In Vivo Scientific, LLC

CO_2 Controller

INSTRUCTION MANUAL

CONTENTS

ABOUT THIS MANUAL

The following symbols are used in this guide:


This symbol indicates a CAUTION. Cautions warn against actions that can cause damage to equipment. Please read these carefully.


This symbol indicates a WARNING. Warnings alert you to actions that can cause personal injury or pose a physical threat. Please read these carefully.

NOTES and TIPS contain helpful information.

INTRODUCTION

The **CO2-200** carbon dioxide controller has an internal CO_2 sensor. It controls the concentration of CO_2 in a background gas from 0.5–15%. This controller offers:

- An RS-232 interface to a computer
- A background flow rate of 25–250mL/min
- Optional air pump (not included) for economical use (as opposed to using bottle pressurized background gas)
- In the future multiple gas controllers of this variety can be daisy chained

Cautions and Warnings


Exercise caution when working with compressed gases. Cylinders must be secured at all times.

Parts List

(1) **CO2-200** CO_2 Controller

(1) Power cord

(1) Instruction Manual

Unpacking

Upon receipt of this instrument, make a thorough inspection of the contents and check for possible damage. Missing cartons or obvious damage to cartons should be noted on the delivery receipt before signing. Concealed loss or damage should be reported at once to the carrier and an inspection requested. Please read the section entitled "Claims and Returns" on page 11 of this manual. Please call IN VIVO SCIENTIFIC Customer Service if any parts are missing.

Returns: Do not return any goods to IN VIVO SCIENTIFIC without obtaining prior approval (RMA # required) and instructions from IN VIVO SCIENTIFIC, LLC's Returns Department. Goods returned (unauthorized) by collect freight may be refused. If a return shipment is necessary, use the original container. If the original container is not available, use a suitable substitute that is rigid and of adequate size. Wrap the instrument in paper or plastic surrounded with at least 100mm (four inches) of shock absorbing material. Please read the section entitled "Claims and Returns" of this manual.

INSTRUMENT DESCRIPTION

The **CO2-200** is controlled by the Watlow EZ-Zone PID controller. This controller is pre-configured at the factory and in many cases is ready to use without further adjustments.

*Fig. 1- The **CO2-200** has both background and CO_2 flow meters on the front panel, as well as the PID controller. The back panel has the power switch and all the connection ports. The Remote Sensor port is not used on the **CO2-200**.*

Flow meters – The background gas and CO_2 flow rates can be adjusted using the knobs on the front of the **CO2-200** controller. Rotate the knobs clockwise to restrict the flow or counter-clockwise to increase the flow rate. The rate can be read on the pressure manometers on the front.

PID controller – By adjusting the parameters of the PID controller, the **CO2-200** can be configured for different applications. However, we recommend using the preset parameters in the controller first.

Serial port – This RS-232 port connects with a computer via USB. IN VIVO SCIENTIFIC does not provide software for computer control or a USB adapter.

Sensor In and Mixed Gas Out pressure fit connectors – When using single gas mode, these two ports are connected. In the future, multiple controllers can be daisy chained using the Mixed Gas Out port.

CO_2 In pressure fit connector – Connect the CO_2 tank to this port.

Background In pressure fit connector – Connect the bottled pressurized background gas or an optional air pump (not included) to this port.

CO_2 and Background Out pressure fit connector – Connect this fitting to the controlled chamber. The regulated gas comes out of this port.

PID Control Description

When the unit is turned on, after initialization, the home page appears (Fig. 2). This is the default upon power up and displays the active process value (% of CO_2) and the target setpoint. The large red number in the upper display shows the active process value. The small, green number in the lower display indicates the target setpoint.

Fig. 2- The home page of the PID controller shows the actual percentage of CO_2 in the chamber and the setpoint.

Upper Display –During normal operations (home page displayed) this value shows the actual CO_2 reading from the sensor. When configuring the controller, the parameter value is displayed here.

Zone Display–The **CO2-200** uses only one zone, Zone 1.

Home Page Key–Press this key to return to the home page display. The home page shows the actual sensor reading (% CO_2) and the setpoint.

EZ Key–This key is not used with the **CO2-200**.

Advance Key–Use this key to access the main menu.

Communications Activity Icon–A communications activity indicator displays when the RS-232 port is used for executing commands.

NOTE: Just above the communications activity indicator, a percent symbol (%) illuminates when the open-loop set point is displayed. This occurs only when the controller operates in Manual mode. See Control Modes on page 8.

Output Activity Indicators–Flashing numbers indicate output activity. When the CO_2 valve is opened by the controller, the number 1 illuminates.

Lower Display–During normal operations (home page) this value indicates the setpoint. When configuring the controller, this display shows the menu or the parameter being configured.

Arrow Keys– Use the arrow keys to adjust the setpoint or change parameter values.

OPERATING INSTRUCTIONS

Basic Setup for Single Gas Mode

The basic setup of the **CO2-200** is shown in Fig. 3. CO_2 connections can be made using ¼" OD tubing.

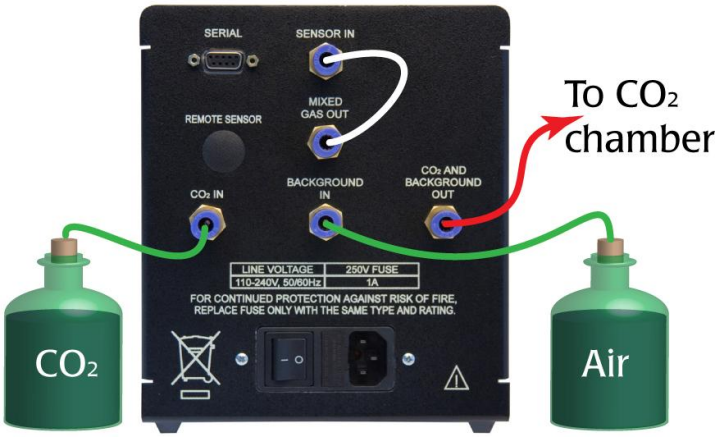

Fig. 3- Use 0.25" OD tubing for making connections.

1. Connect the Sensor In port with the Mixed Gas Out port. Press the tubing all the way into the port.

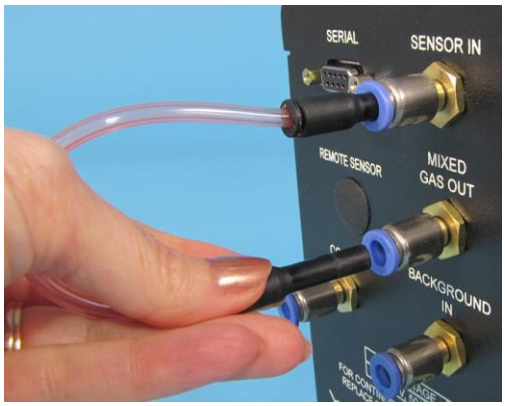

Fig. 4- Slide the tubing all the way into the port. In the image 0.156"tubing is used with quick fit reducers.

2. Connect the CO_2 tank to the CO_2 In port.
3. Connect the background gas tank or the optional pump to the Background In port.
4. Connect the CO_2 and Background Out port to the CO_2 chamber.
5. Turn the power switch on the back of the unit on.
6. Use the flow meters knobs on the front of the controller to set the flow speed of the background gas and the CO_2.

NOTE: If the background gas flow is set too low, the system controller may oscillate.

7. Use the arrow keys (▼ and ▲) on the PID controller to choose the desired setpoint.
8. Allow the system to run for 20 minutes so that the CO_2 level stabilizes.

Changing the Setpoint

On the Home Page, the PID controller displays the actual CO_2 measurement from the chamber and the setpoint. To change the set-point, use the arrow keys (▼ and ▲).

Understanding the PID Controller

A PID control algorithm is typically comprised of three primary control factors: **P**roportional, **I**ntegral and **D**erivative. The **CO2-200**, however, uses only proportional and integral control. The **CO2-200** controller monitors the difference between the actual sensor reading and the setpoint. This is the "error" value (ΔT). The error value is processed by the P and I algorithms. The algorithms are then summed to produce a final control output.

- The proportional control factor is set by the factory and should not be adjusted.
- The integral control factor (`ti`) may be adjusted to fine tune the performance of the unit.
- The derivative control factor is not used with the **CO2-200**.

Measured in seconds/repeat, the integral control factor is set based on the recent changes in the error value. It is proportional to the size and duration of the error. Together the P and I control factors bring the system closer to the setpoint more quickly. If the integral time (`ti`) parameter is set too high, the process value (CO_2 reading) will overshoot the setpoint.

Display Character Set

The **CO2-200** PID controller uses a simple 7-segment display, shown below.

1 = 1	8 = 8	E = E	L = L	S = S
2 = 2	9 = q	F = F	M = 	T = T
3 = 3	0 = 0	G = g	N = n	U = U
4 = 4	A = A	H = h	O = o	V = v
5 = 5	B = b	I = i	P = P	W= 
6 = 6	C = C, c	J = J	Q = q	Y = Y
7 = 7	D = D	K = K	R = R	Z = Z

Viewing and Adjusting Parameters from the Main Menu

When you are on the home page, press the key to toggle through the main menu of **CO2-200** parameters. Some parameters are read-only, and others can be manipulated. After cycling through all the parameters, you return to the home page.

Name	Description	Default Value	Options	Notes
AC.Pv	Active Process Value	none	Read only–CO_2 sensor reading	Shows in the upper display on the home page
AC.Sp	Active Set Point	0..0	Use and keys to change the setpoint	Shows in the lower display on the home page
h.Pr	Percentage Output	none	Read only–actual output of the controller (%). This value is proportional to the voltage output.	Real-time percentage (%) of the control voltage applied to the electronic CO_2 valve.
ti	Time Integral	30 seconds/repeat	Use and keys to change.	Integral parameter used by the PID controller. See “Setting the Integral Time Control Factor” on page 8.
C.⊓	Control Mode	Auto	Use and keys to change the mode. Auto, Automatic ⊓An, Manual	The system runs in AUto mode. ⊓An is reserved for troubleshooting.

Viewing the Percentage Output

The **CO2-200** is a variable output controller. It uses a control voltage to open the CO_2 valve. The control voltage changes based on the results of the PID algorithm. The percentage output shows the real-time percentage of the maximum available control voltage that the controller is outputting. This value compares with the amount the CO_2 valve is open. Because of the unit’s factory calibration settings with built-in safety margins, the CO_2 valve is completely closed before the percentage output reaches 0.0%, and it is fully open shortly before the percentage output reaches 100%.

Fig. 5- The CO2-200 controller displays the percentage output.

1. To view the power output from the home page, press the key.
2. Press the key to return to the home page.

Setting the Integral Time Control Factor

The integral time (ti) is the "I" parameter of the PID algorithm. The default value is 30 seconds/repeat.

Fig. 6- The CO2-200 controller displays the time integral parameter.

1. To view the integral time from the home page, press the key twice.
2. Use the and keys to adjust the parameter.
3. Press the key to return to the home page.

Control Modes

The PID controller has two modes: automatic (AUto) and manual (An). If the mode is set to oFF, the power output is zero. The default setting is Auto.

Fig. 7- The Watlow controller displays the control mode parameter.

Automatic – Typically the controller operates in Auto mode (closed loop control). In this mode, the actual sensor reading and the set-point are used in the control of the CO2-200.

Manual – Manual mode uses open loop control where you directly set the output power level of the controller to a fixed output value (%). No adjustment is made to the output based on either the sensor reading or the setpoint. This mode is normally reserved for troubleshooting.

Switching Between Control Modes

1. From the home page, press the key three times to display the control mode (C.) parameter.
2. Use the and keys to adjust the parameter.
   - An for manual
   - AUto for automatic
   - oFF for zero output
3. Press the key to return to the home page.

INSTRUMENT MAINTENANCE

Changing a Fuse

A spare fuse is provided in the fuse housing (Fig. 8).

1. Turn the main power switch off (0).
2. Unplug the power cord from the power cord socket on the back of the **CO2-200**.

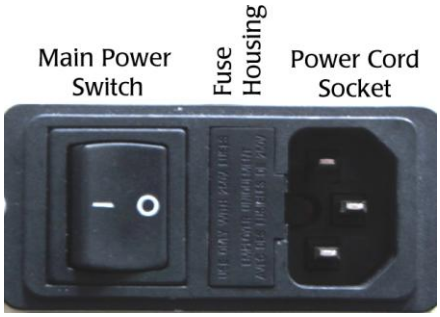

Fig. 8- Unplug the power cord to access the fuse housing release.

3. Insert a small flat blade screwdriver under the lip on the right side of the fuse housing cover (Fig. 9).

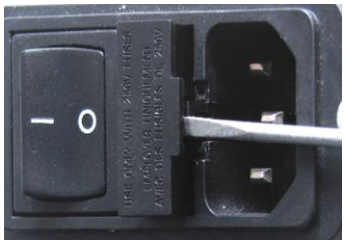

Fig. 9- Insert the screw driver under the fuse housing lip and pry the housing open.

4. Pull the fuse housing out as far as it will go and rotate it to the right. There is a catch to keep the housing from coming completely out (Fig. 10).

Fig. 10- Open the fuse housing and rotate it right to remove the fuse.

5. Remove the bad fuse. It is the one on the top. A spare fuse is stored in the bottom slot of the fuse housing.
6. Use the spare fuse provided to replace the bad fuse. Slide it into the top slot of the fuse housing.
7. Rotate the fuse housing and slide it back into position.
8. Reinstall the power cord.
9. Turn the power switch on to verify that the **CO2-200** has power again.

TROUBLESHOOTING

Issue	Possible Cause	Solution
No power	Fuse is blown.	Check the fuse. See "Changing a Fuse" on page 9. The fuse is a 5x20mm metric fuse. 4A 250V for 230VAC service and 8A 250V for 120VAC service. A spare fuse is included in the fuse housing.
	Power cord is improperly connected	Verify that the power cord is securely connected and plugged into a live wall socket.
Chamber never reaches setpoint	The chamber is too large or has a leak.	Reduce the chamber size or check for leaks.
	The factory default parameters may be corrupt.	Contact technical support for instructions on resetting the default parameters.

NOTE: If you have a problem/issue that falls outside the definitions of this troubleshooting section, contact the IN VIVO SCIENTIFIC Technical Support team at 314.432.6110or kellie@In vivoscientific.com.

SPECIFICATIONS

Power	110/240V, 50/60Hz
Operating Temperature (ambient)	10 – 50°C (50 – 122°F)
Operating Humidity (ambient)	15 – 70% RH, non-condensing
Warm up Time	20 minutes
Computer Interface	USB via external USB/RS232 converter
CO_2 Flow Meter	6 – 60mL/min
Background Flow Meter	20/250mL/min
Sensor	Non-dispersive infrared (NDIR), dual beam, 20s response time
Sensor range	0 – 20% CO_2
Control Range	0.5 – 15%
Control Precision	0.1% CO_2
Control Accuracy	0.1 – 3% of reading
Drift	<2.5% reading/year
Dimensions	7.5 x 6.5 x 8” (190 x 155 x 210mm)
Shipping Weight	10 lb. (4.6kg)

WARRANTY

IN VIVO SCIENTIFIC warrants to the original purchaser that this equipment, including its components and parts, shall be free from defects in material and workmanship for a period of one year* from the date of receipt. IN VIVO SCIENTIFIC 's obligation under this warranty shall be limited to repair or replacement, at IN VIVO SCIENTIFIC 's option, of the equipment or defective components or parts upon receipt thereof f.o.b. IN VIVO SCIENTIFIC

The above warranty is contingent upon normal usage and does not cover products which have been modified without IN VIVO SCIENTIFIC 's approval or which have been subjected to unusual physical or electrical stress or on which the original identification marks have been removed or altered. The above warranty will not apply if adjustment, repair or parts replacement is required because of accident, neglect, misuse, failure of electric power, air conditioning, humidity control, or causes other than normal and ordinary usage.

To the extent that any of its equipment is furnished by a manufacturer other than IN VIVO SCIENTIFIC , the foregoing warranty shall be applicable only to the extent of the warranty furnished by such other manufacturer. This warranty will not apply to appearance terms, such as knobs, handles, dials or the like.

IN VIVO SCIENTIFIC makes no warranty of any kind, express or implied or statutory, including without limitation any warranties of merchantability and/or fitness for a particular purpose. IN VIVO SCIENTIFIC shall not be liable for any damages, whether direct, indirect, special or consequential arising from a failure of this product to operate in the manner desired by the user. IN VIVO SCIENTIFIC shall not be liable for any damage to data or property that may be caused directly or indirectly by use of this product.

Claims and Returns

- Inspect all shipments upon receipt. Missing cartons or obvious damage to cartons should be noted on the delivery receipt before signing. Concealed loss or damage should be reported at once to the carrier and an inspection requested. All claims for shortage or damage must be made within 10 days after receipt of shipment. Claims for lost shipments must be made within 30 days of invoice or other notification of shipment. Please save damaged or pilfered cartons until claim settles. In some instances, photographic documentation may be required. Some items are time sensitive; IN VIVO SCIENTIFIC assumes no extended warranty or any liability for use beyond the date specified on the container.
- IN VIVO SCIENTIFIC cannot be held responsible for items damaged in shipment en route to us. Please enclose merchandise in its original shipping container to avoid damage from handling. We recommend that you insure merchandise when shipping. The customer is responsible for paying shipping expenses including adequate insurance on all items returned.
- Do not return any goods to IN VIVO SCIENTIFIC without obtaining prior approval and instructions (RMA#) from our returns department. Goods returned unauthorized or by collect freight may be refused. The RMA# must be clearly displayed on the outside of the box, or the package will not be accepted. Please contact the RMA department for a request form.
- Goods returned for repair must be reasonably clean and free of hazardous materials.
- A handling fee is charged for goods returned for exchange or credit. This fee may add up to 25% of the sale price depending on the condition of the item. Goods ordered in error are also subject to the handling fee.
- Equipment which was built as a special order cannot be returned.
- Always refer to the RMA# when contacting IN VIVO SCIENTIFIC to obtain a status of your returned item.
- For any other issues regarding a claim or return, please contact the RMA department

Warning: This equipment is not designed or intended for use on humans.

* Electrodes, batteries and other consumable parts are warranted for 30 days only from the date on which the customer receives these items.