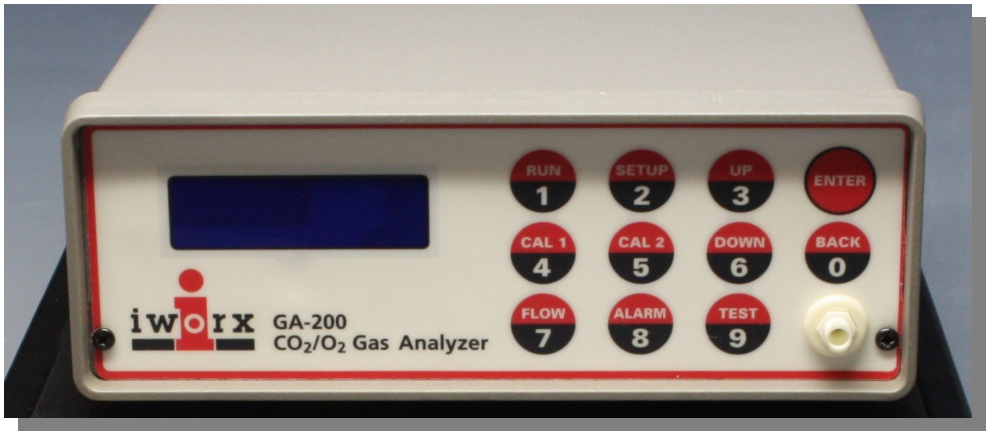
GA-200 Gas Analyzer

Technical Note



GA-200 Gas Analyzer

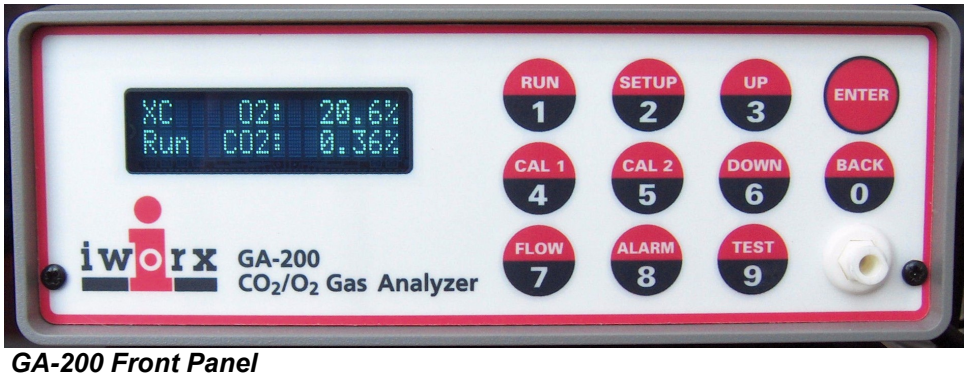
Overview

The GA-200 Gas Analyzer uses sensors to measure and display the concentrations of oxygen and carbon dioxide in a sample as the percentage of a gas in the sample by volume. This method of expressing the concentration of a gas in a sample is also known as the percent volume fraction. In addition to the sampling and sensing systems in the GA-200, the unit has a fluorescent display used for observing measurements and analog outputs that allow the unit to be connected to iWorx data recorders.

When measuring the concentrations of oxygen and carbon dioxide in a gas, a sample is pumped from the input port on the front panel of the GA-200, through the sample cell, and out an exhaust port on the back of the unit. Gas samples are drawn into the unit through an external filter on the input port that protects the sensors from contamination and through Nafion tubing connected to the filter that removes moisture from the samples that would affect the measurements and the unit's calibration.

The GA-200 Gas Analyzer has the ability to measure and record both oxygen and carbon dioxide concentrations over the ranges normally recorded from human and animal subjects.

Front Panel



GA-200 Front Panel

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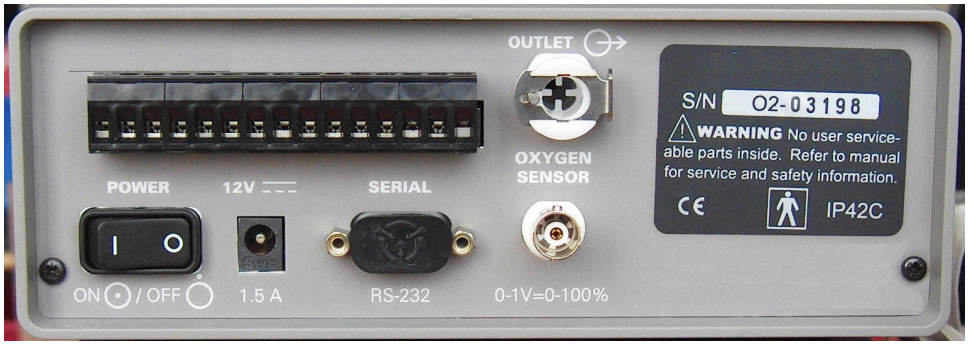
The front panel of the GA-200 (both A and B) has a keypad, a display used to program the modes and parameters of the unit, and an inlet port for the gas sample. For use with LabScribe and iWorx data recorders, it is not necessary to do any programming through the keypad. All parameters are set in the software, as described below.

Rear Panel: GA-200A



GA-200A Rear Panel

The rear panel of the GA-200A has the following features: a switch, a power input, an RS-232 serial port for connection to a computer, an oxygen sensor output, and a gas outlet. The output of the carbon dioxide sensor is incorporated into the relay terminal which allows the unit to be connected to other devices.

1) Power for the GA-200A is supplied by an external power supply. The power supply is connected to the unit through the connector labeled **12V**, **1.5A**. Press the side of the power switch labeled **I** to turn on the GA-200A. Press **O** on the switch when it is time to turn the unit off.
2) The GA-200A can be interfaced to a computer through a serial (**RS-232**) data stream. The default data format is **9600 baud**, **8 bit**, and **no parity** with alternate baud rates of 2400, 4800, 19200, and 38400. The signals present are **RXD**, **TXD**, and ground through the 9-pin D connector on the back panel of the unit.
3) The signal from the oxygen sensor can be recorded from the BNC output labeled **OXYGEN SENSOR**, **0-1V = 0-100%**. The amplitude of the signal ranges from 0 to 1 Volt DC which corresponds to a range of 0 to 100% oxygen, or 1mV for each 0.01% oxygen. The ground of this output is common to the instrument case and the power supply.
4) The exhaust port of the sampling circuit is labeled **OUTLET**. A scavenging system can be connected to this port to collect any gases passing through the GA-200A.
5) Several relays are available from the terminal block on the rear panel of the GA-200A. These relays are normally open, but close when the oxygen sensor detects various alarm conditions. For DC loads, these relays are rated from 5 Amps at 30 Volts DC to 0.25 Amps at 300 Volts DC in an open circuit. For AC loads, these relays are rated from 5 Amps at 250 Volts. When the sockets are

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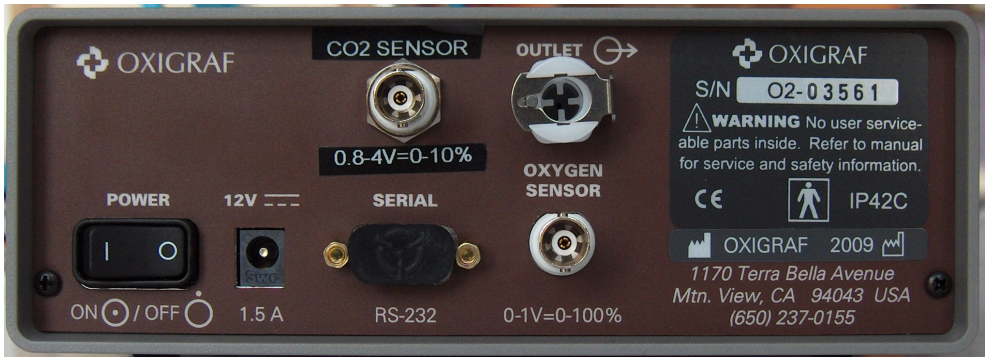
numbered from left to right:

- **Sockets 1 (Common)**, **2 (NC)**, and **3 (NO)** are the connections for **Limit Relay A**.
- **Sockets 4 (Common)**, **5 (NC)**, and **6 (NO)** are for **Limit Relay B**.
- **Sockets 7 (Common)**, **8 (NC)**, and **9 (NO)** are for **Warning Relay**.
- **Sockets 10 (Common)**, **11 (NC)**, and **12 (NO)** are for **System OK**.

6) An analog output for the carbon dioxide sensor and an additional analog output for the oxygen sensor are available from the terminal block. These outputs are non-isolated current sources that are referenced to the current output ground. The range of each current output is 4 to 20 mA and a maximum output voltage of 10 Volts. The oxygen and carbon dioxide concentrations that are equal to the outputs at 4 mA and 20 mA are normally set to the low and high limits of the sensitivity ranges of the two gases, respectively: For example, the 4 mA current output of the oxygen sensor is set to 0%, and the 20 mA current output is set to 100%.
   - Socket 13 is the **Ground** for the both current outputs.
   - Socket 14 is the **oxygen current output**.
   - Socket 15 is the **carbon dioxide current output**.

GA-200B: Rear Panel



GA-200B Rear Panel

The rear panel of the GA-200B has the following features: a switch, a power input, an RS-232 serial port for direct connection to a computer, an oxygen sensor output, a carbon dioxide sensor output, and a gas outlet.

1) Power for the GA-200B is supplied by an external power supply. The power supply is connected to the unit through the connector labeled **12V**, **1.5A**. Press the side of the power switch labeled **I** to turn on the GA-200B. Press **O** on the switch when it is time to turn the unit off.
2) The GA-200B can be interfaced to a computer through a serial (**RS-232**) data stream. The default data format is **9600 baud**, **8 bit**, and **no parity** with alternate baud rates of 2400, 4800, 19200, and 38400. The signals present are **RXD**, **TXD**, and ground through the 9-pin D connector on the back panel of the unit.

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3) The signal from the oxygen sensor can be recorded from the BNC output labeled **OXYGEN SENSOR**, **0-1V=0-100%**. The amplitude of the signal ranges from 0 to 1 Volt DC which corresponds to a range of 0 to 100% oxygen, or 1mV for each 0.01% oxygen. The ground of this output is common to the instrument case and the power supply.
4) The signal from the carbon dioxide sensor can be recorded from the BNC output labeled **CO2 SENSOR, 0.8-4V=0- 10%**. The amplitude of the signal ranges from 0.8 to 4 Volt DC which corresponds to a range of 0 to 10% carbon dioxide, or 1mV for each 0.01% oxygen.

Items Provided With the GA-200 Gas Analyzer

External filter with Luer–Lock fittings
Nafion sampling tube with Luer-Lock fittings
Power supply
GA-200A: One BNC-BNC cable, one BNC- Two wire cable
GA-200B: Two BNC-BNC cables

How the GA-200 Works

The oxygen concentration of the gas in the sample cell is measured using laser diode absorption technology. The laser diode in the oxygen sensor produces light at a wavelength (760 nanometers) that is absorbed by oxygen. The light passes through the gas pumped into the sample cell and onto the surface of a detector. The output of the sensor is inversely proportional to the concentration of oxygen in the sample because the amount of light reaching the detector decreases as the concentration of oxygen in the sample increases. The GA-200 has a very fast response time that enables breath to breath analysis of gas concentrations because the unit analyzes the gas sample every 10 milliseconds, or 100 times per second. During each measurement interval, the analyzer is zeroed automatically by electronic tuning of the laser to a wavelength not absorbed by oxygen.

How to Use the GA-200 Gas Analyzer

Prior to use, users must perform a two-point calibration of the oxygen and carbon dioxide sensors.

Note: Warm up the GA-200 for at least 30 minutes. The input air filter must be connected to avoid damaging the sensors.

Calibrating the O_2 and CO_2 Channels

The outputs of the oxygen and carbon dioxide sensors of the GA-200 are voltages that are proportional to the concentrations of the gases being measured by the analyzer. To determine the volumes of oxygen consumed and carbon dioxide produced during metabolic testing, the voltage outputs of the sensors need to be converted, by the recording software, to the percentages of these gases in the

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inhaled and exhaled air.

To make this conversion, samples of two different concentrations of oxygen, and two different concentrations of carbon dioxide, will need to be put into the GA-200 gas analyzer as the voltage outputs of each sensor are recorded.

One set of samples can be taken from room air, which contains 20.93% O_2 and 0.04% CO_2. The other set of samples can be taken from gas cylinders containing a combination of these two gases at different concentrations. Cylinders containing both oxygen and carbon dioxide are readily available from suppliers. Some of the most commonly used combinations contain:

- 12% O_2 and 5% CO_2, with the balance being N_2, or;
- 16% O_2 and 4% CO_2,with the balance being N_2,.

Recording the Voltage Outputs of the Gas Sensors

Preparation:

1) Turn on the GA-200 for at least 30 minutes before performing a calibration.
2) Connect the CO2 and O2 outputs of the GA-200 to an iWorx data acquisition system.
   - GA-200A: Connect the male BNC-two wire cable included with the GA-200A between the output of the carbon dioxide sensor, which is located on the terminal block on the rear panel of the analyzer, and the BNC input of Channel 1 on the IWX/ 214: Red wire into socket 15 and black wire into Socket 13.
   - GA-200B: Using BNC-BNC cables, connect the BNC outputs of the carbon dioxide and oxygen sensors on the GA-200B to BNC inputs of an iWorx data recorder.
3) Double-click the desktop LabScribe icon to open LabScribe.
4) Configure LabScribe to show the O2 and CO2 channels, or open the settings file of one of the pre-configured GA-200 lab exercises.
5) Prepare the equipment that will deliver any gas samples, other than room air, to the GA-200:
   - Clamp and secure any gas cylinders that will used to provide gas samples near the GA-200 gas analyzer.
   - Attach the regulator to the gas cylinder.
   - Attach a Luer-Lock connector to the outlet of the regulator that will allow the calibration kit for the GA-200 to be connected to the regulator of the gas cylinder.
6) Attach a filter to the inlet port on the front of the GA-200 analyzer.

To measure the voltage outputs of the oxygen and carbon dioxide sensors when measuring a sample of room air:

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1) Place the gas sampling tubing away from the users to prevent the sampling of exhaled air. Allow room air to be pumped through the gas analyzer for 10 seconds before recording the outputs of the sensors.
2) Type “Room Air” in the Mark box to the right of the Mark button.
3) Click on the Record button. The recording should scroll across the screen.
4) While recording, press the Enter key on the keyboard to mark the recording with information about the room air gas sample.
5) Record the outputs of the O_2 and CO_2 gas sensors for about ten seconds.
6) Continue to record while moving to the next series of steps.

To measure the voltage outputs of the oxygen and carbon dioxide sensors when measuring a second sample of a gas mixture containing known concentrations of oxygen and carbon dioxide:

1) Open the secondary valve on the regulator of the cylinder providing the second gas sample. Adjust the flow rate to low. Make sure the flow rate from the gas cylinder is greater than the flow rate on the gas analyzer.
2) While the gas sample is flowing from the regulator, connect the gas sample tubing of the A-CAL-150 Calibration Kit to the Luer-Lock connector on the output of the regulator.
3) Connect the braided Nafion tubing from the outlet from the A-CAL-150 Calibration Kit to the inlet filter port on the front of the GA-200, as illustrated below. The GA-200 will pull the air in from the calibration kit.
4) Type “Gas Sample” in the Mark box. Record with the sample gas flowing into the GA-200, press the Enter key on the keyboard to mark the recording with information about the second gas sample.

A-CAL-150 connected to filter on front of GA-200.

5) Once the recordings of the gas concentrations reach a steady level, record for another ten seconds. This can take up to two minutes.

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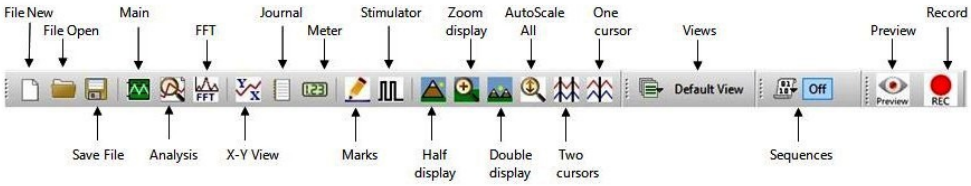
6) Click **Stop**.
7) Select **Save As** in the **File** menu, type a name for the file. Choose a destination on the computer in which to save the file. Designate the file type as *.iwxdata. Click **Save**.

To Convert the Units on Gas Concentration Channels:

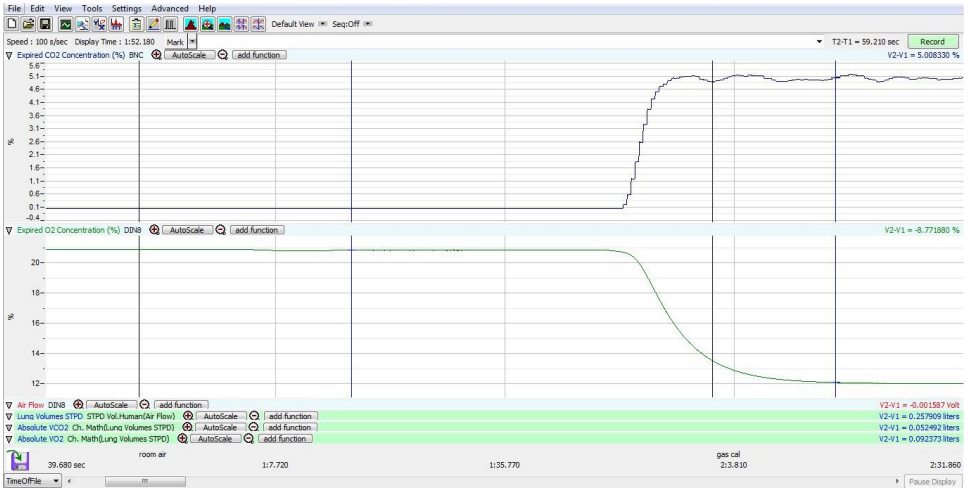
1) Use the **Display Time** icons to adjust the display time of the Main window to show the complete calibration data on the Main window at the same time. The required data can also be selected by:
   - Placing the cursors on either side of data required, and;
   - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the entire segment of data to the width of the Main window.
2) Click the 2-Cursor icon on the LabScribe toolbar so that two cursors appear on the Main window. Place one cursor on the section of data recorded when gas analyzer was collecting a sample of room air and the second cursor on the section of data recorded when the second sample was collected.



The LabScribe toolbar.

To convert the voltages at the positions of the cursors to concentrations using the Advanced Units Conversion dialogue window:

1) To convert the voltages on the **Expired CO2 Concentration (%)** channel, click on the arrow to the left of the channel title to open the channel menu. Select **Units** from the channel menu, and select **Advanced** from the **Units** submenu.



The voltage outputs of the two sensors in the GA-200 gas analyzer, carbon dioxide on the top and oxygen on the bottom. Other recording windows have been minimized to show detail.

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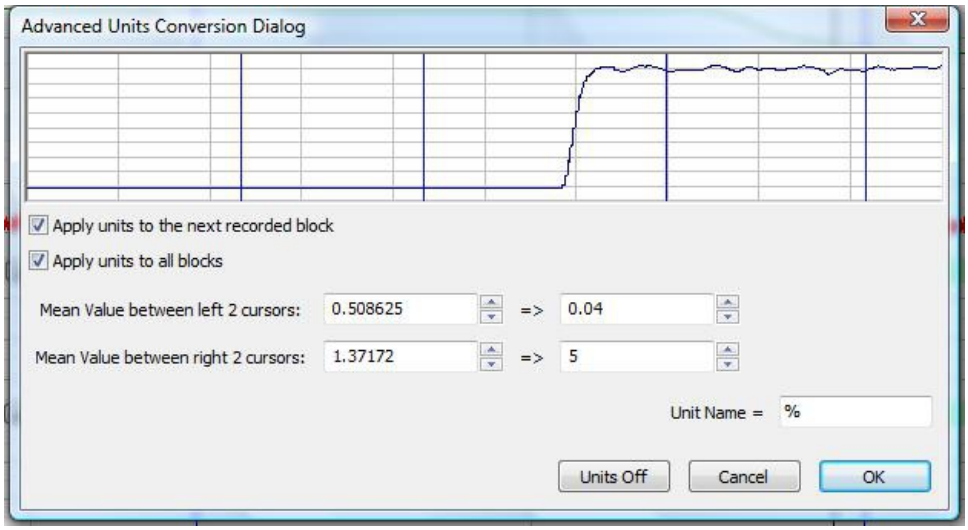
2) On the **Units Conversion** window, make sure **Apply units to the next recorded block** and **Apply units to all blocks** are selected in the menu under the displayed graph on the left side of the window by putting a check mark in the boxes next to each statement.
3) Move the two left hand cursors to the flat line area where room air values were recorded. Leave a space between the cursors so that you have an average value being calculated while room air was moving into the GA-200 gas analyzer.
4) Move the two right hand cursors to the flat line area where the gas sample values were recorded. Leave a space between the cursors so that you have an average value being calculated while the gas sample was moving into the GA-200 gas analyzer.
5) Notice that the voltages from the positions between the cursors are automatically entered into the value equations. Enter the two concentrations of carbon dioxide measured from the two samples in the corresponding boxes on the right side of the conversion equations.
   - Using room air, the concentration of CO_2 = 0.04%.
   - The second gas concentration will be the one from the gas cylinder. Generally a 5% CO_2 concentration is recommended.
6) Enter the name of the units, **%**, in the box below the concentrations.
7) Click **OK**.



The Advanced Units Conversion dialog window with the voltages between the cursors set to equal the concentrations used in calibration.

8) Repeat Steps 1 through 5 on the **Expired O2 Concentration (%)** channel.
   - Room air = 20.9%
   - Second gas concentration will be the one from the gas cylinder. Generally a 12% O_2 concentration is recommended.

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9) Make sure **Apply units to the next recorded block** and **Apply units to all blocks** are selected in the menu under the displayed graph on the left side of the window by putting a check mark in the boxes next to each statement.
10) Click **OK** to activate units conversion.
11) Click **Save**.

Note: When using this LabScribe calibration protocol, the numbers in the software do not correlate with those on the front panel of the GA-200 gas analyzer. If at any time in this procedure you are unable to calibrate the GA-200, start over by using the Test key to Restore Factory Calibration.

Cleaning and Disinfecting

1) The external surfaces of the GA-200 can be cleaned by wiping them with cloth moistened with a mild detergent solution.
2) The external surfaces of the GA-200 can be disinfected by wiping them with a cloth moistened with 70% isopropyl alcohol or a 5% bleach solution. Wipe the disinfecting agent off the surfaces with another cloth moistened with water. Allow the surfaces to dry before using the unit.
3) The internal sample circuit and the sample pump cannot be disinfected. An external barrier filter on the inlet port must be used to prevent contamination of the sample circuit.
4) If the GA-200 is used to collect samples of inspired and expired air during breath to breath spirometry, a new external barrier filter and a new Nafion sampling tube must be used for each subject.
5) If the GA-200 is used to collect samples of expired air from mixing chambers or similar devices, change the external barrier filter according to its daily usage. If the unit is used repeatedly each day, then a new filter should be used every day. If the unit is lightly used, then the filter could be replaced each week. The Nafion sampling tube usually needs to be changed every six months. If the recordings of gas concentrations get noisy, change the external barrier filter and the Nafion sampling tube.

Technical Data and Specifications

Performance specifications are valid under the following conditions:

PERFORMANCE CONDITIONS	
Ambient Temperature:	5-40°C Operation; -20-60°C Storage
Cell Pressure:	10.2-17.4 PSI ; 500-900 mmHg
Warm-Up Time:	5 minutes
Altitude:	Two point calibration required for each 2,000 ft change altitude
Humidity:	0-95%, non-condensing

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PERFORMANCE SPECIFICATIONS	
Range:	5-100% O_2; 0-10% CO_2
Resolution:	0.1% in 0-100% range; 0.01 in 0-10% range
Flow with Pump:	50-250 ml/min, adjustable
Response Time:	150ms@ 150ml/min flow
Stability (4 Hours)	±0.3% O_2 in XC Mode; ±0.1% in LN Mode

OTHER SPECIFCATIONS	
Power Requirements of Analyzer:	12VDC, 1.5A
Requirements of the External Power Supply:	95-250VAC, 47-63 Hz
Dimensions:	190 x 76 x 280mm (WxHxD)
Weight:	Analyzer: 2.3kg; Power Supply: 0.7kg

Storing

Before storing the GA-200 connect an external filter to the inlet port of the unit to prevent contaminations of the sensors.

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