EGM-4 Environmental Gas Monitor For CO_2

Operator's Manual
Version 4.19

For Firmware (EPROM) Version 1.46 and Greater

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Preface

It is extremely important that you take the time to review this operator's manual prior to installation and operation of the EGM-4 CO_2 Gas Analyzer. Otherwise, damage may be caused which is not covered under our normal warranty policy. **This operator's manual is relevant to all EGM-4's running firmware (EPROM) version 1.30 and higher.**

System Calibration

- This product is shipped as a factory calibrated system. System calibration is not required upon receipt from our factory.
- Familiarization with the documentation and calibration procedures is required prior to future recalibration. See section **3CAL** on page 35 of this manual.
- All calibration related questions may be directed directly to PP Systems at:

Telephone: +1 978.834.0505
Fax: +1 978.834.0545

Email: support@ppsystems.com

User Registration

It is very important that **ALL** new customers register with us to ensure that our user's list is kept up to date. If you are a PP Systems' user, please register yourself electronically on our web site at http://www.ppsystems.com/user_registration2.htm .

Only **REGISTERED** users will be allowed access to our protected "Users" section of our web site. This section will contain important product information including hardware/software updates, application notes, newsletters, etc.

Thank you in advance for your cooperation.

The warranty excludes all defects in equipment caused by incorrect installation, operation or maintenance, misuse, alteration, and/or accident.

Warning Notice

This instrument must not be used in situations where its failure could result in injury or death. For applications where failure of this instrument to function correctly would lead to consequential damage, the Analyzer must be checked for correct operation and calibration at intervals appropriate to the criticality of the situation.

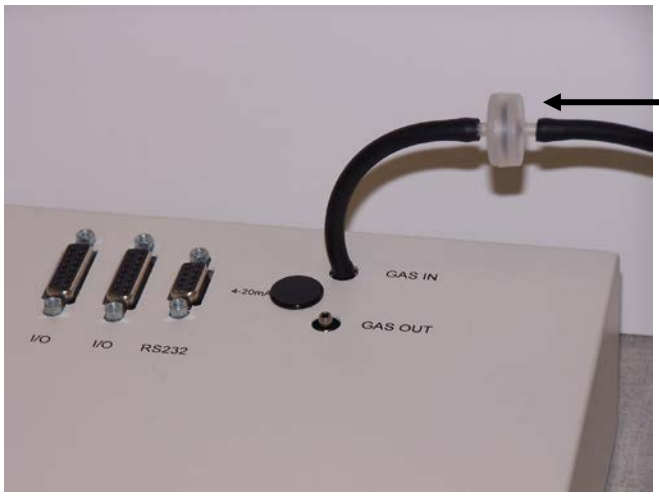
This manual is provided to help you install and operate the equipment. Every effort has been made to ensure that the information contained in this manual is accurate and complete. PP Systems does not accept any liability for losses or damages resulting from the use of this information. PP Systems' equipment warranty is limited to replacement of defective components, and does not cover injury to persons or property or other consequential damage. This manual, and the information contained in it, is copyright to PP Systems. No part of the manual may be copied, stored, transmitted or reproduced in any way or by any means including, but not limited to, photocopying, photography, magnetic or other mechanical or electrical means, without the prior written consent of PP Systems.

The EGM-4 is covered under warranty for one complete year, parts and labour included. This, of course, is provided that the equipment is properly installed, operated and maintained in accordance with written instructions (i.e. Operator's Manual). **The warranty excludes all defects in equipment caused by incorrect installation, operation or maintenance, misuse, alteration, and/or accident.**

If for some reason, a fault is covered under warranty, it is the responsibility of the customer to return the goods to PP Systems or an authorised agent for repair or replacement of the defective part(s).

Condensation Risk

If condensation occurs in the analysis sample line, free water may enter the analyzer causing serious damage which will result in a very expensive repair. Therefore, it is critical that you periodically inspect the pipeline to be sure that condensed water does not enter the analyzer. **If the EGM-4 is supplied on its own, we do NOT supply any external filters.** If the EGM-4 is used in conditions where there is risk of condensation or water in the sample line, (i.e. when used with the SRC-1, CPY-2, CPY-4 or CPY-3 chambers for measurement of soil/canopy assimilation, we strongly recommend fitting our hydrophobic filter to the “Gas In” port as shown below. Our hydrophobic filter assembly (Part No. 10045-1) is supplied with all SRC-1’s, CPY-2’s, CPY-4’s and CPY-3’s. All EGM-4 customers can purchase this filter from PP Systems (Part No. 10045-1) at any time if required. In addition, when this filter is used, it must be checked regularly and replaced as when dirty or wet. Otherwise, blockage can occur.



Our in-line filter assembly
(Part No. 10045-1)

For maintenance instructions, see In-Line Filter Assembly (Hydrophobic) on page 52.

Very Important

If there is any risk of of water entering the EGM-4, you must protect the instrument by using an external 3 µm hydrophobic filter (Part No. 10045-1) or water drop out trap. **We strongly recommend using 3 µm filters as any other size may cause damage to the pump**. If a water drop out trap is used, it should be regularly checked and emptied as required.

If condensation persists, it is then recommended that a PP Systems' water vapor equilibrator (Part No. 10049-1) is used (see picture below). This is constructed from a material that is very permeable to water vapor but impervious to CO_2. If this is placed in-line in the analysis pipe at the sampling point, the water vapor concentration of the analysis air will be brought close to ambient.

Part No. 10049-1 Water Vapor Equilibrator fitted to top of EGM-4

The problem may also be avoided by putting a suitable water drop out trap or drier in the same position. Drierite (anhydrous Calcium Sulphate) is suitable. **DO NOT** use Silica Gel, which also absorbs CO_2.

Please note that any method used to remove excess water from the analysis sample will render any humidity measurement incorrect.

If you have any questions whatsoever with regards to possible condensation risk, contact PP Systems (See PP Systems' Contact Information on page 7**).**

PP Systems' Contact Information

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Technical Specification

Analysis Method	Non-dispersive infrared with microprocessor control and linearisation.
Measurement Range (CO_2)	0-1,000 ppm (µmol mol^{-1}) 0-2,000 ppm (µmol mol^{-1}) 0-5,000 ppm (µmol mol^{-1}) 0-10,000 ppm (µmol mol^{-1}) 0-20,000 ppm (µmol mol^{-1}) 0-30,000 ppm (µmol mol^{-1}) 0-50,000 ppm (µmol mol^{-1}) 0-100,000 ppm (µmol mol^{-1}) Measurements are automatically corrected for temperature and pressure.
Accuracy (CO_2)	< 1% of span concentration over the calibrated range, but limited by the accuracy of the calibration gas mixture.
Linearity	< 1% throughout the range.
Stability	Automatic Zero at regular intervals. It corrects for sample cell contamination, source and detector ageing and pre-amplifier gain changes.
Sample Pump	Integral DC pump operating at a flow rate of approximately 350 ml/min. Pump can be disabled for static measurements on demand.
Gas Flow Rate Through Analyzer	Minimum flow rate: 200 ml/min Maximum flow rate: 400 ml/min
Environmental Sensor Interface	Two inputs available for use with external sensors (humidity, temperature, PAR, oxygen, soil respiration, canopy assimilation, etc.).
Air Filter	Filtered sample line (hydrophobic)
Calibration	Default value preset in factory (Built-in Initialization). Automatic calibration via keypad if required.
CO_2 Control	High and low set points
Alarm	Audio Alarm
Real Time Clock	Accuracy > 1 minute per month at 25 C, operating temperature 0-70 C. Automatic correction for month end and leap years.
Recording	Manual (by keypress) or automatic at user selected intervals between 1 and 250 minutes.
Keypad	Custom, tactile keypad
Data Storage	512 K Battery backed RAM (1,000 records).
Response Time	Display/analog output: 1.6 seconds
Analog Output (CO_2 only)	4-20 mA, 0-1 V, 0-2 V, 0-3 V, 0-4 V, 0-5 V (Linear)
Digital Output (RS232)	9600 baud/8 data bits, 1 start bit/2stop bits/no parity ASCII Format
Display	High contrast 2 x 16 character LCD.
Power Supply	12 V, 2.0 Ah Rechargeable Lead Acid Battery providing up to 4 hours continuous use or 12V NiMH rechargeable battery providing up to 8 hours continuous use. Longer times available with external 12V battery. Battery life may be reduced when EGM-4 is used with add-on sensors/accessories.
Gas Connections	Two barbed fittings (inlet and exhaust) for 1/8" (.125") ID tubing.
Housing	High impact, aluminum enclosure.
Operating Environment	-5^{o} C – 50^{o} C, non-condensing. In dirty or high humidity environments, external air filtration is required.
Dimensions	18 cm (W) x 21.5 cm (H) x 6.3 cm (D)
Weight	1.9 kg

PP Systems is continuously updating its products and reserves the right to amend product specifications without notice.

Introduction

The EGM-4 CO_2 Analyzer is a portable operated unit that is powered by an internal 12 V, 2.0 Ah lead acid rechargeable battery providing up to 4 hours continuous use or 12V NiMH rechargeable battery providing up to 8 hours continuous use. For extended operation in the field, PP Systems can also provide an external power supply cable that will allow you to connect up to an external 12 V battery. If interested, please contact PP Systems (See PP Systems' Contact Information on page 7).

The EGM-4 is a high precision instrument for use in CO_2 monitoring applications such as greenhouses, environment control rooms, nurseries and laboratories. Long term stability and accuracy is ensured as a result of our unique "Auto-Zero" technology. The EGM-4 also features inputs for additional sensors for measurement of humidity, temperature, PAR, O_2, soil respiration, soil temperature and canopy assimilation.

Measurement Principle

The EGM-4 CO_2 is a non-dispersive, infrared gas analyzer that features an "**Auto-Zero"** facility. Using infra-red gas analysis techniques, we can readily determine CO_2 (Carbon Dioxide) concentrations to within a few ppm and instantaneous measurements are possible. Gases with di-atomic molecules such as CO_2 strongly absorbs photons in the infra-red range. For CO_2 , one region of strong absorption is 4.26 microns. A source emitting strongly at this wavelength is a light bulb. If this is positioned at one end of a tube and at the other end is placed a sensor that is sensitive to photons at 4.26 microns, we have a simple infra-red gas Analyzer. As carbon dioxide is passed down the sample cell, it absorbs some of the infra-red and the sensor reading decreases. The "**Auto-Zero**" feature, which occurs at regular intervals, allows for fast warm-up, adaptation to changing ambient conditions and excellent stability of the CO_2 signal. The action of auto-zeroing minimizes the effects on span (gas sensitivity) of sample cell contamination, source aging, changes in detector sensitivity and changes in pre-amplifier gain.

The entire optical bench assembly (i.e. sample cell) is filtered and should never require replacement.

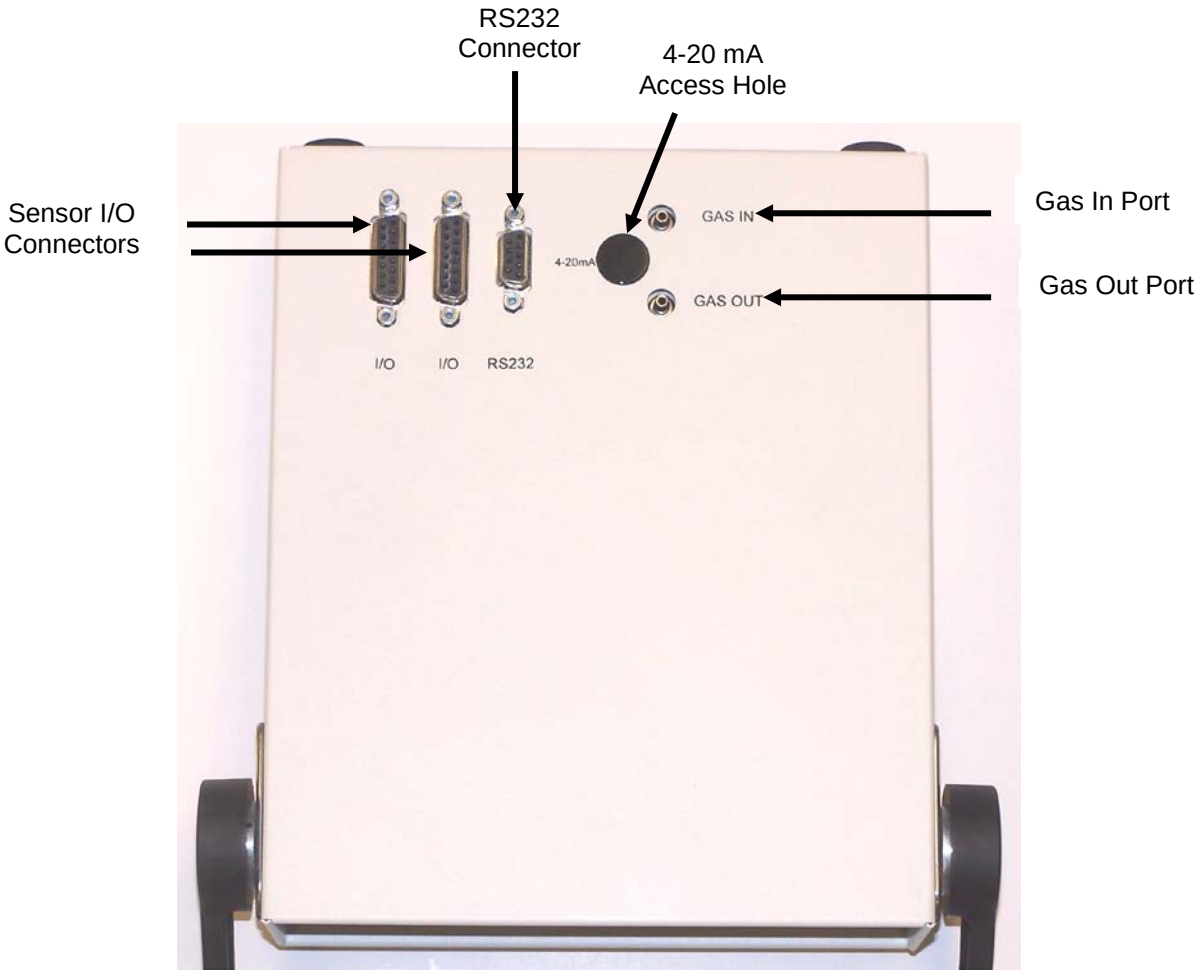
To ensure proper operation, the EGM-4 MUST always be operated in a vertical, upright position.

The EGM-4 can be supplied with two different optical benches. One bench is optimized for measurement of CO_2 in the ranges of 0-1,000 ppm up to 0-30,000 ppm. The other optical bench is optimized for 0-50,000 ppm and 0-100,000 ppm. All instruments are checked and calibrated at the concentration specified at time of order to ensure that the readings are < 1% of that value. When an instrument is reset to its default values (i.e. when the system is initialised, see Initialisation on page 43), it returns to this setting.

It is important to note that the information contained in this documentation normally refers to the latest firmware (EPROM) which can change over time. We recommend that all users keep in contact with us from time to time to ensure that they are running the most up to date system firmware.

Getting Familiar With The EGM-4

Figure 1 EGM-4 Display (Front Panel)



Top of EGM-4

Back Panel of EGM-4 fitted with 12V Lead Acid Battery

Back panel of EGM-4 fitted with 12V NiMH Battery

Environmental Sensor Inputs (I/O Ports)

The EGM-4 has 2 environmental sensor inputs (I/O) to allow external sensors (i.e. soil respiration chamber, CPY-2/CPY-3/CPY-4 Canopy Assimilation Chambers, TRP-1 Temperature/PAR Probe, PAR-1 Probe, etc.) to be used simultaneously. All sensor inputs lines require 0-1V input. Note, the sensor inputs are displayed in mV (i.e. 0-1,000 mV) instead of Volts.

If one of our environmental sensors is used with the EGM-4, it must be plugged into the instrument prior to turning it on. The EGM-4 automatically detects the sensor connected as a result of code resistors which are fitted to the 15 pin D Connector between pins 1 and 6. The code resistors for our environmental sensors are as follows:

Probe Type	PP Systems Sensor	Code Resistor
0	The EGM-4 is being used as a stand alone IRGA (no external sensors connected)	Not applicable. This is determined by keypad selection.
1	STP-1 Soil Temperature Probe	100 KΩ
2	Not Applicable. Used to be used with older sensors.	56 KΩ
3	TRP-1/TRP-2 Temperature/PAR Probe	36 KΩ
4	PAR-1/PAR Sensor	27 KΩ
5	Not Applicable. Used to be used with older sensors.	20 KΩ
6	Not Applicable. Used to be used with older sensors.	15 KΩ
7	Steady State Porometer (PMR-5)	Not applicable. This is determined by keypad selection.
8	SRC-1 Soil Respiration Chamber or CPY-2/CPY-4 Canopy Assmiliation Chamber (Closed System operation)	9.1 KΩ
9	OP-1/OP-2 O_2 Sensor	20 KΩ
10	Not Applicable. Used to be used with older sensors.	5.6 KΩ
11	CFX-1 Open System Soil Respiration Chamber or CPY-3 Canopy Chamber.	4.3 KΩ
12	CPY-4 Canopy Assimilation Chamber (Closed System Operation)	9.1 KΩ

Note. When the EGM-4 is supplied with a PP Systems accessory (i.e. SRC-1, CPY-4, etc.), the probe type will be set at the factory based on the accessory supplied. Therefore, it may be necessary to change the probe type if required. The probe type can be changed from the 2SET menu on page 30. if required. See Analog Output on page 13 for analog output pin-outs and location for code resistor placement (Pin 1).

Analog Output

The EGM-4 has two 15 pin I/O connectors with a 0-5V analog output. The default output is set at 0-5V. However, this can be changed by the user (if required) to any value in between (i.e. 0-1V, 0-2V, 0-3V, 0-4V). (See 7VOUT on page 34). The pin-outs for the two I/O connectors are as follows:

DB15 I/O Connector	Description
1	Code Resistor (connect to pin 6)
2	PAR
3	RH
4	Aux. Analog Input
5	Temp
6	+5V
7	Alarm 1 (Buffered)
8	Digital Ground
9	RS232 Output
10	Data Request /CO_2 Control
11	RS232 Input
12	+12V
13	Aux. Digital I/O
14	CO_2 Analog Out
15	Analog Ground

Current Output

If required, current output (4-20 mA) is available and can be accessed through the top of the EGM-4. Inside the EGM-4, there is a 2 pin connector labelled CN7 on the PC075-1 circuit board. The EGM-4 contains a 4-20 mA current transmitter that is powered from an internal 12V supply. To utilize the current output, simply connect the Iout pins directly to a 4-20 mA meter or digitizer. No power supply or other connections are required to get a 4-20 mA output from the EGM-4. Applying voltage to the Iout pins higher than 12 V will damage the internal circuitry.

RS232 Port

The EGM-4 has one 9 pin RS232 connector used for transferring stored data to a PC or laptop computer. To transfer stored data from the EGM-4 to an external PC, connect the data transfer cable (supplied by PP Systems) between the RS232 connector on the EGM-4 and the 9 pin serial connector on the PC. Data transfer software (supplied by PP Systems) steps you through the data transfer process. See Data Dump on page 37 for more information on data transfer. If required, a data transfer cable can easily be made up by the user. See table below:

9 PIN D Socket on EGM-4	9 Pin D Socket on PC
Pin 2	Pin 2
Pin 5	Pin 5

Soda Lime Absorber Column

The absorber column is labelled “Soda Lime” on the rear panel. It contains a CO_2 scrubbing desiccant known as Soda Lime. When air passes through this column, it removes all of the CO_2 from the air stream. The “Auto-Zero” facility built into the EGM-4 periodically switches the flow of gas from the Analyzer through this column to check the Analyzer zero. This routine ensures long term stability and accuracy of the CO_2 Analyzer. It automatically

corrects for such things as sample cell contamination, source aging, detector sensitivity and changes in electronics.

Soda Lime

Soda lime is used to remove CO_2 from air entering the EGM-4. It is supplied as self-indicating granules (1-2.5mm) that turn from green to brown as it becomes exhausted. The contents of the absorber column should be replaced when it is 2/3rds exhausted (brown). Soda Lime cannot be regenerated and should be discarded when exhausted. For accurate measurements and calibration, it is absolutely critical that the EGM-4 absorber column is not exhausted. If the soda lime is becoming exhausted, it will cause the ZERO to be performed on non-ZERO air causing an error in the calibration.

When exhausted, the Soda Lime Cap should be removed along with the foam filter pad (with the EGM-4 facing upwards) and the contents discarded. When replacing the soda lime, we recommend using a funnel to ensure that the desiccant fills the absorber column. Leave approximately 1" from the end of the column to allow the foam pad and cap to be refitted.

! CAUTION !
WASH YOUR HANDS AFTER HANDLING SODA LIME

Keypad

The custom, tactile keypad consists of 12 keys. There are ten keys that are labelled **0-9**. Also, there are a few keys that have additional functions. The **Y/R** (Yes/Record) key is used to accept settings and to record measurements. In addition, the **Y/R** key is pressed to advance from one display to the next. The **N** key is normally used to return to the Main Menu from Measurement Mode, reject settings or to step back through the menus. The **8/X** key is used to toggle from one display to another in Measurement Mode.

LCD Display

The EGM-4 features a 2x16 character, backlit LCD display.

Gas Ports

There are two barb fittings located on the top of the EGM-4. Each barb fitting is designed for use with 1/8" (.125") ID tubing. One barb fitting is labelled "Gas In" and the other "Gas Out". The sampling line should be fitted to the "Gas In" port using 1/8" tubing. The "Gas Out" line should be left open to atmosphere to allow the sample air to exhaust without restriction. Note, for closed system measurements with our SRC-1 Soil Respiration Chamber or CPY-2 Canopy Asssimilaton Chamber, one gas line is connected to the "Gas In" port and the other to the "Gas Out" port.

Battery

The EGM-4 can be powered by an internal 12V 2.0 Ah lead acid rechargeable battery providing up to 4 hours continuous use or a 12V NiMH rechargeable battery providing up to 8 hours continuous use.

Powering The EGM-4 With Internal 12V NiMH Battery

There are two ways to power the EGM-4 :-

1. Using the internal 12V NiMH battery:

A. Set the slide switch on the rear panel of the EGM-4 to the 'BATTERY' position.
B. Switch the instrument on using the 'POWER' toggle switch.

Note, the internal battery CANNOT be used to power the EGM-4 while it is being charged, but the external power supply can be used simultaneously instead.

2. Using the external power supply

A. Set the slide switch on the rear panel of the EGM-4 to the 'CHARGE' position.
B. Plug the EGM-4 External Power Supply into the '-ve/+ve' socket.
C. Switch the instrument on using the 'POWER' toggle switch.

CHARGING THE INTERNAL 12V NiMH BATTERY

1. Set the slide switch on the rear panel of the EGM-4 to the 'CHARGE' position.
2. Plug the EGM-4 NiMH Battery Charger into the 'CHARGE SKT'. To do this, line up the three socket pins with the plug, and screw on the plug sleeve (do not overtighten).

Charge Cycle and LED Indications for 12V NiMH Battery Charger

LED	Mode
Orange	Battery not connected
Orange	Battery initialization & analysis
Red	Fast charge
Green with intermittent orange flash	Top-off charge
Green	Trickle charge
Alternating red-green	Error

Check to make sure that the “charge indicator light" (red LED) on the charger is a steady state red after connection. If the LED does not come on, or it fluctuates, then there may be a bad connection.

WARNING

THE EGM-4 IS FITTED WITH A SLIDE SWITCH (CHARGE ← → BATTERY).

DO NOT OPERATE THE SLIDE SWITCH WHEN THE EGM-4 IS CONNECTED TO ANY EXTERNAL POWER SUPPLY OR BATTERY CHARGER.

Charge Socket

The charge socket is labelled “12V DC” on the rear panel of the EGM-4. The AC Adapter/charger supplied by PP Systems plugs into this socket to charge the internal 12V 2.0 Ah lead acid battery.

Power Supply/Charger

All systems are supplied complete with an AC Adapter/Charger designed specifically for use with the EGM-4 for charging the internal 12 V 2.0 Ah lead acid battery and for continuous operation in the lab. This unit has the following technical specification:

Input	100-240 V ~ 50-60 Hz

Output	15 V @ 2.7 A
Power Indicator	Green LED
Dimensions	10.5 cm x 6.5 cm x 4.5 cm
Weight	0.3 kg

!!! WARNING !!!

USE OF POWER SUPPLIES AND BATTERY CHARGERS OTHER THAN THOSE SUPPLIED BY PP SYSTEMS FOR THE EGM-4 WILL INVALIDATE THE WARRANTY.

Please note. EGM-4's can also be powered by an internal, rechargeable 12V NiMH battery for extended operation in the field. For more information on this option, refer to Powering The EGM-4 With Internal 12V NiMH Battery on page 14.

Power Switch

To power up the EGM-4, the On/Off Switch should be toggled to the "On" position. To turn the instrument off, the switch should be toggled to the "Off" position.

Operation

The EGM-4 is a menu driven instrument. **Note. If any external sensors/probes are to be used with the EGM-4, they MUST be electrically connected to one (or both) of the I/O ports prior to turning the instrument on.** When the instrument is first powered up, it will go through its normal warm-up period that takes approximately 5 minutes. Immediately after powering up the system, the following is displayed:

```
PP SYSTEMS C2002
EGML  0456   V1.30
```

Whereas:

EGML Or **EGMH** Or **PMR**	Refers to an EGM-4 with a measurement range up to 30,000 ppm. Refers to an EGM-4 with a measurement range of 50,000 or 99,999 ppm. Refers to PMR-5 Steady State Poromter.
0456	Refers to the serial number of the EGM-4
V1.30	Refers to the firmware (EPROM).

During warm-up, there is a delay of approximately 45 seconds to allow for calibration of the electronics and then the instrument proceeds to warm-up until the Analyzer temperature reaches 50 ˚C. A final Zero check is then performed before proceeding to the Main Menu.

Also during warm-up, several system checks are performed. The “Checksum” message is set to a factory default value of 123456. If this is incorrect as when a new version of firmware is first installed, a “CHECKSUM ERROR SEE MANUAL” message is displayed. If this occurs, simply press any key to proceed to the Main Menu. From the Main Menu, press key 0 to re-initialise the system (See Initialisation on page 43).

The next display will be dependent on whether or not any external sensors are being used with the EGM-4.

If the EGM-4 is being used on its own, the following will be displayed:

```
C2000          1V=2000
mV INPUTS      R150
```

Where:

C2000	Corresponds to the last calibration gas concentration. After DEFAULT, it is the original range specified by the end user.
1V=2000	Range of the voltage signal corresponding to the CO_2 concentration.
R150	Number of records stored in memory.

If the EGM-4 is being used with an external sensor (i.e. SRC-1 Soil Respiration Chamber), the following will be displayed:

```
C2000          5V=2000
PROBETYPE 8    R150
```

Where:

C2000	Corresponds to the last calibration gas concentration. After DEFAULT, it is the original range specified by the end user.
5V=2000	Range of the voltage signal corresponding to the CO_2 concentration.
PROBETYPE 8	Refers to the probe/sensor connected to the EGM-4. For a list of probe types, see Environmental Sensor Inputs (I/O Ports) on page 12.
R150	Number of records stored in memory.

If the EGM-4 is being used as a porometer (i.e. PMR-5), the following will be displayed:

```
C2000        5V=2000
POROMETER   R150
```

Where:

C2000	Corresponds to the last calibration gas concentration. After DEFAULT, it is the original range specified by the end user.
5V=2000	Range of the voltage signal corresponding to the CO_2 concentration.
POROMETER	Refers to the PMR-5.
R150	Number of records stored in memory.

After all system checks have been performed and the system achieves warm-up, the EGM-4 Main Menu is displayed as follows:

```
1REC   2SET   3CAL
4DMP   5CLR   6CLK
```

Note. If the instrument was just powered up, the display will show "WARM UP DELAY TEMPERATURE = XX" until the instrument achieves its warm up temperature of 50 ˚C prior to the Main Menu.

While in Measurement Mode, the following key presses can be performed:

Key	To:
Z/0	Perform a manual Zero.
Y/R	Record a measurement and place it in memory.
8/X	Changes to a different display (See section **1REC**).
N	Return to the Main Menu.

Refer to the following sections for more information on menus and displays.

Main Menu

There are 6 options available to the user when the Main Menu is displayed as follows:

```
1REC  2SET  3CAL
4DMP  5CLR  6CLK
```

Where:

Press Key	To
1	Go Into Measurement Mode. See 1REC on page 19.
2	Change system settings (i.e. zero type and time interval, recording type, alarm settings, etc.). See 2SET on page 30.
3	To calibrate the Analyzer. See 3CAL on page 35.
4	To dump stored data to a PC or to view data on the LCD display. See 4DMP on page 36.
5	Clear system memory. See 5CLR on page 41.
6	Set/check the system clock (date and time). See 6CLK on page 42.

Each option is discussed in further detail below.

1REC

To begin recording, press key 1. Please note, the EGM-4 display is dependent upon which probe type is connected to it. The following table illustrates the Probe Types:

If the EGM-4 is used as a:	**Then The Probe Type is set to:**
Stand Alone CO_2 Analyzer (including optional humidity sensor is fitted). See Stand Alone CO2 Analyzer (Probe Type 0) on page 20.	0
Environmental Monitor (With one of our Environmental Sensors such as %RH, temperature, PAR, O_2, etc.). See Environmental Monitor (Probe Types 1-6 and 10) on page 22.	1-5
Steady State Porometer. See Steady State Porometer (Probe Type 7) on page 23.	7
Closed System Soil Respiration (i.e. SRC-1 Soil Respiration Chamber). See Closed System Soil Respiration (Probe Type 8) on page 24.	8
O_2 probe	9
RH and Temperature	10
Open System Measurement (i.e. CFX-1 Soil Respiration Chamber, CPY-3 Chamber). See Open System Soil Respiration (Probe Type 11) on page 27.	11
Closed System operation with the CPY-4. See Closed System Soil Respiration (Probe Type 8) on page 24.	12

Important Note. Most instruments are supplied with the probe type already set if a sensor is supplied with the EGM-4. If an existing EGM-4 user purchases an environmental sensor from us, it may be necessary to set the probe type (see 1EGM on page 30).

In the followng sections, some displays will vary slightly to what is discussed depending on firmware and sensors connected to the EGM-4.

Stand Alone CO_2 Analyzer (Probe Type 0)

To begin recording, press key 1. Immediately after pressing key 1, the instrument will automatically perform a zero check. Once completed and assuming no problems with the zero, the instrument will proceed to "Measurement Mode" where the CO_2 value (plus additional values if optional humidity sensor is present) being measured by the instrument is displayed as follows:

Display 1A (without optional %RH Sensor)

```
C   545
    A1011  P00
```

Display 1B (with optional humidity Sensor)

```
C  545       H11.2
    A1011      P00
```

Where:

C	CO_2 concentration (ppm)
H	Humidity (mb). **Only if optional %RH/Temp sensor is present.**
A	Absolute pressure in sample cell (mb).
P	Refers to probe type. See 1REC on page 19.

To return to the Main Menu while in Measurement Mode, simply press the N key.

Note. If the instrument was just powered up, the display will show "WARM UP DELAY TEMPERATURE = XX" until the instrument achieves its warm up temperature of 50 ^{o}C prior to entering into Measurement Mode.

Additional information (i.e. external sensors, etc.) may be viewed on the LCD display if required. While in Measurement Mode with the CO_2 concentration displayed, subsequent presses of the 8 key will show additional displays as follows:

Measurement Mode Display Structure

Display 1A

```
C  545
   A1011   P00
```

Press Key 8 to display the following:

Display 2

```
REC  0066   PLOT 10
 19-12       13:05
```

Where:

REC	Record Number
PLOT	Plot Number
19-12	Date (19th day of December)
13:05	Time (1:05 PM)

Press Key 8 to display the following:

Display 3

```
Axxxx Bxxxx  xxxx
Dxxxx        Exxxx
```

Where:

A	Signal (mV) from sensor connected to **Pin 1** on the 15 pin D Connector.
B	Signal (mV) from sensor connected to **Pin 2** on the 15 pin D Connector.
xxxx	Signal (mV) from sensor connected to **Pin 3** on the 15 pin D Connector. **Note.** Due to limits on the display, the letter C is not displayed.
D	Signal (mV) from sensor connected to **Pin 4** on the 15 pin D Connector.
E	Signal (mV) from sensor connected to **Pin 5** on the 15 pin D Connector.

See Environmental Sensor Inputs on page 12.

Press key 8 to return to **Display 1A** in Measurement Mode.

Display1B (if optional humidity sensor is fitted)

```
C  545        H11.2
   A1011   P00
```

Press Key 8 to display the following:

Display 2

```
REC  0066   PLOT 10
 19-12       13:05
```

Where:

REC	Record Number
PLOT	Plot Number
19-12	Date (19th day of December)
13:05	Time (1:05 PM)

Press Key 8 to display the following:

Display 3

```
Axxxx Bxxxx  xxxx
Dxxxx        Exxxx
```

Where:

A	Signal (mV) from sensor connected to **Pin 1** on the 15 pin D Connector.
B	Signal (mV) from sensor connected to **Pin 2** on the 15 pin D Connector.
xxxx	Signal (mV) from sensor connected to **Pin 3** on the 15 pin D Connector. **Note.** Due to limits on the display, the letter C is not displayed.
D	Signal (mV) from sensor connected to **Pin 4** on the 15 pin D Connector.
E	Signal (mV) from sensor connected to **Pin 5** on the 15 pin D Connector.

See Environmental Sensor Inputs on page 12.

Press key 8 to return to **Display 1B** in Measurement Mode.

The record number resets each time the instrument starts or when the memory is cleared. It counts up to 9999 and then resets automatically to 1. The internal EGM-4 memory allows data storage of up to 1,000 records. **Please note, when the memory is full, it overwrites the oldest records.**

Changing Plot Number

If the plot number needs to be changed, press key N when Display 2 above is shown and enter the plot number desired. Next, press the Y key to continue. To return to Display 1 press key 8/X twice. Only the plot number can be changed at this point and the record number automatically resets to 1 when the plot number changes.

Environmental Monitor (Probe Types 1-6 and 10)

Immediately after pressing key 1, the instrument will automatically perform a zero check. Once completed and assuming no problems with the zero, the instrument will proceed to "Measurement Mode" where the CO_2 value (plus optional %RH/Temp sensor is present) and sensor values are displayed as follows (**Display 1**):

```
C  365     T24.3
 Q 1200   RH  65.3
```

Where:

C	CO_2 concentration (ppm)
H	Humidity (mb). **Only if optional humidity sensor is present.**
T	Air Temperature (^{o}C)
Q	PAR (µmol m^{-2} s^{-1})
RH	Relative Humidity (%). If the optional humidity sensor is fitted to the EGM-4, press key 8/X to see the humidity displayed in mb.

Note. If the instrument was just powered up, the display will show "WARM UP DELAY TEMPERATURE = XX" until the instrument achieves its warm up temperature of 50 ˚C prior to entering into Measurement Mode.

Press key 8/X to view record number, plot number, date and time (**Display 2**):

```
REC 0001 PLOT 00
03-04        12:40
```

Where:

REC	Record Number (up to 9999).
PLOT	Plot Number (up to 99)
03-04	Date (3rd day of April)
12:40	Time (12:40 PM)

The record number resets each time the instrument starts or when the memory is cleared. It counts up to 9999 and then resets automatically to 1. The internal EGM-4 memory allows data storage of up to 1,250 records. **Please note, when the memory is full, it overwrites the oldest records.**

The Plot Number can be changed as explained in the section Changing Plot Number on page 22.

Additional information may also be viewed on the LCD display. While in Measurement Mode with the CO_2 concentration and sensor data displayed, subsequent presses of the 8/X key will show additional displays as outlined in Measurement Mode Display Structure on page 21.

PP Systems Environmental Sensor Conversions:

The following conversions need to be made to determine actual measurements of PAR, %RH and temperature when using PP Systems' environmental sensors.

PAR Sensor mV x 3 = PAR Level (µmol m^{-2} s^{-1})
%RH Sensor mV / 10 = %RH
Temperature mV / 20 = Temperature (˚C)

To return to the Main Menu while in Measurement Mode, simply press the N key.

Steady State Porometer (Probe Type 7)

Immediately after pressing key 1, the instrument will display the following message to allow the sensors to time for alignment (**Display 1**):

```
KEY 2 = HUMIDITY
SENSOR BALANCE
```

After approximately 3 seconds, the following is displayed to allow entry of record and plot number if required (**Display 2**):

```
REC 0001 PLOT 00
03-04        12:40
```

Where:

REC	Record Number (up to 9999).
PLOT	Plot Number (up to 99)
03-04	Date (3rd day of April)
12:40	Time (12:40 PM)

Note. If the plot number needs to be changed, press key N when Display 2 above is shown and enter the plot number desired. Next, press the Y key to continue. To return to Display 1 press key 8/X twice. Only the plot number can be changed at this point and the record number automatically resets to 1 when the plot number changes.

To proceed to the Measurement Display, press the 8/X key **(Display 3):**

```
I 22.3  O28.4   T22
Q1645 F245 G 0234
```

Where:

I	Inlet Relative Humidity (%RH)
O	Outlet Relative Humidity (%RH)
T	Porometer Temperature (˚C)
Q	PAR (µmol m^{-2} s^{-1})
F	Flow Rate (ml/min)
G	Stomatal Conductance (mmol (H_2O) m^{-2} s^{-1})

The stomatal conductance calculation uses an exact determination of the energy balance.

To return to the Main Menu while in Measurement Mode, simply press the N key.

Closed System Soil Respiration (Probe Type 8)

Before performing closed system measurements with the SRC-1 Soil Respiration Chamber (or CPY-2/CPY-4 Canopy Assimilation Chambers), see the section on Condensation Risk on page 6 at the beginning of this manual to ensure that you do not encounter any problems related to water in the analyzer.

Use of our PAR Sensor with SRC-1 Soil Respiration Chamber

If you have one of our PAR Sensors and you want to use it along with the SRC-1 Soil Respiration Chamber, you need to follow these steps.

1. Connect both the SRC-1 and PAR sensor to the EGM-4 and power it up.
2. From the Main Menu, press 2SET.
3. Press 1EGM and then the N key 3 times.
4. Enter 08 for Probe Type and say Yes to accept.
5. Press key N to return to the main menu.

Immediately after pressing key 1, the instrument will perform zero checks (and may display the "Warm Up Delay" message if the EGM-4 was just powered up) prior to displaying the following message (**Display 1**):

```
SOIL RESP.DATA
RECORD  1ALL  2END
```

The assimilation (respiration/photosynthesis) rate is calculated by plotting the rate of change in the chamber CO_2 concentration. The user has the option of saving the full data used in fitting the soil respiration rate curve or the final results. If you want to save the full set of data, press key 1. Note, data is collected every 4.8 seconds. If 1 is selected (ALL), the internal memory will allow you to store approximately 80 minutes of continuous data. Since there are typically several minutes in between measurements, you could expect to store approximately ½ days work. If 2 is selected, only the final results will be saved and recorded.

Next, choose linear or quadratic fitting for the soil respiration data (**Display 2**). If you are unsure which option to choose, we recommend option 2QUAD (quadratic fitting). For more information on this, please refer to the SRC-1, CPY-2 and CPY-4 technical documentation.

```
DATA FITTING
1LINEAR 2 QUAD.?
```

Please note. If a quadratic fit is selected and the ppm change is less than 0.2ppm/second, a linear fit is used. The system always starts up with the SRC-1 default values. See table below for default values for SRC-1 and CPY-4. If using the CPY-4 or non-standard chambers with the EGM-4, press key 1 to change the system volume, key 2 to change the area exposed for the proper values (**Display 3**):

```
1V: 1171   2A:  78
3V/A*100    1491
```

Where:

	Description	**SRC-1**	**CPY-4** With ring 5 mm into soil	**CPY-4** With ring 10 mm into soil
1V:	Volume of the system up to 999,999 (ml)	1171	2427	2344
2A	Area exposed up to 9999 (ml or cm^3)	78	167	167

3V/A*100	Volume/Area. This is automatically updated when there is a change to 1 (Volume) or 2 (Area). Also, if this value is changed directly, 1 (Volume) and 2 (Area) are set to maximum.	Automatically updated/calculated based on values entered abovee

Important Note. If using the SRC-1 or CPY-4 with collars you must remember to account for the extra volume under 1V for proper calculation of rates.

Press key Y to advance to the next display. Press key 1 to change the time, key 2 to change the CO_2 concentration or key 3 to change the approximate air temperature **(Display 4):**

```
1DT:120     2DC:  50
3TEMP 25.  4SRDIV:2
```

Where:

1DT:	Time for which the change in the chamber CO_2 concentration is monitored (seconds). The minimum and maximum values are 30 and 999 seconds respectively.
2DC:	The maximum change allowed in CO_2 concentration from time zero at which point the final measurement is made (ppm).
3TEMP:	The approximate air temperature (°C).
4SRDIV:2	Only available from firmware version 1.51 and above. Prior to V. 1.51, a divisor of 100 was used to convert the four digit SR number in soil respiration units in $g/m^2/hr$ limiting the maximum recording rate to 99.99. V. 1.51 allows for a selectable SR divisor hat can be set to 10, 100 or 1000 for maximum reported SR of 999.9. The default SRDIV value is 2.

SRDIV Setting	**Corresponding Divisor to convert 4 digits to SR**	**Max. SR reading**	**Min. SR Reading**
1	10	999.9	0.1
2 (default)	100	99.9	0.01
3	1000	9.999	0.001

Press key Y to advance to the next display **(Display 5):**

```
PLOT NO = 0
Y OR NEW VALUE
```

Where:

PLOT	Plot Number (up to 99)

Note. If the plot number needs to be changed, simply enter the new value (leading zeroes required for values less than 10, i.e. 05 for plot number 5) and press key Y when Display 5 above is shown. To return to Display 1 press key 8/X twice. Only the plot number can be changed at this point and the record number automatically resets to 1 when the plot number changes.

The next display is as follows **(Display 6)**:

```
CHAMBER FLUSHING
HOLD IN AIR       03
```

At this stage, the SRC-1 chamber should be held in the air to allow it to flush out prior to placing it on the soil. The number in the bottom right (03 in this case) is a count from 0-15 in 1.6 second increments. When completed, the following is displayed **(Display 7):**

PLACE ON SOIL PRESS Y TO START

After placing the SRC-1 chamber on the soil, press the Y key. The following will be displayed **(Display 8)**:

EQUILIBRATION PLEASE WAIT 03

After approximately 5 seconds, the measurement will commence. Before final calculation of soil respiration rate (g (CO_2) m^2 Hour) can be achieved, the EGM-4 must have accumulated 4 data sets. The measurement display is as follows **(Display 9):**

C 395 H14.7 T22 A02.11 Q0000 110

Where:

C 395	Current measured CO_2 concentration (ppm)
H14.7	Humidity concentration **if optional %RH/Temp sensor is present** (mb)
T22	Soil Temperature **if optional STP-1 probe is present** (˚C)
A02.11	CO_2 exchange (Assimilation) rate (g (CO_2) m^2 Hour). The maximum rate that can be recorded is 99.99 g (CO_2) m^2 Hour.
Q0000	PAR (µmol m^{-2} s^{-1})
110	The elapsed time of measurement (seconds). At the conclusion of measurement, END will be displayed.

At the conclusion of measurement, the following is displayed:

C 395 H14.7 T22 A02.11 Q0000 END

At completion of measurement (with END displayed), press any key to continue. You are now given the option to save the record.

RECORD Y/N

Press the Y key to save the record. Press the N key if you do not want to save the record.

Please Note. If the DC or DT exceeds the set values, the following message is displayed:

NON-LINEAR FIT

This message is displayed with the quadratic fit if the C term in the quadratic fitting expression ($Y = a + bx + cx^2$) is greater than 0.1 x b.

At this stage, the user is still given the opportunity to save the measurement even though the DC an DT settings were exceeded.

```
RECORD  Y/N
```

If you still want to save the measurement, press key Y. If not, press key N. After making your selection, the following is displayed:

```
REMOVE FROM SOIL
THEN PRESS Y KEY
```

The measurement process begins as described above. **Note.** If a ZERO is required, it will be performed in between measurements. At any time, a key press of N will return you to the display that shows Volume, Area, etc. (Display 3 above) and the settings can be changed if required. A subsequent press of the N key will return you to the Main Menu.

To return to the Main Menu while in Measurement Mode, simply press the N key.

For more information on the theory and calculation of soil respiration/canopy assimilation, please refer to the SRC-1 Soil Respiration Chamber or CPY-4 technical documentation.

Oxygen (Probe Type 9)

Immediately after pressing key 1, the instrument will automatically perform a zero check. Once completed and assuming no problems with the zero, the instrument will proceed to "Measurement Mode" where the CO_2 and O_2 value (plus Humidity and Temperature if sensor is present) and sensor values are displayed as follows (**Display 1**):

```
C   365 T24.3
O%  20.9     RH  65.3
```

Where:

C	CO_2 concentration (ppm)
H	Humidity (mb). **Only if optional humidity sensor is present.**
T	Air Temperature (^oC). **Only if optional %RH/Temp sensor is present.**
O%	O2 concentration (%)
RH	Relative Humidity (%RH)

Open System Soil Respiration (Probe Type 11)

Before starting any measurements with the CFX-1 or CPY-3 chambers, see the section on Condensation Risk on page 6 to ensure that you do not encounter any problems related to water in the analyzer.

Immediately after pressing key 1, the instrument will display the following message (**Display 1**):

```
CPY 1:5L  2:20L  3:100L
     4:CFX
```

Where:

1:5L	Select 1 if operating our CPY-3 chamber with 5 Litre/min flow.
2:20L	Select 2 if operating our CPY-3 chamber with 20 Litre/min flow.
3:100L	Select 3 if operating our CPY-3 chamber with 100 Litre/min flow.
CFX	Select 4 if operating our CFX-1 Soil Respiration Chamber

Select the appropriate chamber (CPY-3 or CFX-1). If one of the CPY-3 chambers is selected, it is necessary to enter or to check that the area covered by the chamber is correct. Note, the entry is in cm^2 up to 9999 or approximately 1 m^2. If 9999 is entered when the true area is smaller, the calculated flux will be the chamber flux.

After performing a Zero, the next display will be as follows (**Display 2**):

```
REC 0001 PLOT 00
03-04        12:40
```

Where:

REC	Record Number (up to 9999).
PLOT	Plot Number (up to 99)
03-04	Date (3rd day of April)
12:40	Time (12:40 PM)

Note. If the plot number needs to be changed, press key N when Display 2 above is shown and enter the plot number desired. Next, press the Y key to continue. To return to Display 1, press key 8/X twice. Only the plot number can be changed at this point and the record number automatically resets to 1 when the plot number changes.

To proceed to the first measurement display, press the 8/X key **(Display 3):**

```
R00345 D+0020 T22
A06.15  F0300   R
```

Where:

R	Reference CO_2 concentration (ppm)
D	Difference between Reference and Analysis gas (ppm)
T	Temperature of the CFX-1 or CPY-3 Chamber (˚C)
A	CO_2 exchange (Assimilation rate) (µmol m^2 s^{-1}).
F	Flow Rate (ml/min)
R/A	Indicates if Reference or Analysis is being sampled

If you press the 8/X key, the standard EGM-4 data is displayed (i.e. CO_2, H_2O, etc.).

With the CPY-3 only, the atmospheric pressure Annnn is replaced by the PAR reading (Qnnnn).

If the EGM-4 is fitted with the optional humidity/temperature sensor, then these measured parameters are also displayed.

Use the 8/X key to scroll round Displays 2,3 and Standard

To save the measured data at any time, press key Y.

To return to the Main Menu simply press the N key when either Display 2 or 3 is shown.

System Equilibrium

The EGM-4 is an absolute analyzer. In order to work with open-type chambers, an internal solenoid (built into the chamber) switches every 30 seconds to select either the reference or analysis sample gas stream for measurement. Therefore, a minimum of 45 seconds must elapse before valid data is available. However, this is not the time taken to get to equilibrium which depends on the chamber volume and the flow rate.

For example, with the CFX-1 the effective volume between the Reference and Analysis sampling points is approximately 2.2 litres :

System Response Time (minutes) = Chamber Volume (2.2litres) / Flow Rate (litres/minute)

So at a Flow Rate of 1litre/minute, System Response Time = 2.2 minutes

Assuming the system is perfectly mixed then there is an exponential approach to equilibrium:

63% of final value achieved in 1 System Response Time
86% of final value achieved in 2 System Response Times
95% of final value achieved in 3 System Response Times
98% of final value achieved in 4 System Response Times

Calculation Of Fluxes For CFX And CPY Chambers

Both the CFX-1 and CPY-3 chambers use Honeywell mass flowmeters that are calibrated at STP which is 0 ^{o}C and 1013mb. Results are given in μmol m^{-2} s^{-1} for CO_2 and in mmol m^{-2} s^{-1} for H_2O.

Convert the flow (V) measured in ml min^{-1} at STP through the chamber with an exposed area of (A) cm^2 to mol m^{-2} s^{-1} (Molar Volume at STP is 22.414 l.)

$$= (V \times 10000) / (A \times 22.414 \times 1000 \times 60) = (V / A) \times 7.436 \times 10^{-3}$$

With a CO_2 differential between the inlet and outlet of ΔC ppm, the CO_2 flux is:

$$\Delta C \times (V / A) \times 7.436 \times 10^{-3} \ \mu mol\ m^{-2}\ s^{-1}$$

and with an H_2O differential between the inlet and outlet of ΔH mb, the H_2O flux is:

$$\Delta H \times (V / A) \times 7.436 \times 10^{-3} \ mmol\ m^{-2}\ s^{-1} .$$

For CO_2, to convert to g CO_2 m^2 h^{-1}, multiply by 0.1584.
For H_2O, to convert to g H_2O m^2 h^{-1}, multiply by 64.87.

2SET

Press key 2 from the Main Menu if you need to:

- Select/change probe types used with the EGM-4 (1EGM on page 30).
- Select/change the EGM-4 Zero (2Z on page 31).
- Enable/disable sampling pump (3PMP on page 32).
- Determines within which range of outputs the average is to be taken (4AV on page 32).
- Change the instrument recording feature, automatic vs. manual (5RECD on page 33).
- To set the high and low alarm (6ALM on page 33).
- To change the analog voltage output, 1-5V, **(**7VOUT on page 34).

```
1EGM2Z: 3PMP 4AV
5RECD 6ALM 7VOUT
```

1EGM

Press 1EGM to set the EGM-4 displays according to intended application.

```
  :MV      0:PROBE
Y=OK     N=CHANGE
```

Where:

:MV	EGM-4 set to analyzer only with auxiliary inputs displayed in mv. Probe type should be set to 0 in this case.
0	Probe Type (See Probe Types table below).
Y	Press Y if the settings are correct.
N	Press N to change the Probe Type

The EGM-4 is quite versatile and can be used as a stand alone gas analyzer, part of an environmental monitoring system when used with any of our available sensors (i.e. TRP-2, SRC-1 Soil Respiration Chamber, CPY-4 Canopy Assimilation Chamber, etc.) or as a steady state porometer.

To change the probe type from the current setting:

1. Press key N 3 times until ?? appears next to PROBE.
2. Enter the probe type (use leading 0's for single digit probe types).
3. Press key Y to save.
4. Press key N to return to Main Menu.

Probe Types

Probe Type	PP Systems Sensor
0	The EGM-4 is being used as a stand alone IRGA (no external sensors connected)
1	STP-1 Soil Temperature Probe
2	Not Applicable. Used to be used with older sensors.
3	TRP-1/TRP-2 Temperature/PAR Probe
4	PAR-1/PAR Sensor
5	Not Applicable. Used to be used with older sensors.
6	Not Applicable. Used to be used with older sensors.
7	Steady State Porometer (PMR-5)
8	SRC-1 Soil Respiration Chamber or CPY-2/CPY-4 Canopy Assmiliation Chamber (Closed System operation)
9	OP-1/OP-2 O_2 Sensor
10	Not Applicable. Used to be used with older sensors.

11	CFX-1 Open System Soil Respiration Chamber or CPY-3 Canopy Chamber.
12	CPY-4 Canopy Assimilation Chamber (Closed System Operation)

Probe Setting Override

Some users may want to use the EGM-4 as a stand alone IRGA even with a sensor connected. This option is available under 1EGM:

Press 1EGM. The Probe type should be set to the probe type connected to the EGM-4.

1. Press key N once until * appears next to :MV.
2. There should be a blank (no value) next to PROBE.
3. Press key Y to save.
4. Press key N to return to Main Menu.

If you now press key 1REC from the Main Menu, you will enter into the measurement mode and the EGM-4 will act as a stand alone IRGA (See Stand Alone CO2 Analyzer (Probe Type 0) on page 20.

2Z

Press 2ZERO to change the zero type and the time interval for performing zeros.

Changing the Zero Type

Press key 2 (2ZERO) and then key 1 to change the zero type used by the EGM-4. At present, there are 3 types of zeros that can be performed:

Auto	This is the recommended ZERO type. The EGM-4 performs a Zero on start up, then again after 2 minutes, then again after 4 more minutes, then after 8 minutes and finally after 16 minutes up to a maximum interval set by the ZEROTIME. ZEROTIME by default at start up is 20 minutes but it can be set from 1 to 40 minutes. This is the default mode on startup.
Manual	If selected, the EGM-4 performs a Zero on start up, then again after 2 minutes, then again after 4 more minutes, then after 8 minutes and finally after 16 minutes. After that, the user is responsible for performing ZEROS by pressing the 0 key while in Measurement Mode. **Note, if the user fails to perform a ZERO after 40 minutes, one will be performed automatically.**
EXT	A ZERO can be initiated by pulling DATA/ZERO REQ (Pin 10) line LOW. (Connect to Ground Pin 8) Hold for 3 seconds and then break ground connection. **If no ZERO occurs after 40 minutes, one will be performed automatically.**

An asterisk (*) indicates which ZERO type is selected. By default, the ZERO TYPE is set to AUTO which is what we recommend.

```
ZEROTYPE   *:AUTO
 2:MANUAL    3:EXT
```

To change the ZERO TYPE, press key 1 for AUTO, key 2 for MANUAL or key 3 for EXT. Immediately after pressing the key, the asterisk (*) will be displayed next to your selection. This will be the ZERO TYPE that will be used by the EGM-4 until changed again. Press key Y to return to the 2SET menu.

Changing the Zero Time

Press key 1 (1ZERO) and then key 2 to change the Auto-Zero time.

```
 ZEROTIME = 40
Y=OK  N=NEW VAL
```

Zero time is the interval between Zeros in minutes when ZERO TYPE is set to Auto. If the displayed time is correct, simply press the Y key. If you want to change the ZERO TIME, press key N and enter a value up to a maximum of 40. **Note, for values less than 10, leading zeros are required (i.e. 05 for 5 minutes).** The new value will be updated on the display. To accept, press the Y key.

3PMP

Press 3PMP to enable/disable the internal sampling pump. By default, the sample pump is on.

```
SAMPLE PUMP ON
 Y/OK      N/CHANGE
```

If required, the internal pump can be turned off by pressing the N key.

```
STATIC SAMPLING
 Y/OK    N/CHANGE
```

Static Sampling with the EGM-4

If static sampling is selected, the user can inject samples directly into the sample cell through the port labelled “Gas Out” rather than having the sample pumped through it. This is normally done using a syringe with 1/8” tubing on the end which can easily fit over the “Gas Out” port on the EGM-4. For static measurements injected directly into the “Gas Out” port, we recommend a minimum volume of 5 ml. During the course of measurements, a warning is given 2 minutes and 1 minute prior to the instrument performing a ZERO followed by the pump turning on for a ZERO. On completion of the Analyzer ZERO, the pump will again switch off. By default, the EGM-4 is set to dynamic sampling with the pump on at all times. The general procedure for static measurements is as follows:

1. From the Main Menu, select 2SET, 3PMP.
2. With the “SAMPLE PUMP ON” message displayed, press key N to change to “STATIC SAMPLING”.
3. Press key Y to accept and then press key Y again to return to the Main Menu.
4. Press 1REC. The instrument will now perform a ZERO. Once the ZERO is complete, the pump will turn off.
5. Inject your sample (minimum of 5ml) directly into the Gas Out port. We recommend a slow, steady injection rate of approximately 6 ml/second. Initially, the CO_2 concentration will be higher (due to pressure) and then will drop to the actual concentration and should remain stable. Once the reading stabilizes, press the Y/R key to record the values. Remove the syringe from the “Gas Out” port to allow the system to flush properly.
6. After recording, press the 0/Z key to flush the sample cell and to allow the instrument to perform a ZERO before injecting your next sample.

4AV

The outputs from the CO_2 sensors are normally subjected to an averaging process. This consists of differencing the current reading and the stored average reading (both raw data). If the difference exceeds the average limit, then the current reading replaces the average.

Otherwise, the current reading is incorporated into the average. The average reading is then linearized etc. to give the measured concentration. If AV is set to 0, then averaging is disabled giving instantaneous readings. The averaging band is increased as AV is increased, up to a maximum of 999 units. The AV is automatically set to 1 unit for soil respiration and static sampling measurements. The AV defaults to 6 units without a probe (EGM-4 on its own). The default for the EGM-4 when used on its own is 0.3% of full scale. Therefore, for an EGM-4 calibrated to 2,000 ppm, the default value would be 6 ppm.

Press 4AV to change the AV.

```
AV. LIMIT = 6
 Y/OK    N=NEW VAL
```

If you want to change the AV value, press key N and enter a value up to a maximum of 999.

5RECD

This controls the recording in the EGM-4. Records can be recorded manually or automatically at set time intervals. Press Key 5 to set the recording type.

```
1REC:M   2INT:   0
```

To change the recording from MANUAL (M) to AUTOMATIC (A) and vice versa, press key 1. If M is displayed, the time interval (2INT) is set 0 by default. A key press of 1 will change the recording type to A (Automatic) and the time interval (2INT) will change to 1 (1 minute) by default. To change the time interval for automatic recording, press key 2 and enter a value (not to exceed 720 minutes). **Note, leading zeros are required for values less than 100 (i.e. 005 for 5 minutes).**

The EGM-4 is set to MANUAL recording by default.

6ALM

There are both high and low alarm facilities built into the EGM-4. A 2 pin header type connector (CN6) is located on the internal EGM-4 circuit board for controlling the audible alarm. All EGM-4's are currently supplied with the audible alarm disabled as the jumper is fitted to just one pin on CN6. To enable the audible alarm, simply fit the jumper to both pins on CN6. For access and location of CN6, see Inside the EGM-4 on page 47. A TTL level signal for low CO_2 is always output o npin 7 of the I/O connector whether the audible alarm jumper is in place or not. Note, the alarm facilities are not available with Probe Types 7 or higher (i.e. porometer and soil respiration). Press key 3 to set the Low and High CO_2 alarm setpoints.

```
1:LOCO2 =    250
2:HICO2  =  2000
```

Setting the Low CO_2 Alarm Setpoint

Press key 3 (3ALM) and key 1 to set the low CO_2 alarm setpoint in ppm. The display will show ?????. Enter the required value. **Note, leading zeros are required for values less than 1000 (i.e. 00200 for 200).** The EGM-4 is supplied with a factory default low alarm setting of 250 ppm. The reason for this is that a low CO_2 value can be the result of one of the following scenarios:

- Low or no air flow.
- Absorber column exhausted (soda lime).

- Zero valve failure.
- Source failure.

However, past history has shown that some customers want to work at lower CO_2 concentrations. As a result, lower alarm settings can be set up by the user if required. If the low alarm is set to 250 ppm, the low alarm operates when the self-checking facility finds any of the following system faults:

Error Code	Reported fault
1	Zero to low
2	CO_2 < 250 ppm
3	Analyzer temperature out of range (too cold)
4	Analyzer temperature out of range (too hot)
5	RH > 90%

The above error codes are accompanied by corresponding displays and the error codes are written to the records. Note, with the porometer and soil respiration/canopy chambers (SRC-1, CPY-4 and CFX-1), the display warnings still occur but there is no alarm.

The low alarm signal comes out on Pin 7 and is buffered (i.e. able to drive a load).

Setting the High CO_2 Alarm Setpoint

Press key 2 to set the high CO_2 alarm setpoint. The display will show ?????. Enter the required value. **Note, leading zeros are required for values less than 1000 (i.e. 00900 for 900).** The default EGM-4 high alarm setpoint setting is 2000. As long as the high alarm is set to the maximum CO_2 ppm range of the instrument, the alarm is inactive. If set to a lower value, when the CO_2 concentration exceeds the high setting, the alarm will activate.

The high alarm signal comes out on Pin 13 and is not buffered.

7VOUT

Press key 7 (7VOUT) to check/set the analog voltage output. These settings control the voltage output from the D/A converter in the EGM-4.

```
D/A 1V = 2000 ppm
Y=OK   1/ 2 NEW VAL
```

Where:

D/A 1V	Selects the maximum voltage output of the EGM-4 (1-5V)
2000	Corresponds to the CO2 concentration (ppm).

The FSD (Full Scale Deflection) analog output value can be set from 1 to 5V. Press key 1 and enter any value between 1 and 5 to set the analog output to the value required. Press key 2 if you want to change the CO_2 concentration corresponding to the analog output value. As in the display above, the EGM-4 would be set up with an analog output of 0-1V corresponding to a measurement range of 0-2,000 ppm.

By default, the analog voltage output is 0-5V. If the displayed values are correct, simply press the Y key to return to the 2SET menu.

Note. The voltage output must be set to 5V in order for the current output (4-20 mA) to work properly. If the voltage output is changed to any other value (i.e. 2, 3 or 4V), the current output facility will not work correctly and should not be used.

3CAL

To calibrate the EGM-4, press key 3.

```
CO2 CONC =  2000
CORRECT  (Y-N)?
```

The EGM-4 will display a value. Before proceeding, it is critical that:

- The absorber column is properly seated in its manifold
- The soda lime is fresh.
- The EGM-4 has been on for at least 30 minutes.
- The Gas Out port is unobstructed.
- **No accessories or sensors can be connected to the EGM-4 when recalibrating.**

Connecting Calibration Gas To The EGM-4

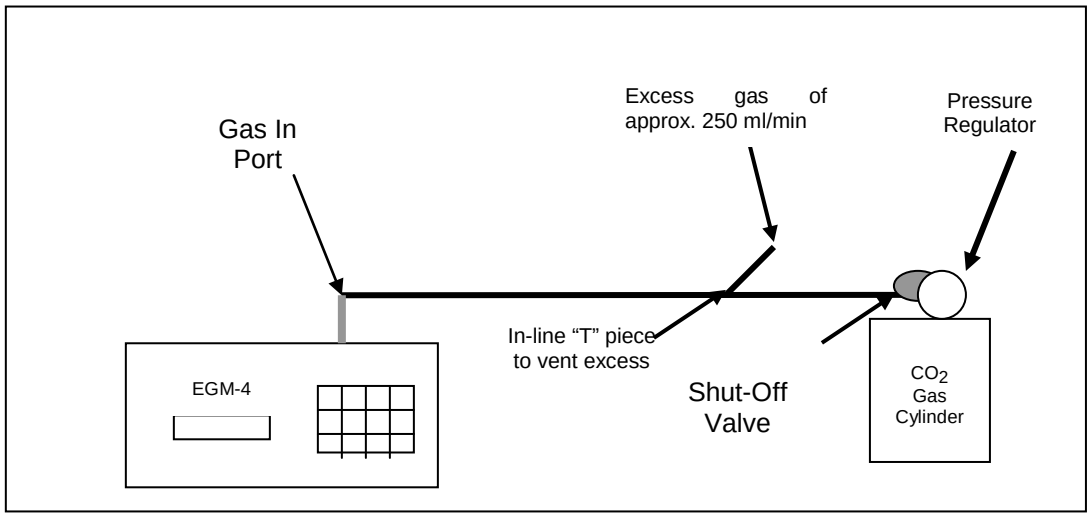
During calibration, the signal from the CO_2 detector is referenced against a gas of known CO_2 concentration. The EGM-4 calibration procedure uses two reference points:

1. Zero CO_2 (generated from air that has been scrubbed through soda lime).
2. Span Gas (a user-defined CO_2 concentration, normally a cylinder of certified CO_2 composition).

It is therefore vital that both of these references are accurate. For greater accuracy, cylinder mixtures should be accurate to +/- 1% and traceable to NIST standards. The zero gas will only be accurate if the soda lime in the absorber column is fresh.

Assuming that a calibration gas mixture is used to calibrate the EGM-4, follow these instructions:

1. To avoid excess pressure in the sample cell and possible damage to the Analyzer, you must connect the sample line with a “T” piece between the calibration gas mixture and the “Gas In” port on the EGM-4 as follows:



2. The pressure regulator should be set to a very low pressure and there should be a slight flow excess gas venting from the open "T" Piece (approx. 250 ml/min). We recommend using a flow rate from the gas cylinder of approximately 200-400 ml/min.
3. Press key N and enter the CO_2 concentration of the calibration gas that you are using. This value must match the certified CO_2 concentration of the calibration cylinder and be similar or higher than the anticipated measurement range of the instrument (*i.e.* it is best to calibrate the instrument with a reference gas containing 350 - 450 ppm CO_2 when measuring around 350 ppm CO_2).
4. The EGM-4 will then perform a ZERO. At completion of successful ZERO, a similar message to the following will be displayed.

```
CO2 CONC = 1050
KEY0 WHEN STEADY
```

5. At this point, all you are looking for is that the CO_2 concentration is steady. **Note, the displayed value may not be the value you entered in step 1 above.** When this value is steady (i.e. not changing by more than 1 ppm after 30 seconds), press the 0 key. Control is passed to the VOUT Set Menu to provide the opportunity to change the scale factor if desired. If no change is desired, press key Y.
6. Calibration is complete. The new calibration and linearization constants are stored in non-volatile memory.

4DMP

Press key 4 to view/transmit stored data.

```
1:SCREEN DISPLAY
2:DATA DUMP 1-2?
```

Stored data can be viewed on the instrument LCD display or transmitted to your PC computer using our data transfer software. The EGM-4 will store up to 1,000 records in memory. **Note, when the memory is full, the oldest record will be overwritten each time additional records are taken. Also note that the record number restarts at 1 when the EGM-4 is powered off. Therefore, more than one record number 1 with different time stamp can exist in memory.**

Screen Display

To view stored data on the LCD display, press key 1. The latest stored record is displayed first. Each record has 3 different displays associated with it as follows:

Display 1

```
REC 0000  PLOT 01
04-01      11:52
```

Where:
REC Record Number
PLOT Plot Number
04-01 Date (4th day of January)
11:52 Time

Press the 8/X key to proceed to the next display:

Display 2

```
A0000 B0000  0000
 D0000    E0000
```

Where:
A mV signal from sensor (Pin 1).
B mV signal from sensor (Pin 2).
C mV signal from sensor (Pin 3).
D mV signal from sensor (Pin 4).
E mV signal from sensor (Pin 5).

Press the 8/X key to proceed to the next display:

Display 3

```
C  950      H06.4
   A 0992   P00
```

Where:
C CO_2 concentration(ppm)
H Humidity (mb). **Only if optional %RH/Temp sensor is present.**
A Atmospheric Pressure (mb)
P Probe Type

A key press of 8 steps you through the 3 above displays before taking you to the next record in memory. After all records have been displayed, a message "No More Records In Store" is displayed before returning you to the Main Menu. **Note. A key press of Y will step you from one display to the same display for the previous record**. For instance, if Display 3 of record number 5 is displayed on the LCD, a key press of Y will step you to Display 3 for the previous record (Record 4). Therefore, if you are only interested in viewing the CO_2 concentration for each record:

1. Press key 4 (4DMP).
2. Press key 1 (Screen Display).
3. Press the 8 key to display the CO_2 concentration for the last stored record.
4. Press the Y key to view previous records.

A key press of N ends the screen display. **Note.** If there are no stored records, the message "NO MORE RECORDS IN STORE" will be displayed before returning you to the main menu. Note, some of the displays will vary according the probe type connected.

Data Dump

To transmit stored data from the EGM-4 to a PC, you must use the data transfer cable and software supplied with the system. Step by step instructions on transferring data from the EGM-4 to the PC are contained in the software Help file.

Transferring Stored Data Using The Windows® Based Software Program

Click on TransferWin.exe to load the software supplied by PP Systems to your local PC hard drive. Once the program is loaded successfully and from the Windows Task Bar:

1. Select **Start**, **Programs**, **PP Systems** and then **Transfer**
2. Click **File**, **Preferences** and select **EGM-4** under **Instrument Type**.

3. Check the Com port selected and change if necessary (i.e. COM1,2,3 or 4).
4. Check Decimal separator to make sure that it matches your requirements. Data can be separated by a period (.) or comma (,).
5. Click **OK** to proceed.
6. Ensure that the EGM-4 is in Dump Menu (Key 4 from Main Menu). Press key 2 Data Dump on the EGM-4. On the EGM-4 "CONNECT TO PC ANY KEY TO SEND" should be displayed.
7. Select **Transfer** on your PC and enter in a file name (the .dat extension is assumed and does not need to be entered) and click on **Save**. All stored data will be stored to this file. On the PC, a message similar to "Com Port 1 opened…. Awaiting EGM-4 data…." will be displayed.
8. On the EGM-4, press any key to transfer the data.

When completed, the EGM-4 will return to the Main Menu and the PC screen will show "Transfer of EGM-4 Records Completed X Record[s] received, Click in Window to clear …" where X refers t the total number of records transferred.

Logging Data

In addition to transferring stored data from the EGM-4 to your local PC, the user can log measured data as well. In Log mode, you have the ability to log records automatically or manually.

For further description and instructions on the Windows® based software supplied by PP Systems, please refer to the on-line help menus built into the software.

Record Structure

A single record consists of 61 characters (no spaces). The last character is a carriage return. Real time and stored data is output in the following format:

M/R	Plot No.	Rec No	Day	Mo	Hr	Min	CO_2 Ref	H_20 Ref	RHT	A	B	C	D	E	F	G	H	AP	PT
M	1	1	28	1	13	19	968	0	000.0	0000	0000	0000	0000	0000	0000	00	00	991	0
R	1	2	28	1	13	21	930	0	000.0	0000	0000	0000	0000	0000	0000	00	00	991	0
M	1	3	28	1	13	23	956	0	000.0	0000	0000	0000	0000	0000	0000	00	00	991	0
M	1	4	28	1	13	25	941	0	000.0	0000	0000	0000	0000	0000	0000	00	00	991	0
R	1	5	28	1	13	27	946	0	000.0	0000	0000	0000	0000	0000	0000	00	00	991	0

Where:

M/R	M = Real Time Measurement R = Record from memory
Plot No.	0-99
Rec No.	1-9999
Day	1-31
Mo	1-12 (January - December)
Hr	1-24 (based on 24 hour clock)
Min(utes)	0-59
CO_2 Ref	CO_2 reading in parts per million (ppm = µmol mol^{-1})
H_20 Ref	H_2O reading in millibars (mb) (**if optional %RH sensor is fitted**).
RHT	Temperature of RH sensor (˚C) (**if optional %RH sensor is fitted**).
A	See Data Structure Based On Probe/Sensors on page 39.
B	See Data Structure Based On Probe/Sensors on page 39.
C	See Data Structure Based On Probe/Sensors on page 39.
D	See Data Structure Based On Probe/Sensors on page 39.
E	See Data Structure Based On Probe/Sensors on page 39.
F	See Data Structure Based On Probe/Sensors on page 39.
G	See Data Structure Based On Probe/Sensors on page 39.

H	See Data Structure Based On Probe/Sensors on page 39.
AP	Atmospheric pressure in millibars (mb)
PT	Probe Type See 1REC on page 19 for more information.

Note. If there are no stored records, the message “NO MORE RECORDS IN STORE” will be displayed before returning you to the main menu.

Data Structure Based On Probe/Sensors

Please note. The data structure, particularly columns A-H described above, is dependent upon the probe/sensor that is connected to the EGM-4.

Probe Type	Description of Sensor Connected	Each Column is described as follows							
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
0	No Sensor Connected. The EGM-4 is being used as a stand alone IRGA.	mV Pin 1 0000	mV Pin 2 0000	mV Pin 3 0000	mV Pin 4 0000	mV Pin 5 0000			
1	STP-1 Soil Temperature Probe or CH15T RH/T Probe	PAR 0000	%RH 000.0	Soil Temp. 000.0		mV Pin 5 0000			
2	HTR-2 %RH/Temp/PAR Probe	PAR 0000	%RH 000.0	Air Temp. 000.0					
3	TRP-1/TRP-2 Temperature/PAR Probe	PAR 0000	%RH 0000	Air Temp. 000.0					
4	PAR-1/PAR Sensor	PAR 0000							
5	PAR-1 LUX								
6	Solarimeter								
7	Steady State Porometer (PMR-4/PMR-5)	PAR 0000	%RH In 000.0	Temp 000.0	%RH Out 000.0	Flow 000.0	GS 0000		
8	SRC-1 Soil Respiration Chamber and CPY-2 Canopy Assimilation Chambers	PAR 0000	%RH 0000	Soil Temp. 000.0	DC 0000	DT 0000	SR Rate 00.00	SRDIV 01/02/03	+/- SR Rate 00=+ 01 = -
9	OP-1/OP-2 Oxygen Sensor	O2 00.00							
10	50Y %RH/Temp Sensor		%RH 000.0	Temp. 000.0					
11	CFX-1 Open System Soil Respiration Chamber	PAR 0000	Evap Rate 0000	Air Temp. 000.0	DC 0000	Flow 000.0	SR Rate 00.00	Flow Multiplier	+/- SR Rate 00=+ 01 = -
11	CPY-3 Canopy Assimilation Chamber	PAR 0000	Evap Rate 0000	Air Temp. 000.0	DC 0000	Flow 000.0	SR Rate 00.00	Flow Multiplier	+/- SR Rate 00=+ 01 = -
12	CPY-4 Canopy Assimilation Chamber	PAR 0000	Soil Temp. 0000	Air Temp. 000.0	DC 0000	DT 0000	SR Rate 00.00		+/- SR Rate 00=+ 01 = -

Further description of the data output is as follows:

Output Data	Units
PAR	µmol m^{-2} s^{-1}
% RH	%
Evaporation Rate	mmol m^2 s^{-1} x 1000
Temperature	˚C
Flow	ml min^{-1}
GS (Stomatal Conductance)	mmol (H_2O) m^{-2} s^{-1}
SR Rate (Assimiliation)	SRC-1: g (CO_2) m^2 $Hour^{-1}$ CPY-2: g (CO_2) m^2 $Hour^{-1}$ CPY-4: g (CO_2) m^2 $Hour^{-1}$ CPY-3 & CFX-1: µmol m^2 s^{-1}

DC (Change in CO_2 concentration)	ppm
DT (Change in time)	seconds
+/-	In column H, if 00 is output, this represents increase in CO_2 (respiration). If it is 01, it represents CO_2 uptake).

In column G, a flow multiplier is output to provide true flow rate (1 or 10).

Error Cod

es

Error code information is stored and output with data and can be located at the end of the data string. The following is a list of current Error Codes:

Error Code	Description	Possible Faults	Remedy
00	Normal Operation	Not Applicable	Not Applicable
01	Zero read to low (<2500)	• Pump Failure • Absorber column not properly fitted. • Exhausted soda lime. • Zero valve failure. • Source/detector failure.	• Refer to Air Sampling Pump on page 51. • Fit properly into manifold. • Change soda lime. • Contact PP Systems. (see PP Systems' Contact Information on page 7) • Contact PP Systems. (see PP Systems' Contact Information on page 7)
02	CO_2 less than 250 ppm	• Pump failure • Genuine low CO_2 concentration. • Absorber column not properly fitted. • Exhausted soda lime. • Zero valve failure. • Source/detector failure.	• Refer to Air Sampling Pump on page 51. • Not Applicable. • Fit properly into manifold. • Change soda lime. • Contact PP Systems. (see PP Systems' Contact Information on page 7) • Contact PP Systems. (see PP Systems' Contact Information on page 7)
03	Analyzer temperature < 50 ˚C	• Possible thermostat failure.	• Contact PP Systems. (see PP Systems' Contact Information on page 7)
04	Analyzer temperature > 60 ˚C	• Possible thermostat failure.	• Contact PP Systems. (see PP Systems' Contact Information on page 7)

05	%RH > 90%	• If an RH sensor is fitted, a reading above 90% could mean condensation.	• Contact PP Systems. (see PP Systems' Contact Information on page 7)
06	Battery voltage to low	• Battery voltage < 10.5v	• Re-charge battery

EGM Serial Outputs

(For Use With WINDOWS Data Transfer Program or other terminal program)

The following data strings are output from the EGM-4 with no user intervention.

On Starting:

<SP>B, EGM4,Serial Number, Firmware version<CR>
<SP>=Space, <CR>=Carriage return.

Then during the delay period at the start:

<SP>I, NN <CR>
Where NN is the same as the count on the EGM display.

During Warm up

<SP>W,TT<CR>
Where TT is the cell temperature.

During ZERO
<SP>Z,NN<CR>
Where NN is the same as the EGM display count.

During Diagnostics a data string is transmitted through the RS232:
<SP>D,ZZZZZ,CCCCC,ANLT,HHHH,HTHT,INPB,INPC,INPD,INPE,ATMP<CR>.

(These values are the reads from the A/D converters and have not been scaled.)

Where:

ZZZZZ	Stored Analyzer reading during last zero.
CCCCC	Current Analyzer reading
ANLT	Analyzer temperature sensor reading.
HHHH	Reading of the internal humidity sensor (optional).
HTHT	Reading from the temperature sensor (optional).
INPA-E	Corresponds to the mV inputs from external sensors (A-E).
ATMP	Reading from the pressure transducer (mb).

5CLR

To clear data stored in memory, press key 5.

CLEAR DATABASE
(YY-N)?

To clear the entire database, press the Y key twice. For data safety reasons, you will be asked to “Press Key 0 To Confirm”. Press the 0 key to clear. The message “Database Cleared” is displayed before returning you to the main menu. If you do not want to clear the database, simply press the N key.

6CLK

To view/set the EGM-4 real time clock, press the 6 key. The following message should be displayed:

```
RESET TIME (Y-N)?
13-12-01     16:51
```

The date is displayed as day/month/year and the time is displayed on a 24 hour format. The display above shows December 13, 2001 and 4:51 PM. If the time is correct, press the Y key. Otherwise, press key N and enter the appropriate date and time. Leading zeros must be entered if required for date and time (i.e. if the time is 8:00 AM, enter 08 for the hour).

! Note ! Do not forget to enter the date as day/month/year and the time based on the 24 hour format.

Diagnostics and Initialisation

The EGM-4 has a diagnostics and "Initialisation" feature built in for troubleshooting and for setting system controls and calibration back to factory default. **It is important to allow the EGM-4 to warm up for at least 30 minutes prior to checking system diagnostics**. To check system diagnostics and to reinitialize the EGM-4, press key 0 with the Main Menu displayed. The following message is displayed:

```
1:DIAGNOSTICS
2:INTIALISE
```

Diagnostics

Press key 1 for system diagnostics and the following will be displayed:

```
CR:44049    Z: 46132
0/Z: ZERO   N: QUIT
```

Where:

CR:44049	Reading from 16 bit A/D converter for CO_2 detector. The CR value should read approximately 35000-45000 for CO_2 concentration around 400 ppm.
Z:46132	Reading from 16 bit A/D converter during last Auto-Zero sequence. The A/D value for Z should read approximately 40000-50000 **if fresh soda lime is present in the absorber column**. The Z value should always be greater than the CR value.
0/Z	Press key 0 to perform an Auto-Zero.,

Press Key N to return to the Main Menu.

Initialisation

This feature is available in the event of a bad or incorrect calibration, if a new EPROM is installed with a new "Checksum" value, or if the system locks up. Press key 2 to reinitialize the EGM-4. **Very Important. Before initializing the EGM-4, you must dump all stored records to your PC or they will be lost for good. All records will be cleared from system memory during Initialisation.**

After pressing key 2, you will be presented with ???? on the display. At this point, enter the code 0462. This will follow with a "Database Cleared" message before returning you to the Main Menu. At this point, your system will be returned to its original factory default conditions (i.e. calibration, etc.). The EGM-4 system settings will automatically revert to:

CO_2 Calibration Concentration	2000 ppm
Recording Type	Manual. No averaging of data.
Zero Type	Automatic
Checksum	123456
Analog Voltage Output	5
Memory	Reset to start of memory.

Maintenance

The EGM-4 is virtually maintenance free. However, there are a few items that should be watched and cared for periodically.

Soda Lime Absorber Column

The soda lime absorber column is built into the EGM-4 and safely protected within the enclosure. It should not require any maintenance with the exception of the soda lime desiccant which will require replacement from time to time (See Soda Lime on page 44). The black aluminium cap, located on the back of the instrument, is fitted with an “O” ring with a grey foam filter between it and the desiccant. The “O” ring should be kept fresh by applying a slight smear of silicone grease from time to time. If this “O” ring gets to dry, it could crack or even break which will lead to a leak in the system and errors in Analyzer ZERO. The black aluminium cap can then be removed and the contents emptied when required. When replacing the soda lime, the column should be tapped to ensure tight packing and the cap replaced as found. Over time, the grey foam filter may require replacement. If so, contact PP Systems (PP Systems’ Contact Information on page 7).

It is sensible to examine the absorber column each time the contents are replaced as any leakage of ambient air into the gas circuit generally causes error messages during “Autozero” operation or fluctuating CO_2 concentration during measurement.

Soda Lime

Soda Lime is supplied as self-indicating granules (1-2.5mm) which turn from green to brown as it becomes exhausted. This desiccant should be replaced when it is two-thirds exhausted (brown). Soda Lime cannot be regenerated and should be discarded when exhausted. Frequent replacement should not be required under normal circumstances. The amount of change is highly dependent on the “Auto-Zero” frequency. Under normal operating conditions, this desiccant is changed approximately 1 time per month. See Soda Lime on page 44.

For accurate measurements and calibration, it is absolutely critical that the EGM-4 absorber column is not exhausted. If the soda lime is becoming exhausted, it will cause the ZERO to be performed on non-ZERO air causing an error in the calibration.

! CAUTION !
WASH YOUR HANDS AFTER HANDLING SODA LIME

MATERIAL SAFETY DATA FOR SODA LIME

CHEMICAL COMPOSITION	
Components	% W/W
Calcium Hydroxide	(Ca(OH)2) > 75.5%
Sodium Hydroxide	(NaOH) < 3.5%
Water	< 21.0%
Indicator (Inorganic Salt)	< 0.2%
PHYSICO-CHEMICAL DATA	
Form	Granules
Color	Green (Exhausted : Brown)
Odor	None
Bulk Density	0.9 g/cm^3
Solubility in Water	None
pH in Water	12-14
Incompatible Substances	Acids, Chloroform, Trichlorethylene
Hazardous Decomposition	
Products	None
PROTECTIVE MEASURES, STORAGE AND HANDLING	
Storage Conditions	Clean dry environment
Preferred temperature range	0 - 35 ˚C. Store away from direct heat/sun.
Protective Measures	Avoid inhaling dust. Wash hands after handling
Industrial Hygiene	Keep containers closed. Keep contents dry.
MEASURES IN CASE OF ACCIDENTS AND FIRES	
Spillage	Contain material. Sweep or vacuum up. Transfer solids to metal or plastic container for disposal. Wash down spillage with water.
Suit. Extinguishing Media	Water, CO2, Powder, Foam, Halon.
FIRST AID	
Inhalation	Remove from exposure. Obtain medical attention if discomfort persists.
Skin Contact	Drench with clean water. Obtain medical attention if skin becomes inflamed.
Eye Contact	Irrigate thoroughly with clean water. Obtain medical attention.
Ingestion	Wash out mouth thoroughly. Drink water. Obtain medical attention.
HAZARD LABELLING	
Transport Codes	None required.
Hazard Classification	None.

Servicing The EGM-4

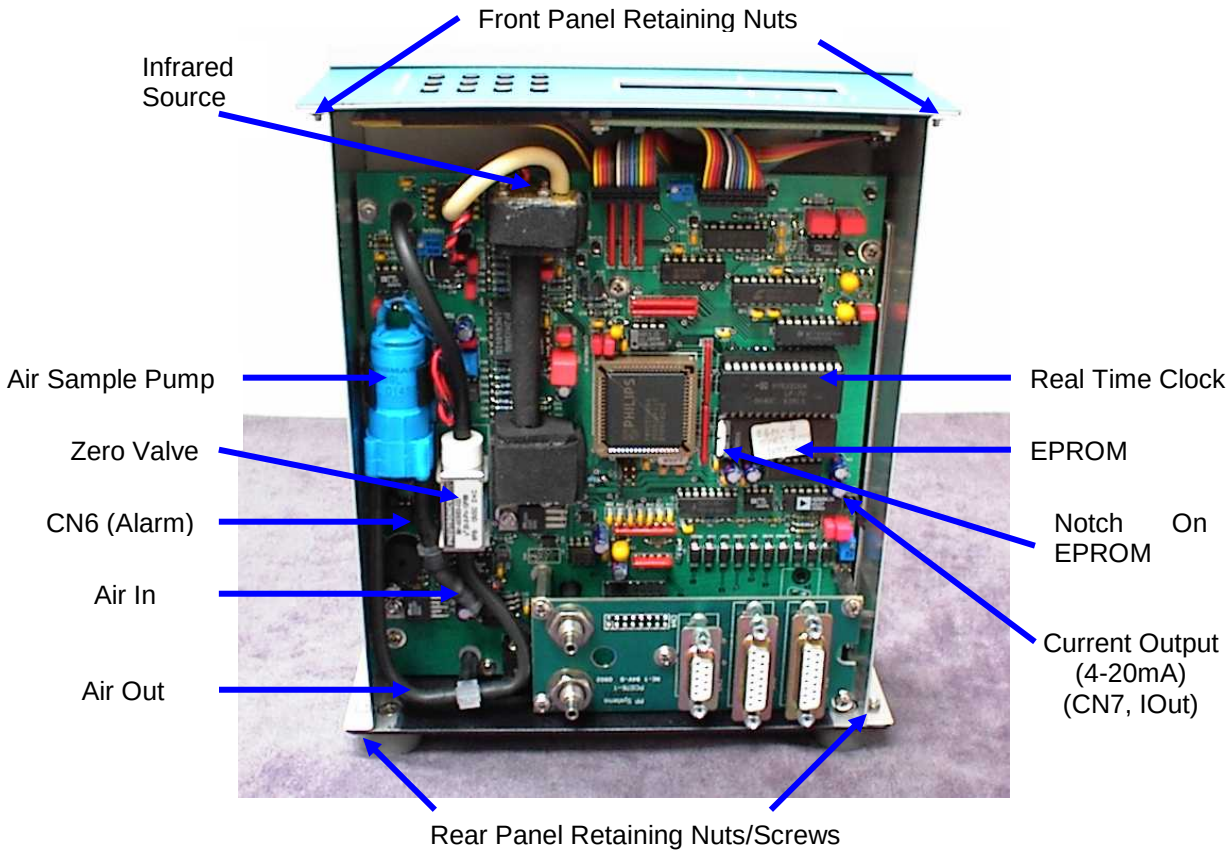
Fuse

The EGM-4 circuitry is protected by a 1A (5x20 mm) fuse. This is located in a black fuse holder located at the back of the instrument (see page 11 for location). If this requires replacement, please ensure that the correct size and type of fuse is used.

It is very easy to determine if a fuse is good or bad. Usually, a bad fuse will be burned out and visually obvious. The true test is to use an ohm meter. Place one lead from the ohm meter on one end of the fuse and the other lead on the opposite end of the fuse. If it reads 0, you have a good fuse. Anything else, the fuse is bad and should be replaced.

The EGM-4 enclosure must be removed in order to service the following items:

- Infrared Source
- EPROM
- Zero Valve
- 12V Lead Acid Battery
- Air Sampling Pump



Inside the EGM-4

Infrared Source

The infrared source should last for many years and not require replacement. The obvious sign of failure is that it is not flashing when the system is powered. It is preferable to return the instrument to PP Systems for full factory recalibration after changing a failed source lamp. However, if that is not possible, a few checks can be made to insure that the analyzer is working properly after changing a source lamp in the field.

1. Ensure that the EGM-4 is not connected to any power source and is turned off.
2. Disconnect the infrared source electrical connector located at CN13 (Source) by pulling up on it.
3. Remove the 4 small screws that secure the infrared source to the end of the sample cell and remove it.
4. Fit the new infrared source to the end of the sample cell aligned to fit in the notch in the sample tube and secure it in place by the 4 small screws**. Be careful handling the IR source. You do not want to touch the bulb with your fingers. Also, do not overtighten the screws**.
5. Connect the new infrared source electrical connector to CN3 on the circuit board. The orientation does not matter.
6. Power up the EGM-4 and allow it to run warm up for 30 minutes. After the warm up period, check the raw IRGA A/D readings with CO_2-free air.

Checking EGM-4 Raw A/D Readings

On the EGM-4, monitor the raw A/D readings on the display. To do so from the main menu (1REC 2SET 3CAL, etc.):

1. Press Key 0 (to go into system diagnostics)
2. Press Key 1 (Diagnostics)

The display will show the current A/D readings for the CO_2 analyzer for both "Measure" and "Zero" mode. Press key Z to check the analyzer zero. At this point, CO_2 free air will be passing through the analyzer. When completed, the raw A/D reading for the analyzer zero will be displayed in the upper right hand corner (i.e. Z:51235).

The raw A/D reading with CO_2-free air must be greater than 40,000 and less than 52,000. Once the raw A/D reading with CO_2-free air is in the range 40,000 to 52,000, the instrument should perform normally and accurately. If you are unable to achieve raw A/D readings in the range of 40,000 to 52,000 after replacement of the infrared source, the SOT resistor (R38) should be changed. The SOT resistor is located on standoffs near the detector end of the sample cell making it easy to identify on the PCB and for easy soldering. The resistor can be any value between 0 ohm and 1000 ohms that makes the zero reading between 40,000 and 52,000. Lower SOT resistor values increases the gain and increases the zero A/D reading. If you are unable to achieve raw A/D readings in the range of 40,000 to 52,000 after replacement of the infrared source, contact PP Systems for advice (see PP Systems' Contact Informationon page 7).

At this point, it would be prudent to perform a single point calibration with a reference gas if possible (See 3CAL on page 35).

EPROM

The firmware and factory measured calibration factors for the EGM-4 are stored on a memory chip commonly referred to as an EPROM inside the instrument. This should never require maintenance but it may need to be replaced if the system is upgraded.

The EPROM that is used in the EGM-4 must be protected from static electricity. As a result, there are several precautions that the customer should take before removing EPROMS. The risk of damage can be minimized by earthing both the operator and the lab bench surface. This can be done by covering the surface of the bench with a conductive material (*e.g.* aluminium foil) that is electrically connected to an earthing point such as a metal water pipe or tap. The operator should also be earthed using a wrist strap or by holding a wire that is connected to the same earthed point. Please contact PP Systems for further information.

Once suitable earthing arrangements have been made, the EGM-4 enclosure can be opened to gain access to the circuit board containing the EPROM. The position of the EPROM is shown above.

Each EPROM is located in a specific orientation. Before starting to remove the chip, note the position of the notch on the end of the chip relative to the rest of the instrument. Using a small, flat screwdriver, gently pry the EPROM up until it is removed from its socket. When fitting the new EPROM to the socket, be careful not to bend any pins. Place the EPROM in the socket (noting the notch on one end of the EPROM) and gently press down to secure in place.

Very Important. After replacing the EPROM, you should reinitialize the instrument (See Initialisation on page 43).

ZERO Valve

If it is suspected that the ZERO valve is not functioning properly, we recommend returning the EGM-4 to our factory for repair as this item is soldered directly to the PC075 circuit board. Contact PP Systems (see PP Systems' Contact Information on page 7).

12V Lead Acid Battery

Some EGM-4's are supplied with a 12V 2.0 Ah sealed, rechargeable, lead acid battery and it should last for several years as long as it is properly maintained. Based on manufacturer's data, the battery is non-spillable (qualified to non-spillable UN2800 standards) and can be used in any orientation. It has a float design life of 5 years. It should be checked periodically to ensure that it takes up charge. Measuring the voltage across the terminals of the battery after it has been charged overnight can assess this.

If the battery is not fully charged after 12 hours, first check that the 1A fuse is ok. This fuse protects the charging circuit and if blown, the internal battery will not take a charge.

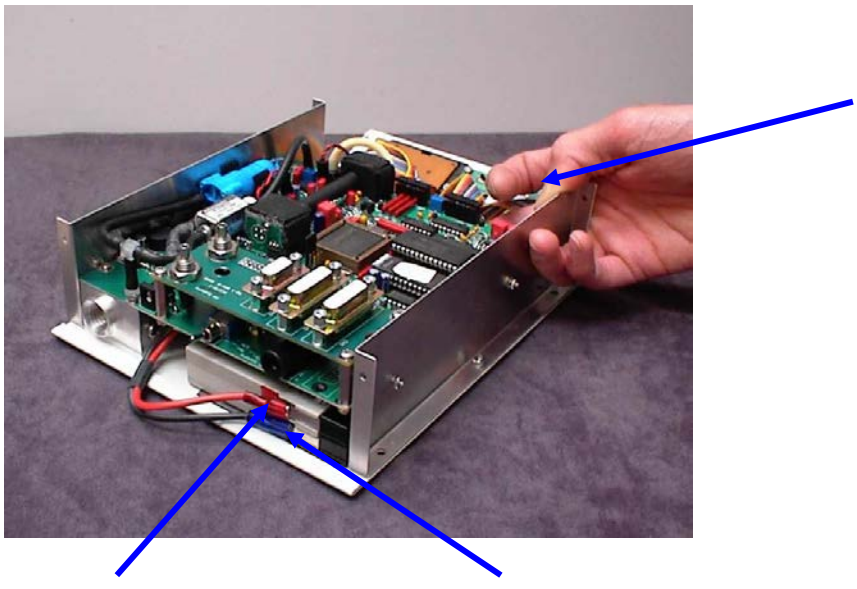
Please Note. The internal 12V battery should always be fully charged before long-term storage. If it is stored in a low or discharged state, it is possible that it will become deep-discharged. If this occurs, the charge capacity of the battery is permanently reduced and will require replacement.

12V Lead Acid Battery Specification

Manufacturer	Enersys
Type	Lead Acid
Voltage	12V
Nominal Capacity @ 20 hr.rate (Ah)	2.0 Ah
Terminals	Faston Tab 0.187"
Housing	ABS Resin
Dimensions	14.6cm L x 8.8cm W x 2cm D
Weight	0.7 kg

Removing The 12V Lead Acid Battery

When removing the battery, first ensure that the power to the EGM-4 is turned off. The front panel may need to be removed to slide the battery out of its compartment if it is stuck. Next, remove the red (positive) and blue (negative) charger leads from the battery.



If the battery is stuck, remove the front panel retaining nuts, gently pull panel forwards, and push back of battery through hole provided.

Red (Positive) Charger Lead Blue (Negative) Charger Lead

Slide the new battery into the battery compartment, connect the charger leads correctly (Red = Positive, Black = Negative) and refit the enclosure.

12V NiMH Battery

Some EGM-4's are supplied with a 12V NiMH, rechargeable battery and it should last for several years as long as it is properly maintained. It should be checked periodically to ensure that it takes up charge. Measuring the voltage across the terminals of the battery after it has been charged overnight can assess this.

If the battery is not fully charged after 12 hours, first check that the 1A fuse is ok. This fuse protects the charging circuit and if blown, the internal battery will not take a charge.

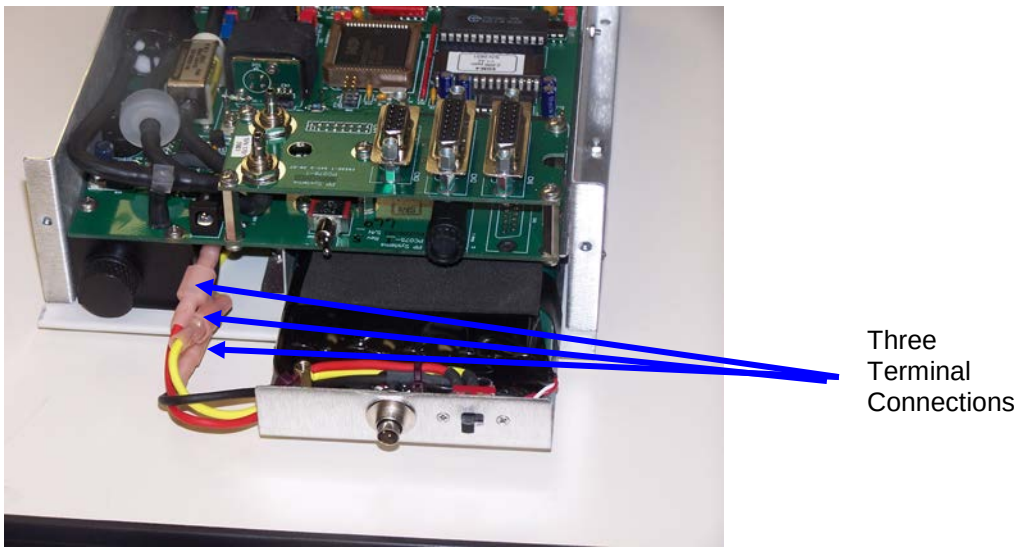
Please Note. When storing the instrument for long periods, the internal 12V NiMH battery will slowly discharge over time regardless of the state of charge. Therefore you must ensure that you charge the instrument fully prior to next use.

12V NiMH Battery Specification

Manufacturer	Sanyo
Type	NiMH
Voltage	12V
Nominal Capacity @ 20 hr.rate (Ah)	4.0 Ah
Terminals	Faston Tab 0.187"
Housing	Shrink wrap cells
Dimensions	13cm L x 8.5cm W x 1.5cm D
Weight	0.5 kg

Removing The 12V NiMH Battery

When removing the battery, first ensure that the power to the EGM-4 is turned off. With the enclosure and back panel removed, simply pull out the battery pack as shown below and locate the three terminal connections. The front panel may need to be removed to slide the battery out of its compartment if it is stuck.



Next, remove the red, yellow and black terminal connections from the internal leads and remove the battery pack. To replace, simply slide in the replacement battery pack and connect up the three leads appropriately.

Air Sampling Pump

The EGM-4 is fitted with a sealed, rotary vane pump to sample the reference air. Rotary vane pump components wear with prolonged use and material from the vanes may build up within the pumps. This can eventually reduce the pumping efficiency or even cause them to stop running. If the pump is not running, the first and simplest thing to do is tap it gently with a small screwdriver or pen and see if that gets it up and running. In many instances, this is all it takes. The normal signs of a bad pump are as follows:

1. **Noise.** A worn pump usually sounds rough or vibrates.
2. **Temperature.** The outer casing is hot when touched with your fingers.

Replacing The Air Sampling Pump

It is very easy to replace a bad air sampling pump. First, trace the electrical connection to the pump and disconnect the 2-pin connector from the terminal on the EGM-4 circuit board. Secondly, the electrical connector is removed by gently bending back the connector lock and sliding out the connector. **Please note the orientation of the red and black wire for correct re-fitting of the pump**. The pump itself is secured in position by the gas tubing connections. Finally, remove the tubing from the inlet and outlet ports on the pump and lift out.

Fit the new pump making sure that:

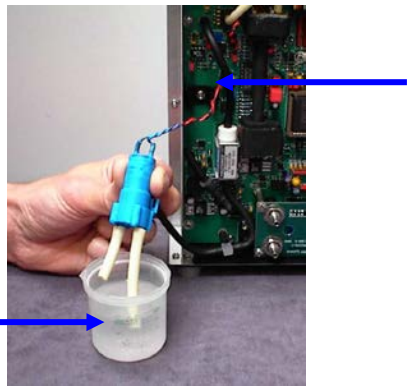
1. The flat back part of the pump sits flush on its manifold.
2. Connect the inlet tubing to the inlet port and the outlet tubing to the outlet port on the pump.
3. Finally, the 2-pin electrical connector should be reconnected in the same orientation. The two notches on the connector latch with the corresponding lock.

Cleaning The Air Sampling Pump

During prolonged operation, the vanes inside the pump will wear and deposit material inside the pump. It is sensible to clean the pump by periodically flushing it with with isopropyl alcohol. The following procedure can be adopted:

1. Connect the pump to a 6-12V source and fit a 30mm tube to the pump inlet.
   (i.e. the EGM-4 can be used to supply power via the pump electrical connector. **It is, however, essential that the flushing is performed outside of the instrument to avoid spillage into it**).

2. Hold the pump above a beaker of isopropyl alcohol and dip the tube into the alcohol (See below). Run the pump to draw alcohol through it. A small roll of cotton wool in the inlet pipe can act as a filter for the re-circulating alcohol.

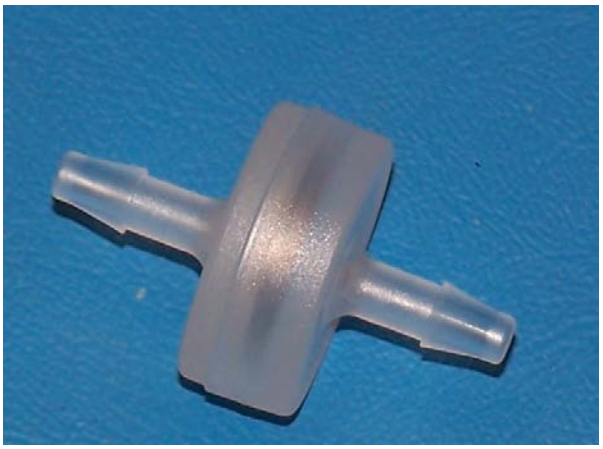


If the pump is not running or appears to be seized, it may be freed by tapping it with a small screwdriver or on the bench or by reversing the voltage to run it backwards.

3. Run alcohol through the pump for a minute or two to ensure that any material is removed. When finished, run the pump in air for at least 15 minutes to allow any residual alcohol to eVaporate. Ideally, let the pumps dry outside of the EGM-4 overnight. If the pumps are reconnected prematurely, the absorber chemical (soda lime) will be exhausted quicker than usual.

In-Line Filter Assembly (Hydrophobic)

The In-Line Filter Assembly (Hydrophobic) is commonly used with the EGM-4 especially when used with the SRC-1 Soil Respiration Chamber and CPY-2/CPY-4/CPY-3 Canopy Assimilation Chambers. It is fitted with a 3 micron PTFE hydrophobic filter and “O” ring ensuring proper seal. It is very important that this be checked frequently for signs of dirt/dust and water. The entire assembly should be replaced as necessary.



Part No. 10045-1 Filter Assembly (Hydrophobic)

Consumables and Spares for EGM-4

STD005	12V 2.0 Ah Lead Acid Battery (EGM-1/2/4)
STD535	12V NiMH Battery Pack Assembly (EGM-4)
STD511	Mains Charger for EGM-4 (does not include mains cable)
STD007	Self Indicating Soda Lime, 1.0 kg
20218-1	Absorber Column Plug
30013-10	“O” Ring for Absorber Column Plug
20041-3	Absorber Column for EGM-4
STD076	Sealed Miniature Rotary Pump (ASF)
30032-1	Solenoid Valve (SBA-4, EGM-4, WMA-4)
PC073-1	EGM/SBA/WMA Infra-Red Source (Low Range Instruments)
PC073-2	EGM/SBA/WMA Infra-Red Source (High Range Instruments)
10020-1	IRGA Tubeset Assembly-Long (For SBA-4, EGM-4, WMA-4, TPS-1 & TPS-2)
10020-2	IRGA Tubeset Assembly-Short (For SBA-4, EGM-4, WMA-4)
STD053-1	20mm Fuse, 1A (Qty. 5)
STD070	RS232 Ribbon Cable (9 pin I/F) for EGM-4
STD521	USB to Serial Adapter
10045-1	Filter Assembly (Hydrophobic)

User Notes