

LCpro T

ADC
BioScientific Ltd.

The Intelligent Photosynthesis System



User-friendly chamber climate control

Instant, touch screen data entry

Real time, colour graphing

Choice of integrated light units

With colour, touch screen LCD and RGB LED light unit





Hear from users of the established forerunner of the LCpro T:

“It is not hard to use the instrument. Indeed, the instrument is easy to work with and the manual is very helpful.” *André Araujo da Paz (Msc.), Science Teacher, Colégio Santa Maria Nova Suíça, Brasil.*

“This system is the right solution when time matters; you can get the measurements you want easily and rapidly”. *Dr JT Tsialtas, Aristotle University of Thessaloniki.*

Enhanced performance

- Touch screen, colour LCD display
- Instant touch key response
- Advanced graphing functionality and visibility
- Choice of light units; one supplied as standard:

Red Green Blue (RGB) LED light unit

White LED light unit
- Light unit control integrated into the console
- Enhanced, elevated CO₂ control, expert gas circuitry and dedicated soda lime column
- Automatic screen-dimming function and energy efficient components to save power
- Lightweight, high capacity lithium-ion battery
- GPS to record location and elevation data

Unparalleled Portability

Weighing only 4.1kg

The LCpro T is an exceptionally lightweight, portable system.

A comfortable, adjustable strap is supplied, so that the LCpro T can be easily carried and operated around the waist or on the shoulder.

Featuring our highly accurate, miniaturised infrared gas analyser and surface mount technology.

Full programmability, data display and capture is contained within the compact and rugged console.

16 hour battery life

Powered by a single, small 12V Lithium-ion rechargeable battery. The LCpro T will function continuously for a maximum of 16 hours, depending on the environmental controls being operated.

Membrane sealed LCD

Designed for prolonged, reliable operation in harsh field conditions, the LCpro T maintains optimal performance even in highly humid and dusty climates. Both the touch screen LCD and control panel are sealed within a membrane.

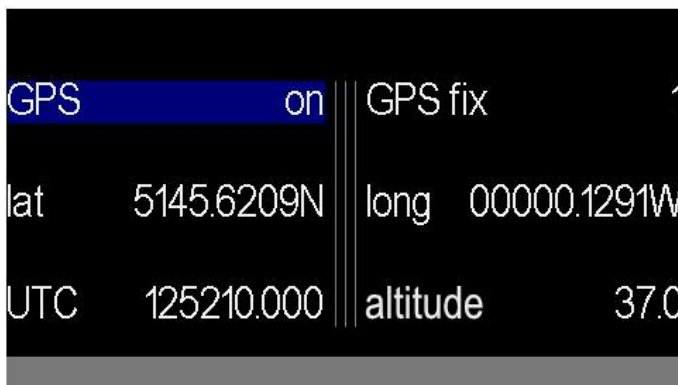
GPS

Pinpoint your data

The LCpro T is fitted with a GPS unit to automatically record the exact position of each sampling location.

For all measurements taken outside: Latitude, longitude, UTC (Coordinated Universal Time) and GPS alt (altitude) are displayed on screen within 30 seconds of obtaining a signal.

GPS parameters are automatically saved with each data record, and then integrated into the data files for viewing on spreadsheet software.



Expert gas exchange performance

0-3000ppm CO₂ range:

Supplied as standard. Exceptional IRGA performance maintained at this maximum CO₂ concentration.

Rapid auto-zero:

The **LCpro T** has an auto-zero cycling time of only 4 seconds, optimised to chamber type (subject to a flow check being performed).

This rapid cycling significantly improves response times whilst maintaining analyser stability.

Stability of data:

The effect of fluctuations in CO₂ concentrations in ambient air on gas exchange data is kept to a minimum by a refined, gas circuit system.

Long-term field performance:

Long life, durable components and sensors further enhance performance, even in harsh field conditions.

Quality testing:

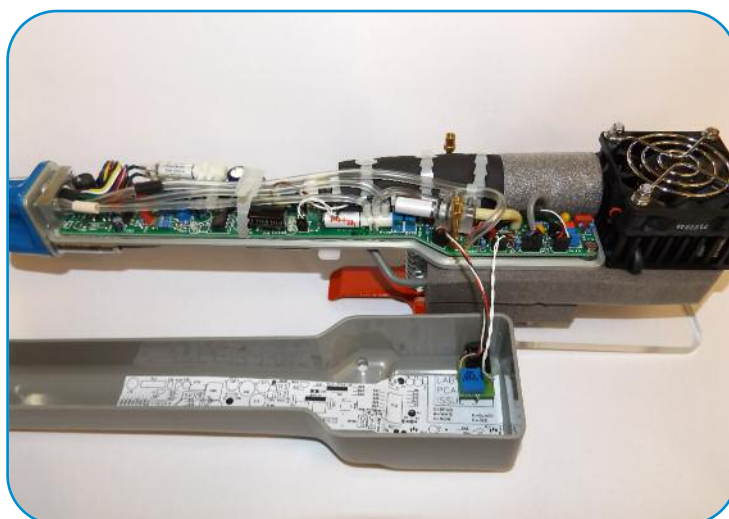
Each instrument is checked and tested rigorously at each stage of assembly. A final, comprehensive calibration is performed by our expert engineers prior to release of a system.

Expert measurement technique

Since 1969, ADC have been world leaders in the design and manufacture of infrared gas analysers (IRGAs). We have consistently advocated the **open mode** of analysis, whereby a constant flow of air and ambient pressure are maintained throughout the sample chamber. This technique is accepted within the plant science community as the most accurate and versatile operating system for photosynthesis research.

The **LCpro T** chamber handle (see below) houses our expertly crafted, miniaturised IRGA. Gold-plated by hand, the IRGA provides accurate, fast and stable gas exchange performance.

By housing the IRGA directly within the chamber handle, we minimise any possible response delays in either gas exchange measurements or environmental controls. In addition, this configuration reduces gas 'hang-up' or water vapour 'drop-out', which is known to occur in long lengths of gas tubing.



Reliably stable

The **LCpro T** IRGA carries out an automatic zero within the standard operational cycle, ensuring long-term measurement stability.

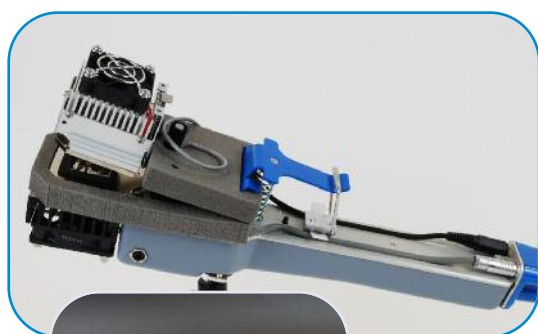
All CO₂ measurements are automatically corrected for atmospheric pressure, temperature and for the effects of water vapour.

Our novel 'differential in time' IRGA design removes the need to constantly balance dual IRGA systems to prevent the calibration of the two cells drifting apart over time.

Highest quality sensors

To provide full photosynthesis data, the **LCpro T** plant leaf chamber encloses several environmental sensors. Two highly accurate, laser-trimmed humidity sensors provide exceptionally reliable transpiration data. High calibre sensors also measure Photosynthetically Active Radiation (PAR) and chamber temperature.

The **LCpro T** offers a choice of accurate, leaf temperature determination methods. An innovative, self-positioning thermistor is provided as standard in many chambers. Alternatively, a manual placement sensor can be employed, or the proven Energy Balance Equation can be used with any chamber.



Chamber Climate Control

The **LCpro T** provides complete and automatic climate control within each chamber type.

All climate facilities are controlled through the **LCpro T** console.

Each of 4 parameters (H_2O , CO_2 , PAR and temperature) can either be set to a constant level, or controlled at multiple concentrations in a sequence. Any combination of parameters can be controlled simultaneously.

The **LCpro T** climate control facilities use power efficient components to maximise the internal battery life.

Rapid, intuitive experimental programming, either by climate or sequential control, is via the **LCpro T** touch screen software.

climate	sequence	logging	record
C_{ref}	871	e_{ref}	13.6
C'_{an}	874	e'_{an}	14.1
ΔC	-2	Δe	0.5
Q_{leaf}	4	p	1001
T_{ch}	24.8		

H_2O control

Individual or sequential control of H_2O between 0-75mbar, is achieved using self-indicating, conditioning chemicals housed within dedicated, removable columns.

Humidifying the chamber air is advantageous in experimental conditions that excessively dry the chamber air. Restoring and controlling ambient humidity of chamber air can prevent influence on the transpiration activity of a sample.

Drying the air inside the chamber can be useful when working with a moist soil, for example, to prevent condensation occurring inside the soil respiration chamber.



CO_2 control



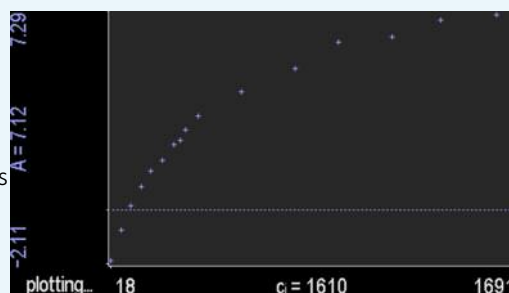
The **LCpro T** elevated CO_2 supply system enables the advancement of crop resilience research in the face of global climate change.

This system is internally housed and protected from any potential environmental or physical damage. A 4g, pure CO_2 cartridge is used to deliver a stable, elevated supply for up to 32 hours of continuous operation. This supply is combined with air stripped of CO_2 to maintain the leaf chamber CO_2 at any desired concentration between 0 and 2000ppm.

Automatic 'A/Ci curves' may be easily performed by programming a number of sequential control levels with required dwell times and automatic data recording.

The influence of local, elevated CO_2 can be quantified, for plant leaves or soils, by calculated gas exchange data generated by the **LCpro T**.

Partially used cartridges are safely exhausted via an external vent.



PAR control

Via a fully integrated, White or adjustable R:G:B light unit

A mixed Red/Green/Blue LED array provides versatile control of light between 0 - 2,400 $\mu\text{mol m}^{-2} \text{s}^{-1}$.

A White LED array provides a maximum intensity of 2,500 $\mu\text{mol m}^{-2} \text{s}^{-1}$.

A micro PAR sensor measures the light emitted from a fitted LED array, onto the leaf surface. The light units closely replicate the PAR spectrum evenly throughout the leaf chamber window.

Both energy efficient LED arrays maintain spectral quality over the entire intensity range with no heating effect.

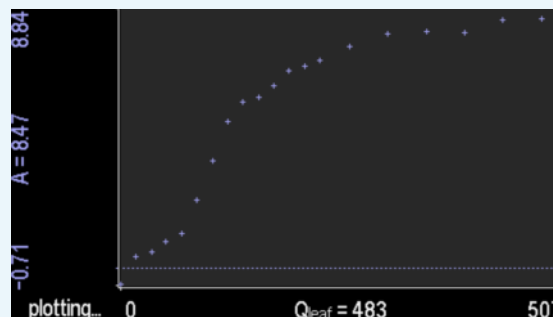
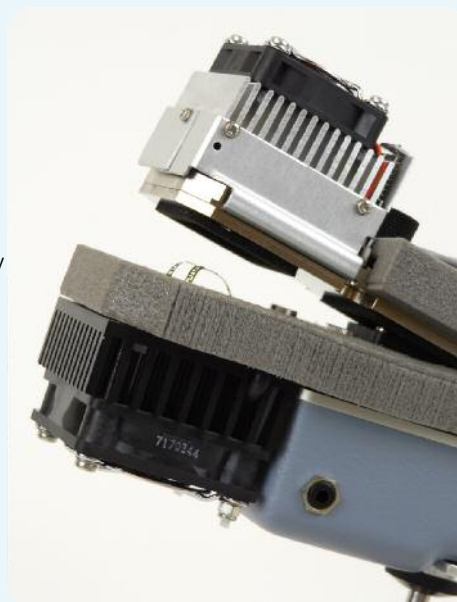
The **LCpro T** can be easily programmed to generate automatic, light response curves (LRCs) using either unit.

To ensure the optimal light control on the widest possible number of plant species, each type of **LCpro T** chamber head (Broad, Narrow and Conifer) is supplied with a dedicated LED unit; with the choice of either RGB or White for Broad and Narrow heads.

Multiple options for setting PAR:

When using the white light unit: Total PAR can be set with the chamber climate control menu.

When using the RGB light unit, total PAR can be set directly from the same menu, or the relative % of Red, Green and Blue light can be set to achieve a total PAR comprising a desired ratio of RGB.



Temperature control



The **LCpro T** advanced, compact, Peltier heat transfer system provides the most dynamic temperature control range available.

Temperature inside all standard leaf chambers (Broad, Narrow, Conifer) can be automatically regulated +15°C and -10°C above and below ambient, or set to track ambient air temperature.

The **LCpro T** temperature control is both responsive and stable.

select	change +	change -	ambient
Tset	amb.		
Qset	amb.	Tch	20.2
Q%rgb	35:22:43	Q	6
Cset	amb.	Cref	1174
e set	amb.	Eref	15.0

Simple, time-saving programming



ADC BioScientific are proud of our long-standing ability to design the easiest to use gas exchange devices. The **LCpro T** enables *even more* intuitive, rapid menu navigation, parameter editing and sequence programming.

Instant, touch key response

Two selection options are provided on each menu screen:

1. Swipe across the screen with one finger to reveal the next menu page, then simply touch the parameter to be changed.
2. Select parameters in turn by pressing the key labelled 'select'.

select	change +	change -	ambient
T _{set}	amb.		
Q _{set}	amb.	T _{ch}	20.2
Q% _{rgb}	35:22:43	Q	6
C _{set}	amb.	C _{ref}	1174
e _{set}	amb.	e _{ref}	15.0

Experienced researchers and novice users can quickly and easily program sophisticated gas exchange experiments. Sequential changes in multiple parameters or factors are made by setting a 'sequence file':

stop						
Step#	Dwell	Temp	PAR	CO ₂	H ₂ O	Opts
11	10	amb.	200	amb.	amb.	-R--
12	10	amb.	220	amb.	amb.	-R--
13	10	amb.	240	amb.	amb.	-R--
14	10	amb.	260	amb.	amb.	-R--
15	10	amb.	300	amb.	amb.	-R--

Running 'seq-001', 29 step(s), dwell 0:03:49.

Unlimited data storage

The **LCpro T** features unlimited data storage. All experimental protocols, photosynthesis data and calculations are stored on Secure Digital (SD) cards.

Separate cards can be allocated to specific experiments or to individual users.

Data recording can be initiated both automatically and manually. Automatic data recording can be programmed to take place as part of an experimental sequence, such as during the generation of an A/Ci curve. Alternatively, manual recordings can be made either via the keypad or the button on the chamber handle.

Stored data can be viewed directly on the console LCD. Data can be downloaded directly from SD card or via USB output.

Colour, graphic display

Recorded, experimental data are easily plotted on a graph in real time, with automatic scaling for presentation clarity.

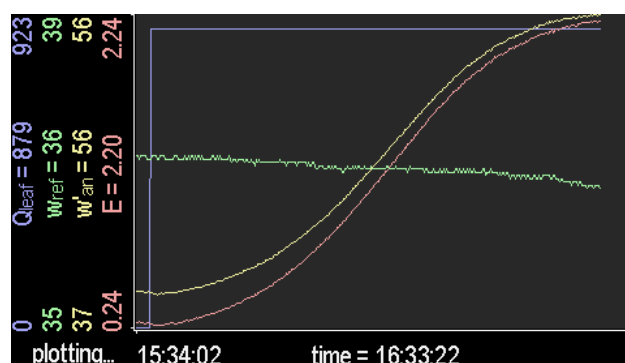
Parameters may be plotted against time or record number. As many as four parameters may be plotted against each other, in distinct colours, providing a greater depth of data analysis.

stop	clear	disable	more
X axis	time	Y1 axis	Q _{leaf}
every	0:10	Y2 axis	W _{ref}
		Y3 axis	W' _{an}
		Y4 axis	E

graph settings

Status: Using Q from climate control

The resulting plots of multiple parameters can include: Light Response Curves (LRCs) of photosynthetic rate, A ($\mu\text{mol m}^{-2} \text{sec}^{-1}$) against effective irradiance, PAR, and also curves generated by A against intercellular CO₂ concentration (Ci).



Interchangeable chambers

The **LCpro T** is available with interchangeable chambers for the widest range of experimental applications. These chambers are easily and quickly exchanged by hand, in any location. Upon fitting, each chamber has an automatic configuration, simply selected from the **LCpro T** LCD.

Boundary layer resistances and concentration gradients are minimised in all chambers. Carefully chosen materials ensure that there is minimal interaction with CO₂ or water vapour. All chamber windows are hard coated to reduce scratching.



Broad Leaf Chamber

Our most widely used chamber, suitable for the largest number of plant species, featuring both a self-positioning leaf temperature sensor and a manual placement temperature sensor. The chamber window area is 6.25cm².

Narrow Leaf Chamber

Designed especially for long grasses and narrow leaves less than 1cm in width. Featuring a self-positioning leaf temperature sensor and a manual placement sensor. The chamber window area is 5.8cm².



Conifer Leaf Chamber

Transparent, cylindrical design suitable for pine needles and conifers, also suitable for small fruits and composites of very small leaves. The dedicated light unit provides even irradiance throughout the chamber. An approximate cylinder of 69mm in length and 47mm in diameter.

Small Leaf Chamber

This chamber has a unique flexible arm to allow easy, non-destructive positioning onto a leaf, even when the leaf is close to the soil surface. Chamber window diameter is 16.5mm, window area is 2.16cm².



Soil / Small Plant Chamber

1 litre chamber with detachable collar (area 97.5 cm²) for determining Net Carbon Exchange Rate over soil. This chamber may also be configured for photosynthesis measurement on turf or whole plants up to 55mm tall.

NEW: Versatile Chamber

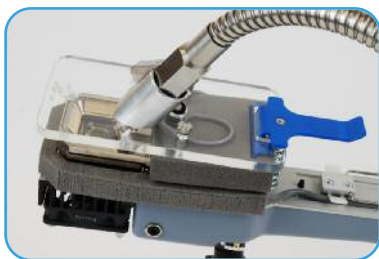
Two-part chamber with multiple uses. Examples include whole, small plant photosynthesis, Antarctic microalgal gas exchange (Davey, M.P. Cambridge University UK), and soil respiration measurement. Plants can be grown in the sealed pot, or the lower collar can be embedded into soil. Adapters are available for direct connection to 4" or 6" pipe. For whole plant measurement, a suitable medium must be used to exclude soil respiration influence.



Fruit Chamber

Two part chamber with transparent upper compartment and sealing base for fruit. Sample fruit can be a maximum diameter of 11cm and maximum height of 10.5cm within the sealed chamber.

Fluorometer Adapter



A fibre-optic cable adapter to enable use of the **LCpro T** with chlorophyll fluorometers.

Broad and Narrow leaf chambers are compatible with the OS5p+ and OS1p Portable Fluorometers, supplied by ADC. Fluorescence data can be recorded to a fluorometer at the same time as gas exchange data are recorded to the **LCpro T**. Resulting data files may be combined within spreadsheet software.

For the investigation of plant, soil and atmospheric interactions, ADC BioScientific Ltd. expertly produce a wide range of portable, user-friendly and cost-effective devices, from photosynthesis to soil respiration systems. We are committed to enabling carbon cycle research worldwide through quality instrumentation and local, technical support.

ADC BioScientific Ltd. also supply: Leaf Area Meters, Chlorophyll Content Meters, Advanced Fluorometers, Automated Soil CO₂ Exchange Systems, Portable Soil Respiration Systems and Field Gas Analysers.

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LCpro T Technical Specification

Measurement range and technique:

CO₂: 0-3000ppm, 1ppm resolution
Infrared gas analysis; differential open system, auto zero, automatic atmospheric pressure and temperature compensation

H₂O: 0-75mbar, 0.1mbar resolution
Two laser-trimmed, fast response water vapour sensors

PAR: 0-3000μmol m⁻² sec⁻¹
Silicon photocell

Chamber Temperature: -5°C to 50°C
Precision thermistor
+/- 0.2°C accuracy

Direct Leaf Temperature: -5°C to 50°C Self positioning microchip thermistor/energy balance/manually positioned thermistor

Flow rate to leaf chamber: 100 to 500ml min⁻¹

Automatic Environmental Control:

Programming: Internal **LCpro T** 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.

CO₂: Up to 2000ppm CO₂, by integral elevated CO₂ supply system

H₂O: Above and below ambient (dependent on ambient conditions), by on-board self-indicating conditioning chemicals

Temperature: Micro-peltier element.
All chambers automatically regulated
+15°C, -10°C from ambient.

PAR: Up to 2400μmol m⁻² sec⁻¹ mixed RGB LED array, or up to 2,500μmol m⁻² sec⁻¹ by White LED array.

Warm up time: 5 minutes @ 20°C

Display: Colour WQVGA touch sensitive LCD

Recorded Data: Removable SD cards. Compatible with cards up to 32GB in size.

Battery: 7.5Ah 12V Lithium-ion battery
Up to 16 hours between charges

Battery Charger: Universal input voltage, fixed output

Electrical Outputs: Mini-B
USB connection: Functions as a mass storage device

RS232 output: 9 Pin "D" type
User-selectable rates of up to 230400 baud for computer or printer connection

Operating temperature range: 5°C to 45°C

Dimensions H X W X D:
Console: 230 x 110 x 170mm

Plant Leaf Chamber: 300 x 80 x 75mm

Weight:
Console: 4.1kg
Plant Leaf Chamber: 0.8kg

ADC BioScientific Ltd. retain the right to change any specification as part of their continual product development

ADC BioScientific Ltd.