CO2-300

CO_2 Controller with External Sensor

INSTRUCTION MANUAL

Serial No._____

091411

World Precision Instruments

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.

Fig. 1—The CO2-300 has an external sensor.

INTRODUCTION

The **CO2-300** carbon dioxide controller has an external CO_2 sensor which allows the sensor to be located at the site where the CO_2 percentage is maintained. 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 100–1000mL/min.
- Optional air pump (not included) for economical use (as opposed to using bottle pressurized background gas)

Cautions and Warnings

WARNING: EXERCISE CAUTION WHEN WORKING WITH COMPRESSED GASES. CYLINDERS MUST BE SECURED AT ALL TIMES.

Parts List

After unpacking, verify that there is no visible damage to the sensor. Verify that all items are included:

(1) **CO2-300** CO_2 Controller

(1) Power cord

(1) **801541** Sensor

(1) Calibration Certificate

(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 damage should be reported at once to the carrier and an inspection requested. Please read the section entitled "Claims and Returns" on page 18 of this manual. Please contact WPI Customer Service if any parts are missing at 941.371.1003 or customerservice@wpiinc.com.

Returns: Do not return any goods to WPI without obtaining prior approval (RMA # required) and instructions from WPI's Returns Department. Goods returned (unauthorized) by collect freight may be refused. If a return shipment is necessary, use the original container, if possible. 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. For further details, please read the section entitled "Claims and Returns" on page 18 of this manual.

INSTRUMENT DESCRIPTION

The **CO2-300** is controlled by the Watlow EZ-Zone PID controller. This controller is pre-configured at the factory and calibrated at 37ºC. It is ready to use without further adjustments.

Fig. 2—The CO2-300 has both a background flow meter measured in L/min. (left side) and CO_2 flow meter measured in mL/min. (right side) on the front panel, as well as the PID controller. The back panel has the power switch and all the connection ports. The Sensor In and Mixed Gas Out ports are not used on the CO2-300.

Front Panel

Flow meters – The background gas and CO_2 flow meters are located on the front of the **CO2-300** controller. The rate can be read on the pressure manometers on the front. The background flow meter is marked in liters/minute, and the CO_2 flow meter is marked in milliliters/minute. Rotate the knob on the background flow meter clockwise to restrict the flow or counter-clockwise to increase the flow rate. The CO_2 flow meter (on the right front panel) is pre-adjusted at the factory to be fully open for maximum flow. This one should never be adjusted.*

***NOTE**: Although the CO_2 flow rate is adjustable, it should always be fully open (adjusted to the maximum flow rate). The CO_2 flow is controlled by the PID controller. If the CO_2 flow is also limited by the flow control knob, the system will not operate correctly.

PID controller – The PID parameters are configured at the factory and should not be modified. If the factory settings need to be reset, refer to the calibration document that came with your controller or contact WPI technical support at technicalsupport@wpiinc.com or 941.371.1003.

Back Panel

Serial port – This RS-232 port connects with a computer via USB. This port is for factory use.

Remote Sensor – The 6′ cable from this port connects with the external CO_2 sensor. This external sensor must be installed at the measurement site.

CO_2 In pressure fit connector – Connect the CO_2 tank to this ¼″ 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 ¼″ port.

PID Control Description

When the unit is turned on, after initialization, the home page appears (Fig. 3). 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. 3—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.

Zone Display–The **CO2-300** uses only one zone, Zone 1.

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

EZ Key–This key is not used with the **CO2-300**.

Advance Key–Use this key to scroll through the menu of parameters.

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 setpoint is displayed. This occurs only when the controller operates in Manual mode. See "Control Modes" on page 10.

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 displayed) this value indicates the setpoint. When changing the controller parameters, 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 **CO2-300** is shown in Fig. 4. CO_2 connections can be made using ¼″ OD tubing.

CAUTION: This system is configured at the factory for a chamber located six feet from the **CO2-300**. If you significantly alter the length of the tubing, you may need to adjust the background gas flow rate and auto tune the system.

The **CO2-300** is optimized at the factory for 5% using a humidifier in line with the chamber, however, a range of other control percentages may be used. During the initial setup, the setpoint should be set to 0% CO_2 concentration and allowed to settle for 15 minutes. The **CO_2 flow control should be fully open**,* and the background air should be running at 0.8L/min. Once settled, the setpoint can be adjusted to the desired concentration.

***NOTE**: For the system to operate correctly, it is important that the CO_2 flow control be set at maximum so that it does not restrict the flow of CO_2.

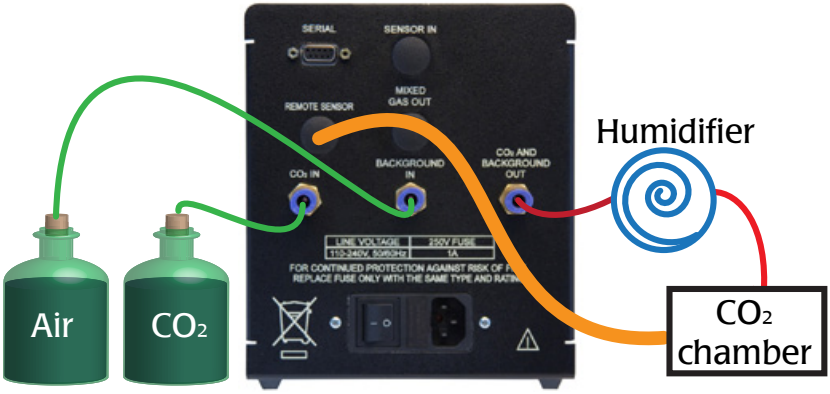

Fig. 4—Use 0.25″ OD tubing for making connections.

1. Connect the CO_2 tank to the **CO_2 In** port. Press the tubing all the way into the port.
2. Connect the background gas tank to the **Background In** port.
3. Connect the **CO_2 and Background Out** port to the environmental control chamber.

   NOTE: If a humidifier is used, connect the **CO_2 and Background Out** port to the humidifier input, and connect the humidifier output to the chamber.
4. Line up the pins and notch on the sensor with the holes on the sensor cable to connect the sensor. Press the sensor onto the fitting and screw it together finger tight.

5. Carefully insert the sensor into the chamber.

CAUTION: Use caution when handling the sensor. The sensor housing is a sealed unit. Attempts to remove the tip could damage the sensor.

6. Turn the power switch on the back of the unit on.
7. Use the flow meters knob on the front of the controller to set the flow rate of the background gas. Set the background airflow at 800mL/min. (That means the ball should float at 0.8L/min. on the background gas flow meter.) The recommended pressure at the background air port is 25 PSI and at the CO_2 air port is 15 PSI. Let the system stabilize for 15 minutes before making setpoint adjustments.

	Background	**CO_2**
Pressure	25 PSI	15 PSI
Flow Rate	0.8L/min.	Set to fully open. Flow rate controlled by **CO2-300**.

8. Use the arrow keys (▼ and ▲) on the PID controller to choose the desired setpoint.
9. 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 sensor and the setpoint. To change the setpoint, use the arrow keys (▼ and ▲).

Understanding the PID Controller

A PID control algorithm is comprised of three primary control factors: Proportional, Integral and Derivative. These values are set at the factory and do not need to be adjusted.

Display Character Set

The **CO2-300** PID controller uses a simple 7-segment display, shown below.

1 = 1	8 = 8	E = E	L = L	S = 5
2 = 2	9 = 9	F = F	M = M	T = t
3 = 3	0 = 0	G = 9	N = n	U = U
4 = 4	A = A	H = h	O = o	V = u
5 = 5	B = b	I = ı	P = P	W= uu
6 = 6	C = C, c	J = J	Q = 9	Y = y
7 = 7	D = d	K = H	R = r	Z = 2

Viewing and Adjusting Parameters from Main Menu

When you are on the home page, the active process value appears in the upper display (red numbers) of the home page, and the setpoint shows in the lower display (green numbers). Press the key to toggle through the menu of **CO2-300** 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
Home Page Display	Active Process Value	none	Read only–CO_2 sensor reading	Shows in the upper display on the home page (Red numbers)
	Active Set Point	0.0	Use ▼ and ▲ keys to change the setpoint	Shows in the lower display on the home page (Green numbers)
hPr	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. See page 8.
ti	Time Integral	Set at the factory	Use ▼ and ▲ keys to change.	Integral parameter used by the PID controller. See page 9.
CM	Control Mode	Auto	Use ▼ and ▲ keys to change the mode. Auto, Automatic MAn, Manual	The system runs in Auto mode. MAn is reserved for troubleshooting. See page 10.
HPb	Heat Proportional Band	Set at the factory	Use ▼ and ▲ keys to change.	Proportional parameter used by the PID controller. See page 10.
td	Time Derivative	Set at the factory	Use ▼ and ▲ keys to change.	Derivative parameter used by the PID controller. See page 11.

Viewing the Percentage Output

The **CO2-300** 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 Watlow 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 (t1) is the "I" parameter of the PID algorithm. This value is set at the factory and should not be adjusted.

Fig. 6—The Watlow 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 (MAn). 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 setpoint are used in the control of the **CO2-300**.

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.M) parameter.
2. Use the and keys to adjust the parameter.
   - MAn for manual
   - AUto for automatic
   - oFF for zero output
3. Press the key to return to the home page.

Setting the Heat Proportional Band (P)

The heat proportional band (h.Pb) is the "P" parameter of the PID algorithm. This value is set at the factory and should not be adjusted.

Fig. 8—The Watlow controller displays the heat proportional band parameter.

1. To view the heat proportional band parameter from the home page, press the key four times.
2. Use the or keys to adjust the parameter.

   NOTE: If this value is set too high, the temperature will oscillate around the setpoint. If it's too low, the response is sluggish.
3. Press the key to return to the home page.

Setting the Derivative Time

The derivative time (td) is the "D" parameter of the PID algorithm. This value is set at the factory and should not be adjusted.

Fig. 9—The Watlow controller displays the derivative time parameter.

1. To view the derivative time value from the home page, press the key five times.
2. Use the or keys to adjust the parameter.
3. Press the key to return to the home page.

MAINTENANCE

Changing a Fuse

A spare fuse is provided in the fuse housing (Fig. 10).

1. Turn the main power switch off (0).
2. Unplug the power cord from the power cord socket on the back of the **CO2-300**.

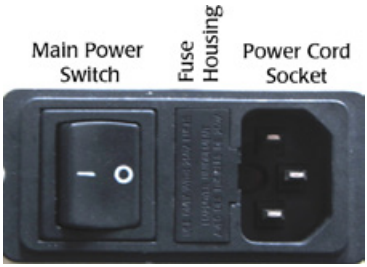

Fig. 10—Unplug the power cord to access the fuse housing release.

3. Insert a small flat blade screwdriver under the lip on the right side of the fuse housing cover (Fig. 11).

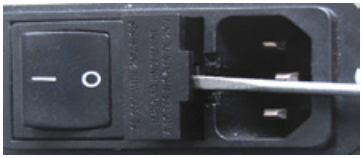

Fig. 11—Insert the screw driver under the fuse housing lip and pry the housing open.

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. 12).

Fig. 12—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 **CO2-300** has power again.

ACCESSORIES

Table 1: Accessories

Part Number	Description
3245	Quick fit reducers ¼″ OD, 5/32″ ID
3301	European power cord
3302	UK power cord
3006	US power cord
13972	4A Fuse (for 220V)
14088	Australian power cord
400195	0.156″ OD Tubing
800668	8A Fuse (for 110V)
801541	Replacement external sensor head

TROUBLESHOOTING

Issue	Possible Cause	Solution
No power	Fuse is blown	Check the fuse. See "Changing a Fuse" on page 12. 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	Reset the parameters to the factory settings. Factory settings can be found on the calibration document that came with your controller.
System does not stably regulate CO_2	PID control parameter have changed or the setup has changed.	Reset the parameters to the factory settings. Factory settings can be found on the calibration document that came with your controller.
		Auto tune the system using an auto tune request. Contact Technical Support for instructions.
Power output is fixed at a set percent	Controller is set in Manual mode	Set the controller to Auto mode. See "Control Modes" on page 10.

NOTE: If you have a problem/issue with that falls outside the definitions of this troubleshooting section, contact the WPI Technical Support team at 941.371.1003 or technicalsupport@wpiinc.com.

SPECIFICATIONS

This unit conforms to the following 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	100-10000mL/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)

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WARRANTY

WPI (World Precision Instruments, Inc.) 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 30 days* from the date of receipt. WPI's obligation under this warranty shall be limited to repair or replacement, at WPI's option, of the equipment or defective components or parts upon receipt thereof f.o.b. WPI, Sarasota, Florida U.S.A. Return of a repaired instrument shall be f.o.b. Sarasota.

The above warranty is contingent upon normal usage and does not cover products which have been modified without WPI'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 WPI, 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.

WPI 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. WPI 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. WPI 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 ten (10) days after receipt of shipment. Claims for lost shipments must be made within thirty (30) days of receipt of invoice or other notification of shipment. Please save damaged or pilfered cartons until claim is settled. In some instances, photographic documentation may be required. Some items are time-sensitive; WPI assumes no extended warranty or any liability for use beyond the date specified on the container

Do not return any goods to us without obtaining prior approval and instructions from our Returns Department. Goods returned (unauthorized) by collect freight may be refused. Goods accepted for restocking will be exchanged or credited to your WPI account. Goods returned which were ordered by customers in error are subject to a 25% restocking charge. Equipment which was built as a special order cannot be returned.

Repairs

Contact our Customer Service Department for assistance in the repair of apparatus. Do not return goods until instructions have been received. Returned items must be securely packed to prevent further damage in transit. The Customer is responsible for paying shipping expenses, including adequate insurance on all items returned for repairs. Identification of the item(s) by model number, name, as well as complete description of the difficulties experienced should be written on the repair purchase order and on a tag attached to the item.

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

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