SRC-1 / CPY-2
Closed System Chambers

For Use With All EGM's (1/2/3/4)
And
CIRAS-1

Operator's Manual

Version 3.32

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Preface

Document Conventions

If viewed electronically, text marked blue acts as Hyperlinks. Some links refer to links to external files, which may cause the viewer to prompt whether the action should be performed.

Other Documentation

EGM (1-3) Operators Manual
EGM-4 Operators Manual
CIRAS-2 Operators Manual
Soil Temperature Probe

User Registration

It is very important that ALL new customers register themselves 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/Register.html

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 co-operation.

Please visit our web site for periodic updates on Technical Documentation and Software.

http://www.ppsystems.com

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 analyser 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.

Technical Specification

EGM Environmental Gas Monitor

Refer to the EGM Technical Specification and Operator's Manual, with the following amendments/additions:

Inputs	Temperature: 0-1v - 0-50 °C.
Data Storage	Capacity to store up to 1,500 records.
Record Options	Automatic logging after user set time up to 255 seconds, or if the system CO_2 concentration increases by user set concentration of up to 255 ppm. Manual logging by keypress.
Power Supply	Battery life of approximately 5 hours, based on manufacturer's data.
EGM Program	**EGM-1-3** Though the chambers will work with any program version greater than V2.0 this manual refers to program versions greater than V3.1. If the EGM is fitted with an earlier version then it is recommended that you approach PP SYSTEMS for an upgrade. **EGM-4** All Versions.

CIRAS-1 Infra Red Gas Analyser

Refer to the CIRAS-1 Technical Specification and Operator's Manual, with the following amendments/additions:

Inputs	Temperature: 0-1v - 0-50 °C.
Data Storage	Capacity to store up to 820 records.
Record Options	Automatic logging after user set time up to 255 seconds, or if the system CO_2 concentration increases by user set concentration of up to 255 ppm. Manual logging by keypress.
Power Supply	Battery life of approximately 2 hours, based on manufacturer's data.
CIRAS Program	Though the chambers will work with any program version this manual refers to program versions greater than V3.7. If the CIRAS-1 is fitted with an earlier version then we recommended an upgrade.

SRC-1 Soil Respiration Chamber

Range	+/- 9.99 g CO_2/m^2 /hour.
Fan	12v DC.
Housing	PVC and stainless steel.
Dimensions	150 mm Height x 100 mm Diameter (excluding handle).
Weight	900 g.

CPY-2 Canopy Chamber

Range	+/- 9.99 g CO_2/m^2 /hour.
Sensors	Thermistor air temperature sensor + PAR sensor.
Fan	12v DC.
Housing	TPX and stainless steel.
Dimensions	Serial No. 5-19: 134 (Exposed Diameter) x 170 mm (Height). Exposed Area: 141 cm^2 Volume: 2,572 ml Serial No. 20 and above: 146 (Exposed Diameter) x 150 mm (Height). Exposed Area: 167 cm^2 Volume: 2,367 ml
Weight	500 g.

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

STP-1 Soil Temperature Probe

Construction	Electronics housed in anodized aluminium with stainless steel tip (sensor housing).
Connector	1 Meter cable fitted with appropriate connector.
Power Supply	7-12v DC @ 33 mA.
Range	0-50° C.
Accuracy	0.5° C.
Dimensions	40 cm (L) x 1.9 cm (D)- excluding handle.
Weight	0.2 kg.

Installation

SRC-1 with EGM-1

All electrical connections must be made before the analyser is switched on.
The SRC 15 pin D connector must be plugged into the I/O port.
If a soil temperature probe is being used, then a Y connector is required to double up the port.

The pipe marked Reference (R) must be attached to the gas inlet on the rear panel of the EGM-1, and the other pipe to the exhaust on the top.

After first switching on, if possible, the EGM-1 should be left for 20 minutes before making any measurements. During this period, the EGM-1 reading is changing slightly between zeroing, which, though well within specification, could give rise to errors in respiration.

SRC-1 with EGM-2/3/4

All electrical connections must be made before the analyser is switched on.
The SRC 15 pin D connector must be plugged into either I/O port.
If a soil temperature probe is being used, it should be plugged into the other I/O port.

The pipe labelled “R” must be attached to the GAS IN and the other pipe to the GAS OUT (see below).

After first switching on, if possible, the EGM should be left for 20 minutes before making any measurements. During this period, the EGM reading is changing slightly between zeroing, which, though well within specification, could give rise to errors in respiration.

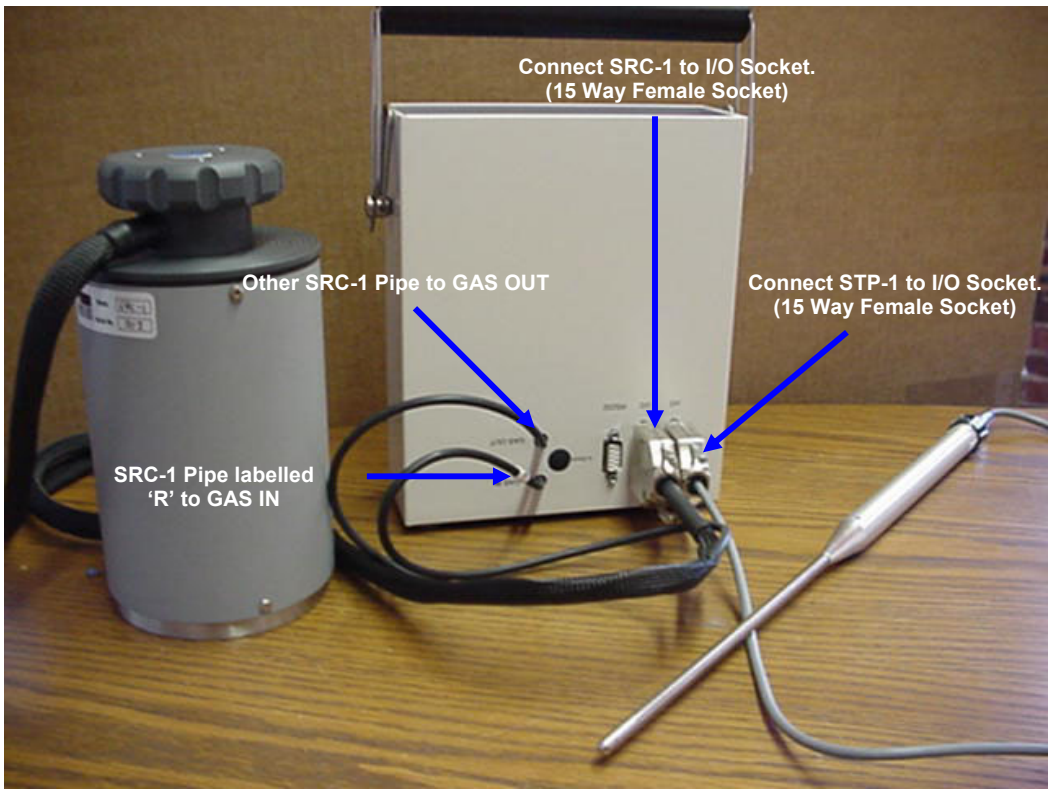


Figure 1 SRC and STP Electrical and Gas Connections to EGM (EGM-4 Shown)

SRC-1 with CIRAS-1

The SRC-1 works as a closed system, with the Analysis side of the CIRAS analyser connected in-line. The CIRAS analysis pumps are not sealed as standard (not necessary in an open system). However, when they are used in a closed system then they should be sealed. If an SRC is supplied with a new CIRAS then a sealed analysis pump is fitted as standard, leaving the original unsealed pump as a spare. If an SRC is supplied separately, then it is supplied with a sealed analysis pump, which the user must fit.

The SRC-1 15 pin D connector must be plugged into the Accessory I/O port. If a soil temperature probe is being used, then a Y connector is required to double up the port.

The pipe with the connector (labelled “R”) must be fitted to the ANalysis inlet, and the plain pipe to the analysis outlet below.

After switching on, the CIRAS-1 will automatically go through the start up procedure if the instrument is not already warmed up.

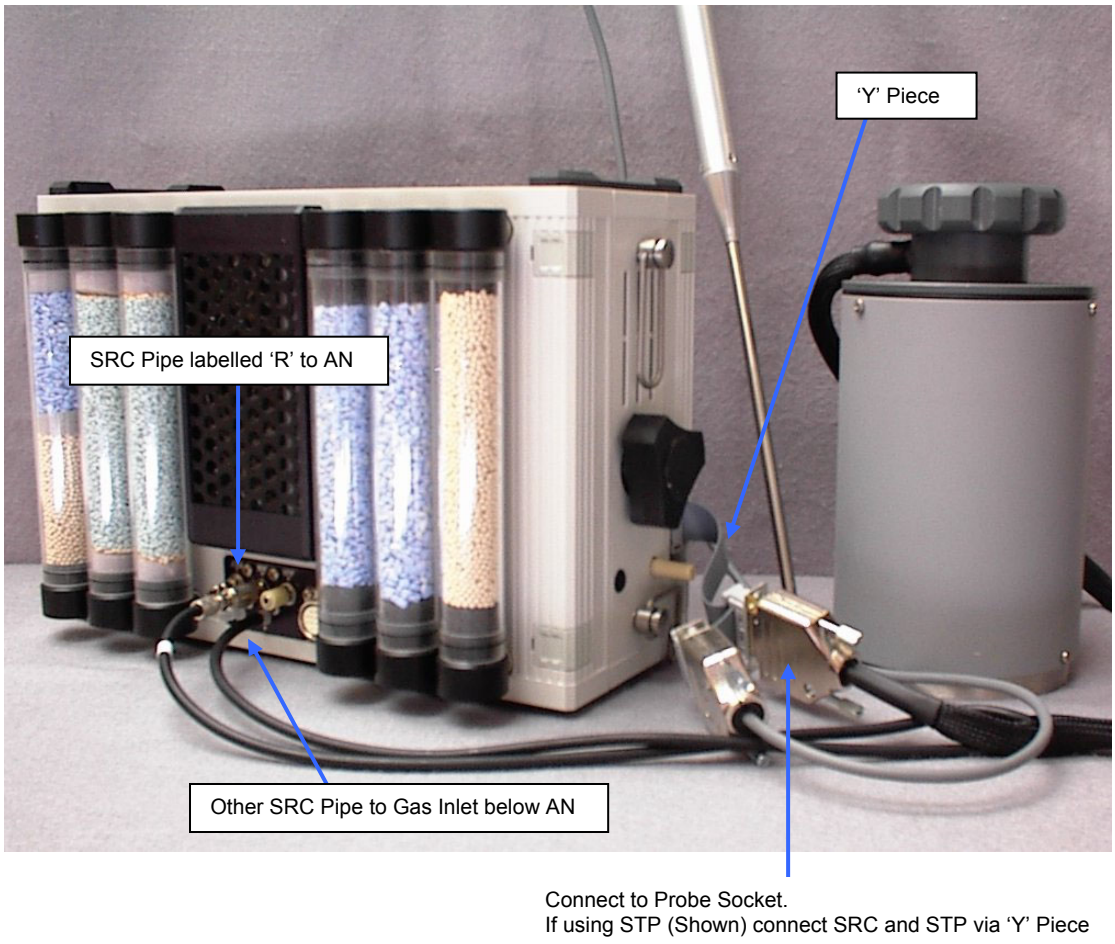


Figure 2 SRC and STP Connection to CIRAS-1

CPY-2 with EGM-4

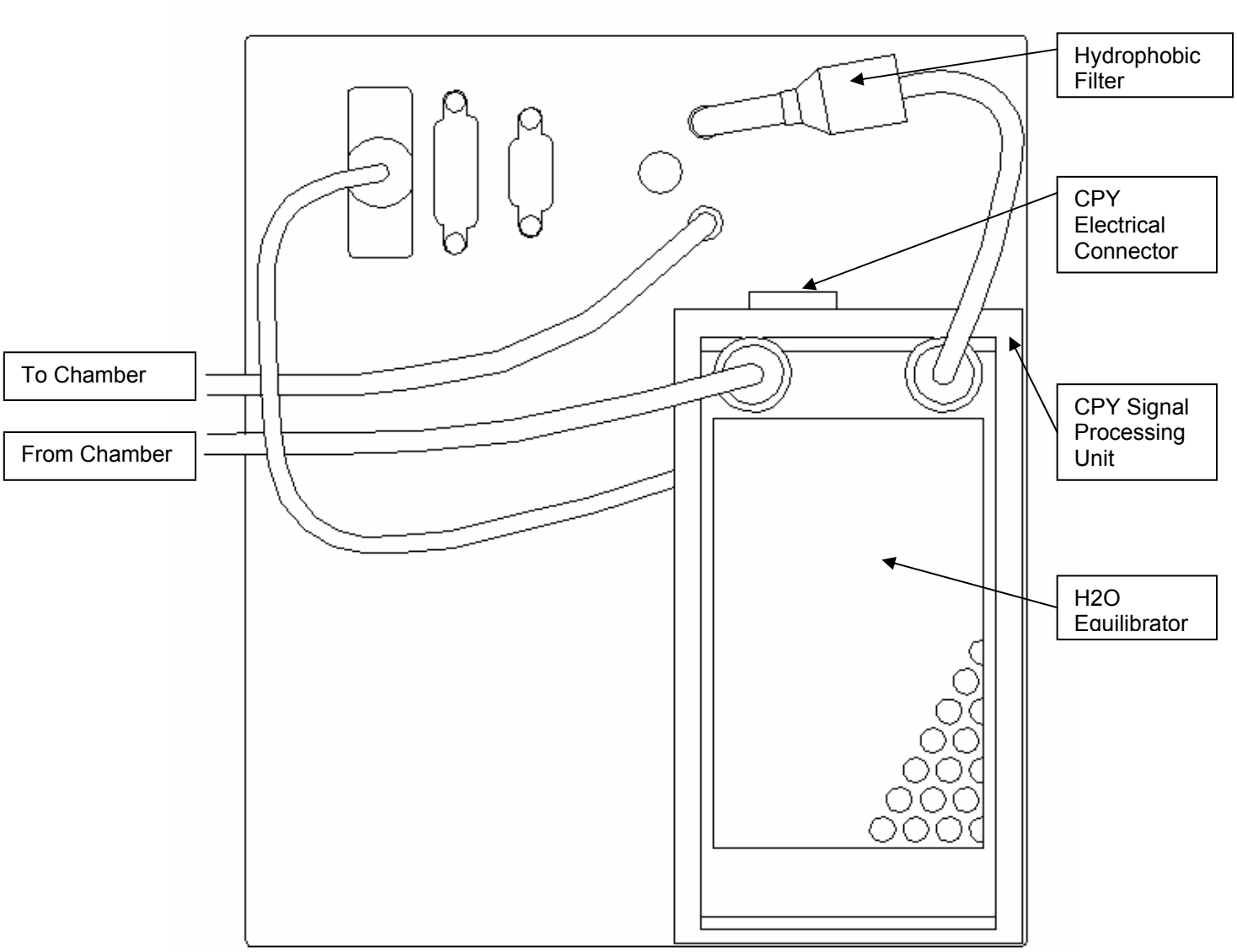
The CPY-2 differs from the SRC-1 in that it has a Signal Processing Unit.
Also, it cannot be used with a soil temperature probe.

The Water Vapour Equilibrator is attached to the top of the processing unit using the velcro provided. This assembly is then attached to the top of the EGM using the velcro provided.

But first make sure the electrical and pneumatic connections will reach.

All electrical connections must be made before the analyser is switched on.
The 15 pin D connector from the Signal Processing Unit must be plugged into the I/O port.
Refer to the following diagram for connection details.

After first switching on, if possible, the EGM should be left for 20 minutes before making any measurements. During this period, the EGM reading is changing slightly between zeroing, which, though well within specification, could give rise to errors in assimilation.



CPY Signal Processing Unit connection to EGM-4

CPY-2 with CIRAS-1

The CPY works as a closed system, with the Analysis side of the CIRAS analyser connected in-line. The CIRAS analysis pumps are not sealed as standard (not necessary in an open system). However, when they are used in a closed system then they should be sealed. If the chamber is supplied with a new CIRAS then a sealed analysis pump is fitted as standard, leaving the original unsealed pump as a spare. If the chamber is supplied separately, then it is supplied with a sealed analysis pump, which the user must fit.

The CPY-2 differs from the SRC-1 in that it has a Signal Processing Unit.
Also, it cannot be used with a soil temperature probe.

The Water Vapour Equilibrator is attached to the top of the processing unit using the velcro provided. This assembly is then attached to top of the CIRAS equilibrator using the velcro provided.

But first make sure the electrical and pneumatic connections will reach.

All electrical connections must be made before the analyser is switched on. The 15 pin D connector from the Signal Processing Unit must be plugged into the Accessory I/O port.

The general pipe configuration is the same as with the EGM. However there is no external hydrophobic filter (it is internal to Ciras).
The equilibrator pipe with the connector is fitted to the ANalysis inlet.
The return pipe to the chamber is fitted to the ANalysis outlet.

After switching on, the CIRAS-1 will automatically go through the start up procedure if the instrument is not already warmed up.

Removal of the Chamber

Switch off the analyser then carefully remove the electrical and gas connections.
When the instrument is switched on again it will function as described in the Operator's Manual.

Warnings

1. Orientation

The EGM and CIRAS must never be used in the horizontal position as there is the possibility of air tracking over the top of the Zero column(s) rather than passing through the absorber. This will give rise to an incorrect zero and an apparent loss in the analyser sensitivity.

2. Calibration

Do not calibrate with the chamber connected.

3. Condensation

It is very important that the analyser should not be cooler than it's surroundings when the assimilation measurements are being made, otherwise, there is a risk of condensation particularly if the soil is wet. Keep a check on the pipelines to be sure that condensate is not coalescing and entering the analyser.

The problem can be avoided by putting a suitable drier in the airline to the analyser. Drierite (anhydrous Calcium Sulphate) is suitable. Do NOT use Silica Gel, which also absorbs CO_2.

PP Systems can supply a water vapour equilibrator which is constructed from a material that is very permeable to water vapour but impervious to CO_2 If this is put in the pipe to the analyser then the water vapour concentration of the analysis air will be brought close to ambient.

NB. The CPY is fitted with an equilibrator as standard.

Using a Water Vapour Equilibrator with the SRC

To protect against a build up of water vapour, and therefore risk of condensation within the system, an equilibrator can be fitted in-line with the SRC as shown.

Figure 3 SRC connected to Water Vapour Equilibrator

Operation

When the analyser is started up, it will automatically recognise the chamber. It is recommended that the memory is cleared before commencing, otherwise the assimilation measurements will be appended to the end of any measurements already held in the database, and may be difficult to identify.

From the Main Menu select (1REC), then the operator is taken through the series of actions required before a measurement can be made. Press key "Y" to move on to the next menu in each case. Press key "N" to quit at any point and return to the Main Menu.

EGM 1-3

NB. For EGM 1-3 Firmware Version 3.60 and above refer to EGM-4.

V/10:117	A *10:785
100*V/A: 1490	

Where:

1V: Volume of the system up to 999 (ml)
2A Area exposed up to 9999 (cm^3)
3V/A*100 Volume/Area

If a non-standard chamber is used then the default Volume and Area settings can be changed. The system will automatically calculate the new V/A from the values entered. Use keys 1 and 2 to change V and A.

If the Volume or Area exceed the input limits then the user can input V/A instead (key 3). The EGM will then set V/10 and A*10 to 999 to maximum as they are unknown to the system.

The system always starts up with the SRC default values.

If the CPY-2 is used, the appropriate values should be entered based on the following table:

Type	Serial No.	Exposed Diameter (mm)	Height (mm)	Exposed Area (cm2)	Volume (ml)
CPY-2	5-19	134	170	141	2,572
CPY-2	20 and above	146	150	167	2,367

Therefore the SRC default V/A can be used.

CIRAS-1

1P:01 :93	B:13.6
2ZERO:0	FRC:0820

Where:-

1P Plot Number (changed between 1 & 99 by selecting 1)

93 Indicates that the chamber is connected

B Battery voltage

2ZERO Zero Mode (Automatic zero after every 30 minutes when the chamber is connected, taken in between measurements)

FRC Number of free records

To continue, press “Y”.

The next display CIRAS display is :-

1: VOL CM3 1170
2: AREA CM2 78

These are the defaults for the SRC-1.

If the CPY-2 is used, the appropriate values should be entered based on the following table:

Type	Serial No.	Exposed Diameter (mm)	Height (mm)	Exposed Area (cm2)	Volume (ml)
CPY-2	5-19	134	170	141	2,572
CPY-2	20 and above	146	150	167	2,367

Therefore the SRC default V/A can be used.

EGM 1-3 / CIRAS-1

The next display is:-

1DT: 64 2DC: 50
APPROX TEMP:*

* CIRAS only

Where:

1DT Time for which the change in the chamber CO_2 is monitored (EGM from 0 to 255, CIRAS 0-999 seconds).

2DC The maximum change allowed in CO_2 concentration from time zero at which point the measurement is made.(EGM from 0 to 255, CIRAS 0-99 ppm).

3APPROX TEMP On the CIRAS you MUST enter the approximate ambient temperature.

Note. Readings are taken every 4 seconds in CIRAS and every 8 seconds in the EGM and are fitted to a quadratic equation. A minimum of three measurements are required to get the first fit. DT is best set to a minimum of 64 seconds, and DC initially to 50. If the record is automatically taken within the first 24 seconds, then DT or DC is too low, and the results will be meaningless.

The next display will show:

EGM1-3

ZERO. PLEASE WAIT UNTIL ALARM OFF

CIRAS-1

HOLD CUVETTE IN AIR TO FLUSH

Now, the fan motor in the chamber will run at maximum speed, and the analyser will enter it's zero mode. During this operation, the chamber should be held well clear of the soil, open to the air, so that it is thoroughly flushed out.

During this process, with the EGM, the alarm will sound. If it is too loud, then a small piece of adhesive tape can be placed over the alarm port on the rear panel of the EGM.

The next display will show :-

PUT IN PLACE PRESS R TO START

The area of soil for analysis should be level, without any obviously projecting stones. Push the chamber firmly down onto the soil so that the stainless steel perimeter ring is partially embedded to give a seal.

Next, press Key R/8 to start the measurement, acknowledged by the display "INPUT ACCEPTED".

Note for EGM use. Since zero is suppressed during the analysis period, if more than 3 minutes elapses between the above display and pressing "R", then it would be wise to terminate by pressing the "N" key to automatically re-zero the analyser.

There is a delay of approximately 20 seconds after pressing Key R/8 before any measurements begin. This is to allow equilibration of the system. This is followed by a further delay before any record can be made, to allow 3 measurements to be taken and the first quadratic fit applied.

EGM 1-3

The display will show:

C xxxx	H xx	T xx
A x.xx	Q xxxx	tt

This is the measured data, where:-

C = Current measured CO_2 concentration in ppm

H = See Note below

T = Soil Temperature when an STP-1 is connected
or
Air Temperature when a CPY-2 is connected

A = Assimilation Rate in g CO_2/m^2 /hour
+ve value = CO2 Evolution = Respiration
-ve value = CO2 Uptake = Photosynthesis

Q = PAR inside the chamber if a CPY-2 is connected

tt = Elapsed time in seconds from the start of the measurement period

Note : Q, H and T = PAR, Relative humidity and temperature if an HTR-2 is connected

CIRAS-1

The display shows:-

DCxx	Qxxxx	Txx
Axx.x	DTxxx	EC

This is the measured data, where:-

DC = the change in CO2 during the course of the measurement calculated from the fitted curve

Q = PAR inside the chamber if a CPY-2 is connected

T = Soil Temperature when an STP-1 is connected
or
Air Temperature when a CPY-2 is connected

A = Assimilation Rate in g CO_2/m^2 /hour
+ve value = CO2 Evolution = Respiration
-ve value = CO2 Uptake = Photosynthesis

DT = Elapsed time in seconds from the start of the measurement period.

EC = Error Code

Note : Q and T = PAR and temperature if an HTR-2 is connected

EGM 1-3 / CIRAS-1

Both DC and A are determined from the quadratic fitting. The first 3 sets of readings will show zero for these parameters as a quadratic fit requires at least 3 data sets.

The rate of change in CO_2 should be linear, though any leakage to the outside air will cause it to decline with time. A quadratic equation is fitted to the relationship between the changing CO_2 concentration and elapsed time. The coefficients of this are used to determine the rate of change at time 0. A warning is given if the relationship is excessively non-linear.

Measurements terminate when either the chosen elapsed time or the CO_2 concentration change is exceeded. The operator can initiate a recording by pressing the “R” key.

The assimilation rate is recorded in g CO_2/m^2 /hr. The maximum +ve rate which can be recorded is 9.99 g CO_2/m^2 /hr.

When the measurement is completed an option to save the result is displayed. Press Y to save or N to quit.

Then next display will show:-

REMOVE FROM SOIL
THEN PRESS R KEY

Press the "R" key to start the next measurement (the EGM will auto-zero first. The CIRAS will auto-zero after 30 minutes has elapsed.). Press any other key to return to the Main Menu.

EGM-4

Please note that following also applies to EGM 1-3 Firmware Version 3.60 and above.

Display 1 is shown immediately after pressing key 1.

SOIL RESP.DATA RECORD 1ALL 2END?

The assimilation 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 assimilation rate curve or only 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 is typically several minutes in between measurements, you could expect to store approximately ½ a days work. If 2 is selected, only the final results will be saved and recorded.

Display 2 is used to determine how the results will be fitted.

DATA FITTING 1LINEAR 2QUAD.?

This is to allow the choice of a linear or quadratic fitting for the assimilation data. In the past only quadratic fitting has been used but at the request of some customers we have now also introduced a linear fitting. As discussed in the theory section, on theoretical grounds, the relationship is likely to deviate from a linear response, especially at low assimilation rates.

Display 3 defines the size of the chamber.

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

Where:

1V: Volume of the system up to 999 (ml)
2A Area exposed up to 9999 (cm^3)
3V/A*100 Volume/Area

If a non-standard chamber is used then the default Volume and Area settings can be changed. The system will automatically calculate the new V/A from the values entered. Use keys 1 and 2 to change V and A.

If the Volume or Area exceed the input limits then the user can input V/A instead (key 3). The EGM will then set V/10 and A*10 to 999 to maximum as they are unknown to the system.

The system always starts up with the SRC default values.

The CPY-2 defaults are Volume = 2465 cm3 Area = 170 cm2 and V/A = 1450
Therefore the SRC default V/A can be used.

Display 4 by using key Y to continue.

1DT:120	2DC:50
3APPROX.	TEMP.25

Where:

1DT: Time for which the change in the chamber CO_2 concentration is monitored (seconds). The minimum and maximum 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 (upto 999 ppm)
3APPROX.TEMP: The approximate chamber air temperature.
NB APPROX TEMP does not apply to EGM-1/3.

Press keys 1/2/3 to change the associated parameter.

Display 5 is shown by using key Y to continue.

PLOT NO =	00
Y OR NEW	VALUE

If the plot number needs to be changed, the press the key corresponding to the most significant digit of the required number (or 0 if less than 10) then enter the final digit.
(**NB** With EGM-1/3 Select entry of new plot number by pressing 'N').

Display 6 is shown by using the Y key to continue.

CHAMBER FLUSHING	
HOLD IN AIR	03

At this stage, the 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.

Display 7 shown on completion.

PLACE ON SOIL
PRESS Y TO START

Display 8 after placing on the soil and pressing Y.

EQUILIBRATION	
PLEASE WAIT	03

After approximately 5 seconds, the measurement will commence. Before final calculation of assimilation rate (g (CO_2) m^2 Hour) can be achieved, the EGM-4 must have accumulated 4 data sets.

Display 9 is the measurement display.

C00395	H14.7	T22
A02.11	Q0000	110

Where:

C00395 Current measured CO_2 concentration (ppm)
H14.7 Humidity concentration **if sensor is present** (mb)
T22 Soil Temperature if probe is present (°C)
A02.11 CO2 exchange (Assimilation) rate (g (CO_2)/ m^2 /Hour). The maximum rate that can be recorded is 9.99 g (CO_2) m^2 Hour.
Q0000 PAR (µmol m^{-2} s^{-1})
110 The elapsed time of measurement (seconds)

The following message will be shown with the quadratic fit if the C term in the quadratic fitting expression ($Y = a + bx + cx^2$) is greater than 0.2 * b.

NON LINEAR FIT

When either the DC or DT exceeds the set values, the measurement terminates and the following message is displayed:

C00395	H14.7	T22
A02.11	Q0000	
		END

Pressing any key then shows: -

RECORD Y/N

If you 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 presses of the N key will return you to Display 2 , then Display1 and finally to the Main Menu.

For more information on the theory and calculation of assimilation, see Calculations

Calculations

Theory

The assimilation is measured by placing a closed chamber on the soil and measuring the rate of increase of the CO_2 concentration inside the chamber.

Then, assuming a well mixed sealed system :-

$$R = \frac{(Cn - Co)}{Tn} * \frac{V}{A} \qquad (1)$$

Where R is the assimilation rate (Flux of CO2 /unit area/unit time), Co is the CO_2 concentration at T=0 and Cn is the concentration at a time Tn later, A is the area of soil exposed and V the total system volume.

It has been suggested that to make accurate measurements of the assimilation it is essential to start with a CO_2 concentration in the cuvette below (respiration)/above(photosynthesis) ambient and measure until the concentration is above/below ambient, presumably with the intention of getting some compensation for leakage. However, this leakage can only take place at ground level, where the CO_2 concentration is unknown and most certainly will not be what we would consider as ambient.

Over the short period of measurement and with the relatively small CO_2 concentrations in the cuvette compared with the soil concentrations, we would expect the assimilation to be a constant flux, giving a constant rate of change in the cuvette CO_2 concentration.
Any leakage should be a function of the concentration difference between the cuvette and the exchange air. Due to leakage, the apparent assimilation rate decreases with time.

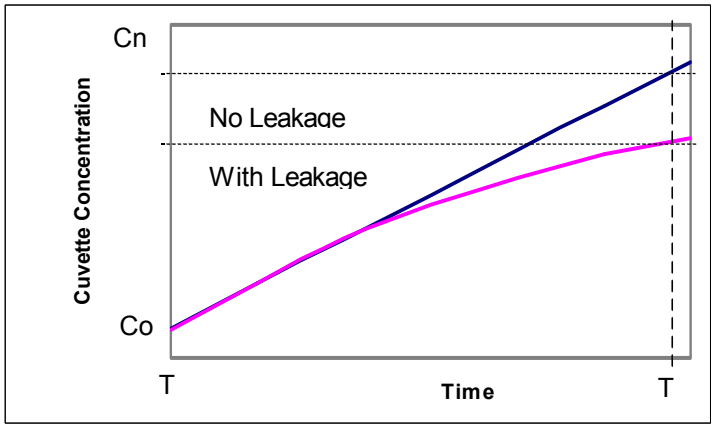


Figure 4 Simulated Soil Respiration Measurements

With CIRAS-1 and the EGM-1 software a quadratic relationship ($y = a + bx + cx^2$) is fitted between the cuvette concentration (C=y) and time (T=x) from the start of measurement.
N.B. There is a delay after the chamber is first placed on the soil to allow for the establishment of stable gradients etc, before the measurements start.

Then $$C = a + bT + cT^2$$

The true assimilation rate will be calculated from dC/dT at T=0.

Now $dC/dT = b + 2cT$

so at T=0 $dC/dT = b$ (2)

A comparison of b and cT gives an indication of the leakage.
With the PP Systems program cT must be less than 20% of b or the “non-linear“ error message is given.

This is believed to be a better approach than lowering the CO_2 value at the start of the measurement.

Measurement Units

From 1 and 2:-

R = b x V/A

To give the flux in mass/unit area/unit time then b must be measured in mass/unit volume.

The CO_2 analyser measures the volume/volume ratio (= ppm by volume = micro-litre/litre = micro-bar/bar = micro-mol/mol).

Now one kg mol of gas (44.01kg of CO_2) at STP occupies 22.41 m^3.

Thus: -

$$R = b * \frac{P}{1000} * \frac{273}{273 + Ta} * \frac{44.01}{22.41} * \frac{V}{A} \quad (3)$$

Where:

R is the CO_2 flux in $kg.m^{-2}.s^{-1}$
V is the system volume (largely the chamber volume) in m^3
A is the soil area exposed in the chamber in m^2, P is the atmospheric pressure in mb
Tc is the temperature of the system volume (chamber) in ºC.

We measure: -

DC/DT = b as ppm/second
V in cm^3
A in cm^2
R is expressed as $g.m^{-2}.hr^{-1}$.

To convert ($g.m^{-2}.hr^{-1}$) to (micro-$mol.m^{-2}.s^{-1}$) multiply by 6.312

Water Vapour, Temperature And Pressure Corrections

EGM Program

The following details the effects of water vapour, temperature and pressure on CO_2 measurements made by the EGM.

1) Water Vapour

If we start with a dry sample of air of known CO_2 concentration then add to it water vapour, then the CO_2 becomes diluted because the air volume is increased by the volume of the water vapour added.

From the point of view of the infra-red measurement, by careful choice of the interference filters covering the detector, there is only a very small direct effect of the water vapour. This is typically equivalent to less than 0.1ppm/mb measured with CO_2 free air. However, the presence of the water molecules induces an increase in infra-red absorption by the CO_2 molecules (foreign gas broadening) and therefore an increase in the apparent CO_2 concentration. This is of a similar magnitude but opposite in effect to the dilution reported above. The net effect is that the analyser will approximately report the DRY gas concentration.

2) Atmospheric pressure

Increase in pressure causes increase in concentration according to The Gas Law. However, there is a greater increase in the infra-red absorption than would be expected due to the concentration increase (pressure broadening of the absorption bands).

An approximate correction is: -

$$C = CM * \frac{1000}{0.75 * P + 0.00025 * P * P}$$

Where C is concentration that would be measured at 1000 mb.
CM is the concentration measured at P mb.

3) Air Temperature

The major effect of temperature on infra-red based analysers is usually on the selective interference filters on the sensor. With the current EGM the detector/ filter combination is thermostatted at about 45 ºC so the major temperature effect should be on gas density and will follow the Gas Law (approximately -0.3% / ºC increase).

The correction, referred to a calibration at 0 ºC, is:-

$$C = CM * \frac{273 + Ta}{273}$$

Where Ta is the air temperature.

If we now apply these corrections then equation (3) becomes:-

$$R = b * \frac{P}{1000} * \frac{1000}{P(75 + 0.00025 * P)} * \frac{273}{273 + Ta} * \frac{273 + Ta}{273} * \frac{44.01}{22.41} * \frac{V}{A}$$

$$= \frac{b * 44.01 * V}{(0.75 + 0.00025 * P) * 22.41 * A}$$

We see that no temperature correction is required and that the effect of pressure is small.

However, when working at a high altitude, it is usual to calibrate at that pressure, so then the correction would be: -

$$R = b * \frac{Pav}{1000} * \frac{44.01}{22.41} * \frac{V}{A}$$

Where Pav is the average atmospheric pressure at that altitude.

CIRAS Program

CIRAS readings are pressure compensated and the analyser is thermostatted. Therefore a standard gas should read the correct ppm value independent of atmospheric pressure and temperature changes.

The CO_2 concentration change is corrected for both the cross sensitivity of the CO_2 IRGA to water vapour and also for the dilution effects of any increase in the water vapour concentration.

(In program versions prior to V3.6I it is necessary to correct the CIRAS result by multiplying by :-

$$\frac{P * 273}{1000 * (273 + Ta)}$$

).
From V3.6I and later versions the results are fully corrected as in equation (3) but since the ambient temperature is not measured, this is entered from the keypad.

Data Transfer

Assimilation data may be transferred in the usual way to a PC or printer and the data format is shown below:

EGM 1-3 Records

1, DD, MM, HH, MM, CCO2, PAR
2, 8, RH, TC, DC, A, 0/1

A complete record consists of two lines, indicated by the 1 and 2 at the start of the lines.

The number 8 in the 2nd line indicates that this is a closed system record.

DD,MM,HH,MM	DATE (Day and Month) and TIME (hour and minute) when the record was made
CCO2	CO2 concentration in ppm by volume in the chamber when the record was taken
PAR	PAR reading in micromol/m2/s
RH	Relative Humidity for chambers with an RH sensor (plus those incorporating the HTR-1)
TC	Chamber Air Temperature
DC	Change in the CO2 concentration between the start and end of the measurement period
A	Calculated CO2 assimilation rate in (g/m2/hr)
0/1	0 = CO2 Evolution = Respiration 1 = CO2 Uptake = Photosynthesis

EGM-4 Records

Please refer to the Online Help in the Windows Transfer Software.

Org File

Data is Fixed Width ‘Fields’.
X = Character 0 to 9

Field	Number of Characters	Position of Decimal Point
Plot	XX	
Record	XXXX	
Day	XX	
Month	XX	
Hour	XX	
Minute	XX	
Ref CO2	XXXXX	
Ref mb	XXX	XX.X
Internal Temp	XXXX	[+/-]XX.X First character indicates sign. 0 = +ve, 1 = -ve
PAR	XXXX	
RH	XXXX	XXX.X
Temperature	XXXX	XXX.X

Field	Number of Characters	Position of Decimal Point
DC	XXXX	
DTime	XXXX	
SR	XXXX	XX.XX
+-	XX	00 = +ve 01 = -ve
Input H	XX	NA
ATMP	XXXX	
Probe Type	XX	Always 08

Dat File

Data is tab delimited.

Field	Range	Meaning
Plot	0 to 99	Plot Number
Record	0 to 9999	Record Number
Day		
Month		
Hour		
Minute		
Ref CO2	0 to 99999	CO_2 in parts per million (ppm)
Ref mb	0 to 99.9	H_2O in millibar (mb)
Internal Temperature	-99.9 to 99.9	Temperature of internal mb sensor (ºC)
PAR	0 to 9999	micro-mols/m^2/s
RH	0 to 999.9	%
Temperature	0 to 999.9	ºC
DC	0 to 9999	Change in CO_2 ppm
DTime	0 to 9999	Elapsed Time seconds
SR	-99.99 to 99.99	g CO2/m2/hour
+-	00 or 01	00 = +ve 01 = -ve
Input H	NA	
ATMP	0 to 1099	Atmospheric Pressure in mb
Probe Type	Always 8	

CIRAS Records (DOS Software)

Character Position	1	3	5	9	13	18	23	27
	PP	RR	DDMM	HHMM	CCO2	+CO2D	QQQQ	MBS
30	35	38	41	45	49	53	57	61
+MBDF	ST	0000	0000	0000	0000	0000	+AR	ET

A complete record consists of a single line of 64 characters (excluding <LF> & <CR>). It is only shown above on 2 lines for convenience.

The position of each character in the string is numbered to facilitate string handling in any user program.

PP	PLOT NUMBER (range is 00 to 99)
RR	93 (closed system measurement)
DDMM HHMM	DATE (Day and Month) and TIME (hour and minute)
CCO2	CO2 concentration (ppm) at the end of the measurement corrected to 1

(nnnn.n)	bar pressure and for cross-sensitivity to water vapour.
CO2D (+/-nnn.n)	Change in the CO2 concentration between the start and end of the measurement
MBS (nn.n)	Water vapour concentration in millibars corrected to 1 bar atmospheric pressure at start of measurement period
+MBDF (+/-nn.nn)	Change in the water vapour concentration (mb) between the start and end of the measurement period
ST (nn.n)	Soil temperature if soil temperature probe is used
AR (+/-nn.n)	Calculated CO2 exchange rate in (g/m2/hour) x 10 (+ = CO2 evolution / - = CO2 uptake)
ET (nnnn)	Total measurement time in seconds

NB. Updated measurements of this format are also transmitted every 4 seconds during the measurement period.

CIRAS-1 Records (Windows Software)

Org Files are structured as above. For the dat files, data is TAB delimited and the field positions are as above.
Please refer to the Online Help in the Windows Transfer Software.

Interface Connections

15 Pin D connector with the following pin outs:

Pin Number	Function
1-6	9k 1 ohm resistor = closed system chamber
5	Soil temperature output
6	+5v Supply (Interface circuit)
7	Alarm input used to switch relay selecting fan high & low speeds
8	Supply ground
12	+12v Supply (Fan & probe)
15	Signal ground

SRC Maintenance

Wipe around the rim of the chamber after each measurement.

On completion of the day's measurements, leave the analyser running on ambient air for a period to ensure that there is no condensation in the unit.

Please refer to the EGM or CIRAS Operator's manuals for more details regarding analyser maintenance.

Stirring Fan

To replace the fan, remove the 3 screws around the top of the chamber and remove the upper section. The fan is now accessible for replacement. New fans are available from PP Systems, or an authorised agent, or your local Micronel agent (Type V369L-0129K-1). When fitting a new fan, ensure that it blows vertically onto the soil surface.

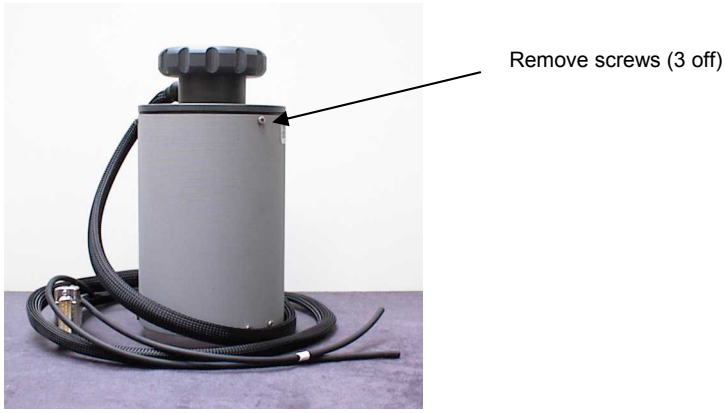


Figure 5 Replacing SRC Fan

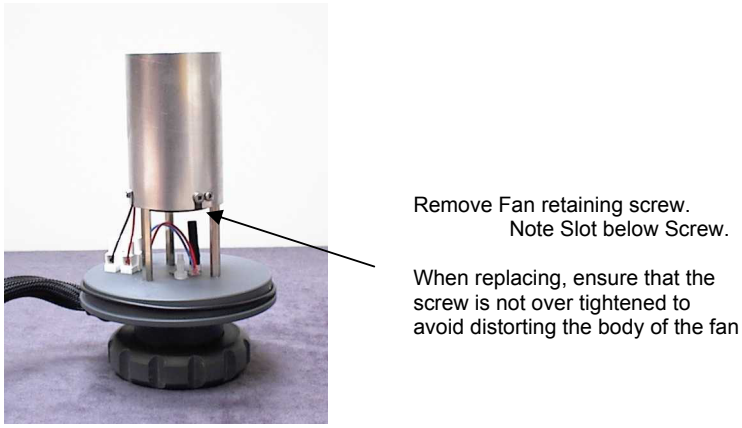


Figure 6 Remove Fan retaining Screw

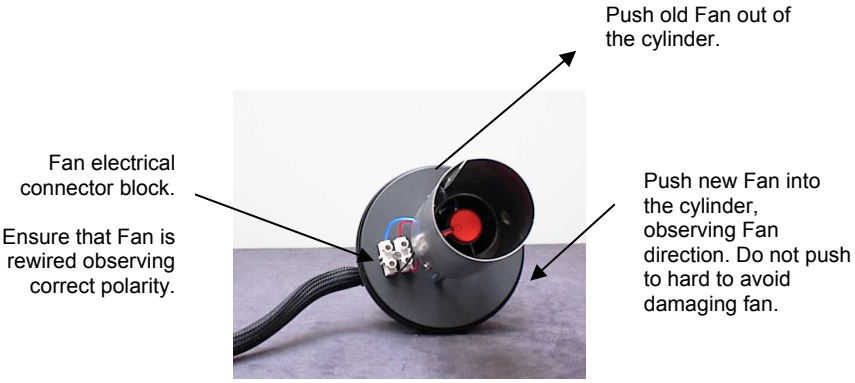


Figure 7 Remove and Replace Fan

STP-1 Soil Temperature Probe

The STP-1 Soil Temperature Probe is an optional accessory typically used with our soil respiration system for accurate measurement of soil temperature.

Usage

The probe must only be pushed in and out of the soil by hand.
NEVER hammer down onto the end cap or pull the probe out by using the cable.

Storage

Storage must be at relative humidity < 70% and temperature < 35 ºC.

Connections

15 pin D connector with the following Pin Outs :-

Pin Number	Function
1-6	100 kΩ resistor (*)
5	Temperature output (0-1V = 0-50 ºC)
8	Supply Ground
12	7-12V unregulated DC at <10mA
15	Signal Ground

(*) For use with an EGM to identify the probe type.

Temperature Sensor Calibration

This is a BETATHERM linear thermistor network and recalibration should not be required. If recalibration is thought to be necessary then contact your agent for instructions.

References

Parkinson K.J. (1981). An improved method for measuring soil respiration in the field. Journal of Applied Ecology, 18, 221-228.

User Notes