PRODUCT MANUAL

Zero Air Generator



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Please read first

About this manual

Please note that this manual was produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this. In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users. Differences include the U.S. standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. Please note, however, *that when a power supply adapter is ordered from Campbell Scientific it will be suitable for use in your country*.

Reference to some radio transmitters, digital cell phones and aerials (antennas) may also not be applicable according to your locality. Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered.

Recycling information for countries subject to WEEE regulations 2012/19/EU



At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the products life should be removed from the product and also be sent to an appropriate recycling facility, per The Waste Electrical and Electronic Equipment (WEEE) Regulations 2012/19/EU. Campbell Scientific can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories. For further support, please contact Campbell Scientific, or your local agent.

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1. Introduction

The Zero Air Generator provides a convenient source of zero air (air that contains no CO₂ or water vapor) for zeroing a gas analyzer where normally a compressed-gas cylinder of zero air would be used. The Zero Air Generator effectively eliminates the need for a cylinder of compressed gas and the required pressure regulator and flow controller, making it extremely useful in zeroing open- or closed-path infrared gas analyzers (IRGA) that are located in remote field sites.

2. Precautions

- READ AND UNDERSTAND the Safety section at the back of this manual.
- WARNING
 - Do not connect the Zero Air Generator to any source of pressurized air, such as an external pump or a cylinder of compressed gas.
- CAUTION
 - Do not operate the Zero Air Generator pump with both outlets, **Out** and **Test**, plugged.

3. Initial inspection

Upon receipt of the Zero Air Generator, inspect the packaging and contents for damage. File damage claims with the shipping company. Contact Campbell Scientific to facilitate repair or replacement.

The Zero Air Generator ships with the instrument, three sets of 1/4-in Swagelok® nuts and ferrules, and two 1.5V AA alkaline batteries.

4. Overview

The Zero Air Generator is a low-cost, handheld source of zero air (air that has been scrubbed of CO₂ and water vapor) intended for zeroing infrared gas analyzers (IRGAs). The Zero Air Generator (shown in Figure 4-1 [p. 2]) can be used to replace the traditional method of zeroing an IRGA requiring a cylinder of compressed gas with a pressure regulator and flow controller. A simpler source of zero air is particularly useful in remote field sites.

All IRGAs are subject to drift in the zero response due to aging over time, changes in temperature, window contamination, etc. An IRGA should undergo a zeroing procedure frequently to maintain peak accuracy. In many cases, IRGAs are zeroed infrequently because of the cost and difficulty of providing a source of zero air.



Figure 4-1. Zero Air Generator

The Zero Air Generator makes it easy to zero an IRGA in the field. For open-path IRGAs, such as the IRGASON or EC150 (sold by Campbell Scientific, Inc.) or the LI-7500 (sold by LI-COR[®], Inc.), a zero/span shroud is also required. The Zero and Span Shroud Kit sold by Campbell Scientific is compatible with the IRGASON and EC150. For these open-path analyzers, the zero/span shroud

is installed and the Zero Air Generator is connected in either an open- or closed-loop configuration. The small battery-powered pump in the Zero Air Generator circulates a low flow through a bottle filled with molecular sieve that removes CO₂ and water vapor, and pushes it through the zero/span shroud.

The Zero Air Generator may also be used to zero a closed-path IRGA such as the EC155 (sold by Campbell Scientific, Inc.), or the LI-6262, LI-7000, LI-7200, or LI-840A (sold by LI-COR[®], Inc.). Closed-path analyzers do not require a zero/span shroud.

The Zero Air Generator includes a third connection that allows the user to assess the status of the molecular sieve. This gives an indication of when to replace the molecular sieve, ensuring that CO₂ and water vapor are always completely removed.

4.1 Accessories

4.1.1 Other accessories

Plastic tubing

Bev-A-Line IV plastic tubing with an outer diameter of 1/4 in and inner diameter of 1/8 in is offered by Campbell Scientific. The tubing remains flexible even at cold temperatures and holds up well in applications that require repeated handling and flexing. Campbell Scientific recommends this tubing for the plumbing connection between the Zero Air Generator and the instrument under test.

4.1.2 Replacement parts

AA alkaline cells

The power that operates the small pump of the Zero Air Generator is supplied by a pair of AA alkaline cells. Campbell Scientific offers the 1.5 V AA Alkaline Cell Battery, which is a long-life alkaline battery.

Molecular sieve

The Zero Air Generator scrubs an air sample of CO_2 and water vapor with a 13X molecular sieve. The sieve requires periodic replacement. Campbell Scientific offers the Molecular Sieve Desiccant, which is a bottle containing 250 g of 13X molecular sieve beads ranging from 1.6 to 2.5 mm diameter.

NOTE:

Two 250 g bottles are required to replace the sieve.

Filter

The original filter of the Zero Air Generator can be replaced by the Syringe Filter Element offered by Campbell Scientific. The filter is an in-line, 2.5 cm (1.0 in) diameter, PTFE membrane filter of 3-micron pore size with Luer lock connections.



Swagelok[®] plug

Spare 1/4-in OD Swagelok[®] Plugs are available from Campbell Scientific. This part is used to plug a fitting when the accompanying tube is disconnected. Plugging the fittings is necessary to keep the fittings clean and to avoid consumption of the molecular sieve during storage. It is strongly recommended to replace plugs in the event that those provided with the Zero Air Generator are lost or become damaged.



Velcro[®] strap

A Velcro[®] strap is used as a lanyard to secure the Zero Air Generator to a crossarm or other support when it is used in the field. If this strap is lost or damaged, it can be replaced with the Velco Strap, which is a 30 cm (12 in) length of 2.5 cm (1.0 in) wide Velcro[®] with a plastic loop offered by Campbell Scientific. Longer or shorter straps are also available. Contact Campbell Scientific for details.



5. Specifications

Dimensions

Length:	14.0 cm (5.5 in)
Width:	9.6 cm (3.8 in)
Height:	27.4 cm (10.8 in)
Weight:	1.16 kg (2.55 lb)
Operating temperature range:	–20 to 50 °C
Capacity:	750 ml (holds approximately 450 g molecular sieve)
Flow rate:	0.2 LPM (typical)
Power:	two AA batteries

6. Operation

6.1 Theory of operation

In normal operation, ambient air enters the Zero Air Generator through an **In** port on the front of the module, flows through an inline filter, and is pushed by a small pump into the top of a bottle containing molecular sieve. The molecular sieve removes the CO_2 and water vapor from the air as it flows down the length of the bottle. Scrubbed air enters a tube at the bottom of the bottle and then emerges from the **Out** port at the front of the module.

The **Test** port provides scrubbed air pulled from the middle of the molecular sieve, whereas the **Out** port has zeroed air removed from the bottom of the molecular sieve. See Figure 6-1 (p. 6) for the configuration of the ports.



Figure 6-1. Zero Air Generator port configuration

The **Test** connection pulls air from two inches above the bottom of the bottle of molecular sieve. This air sample is used to monitor the effectiveness of the molecular sieve scrubbing the air. Because unscrubbed air enters at the top and flows downward, the molecular sieve will be consumed from the top down. Measuring the CO_2 and water vapor from this **Test** port and comparing the values to the readings from the bottom of the bottle shows when the molecular sieve at the top of the bottle has been consumed. If air from the **Test** port contains more CO_2 or water vapor than the air exiting the **Out** port, the molecular sieve should be replaced. Molecular sieve 13X with 1.6 - 2.5 mm bead diameter is recommended. Approximately 450 g is needed to refill the bottle (see Replacement parts [p. 3]).

The **In** port should either be connected to the exhaust side of an IRGA zero/span shroud or sample cell, left capped (a tee-connection allows entry of ambient air from under the Zero Air Generator cover, see Figure 6-2 [p. 7]), or left uncapped. If the Zero Air Generator is used in

recirculating mode, the open port of the tee will keep the IRGA near ambient pressure. The **Out** port or **Test** port should be connected to the intake side of the IRGA zero/span shroud or sample cell. All connections should be made via tubing with1/4-in Swagelok[®] connectors.

NOTE:

Do not operate the Zero Air Generator with both outlets, **Out** and **Test**, plugged.



Figure 6-2. Internal connections of Zero Air Generator

6.2 Zeroing an open-path IRGA

The Zero Air Generator makes it easy to zero an IRGA in the field. For open-path IRGAs, such as the IRGASON or EC150 (sold by Campbell Scientific, Inc.) or the LI-7500 (sold by LI-COR[®], Inc.), a zero/span shroud is required. Install the zero/span shroud according to the manufacturer's instructions.

Secure the Zero Air Generator to the crossarm or other structure using the Velcro[®] strap. Connect the Zero Air Generator to the IRGA zero/span shroud in either an open-loop or a closed-loop configuration. Figure 6-3 (p. 8) shows the zero/span shroud connected to an LI-7500 in an open-loop configuration. Figure 6-4 (p. 8) shows the Zero Air Generator connected to an IRGASON in a closed-loop configuration. Either configuration will give good results.

The closed-loop configuration will exhaust the molecular sieve more slowly, which may be important if the Zero Air Generator is used extensively. The instrument will operate for many hours in an open-loop configuration. Normally, the batteries will have to be replaced a few times before the molecular sieve must be replaced, even in open-loop operation.

Follow the manufacturer's instructions to zero the specific IRGA. To ensure the molecular sieve is removing all of the CO_2 and water vapor, compare the IRGA readings by using the **Test** outlet.



Figure 6-3. Zero Air Generator connected to LI-7500 in open-loop configuration



Figure 6-4. Zero Air Generator connected to IRGASON in closed-loop configuration

6.3 Zeroing a closed-path IRGA

The Zero Air Generator may also be used with a closed-path IRGA in either an open-loop or a closed-loop configuration. Figure 6-5 (p. 9) shows the Zero Air Generator connected to an LI-840A (sold by LI-COR[®], Inc.) in a closed loop configuration. Connect the **Out** port to the LI-840A **IN** port and the LI-840A **OUT** port to the Zero Air Generator **In** port. Turn the pump on to start the flow of zero air. Follow the recommendations of the IRGA manufacturer for the zero procedure.



Figure 6-5. Zero Air Generator connected to LI-840A

7. Maintenance

7.1 Replacing batteries

The Zero Air Generator ships with two AA alkaline cells. Refer to the following instructions and figures to replace the batteries.

- 1. Make sure the switch is in the "OFF" position as shown on the lid of the Zero Air Generator.
- 2. Loosen the three screws that attach the lid and remove the lid as shown.



3. Slide the battery holder off its lid. The lid is held captive by a strip of Velcro[®]. The battery holder is captive to the pump by wires.



4. Insert two AA cells into the battery holder, taking care to put them in the proper orientation as indicated.



5. Replace the battery holder and lid in the reverse order.

Batteries will typically last approximately 45 hours of operation. The pumping speed will depend on the charge state of the batteries, as shown in Figure 7-1 (p. 12). Replace the batteries if the pump seems to be running slower than normal, or if it does not run at all. Replacement 1.5 V AA Alkaline Cell Batteries can be obtained from Campbell Scientific, but can usually be sourced locally. Any type of AA cells may be used: rechargeable or disposable.



Figure 7-1. Pumping speed relative to hours of use, indicating time for battery replacement

7.2 Replacing molecular sieve

The molecular sieve in the Zero Air Generator requires periodic replacement. Time for replacement can be determined by comparing the values of an air sample taken from the **Test** port to those of an air sample taken at the **Out** port as described in Theory of operation (p. 5). Two bottles of the Molecular Sieve Desiccant, available from Campbell Scientific, are needed to fill the bottle when replacing the molecular sieve material as described in the following steps and illustrations.

- Loosen the three screws that attach the box lid as shown in step 1 of Replacing batteries (p. 9) and remove the lid.
- 2. Unscrew the two 1/8-in Swagelok[®] nuts.



3. Loosen the four screws that clamp the bottle cap to the bracket approximately one turn.



4. Slide tubes out until filters touch the bottle cap.

NOTE:

Pull gently at first increasing force just until the tubes begin sliding out. Stop pulling when you feel the filter touch the bottle cap. Pulling too hard will pull the filter off the end of the tube.



5. Unscrew the bottle, keeping it upright to avoid spilling the contents, and set the O-ring aside for reassembly.



- 6. Empty the old molecular sieve into a disposal container and dispose according to local regulations.
- 7. Fill the bottle with new molecular sieve until the sieve is mounded as much as possible. Jiggle the bottle slightly to settle the beads and make room for the tubes and filter.

8. Place O-ring on top of the bottle and secure the cap tightly to the bottle.



9. Invert the bottle assembly so the tubes can be more easily pushed in to the molecular sieve.



10. Tighten the two 1/8-in Swagelok[®] nuts.

- 11. Tighten the four screws that clamp the lid to the bracket.
- 12. Reattach the box lid and tighten the screws until snug.

7.3 Replacing filter

The Zero Air Generator inlet filter is likely to last several years with normal usage. Heavy use in dirty environments may eventually clog the filter causing a reduction of air flow. If the inlet filter becomes plugged it may be replaced with the Syringe Filter Element, available from Campbell Scientific, through the following steps.

- 1. Loosen the three screws and remove the box lid.
- 2. Twist the fittings on each side of the filter to remove the filter.
- 3. Replace the filter with the Syringe Filter Element.
- 4. Tighten the fittings securely to avoid leakage.
- 5. Reattach the box lid and tighten the screws until snug.

Appendix A. Replaceable parts

The following table lists replaceable parts available from Campbell Scientific for the Zero Air Generator.

NOTE:

Part numbers are specific to Campbell Scientific, Inc.

Table A-1: Replaceable parts for the Zero Air Generator	
Part number	Description
26064	1.5 V AA Alkaline Cell Battery
27450	Molecular Sieve Desiccant
29998	Syringe Filter Element for Intake Assembly of AP200
15891	1/4 in OD Swagelok Plug
4180	Velcro Strap, 12 in x 1 in

Limited warranty

Covered equipment is warranted/guaranteed against defects in materials and workmanship under normal use and service for the period listed on your sales invoice or the product order information web page. The covered period begins on the date of shipment unless otherwise specified. For a repair to be covered under warranty, the following criteria must be met:

1. There must be a defect in materials or workmanship that affects form, fit, or function of the device.

2. The defect cannot be the result of misuse.

3. The defect must have occurred within a specified period of time; and

4. The determination must be made by a qualified technician at a Campbell Scientific Service Center/ repair facility.

The following is not covered:

1. Equipment which has been modified or altered in any way without the written permission of Campbell Scientific.

2. Batteries; and

3. Any equipment which has been subjected to misuse, neglect, acts of God or damage in transit.

Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page of the manual for a list of regional offices or visit www.campbellsci.com/contact to determine which Campbell Scientific office serves your country. For directions on how to return equipment, see Assistance.

Other manufacturer's products, that are resold by Campbell Scientific, are warranted only to the limits extended by the original manufacturer.

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MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Campbell Scientific hereby disclaims, to the fullest extent allowed by applicable law, any and all warranties and conditions with respect to the products, whether express, implied, or statutory, other than those expressly provided herein.

Campbell Scientific will, as a default, return warranted equipment by surface carrier prepaid. However, the method of return shipment is at Campbell Scientific's sole discretion. Campbell Scientific will not reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This warranty and the Company's obligation thereunder is in lieu of all other warranties, expressed or implied, including those of suitability and fitness for a particular purpose. Campbell Scientific is not liable for consequential damage.

In the event of any conflict or inconsistency between the provisions of this Warranty and the provisions of Campbell Scientific's Terms, the provisions of Campbell Scientific's Terms shall prevail. Furthermore, Campbell Scientific's Terms are hereby incorporated by reference into this Warranty. To view Terms and conditions that apply to Campbell Scientific, Logan, UT, USA, see Terms and Conditions 1. To view terms and conditions that apply to Campbell Scientific offices outside of the United States, contact the regional office that serves your country.

Assistance

Products may not be returned without prior authorization. Please inform us before returning equipment and obtain a **return material authorization (RMA) number** whether the repair is under warranty/guarantee or not. See Limited warranty for information on covered equipment.

Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page of the manual for a list of regional offices or visit

www.campbellsci.com/contact 🗹 to determine which Campbell Scientific office serves your country.

When returning equipment, a RMA number must be clearly marked on the outside of the package. Please state the faults as clearly as possible. Quotations for repairs can be given on request.

It is the policy of Campbell Scientific to protect the health of its employees and provide a safe working environment. In support of this policy, when equipment is returned to Campbell Scientific, Logan, UT, USA, it is mandatory that a "Declaration of Hazardous Material and Decontamination" form be received before the return can be processed. If the form is not received within 5 working days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. For details on decontamination standards specific to your country, please reach out to your regional Campbell Scientific office.

NOTE:

All goods that cross trade boundaries may be subject to some form of fee (customs clearance, duties or import tax). Also, some regional offices require a purchase order upfront if a product is out of the warranty period. Please contact your regional Campbell Scientific office for details.

Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a hardhat and eye protection, and take other appropriate safety precautions while working on or around tripods and towers.
- Do not climb tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- You can be killed or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in contact with overhead or underground utility lines.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, whichever is greater, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.

• Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.

• Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

Use and disposal of batteries

- Where batteries need to be transported to the installation site, ensure they are packed to prevent the battery terminals shorting which could cause a fire or explosion. Especially in the case of lithium batteries, ensure they are packed and transported in a way that complies with local shipping regulations and the safety requirements of the carriers involved.
- When installing the batteries follow the installation instructions very carefully. This is to avoid risk of damage to the equipment caused by installing the wrong type of battery or reverse connections.
- When disposing of used batteries, it is still important to avoid the risk of shorting. Do not dispose of the batteries in a fire as there is risk of explosion and leakage of harmful chemicals into the environment. Batteries should be disposed of at registered recycling facilities.

Avoiding unnecessary exposure to radio transmitter radiation

• Where the equipment includes a radio transmitter, precautions should be taken to avoid unnecessary exposure to radiation from the antenna. The degree of caution required varies with the power of the transmitter, but as a rule it is best to avoid getting closer to the antenna than 20 cm (8 inches) when the antenna is active. In particular keep your head away from the antenna. For higher power radios (in excess of 1 W ERP) turn the radio off when servicing the system, unless the antenna is installed away from the station, e.g. it is mounted above the system on an arm or pole.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

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