



SRC-1 Soil Respiration System

Operators Manual for CIRAS-2

Version 4.01

© 2002 PP Systems. All Rights Reserved

9th October 2002

Europe

PP Systems
Unit 2, Glovers Court, Bury Mead Road.
Hitchin, Hertfordshire, SG5 1RT, U.K.
Tel: +44 1 462 453 411
Fax: +44 1 462 431 090

North America

PP Systems Inc.
241 Winter Street
Haverhill, MA 01830 U.S.A.
Tel: +1 978 374-1064
Fax: +1 978 374-0972

Email: support@ppsystems.com

Web Site: <http://www.ppsystems.com>

This page is left intentionally blank.

Table of Contents

Table of Contents	1
Index of Figures	2
Preface	3
Document Conventions.....	3
Other Documentation	3
User Registration	3
Notice	4
Service	5
Technical Specifications of the SRC	6
Fan.....	6
Housing.....	6
Dimensions	6
Weight.....	6
Installation	7
CIRAS-2 Connections	7
Ciras Pumps.....	8
General Advice.....	8
Using a Water Vapour Equilibrator.....	8
Removal of the SRC-1/STP-1	8
Operation	9
Warning.....	9
System Parameters.....	9
Volume of the System.....	9
Area of soil exposed	9
Maximum Time	9
Maximum CO ₂	9
Chamber Temperature	9
Note	9
Windows Software	10
Windows software	10
Results	11
Calculations	12
Theory	12
Measurement Units	13
Water Vapour, Temperature and Pressure Corrections	14
Maintenance	15
Stirring Fan.....	15
Appendix	17
References.....	17
SRC-1 Interface Connections.....	18
User Notes	19

Index of Figures

Figure 1 SRC and STP Electrical and Gas Connections to CIRAS-2 7
Figure 2 SRC connected to Water Vapour Equilibrator 8
Figure 3 Simulated Measurements 12
Figure 4 Replacing SRC Fan 15
Figure 5 Remove Fan retaining Screw 15
Figure 6 Remove and Replace Fan 16

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

Refer to the CIRAS Operators Manual (Ciras2Operation.pdf) for Analyser Maintenance and operation of the Windows Software.

Soil Respiration Measurements are also covered in the Closed System Help Files.
(See Help\ClosedSys.hlp).

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.

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.

Service

Most equipment is covered under warranty for one complete year, parts and labor 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). For service in Europe and U.S.A., please contact us at:

In Europe
PP Systems
Unit 2, Glovers Court, Bury Mead Road.
Hitchin, Hertfordshire, SG5 1RT, U.K.
Tel: +44 1 462 453 411
Fax: +44 1 462 431 090

In North America
PP Systems Inc.
241 Winter Street
Haverhill, MA 01830 U.S.A.
Tel: +1 978 374-1064
Fax: +1 978 374-0972

Email: support@ppsystems.com

Web Site: <http://www.ppsystems.com>

Technical Specifications of the SRC

Fan

12v DC.

Housing

PVC and stainless steel.

Dimensions

150 mm Height x 100 mm Diameter (excluding handle).

Weight

900 g.

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

Installation

CIRAS-2 Connections

Electrical connections should be made before switching on CIRAS-2.

The SRC-1 will be supplied with an adapter to connect the 15 pin D connector on the SRC to the probe input on CIRAS. If a soil temperature probe is being used, then a Y connector is required to double up the connection to the adapter.

The pipe, labelled "R" on the SRC should be connected to the REF inlet on CIRAS-2 and the second pipe should be connected to the REF outlet.

After switching on, CIRAS-2 will automatically go through the start up procedure if the instrument is not already warmed up.

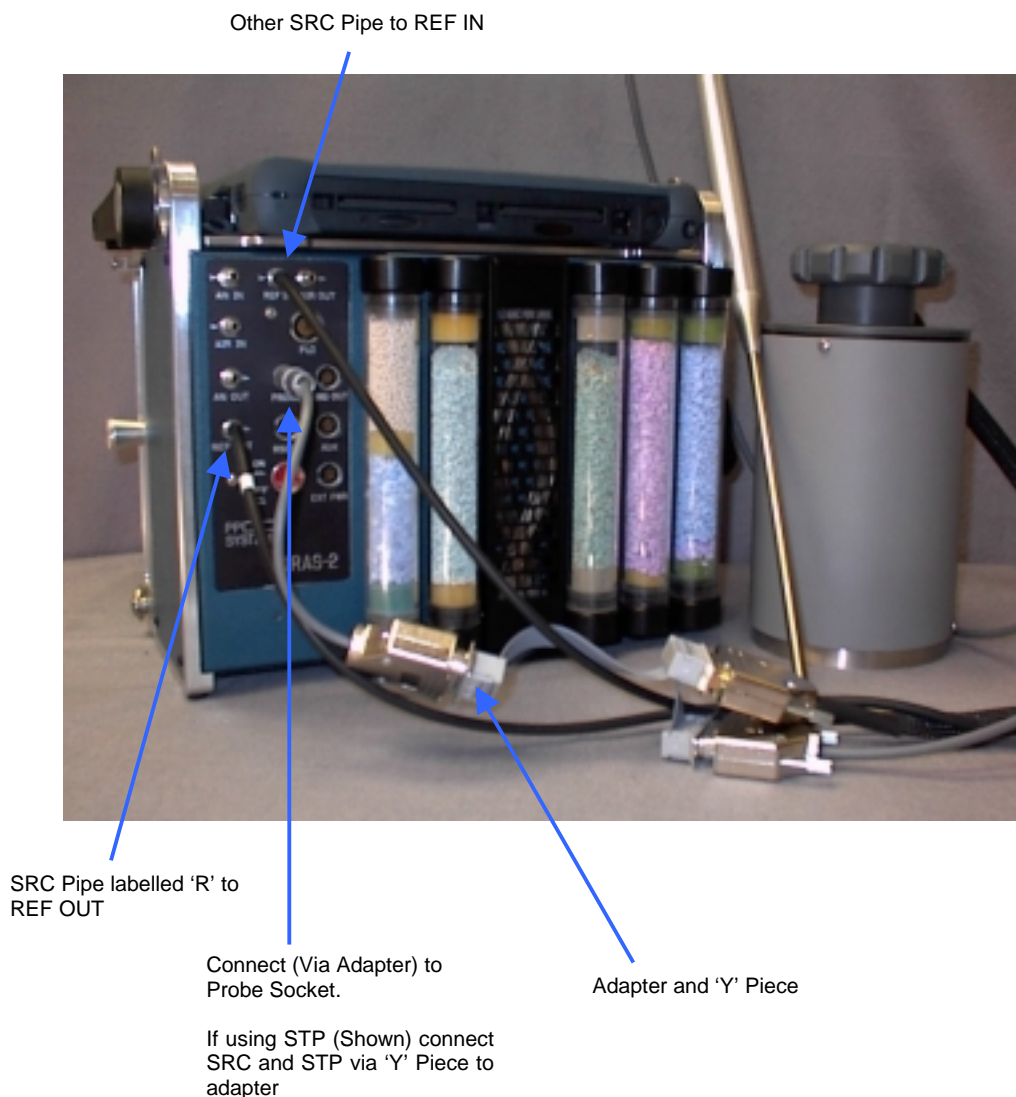


Figure 1 SRC and STP Electrical and Gas Connections to CIRAS-2

Ciras Pumps

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

General Advice

The CIRAS-2 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.

Do not calibrate with the SRC-1 connected.

Using a Water Vapour Equilibrator

To protect the analyser from excessive water vapour, an equilibrator may be 'in-lined' with the SRC as shown.

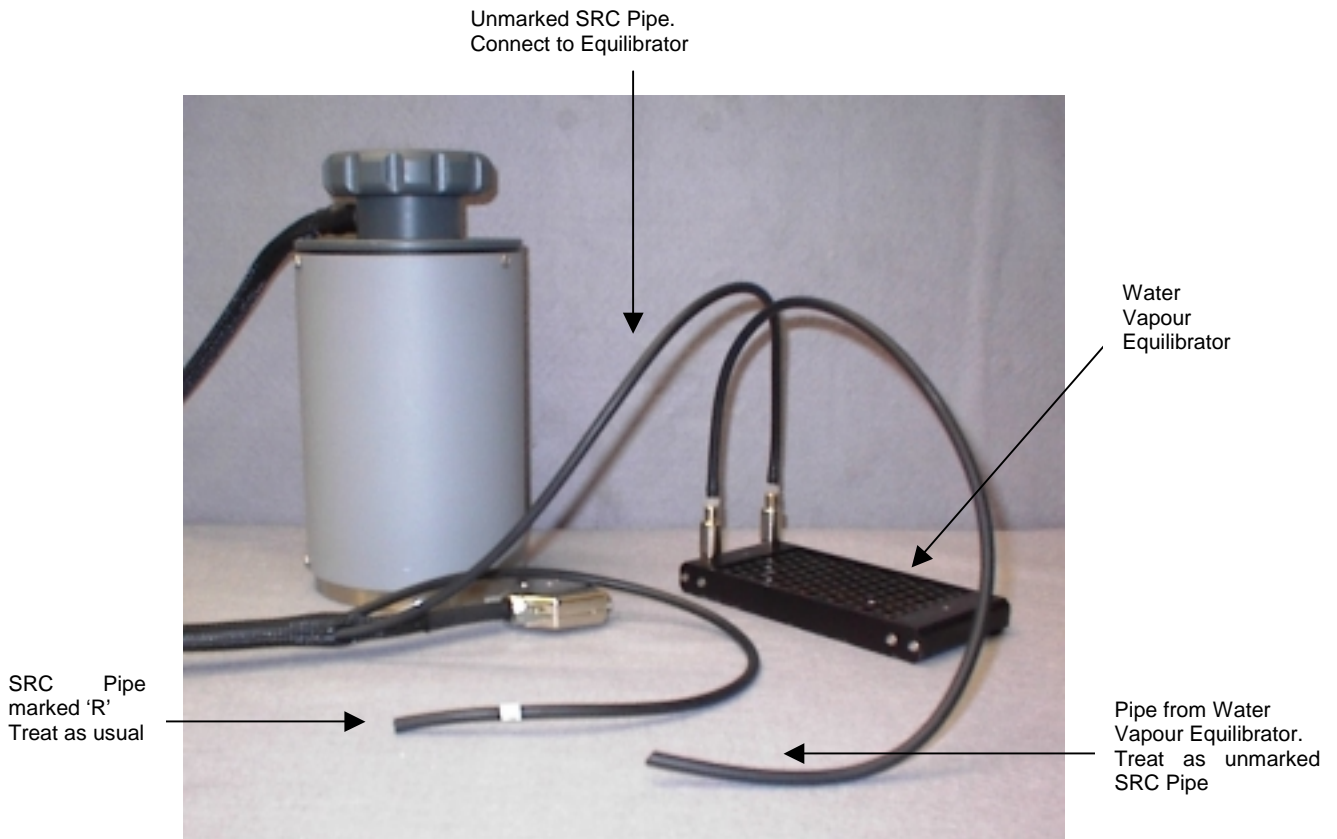


Figure 2 SRC connected to Water Vapour Equilibrator

Removal of the SRC-1/STP-1

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.

Operation

Warning

It is very important that the analyser should not be cooler than its surroundings when the respiration 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.

If working on very wet soils then it is recommended that a PP Systems Water Vapour equilibrator is placed in the REF line before CIRAS-2.

The water vapour equilibrator which is constructed from a material that is very permeable to water vapour but impervious to CO₂. 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.

The problem may also 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 CO₂

System Parameters

For the Closed System PC software the following parameters are user changeable. (selection of the SRC will automatically set default values shown).

Volume of the System

1170 cm³.

Area of soil exposed

78 cm².

Maximum Time

Time for which the change in the chamber CO₂ is monitored (120 seconds).

Maximum CO₂

The maximum change allowed in the CO₂ concentration from the start of measurement (60ppm).

Chamber Temperature

Approximate chamber temperature should be entered and the units that are to be used for the results. ($\mu\text{mol.CO}_2.\text{m}^{-2}.\text{s}^{-1}$ or $\text{g CO}_2 \text{m}^{-2}.\text{h}^{-1}$)

Note

Readings are taken every 3.2 seconds by the PC and are fitted to a quadratic equation. A minimum of three readings is required to get the first fit. Try first with the default settings. If the record is automatically taken within the first 24 seconds, then Maximum Time or Maximum CO₂ is too low, and the results will be meaningless.

Windows Software

Windows software

Start up the CIRAS-2 program as usual and from the main display select SETTINGS then from the SETTINGS EDITOR select the PARAMETERS button.
This will now show the PARAMETERS EDITOR.

Select under PROBETYPE on the drop down menu, CLOSED SYSTEM CHAMBER then check or select SRC from CHAMBER CUVETTE TYPE box.

Press OK, then a Dialog box appears when you should select to save the changes. When the SETTINGS EDITOR is again displayed you should press YES.
Then the SELECT USER box is displayed so again press YES.

The next display is the CLOSED SYSTEM display.

From this, SETUP allows setting of the System parameters listed earlier as well as setting up the recording option and record file name.

The message at the box at the top of the display is :-
REMOVE FROM SOIL. PRESS START TO BEGIN.

After pressing START then the message is:-
HOLD CHAMBER IN AIR TO FLUSH (+ display of the elapsed time)

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

On completion the message is :-
PLACE ON SOIL "READY" to continue.

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 the "READY" button.

There is then a delay of approximately 20 seconds after pressing before any measurements begin. This is to allow equilibration of the system. This is followed by a further delay to allow 3 measurements to be collected and the first quadratic fit applied.

During this period the message is :-
EQUILIBRATING and the display of the elapsed time.

The graph shows the progress of the measurement. Only 3 values are plotted, the CO₂ reference the change in CO₂ (dC) and the soil respiration (Sr). The current values are only plotted in the measurement cycle. At other times the values are set to 0 and the display will be a straight line.

By clicking the <SETUP> button and clicking on the <Graphing Options> you may change the limits for the values.

On completion of the measurement the Results Box appears with the option to record the data.. If at this point you elect to save the data then all subsequent measurements will be recorded to the selected file.

To take more measurements with the current settings then begin the Measurement cycle again or click<SETUP> to modify the parameters.

A measurement may be aborted by clicking the <QUIT> button.

To start a new set of measurements to a new file then click <SETUP> and then<NEW MEASUREMENT>.

A different treatment may be selected by clicking<T> next to the <SETUP> button.

Results

Both dC and Sr 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 increase in CO₂ 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 increasing CO₂ concentration and elapsed time. The coefficients of this are used to determine the rate of increase at time 0. A warning is given if the relationship is excessively non-linear.

Measurements terminate when either the chosen elapsed time or the CO₂ concentration changes are exceeded.

The PC records have headers that will be displayed when the file is imported into Microsoft Excel.

Further details on Closed System Measurements are to be found in the Operators Manual and the Software Help Files.

Calculations

Theory

The soil respiration is measured by placing a closed chamber on the soil and measuring the rate of increase of the CO₂ concentration inside the chamber.

Then, assuming a well mixed sealed system :-

$$R = \frac{(C_n - C_o)}{T_n} * \frac{V}{A} \quad (1)$$

Where:-

- R is the soil respiration rate (Flux of CO₂ /unit area/unit time)
- Co is the CO₂ concentration at T=0
- 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 respiration it is essential to start with a CO₂ concentration in the cuvette below ambient and measure until the concentration is above ambient, presumably with the intention of getting some compensation for leakage. However, this leakage can only take place at ground level, where the CO₂ 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 CO₂ concentrations in the cuvette compared with the soil concentrations, we would expect the soil respiration to be a constant flux, giving a constant rate of change in the cuvette CO₂ concentration. Any leakage should be a function of the concentration difference between the cuvette and the exchange air. Due to leakage, the apparent soil respiration rate decreases with time.

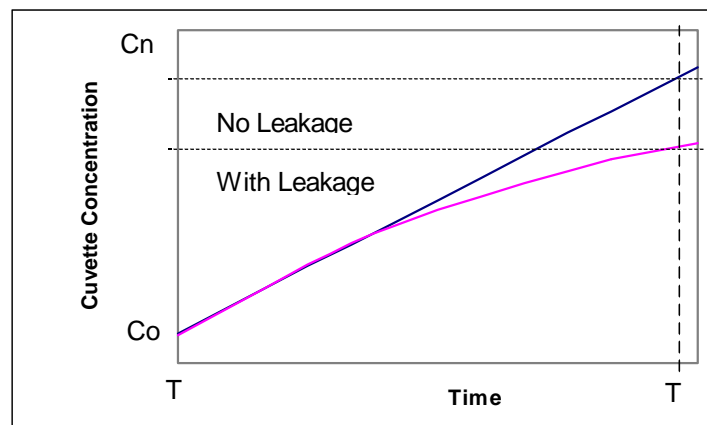


Figure 3 Simulated Measurements

With CIRAS, 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 soil respiration rate will be calculated from dC/dT at T=0.

Now $dC/dT = b + cT$

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):-

$$R = b * V/A$$

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 :-

$$R = b * \frac{P}{1000} * \frac{273}{273 + T_a} * \frac{40.01}{22.41} * \frac{V}{A} \quad (3)$$

Where :-

R is the CO_2 flux in $\text{kg.m}^{-2}.\text{s}^{-1}$

V is the system volume (largely the soil respiration chamber volume) in m^3

A is the soil area exposed in the chamber in m^2 ,

P is the atmospheric pressure in mb

T_c is the temperature of the system volume (Soil Respiration Chamber) in $^{\circ}\text{C}$.

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

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

See [References](#).

Water Vapour, Temperature and Pressure Corrections

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 CO₂ concentration change is corrected for both the cross sensitivity of the CO₂ IRGA to water vapour and also for the dilution effects of any increase in the water vapour concentration.

Since the ambient temperature is not measured, this is entered.

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 CIRAS Operator's Manual 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.

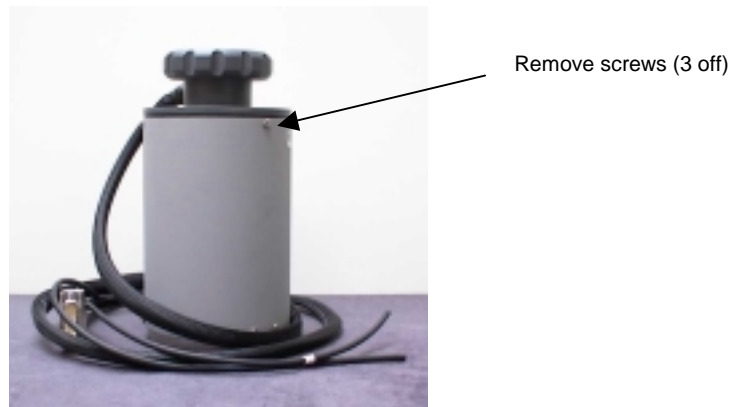


Figure 4 Replacing SRC Fan

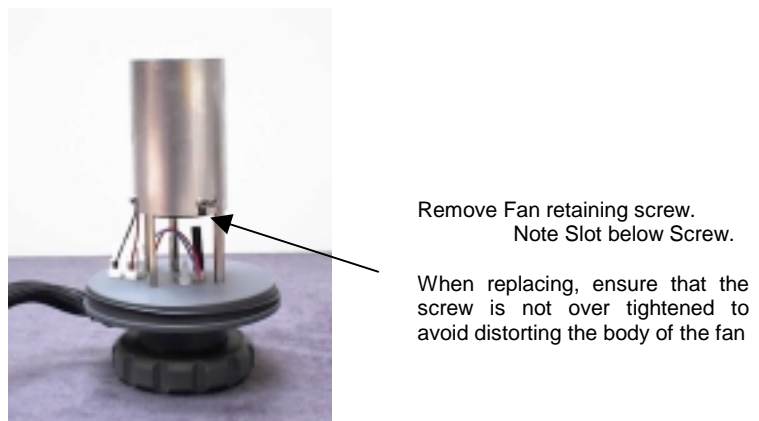


Figure 5 Remove Fan retaining Screw

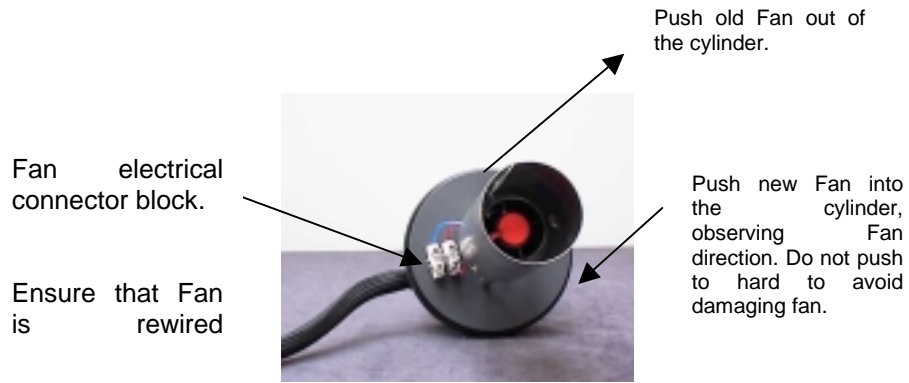


Figure 6 Remove and Replace Fan

Appendix

References

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

SRC-1 Interface Connections

15 Pin D connector with the following pin outs:

Pin Number	Function
1-6	9k 1 ohm resistor = SRC-1
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

User Notes

