure of O2 and thus the module output is proportional to the pressure in the sample cell.

- Gas sampled must be free of liquids or any condensable vapors.
- Gas should be filtered to 5 microns or better.

### *Technical Use Notes*

1. Snap the O2100C module together with the UIM100C (or other BIOPAC modules). Be sure to select an unused channel on the channel selector switch on top of the module. If two or more BIOPAC modules are set to the same channel, the outputs will conflict, resulting in erroneous readings.
2. Turn on the MP150/MP100 unit and start up the Acq*Knowledge* software. Please consult the "MP System Guide" for more information about running Acq*Knowledge*.
3. Plug the adapter into the main power and insert the adapter plug into the back of the O2100Cmodule. The O2100C module is supplied with a 12 vdc @ 1 amp wall adapter**—do not use other wall adapters with the O2100Cmodule.**
4. The green POWER LED should light up. If it doesn't, check the adapter main power and the connection to the O2100C module. If all looks OK, then check the FUSE on the back of the O2100C module. [The FUSE ratings are: Instrumentation Type, Fast Blow @ 2 amps.]
5. The O2100C module has a warm-up time of approximately 5 minutes. Output readings during this warm-up period will be very erratic.

   If the green POWER LED comes on, check for pump operation by turning the PUMP switch ON. You should hear a humming from the box, indicating that the pump is working. Generally, you will never have to adjust the PUMP SPEED control.

   The PUMP will start fast, then slow down and stabilize on a speed after a few seconds. This is a perfectly normal process, designed to overcome the pump's initial mechanical hysteresis.

   If the pump does not come on or comes on for a brief period and then shuts off, the PUMP SPEED control is set to a very low value (i.e., zero speed). To change the pump speed, use a small straight blade screwdriver to turn the recessed potentiometer in the PUMP SPEED control.

   To increase PUMP speed: Turn trim POT clockwise.

   To decrease PUMP speed: Turn trim POT counter-clockwise.

   Keep the PUMP switch in the ON position as you change the PUMP SPEED control.
6. If everything is OK so far, adjust the GAIN switch on the front of the O2100C module. Set the GAIN for the range desired. Generally, you should have no trouble if you leave the GAIN at the minimum setting of 10% carbon dioxide per volt (top position).

   The GAIN ranges imply the following:

   | | |
   |---|---|
   | **10% / V** | One volt output equals 10% carbon dioxide concentration<br>Voltage output range is from 0 to 1 volt |
   | **5% / V** | One volt output equals 5% carbon dioxide concentration<br>Voltage output range is from 0 to 2 volts |
   | **2% / V** | One volt output equals 2% carbon dioxide concentration<br>Voltage output range is from 0 to 5 volts |
   | **1% / V** | One volt output equals 1% carbon dioxide concentration<br>Voltage output range is from 0 to 10 volts |

   For example, if the **10% / V** setting is used, then 4% carbon dioxide (approximate concentration in expired breath) will be output as: 0.40 volts or 400 mV.

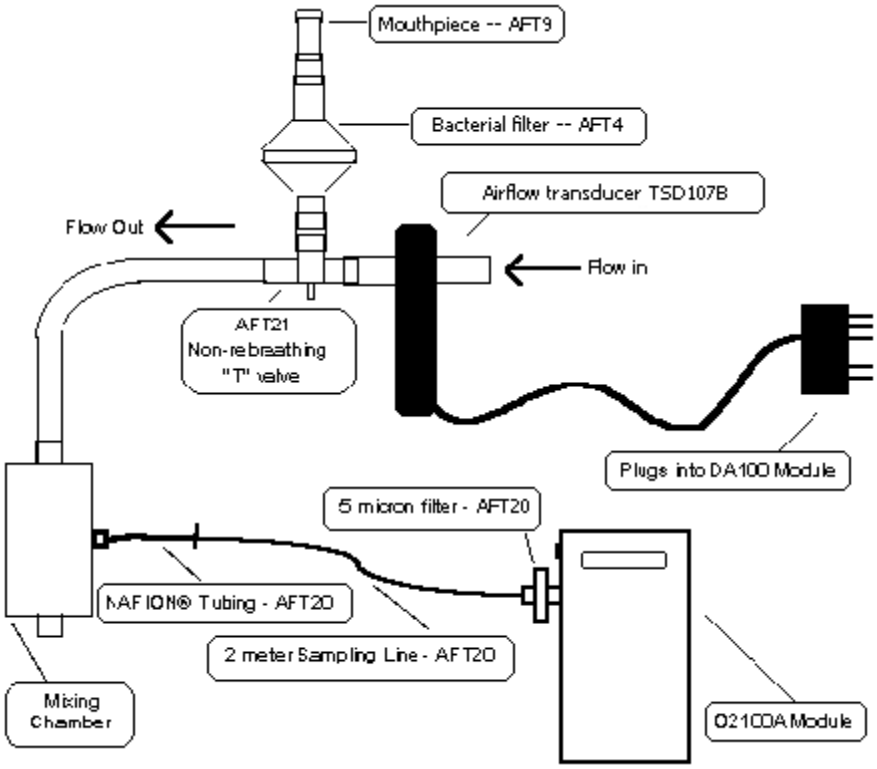
### *Gas Sampling Setup*

1. Stabilize the measurement setup prior to sampling any gases.
   Pump speed, filters and sampling lines all affect the oxygen measurement of the O2100C module. Everything should be stable prior to attempting a O2100C module calibration.
2. Attach a 5 micron filter (or better) on the sample input port prior to sampling any gases.
   The sample input port is a male Luer fitting on the front of the O2100C module. The O2100C module incorporates an internal particulate filter, however the addition of this external filter will extend the life of the internal filter and otherwise improve the long-term performance of the O2100C module. Always use a 5 micron hydrophobic sampling filter (or better) at the sampling input of the O2100C module. One is included with each O2100C module and each Gas Sampling Interface Kit (AFT20). The 5-micron hydrophobic filter will help to protect the O2100C module from airborne particulate matter and other contaminants.
3. Screw a 10/32 Luer adapter into the bulkhead fitting and attach the venting line to the Luer adapter to vent undesirable gases away from the site of the O2100C module.
   The sample output port is adjacent to the sample input port (on the right, facing the front panel of the module) and is a bulkhead fitting with a 10/32 internal thread.

## Important

Sample dry gases only. All water vapor needs to be removed from the sampling stream prior to being monitored by the O2100C module. To dry the sampling stream, use water vapor permeable tubing (i.e. NAFION®). The AFT20 Gas Sampling Interface Kit includes all the items necessary (including NAFION® tubing) to efficiently connect the O2100C module to the sampling chamber.

The following diagram illustrates a typical connection for the O2100Cmodule to a mixing chamber, AFT21 and TSD107B:

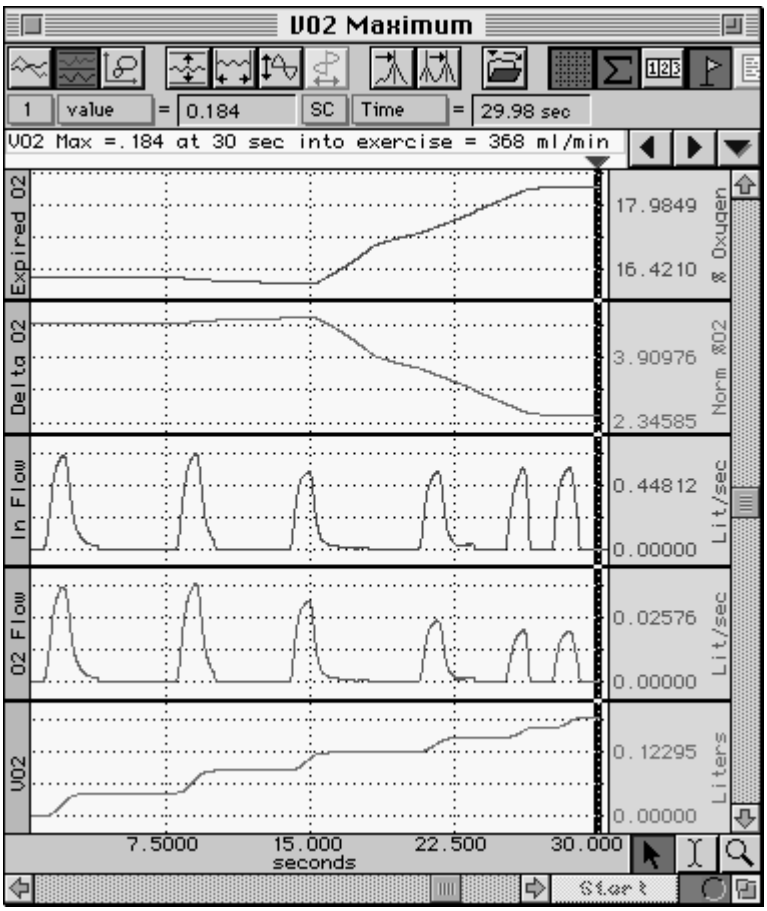


The subject breathes through the mouthpiece (AFT9) that attaches to the non-rebreathing “T” valve (AFT21) via a bacteria filter (AFT4). When the subject inspires, air is drawn into the AFT21, through the TSD107B, as shown by the “Flow In” arrow. When the subject expires, air is forced out through the mixing chamber, as shown by the “Flow Out” arrow.

Assuming the O2100C module is connected to the sampling port of the mixing chamber (via the AFT20 Gas Sampling Interface Kit), the O2100C module will sense the changes in oxygen concentration that occur as the subject breathes. If the TSD107B is placed in the “Flow In” line, the total volume of expired air can be calculated on a breath-by-breath basis. Because both the oxygen concentration and total volume of expired air are known, it is possible to determine the precise amount of oxygen consumed by the subject during the course of breathing. The following graph illustrates data collected using this procedure. Acq*Knowledge* calculated and derived the waveforms in real-time.

## Waveform descriptions

(as referenced from the top down):




### *Waveform 1 Concentration of $O_2$*

This waveform is the O2100Cmodule output. The O2100Cmodule samples the $O_2$ concentration directly from the mixing chamber.

### *Waveform 2 - V $O_2$*

This waveform is the $O_2$ concentration in the mixing chamber subtracted from the $O_2$ concentration in the ambient environment ($O_2$ = 20.93%). This waveform is the $O_2$ concentration consumed.

### *Waveform 3 - V $O_2$*

This waveform is the total inspired $O_2$ flow.

### *Waveform 4 - $O_2$ Flow*

This waveform is the mathematical result of multiplying the expired airflow signal measured by the TSD107B by the consumed oxygen concentration (waveform 2). Accordingly, this waveform is the oxygen flow consumed by the subject. Note how the flow signal drops as the normalized oxygen concentration level drops.

### *Waveform 5 - V $O_2$*

This waveform is the integral of the oxygen flow consumed by the subject. The integral of the oxygen flow is the amount of oxygen consumed up to a particular point in time. In this case, V $O_2$ equaled 184 ml after 30 seconds of exercise, which extends to an estimate of 368 ml/min oxygen consumption.

## O2100C Calibration

The O2100C module comes factory-calibrated to ± 1% carbon dioxide concentration accuracy. If you run at increased flow rates, the calibration may veer further from ±1% accuracy. Generally, **you should perform a gas calibration prior to all exacting measurements**. This may also be required if you are running at increased pump speeds and thus increased flow rate.

Initial (Factory) carbon dioxide accuracy calibration is usually inadequate for varying setup protocols. Proper calibration of the O2100C module should be performed after the specific measurement setup is in place.

Exact calibration is typically performed in Acq*Knowledge*, using the **Scaling** function under **Setup Channels**, once the measurement setup is in place.

6. Set up your measurement so that all gas sampling lines are in place between the O2100C module and the sampling chamber.
7. Adjust the PUMP SPEED control (if required) on the O2100C module.
8. Run the O2100C module and click on the CAL1 button when the first calibration gas is introduced into the sampling chamber.
9. Click on CAL2 when the second calibration gas is introduced into the sampling chamber. The calibration gases should be chosen to bracket your expected measurements. For example, when performing End Tidal O2 measurements, you can use normal air as the first calibration gas because you know the carbon dioxide concentration is 0.04%.
10. Introduce a second calibration gas into the chamber. For the second gas, it might be best to use a calibration gas of 4% carbon dioxide and 96% nitrogen. In this case, your measurements will be most accurate for the range of 0.04% to 4% carbon dioxide.

**Note**: Do not change the pump speed, the sampling filter or the sampling line length/configuration during or after a calibration. Changing any of these elements may reduce the accuracy of the calibration.

### *Pump Speed Control*

The pump speed is factory preset to result in a sampling flow rate of approximately 100 ml/min, when used with the AFT20 Gas Sampling Interface Kit. The time delay between change of carbon dioxide concentration at the sampling end of the Gas Sampling Interface Kit (AFT20) to measurement at the O2100C module is approximately 2.4 seconds. This is because the pump will move 100 ml/min and the internal volume of the Gas Sampling Interface Kit is about 4.0 ml.

$$\text{Volume in ml} = (\pi) \bullet (\text{radius in cm})^2 \bullet (\text{length in cm})$$

The Gas Sampling Interface Kit volume is calculated using:

| | | |
|---|---|---|
| PVC Sample Line: | 72" long at 0.060" ID | Volume = 3.336 ml |
| NAFION® Dryer: | 12" long at 0.050" ID | Volume = 0.386 ml |
| Misc. Tubing/Junctions: | 6" long at 0.060" ID | Volume = 0.278 ml |

If the sample rate is 100 ml/min, then the pump will pull 4 ml in 2.4 seconds:

$$(60 \text{ min/sec}) \bullet (4 \text{ ml}) / (100 \text{ ml/min}) = 2.4 \text{ sec}$$

To check the flow rate, breathe into the free end of the sampling line at the moment you mark the recording (using the marker function in Acq*Knowledge*). You should see no change in the carbon dioxide concentration level until after 2.4 seconds. Please note that you can change the pump speed to a relatively fast level. It's quite possible to exceed the maximum acceptable flow rate to the module, depending on the sampling line type and conditions. You won't harm the module by setting a fast flow rate, but erroneous readings may occur.

To achieve the best results, run the pump speed so the flow rate to the module does not exceed 200 ml/min. The O2100C module output will be relatively insensitive to flow changes between 50 and 200 ml/min. However, above 200 ml/min, the O2100C module output may start to behave very erratically. Run at higher flow rates when you wish to improve the response time of the O2100C module. Response times can often be boosted 10% over the nominal response times of 100ms at 100 ml/min. This particular increase is not exactly specified, as it is somewhat module dependent.

O2100CSpecifications

| | |
|---|---|
| Range: | 0-100% $O_2$ |
| Gain: | 10, 20, 50, 100 (%$O_2$/Volt) |
| Output Range: | 0-10 volts |
| Repeatability: | ±0.1% $O_2$ |
| Resolution: | 0.1% $O_2$ |
| Linearity: | ±0.2% $O_2$ |
| Zero Stability: | ±0.01% $O_2$/hr |
| Response Time | |
| @50 ml/min: | 1000msec (T10-T90) |
| @ 100 ml/min: | 500msec (T10-T90) — factory preset |
| @ 200 ml/min: | 160msec (T10-T90) |
| Flow Range: | 50-200 ml/min |
| Temp Range: | 5-50°C |
| Zero Drift: | ±0.05% $O_2$/°C |
| Span Drift | ±0.25% $O_2$/°C |
| Sampling Port: | Male Luer |
| Weight: | 990 grams |
| Dimensions: | 7cm (wide) x 11cm (deep) x 19cm (high) |
| Power Source: | 12VDC @ 1 amp (uses AC100A transformer) |
| Note: | The module measures the partial pressure of $O_2$ so the module output is proportional to the pressure in the sample cell. Gas sampled must be free of any liquid or condensable vapors. Gas should be filtered to 5 microns or better. The module utilizes Servomex, Inc. technology for $O_2$ concentration signal processing. |

***See also***: AFT Series Air Flow & Gas Analysis Accessories, page 131.
Application Note # AH149 — O2100C Module
Application Note # # AH150 — O2100C Module: Sample application