OPTI-SCIENCES Presents - ADC BioScientific Ltd.

LCpro+ The *truly portable* precision photosynthesis gas exchange system with micro climate control

World Class Precision

40 years of experience and reliability

U.S. warrantee and service center

	ADC *LCpro+*	LI-COR® LI-6400XT
Console Weight	9.7 lbs.	23.2 lbs.
Hand Held Leaf Chamber Weight	1.8 lbs.	3.0 lbs.
Total Weight	11.5 lbs.	26.2 lbs.
Battery Life	up to 16 hours 1 battery	4 - 8 hours 4 batteries

Miniature high precision Infrared gas analyzer in the measuring head next to leaf chamber.

"Matching" measurement reliability without the hassle and additional time required.

Automated programable micro-climate control of PAR, CO_2 , H_2O, and temperature.

Automated programable *A/Ci curves* and *light response curves.*

The *LCpro+* - *The perfect portable compliment to "transportable" gas exchange systems*

Lightweight - High Precision - 16 hour Battery Life - Easiest to Use

Photosynthesis Measuring Parameters

A	- Net assimilation rate of CO_2
Area	- Leaf area
C_i	- Intercellular CO_2 concentration.
c_{ref}	- O_2 reference
c'_{an}	- CO_2 analysis value corrected for dilution
Δc	- Delta CO_2
E	- Transpiration
e_{ref}	- Reference partial pressure H_2O
e'_{ad}	- Dilution corrected H_2O analysis measurement
Δe	- Delta H_2O
g_s	- Stomatal conductance
T_{ch}	- Chamber temperature
T_l	- Leaf surface temperature
P	- Barometric pressure
Q	- PAR light at window
Q_{leaf}	- PAR at leaf
r_s	- Stomatal resistance to H_2O
r_b	- Boundary resistance to H_2O
U	- ASU measured mass flow
W_{flux}	- Net H_2O exchange rate

A/Ci curves - automated & programable by time or record

Light Curves - automated & programable by time or record

Parameter against parameter curves

Parameter against time curves

Soil Respiration Parameters

Ce	- Soil respiration
NCER	- Net CO_2 Exchange Rate

Other Parameters and Variables

(cab)a	- Infrared absorption due to CO_2 analysis
(cab)r	- Infrared absorption due to the reference CO_2 measurement.
(c)z	- Raw CO_2 zero reading
Dt	- Date
H_{fac}	- Energy conversion factor
Log	- Name of measuring file
Phase	- CO_2 rectifier phase shift
$r_b$set	- Boundary resistance at full flow
Tm	- Time
Trw	- Chamber window transmission factor
U_a	- Last value of flow from flow check
u_s	- Flow per unit leaf area
u_{set}	- Desired molar air flow rate
V_a	- Measured analyzer flow rate
V_{aux}	- Auxiliary input, scaled as Volts
V_{batt}	- Battery Voltage
W_{ref}	- H_2O reference as a % of relative humidity
w'_{an}	- H_2O analysis measurement corrected as a % of relative humidity
w'_{ad}	- H_2O analysis measurement dilution corrected
Δw	- Delta H_2O as a % of relative humidity
(w)a	- Raw H_2O analysis reading
(w)r	- Raw H_2O reference reading

OPTI-SCIENCES

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ADC BioScientific Ltd.
located in
Great Amwell, Herforshire
England.

Opti-Sciences, a manufacturer of precision Chlorophyll Fluorometers, is now the exclusive US distributor for ADC BioScientific products.

Opti-Sciences also operates the US Customer Service and Repair Center in Hudson NH.

ADC- a history of innovation, precision and portability.

- **In 1970 ADC introduces the *first* "Differential" Infrared Gas Analyzer (IRGA) system available anywhere for plant science.**

- **ADC champions the first "Open" plant IRGA system in 1970. Open IRGA systems are now the standard in photosynthesis investigation.**

- **ADC introduced the *first* portable IRGA system with hand held leaf chamber in 1983.**

- **The *first* micro-environmental control system for photosynthesis was an ADC innovation in 1987.**

- **ADC now offers "truly portable" high precision gas exchange instrumentation. Compact light weight electronics, innovative IRGA design, a very easy to use human interface, and a sixteen hour built in battery make this the perfect field companion instrument to heavier transportable green house gas exchange instruments.**

Portable systems were introduced to the market place by ADC in the early 1980s.

1983: LCA1
1984: LCA2
1987: LCA-3
1993: LCA-4
1997: LCA-4M
2001: LC*pro*

Current Models

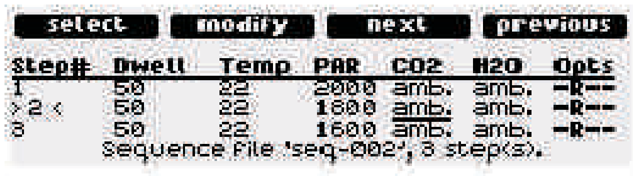
LC*i* - *Current model for portable ambient differential CO_2 & H_2O gas exchange measurement.*

LC*pro+* - *Current model for portable micro- environmental control, A/Ci curves and Light curves.*

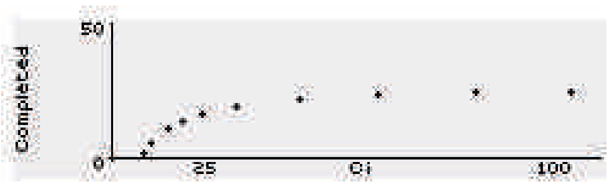
Flexible design - Easy to control and program

A/Ci curves and light curves are reliable and very easy to create.

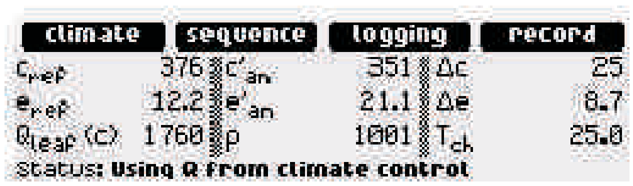
CO_2 stability curves & measuring trends viewed from graphic display



Automated test sequence building screen. In this case, a ***light curve*** is being created by changing the PAR irradiance at each step. Several steps are possible.



Typical A/Ci curve that can be produced by the LCpro +



Raw Data Screen

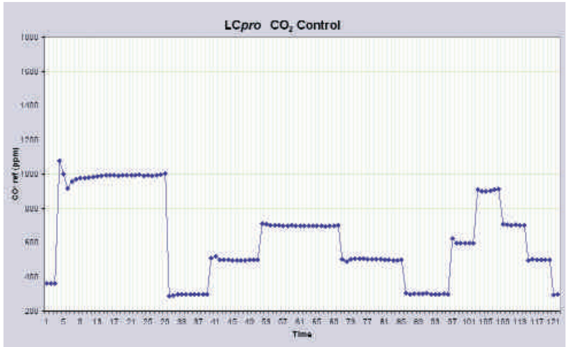
A	Net assimilation rate of CO_2	E	Transpiration	Ci	Intercellular CO_2 concentration
Gs	Stomatal conductance	TLc	Chamber leaf temperature	U	ASU measured mass flow rate
Uset	Mass flow rate setting	Power	Battery life remaining	Record	measurement number

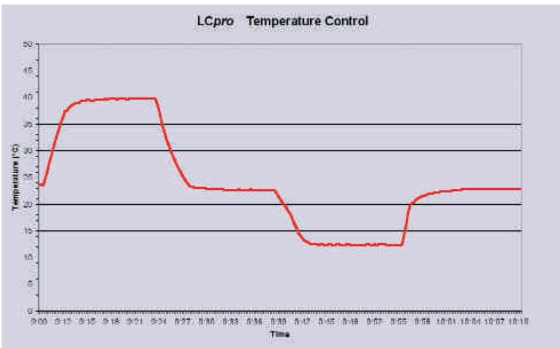
Main Calculated Parameter Screen

Five Buttons scroll through menu driven software.

Automatic Micro-Environmental Control - Complete control in a single compact console

Complete, software controlled, environmental control facilities are contained within a single compact and lightweight console. Environmental parameters may be controlled at single or multiple concentrations. A single or combination of parameters may be controlled at any one time. The LC*pro*+ internal battery powers all environmental control facilities. These controls have been especially designed using low power consumption components so maximizing battery life. There is no requirement for an external PC, batteries or control units. Gas control is user-selectable to either the reference or analysis gas streams.

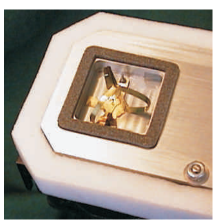




Self indicating chemicals

CO_2 Cartridges

Peltier heat transfer controller



Spider - leaf temperature thermistor

CO_2 control:

The LC*pro*+ features a compact integral elevated CO_2 supply system. This miniaturized regulatory system is internally housed and, therefore, protected from any potential environmental or physical damage. A small 100% CO_2 delivery cartridge is used to provide a stable elevated supply within the system. This is combined with ambient air stripped of CO_2 to accurately and effectively maintain the leaf chamber CO_2 at user-selected concentrations. The CO_2 cartridges are conveniently located for speed of exchange. Automatic A/Ci curves may be easily created.

This highly efficient system enables a 4g CO_2 cartridge to provide up to 32 hours of continuous field operation.

Temperature control:

For the optimized regulation of temperature above and below ambient (+/- 15°C), the leaf chamber incorporates a compact *Peltier heat transfer controller.* This unit provides responsive and stable temperature control.

Single or sequential step measurements are possible.

Leaf temperature - Leaf temperature may be determined by the energy balance equation or directly measured by a solid state thermistor mounted on a spider like spring that touches the leaf bottom.

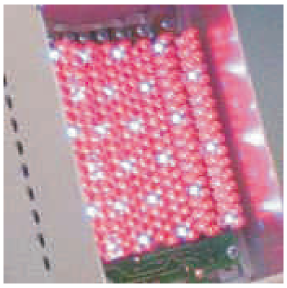
H_2O control:

Sequential control of H_2O concentrations is achieved using on-board conditioning chemicals. Housing the gas analysis system within the leaf chamber results in faster responses to leaf gas exchanges, fast chamber environmental equilibrium and also assures long term stability. The use of self-indicating chemicals ensures that optimal control is maintained at all times.

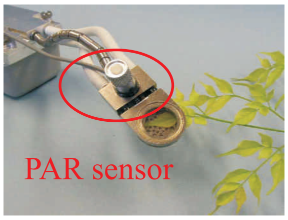
Automatic Barometric pressure compensation - for all measurements. Barometric pressure is constantly being measured.

Equations used - for measurments come from: S.von Caemmerer and G.D.Farquhar (1981) “Some relationships between the biochemistry of photosynthesis and the gas exchange of leaves”, *Planta* 153:376-387.

Measurement of PPFD or PAR - Two sensors for different needs

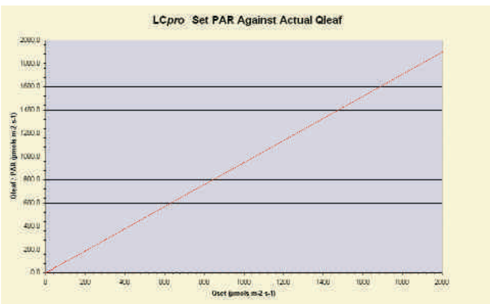


Automatic Control of PAR- Whether one is trying to match existing ambient conditions, measure at a different light setting, create a light response curve, or study changing lighting conditions, the series of integrated and attachable illuminators provide single light levels or programable sequentially stepped light levels. Using a combination of red and blue LEDs, the intensity range can be adjusted between 0 and 2000 µmols. The units are designed to closely replicate the PAR spectrum evenly throughout the leaf chamber window. It also maintains spectral quality over the whole intensity range with minimal or no heating. A micro PAR sensor measures the light emitted from the LED array onto the leaf surface. The LC*pro*+ can be easily programmed to generate automatic light response curves.



To ensure the optimal light control. Each type of LC*pro*+ chamber head (Broad, Narrow and Conifer) is supplied with its own dedicated LED unit. Full experimental programming is quick and uncomplicated to perform using the user-friendly LC*pro*+ menu driven software.

All environmental control components and software are supplied as standard and they are built into the hand held leaf chamber cuvette or the main consol.



PAR or Photosynthetically Active radiation is measured by one of two PAR Sensors.

There is a Silicon photo diode that can be mounted near the leaf chamber, or moved to other areas to measure PAR. The sensor is cosine corrected.

A second PAR sensor is built into the illuminators and used for micro-climate control measurements. Since the illumination angle is constant, no cosine correction is necessary.

Measurement File and Data Storage

Unlimited data storage - The storage of all data files and measuring files are located on PC Cards. Each card is capable of storing up to 8000 data sets. Of course storage is increased with more cards or cards with more storage capacity. Standard cards contain 518 kilobytes fo storage. Cards with memory storage up to two megabyte can be used.

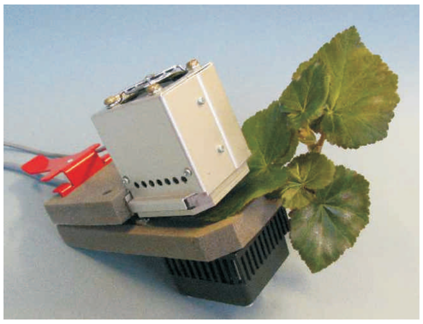
Data from files may be reviewed with the console display.

Designed for research organiztions with several users.

Since each user can have a data card, preprogramed measuring routines, data files, and curves can be stored on an individual card. Files do not need to be reconstituted if the system is used by many researchers. Simply insert your card, open a file, and the system will be set up the way that you programed it earlier.

Interchangeable chamber heads - for optimal air flow and optimal special application design.

The LC*pro+* is available with a range of interchangeable heads. These are easily and quickly exchanged in the field using only a small coin. *Boundary layer resistances and concentration gradients are minimized irrespective of which head is in use*. Chamber materials, such as nickel plating, have been carefully chosen to ensure that there is minimal interaction with CO_2 or water vapor. Chamber windows are silica coated to reduce scratching. While attaching each chamber the system is autoconfigurable, removing the requirement for complex reprogramming whenever a different head is used. The LC*pro+* chamber is simple to operate with a thumb trigger opening mechanism. All areas of the chamber are easily accessed for cleaning.



Broad Leaf Chamber

The broad leaf chamber is *the most widely used* chamber and the one most suited for the largest number of plant species. It features both a self-positioning leaf temperature sensor and a manual placement temperature sensor. The chamber window area is 6.25cm^2.

Narrow Leaf Chamber

This is designed especially *for long grasses and narrow leaves under 1cm in width.* For leaves wider than 1cm, we recommend the broad leaf chamber. The LC*pro+* narrow leaf chamber features both a self-positioning leaf temperature sensor and a manual placement sensor. The chamber window area is 5.8cm^2.

Fluorometer Adapter Chambers

For simultaneous gas exchange/chlorophyll fluorescence studies. The chambers feature a fibre optic cable adapter to allow use with chlorophyll fluorometers. Broad and narrow leaf chambers are available that are compatible with the majority of commercially available fluorometers

Opti-Sciences offers portable modulated chlorophyll fluorometers capable of making the following measurements:

Fv/Fm, ∆F/Fm' or Yield, ETR, PAR, Leaf Temp, Light curves, and advanced quenching relaxation analysis, Fo, Fm, Fo', Fm', Fs, NPQ, qN, qE, qT, qI, qP, qL, Y(NPQ), Y(NO),

Soil Chamber- Designed for Survey Measurements

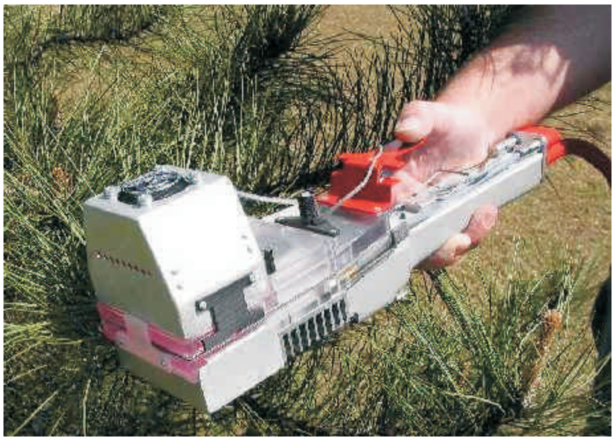
A high quality Soil chamber, that includes a detachable collar, provides accurate soil flux measurements in ambient field conditions and it also allows humidity control that is ideal for wet soils. When the Soil chamber is fitted, the LC*pro+* will calculate soil flux rates.Both Ce and NCER are provided.

It features a pressure release valve that minimizes any potential pressure

Interchangeable chamber heads for special applications

ADC's innovative approach has led to many firsts. The Two specialty chambers shown below are yet more examples of forward thinking.

Conifer Leaf Chamber

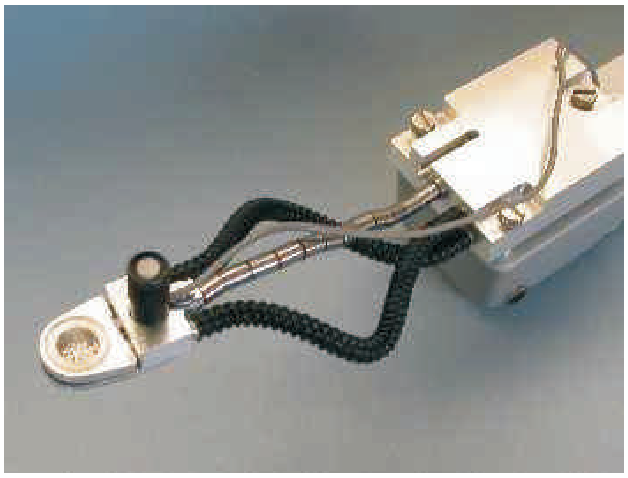


Conifer Cylindrically Arranged Lighting

The *first* Conifer chamber with cylindrically arranged chamber, curved cylindrically arranged lighting, and a cylindrically arranged reflector on the bottom for illumination on all sided. The total chamber volume is 175cm^3.

Unique Small Leaf Chamber

Unique Arabidopsis Leaf Chamber



ADC Arabidopsis and Small leaf Chambers offer a significant improvement over competitive models. Adjustable articulating mechanical arms are provided with a locking mechanisms. *Now small leaves may be easily oriented in the desired position and locked before measurement*, even when the leaf is close to the soil surface. The window size of the Arabidopsis chamber is 11mm in diameter. The window size of the Small Leaf Chamber is 16.5 mm.

Single IRGA Design vs. Multiple IRGA Designs.

Manufacturers of today's CO_2, and H_2O gas exchange equipment offer competing designs for photosynthesis measurement. One of the differences between systems is the use of a single Infrared Gas Analyzer or IRGA to measure CO_2 and the use of multiple IRGAs to measure CO_2 and H_2O. Both designs have been around for a very long time. ADC developed the first single differential IRGA system for photosynthesis in 1970.

Today the challenge for ADC BioScientific is to provide a reliable, easy to use, truly field portable photosynthesis system without compromise.

The Case for Single IRGA Design

The question that has to be asked is: How is ADC able to provide this capability without giving up something?

The answer requires a detailed explanation.

Most companies that use gas exchange to measure CO_2 and H_2O with IRGA s (Infrared gas analysers) use four IRGAs. Two IRGAs are used to measure CO_2. One measures the reference air for CO_2 before it enters the leaf measuring chamber, and one measures the air for CO_2 after the air passes through the leaf chamber. In this case, both are measured at exactly the same time. The other two IRGAs are used to measure H_20 in the same way as the CO_2 IRGAs are used for CO_2 except that the H_20 IRGAs measure in a different wavelength range.

ADC uses a *single* IRGA to measure air CO_2 before it enters the leaf measuring chamber and again after it passes through the leaf measuring chamber. H_20 is measured by modern solid state humidity sensors.

Why does ADC do it differently?

1. Because the light sources and sensors in all IRGAs drift significantly over time, light sources and sensors of multiple IRGAs all drift independently and can drift in different directions. Drift affects accuracy, and repeatability.

Other manufacturers that use multiple IRGAs require a "Matching" function that must be used on a regular basis to eliminate multiple IRGA drift. It is recommended that matching be done at the start of that day and periodically through out the day. ***Matching is also recommended when small differences in CO_2 level exist between the reference air and the sample air.***

In multi-IRGA systems, the user must decide when to match and remember to do the matching to eliminate IRGA drift. *The time required for making a "matching" measurement by one manufacturer adds fourty seconds to every measurement.*

So what is matching? Under matching conditions, multiple IRGA systems use only a single IRGA to measure both the reference air and the sample chamber air like the ADC Bio-Scientific single IRGA design, proving the superiority of the single IRGA concept.

2. The ADC LCpro+ is easier to use, requires less training and is designed to eliminate more measuring mistakes. Greater automation of housekeeping functions and the single IRGA design allow the researcher to make confident field measurements, and eliminates such decisions as: When should I match? How often should I match? and did I remember to match for every measurement? ADC automates the auto-zero function to run every sixteen seconds to zero out drift. ***Since the ADC system always uses a single IRGA, it is like running a multiple IRGA system in the matched mode for every measurement, but without the large time delay (Auto-zero takes four seconds).***

3. The ADC design provides dramatic improvements for field portability because ADC systems weigh significantly less, and draws substantially less power for much longer battery charge life.

4. The measurement of H_2O is normally a secondary measurement necessary to correct CO_2 measurements. Since CO_2 and H_2O both absorb infrared in a similar spectral range, it is important to measure H_2O content and barometric pressure to provide reliable CO_2 measurements. Other manufactures still use a set of separate IRGA chambers to measure water content. ADC has found that modern solid-state humidity sensors provide a more reliable solution for the measurement of relative humidity while offering the advantages of lighter weight, greater power efficiency, and greater stability. In the 1980's, humidity sensors were highly variable. Today the opposite is true. ***For 95% of plant applications, humidity sensors and the single IRGA design offer a better solution.***

ADC - The "truly portable" compliment to transportable instrumentation.

CO_2 Gas exchange understanding and comparing measuring terms.

Resolution- is the ability to read in fine incrementation. Resolution is directly related to the length of the infrared gas analyzer chamber length. The longer the tube, the finer the resolution. It is important to understand, however, that just because a tool can read to 0.2 umols of CO_2 or .03 mb of H_2O does not mean that the measurement is accurate, repeatable, reliable or even necessary. For example, a measuring gauge may read to millionths of an inch, but the measuring tool may only be capable of reliable measurements to a thousandth of an inch due to heat, humidity, measuring standards, measuring technique, electronic drift, or other conditions. It is also important to understand that measuring a 2X4 board to millionths of an inch is of little value. The same can be true of gas exchange measurements. ***If a measurement is of high resolution but not repeatable, it is normally of limited use.***

Repeatability is the ability to repeat the same measurement over again. All measuring tools repeat measurements within a certain tolerance range for specific conditions. For most gas exchange applications, repeatability is much more important that resolution. In all IRGA designs made by all manufactures, the light sources and the infrared sensors that are used, drift electronically over time. If four IRGA tubes are used with four different light sources and four different sensors, then all components can drift independently of each other. This is an important component of a machine's ability to achieve repeatability.

ADC, the company that developed the first differential plant IRGA analysis system, now uses a single IRGA tube next to the leaf chamber to measure CO_2 level before and after the leaf chamber. Such a design was chosen because there is only one infrared sensor and one light source to cause drift as opposed to many components that drift. In addition, the single chamber IRGA is ideal for lightweight portable use. ADC has found that the repeatability of the LCi is similar to that of its primary competitor for most applications.

H_2O measurement is a secondary type of measurement required to eliminate humidity as a source of error in CO_2 measurement. Water absorbs infrared in a similar range as CO_2 so one has to correct for water content in the air. Most companies use separate IRGAs to measure water content. ADC has found that modern laser trimmed humidity sensors provide high repeatability and the necessary resolution for 95% of CO_2 gas exchange measurements and applications. While such humidity sensors were not adequate in the 1980's, advances have significantly improved results. Such sensors provide a lightweight solution with minimum sensor drift.

ADC's repeatability is similar to competitor's precision.

Accuracy If one is shooting an arrow at a target, then accuracy is the ability to hit the bull's-eye. *In Gas exchange, accuracy is determined by the standard CO_2 gas that is used to calibrate the tool.* If the quality of the standard is good, then the accuracy is likely good. All IRGAs drift and so it is important to zero out IRGA drift for optimal accuracy. This may be done automatically, or as one manufacture recommends, it can be done manually by matching.

ADC's systems are designed to minimize sensor and light source drift automatically.

Reliability- A reliable measurement is one that is accurate and repeatable.

Leaf equilibrium It normally takes between 45 seconds and two minutes for a leaf and the leaf chamber to reach equilibrium. This is species dependant and it is independent of the instrument used for measurement. Of course, the process of equilibrium can be monitored on the graphic display screen.

As with all open differential non-dispersive IRGA systems in ambient conditions, a measurement of air is made before it enters the leaf chamber and then again after it passes through the leaf chamber. Some incoming ambient air is also scrubbed of H_2O and CO_2 for the auto-zero function test that occurs every 16 seconds. This test adjusts the gain to zero to compensate for sensor drift due to changes in temperature and barometric pressure.

Under microclimate control conditions, CO_2 and water may be added or reduced from ambient levels. Temperature and light irradiance may also be controlled.

Since measurements are made before air enters the leaf chamber, and after the air leaves the leaf chamber, the *plant and the environment are only required to reach equilibrium once* as is true for all differential IRGA systems.

After the leaf and its environment reaches equilibrium, several measurements can be made.

IRGA location (infrared gas analyzer) While ADC developed the first non-dispersive differential plant IRGA, the first open system for plants, and the first microclimate control system for plants, it was by a company in Nebraska that was the first to put the IRGA next to the leaf chamber. In the past, IRGAs had been in the console and not in the hand held leaf cuvette.

By placing the IRGA next to the leaf chamber, a few problems were solved. Measurement response times were improved dramatically, and other problems associated with longer distances were eliminated. When the path to the IRGA is long, there can be gas hang-ups and water vapor drop out. Changes in ambient lighting, sun flecks, changes in temperature and CO_2 diffusion, can be greater sources of error because they can affect the gases as they flow throw the tube.

ADC uses a single non-dispersive differential IRGA in the hand held leaf cuvette next to the leaf chamber. This improves upon previous designs by making the hand held leaf cuvette lighter for greater portability and it reduces the problem of IRGA light source and sensor drift. The humidity sensors are also next to the leaf chamber.

Open system vs. closed system. Close systems measure the concentration of CO_2 and H_2O at the beginning of the experiment, and after some time has passed using the air that is in measuring system from the beginning of the experiment. While all of ADC's plant gas exchange systems have always been of the open type, earlier competitive systems were closed systems.

Today most commercial systems are open systems where ambient air is taken in and measured for CO_2 and H_2O before it enters the leaf chamber and after it flows through the leaf chamber. Flow rates can be changed for more rapid measurements or slowed for improved repeatability. Ambient air can also scrubbed of CO_2 and H_2O, and CO_2 and H_2O can be added back in a constant predetermined mole fraction. This allows measurements with lowered or raised CO_2 levels relative to ambient conditions. As before, air is measured before the leaf chamber and after the leaf chamber. Open systems provide a faster more reliable measurements with greater experimental control. A slightly higher air pressure inside the leaf chamber ensures that ambient air does not enter the chamber. In addition, open systems allow environment control and manipulation.

ADC plant gas exchange systems are all open systems.

Non-Dispersive - This term refers to the use of an infrared light source instead of using a monochromator as an light source in the IRGA. Monochromator based sources are dispersive and large.

ADC systems are all non-dispersive.

Differential IRGA - There are absolute and differential plant IRGA systems. Absolute systems measure CO_2 level against an absolute CO_2 calibration. Differential IRGAs compare the measurement of CO_2 and H_2O before the leaf chamber to the measurement of CO_2 and H_2O after the leaf chamber. Almost all commercial plant IRGA systems are of the differential type. Certainly, the most advanced systems are of the differential type.

ADC developed the first differential plant IRGA in 1970. Both current plant gas exchange systems, the LCi and the LCpro+, are of the differential type.

Laser Trimmed Relative Humidity Sensors The measurement of H_2O is a secondary measurement necessary to correct CO_2 measurements. Since CO_2 and H_2O both absorb infrared in a similar spectral range, it is important to measure H_2O content and barometric pressure to provide reliable CO_2 measurements. Other manufactures still use a set of separate IRGA chambers to measure water content. ADC has found that modern solid-state humidity sensors provide a more reliable solution for the measurement of relative humidity while offering the advantages of lighter weight, greater power efficiency, and greater stability. In the 1980's, humidity sensors were highly variable. Today the opposite is true.

ADC's laser trimmed relative humidity sensors offer advantages for 95% of plant applications.

While specifications can be valuable and helpful, the only way to be sure that an instrument works best for an application is to try it.

Call us for a test drive today.

Prove it to your self.

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Email: sales@optisci.com Website: www.optisci.com

Technical specifications

OPTI-SCIENCES

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Measurement range and technique:

CO_2:	0-2000ppm, optional 0-3000ppm, 1ppm resolution. Infrared gas analysis, differential open system, auto zero, automatic atmospheric pressure and temperature compensation.
H_2O:	0-75mbar, 0.1mbar resolution. Two laser trimmed, fast response water vapor sensors.
PAR:	0-2000 umols / m^2 / sec. Silicon photocell. Cosine corrected.
Chamber temperature:	–5°C - 50°C Precision thermistor.
Leaf temperature:	–5°C - 50°C Self positioning microchip thermistor/Energy balance/manually positioned thermistor.
Flow rate to Plant Leaf Chamber:	100ml to 500ml min
Automatic environmental control: (The LCpro+ may also be used for ambient work) Programming:	Internal LCpro+ menu driven software. Automatic and independent control of environmental conditions within the leaf chamber. For automatic response curves, sequential control levels and dwell times may be set.
CO_2:	Up to 2000ppm CO_2, by the integral elevated CO_2 supply system.
H_2O:	Above and below ambient (dependent on ambient conditions), by on-board self-indicating conditioning chemicals.
Temperature:	+ / - 10°C above and below ambient, by micro-peltier element.
PAR:	Up to 2000 umols / m^2 / sec, (up to 1500 umols / m^2 / sec for conifer) by high efficiency, low heat output, mixed red/ blue LED array unit.
Display:	240 x 64 dot matrix super twist LCD.
Recorded data:	Removable PC compatible cards storing unlimited data.
Battery:	7.0 Ah rechargeable lead acid battery. Life up to 16 hours. Battery charger: Universal input Voltage, intelligent control.
RS232 output:	User-selectable rates of up to 57,600 baud for printer or computer connection.
Analog output:	Two channels. 0 - 5V user-selectable parameters.
Operating temperature:	5°C - 45°C
Weight and Dimensions:	
Console:	9.7 lbs or 4.4kg, 23 x 11 x 17cm
Plant Leaf Chamber:	1.8 lbs or 0.8kg, 30 x 7 x 7 cm