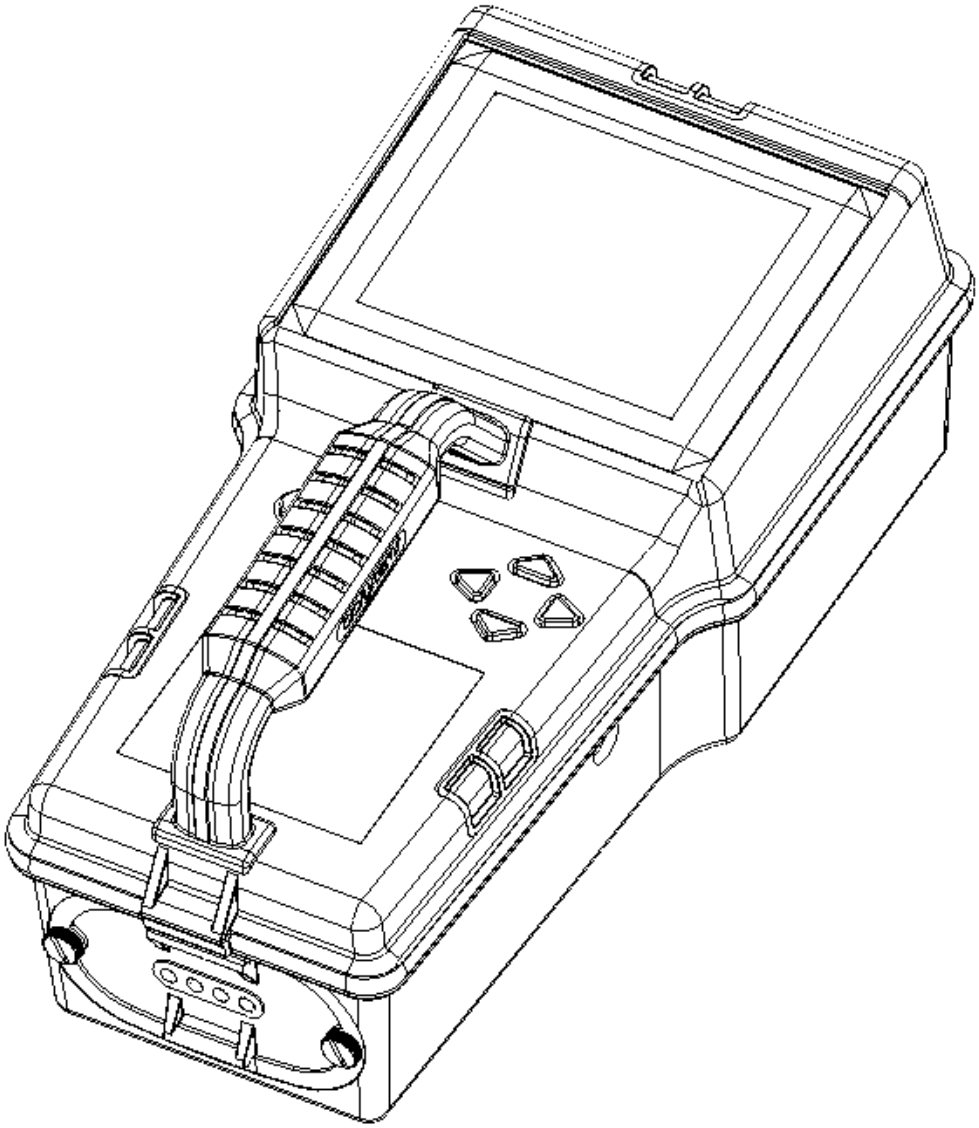
Dilution Manual
Cannonball 3
Multi Gas Detector



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⚠WARNING

THE CANNONBALL 3 PERSONAL PORTABLE GAS DETECTOR HAS BEEN DESIGNED FOR THE DETECTION OF OXYGEN DEFICIENCIES, FLAMMABLE GAS, AND TOXIC VAPOR ACCUMULATIONS.

IN ORDER TO ASSURE THAT THE USER IS PROPERLY WARNED OF POTENTIALLY DANGEROUS ATMOSPHERIC CONDITIONS, IT IS ESSENTIAL THAT THE INSTRUCTIONS IN THIS MANUAL BE READ, FULLY UNDERSTOOD, AND FOLLOWED.

AVERTISSEMENT: LIRE ATTENTIVEMENT LES INSTRUCTIONS AVANT DE METTRE EN MARCHE.

Cannonball 3 Operation Manual
Version 1.10

by
Biosystems
Middletown, Connecticut 06457

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Signal Words

The following signal words, as defined by ANSI Z535.4-1998, are used in the Cannonball 3 Dilution and Reference Manuals.

⚠DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠CAUTION indicates a potentially hazardous situation, which if not avoided, may result in moderate or minor injury.

CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

Warnings

1. **⚠WARNING The Cannonball 3 personal, portable gas detector has been designed for the detection of dangerous atmospheric conditions. An alarm condition indicates the presence of a potentially life-threatening hazard and should be taken very seriously.**
2. **⚠WARNING In the event of an alarm condition it is important to follow established procedures. The safest course of action is to immediately leave the affected area, and to return only after further testing determines that the area is once again safe for entry. Failure to immediately leave the area may result in serious injury or death.**
3. **⚠WARNING Use only Energizer E95 or EN95, Duracell MN1300, or Duracell PC1300, 1.5V D cell Alkaline batteries in the Cannonball 3. Substitution of batteries may impair intrinsic safety.**
4. **⚠WARNING The accuracy of the Cannonball 3 should be checked periodically with known concentration calibration gas. Failure to check accuracy can lead to inaccurate and potentially dangerous readings.**
5. **⚠WARNING The accuracy of the Cannonball 3 should be checked immediately following any known exposure to contaminants by testing with known concentration test gas before further use. Failure to check accuracy can lead to inaccurate and potentially dangerous readings.**
6. **⚠WARNING A sensor that cannot be calibrated or is found to be out of tolerance should be replaced immediately. An instrument that fails calibration may not be used until testing with known concentration test gas determines that accuracy has been restored, and the instrument is once again fit for use.**
7. **⚠WARNING Do not reset the calibration gas concentration unless you are using a calibration gas concentration that differs from the one that is normally supplied by Biosystems for use in calibrating the Cannonball 3.**

Customers are strongly urged to use only Biosystems calibration materials when calibrating the Cannonball 3. Use of non-standard calibration gas and/or calibration kit components can lead to dangerously inaccurate readings and may void the standard Biosystems warranty.

8. **⚠WARNING Use of non-standard calibration gas and/or calibration kit components when calibrating the Cannonball 3 can lead to inaccurate and potentially dangerous readings and may void the standard Biosystems warranty.**

Biosystems offers calibration kits and long-lasting cylinders of test gas specifically developed for easy Cannonball 3 calibration. Customers are strongly urged to use only Biosystems calibration materials when calibrating the Cannonball 3.

9. **⚠WARNING Substitution of components may impair intrinsic safety.**
10. **⚠WARNING For safety reasons this equipment must be operated and serviced by qualified personnel only. Read and understand this reference manual before operating or servicing the Cannonball 3.**
11. **⚠WARNING A rapid up-scale reading followed by a declining or erratic reading may indicate a hazardous combustible gas concentration that exceeds the Cannonball 3's zero to 100 percent LEL detection range for units without a dilution pump, or zero to approximately 200 percent detection range for units with a dilution pump.**

1. Overview of Dilution Monitoring

The Cannonball 3 sample dilution system allows the user to accurately sample combustible gases from otherwise inert environments.

Note: This dilution manual assumes that the user is familiar with the basic menu functions of the Cannonball 3. If questions arise as to how to access certain menu items, see the Cannonball 3 Reference Manual.

⚠WARNING Dilution monitoring is extremely hazardous and should only be performed by individuals trained in the safe monitoring of inert environments. Failure to follow established procedures while performing dilution monitoring may lead to dangerous and potentially life-threatening conditions.

Note: The ability to perform dilution monitoring is automatically disabled by the Cannonball3 software upon recognition of an installed HC/LEL sensor.

1.1 Theory

Catalytic hot bead LEL sensors, such as the type used in the Cannonball 3, require oxygen levels of at least 10% by volume to produce an accurate LEL reading. Catalytic hot-bead LEL sensors physically burn the combustible gas that is present in the environment in order to produce a reading. Since inert environments are devoid of oxygen by definition, it is necessary to add oxygen to the sample stream to allow the combustible gas sensor to operate.

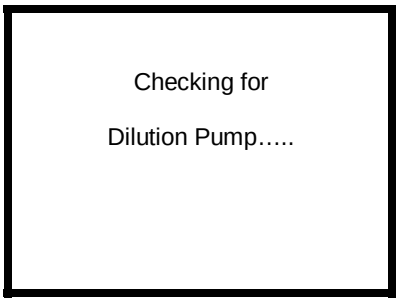
The Cannonball 3's sample dilution system utilizes two separate sample draw pumps to overcome this obstacle by accurately mixing the inert sample with a fresh air sample. This method provides enough oxygen to the LEL sensor to allow it to respond to the combustible gas. The Cannonball 3's microprocessor then calculates the level of combustible gas in the sample by dividing the LEL sensor's response by the percentage of flow taken from the sample pump versus the amount of flow taken from dilution pump.

Note: The Cannonball 3 must be located in a fresh air atmosphere containing 20.9 percent oxygen while conducting dilution sampling. The sample draw probe must be inserted into the inert atmosphere to collect the sample.

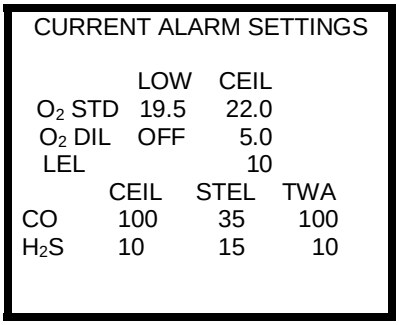
2. Operation in dilution mode

2.1 Start up procedure in dilution mode

The start up procedure for dilution capable instruments is similar to the start up procedure for non-dilution instruments except for a few minor changes. The software in the Cannonball 3 includes two additional oxygen alarms for use with the dilution pump in inert or nearly inert environments. At start up, the Cannonball 3 automatically checks for the dilution pump.



Once the dilution pump is recognized, the instrument will display the dilution Oxygen alarm settings in the current alarm settings screen.

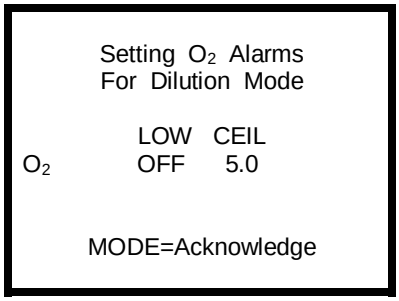


Current alarm settings screen with dilution-capable instrument.

Although standard and dilution alarms are provided in dilution-ready Cannonball 3 instruments, only one set of oxygen alarms can be enabled at any time. Whenever the Cannonball 3's dilution system is enabled or disabled, oxygen

alarm set points are automatically changed. The user will have to acknowledge the new oxygen alarm set points by pressing the MODE button.

Instruments that were turned off in dilution mode will automatically return to dilution mode when the instrument is started up again. The user will be required to acknowledge the dilution alarms.



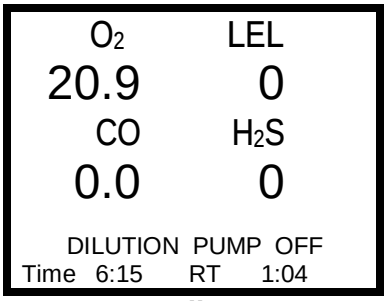
Press the MODE button to acknowledge the oxygen alarm settings. These alarms are adjustable through the Alarms menu as detailed below in section 2.3. The Cannonball 3 will then proceed to the current gas readings screen.

Note: Instruments that were turned off in dilution mode will automatically return to dilution mode upon start up and may go into an immediate alarm depending on the dilution alarm set points and environment in which the sample draw probe is located. To quickly disable the dilution pump, see the shortcut to disabling/enabling the dilution pump below in section 2.2.2.

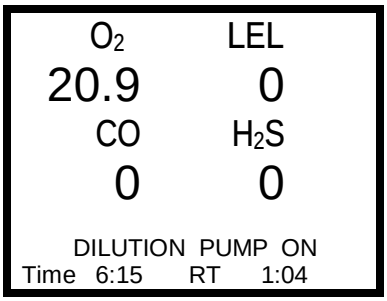
2.2 Enabling the dilution option

Cannonball 3 instruments with dilution capability can be easily distinguished from those without by the current gas readings screen, which will contain a separate line noting the status of the dilution pump in dilution-capable instruments.

Note: If the dilution pump status line does not appear in the current gas readings screen, and a dilution pump has been installed in the instrument, call Biosystems for the dilution pump initialization procedure.



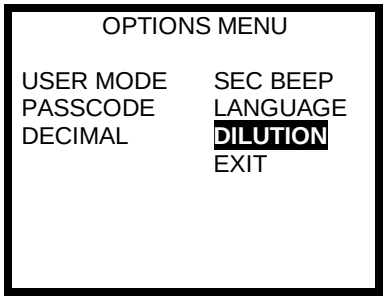
Current gas readings screen with dilution pump disabled.



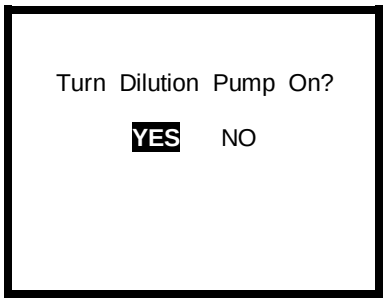
Current gas readings screen with dilution pump enabled.

2.2.1 Conventional entry to dilution mode

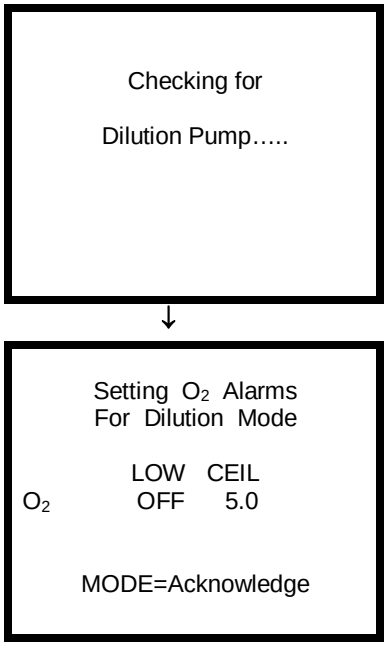
1. Enter the OPTIONS subdirectory of the Main Menu. Only instruments with a recognized dilution pump will have the DILUTION option.



2. Use the navigation arrows to highlight DILUTION and press the MODE button to confirm the selection. The following screen will then be shown:



3. Press the MODE button with YES highlighted to enable the dilution pump.

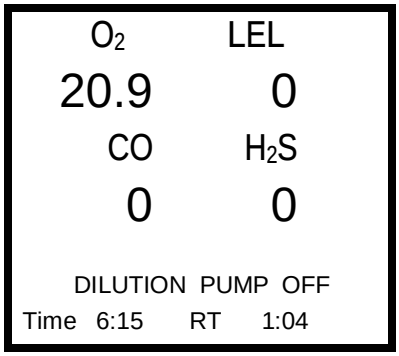


4. Press the MODE button to acknowledge the dilution Oxygen alarms.

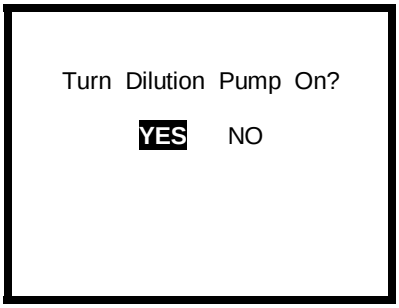
⚠WARNING Dilution monitoring is extremely hazardous and should only be performed by individuals trained in the safe monitoring of inert environments. Failure to follow established procedures while performing dilution monitoring may lead to dangerous and potentially life-threatening conditions.

2.2.2 Shortcut to dilution mode

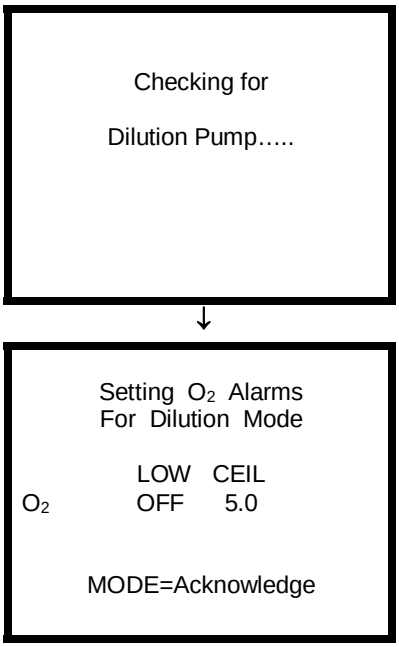
From the current gas readings screen, the following shortcut is available for rapid entry into or out of dilution mode:



1. Press the right and left navigation arrows simultaneously. Release the buttons when prompted by the instrument. If enabling the dilution pump, the following screen will then be shown.



2. Press the MODE button with YES highlighted to enable the dilution pump.



3. Press the MODE button to acknowledge the dilution Oxygen alarms.

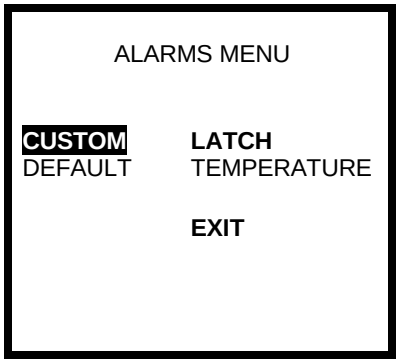
Note: This procedure may also be used to disable the dilution pump. The Cannonball 3 will then require acknowledgement of the non-dilution Oxygen alarm settings.

2.3 Alarm changes in dilution mode

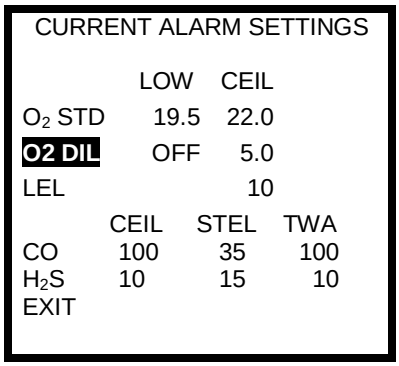
Changes to the dilution alarm set points are done in the same way as changes to the conventional alarm set points.

To change the dilution alarm settings:

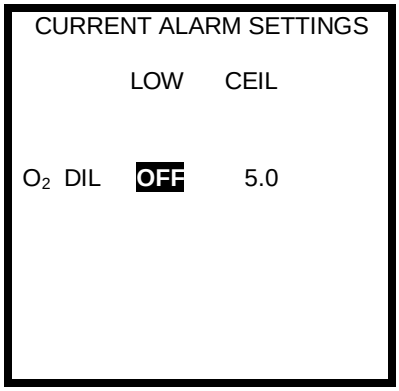
1. Enter the Alarms Menu.



2. Use the navigation arrows to highlight CUSTOM and press the MODE button. The current alarm settings screen will then be shown.

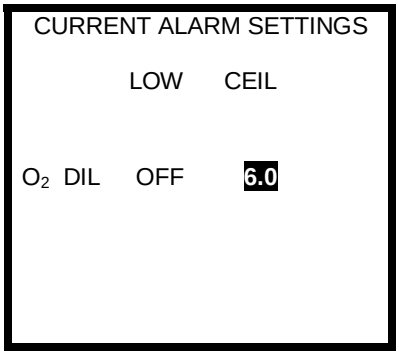


3. Use the up and down navigation arrows to select O_2 DIL and press the MODE button.

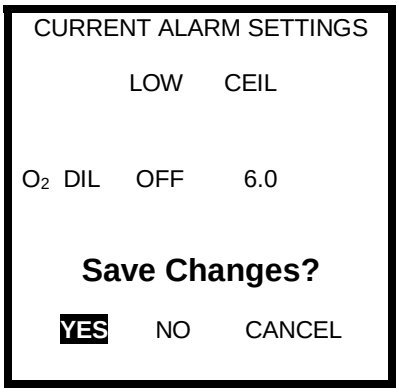


4. Use the left and right navigation arrows to select the low or ceiling alarm for modification.

Note: The ceiling O_2 dilution alarm is an ascending alarm. If the amount of oxygen is higher than the alarm set point, the visible and audible alarms will be activated.



5. Use the up and down navigation buttons to modify the current setting. When the alarm adjustment is completed, press the MODE button to enter the new setting.



6. Press the MODE button with YES highlighted to save the new alarm settings.

3. Calibration in dilution mode

To ensure O_2 sensor accuracy at levels approaching 0.0%/Vol. oxygen, calibration procedures in dilution-capable instruments include specific sub-routines involving calibration with 99.9% or better nitrogen (N_2).

3.1 Calibration frequency recommendations: dilution

See Appendix A for Biosystems' calibration frequency recommendations. Dilution-capable Cannonball3 instruments should be calibrated on a similar schedule for both standard and dilution-related calibration procedures.

Due to the need for increased accuracy at levels approaching 0.0%/Vol. oxygen, it is necessary to perform both the manual fresh air calibration (see section 3.3.1) and the O_2 zero calibration (see section 3.3.2) whenever an oxygen

sensor is replaced in a dilution-capable Cannonball3.

3.2 Automatic calibration in dilution mode

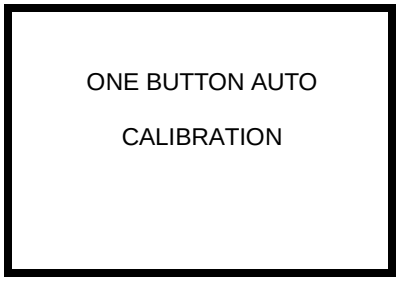
Automatic calibration in dilution mode may only be done while the instrument is being operated in the Technician, Basic/Peak or Basic operating modes.

⚠WARNING Automatic calibration procedures in a dilution-capable Cannonball 3 must be performed in an atmosphere that is known to be fresh. Failure to calibrate a dilution-capable Cannonball 3 in fresh air can lead to inaccurate and potentially dangerous readings.

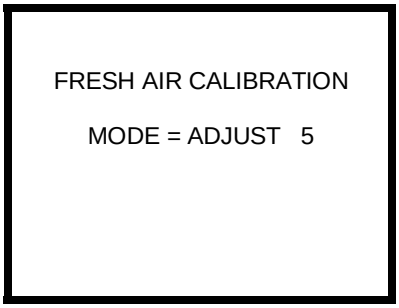
1. Turn the instrument on and make sure gas readings are given in numbers.

If sensor readings are displayed in the form of "OK" text messages, the instrument is currently in the "Text-Only" mode. It will be necessary to change the operating mode to Basic, Basic/Peak or Technician.

2. After turning the instrument on, wait at least three minutes to allow sensor readings to stabilize fully before initiating any calibration procedures.
3. Make sure the instrument is located in an area where the air is known to be fresh.
4. Press the MODE button three times within two seconds. This will "wake up" the instrument from normal operation, and initiate the auto-calibration sequence. A screen will briefly display the message "One Button Auto-Calibration".

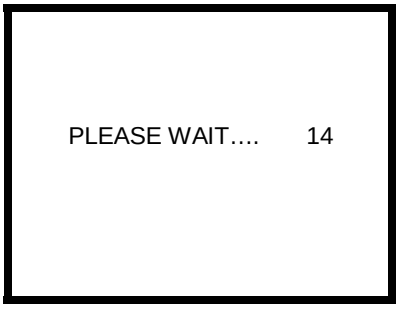


The instrument will then proceed to the following screen and begin a 5-second countdown.

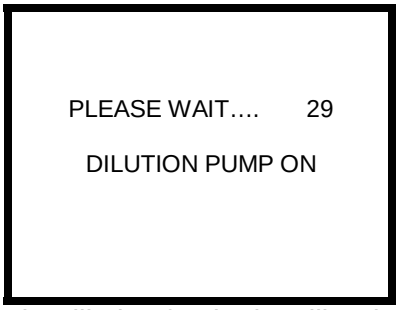


5. To initiate the fresh air calibration, press the MODE button before the unit finishes the countdown.

The instrument will then disable the dilution pump and proceed to fresh air calibrate the LEL and toxic sensors. The following screen will be shown:



Upon successful completion of the fresh air calibration of the LEL and toxic sensors, the instrument will re-enable the dilution pump and automatically proceed to the fresh air calibration of the oxygen sensor.



Once the dilution fresh air calibration of the oxygen sensor is completed, the Cannonball 3 will proceed to the calibration of the LEL and toxic sensors with the dilution pump enabled.

Dilution Fresh Air Cal

Please Wait….. 8

The Cannonball 3 will then proceed to the automatic span calibration.

SPAN CALIBRATION

MODE = ADJUST 5

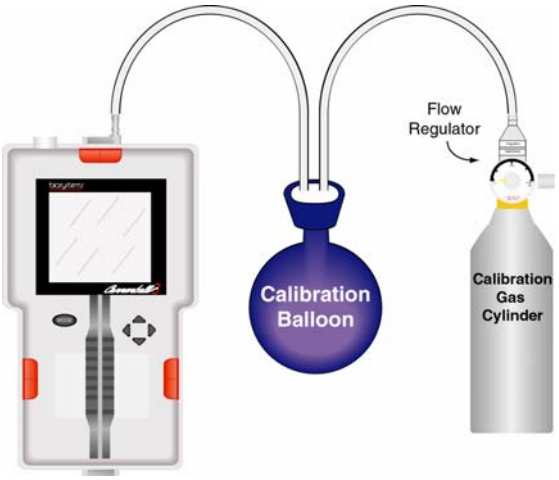
6. If span calibration is not required, allow the unit to complete the 5-second countdown without pressing any buttons.

Press MODE before the before the end of the 5-second countdown to initiate the span calibration sequence. The Cannonball 3 will then temporarily disable the dilution pump and show the following screen:

APPLY GAS

MODE = CANCEL

7a. If using a calibration balloon, fill the empty balloon with calibration gas until it is nearly full. Connect the calibration balloon assembly to the inlet coupling on the Cannonball 3. Continue to flow gas to the balloon throughout the span calibration procedure.



7b. If using a demand flow regulator, connect it and flow gas to the instrument.

⚠WARNING Failure to purge the calibration balloon of all gas prior to inflation with calibration gas may result in inaccurate and potentially dangerous readings.

⚠WARNING Make sure the calibration balloon is filled with the appropriate calibration gas before attempting to calibrate the Cannonball 3. Use of improper calibration gas or failure to nearly fill the calibration balloon may lead to inaccurate and potentially dangerous readings.

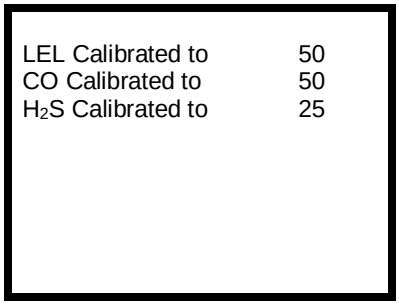
The Cannonball 3 automatically recognizes the type of gas supplied and automatically adjusts the sensors.

The instrument will then show the following screen as each sensor that may be calibrated using the current gas mixture is adjusted in turn. The span adjustment process from this point on is automatic and requires no user input.

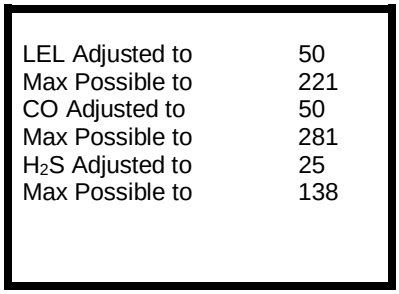
LEL Sensor Reading 49
CO Sensor Reading 51
H_2S Sensor Reading 24

Multi Cal Gas Detected

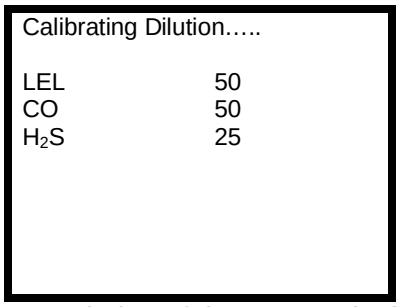
Once the readings stabilize, the Cannonball will automatically adjust itself so that the sensor readings match the expected gas concentration values as they appear in the gas values subdirectory of the Calibration Menu.



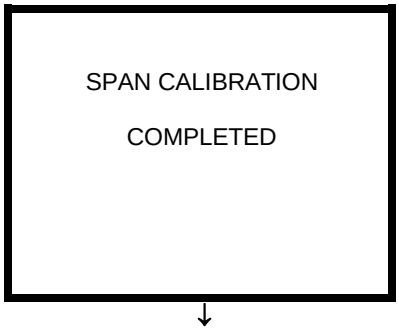
The Cannonball 3 will then display the following screen, which shows the final calibration values for the current span calibration, as well as the maximum adjustment values possible for the LEL sensor and any toxic sensors that are currently recognized by the instrument. As a sensor loses sensitivity, the maximum possible adjustment will decrease to approach the expected concentration of the calibration gas.

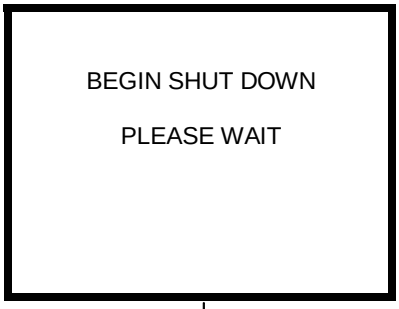


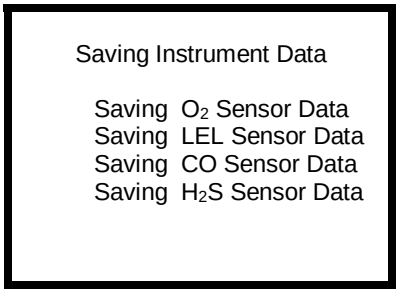
The instrument will then re-enable the dilution pump and proceed to the automatic dilution span calibration.



Upon completion of the automatic dilution span calibration, the Cannonball 3 will proceed through the following screens before turning itself off.







After shut down, immediately remove all calibration fittings from the Cannonball 3. Press the MODE button to turn the instrument on and resume normal operation.

Note: If the MODE button is pressed at any time prior to completion of the calibration, the calibration procedure will be cancelled and the instrument will return to normal operation.

⚠WARNING Wait at least 3 minutes after turning the instrument on to allow sensor readings to stabilize fully before initiating any calibration procedures. Failure to wait three minutes before initiating calibration procedures may lead to inaccurate and potentially dangerous readings.

⚠WARNING Make sure the regulator, cylinder seating surfaces and threads are clean and dry before attaching the regulator to the cylinder of gas. Introduction of contaminants through the regulator fittings may alter or degrade the concentration of the gas contained in the cylinder and may lead to inaccurate and potentially dangerous gas readings.

⚠WARNING Make sure the calibration balloon is filled with the appropriate calibration gas before attempting to calibrate the Cannonball 3. Use of improper calibration gas or failure to nearly fill the calibration

balloon may lead to inaccurate and potentially dangerous gas readings.

⚠WARNING Use of non-standard calibration gas and/or calibration kit components when calibrating the Cannonball 3 may lead to dangerously inaccurate readings and may void the standard Biosystems warranty.

3.2.1 Reading "Too High" or "Too Low" for zero adjust

To reduce the chances of the Cannonball 3 being inadvertently calibrated in contaminated air, only small adjustments are allowed in the automatic fresh air calibration sequence. If the necessary adjustments are too large, the display will indicate the sensor (or sensors) affected, and a message screen will indicate that the reading is "Too Low" or "Too High" for zero adjustment. In this case the instrument must be fresh air calibrated using the manual calibration procedures as discussed in section 3.2.1 of this manual.

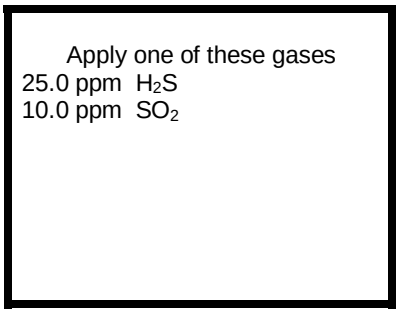
Once the instrument has been successfully fresh air calibrated using the manual fresh air calibration procedure, subsequent calibration adjustments may be made using the MODE button and automatic calibration logic discussed in this section.

3.2.2 Automatic span calibration with more than one gas cylinder

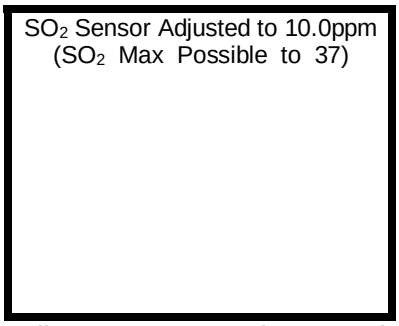
Depending on the sensor configuration of the Cannonball 3, it will sometimes be necessary to use more than one cylinder of calibration gas to complete the calibration of the Cannonball 3.

Note: When using the calibration balloon and multiple cylinders of calibration gas during calibration, it is necessary to purge the calibration balloon and refill it with new calibration gas between span adjustments. In this case the display will indicate the type and concentration of the next cylinder of calibration gas to be applied.

If the initial span calibration covered above fails to calibrate the LEL sensor or any of the toxic sensors, the Cannonball 3 will show the following screen, which indicates the calibrations that still need to be performed.



Once the instrument detects the proper gas and the reading stabilize, the instrument will automatically calibrate the sensor.



When all sensors currently recognized have been successfully span-calibrated, the instrument will display "Auto Calibration Completed" and proceed to shut itself off.

Remove all fittings from the Cannonball 3 before turning the instrument back on.

Note: It is possible to exit the automatic span calibration sequence at any time prior to completion by pressing and holding down the MODE button to turn the instrument off. The instrument will retain the updated settings for those sensors whose span adjustments have been successfully completed. Sensors that were not successfully adjusted at the time the auto-calibration sequence was terminated will trigger a "Needs Cal" message at the time the instrument is next turned on. The accuracy of those remaining sensors should be verified by exposure to known concentration test gas before the instrument is put back into service.

3.3 Manual dilution calibration procedures

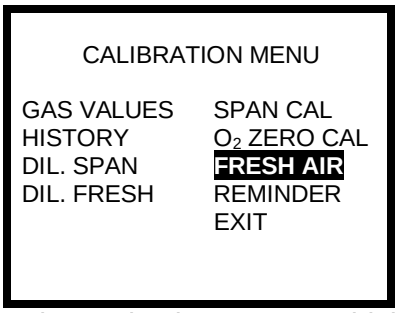
Cannonball 3 instruments with dilution capability have five different manual calibration options in the Calibration Menu: FRESH AIR, O2 ZERO, SPAN CAL, DIL FRESH and DIL SPAN.

3.3.1 Fresh air calibration in dilution mode

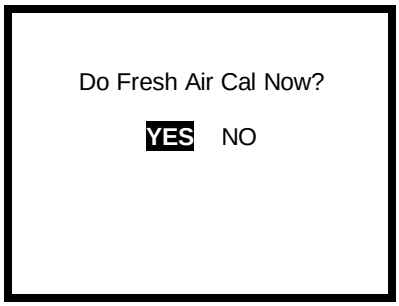
While in dilution mode, manual fresh air calibrations include calibrations with and without the dilution pump.

To perform a fresh air calibration:

1. Enter the Calibration Menu.

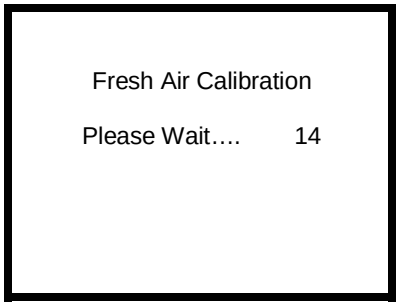


2. Use the navigation arrows to highlight FRESH AIR as shown above. Press the MODE button to confirm the selection.

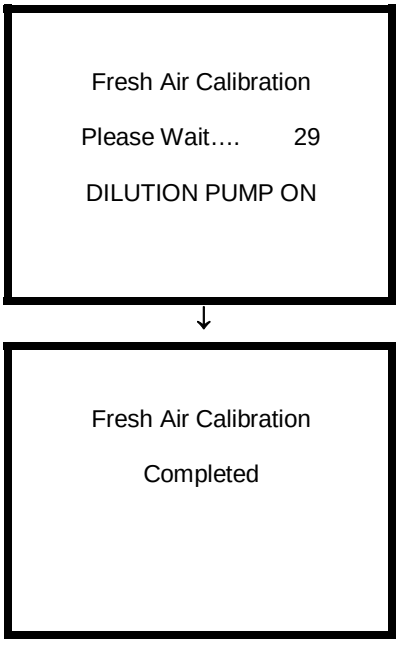


3. Press the MODE button with YES highlighted to begin the fresh air calibration.

The dilution pump will be automatically disabled by the instrument during the first stage of the fresh air calibration.



After the completion of the fresh air calibration without the dilution pump, the instrument will re-enable the dilution pump and automatically proceed to the fresh air calibration with the dilution pump.



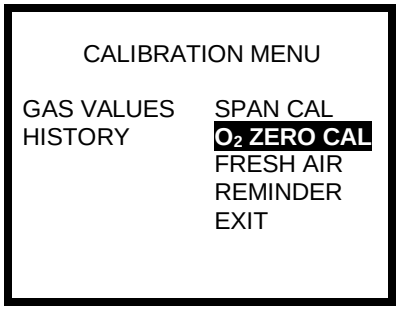
3.3.2 O2 zero calibration in dilution mode

In dilution mode, the O_2 zero calibration includes two separate calibration routines. The first calibration routine calibrates the oxygen sensor to zero with the dilution pump disabled. The second routine enables the dilution pump and sets the O_2 zero point for use with the dilution pump enabled.

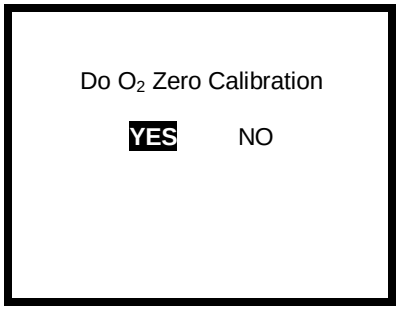
The O_2 zero calibration adjustment in the Cannonball 3 should not be confused with the fresh air calibration adjustment of the oxygen sensor. The O_2 zero calibration adjustment is used to calibrate the oxygen sensor in an atmosphere containing no oxygen, while the fresh air calibration adjustment calibrates the oxygen sensor in an atmosphere containing 20.9% Oxygen.

To perform the O_2 zero calibration while in dilution mode:

1. Turn the Cannonball 3 on and wait at least three minutes to allow sensor readings to stabilize fully before initiating any calibration procedures.
2. Enter the Calibration Menu.

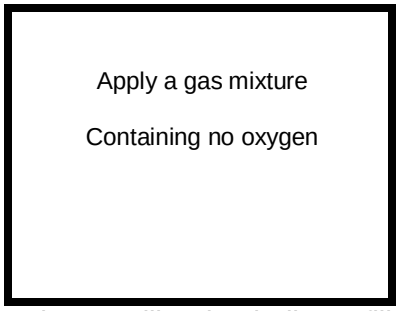


3. Use the navigation arrows to highlight O_2 ZERO CAL and press the MODE button.

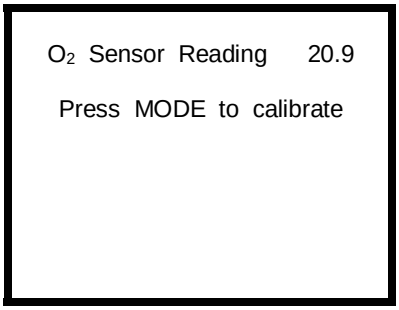


4. Press the MODE button with YES highlighted to begin the O_2 zero calibration.

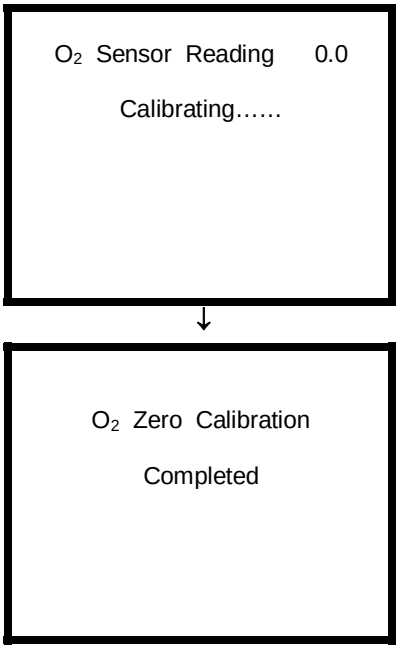
The dilution pump will be temporarily disabled for the initial phase of this calibration.



5. If using a calibration balloon, fill the calibration balloon nearly full with calibration gas containing no oxygen and connect the balloon to the inlet coupling on the front of the Cannonball 3. Continue to allow gas from the calibration cylinder to fill the balloon while calibrating. If using a demand flow regulator, flow gas to the sensors.



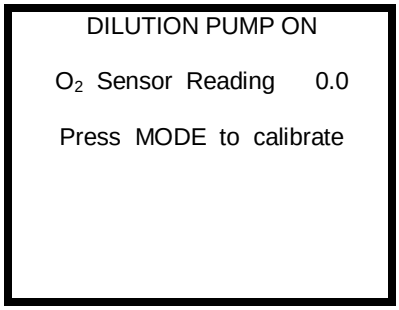
6. The oxygen reading will drop immediately and should approach a reading of 0.0. The sensor should stabilize in approximately 2 minutes. Press the MODE button once the oxygen reading stabilizes to calibrate the sensor.



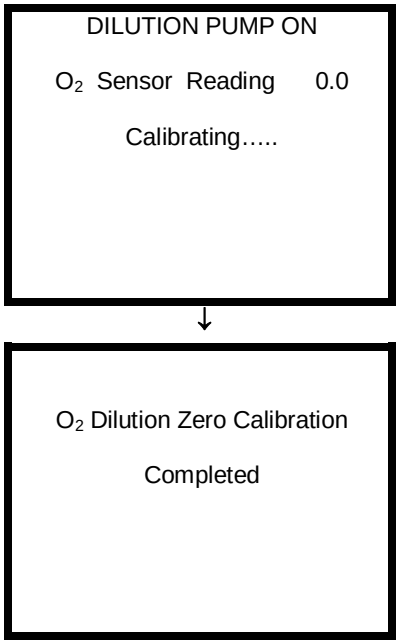
At this point the Cannonball 3 will automatically re-enable the dilution pump for the second part of the O_2 zero calibration.

If using a calibration balloon, continue to flow gas into the balloon. If using a demand flow regulator, continue to flow gas to the instrument.

The following screen will be shown:



7. The oxygen reading will drop immediately and should approach a reading of 0.0. The sensor should stabilize in approximately 2 minutes. Press the MODE button once the oxygen reading stabilizes to complete the O_2 zero calibration.



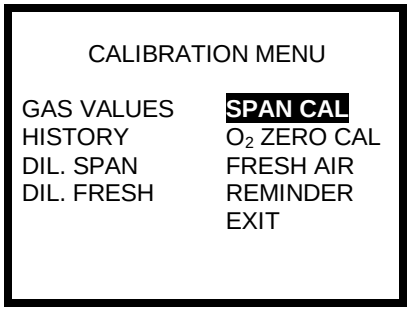
After completion of the O_2 zero calibration, the Cannonball 3 will return to the Main Menu. Remove all fittings from the Cannonball 3 before proceeding with any other operations.

3.3.3 Manual span calibration in dilution mode

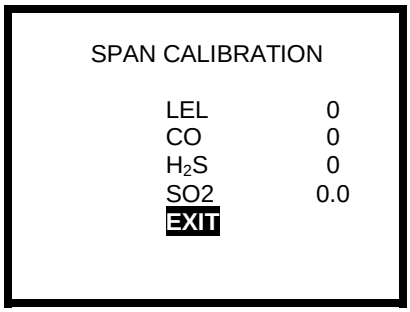
The manual span calibration in dilution mode is identical to the manual span calibration in non-dilution mode. The dilution pump is disabled for the duration of the manual span calibration procedure.

To perform the manual span calibration:

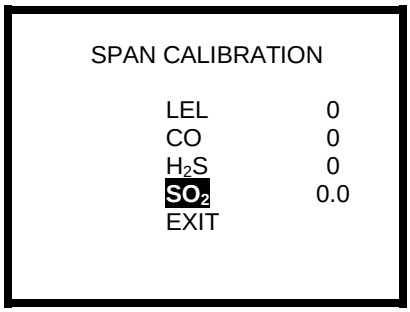
1. Turn the instrument on and wait at least three minutes to allow sensor readings to stabilize fully before initiating the manual span calibration procedure.
2. Enter the Calibration Menu.



3. Use the navigation arrows to highlight SPAN CAL and press the MODE button.



4. Use the up and down navigation arrows to highlight the sensor that requires calibration. Confirm the sensor selection by pressing the MODE button.

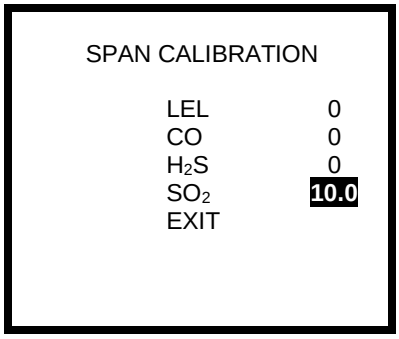


5. Once the sensor type has been selected, fill the calibration balloon with the appropriate calibration gas and connect the balloon assembly to the inlet coupling on the front of the Cannonball 3 or use a demand flow regulator to deliver the calibration gas.

⚠WARNING Make sure the regulator, cylinder seating surfaces and threads are clean and dry before attaching the regulator to the cylinder of gas. Introduction of contaminants through the regulator fittings may alter or degrade the concentration of the gas contained in the cylinder and may lead to inaccurate and potentially dangerous gas readings.

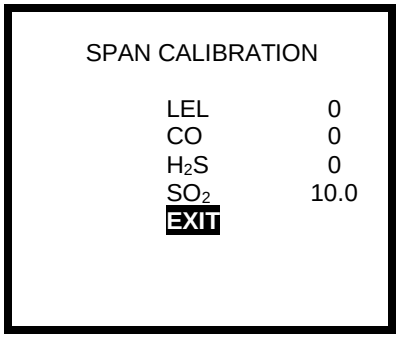
⚠WARNING Make sure the calibration balloon is filled with the appropriate calibration gas before attempting to calibrate the Cannonball 3. Use of improper calibration gas or failure to nearly fill the calibration balloon may lead to inaccurate and potentially dangerous readings.

6. When the readings stabilize, use the up and down navigation arrows to raise or lower the readings to match the concentration printed on the calibration cylinder label.

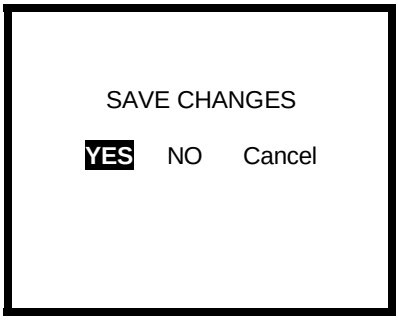


7. When the span calibration for a particular sensor is completed, press the MODE button to confirm the calibration. If span calibration of additional sensors is required, use the navigation arrows to advance to the next sensor channel and repeat steps 4,5 and 6 above.

⚠WARNING If using a calibration balloon and calibration of more than one sensor is required, deflate the calibration balloon fully before filling it with new gas for subsequent calibrations. Failure to fully deflate the calibration balloon between calibrations may lead to inaccurate and potentially dangerous readings.



8. When all sensors requiring calibration have been successfully calibrated, use the navigation arrows to highlight EXIT and press the MODE button to exit and save the new calibration settings.



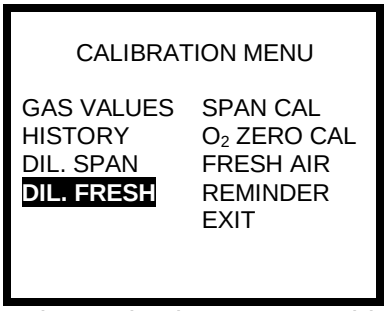
9. Press the MODE button with yes highlighted to save changes. Remove all fittings before turning the instrument back on and returning to normal operation.

3.3.4 Dilution fresh air calibration

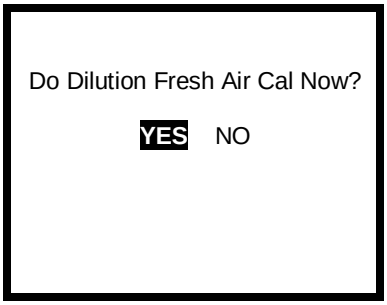
The dilution fresh air calibration performs a fresh air calibration with the dilution pump enabled.

To perform a dilution fresh air calibration:

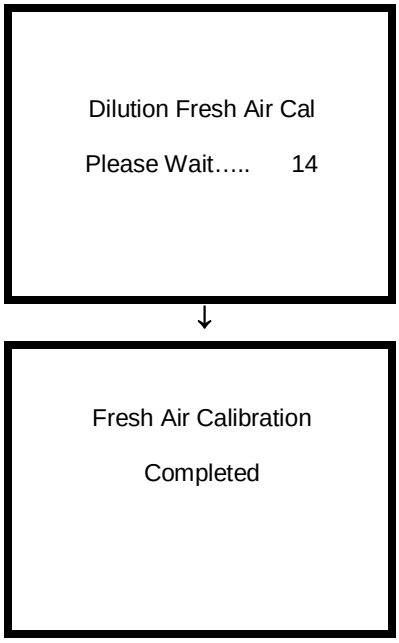
1. Enter the Calibration Menu.



2. Use the navigation arrows to highlight DIL. FRESH as shown above and press the MODE button.



3. Press the MODE button with YES highlighted to confirm the selection. The instrument will then show the following screen.



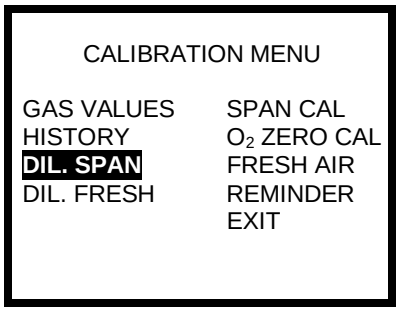
Upon completion of the manual dilution fresh air calibration, the Cannonball 3 will return to the Main Menu.

3.3.5 Dilution span calibration

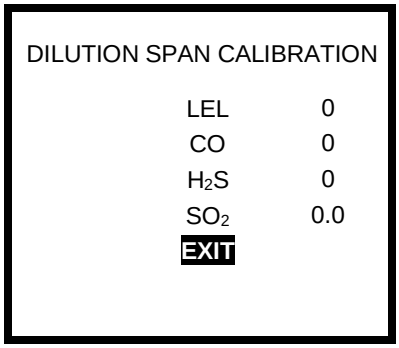
The manual dilution span calibration performs a span calibration with the dilution pump enabled.

To perform a dilution span calibration:

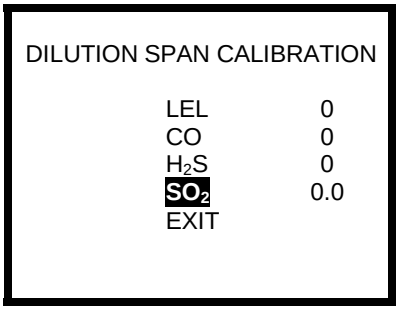
1. Enter the Calibration Menu.



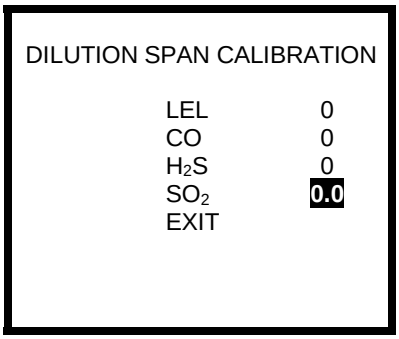
2. Use the navigation arrows to highlight DIL. SPAN as shown above and press the MODE button.



3. Use the up and down navigation arrows to highlight the sensor that requires calibration.



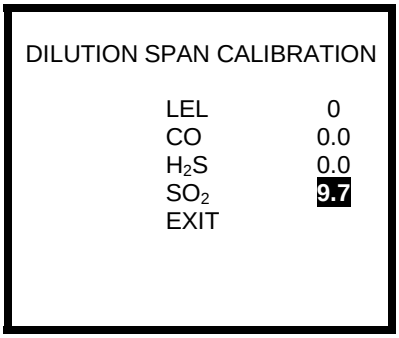
4. Confirm the sensor selection by pressing the MODE button.



5. Once the sensor type has been selected, fill the calibration balloon with the appropriate calibration gas and connect the balloon assembly to the inlet coupling on the front of the Cannonball 3 or use a demand flow regulator to deliver the gas.

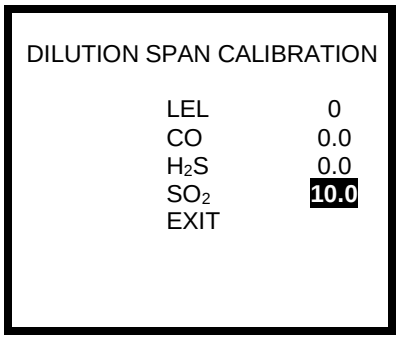
⚠WARNING Make sure the regulator, cylinder seating surfaces and threads are clean and dry before attaching the regulator to the cylinder of gas. Introduction of contaminants through the regulator fittings may alter or degrade the concentration of the gas contained in the cylinder and may lead to inaccurate and potentially dangerous gas readings.

⚠WARNING Make sure the correct cylinder of gas is used to fill the calibration balloon! Use of incorrect calibration gas may lead to inaccurate and potentially dangerously readings.



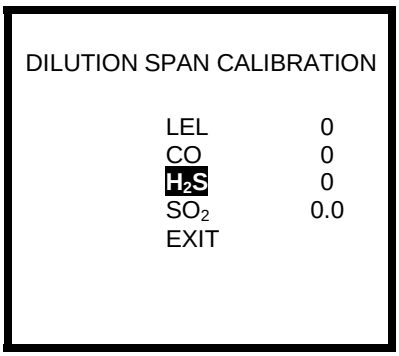
6. When the readings stabilize, use the up and down navigation arrows to

raise or lower the readings to match the concentration printed on the calibration cylinder label.

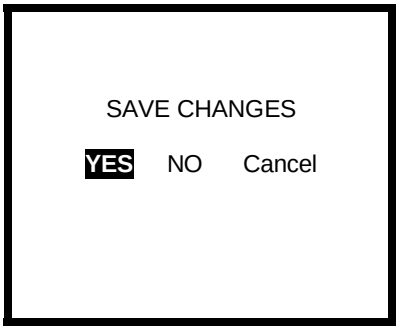


7. When the span calibration for a particular sensor is completed, press the MODE button to confirm the calibration and then use the navigation arrows to advance to the next sensor channel to be adjusted.

⚠WARNING If using a calibration balloon and the calibration of more than one sensor is required, deflate the calibration balloon fully before filling it with new gas for subsequent calibrations. Failure to fully deflate the calibration balloon between calibrations may lead to inaccurate and potentially dangerous readings.



8. Repeat steps 5, 6 and 7 until all sensors have been calibrated. When finished, use the navigation arrows to highlight EXIT and press the MODE button to exit and save the new calibration settings.



9. Press the MODE button with yes highlighted to save changes. Remove all fittings before turning the instrument back on and returning to normal operation.

Appendix A: Calibration Frequency

One of the most common questions that we are asked at Biosystems is: ***"How often should I calibrate my gas detector?"***

Sensor Reliability and Accuracy

Today's sensors are designed to provide years of reliable service. In fact, many sensors are designed so that with normal use they will only lose 5% of their sensitivity per year or 10% over a two-year period. Given this, it should be possible to use a sensor for up to two full years without any significant loss of sensitivity.

A lot of sensors indeed do last that long with only minimal loss of sensitivity. However, there are a number of reasons why a sensor may unexpectedly lose additional sensitivity or even fail to respond to gas. Such reasons include desiccation, poisoning, physical restriction of airflow, overexposure, leakage, and mechanical damage due to dropping or immersion.

Verification of Accuracy

With so many reasons why a sensor can lose sensitivity and given the fact that dependable sensors can be key to survival in a hazardous environment, frequent verification of sensor performance is paramount.

There is only one sure way to verify that a sensor can respond to the gas for which it is designed. That is to expose it to a known concentration of target gas and compare the reading with the concentration of the gas. This is referred to as a "bump" test. This test is very simple and takes only a few seconds to accomplish. **The safest course of action is to do a "bump" test prior to each day's use**. It is not necessary to make a calibration adjustment if the readings are between 90% and 120% of the expected value. As an example, if a CO sensor is checked using a gas concentration of 50 PPM it is not necessary to perform a calibration unless the readings are either below 45 PPM or above 60 PPM.

Lengthening the Intervals between Verification of Accuracy

We are often asked whether there are any circumstances in which the period between accuracy checks may be lengthened.

Biosystems is not the only manufacturer to be asked this question! One of the professional organizations to which Biosystems belongs is the Industrial Safety Equipment Association (ISEA). The "Instrument Products" group of this organization has been very active in developing a protocol to clarify the minimum conditions under which the interval between accuracy checks may be lengthened.

A number of leading gas detection equipment manufacturers have participated in the development of the ISEA guidelines concerning calibration frequency. Biosystems procedures closely follow these guidelines.

If your operating procedures do not permit daily checking of the sensors, Biosystems recommends the following procedure to establish a safe and prudent accuracy check schedule for your Biosystems instruments:

1. During a period of initial use of at least 10 days in the intended atmosphere, check the sensor response daily to be sure there is nothing in the atmosphere that is poisoning the sensor(s). The period of initial use must be of sufficient duration to ensure that the sensors are exposed to all conditions that might have an adverse effect on the sensors.
2. If these tests demonstrate that it is not necessary to make adjustments, the time between checks may be lengthened. The interval between accuracy checking should not exceed 30 days.
3. When the interval has been extended the toxic and combustible gas sensors should be replaced immediately upon warranty expiration. This will minimize the risk of failure during the interval between sensor checks.
4. The history of the instrument response between verifications should be kept. Any conditions, incidents, experiences, or exposure to contaminants that might have an adverse effect on the calibration state of the sensors should trigger immediate re-verification of accuracy before further use.
5. Any changes in the environment in which the instrument is being used, or changes in the work that is being performed, should trigger a resumption of daily checking.
6. If there is any doubt at any time as to the accuracy of the sensors, verify the accuracy of the sensors by exposing them to known concentration test gas before further use.

Gas detectors used for the detection of oxygen deficiencies, flammable gases and vapors, or toxic contaminants must be maintained and operated properly to do the job they were designed to do. Always follow the guidelines provided by the manufacturer for any gas detection equipment you use!

If there is any doubt regarding your gas detector's accuracy, do an accuracy check! All it takes is a few moments to verify whether or not your instruments are safe to use.

One Button Auto Calibration

While it is only necessary to do a "bump" test to ensure that the sensors are working properly, all current Biosystems gas detectors offer a one button auto calibration feature. This feature allows you to calibrate a Biosystems gas detector in about the same time as it takes to complete a "bump" test. The use of automatic bump test and calibration stations can further simplify the tasks, while automatically maintaining records.

Don't take a chance with your life.
Verify accuracy frequently!

Biosystems Applications Notes are available at the Biosystems website at

http://www.biosystems.com

Biosystems Standard Warranty Gas Detection Products

General

Biosystems LLC (hereafter Biosystems) warrants gas detectors, sensors and accessories manufactured and sold by Biosystems, to be free from defects in materials and workmanship for the periods listed in the tables below.

Damages to any Biosystems products that result from abuse, alteration, power fluctuations including surges and lightning strikes, incorrect voltage settings, incorrect batteries, or repair procedures not made in accordance with the Instrument's Reference Manual are not covered by the Biosystems standard warranty.

The obligation of Biosystems under this warranty is limited to the repair or replacement of components deemed by the Biosystems Instrument Service Department to have been defective under the scope of this standard warranty. To receive consideration for warranty repair or replacement procedures, products must be returned with transportation and shipping charges prepaid to Biosystems at its manufacturing location in Middletown, Connecticut, or to a Biosystems Authorized Warranty Service Center. It is necessary to obtain a return authorization number from Biosystems prior to shipment.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY AND ALL OTHER WARRANTIES AND REPRESENTATIONS, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE. BIOSYSTEMS WILL NOT BE LIABLE FOR LOSS OR DAMAGE OF ANY KIND CONNECTED TO THE USE OF ITS PRODUCTS OR FAILURE OF ITS PRODUCTS TO FUNCTION OR OPERATE PROPERLY.

Instrument & Accessory Warranty Periods

Product(s)	Warranty Period
PhD[5], PhD Lite, PhD Plus, PhD Ultra, Cannonball*3,* MultiVision, Toxi, Toxi/Oxy Plus, Toxi/Oxy Ultra, ToxiVision, Ex Chek	As long as the instrument is in service
ToxiPro, MultiPro	2 years from date of purchase
ToxiLtd	2 years after activation or 2 years after the "Must Be Activated By" date, whichever comes first
Mighty-Tox	90 days after activation or 90 days after the "Must Be Activated By" date, whichever comes first
Mighty-Tox 2 Prorated credit is given towards repair or purchase of a new unit of the same type.	0 – 6 months of use 100% credit 6 – 12 months of use 75% credit 12 – 18 months of use 50% credit 18 – 24 months of use 25% credit
IQ Systems, Series 3000, Airpanel, Travelpanel, ZoneGuard, Gas✓Chek1 and Gas✓Chek4	One year from the date of purchase
Battery packs and chargers, sampling pumps and other components, which by their design are consumed or depleted during normal operation, or which may require periodic replacement	One year from the date of purchase

Sensor Warranty Periods

Instrument(s)	Sensor Type(s)	Warranty Period
PhD Plus, PhD Ultra, PhD[5], PhD Lite, Cannonball*3*, MultiVision, MultiPro, ToxiVision, ToxiPro, Ex Chek	O_2, LEL**, CO, CO+, H_2S & Duo-Tox	2 Years
	All Other Sensors	1 Year
Toxi, Toxi/Oxy Plus, Toxi/Oxy Ultra	CO, CO+, H_2S	2 Years
	All Other Sensors	1 Year
All Others	All Sensors	1 Year

**** Damage to combustible gas sensors by acute or chronic exposure to known sensor poisons such as volatile lead (aviation gasoline additive), hydride gases such as phosphine, and volatile silicone gases emitted from silicone caulks/sealants, silicone rubber molded products, laboratory glassware greases, spray lubricants, heat transfer fluids, waxes & polishing compounds (neat or spray aerosols), mold release agents for plastics injection molding operations, waterproofing formulations, vinyl & leather preservatives, and hand lotions which may contain ingredients listed as cyclomethicone, dimethicone and polymethicone (at the discretion of Biosystems Instrument Service department) void Biosystems' Standard Warranty as it applies to the replacement of combustible gas sensors.**