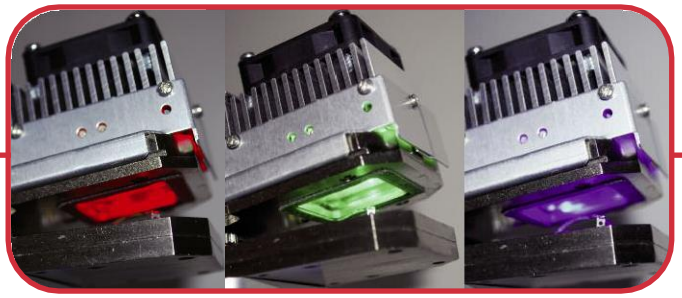
LCi T

ADC BioScientific Ltd.

The Accessible Photosynthesis System

- Choice of integrated light units
- Instant, touch screen data entry
- 360º screen visibility
- GPS unit fitted

With colour, touch screen LCD and RGB LED light unit



Designed for field use

Portable comfort

The LC*i* ***T*** can be comfortably carried and operated whilst wearing on a shoulder or waist strap.
A lightweight and compact system incorporating a console, miniaturised IRGA, leaf chamber and light unit.

Up to 10 hours of battery

Powered by a 12V rechargeable battery and incorporating the latest in low-power consumption components, including adjustable, automatic screen dimming, the LC*i* ***T*** will function continuously for up to 10 hours on a single charge.

Robust and reliable

Full functionality, chamber flow control, live data display and storage are contained within the console. A truly robust system.

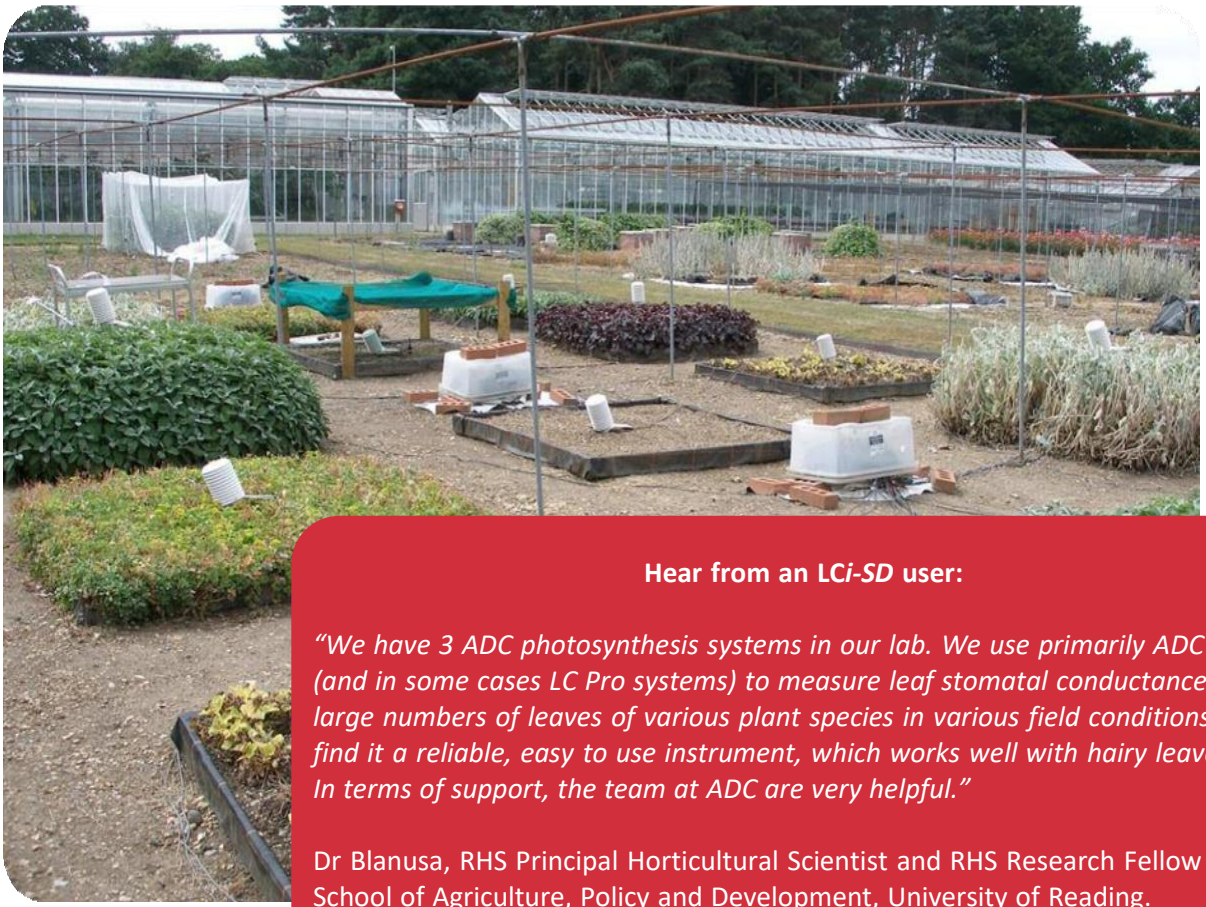
Even in harsh field conditions

Designed for prolonged, reliable operation in harsh field conditions, the LC*i* ***T*** maintains optimal performance even in highly humid and dusty climates. Adjustable screen settings maintain visibility with changing light levels.

360° screen viewing

The touch screen, colour LCD can be viewed clearly from any angle.

At ADC BioScientific Ltd., customer feedback is embedded into our product development



Hear from an LC*i-SD* user:

"We have 3 ADC photosynthesis systems in our lab. We use primarily ADC LCi (and in some cases LC Pro systems) to measure leaf stomatal conductance on large numbers of leaves of various plant species in various field conditions. We find it a reliable, easy to use instrument, which works well with hairy leaves too. In terms of support, the team at ADC are very helpful."

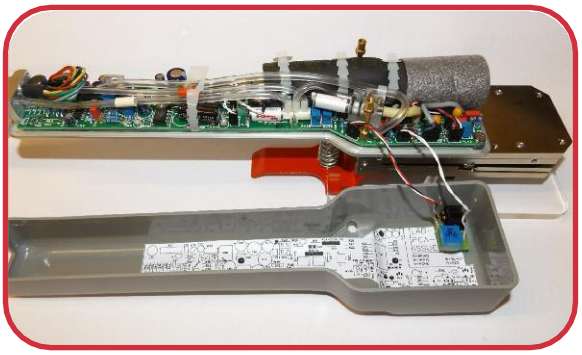
Dr Blanusa, RHS Principal Horticultural Scientist and RHS Research Fellow at the School of Agriculture, Policy and Development, University of Reading.

Photograph (above): Dr Blanusa and team's experiement in the grounds of the School of Agriculture, Policy and Development, University of Reading.

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

All CO_2 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.

Rapid measurements 'on the move'

- Each measurement takes under 16 seconds to complete. Record data manually using the LCD or the button on the chamber handle.
- Your measurement is now safely stored by LC*i* ***T***.
- Simply move to your next sample and repeat.
- 1000s of measurements can be stored on the SD card and transferred to your computer device.

Highest quality sensors

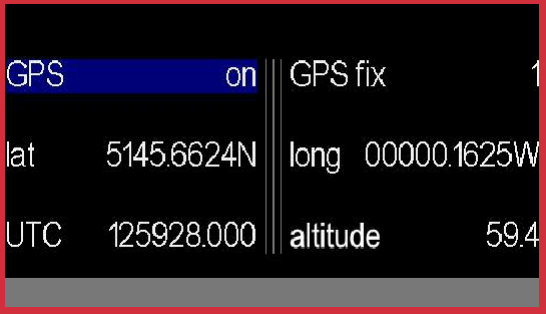
To provide full plant gas exchange data, the LC*i* ***T*** plant leaf chamber encloses several environmental sensors. Two laser-trimmed humidity sensors provide exceptionally accurate transpiration data. High calibre sensors also measure Photosynthetically Active Radiation (PAR) and chamber temperature.

The LC*i* ***T*** offers a choice of leaf temperature determination methods. A 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. System flow rates to the chamber are controlled from the console to provide the optimum flow range, from 68 to 340µmol^{-2} s^{-1}.

GPS to pinpoint your data

The LC*i* ***T*** is fitted with a GPS unit to record the exact position of every measurement taken when outdoors.

Latitude, longitude and altitude data are all recorded, displayed on a GPS menu screen, and integrated into the data file for review upon download of data.



Interchangeable chambers

The LCi 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 LCi T console.

Boundary layer resistances and concentration gradients are minimised, irrespective of which head is in use. Carefully chosen materials ensure that there is minimal interaction with CO_2 or water vapour. All chamber windows are hard coated to reduce scratching. Radiation shields and dedicated light units are included, where applicable.

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 6.25cm^2.

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 5.8cm^2.

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 features a unique, flexible arm that enables positioning onto the leaf, even when close to the soil surface, without damaging the sample or neighbouring leaves. The chamber window diameter is 16.5mm, window area is 2.16cm^2.

NEW: Versatile Chamber

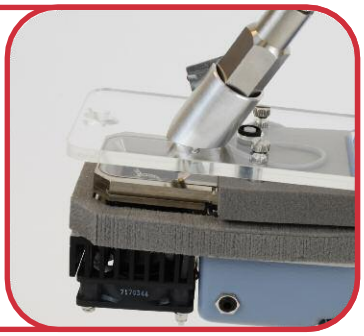
Two-part chamber with multiple uses. Examples include whole, small plant photosynthesis, Antarctic microalgal gas exchange (Davey, M.P. Cambridge University UK), and soil respiration measurement. Plants can be grown in the sealed pot, or the lower collar can be embedded into soil. Adapters are available 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 LC*i* ***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 LC*i* ***T*** .
Resulting data files may be combined within spreadsheet software.



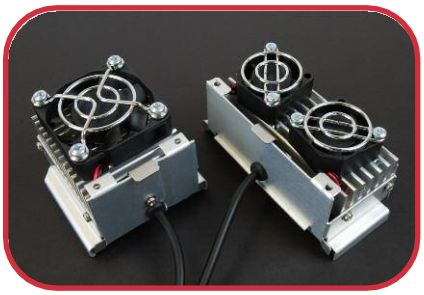
Small Plant Chamber

1 litre chamber with detachable collar (area 97.5cm^2) for photosynthesis measurement on turf or whole plants up to 55mm tall. *Arabidopsis thaliana* and other small plants can be grown in sealed pots constructed from standard size PVC waste pipes. The soil area must be covered with a medium to exclude soil respiration influence.

Also available: Large Canopy Chamber Suitable for plants up to 120mm tall.

Fully Integrated LED light units

Choose from: White and fully adjustable RGB



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

A White LED array provides a maximum intensity of 2,500 µmol m^{-2} 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.

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

Multiple options for setting PAR (Q):

When using the White light unit, total PAR (labelled as Q) can be set with the chamber climate control menu.

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

Create and save sequence files:

Experienced researchers and novice users can quickly and easily program gas exchange experiments. Sequential changes in multiple parameters or factors are made by setting a 'sequence file'. Automatic data recording and real time graphing can take place as part of an experimental sequence.

Create A/Q curves:

With a light chamber employed, the resulting plots of sequence files can include Light Response Curves (LRCs) of carbon assimilation rate, A (µmol m^{-2} s^{-1}) against Q.

Soil respiration measurement

The LC*i* ***T*** can also be fitted with a high quality, robust soil chamber, comprising an upper compartment and a detachable, lower collar. A pressure release valve in the upper compartment ensures accurate field soil flux measurements, by minimising any potential pressure gradients and by being insensitive to wind.
The chamber volume is 1L.

The LC*i* ***T*** is auto-configured to provide soil respiration data and calculations when the soil chamber is fitted.
A soil temperature sensor is supplied.

Multiple collars may be placed over a large experimental site and left in the soil for spatial and temporal studies.

Adaptors for Soil Respiration Chamber

Adaptors for 4" (110mm) and 6" (160mm) PVC piping and additional round collars for fitting PVC piping with the soil respiration chamber or the versatile chamber.

Discover the applications

Recent application areas of the ADC LC*i* system include:

- Analysing the effectiveness of treatments for heat-stressed crops
- Screening for drought tolerance in commercial crops
- Exploring the mechanisms of salt tolerance in plants
- Determining optimum lighting conditions for greenhouse crops
- Measuring gas exchange in vegetable crops under drought-stressed conditions
- Quantifying the growth and yield benefits of applying macronutrients to crops
- Carbon assimilation and yield responses to water stress in vegetable crops

The LC*i* ***T*** instantly calculates and displays a complete set of the most widely utilised parameters for plant gas exchange determination:

CO_2 Assimilation Rate, A (displayed in µmol mol^{-1})
Stomatal conductance, gs (mol m^{-2} s^{-1})
Transpiration rate, E (mol m^{-2} s^{-1})
Sub-stomatal CO_2 concentration, Ci (µmol mol^{-1})

For soil respiration measurement, the LC*i* ***T*** calculates the Net Carbon Exchange Rate over the soil sample area, NCER (displayed in µmol m^{-2} s^{-1}).

A powerful tool for both research and teaching

ADC BioScientific are proud of our long-standing ability to design the easiest to use gas exchange devices. Since 1979, our company has striven to make whole plant physiology devices accessible to all, being both easy to use and priced to suit most research funding budgets.

The LCi ***T*** now enables *even more* intuitive, rapid menu navigation and parameter editing, providing a powerful tool for research and for teaching plant gas exchange mechanisms.

The fully adjustable LCD settings provide enhanced visibility in variable light conditions. Text and graphical images can be viewed clearly 360° around the console, further enhancing the flexibility of the LCi ***T***.

Colour, touch screen, graphic display

All real time data, calculations and graphs are clearly presented on the high definition, colour LCD.

Parameters may be plotted against time or record number, enabling measurement trends to be easily monitored and observed.

Plots are automatically scaled to values, for presentation clarity.

Up to four 'Y axis parameters' may be plotted as distinctively coloured legends, providing a greater depth of data analysis.

With a light chamber employed, the resulting plots of multiple parameters can include Light Response Curves (LRCs) of photosynthetic rate, A (µmol m^{-2} sec^{-1}) against effective irradiance, Q (also known as PAR).

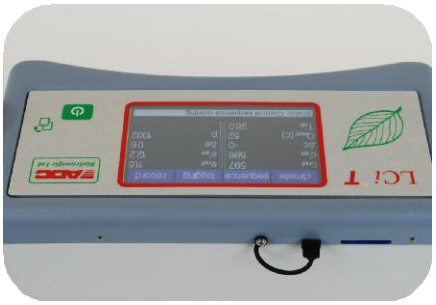
Instant, touch key response

Two selection options are provided:

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'.

To save power, the LCD will automatically dim after a user-set period of inactivity.

Unlimited data storage



The LCi ***T*** provides unlimited data storage. All experimental protocols, data and calculations are stored on Secure Digital (SD) cards. SD cards can be interchanged for individual users or for specific experimental applications.

Data recording can be initiated both automatically and manually. Automatic data recording can take place at timed intervals, synchronised to the same point of the measurement cycle. Alternatively, manual recordings can be made either via the keypad or the button on the chamber handle.

Data is downloaded either directly from the SD card or USB output.

Selected LC*i T* publications

1. Xia, H., Zhang, T., Li, X., He, T., Wang, X., Zhang, J., & Zhang, K. (2023). **Effects of drought and nutrient deficiencies on the allocation of recently fixed carbon in a plant–soil–microbe system**. *Tree Physiology*. https://doi.org/10.1093/TREEPHYS/TPAD098
2. Nerva, L., Balestrini, R., & Chitarra, W. (2023). **From Plant Nursery to Field: Persistence of Mycorrhizal Symbiosis Balancing Effects on Growth-Defence Tradeoffs Mediated by Rootstock**. *Agronomy*, *13*(1), 229. https://doi.org/10.3390/AGRONOMY13010229/S1
3. Tiwari, V., Kamara, I., Ratner, K., Many, Y., Lukyanov, V., Ziv, C., Gilad, Z., Esquira, I., & Charuvi, D. (2022). **Daytime or Edge-of-Daytime Intra-Canopy Illumination Improves the Fruit Set of Bell Pepper at Passive Conditions in the Winter**. *Plants*, *11*(3). https://doi.org/10.3390/plants11030424
4. Hnilickova, H., Kraus, K., Vachova, P., & Hnilicka, F. (2021). **Salinity stress affects photosynthesis, malondialdehyde formation, and proline content in portulaca oleracea l**. *Plants*, *10*(5). https://doi.org/10.3390/plants10050845
5. Joshi, N. C., Yadav, D., Ratner, K., Kamara, I., Aviv-Sharon, E., Irihimovitch, V., & Charuvi, D. (2020). **Sodium hydrosulfide priming improves the response of photosynthesis to overnight frost and day high light in avocado (Persea americana Mill, cv. 'Hass')**. *Physiologia Plantarum*, *168*(2), 394–405. https://doi.org/10.1111/ppl.13023
6. Khalid, M. F., Hussain, S., Anjum, M. A., Ahmad, S., Ali, M. A., Ejaz, S., & Morillon, R. (2020). **Better salinity tolerance in tetraploid vs diploid volkamer lemon seedlings is associated with robust antioxidant and osmotic adjustment mechanisms**. *Journal of Plant Physiology*, *244*. https://doi.org/10.1016/j.jplph.2019.153071
7. Tůmová, L., Tarkowská, D., Řřová, K., Marková, H., Kočová, M., Rothová, O., čečetka, P., & Holá, D. (2018). **Drought-tolerant and drought-sensitive genotypes of maize (Zea mays L.) differ in contents of endogenous brassinosteroids and their drought-induced changes**. *PLoS ONE*, *13*(5). https://doi.org/10.1371/journal.pone.0197870
8. Elansary, H. O. (2017). **Green roof Petunia, Ageratum, and Mentha responses to water stress, seaweeds, and trinexapac-ethyl treatments**. *Acta Physiologiae Plantarum*, *39*(7). https://doi.org/10.1007/S11738-017-2444-3

Online resources

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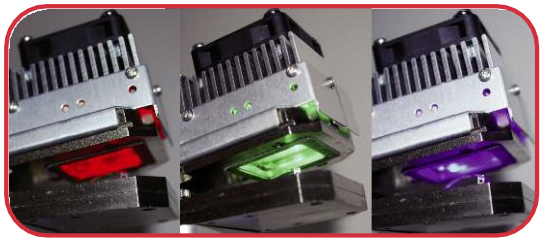

For the investigation of plant, soil and atmospheric interactions, ADC BioScientific Ltd. expertly produce a wide range of portable, user-friendly and cost-effective devices, from photosynthesis to soil respiration systems.

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 CO_2 Exchange Systems, Portable Soil Respiration Systems and Field Gas Analysers.

LC*i T* Technical Specifications

Measurement range and technique:	
CO_2:	0-2000ppm, 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 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
PAR control by LED light unit:	Up to 2400µmol m^{-2} sec^{-1} RGB LED array, or up to 2,500 m^{-2} sec^{-1} by White LED array.
Flow rate to leaf chamber:	68 to 340µmol m^{-2} sec^{-1}
Gas connections:	3mm barbed
Warm up time:	5 minutes @ 20°C
Display:	Colour WQVGA touch sensitive LCD
Recorded Data:	Removable SD cards. Up to 32GB supported.
Battery:	2.8Ah 12V lead acid battery Up to 10 hours between charges
Battery Charger:	Universal input voltage, fixed 13.8V output
Electrical Outputs: USB connection:	Mini-USB 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 W x D x H: Console:	125 x 140 x 240mm
Plant Leaf Chamber:	80 x 75 x 300mm
Weight: Console: Plant Leaf Chamber:	 2.4kg 0.6kg

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

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