

CLAMS / Oxymax Model 2018

Hardware Setup Manual

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Chapter 1 – Introduction

1.1 Overview

Columbus Instruments' Comprehensive Lab Animal Monitoring System (CLAMS) is capable of simultaneously recording a diverse range of measurements from as many as 32 subjects. All of the data collection components of CLAMS connect by way of the "CI-Bus" technology system. The CI-Bus easily integrates all of the data from all devices for collection by the host computer. Configuration options within each system allow around-the-clock, automated, non-invasive collection of physiological and behavioral parameters such as activity, food and water consumption, metabolic performance, temperature, etc. Each CLAMS is built to the client's specifications, therefore, no two systems are likely to look or function exactly the same.

The metabolic data is based upon Columbus Instruments' Oxymax open-circuit calorimeter. It infers heat production based upon observations of the oxygen (O_2) consumption and carbon dioxide (CO_2) production. By measuring the difference in gas concentrations appearing between the inlet and outlet of a sealed chamber through which the input (V_i) and output (V_o) flows are known, the volume of oxygen consumed (VO_2) and carbon dioxide produced (VCO_2) can be calculated. The measured differential is a function of the metabolic rate and the air flow through the chamber. The relationship of VCO_2/VO_2 is the Respiratory Exchange Ratio (RER). Oxymax employs the "Lusk" equation that derives a calorific heat value (CV in Calories or Joules) based upon the observed RER or user-defined constants of CV for each measured gas. Then the exact heat of the subject can be calculated.

1.1.1 Gas Equations

$$VO_2 = Vi \cdot O_{2i} - Vo \cdot O_{2o}$$

Vi and Vo are the input and output ventilation rates.
 O_{2i} and O_{2o} are the oxygen fractions at the input and output.

$$VCO_2 = Vo \cdot CO_{2o} - Vi \cdot CO_{2i}$$

Vi and Vo are the input and output ventilation rates.
 CO_{2i} and CO_{2o} are the carbon dioxide fractions at the input and output.

$$Vi = Vo \cdot No / Ni$$

Vi is calculated using the Haldane transform which requires the known balances of nitrogen (calculated below).
 Ni and No are the nitrogen fractions at the input and output.

$$Ni = 1 - O_{2i} - CO_{2i}$$

$$No = 1 - O_{2o} - CO_{2o}$$

Ni and No are the nitrogen fractions at the input and output.
 O_{2i} and O_{2o} are the oxygen fractions at the input and output.
 CO_{2i} and CO_{2o} are the carbon dioxide fractions at the input and output.

$$RER = VCO_2 / VO_2$$

VCO_2 and VO_2 are the volumes of carbon dioxide produced and oxygen consumed.

$$\text{Heat} = CV \cdot VO_2$$

Lusk Heat Equation. CV is the calorific value based upon the data points of the Lusk Table as calculated below. VO_2 is the volume of oxygen consumed.

$$CV = 1.232 \cdot RER + 3.815$$

RER is the calculated Respiratory Exchange Ratio.

$$\text{Heat} = CV_1 \cdot VO_2 + CV_2 \cdot VCO_2$$

User-defined Heat Equation. CV_1 and CV_2 are user-defined calorific values related to the oxygen consumption and carbon dioxide production.

1.1.2 Additional Notes

This manual serves as a guide for the general setup of the Oxyman calorimetry components of most systems. Not all sections of the manual may pertain to the system you are using. Also, components and parts are subject to change as improvements and modifications are made. Therefore, the photos and images of particular components may not exactly match the ones you have. However, their function and setup in the system should be similar. Some of the images used for the assembly instructions were not performed on actual CLAMS shelving for clarity.

1.2 Electrical Connections

There are many electrical connections used throughout the CLAMS system. The following details most of the connections and the correct way to make and check them.

1.2.1 AC Power

It is highly recommended to use an AC power strip with power switch and surge protection for connecting and protecting all of the CLAMS components. A single-source AC power strip also provides a beneficial common ground between all connected components which helps prevent unintentional ground loops that can occur when using different AC outlet power sources. Likewise, the power switch can serve as a “master” power switch that will switch on the power to all of the CLAMS components.

Note – Power Surges

The CLAMS warranty does not cover damage due to power surges.

It is also recommended to connect the host computer and CLAMS system to one or more uninterruptible power supplies (UPS). This can prevent the loss of data during brief power outages and brownouts. Make sure to use a UPS capable of delivering power to the components that are connected to them. For example, a 1000VA UPS is sufficient for most 8-cage CLAMS systems. Another, separate UPS should be used for the host computer. Each UPS’s batteries should be replaced every three (3) years to ensure uninterrupted service.

1.2.2 DC Coaxial Connection

The DC Coaxial cable with plugs are typically used to connect low-voltage DC power from an AC-sourced power supply or inter-connect DC power between various components of the CLAMS system. Common low-voltage power sources are rated at 5, 12 or 24 volts with varying current capacities for their intended devices. Improper source voltage and/or over-loading the power supply may cause intermitted or faulty operation of the connected devices.

- To connect a DC coaxial power plug, fully insert the plug into the cabinet/component jack. In some cases, part of the outside metallic barrel may be exposed.

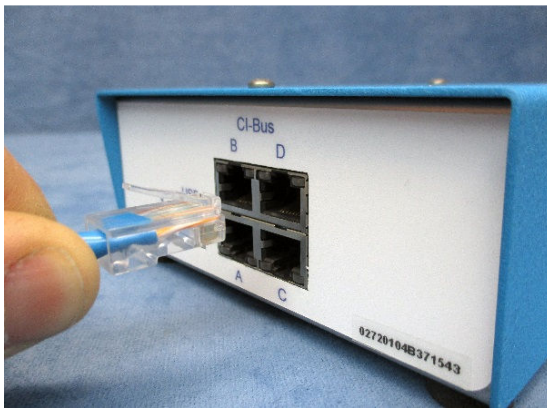


The connection is secured by a friction-fit. Therefore, be sure to route the power cable as to minimize any physical tension on the plugs and protect them from being unintentionally pulled from their jacks.

1.2.3 Ethernet Cable Connection

The Ethernet cable connection is used for CI-Bus communication and other electrical connections between various components of the CLAMS system. It is an 8-pin, 8-conductor, plug to plug cable commonly referred as: RJ-45, CAT5, CAT5e, network cables, etc... They are found between all of the CI-Bus devices and the Optical Activity sensors. The cable plug incorporates a locking tab which mates to the panel jack to secure the connection.

- To make an ethernet connection, fully insert the cable plug into the panel jack until a “click” is heard. The plug should not pull free from the jack.



- To remove, simply depress the locking tab and pull the plug free.

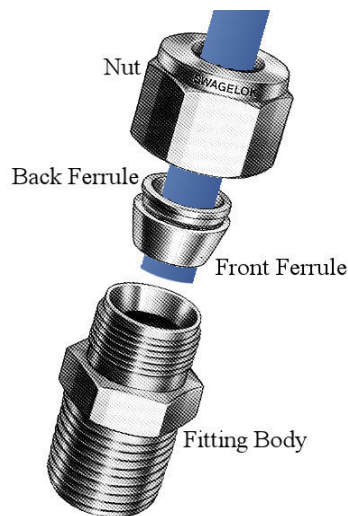
1.3 Air and Water Connections

There are many air and water connections used throughout the CLAMS system. The following details most of them and the correct way to make and check them.

1.3.1 Nut and Ferrule Fittings

A nut and ferrule are used to make an air-tight or water-tight connection. These connections are commonly found between calorimetry and drinking components of the system and cages.

- To make a new nut and ferrule connection: trim the end of the plastic tube with a sharp implement (tube cutter preferred) leaving the end as square as possible. Ensure there are no frayed edges on the end.
- Slide the nut and 2-piece ferrule 3cm over the end of the tube as indicated in the diagram below.
- Fully insert and hold the tube (about 1cm) into the flared fitting on the cabinet or cage.
- Slide the nut (and ferrule) to the mating threads of the fitting and finger-tighten until firm.



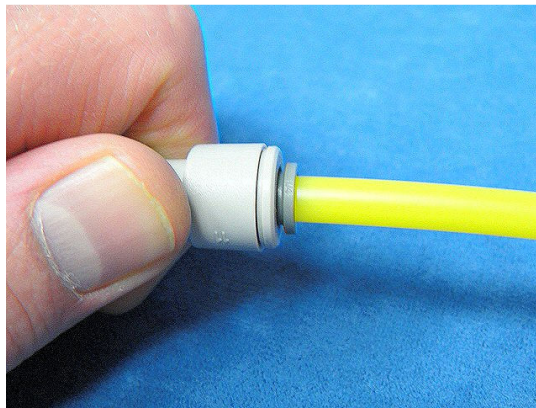
Note – Only use nylon ferrules

Metal ferrules may leak when used with plastic tubing and can damage metal sipper tubes. Excessive tightening may pinch the tube or damage the fitting.

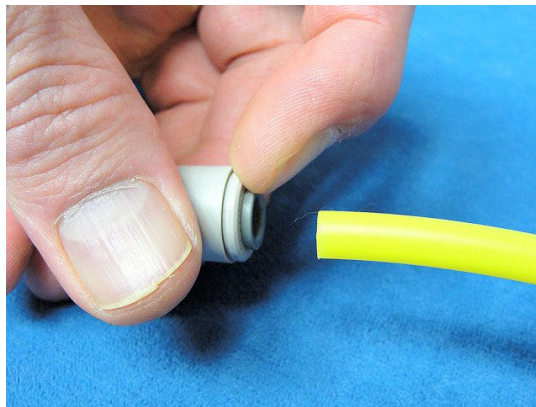
1.3.2 Push-Fit Fittings

Push-Fit fittings are used to make air-tight connections. They are commonly found near components of the system that may require frequent maintenance (such as filters) or around components which modify the operation of the system (such as flow restrictors).

- To make a connection, ensure the end of the tube is smooth with no frayed edges. If required, trim the end of the plastic tube with a sharp implement (tube cutter preferred) leaving the end as square as possible.
- Fully insert the tube into the plastic fitting, through the resistance, until it stops (about 1.5cm for most fittings). The tube should not pull free from the fitting and the locking collar around the tube socket will travel and rotate with the tube.

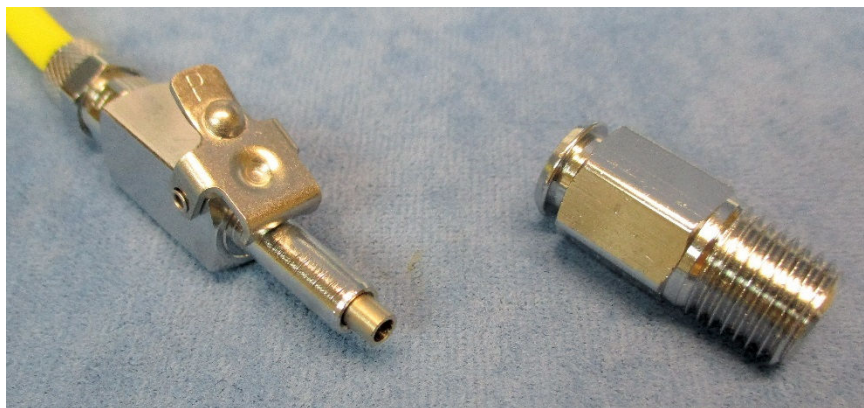


- To remove the tube from the connector, press and hold the locking collar against the body of the fitting.
- Now pull the tube free from the fitting.



1.3.3 Quick-Connect Fittings with Lock

Quick-connect fittings with lock are used to make air-tight connections to sources which require intermittent use. They are commonly installed on the regulators of calibration gas bottles and associated tubing. The female fitting will need to be installed on the output of the gas regulator. The male plug should already be connected to a tubing assembly.



- Using Teflon tape or pipe sealant (which may already have been applied at the factory), thread the female quick-connect fitting into the output of the pressure regulator (compressed air bottle shown). Use a 9/16" open-end or crescent wrench to fully tighten.



- When a connection is needed, fully insert the male plug into the female fitting. A spring-like resistance will be felt and the integrated locking lever should “click” over the beveled edge of the female fitting, securing the connection together.
- To remove, simply depress the locking lever and pull the plug free.

Chapter 2 – Computer Setup

2.1 Minimum Computer Requirements

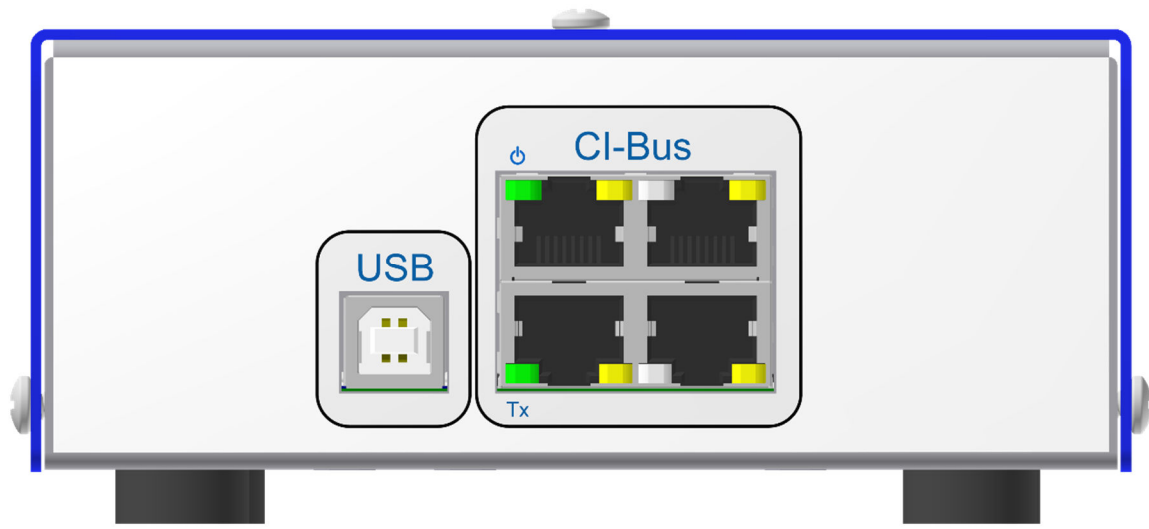
The host computer is expected to be a IBM-PC compatible running a Windows operating system (XP, Vista, 7, 8.1, 10). It must have a minimum of: 128MB of memory, 1GB of free harddrive space and an free Universal Serial Bus (USB) port.

2.2 CI-Bus Hub



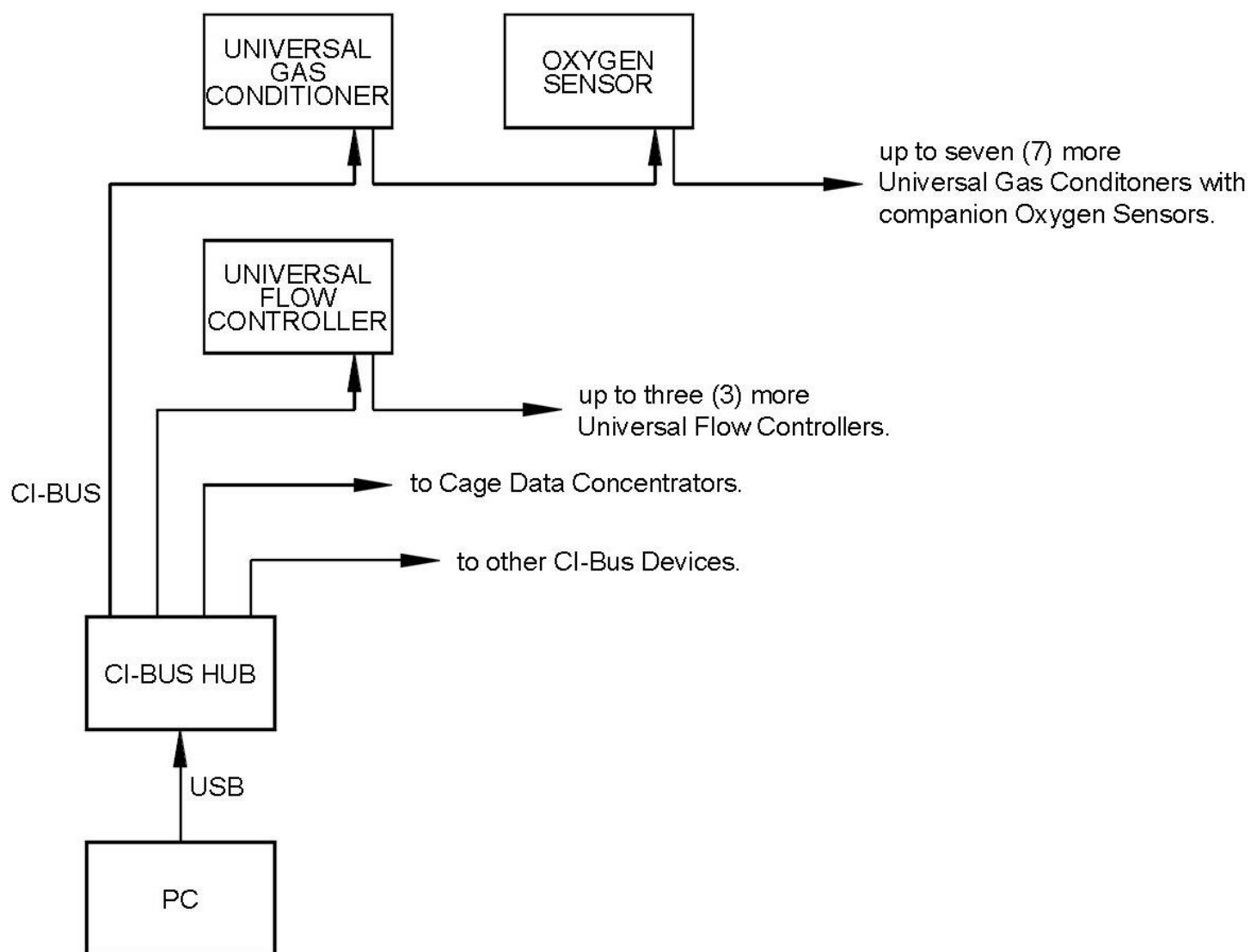
The CI-Bus Hub is used to create the interface between the host computer and the CLAMS/Oxymax system. It connects via a USB port which creates a virtual COM port accesible by the Oxymax software. All communications from the Oxymax software are passed through the CI-Bus Hub to four (4) terminated CI-Bus ports. By “daisy-chain” fashion, ethernet cables are used to connect devices to the CI-Bus.

The following details the indicators and ports found on the CI-Bus Hub:



Rear View

1. **USB** – A type B port which connects to a free USB A port on the host computer via a standard USB A-B cable.
2. **CI-Bus** - Four (4) terminated CI-Bus ports. Each can host up to a minimum of 32 daisy-chain connected CI-Bus devices.
3. **Power** – The IEC line and circle indicator (typically green) which indicates connection to an active USB port on the host computer.
4. **Tx** - An indicator (typically green) which indicates the host computer is transmitting data to all of the CI-Bus ports.
5. **Rx** – The right-side indicator of each port (typically yellow, four in all) indicates that a CI-Bus device connected to that port is transmitting data for the host computer.



Typical CI-Bus Connections with a Desktop Oxymax System

2.3 Placing the CI-Bus Hub

As the CI-Bus Hub is a USB connected device, it is placed locally near the host computer.

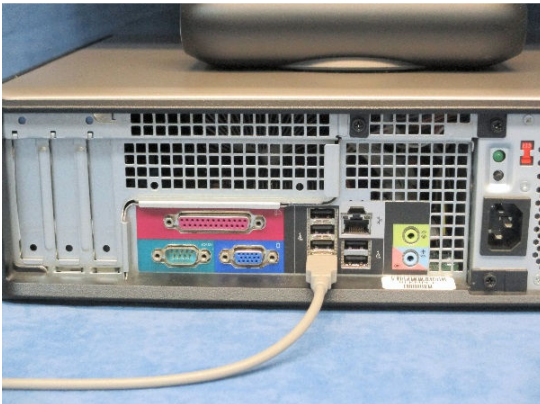


You will also need the following:

- 1 x USB A-B cable.

2.4 Connecting the CI-Bus Hub

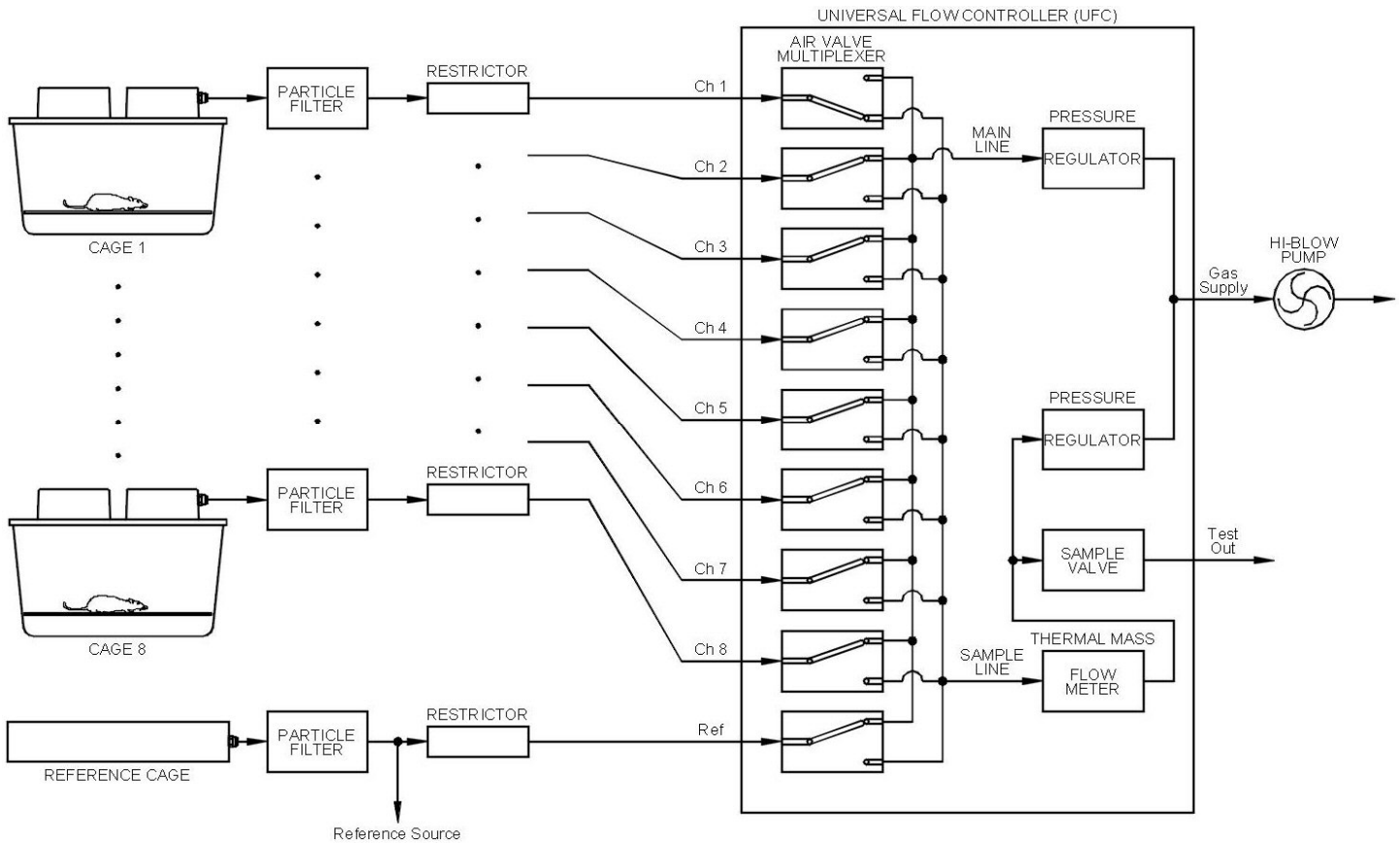
- Using the USB A-B cable, insert the A plug into a free USB port on the host computer.
- Insert the B plug into the USB port on the CI-Bus Hub. When properly connected, the power indicator should light.



Chapter 3 – Negative Ventilation Setup

3.1 Negative Ventilation Overview

In a negative ventilation system, fresh air travels from the atmosphere into the cage, then through the air supply line to the Universal Flow Controller (UFC). The air flows of all channels are regulated and passed to the ventilation pump where it is returned back to the atmosphere as illustrated below. One of the channels is selected for sampling and provided to the Gas Sensor chain.



Air Flow Schematic of the Negative Ventilation System

Negative ventilation provides many advantages:

- Small leaks around the openings in the cage lid have a minimal effect upon respiratory gas concentrations because the intended fresh air is drawn from the immediate atmosphere around the cage. A fan inside the cage ensures that all of the gases are uniformly mixed.
- The sample line used in a positive ventilation system is eliminated as the air supply line ventilates the cage and supplies the gas sample to the Gas Sensor chain.

The following sub-sections detail the components used in the Negative Ventilation Setup.

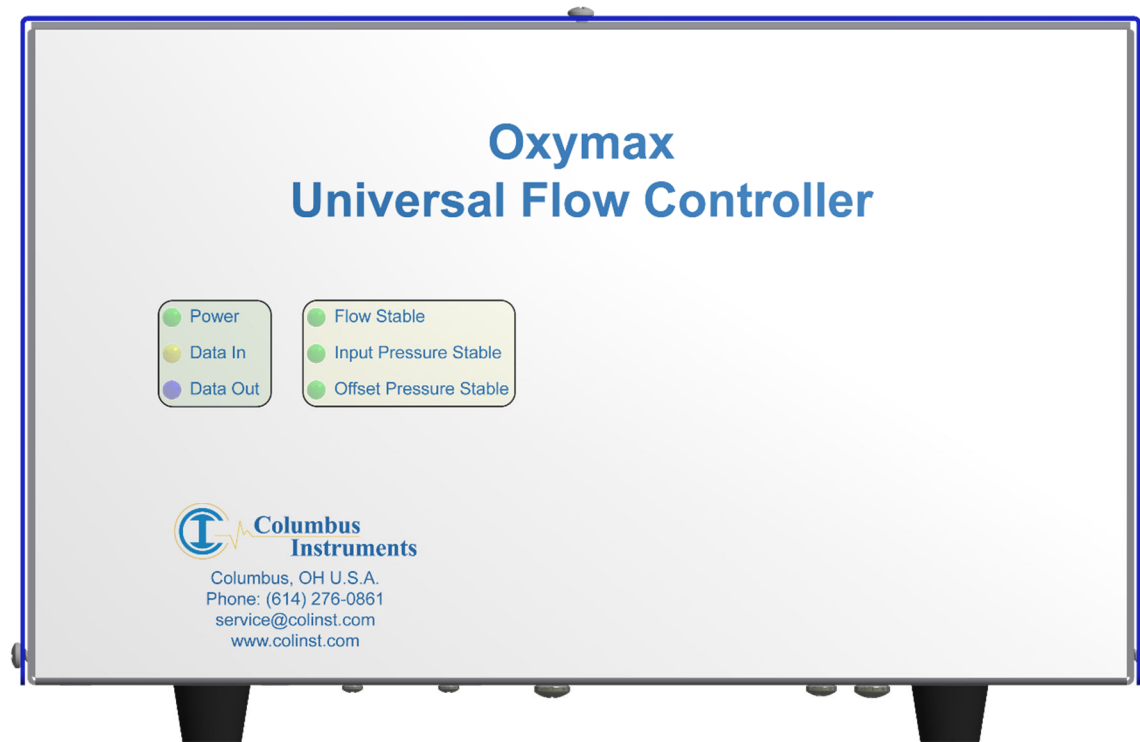
3.2 Universal Flow Controller



The Universal Flow Controller (UFC) provides ventilation for eight cages and one reference cage. It also selects one of the air supply lines (channels) for gas sampling. The UFC requires an external ventilation pump, matched in size for the required ventilation rate of all channels.

3.2.1 Universal Flow Controller Specifications

Mass Flow Range:	0-3L/min (each channel)
Mass Flow Resolution:	0.0003L/min
Physical Size (WxHxD):	30cm x 20cm x 35cm
Physical Weight:	6kg
Power Requirements:	12VDC 3A, 6W



**Universal Flow Controller
Front View**

1. **Power** – A green light which indicates connection to a source of DC power.
2. **Data In** - A yellow light which indicates the host computer is transmitting data.
3. **Data Out** – A blue light which indicates the UFC is transmitting data.
4. **Flow Stable** - A green light which indicates the status of the measured flow rate of the selected gas source.
 - ON:** The flow rate is at the desired set-point.
 - FLASH:** The flow rate does not match or is moving toward the desired setpoint.
5. **Input Pressure Stable** – A green light which indicates the status of the pressure of the selected gas source:
 - ON:** The input pressure is at the desired set-point.
 - FLASH:** The input pressure does not match the desired set-point for the selected gas source.
6. **Offset Pressure Stable** – A green light which indicates the status of the pressure of all non-selected gas sources
 - ON:** The offset pressure is at the desired set-point.
 - FLASH:** The offset pressure does not match the desired set-point.



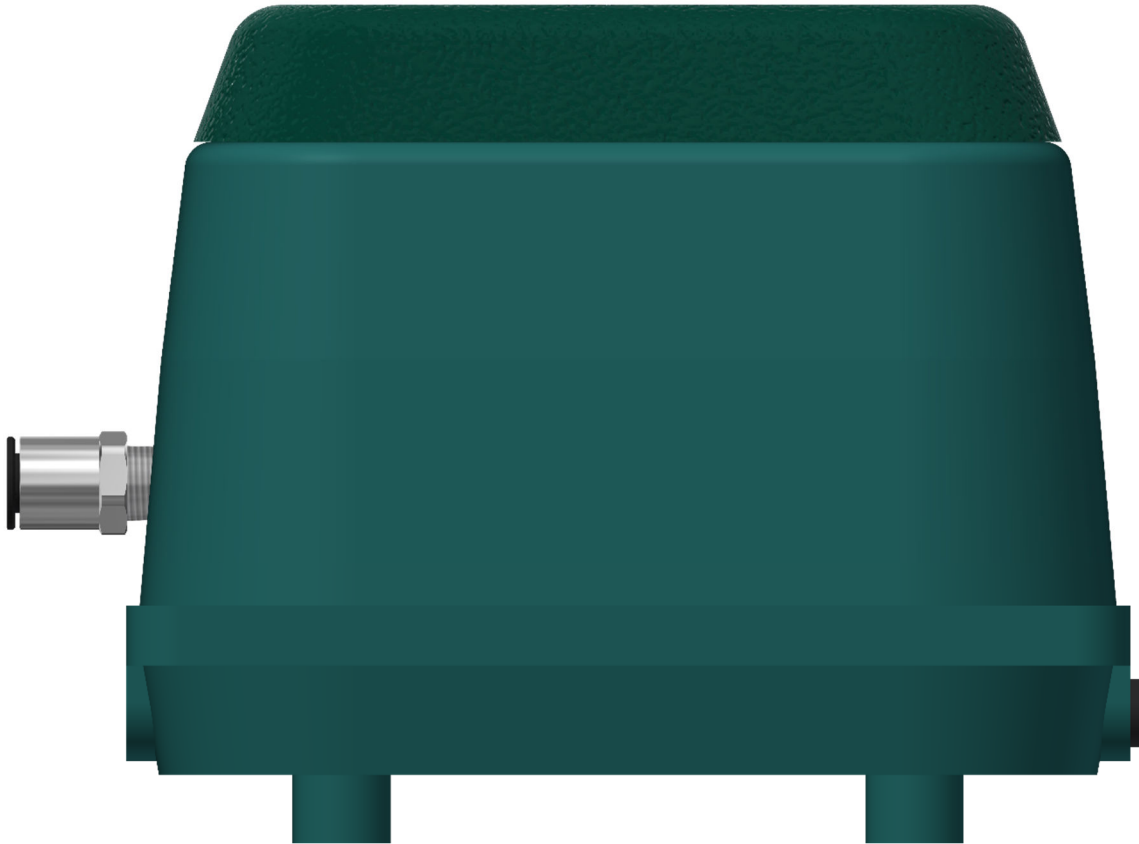
**Universal Flow Controller
Rear View**

1. **CH[1:8] & Ref** – The ports for connection of the particle-filtered and restricted 1/4" air supply lines from each cage in the system plus the reference cage.
2. **Test Out** – The output port for gas sampling.
3. **Gas Supply** – The port for connection to an external air-supply ventilation pump.
4. **12VDC = 3A** – DC coaxial jack for connection to a suitable power supply.
5. **CI-Bus** – Two (2) ports for connection to the CI-Bus.
6. **Power** – An indicator (typically green) on the top right corner of the left-most CI-Bus port which indicates connection to DC power.
7. **Rx** – An indicator (typically yellow) on the top left corner of the right-most CI-Bus port which indicates the UFC is transmitting data.
8. **Tx** – An indicator (typically green) on the top right corner of the right-most CI-Bus port which indicates the host computer is transmitting data.

3.3 Ventilation Pump

A Ventilation Pump is paired with each Universal Flow Controller (UFC) to provide the vacuum pressure and flow necessary to ventilate all of the air supply lines and cages. Typically, the pump is a HIBLOW, model 40 or 80.

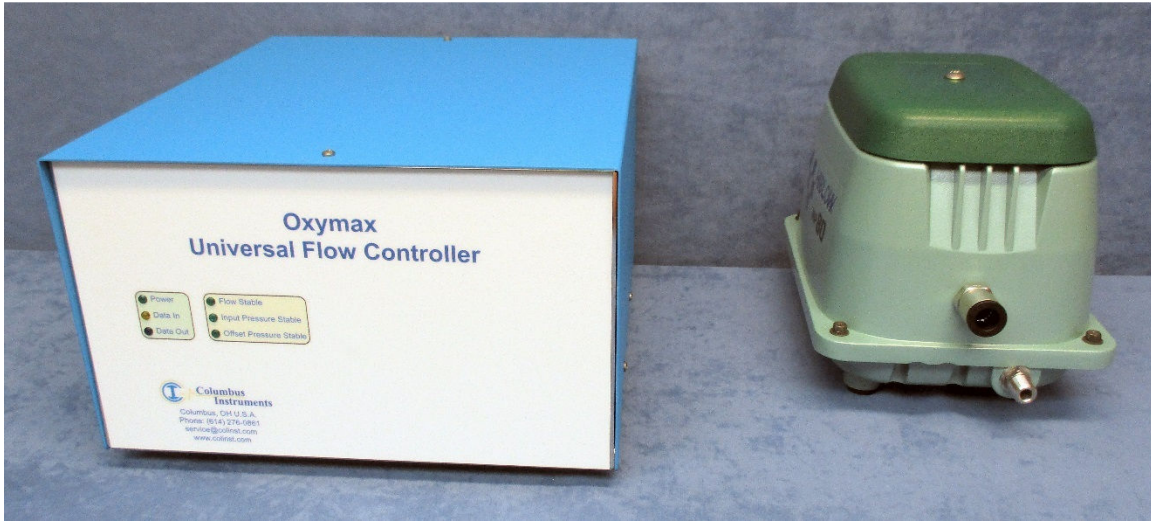
The following details the connections found on the Ventilation Pump:



1. **Vacuum Port** - The vacuum source, provided by a push-fit fitting situated in the middle of the left side of the pump.
2. **Pressure Port** - The exhaust port, provided by a 3/4" NPT MIP situated on bottom corner of the left side of the pump.
3. **Power Cord** - The power cable situated on the bottom corner of the right side of the pump for connection to a switched AC power source

3.4 Placing the Components

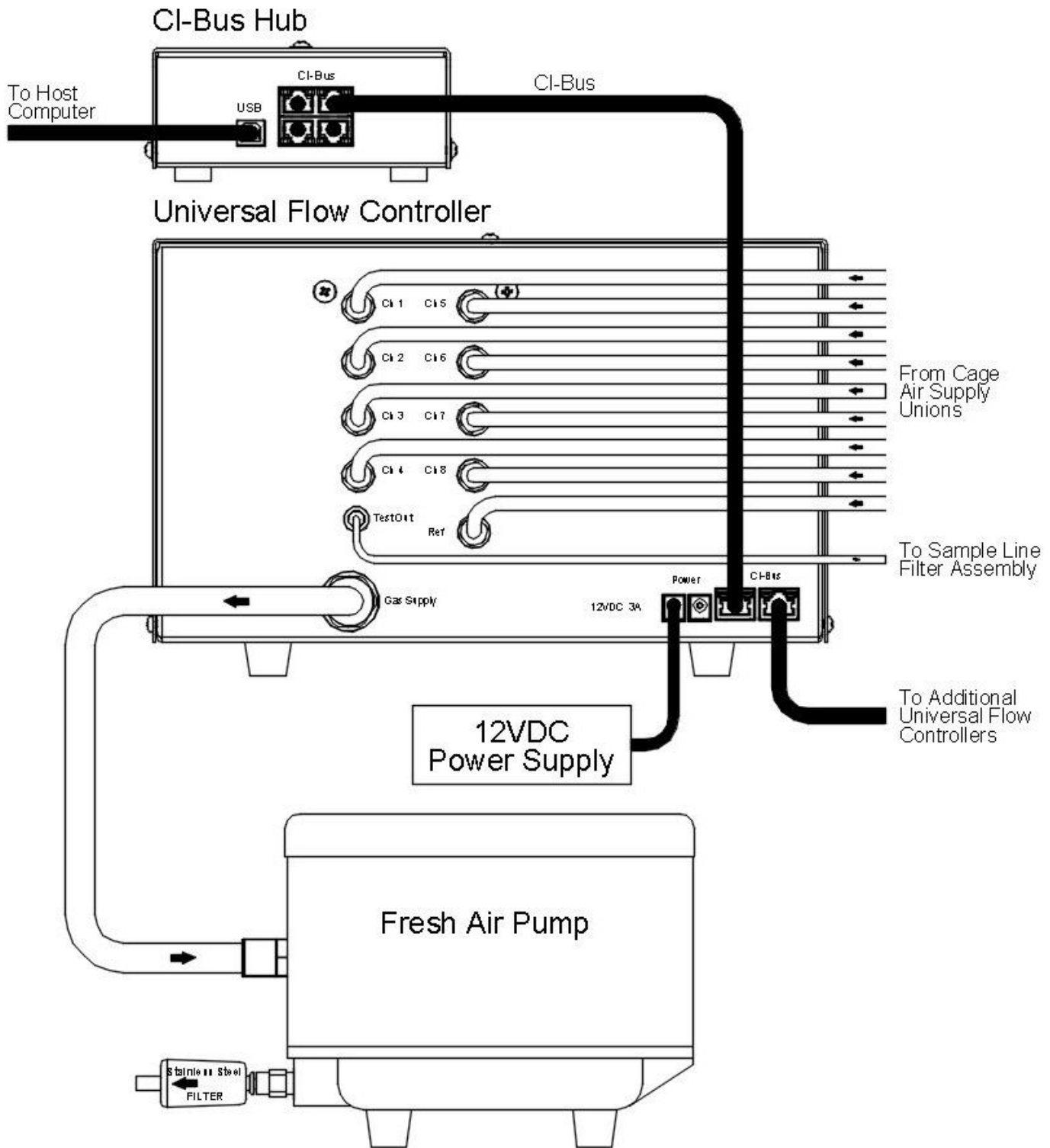
The components of the Negative Ventilation system are easy to assemble. A working surface that averages 1.0m x 0.5m (40" x 20") is required which should be situated locally and centrally to each group of up to eight cages (plus the reference cage). This can be on the bottom shelf of a rack system or on top of a temperature controlled incubator. The reference and subject cages should already be setup, each with particle filter and system specific restrictor (refer to the appropriate cage manual, specific to your system) The following details a typical layout:



You will also need the following:

- 2 x AC outlets from a common-switched source.
- 1 x suitable 12V coaxial DC power supply with AC power cord.
- 1 x ethernet cable.
- 1 x filter assembly for the ventilation pump.
- Supply of 1/2" OD natural air line.
- Supply of 1/4" OD green air line.
- 1 x CI-Bus terminator (for all of the UFCs in the system).

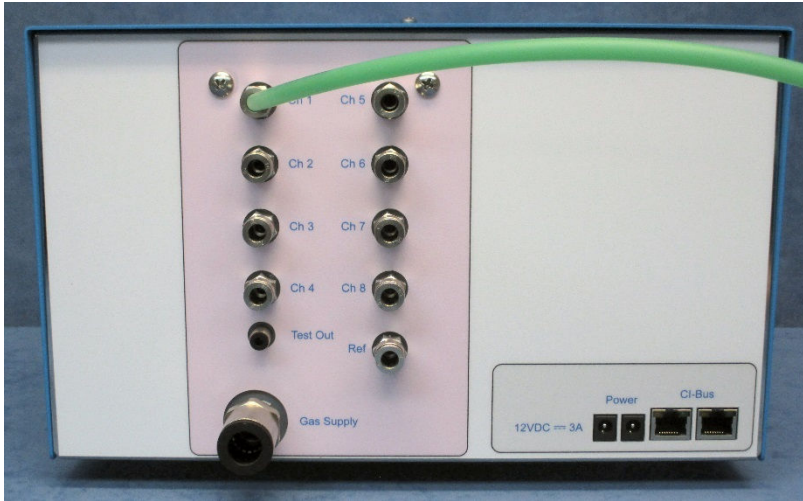
3.5 Connecting the Components



Schematic of Air and Electrical Connections of the Negative Ventilation System

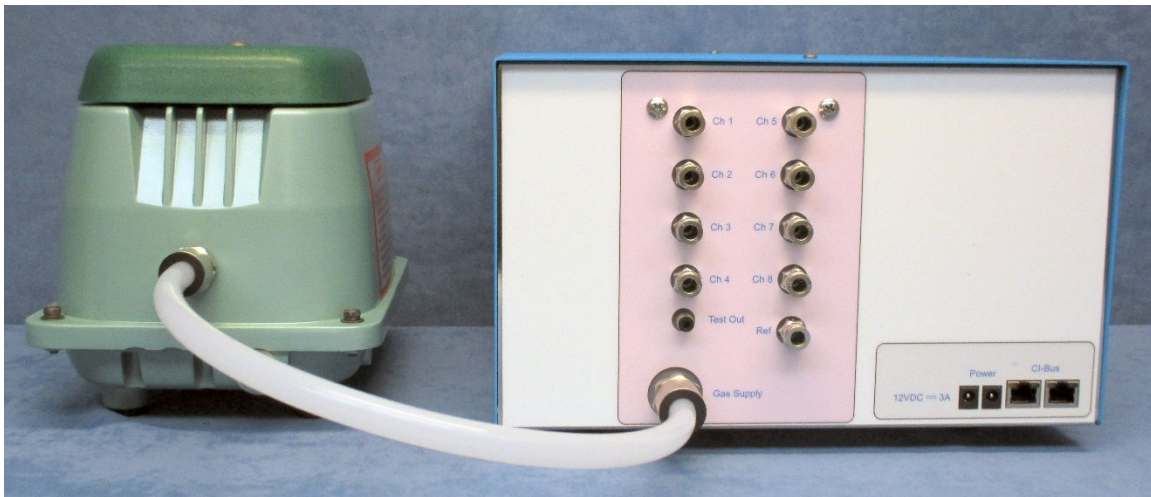
For each group of cages with UFC and ventilation pump:

- Using an appropriate length of 1/4" green air line, connect each port (Ch[1:8] and Ref) to its associated cage's air supply 1/4" union (at the end of the cage restrictor assembly).



Note – For proper operation, all channel and reference ports require a particle filter and system specific flow restrictor.

- Using an appropriate length of 1/2" natural air line, connect the vacuum port of the Ventilation Pump to the “Gas Supply” port of the UFC.



- Locate the filter assembly for the ventilation pump. It's primary purpose is to quite the noise of the pump and typically consists of serially connected filters.
- Thread the up-stream port of the filter assembly onto the output of the pump and hand-tighten.

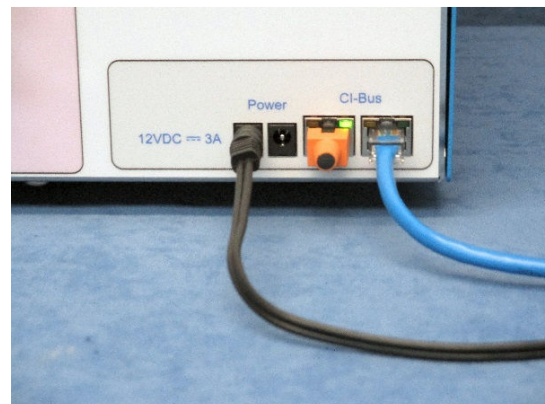
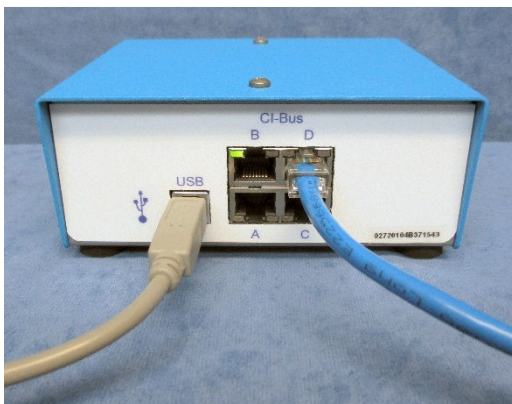


- Using the 12V power supply, connect the DC coaxial plug into the “12V = 3A” coaxial power jack of the UFC
- Using an AC power cord, connect the 12V power supply to a switched AC power source.
- Connect the Ventilation Pump to the same switched AC power source.

Note – The Ventilation Pump should never be switched ON unless its associated UFC is also switched ON.

For all UFCs:

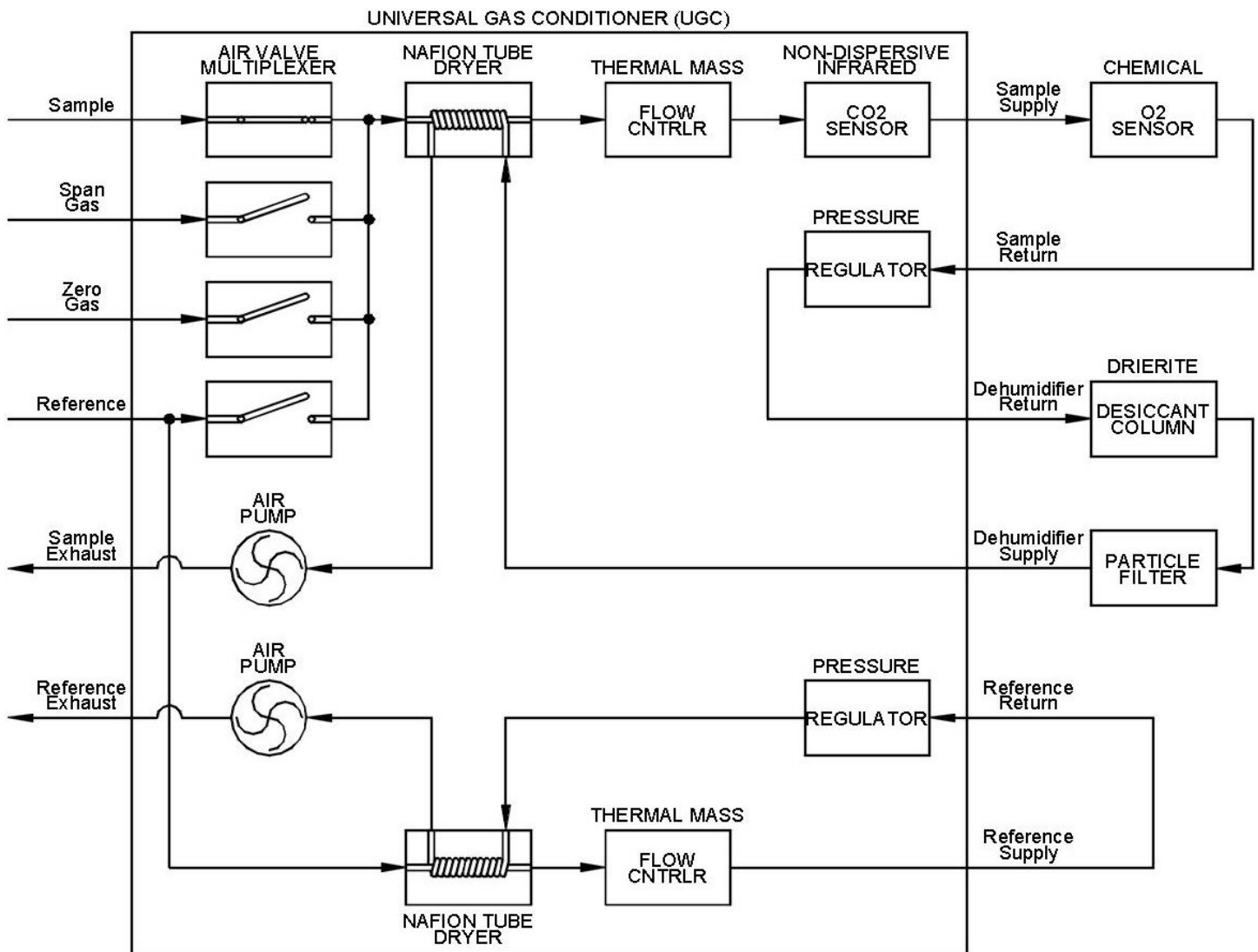
- Attach the first UFC to the CI-Bus by connecting any free port from the CI-Bus Hub to one of the ports of the UFC using an appropriate length ethernet cable.
- Attach additional UFCs to the free port of the previous one in a daisy-chain fashion.
- Place a CI-Bus Terminator into the free port of the last UFC in the daisy-chain.



Chapter 4 – Gas Sensor Chain Setup

4.1 Gas Sensor Chain Overview

In preparation for measurement, one of four gas sources: a sample from the animal cage, the zero or span calibration gas, or reference, is dried, metered and passed sequentially through serially connected gas sensors. Each sensor reports the concentration of a particular gas as a percentage. The gas sensors cabinets are placed locally to each other and central to all cages of the system, typically on a cart or flat working surface. Below is a schematic of the two most common components of the gas sensor chain: the Universal Gas Conditioner (UGC) and the Chemical Oxygen (O₂) sensor.



Gas Flow Schematic of the Universal Gas Conditioner and Chemical O₂ Sensor

4.2 Universal Gas Conditioner



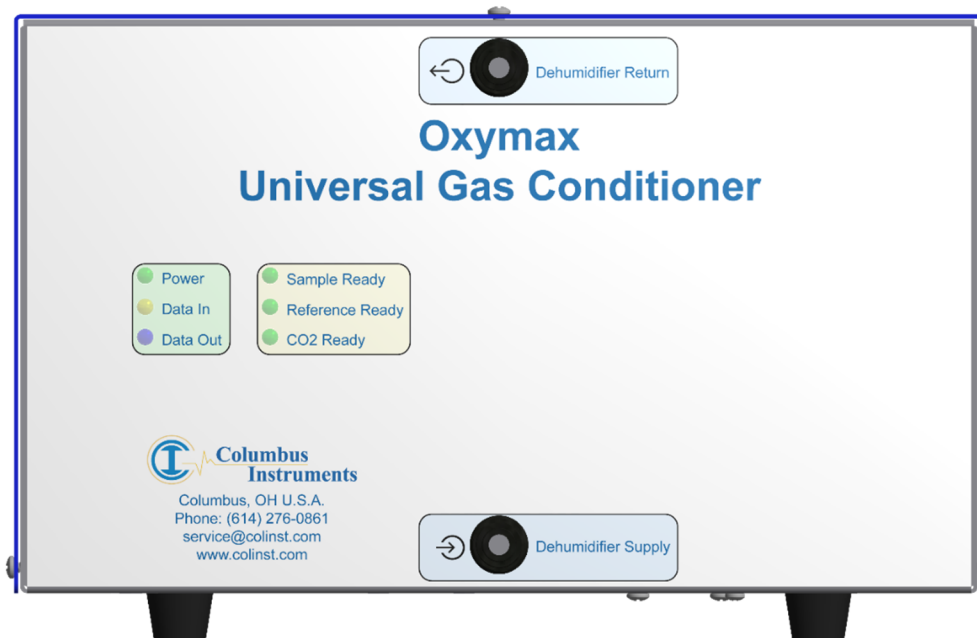
The Universal Gas Conditioner (UGC) combines the functions of prior sub-systems and components into one comprehensive unit. It comprises two Nafion tube driers, a carbon dioxide sensor (CO_2) and humidity, temperature and pressure sensors. One of four selectable gas sources is drawn into the unit where it is dried and metered for output through the integrated carbon dioxide sensor and then to other external gas sensors. The returned gases from the sensors are expelled through the exhaust ports.

The carbon dioxide sensor employs a non-dispersive infrared light source which is directed through the gas sample. Carbon dioxide gas absorbs infrared light. An infrared light detector measures the amount of absorbed light which is proportional to the concentration of carbon dioxide.

The Nafion tube drier and carbon dioxide sensor should be replaced every two (2) years for uninterrupted service.

4.2.1 Universal Gas Conditioner Specifications

Mass Flow Range:	0-1000mL/min
Mass Flow Resolution:	0.25mL/min
CO ₂ Range:	0-1%
CO ₂ Resolution:	0.0001%
Humidity Range:	0-100%
Humidity Resolution:	0.006%
Pressure Range:	15-115kPa
Pressure Resolution:	0.003kPa
Physical Size (WxHxD):	30cm x 20cm x 35cm
Physical Weight:	5kg
Power Requirements:	12VDC 2A, 12W



**Oxymax Universal Gas Conditioner (UGC)
Front View**

7. **Power** – A green light which indicates connection to a source of DC power.
8. **Data In** - A yellow light which indicates the host computer is transmitting data.
9. **Data Out** – A blue light which indicates the UGC is transmitting data.
10. **Sample Ready** - A green light which indicates the status of the gas sampling circuit.
 - OFF:** The sampling pump or circuit is switched off.
 - FLASH:** The humidity, flow, and pressure are moving toward their respective operating setpoints.
 - ON:** The humidity, flow and pressure are steady at their setpoints.
11. **Reference Ready** – A green light which indicates the status of the reference circuit:
 - OFF:** the reference pump or circuit is switched off.
 - FLASH:** The humidity, flow, and pressure are moving toward their respective operating setpoints.
 - ON:** The humidity, flow and pressure are steady at their setpoints.
12. **CO2 Ready** – A green light which indicates the status of the CO2 sensor
 - OFF:** a) the sampling pump or circuit is switched off.
b) the sampling circuit is switched on and the CO2 sensor is warming up.
 - FLASH:** A fault has been detected within the CO2 sensor.
 - ON:** the CO2 sensor has reached operating temperature and reports valid measurements.
13. **Dehumidifier Return** – The output port of gas to be dried for connection to the Drierite column(s).
14. **Dehumidifier Supply** – The input port of dry gas for connection from the particle filtered Drierite column(s).



Oxymax Universal Gas Conditioner (UGC)
Rear View

9. **Sample** – The input port for an ammonia-trapped and particle-filtered sample from a Universal Flow Controller’s selected “Test Out” port.
10. **Reference** – The input port for a particle-filtered sample from the room air reference (typically the same source provided to the cages).
11. **Span Gas** – The input port for connection from a particle filtered span gas (used for calibration of all sensors).
12. **Zero Gas** – The input port for connection from a particle filtered source of CO₂ free gas. Based upon the oxygen sensor employed, this can be a column of Soda lime or nitrogen (N₂) gas bottle.
13. **Sample Exhaust** – The output port for collection of the gas from the “Sample Return” input port.
14. **Reference Exhaust** – The output port for collection of the gas from the “Reference Return” input port.
15. **Sample Supply** – The output port for connection to the serially connected external gas sensors: oxygen, methane, etc.
16. **Sample Return** – The input port for connection from the serially connected external gas sensors.
17. **Reference Supply** – The output port for connection to the Zirconia Oxygen Sensor’s “Reference Supply” input port.
18. **Reference Return** – The input port for connection from the Zirconia Oxygen Sensor’s “Reference Return” output port.

- 19. **CI-Bus** – Two (2) ports for connection to the CI-Bus.
- 20. **Power** – An indicator (typically green) in the top left corner which indicates connection to DC power.
- 21. **Tx** – An indicator (typically green) in the bottom left corner which indicates the host computer is transmitting data.
- 22. **Rx** – An indicator (typically yellow) on the bottom right corner which indicates the UGC is transmitting data.
- 23. **12VDC – 2A** – DC coaxial jack for connection to a suitable power supply.
- 24. **Analog Input** – A 25-pin female D-SUB connector for future expansion and connection to various sensors.

4.3 Filter Columns

One or two types of filter media, housed in user-serviceable columns, are exclusively used by the Universal Gas Conditioner to trap or remove specific gases. The columns should be positioned and secured vertically in a bracket. For all columns, unfiltered gas enters the top of the column and the filtered gas is drawn from the bottom.



Two columns of Drierite and one column of Soda Lime

The following sections detail the specific filter media used and how to check and replace them.

4.3.1 Indicating Drierite

Indicating Drierite is used as a desiccant or drying agent to remove water vapor. It is naturally occurring gypsum (Anhydrous Calcium Sulfate, CaSO_4) impregnated with Cobalt Dichloride (CoCl_2). Drierite is blue in color when active and changes to pink when it absorbs moisture indicating exhaustion. One or two columns of Drierite provide more than 36 or 72 hours of continuous use respectively.

Under no circumstance should the last column of Drierite be allowed to become more than 90% exhausted (pink in color) leaving about 2cm or 1inch of blue, active media remaining. Replace exhausted media as detailed in section 4.3.3.

4.3.2 Indicating Soda Lime

Indicating soda lime is used as a scrubber to provide a carbon dioxide (CO_2) free gas source from room air. It is mostly Calcium Hydroxide ($\text{Ca}(\text{OH})_2$) and less than 4% of Sodium Hydroxide (NaOH). Soda lime is white in color when active and changes to pink when it absorbs carbon dioxide indicating exhaustion. When the Chemical or Zirconia Oxygen Sensors are employed, one column of soda lime is provided and should be replaced (in the same manner as Drierite) every five (5) years for uninterrupted service.

4.3.3 Filter Media Replacement

Both Drierite and Soda Lime are hazardous substances. They can release nuisance dust in handling or during use. They can cause eye, skin, nose, throat and upper respiratory irritation. Please wear protective gloves, protective clothing, eye protection, face protection and wash thoroughly after handling raw media. Please see their specific Material Safety Data Sheets (MSDS) for complete information.



- Disconnect the air lines from the top and bottom of the column and remove it from its holding bracket.
- Unscrew the lid and remove the spring-loaded screen and filter pad.
- Pour out the used filter media (pink color change indicated).
- Add fresh filter media to the level just below the top output port and then tap the column on a hard surface to pack and settle the material.
- Replace the filter pad, spring-loaded screen and firmly screw the lid on top of the column.
- Replace the column into the bracket and reconnect the air lines.

4.4 Ammonia Traps

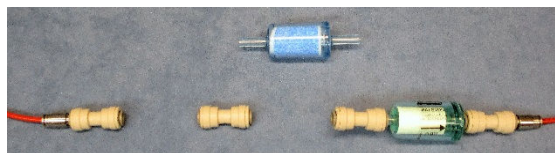


These contain copper sulfate pentahydrate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) and is used to trap ammonia (NH_3) gas which has a negative impact on the service life of the Nafion Tube drier within the Universal Gas Conditioner. The filter media is blue in color when active and changes to a 'wet' dark blue / aqua green when exhasuted. Typically, two are placed in series ahead of a particle filter in the sample line and all together are called the "Sample Line Filter Assembly".

4.4.1 Ammonia Trap Replacement

Observe the second (middle) ammonia trap in the assembly. When a color change (from blue to 'wet' dark blue / aqua green) is noted, then the first ammonia trap is completely exhausted. Use the following procedure to replace the ammonia trap:

1. Separate the first, completeley exhausted ammonia trap from the 1/4" union connectors and discard.
2. Separate the second ammonia trap from the 1/4" union connectors and save.



3. Place and connect a new ammonia trap in the middle position.
4. Place the saved, second place ammonia trap, into the first place postion preserving the orientation of the gas flow direction.



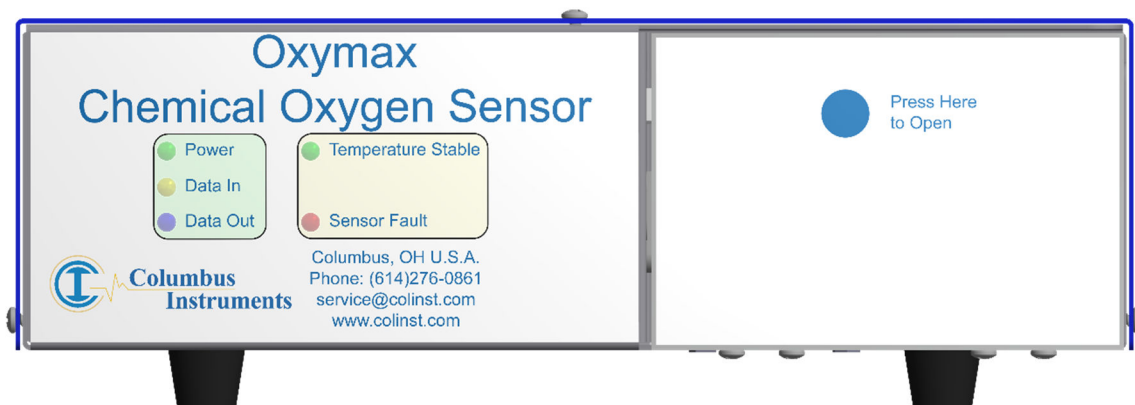
During continuous use, the exhausted media inside the trap is prevented from impairing (restricing) the flow of gases through it. In some cases, when the Oxymax system is left idle for a week or more, the partially exhausted media in the ammonia trap can "expand" and begin to restrict the gas flow. Although not completely exhausted, the trap should be replaced to ensure proper gas flow.

4.5 Particle Filters



These 0.01micron microfiber filters are placed throughout the Oxymax system to prevent particles and debris from entering and possibly impairing sensitive components. They are placed down-stream of animal cages in front of the restrictors to prevent them from clogging. They are placed down-stream of the Filter Columns and the ammonia traps to prevent dust particles from the filter media from entering the Universal Gas Conditioner. Rarely do these particle filters exhibit notable visual signs of their use. Therefore, it is recommended to change them at least once every five (5) years.

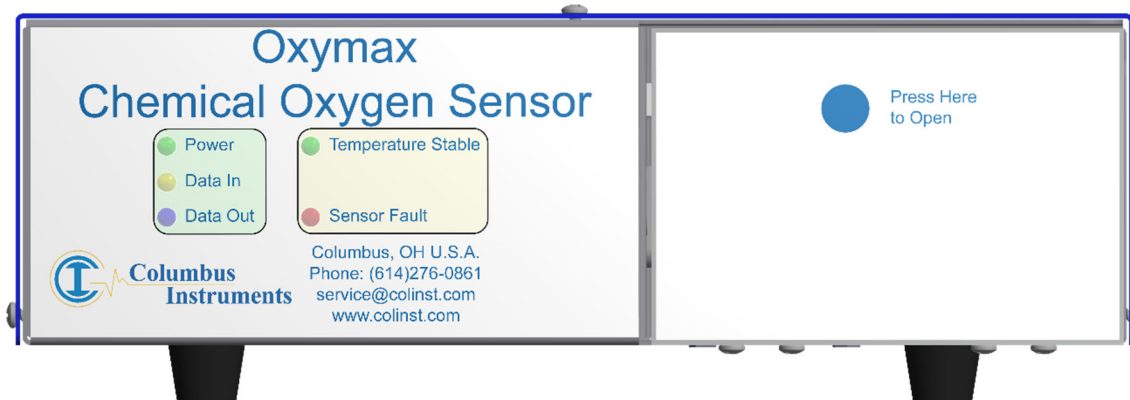
4.6 Chemical Oxygen Sensor



The Chemical Oxygen Sensor is used to measure the concentration of oxygen present in the gas sample as a percentage. Sensing is performed by an electrochemical cell. Sample air diffuses through a membrane on the end of the cell which drives a chemical reaction which generates a voltage. This voltage is proportional to the oxygen concentration in the gas sample. The cell is consumable, which should be replaced every nine (9) months to provide uninterrupted service. It produces accurate results at a rate of two (2) minutes per cage.

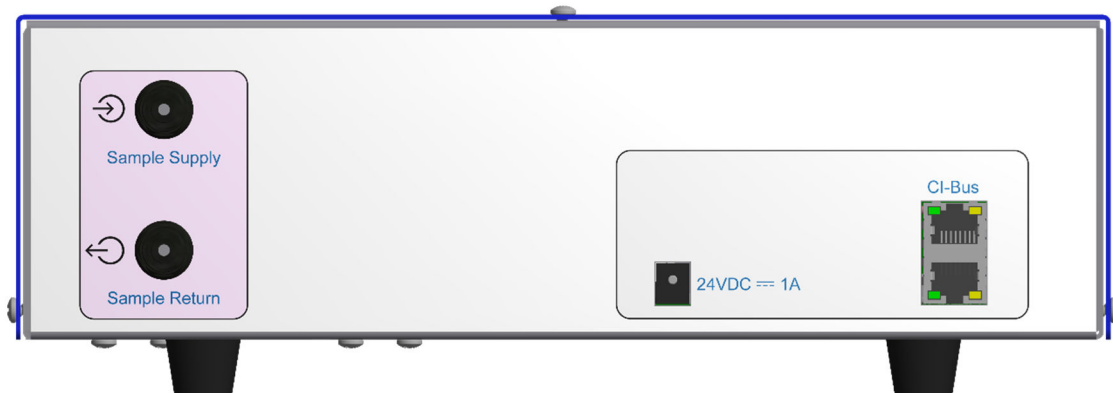
4.6.1 Chemical Oxygen Sensor Specifications

O2 Range:	0-27%
O2 Resolution:	0.0001%
Physical Size (WxHxD):	30cm x 11cm x 35cm
Physical Weight:	3kg
Power Requirements:	24VDC 1A, 12W



**Oxymax Chemical Oxygen Sensor
Front View**

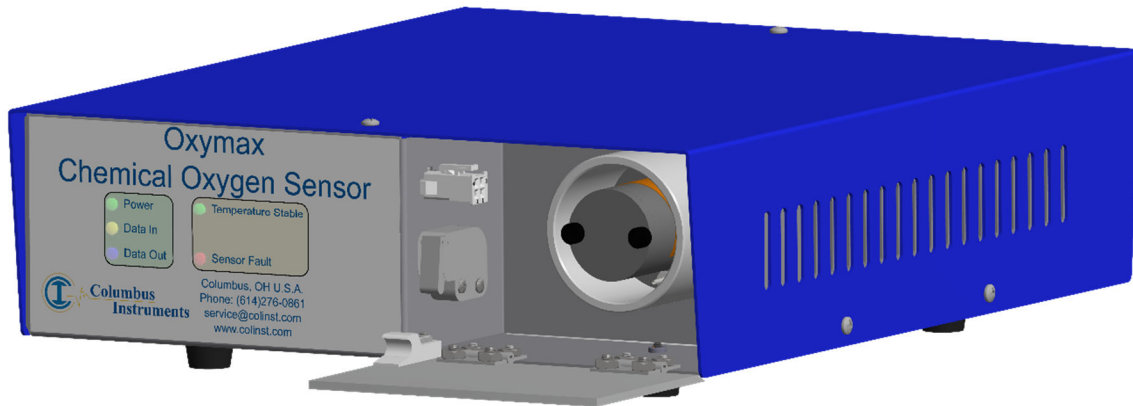
1. **Power** – A green light which indicates connection to a source of DC power.
2. **Data In** - A yellow light which indicates the host computer is transmitting data.
3. **Data Out** – A blue light which indicates the Oxygen Sensor is transmitting data.
4. **Temperature Stable** - A green light which indicates the status of the gas sampling circuit.
 - OFF:** The sample heater is switched off..
 - FLASH:** The sample temperature is moving toward it's respective operating setpoint.
 - ON:** The sample temperature is steady and reports valid measurements.
5. **Sensor Fault** – A red light which indicates the status of the sample heater circuitry:
 - OFF:** The heater circuitry is operating normally.
 - FLASH:** A fault has been detected within the heater circuitry.
6. **Sensor Compartment Door** – A push-to-open and close door which conceals the compartment for the oxygen sensor receptacle and connector.
7. **Sensor Connector** – A four(4) or two(2) pin connector used to connect the electrical output of the oxygen sensor to the measurement circuitry.
8. **Sensor Receptacle** – A temperature controlled receptacle for housing and interfacing the oxygen sensor to the sample gas.



Oxymax Chemical Oxygen Sensor
Rear View

1. **Sample Supply** – The input port for connection from the UGC’s “Sample Supply” port.
2. **Sample Return** – The output port for connection to the next gas sensor or to the UGC’s “Sample Return” port.
3. **24VDC = 1A** – DC coaxial jack for connection to a suitable power supply.
4. **CI-Bus** – Two (2) ports for connection to the CI-Bus.
5. **Power** – An indicator (typically green) in the top left corner which indicates connection to DC power.
6. **Tx** – An indicator (typically green) in the bottom left corner which indicates the host computer is transmitting data.
7. **Rx** – An indicator (typically yellow) on the bottom right corner which indicates the Oxygen Sensor is transmitting data.

4.6.2 Chemical Oxygen Sensor Replacement



When necessary, use the following procedure to replace chemical oxygen sensor.

- Access the sensor compartment by pressing the blue dot labeled: “Press Here to Open” on the front panel of the cabinet. The locking mechanism will click and allow the hinged door to fully swing down.
- Disconnect the red or black plug from the connector adapter mounted on the side of the sensor compartment.
- Remove the two screws and gray plastic cover from the sensor case and set aside.
- Using the sensor wires, pull the chemical oxygen sensor from the socket and dispose of it properly.
- Orient the replacement chemical sensor with its wires and tab toward the bottom and insert it into the sensor socket. The end of the sensor should almost be flush with the edge of the socket.
- Gather together and position the sensor's wires at the bottom of the sensor case and replace the gray plastic cover. A notch under the cover allows passage of the sensor wires from the socket.
- Then secure the cover with the two thumbscrews.
- Connect the sensor's plug into the connector adapter.
- Raise the access door to the closed position and press the blue dot again. The locking mechanism will click to secure the door.

Note: - Allow a minimum of 30 minutes for the oxygen sensor to thermally equalize with sensor case before calibration and use.

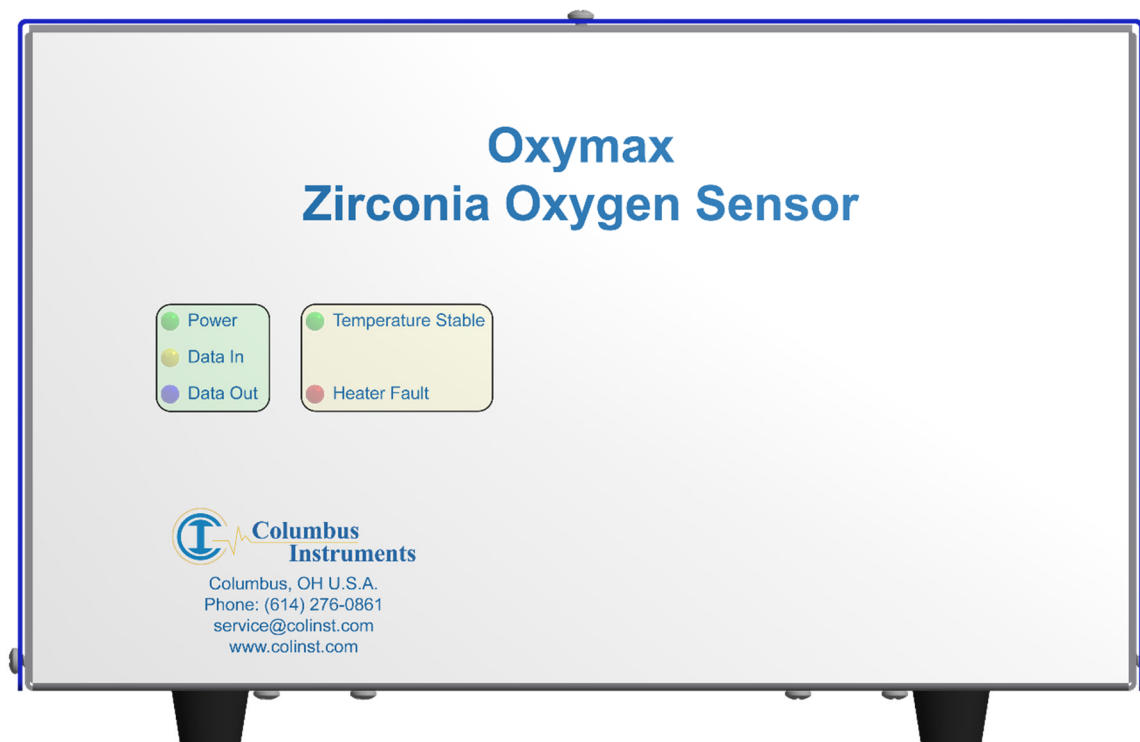
4.7 Zirconia Oxygen Sensor



The Zirconia Oxygen Sensor is used to measure the concentration of oxygen present in the gas sample as a percentage. Sensing is performed by a layer of zirconium dioxide heated to a high temperature. The sample gas is presented on one side and a reference gas to the other. The diffusion of oxygen through the layer produces a “Nernst Voltage” which is proportional to the natural log ratio of oxygen concentrations of the gases across the layer. The sensing element is consumable, which should be replaced every four (4) years to provide uninterrupted service. It has a high rate of data throughput which can produce accurate results every twenty (20) seconds per cage. This sensor is commonly employed in large, multi-channel CLAMS / Oxymax systems.

4.7.1 Zirconia Oxygen Sensor Specifications

O2 Range:	13.5%-24.5%
O2 Resolution:	0.00005%
Physical Size (WxHxD):	30cm x 20cm x 35cm
Physical Weight:	5kg
Power Requirements:	24VDC 2.7A, 24W



Oymax Zirconia Oxygen Sensor
Front View

1. **Power** – A green light which indicates connection to a source of DC power.
2. **Data In** - A yellow light which indicates the host computer is transmitting data.
3. **Data Out** – A blue light which indicates the Oxygen Sensor is transmitting data.
4. **Temperature Stable** - A green light which indicates the status of the gas sampling circuit.
 - OFF:** The sample heater is switched off..
 - FLASH:** The sample temperature is moving toward it's respective operating setpoint.
 - ON:** The sample temperature is steady and reports valid measurements.
5. **Sensor Fault** – A red light which indicates the status of the sample heater circuitry:
 - OFF:** The heater circuitry is operating normally.
 - FLASH:** A fault has been detected within the heater circuitry.



Oxymax Zirconia Oxygen Sensor
Rear View

1. **Sample Supply** – The input port for connection from the UGC’s “Sample Supply” port.
2. **Sample Return** – The output port for connection to the UGC’s “Sample Return” port.
3. **Reference Supply** – The input port for connection from the UGC’s “Reference Supply” port.
4. **Reference Return** – The output port for connection to the UGC’s “Reference Return” port.
5. **24VDC – 2.7A** – DC coaxial jack for connection to a suitable power supply.
6. **CI-Bus** – Two (2) ports for connection to the CI-Bus.
7. **Power** – An indicator (typically green) in the top left corner which indicates connection to DC power.
8. **Tx** – An indicator (typically green) in the bottom left corner which indicates the host computer is transmitting data.
9. **Rx** – An indicator (typically yellow) on the bottom right corner which indicates the Oxygen Sensor is transmitting data.

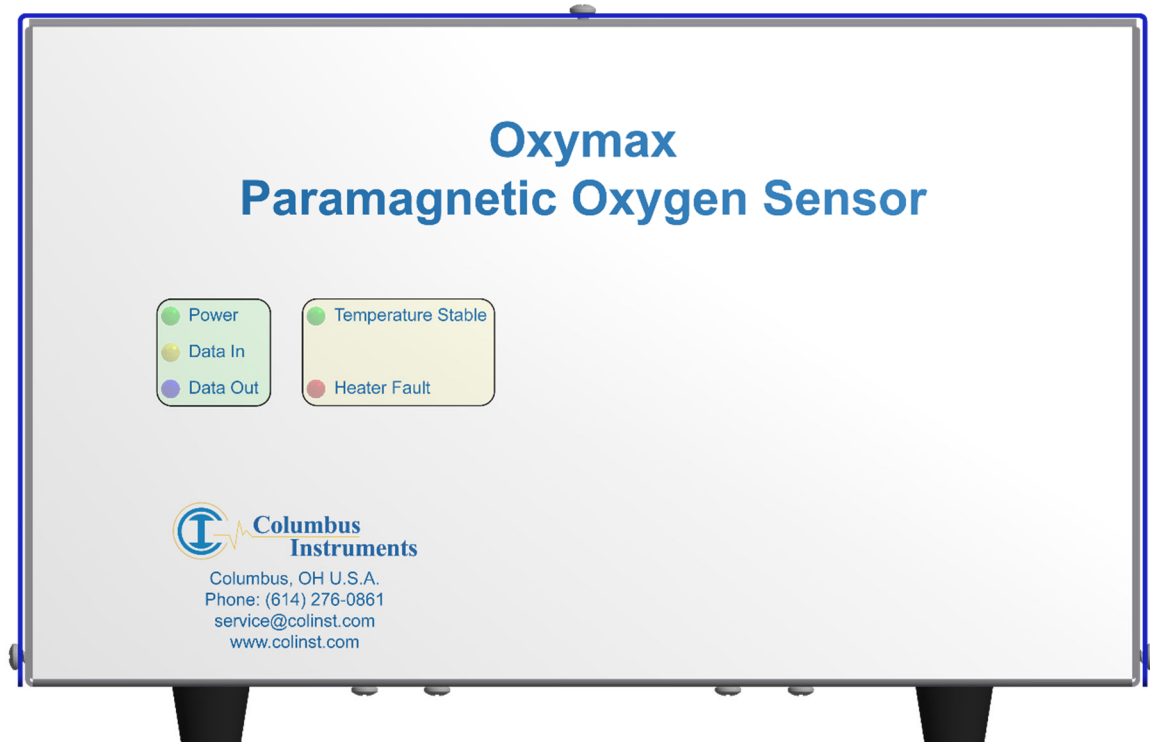
4.8 Paramagnetic Oxygen Sensor



The Paramagnetic Oxygen Sensor is used to measure the concentration of oxygen present in the gas sample as a percentage. Sensing is performed by a glass dumbbell assembly suspended in a magnetic field which twists when exposed to oxygen. An electric current is used to counteract the twist in which its magnitude is proportional to the concentration of oxygen in the gas sample. The sensor is maintenance free with no consumable element and can be calibrated within any range inclusive of 0-100%. It produces accurate results at a rate of two (2) minutes per cage.

4.8.1 Paramagnetic Oxygen Sensor Specifications

O2 Range:	0%-40%
O2 Resolution:	0.0001%
Physical Size (WxHxD):	30cm x 20cm x 35cm
Physical Weight:	5kg
Power Requirements:	24VDC 2.7A, 20W



Oxymax Paramagnetic Oxygen Sensor
Front View

1. **Power** – A green light which indicates connection to a source of DC power.
2. **Data In** - A yellow light which indicates the host computer is transmitting data.
3. **Data Out** – A blue light which indicates the Oxygen Sensor is transmitting data.
4. **Temperature Stable** - A green light which indicates the status of the gas sampling circuit.
 - OFF:** The sample heater is switched off..
 - FLASH:** The sample temperature is moving toward it's respective operating setpoint.
 - ON:** The sample temperature is steady and reports valid measurements.
5. **Sensor Fault** – A red light which indicates the status of the sample heater circuitry:
 - OFF:** The heater circuitry is operating normally.
 - FLASH:** A fault has been detected within the heater circuitry.



Oxymax Paramagnetic Oxygen Sensor
Rear View

1. **Sample Supply** – The input port for connection from the UGC’s “Sample Supply” port.
2. **Sample Return** – The output port for connection to the next gas sensor or to the UGC’s “Sample Return” port.
3. **24VDC – 2.7A** – DC coaxial jack for connection to a suitable power supply.
4. **CI-Bus** – Two (2) ports for connection to the CI-Bus.
5. **Power** – An indicator (typically green) in the top left corner which indicates connection to DC power.
6. **Tx** – An indicator (typically green) in the bottom left corner which indicates the host computer is transmitting data.
7. **Rx** – An indicator (typically yellow) on the bottom right corner which indicates the Oxygen Sensor is transmitting data.

Chapter 5 – Chemical Oxygen Sensor Setup

5.1 Placing the Components with the Chemical Oxygen Sensor

The components of the Gas Sensor Chain are easy to assemble. A working surface that averages 1.0m x 0.5m (40" x 20") is required. It would be best if there is access to the front, rear and right sides of the working surface. The components are best placed as follows from the right (the side edge of the working surface) to the left: Filter Columns, Universal Gas Conditioner, and the Chemical Oxygen Sensor. Each CLAMS/Oxymax system ships with a detailed schematic drawing detailing the expected connections for that system. Typically, the color of each port indicates the typical color of tubing for connection. The following sections detail the typical connections for each component of the system.

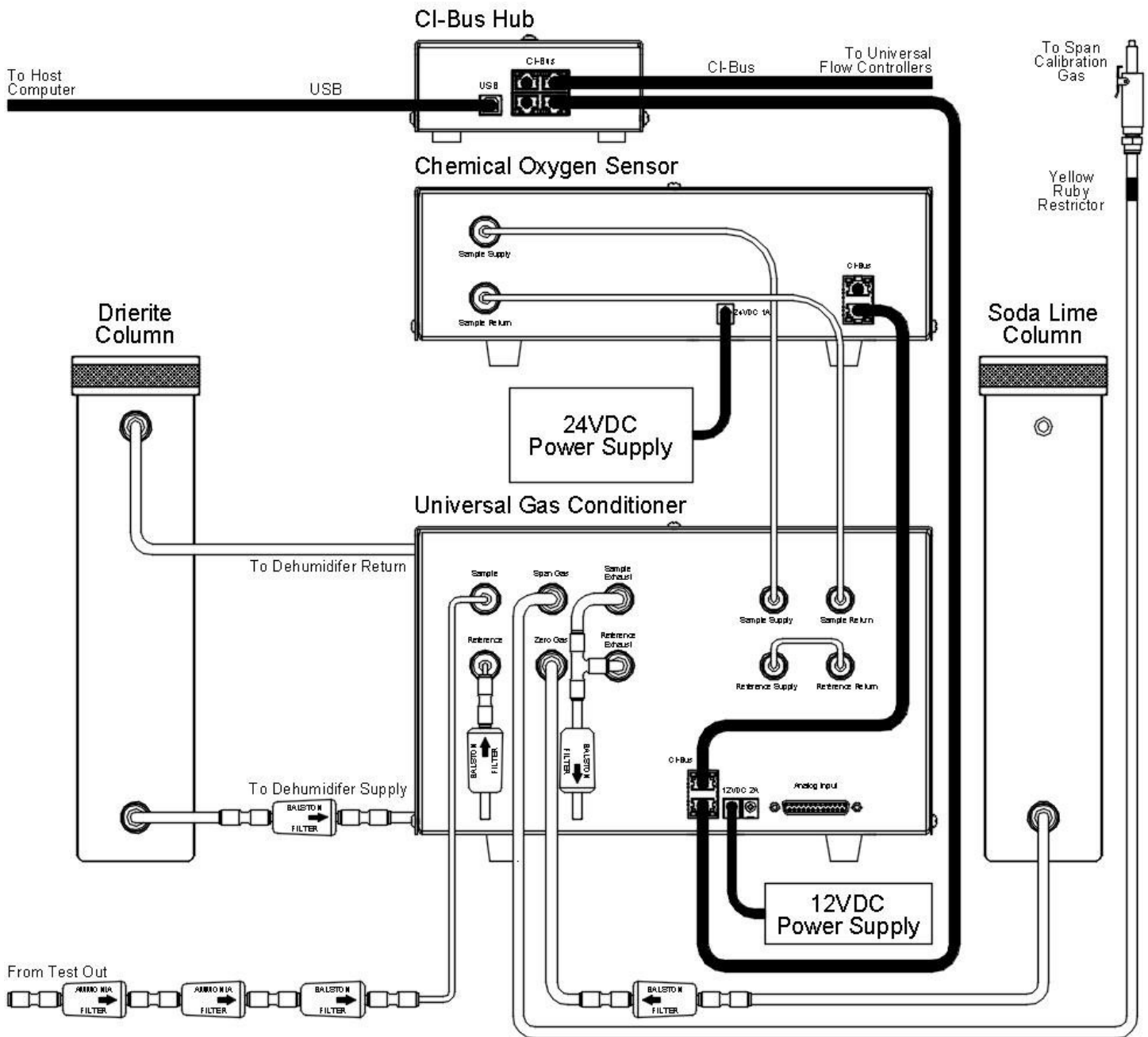


Chemical Oxygen Sensor, Universal Gas Conditioner, Filter Columns

You will also need the following:

- 1 x 12VDC power supply with AC power cord for the Universal Gas Conditioner
- 1 x 24VDC power supply with AC power cord for the Chemical Oxygen Sensor.
- 2 x ethernet cables for CI-Bus communication connections.
- Supply of 1/4" OD air line (red, blue, yellow and natural recommended).
- Supply of 1/8" OD air line (red and blue recommended)
- Dehumidifier Supply Filter Assembly.
- Sample Line Filter Assembly
- Reference Filter Assembly.
- Zero Gas Filter Assembly.
- Span Gas Supply Assembly
- Exhaust Port Filter Assembly
- Tubing cutter.

5.2 Connecting the Components with the Chemical Oxygen Sensor



Schematic of Air and Electrical Connections with the Chemical Oxygen Sensor

5.2.1 Assembling the Dehumidifier

- Locate the Dehumidifier Supply Filter Assembly. It consists of a Parker/Balston filter with a 1/4" union connector over each end and a short section of 1/4" blue air line connected to the down-stream port



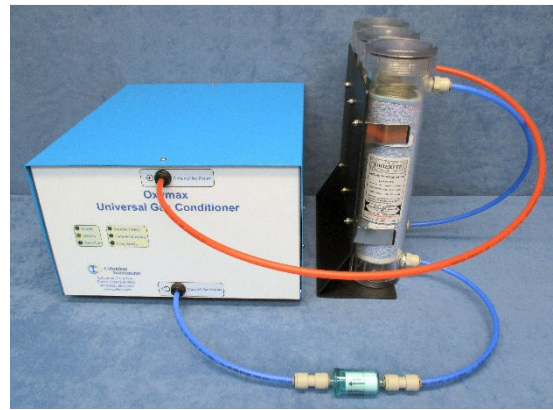
- Connect the 1/4" blue air line of the Dehumidifier Supply Filter Assembly to the "Dehumidifier Supply" port of the UGC.
- Using an appropriate length of 1/4" blue air line, connect the filter end to the bottom port of the Drierite column.



- If two Drierite columns are present, use an appropriate length of 1/4" blue air line and connect the top port of the first column to the bottom port of the next.

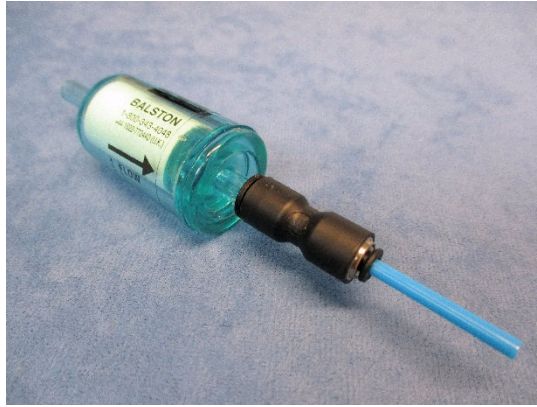


- Using an appropriate length of 1/4" red air line,, connect the top port of the Drierite column to the “Dehumidifier Return” port of the UGC.

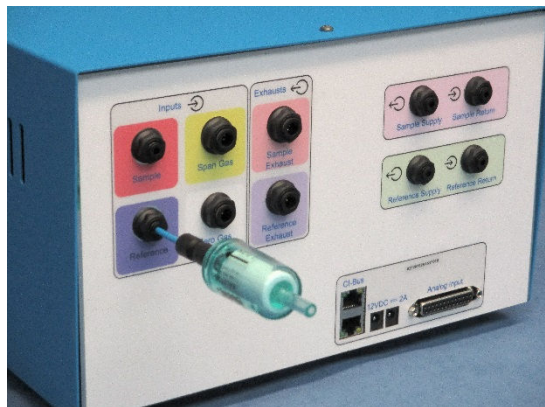


5.2.2 Assembling the Reference Source

- Locate the Reference Filter Assembly. It consists of a Parker/Balston particle filter with a black 1/4" to 1/8" reducing union and a short length of 1/8" blue tubing.

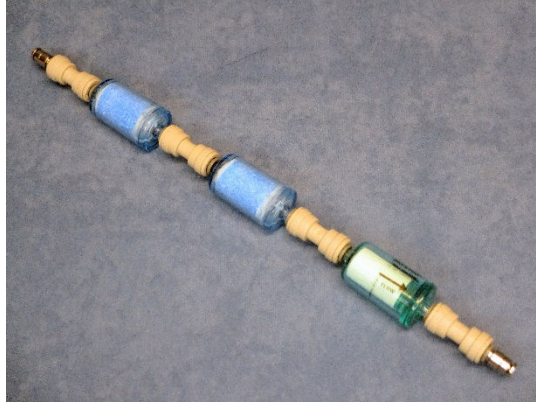


- Fully insert the free end of the 1/8" blue tube into the Input "Reference" port of the UGC.

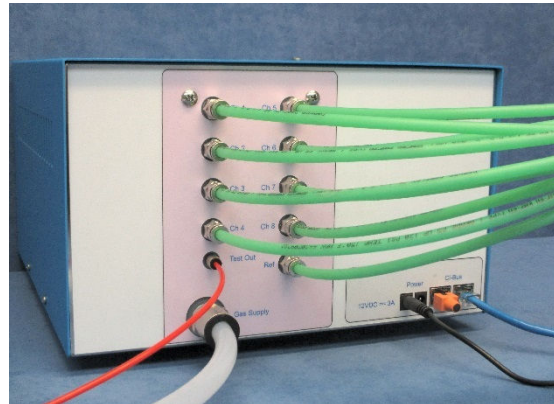
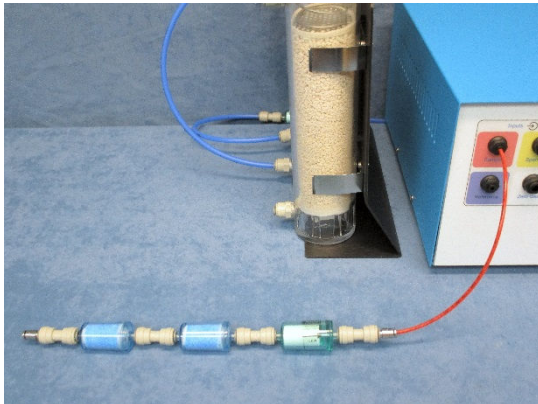


5.2.3 Assembling the Sample Line

- Locate the Sample Line Filter Assembly. It consists of two blue ammonia traps and one Parker/Balston particle filter all serially connected together using 1/4" union connectors with 1/8" air line ports on each end.

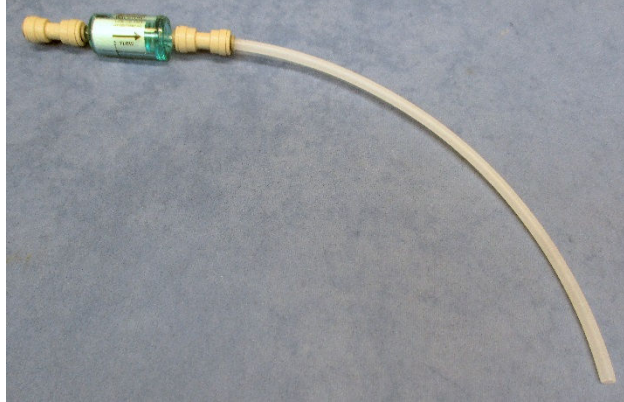


- Position the assembly near the UGC and use an appropriate length of 1/8" red air line to connect the down-stream port of the filter (the end with the particle filter) to the "Sample" port of the UGC.
- Using an appropriate length of 1/8" red air line, connect the up-stream port of the filter (the end with an ammonia trap) to the "Test Out" port of the Universal Flow Controller.



5.2.4 Assembling the Zero Gas Source

- Locate the Zero Gas Filter Assembly. It consists of a Parker/Balston filter with a 1/4" union connector over each end and a short section of 1/4" natural air line connected to the down-stream port



- Connect the 1/4" natural air line of the Zero Gas Filter Assembly to the "Zero Gas" port of the UGC.
- Using an appropriate length of 1/4" natural air line, connect the filter end to the bottom port of the Soda Lime column. The top port is open to room air.

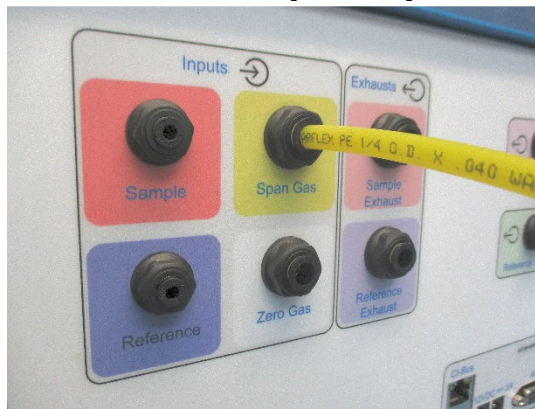


5.2.5 Assembling the Span Gas Source

- Locate the Span Gas Supply Assembly. It consists of 6 meters (20 feet) or more of yellow 1/4" air line joining with a male quick-connect fitting plug and a yellow ruby restrictor.



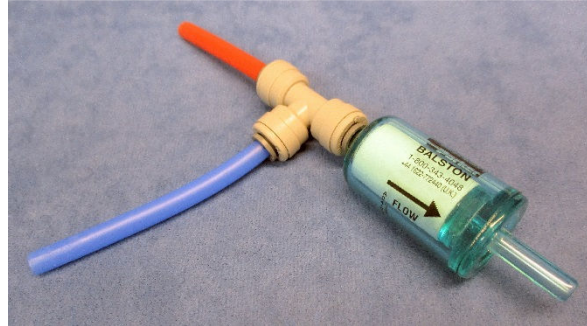
- Connect the free end of the air line to the "Span Gas" port of the UGC.



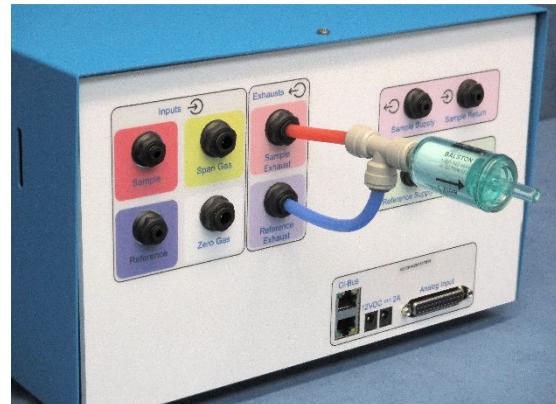
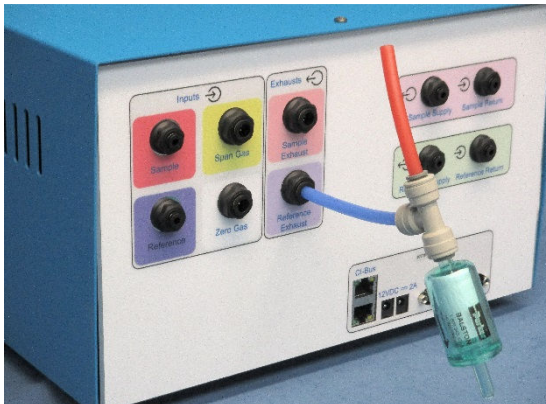
Form the length of the air line into a coil and store in a non-obtrusive location.

5.2.6 Assembling the Exhaust Ports

- Locate the Exhaust Port Filter Assembly. It consists of a 1/4" tee fitting already connected with short lengths of red and blue air line and a Parker/Balston particle filter.

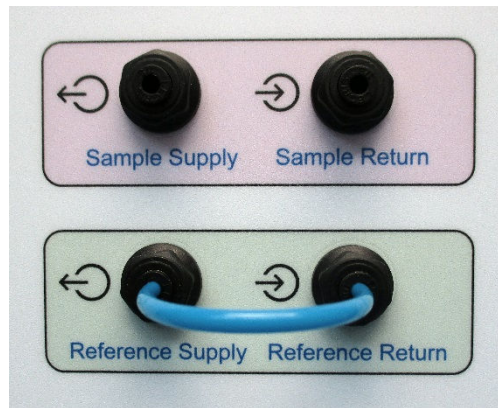


- Fully insert the free end of the 1/4" blue air line into the "Reference Exhaust" port of the UGC.
- Then fully insert the free end of the 1/4" red air line into the "Sample Exhaust" port of the UGC. The filter should now be oriented horizontally, projecting away from the UGC.



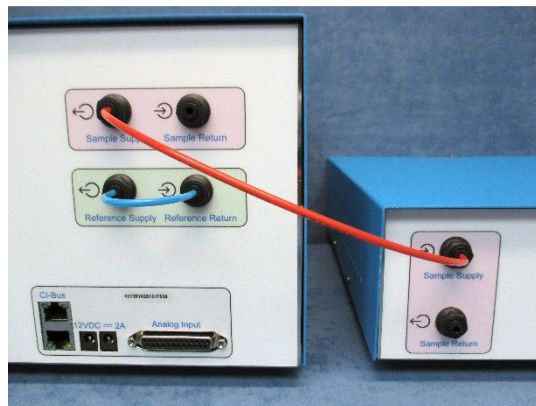
5.2.7 Sensor Reference Tubing Connections

- Using a short length of 1/8" blue air line, connect the output "Reference Supply" port to the input "Reference Return" port on the UGC

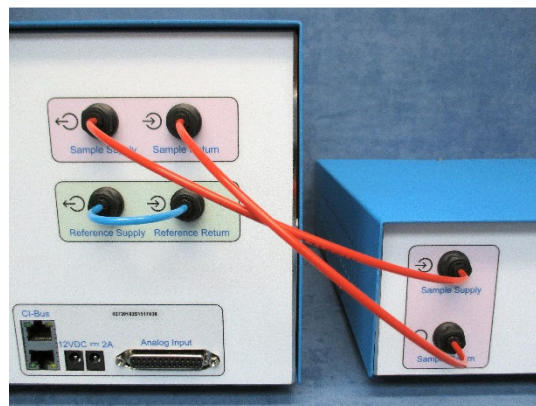


5.2.8 Sensor Sample Tubing Connections

- Using an appropriate length of 1/8" red air line, connect the output "Sample Supply" port of the UGC to the input "Sample Supply" port of the Oxygen Sensor.



- Using an appropriate length of 1/8" red air line, connect the output "Sample Return" port of the Oxygen Sensor to the input "Sample Return" port of the UGC.



5.2.9 Electrical Power Connections

- Using the 24V power supply, connect the DC coaxial plug into the “24V = 1A” coaxial power jack of the Chemical Oxygen Sensor.
- Using an AC power cord, connect the 24V power supply to an AC power source.
- Using the 12V power supply, connect the DC coaxial plug into the “12V = 2A” coaxial power jack of the UGC.
- Using an AC power cord, connect the 12V power supply to an AC power source.

Note – The UGC should only be connected to an active AC power source after all of the gas ports have been properly connected with particle filters where appropriate.

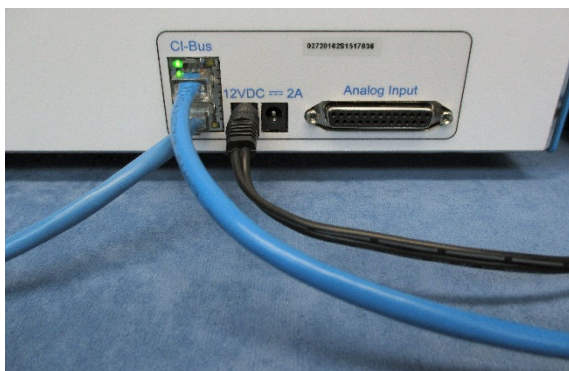
This will prevent debris from being drawn into the unit where it may restrict and clog the internal faculties of the Universal Gas Conditioner.

5.2.10 CI-Bus Connections

- Attach the UGC to the CI-Bus by connecting any free port from the CI-Bus Hub to one of the ports of the UGC using an appropriate length ethernet cable.



- Attach the Oxygen Sensor to the CI-Bus by connecting the free port of the UGC to one of the free ports of the Oxygen Sensor.
- Place a CI-Bus Terminator into the free port of the Oxygen Sensor.



Chapter 6 – Zirconia Oxygen Sensor Setup

6.1 Placing the Components with the Zirconia Oxygen Sensor

The components of the Gas Sensor Chain are easy to assemble. A working surface that averages 1.0m x 0.5m (40" x 20") is required. It would be best if there is access to the front, rear and right sides of the working surface. The components are best placed as follows from the right (the side edge of the working surface) to the left: Filter Columns, Universal Gas Conditioner, and the Zirconia Oxygen Sensor. Each CLAMS/Oxymax system ships with a detailed schematic drawing detailing the expected connections for that system. Typically, the color of each port indicates the typical color of tubing for connection. The following sections detail the typical connections for each component of the system.

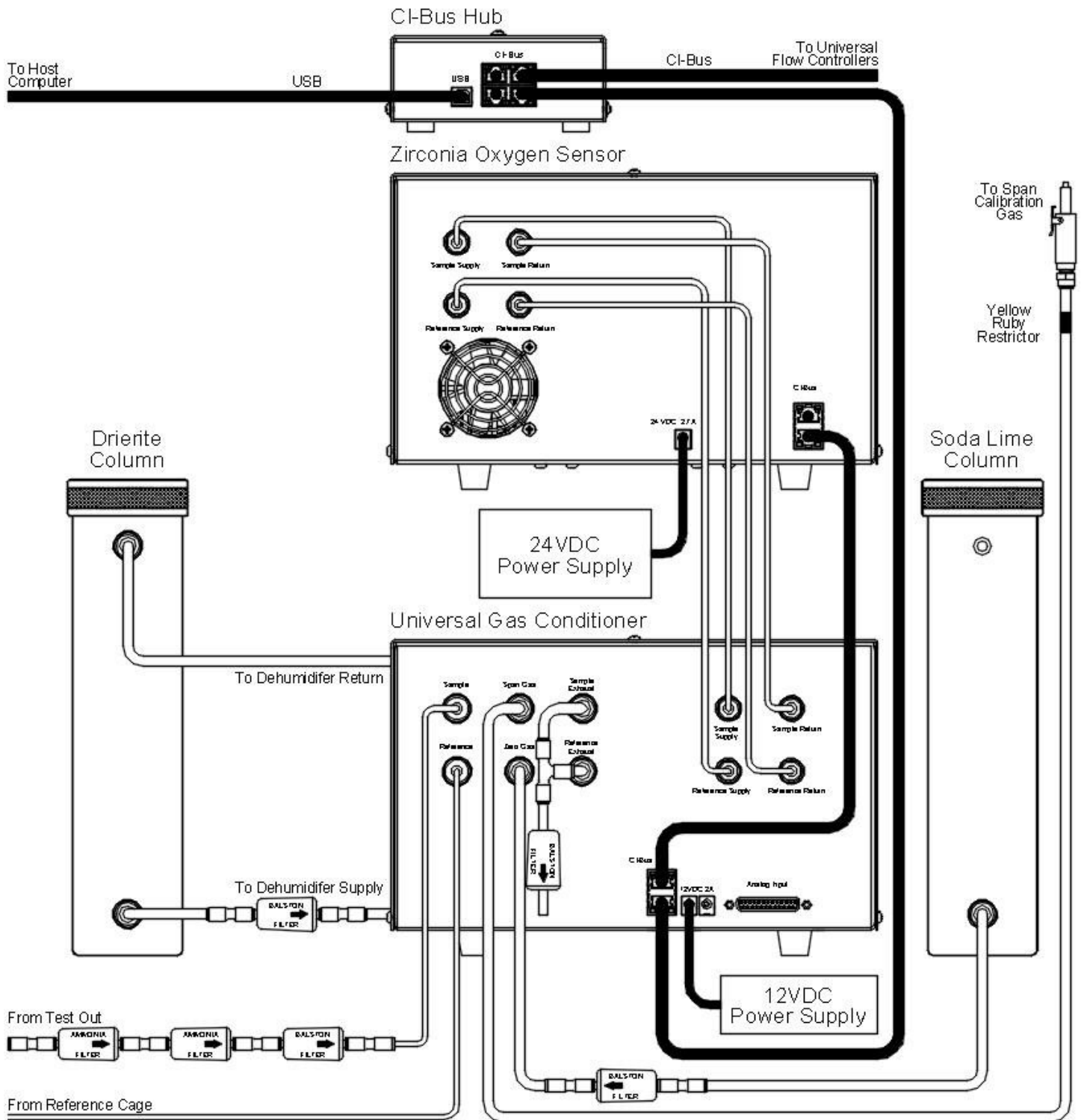


Zirconia Oxygen Sensor, Universal Gas Conditioner, Filter Columns

You will also need the following:

- 1 x 12VDC power supply with AC power cord for the Universal Gas Conditioner
- 1 x 24VDC power supply with AC power cord for the Zirconia Oxygen Sensor.
- 2 x ethernet cables for CI-Bus communication connections.
- Supply of 1/4" OD air line (red, blue, yellow and natural recommended).
- Supply of 1/8" OD air line (red and blue recommended)
- Dehumidifier Supply Filter Assembly.
- Sample Line Filter Assembly
- Zero Gas Filter Assembly.
- Span Gas Supply Assembly
- Exhaust Port Filter Assembly
- Tubing cutter.

6.2 Connecting the Components with the Zirconia Oxygen Sensor



Schematic of Air and Electrical Connections with the Zirconia Oxygen Sensor

6.2.1 Assembling the Dehumidifier

- Locate the Dehumidifier Supply Filter Assembly. It consists of a Parker/Balston filter with a 1/4" union connector over each end and a short section of 1/4" blue air line connected to the down-stream port



- Connect the 1/4" blue air line of the Dehumidifier Supply Filter Assembly to the "Dehumidifier Supply" port of the UGC.
- Using an appropriate length of 1/4" blue air line, connect the filter end to the bottom port of the Drierite column.



- If two Drierite columns are present, use an appropriate length of 1/4" blue air line and connect the top port of the first column to the bottom port of the next.

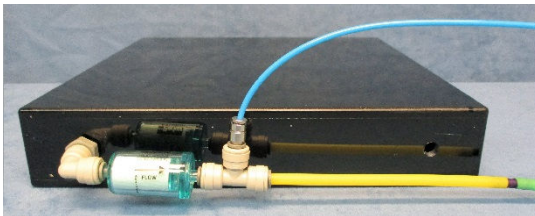


- Using an appropriate length of 1/4" red air line,, connect the top port of the Drierite column to the "Dehumidifier Return" port of the UGC.



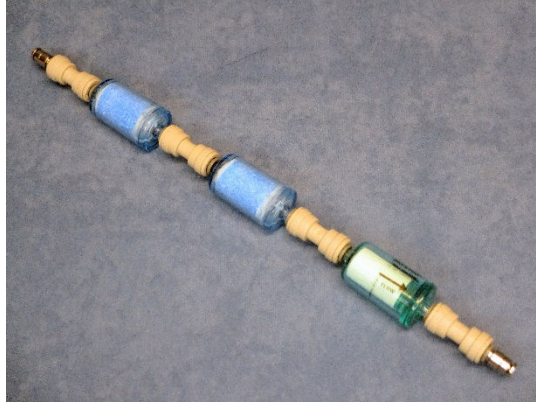
6.2.2 Assembling the Reference Source

- Using an appropriate length of 1/8" blue air line, connect the source of reference gas (typically from a tee fitting placed in the air supply line of the Reference Cage) to the Input "Reference" port of the UGC.

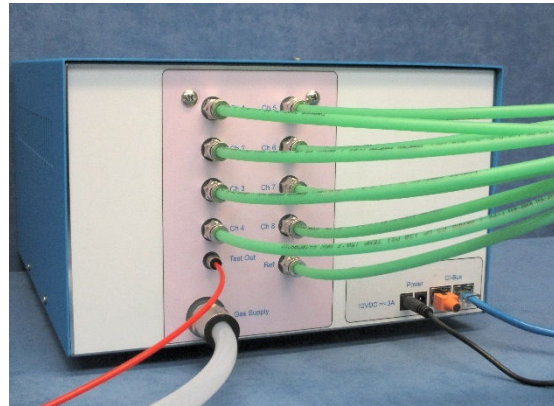
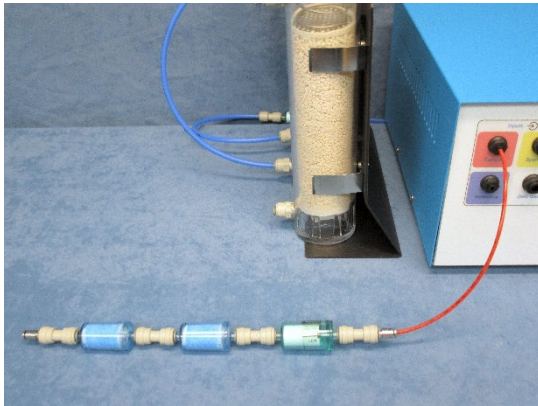


6.2.3 Assembling the Sample Line Filter

- Locate the Sample Line Filter Assembly. It consists of two blue ammonia traps and one Parker/Balston particle filter all serially connected together using 1/4" union connectors with 1/8" air line ports on each end.

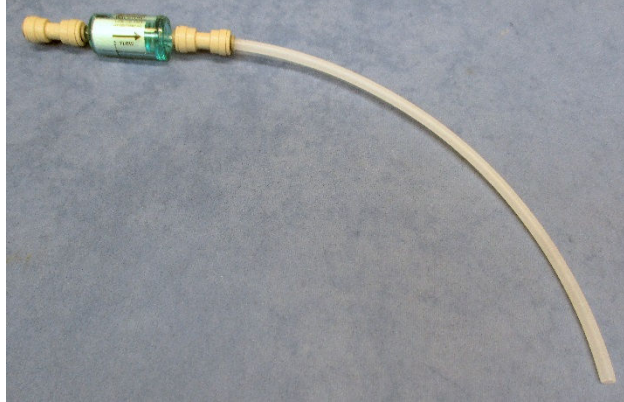


- Position the assembly near the UGC and use an appropriate length of 1/8" red air line to connect the down-stream port of the filter (the end with the particle filter) to the "Sample" port of the UGC.
- Using an appropriate length of 1/8" red air line, connect the up-stream port of the filter (the end with an ammonia trap) to the "Test Out" port of the Universal Flow Controller.



6.2.4 Assembling the Zero Gas Source

- Locate the Zero Gas Filter Assembly. It consists of a Parker/Balston filter with a 1/4" union connector over each end and a short section of 1/4" natural air line connected to the down-stream port



- Connect the 1/4" natural air line of the Zero Gas Filter Assembly to the "Zero Gas" port of the UGC.
- Using an appropriate length of 1/4" natural air line, connect the filter end to the bottom port of the Soda Lime column. The top port is open to room air.

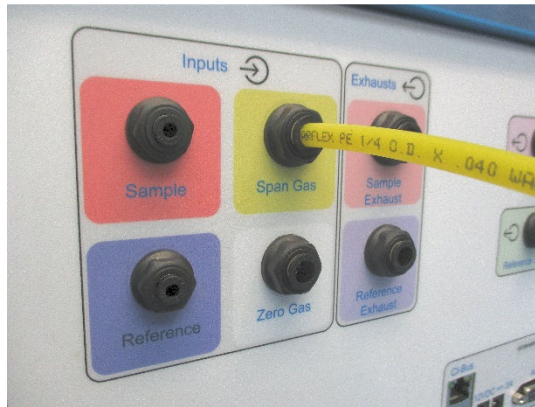


6.2.5 Assembling the Span Gas Source

- Locate the Span Gas Supply Assembly. It consists of 6 meters (20 feet) or more of yellow 1/4" air line joining with a male quick-connect fitting plug and a yellow ruby restrictor.



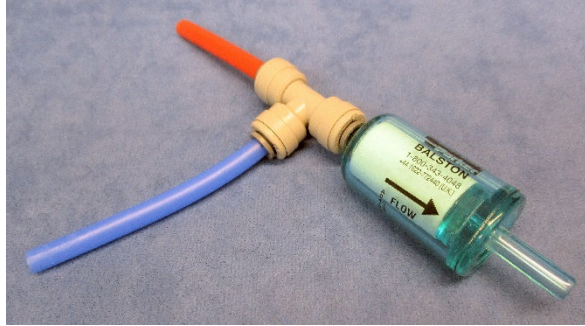
- Connect the free end of the air line to the "Span Gas" port of the UGC.



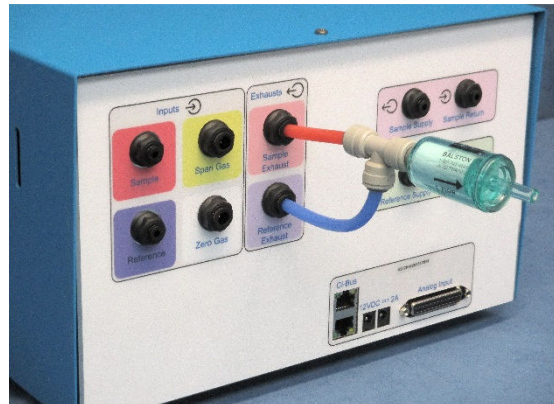
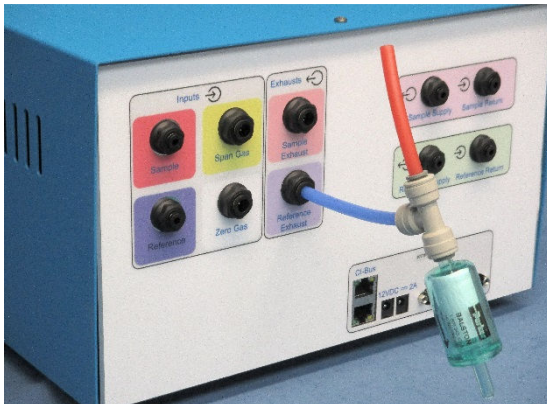
Form the length of the air line into a coil and store in a non-obtrusive location.

6.2.6 Assembling the Exhaust Ports

- Locate the Exhaust Port Filter Assembly. It consists of a 1/4" tee fitting already connected with short lengths of red and blue air line and a Parker/Balston particle filter.

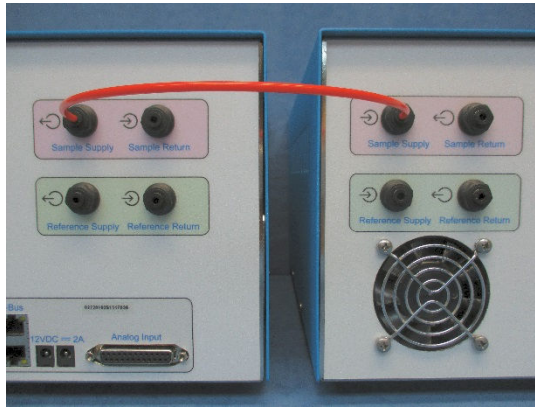


- Fully insert the free end of the 1/4" blue air line into the "Reference Exhaust" port of the UGC.
- Then fully insert the free end of the 1/4" red air line into the "Sample Exhaust" port of the UGC. The filter should now be oriented horizontally, projecting away from the UGC.

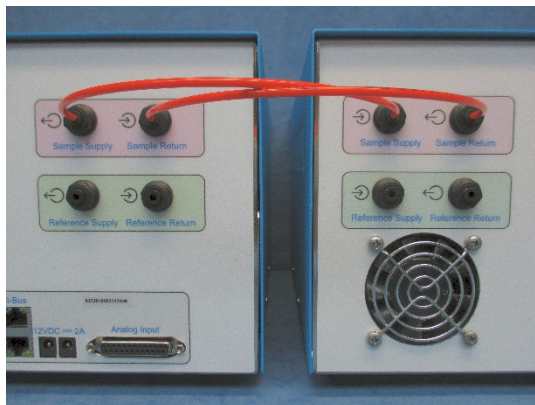


6.2.7 Sensor Sample Tubing Connections

- Using an appropriate length of 1/8" red air line, connect the output "Sample Supply" port of the UGC to the input "Sample Supply" port of the Oxygen Sensor.



- Using an appropriate length of 1/8" red air line, connect the output "Sample Return" port of the Oxygen Sensor to the input "Sample Return" port of the UGC.

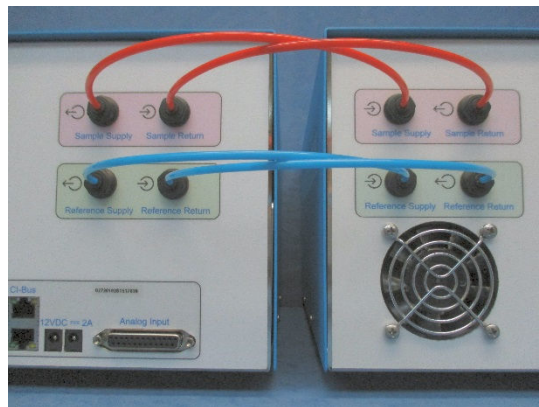


6.2.8 Sensor Reference Tubing Connections

- Using an appropriate length of 1/8" blue air line, connect the output "Reference Supply" port of the UGC to the input "Reference Supply" port of the Oxygen Sensor.



- Using an appropriate length of 1/8" blue air line, connect the output "Reference Return" port of the Oxygen Sensor to the "Sample Return" port of the UGC.



6.2.9 Electrical Power Connections

- Using the 24V power supply, connect the DC coaxial plug into the “24V \approx 2.7A” coaxial power jack of the Zirconia Oxygen Sensor.
- Using an AC power cord, connect the 24V power supply to an AC power source.
- Using the 12V power supply, connect the DC coaxial plug into the “12V \approx 2A” coaxial power jack of the UGC.
- Using an AC power cord, connect the 12V power supply to an AC power source.

Note – The UGC should only be connected to an active AC power source after all of the gas ports have been properly connected with particle filters where appropriate.

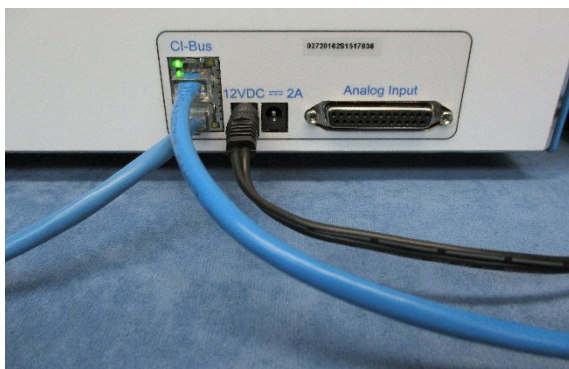
This will prevent debris from being drawn into the unit where it may restrict and clog the internal faculties of the Universal Gas Conditioner.

6.2.10 CI-Bus Connections

- Attach the UGC to the CI-Bus by connecting any free port from the CI-Bus Hub to one of the ports of the UGC using an appropriate length ethernet cable.



- Attach the Oxygen Sensor to the CI-Bus by connecting the free port of the UGC to one of the free ports of the Oxygen Sensor.
- Place a CI-Bus Terminator into the free port of the Oxygen Sensor.



Chapter 7 – Paramagnetic Oxygen Sensor Setup

7.1 Placing the Components with the Paramagnetic Oxygen Sensor

The components of the Gas Sensor Chain are easy to assemble. A working surface that averages 1.0m x 0.5m (40" x 20") is required. It would be best if there is access to the front, rear and right sides of the working surface. The components are best placed as follows from the right (the side edge of the working surface) to the left: Filter Columns, Universal Gas Conditioner, and the Paramagnetic Oxygen Sensor. Each CLAMS/Oxymax system ships with a detailed schematic drawing detailing the expected connections for that system. Typically, the color of each port indicates the typical color of tubing for connection. The following sections detail the typical connections for each component of the system.

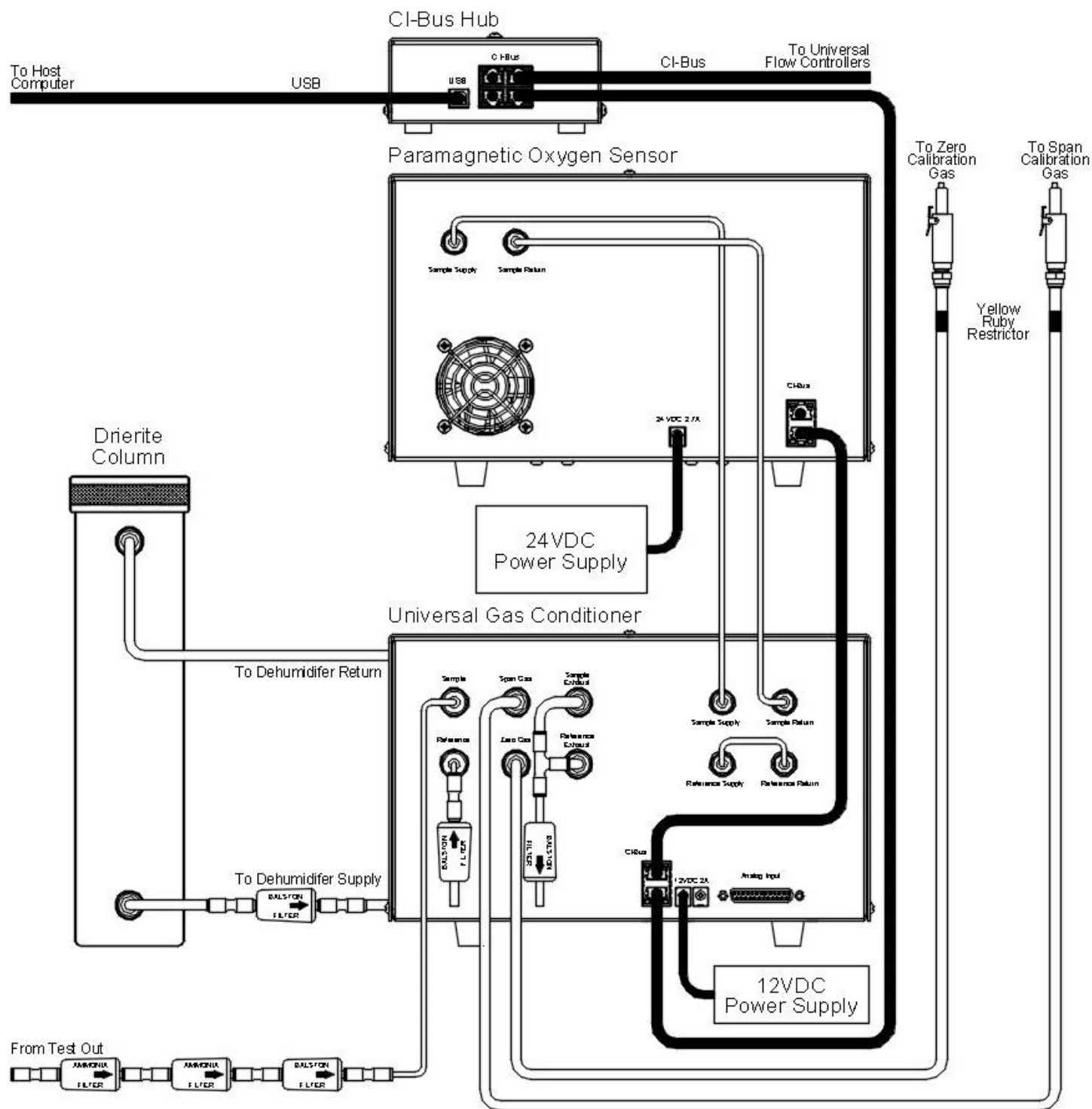


Zirconia Oxygen Sensor, Universal Gas Conditioner, Filter Columns

You will also need the following:

- 1 x 12VDC power supply with AC power cord for the Universal Gas Conditioner
- 1 x 24VDC power supply with AC power cord for the Paramagnetic Oxygen Sensor.
- 2 x ethernet cables for CI-Bus communication connections.
- Supply of 1/4" OD air line (red, blue, yellow and natural recommended).
- Supply of 1/8" OD air line (red and blue recommended)
- Dehumidifier Supply Filter Assembly.
- Sample Line Filter Assembly
- Zero Gas Supply Assembly.
- Span Gas Supply Assembly
- Exhaust Port Filter Assembly
- Tubing cutter.

7.2 Connecting the Components with the Paramagnetic Oxygen Sensor



Schematic of Air and Electrical Connections with the Paramagnetic Oxygen Sensor

7.2.1 Assembling the Dehumidifier

- Locate the Dehumidifier Supply Filter Assembly. It consists of a Parker/Balston filter with a 1/4" union connector over each end and a short section of 1/4" blue air line connected to the down-stream port



- Connect the 1/4" blue air line of the Dehumidifier Supply Filter Assembly to the "Dehumidifier Supply" port of the UGC.
- Using an appropriate length of 1/4" blue air line, connect the filter end to the bottom port of the Drierite column.



- If two Drierite columns are present, use an appropriate length of 1/4" blue air line and connect the top port of the first column to the bottom port of the next.

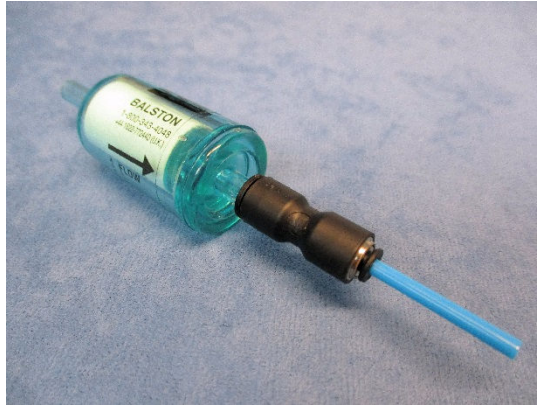


- Using an appropriate length of 1/4" red air line,, connect the top port of the Drierite column to the “Dehumidifier Return” port of the UGC.

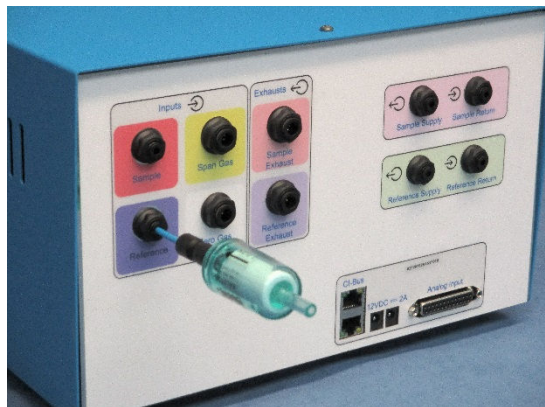


7.2.2 Assembling the Reference Source

- Locate the Reference Filter Assembly. It consists of a Parker/Balston particle filter with a black 1/4" to 1/8" reducing union and a short length of 1/8" blue tubing.



- Fully insert the free end of the 1/8" blue tube into the Input "Reference" port of the UGC.

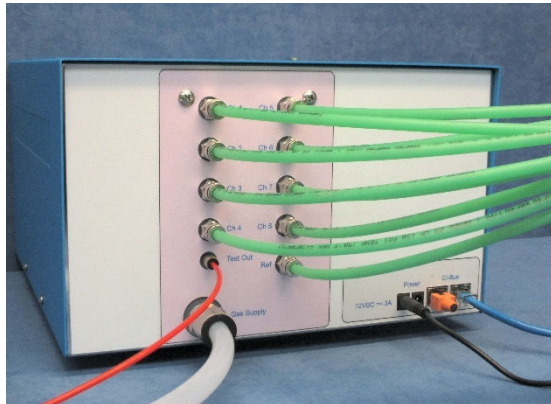
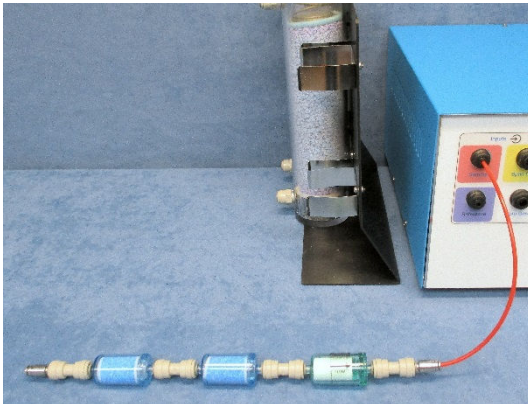


7.2.3 Assembling the Sample Line

- Locate the Sample Line Filter. It consists of two blue ammonia traps and one Parker/Balston particle filter all serially connected together using 1/4" union connectors with 1/8" air line ports on each end.

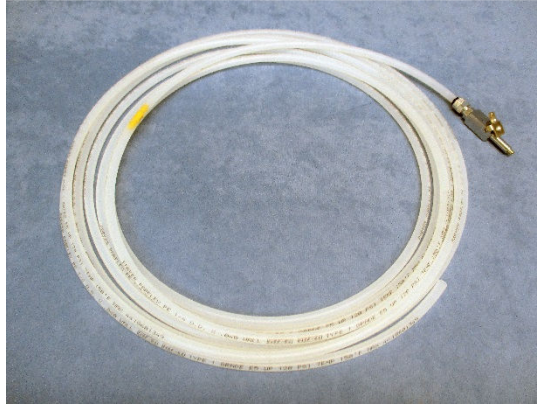


- Position the assembly near the UGC and use an appropriate length of 1/8" red air line to connect the down-stream port of the filter (the end with the particle filter) to the "Sample" port of the UGC.
- Using an appropriate length of 1/8" red air line, connect the up-stream port of the filter (the end with an ammonia trap) to the "Test Out" port of the Universal Flow Controller.

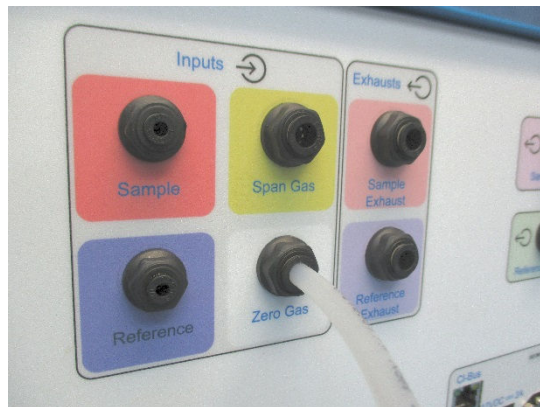


7.2.4 Assembling the Zero Gas Source

- Locate the Zero Gas Supply Assembly. It consists of 6 meters (20 feet) or more of natural 1/4" air line joining with a male quick-connect fitting plug and a yellow ruby restrictor.



- Connect the free end of the air line to the "Zero Gas" port of the UGC.



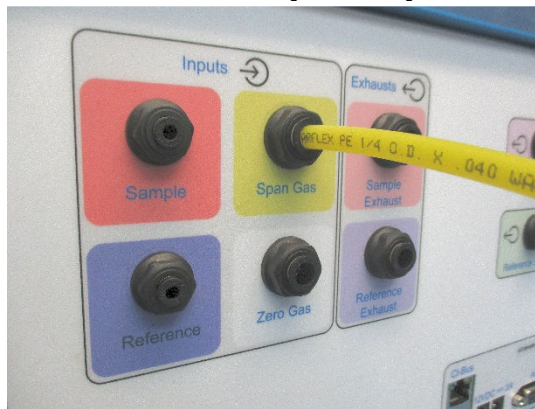
Form the length of the air line into a coil and store in a non-obtrusive location.

7.2.5 Assembling the Span Gas Source

- Locate the Span Gas Supply Assembly. It consists of 6 meters (20 feet) or more of yellow 1/4" air line joining with a male quick-connect fitting plug and a yellow ruby restrictor.



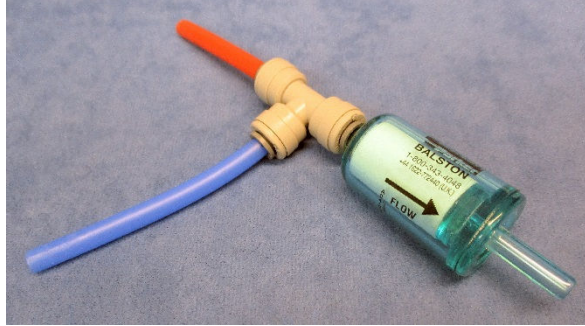
- Connect the free end of the air line to the "Span Gas" port of the UGC.



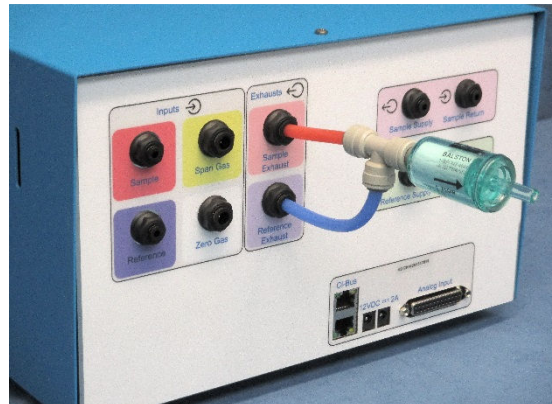
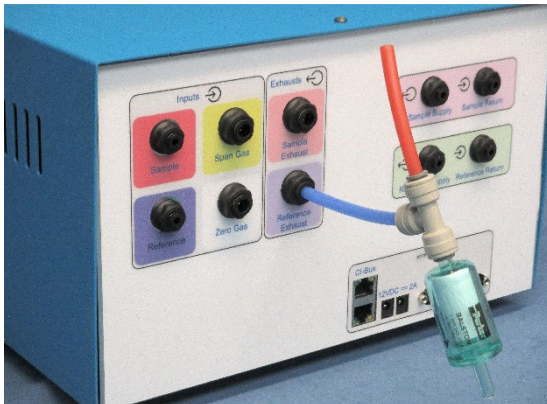
Form the length of the air line into a coil and store in a non-obtrusive location.

7.2.6 Assembling the Exhaust Ports

- Locate the Exhaust Port Filter Assembly. It consists of a 1/4" tee fitting already connected with a short length of red and blue tubes and a Parker/Balston particle filter.

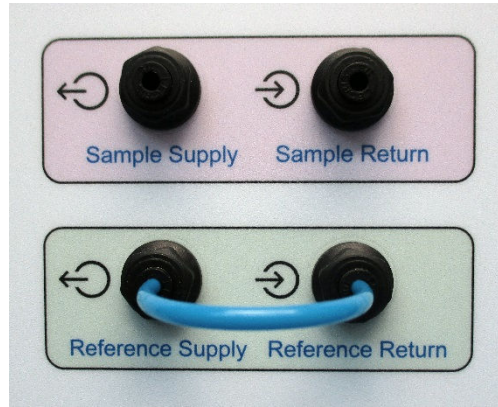


- Fully insert the free end of the 1/4" blue tube into the "Reference Exhaust" port of the UGC.
- Then fully insert the free end of the 1/4" red tube into the "Sample Exhaust" port of the UGC. The filter should now be positioned horizontally, projecting away from the UGC.



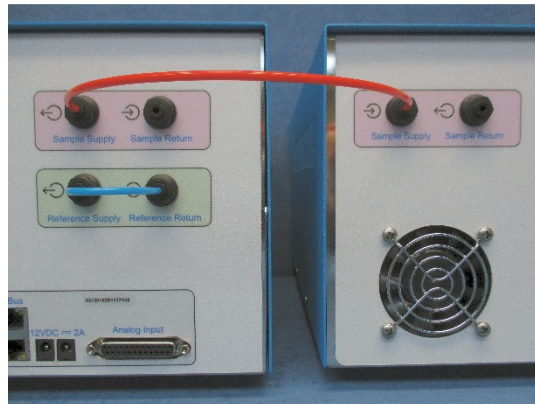
7.2.7 Sensor Reference Tubing Connections

- Using a short length of 1/8" blue air line, connect the output "Reference Supply" port to the input "Reference Return" port on the UGC

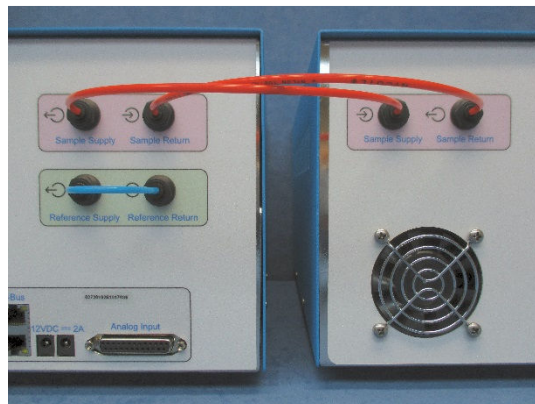


7.2.8 Sensor Sample Tubing Connections

- Using an appropriate length of 1/8" red air line, connect the output "Sample Supply" port of the UGC to the input "Sample Supply" port of the Oxygen Sensor.



Using an appropriate length of 1/8" red air line, connect the output "Sample Return" port of the Oxygen Sensor to the input "Sample Return" port of the UGC.



7.2.9 Electrical Power Connections

- Using the 24V power supply, connect the DC coaxial plug into the “24V \approx 2.7A” coaxial power jack of the Paramagnetic Oxygen Sensor.
- Using an AC power cord, connect the 24V power supply to an AC power source.
- Using the 12V power supply, connect the DC coaxial plug into the “12V \approx 2A” coaxial power jack of the UGC.
- Using an AC power cord, connect the 12V power supply to an AC power source.

Note – The UGC should only be connected to an active AC power source after all of the gas ports have been properly connected with particle filters where appropriate.

This will prevent debris from being drawn into the unit where it may restrict and clog the internal faculties of the Universal Gas Conditioner.

7.2.10 CI-Bus Connections

- Attach the UGC to the CI-Bus by connecting any free port from the CI-Bus Hub to one of the ports of the UGC using an appropriate length ethernet cable.



- Attach the Oxygen Sensor to the CI-Bus by connecting the free port of the UGC to one of the free ports of the Oxygen Sensor.
- Place a CI-Bus Terminator into the free port of the Oxygen Sensor.

