CIRAS-3
Portable Photosynthesis System

Fastest & most accurate mobile system for simultaneous leaf gas exchange & chlorophyll fluorescence measurement.
Rapid A/Ci curves in minutes with our innovative high-speed CO_2 ramping technique
Small system volume optimized for high-level field performance
Multiple field-customizable leaf cuvettes
Full control of CO_2, H_2O, temperature & light

CIRAS-3 Redefining "portability" for high-level field research

Learn More

Mobile

The first truly mobile system for simultaneous measurement of photosynthesis and chlorophyll fluorescence. **For field work, size and weight matter.** At a weight of approximately 5 kg for both the console and cuvette, benefits include:

- Less site disturbance
- Easy access to hard-to-reach areas
- No need for a tripod or assistance
- Reduced fatigue
- An entirely new research experience

Learn More

Powerful, Customizable & Intuitive

Our system is easy to use and highly intuitive. That means minimal training is needed, allowing you to begin collecting data shortly after your system arrives. Built-in system help dialogs are there to guide even the most inexperienced user every step of the way. Rely on the defaults or customize your own settings to monitor and display numerical and graphical data.

Learn More

Environmental Control & Stability

The CIRAS-3 offers fully-automatic, complete and independent control of CO_2, H_2O temperature and light for response curves (i.e. fast A/Ci curves, light response, etc.) Control of all environmental parameters can be dynamic or preprogrammed. **The CIRAS-3's temperature stability and control is the most reliable in the industry.** We also offer one of the widest temperature control ranges available with an extensive variety of different controlling options.

Learn More

Measure Photosynthesis & Chlorophyll Fluorescence Simultaneously

Our CFM-3 Chlorophyll Fluorescence Module has a built-in light source. It can be used as both a fluorometer (PAM) and as an independent light source making it not only versatile but time and cost-efficient. Our unique "Multi-Pulse™ technology allows for the popular estimation of apparent F_m'.

Rapid A/C_i Curves

Generate ultra-fast A/C_i curves in a fraction of the timeusing our innovative and programmable high-speed CO_2ramping technique.

Learn More

Fast & Accurate

The CIRAS-3 is a true differential analyzer featuring four independent gas analyzers for CO_2 and H_2O. It's compact size and small total system volume ensures the most rapid, accurate equilibration and leaf gas exchange measurement.

Learn More

Plug & Play Accessories for Added Versatility

The CIRAS-3 can be used with a number of different leaf cuvettes for measurement of leaf gas exchange and chlorophyll fluorescence. **It can also be used as a stand-alone CO_2 and H_2O differential gas analyzer**. You can measure soil CO_2 efflux and net canopy flux using our chambers or yours.

Learn More

Auto Control of Light Intensity & Wavelength

Our PLC3 LED Light Units feature red, green, blue and white light enabling users to control both light intensity up to 2500 µmol $m^{-2}s^{-1}$ and proportion of light by wavelength.

Learn More

No Calibration Required

Our **Auto-Zero measurement principle** ensures an inherent calibration stability confirmed by more than 35 years of experience in gas technology. It allows for fast warm-up, adaptation to changing ambient conditions and unsurpassed stability for many years.

Learn More

Eliminating the obstacles while elevating the experience.

Minimal Size. Maximum Performance.

The CIRAS-3 is designed with the high-level field researcher in mind. Its small size makes it the mobile photosynthesis system of its kind, alleviating the need for assistance or tripods.

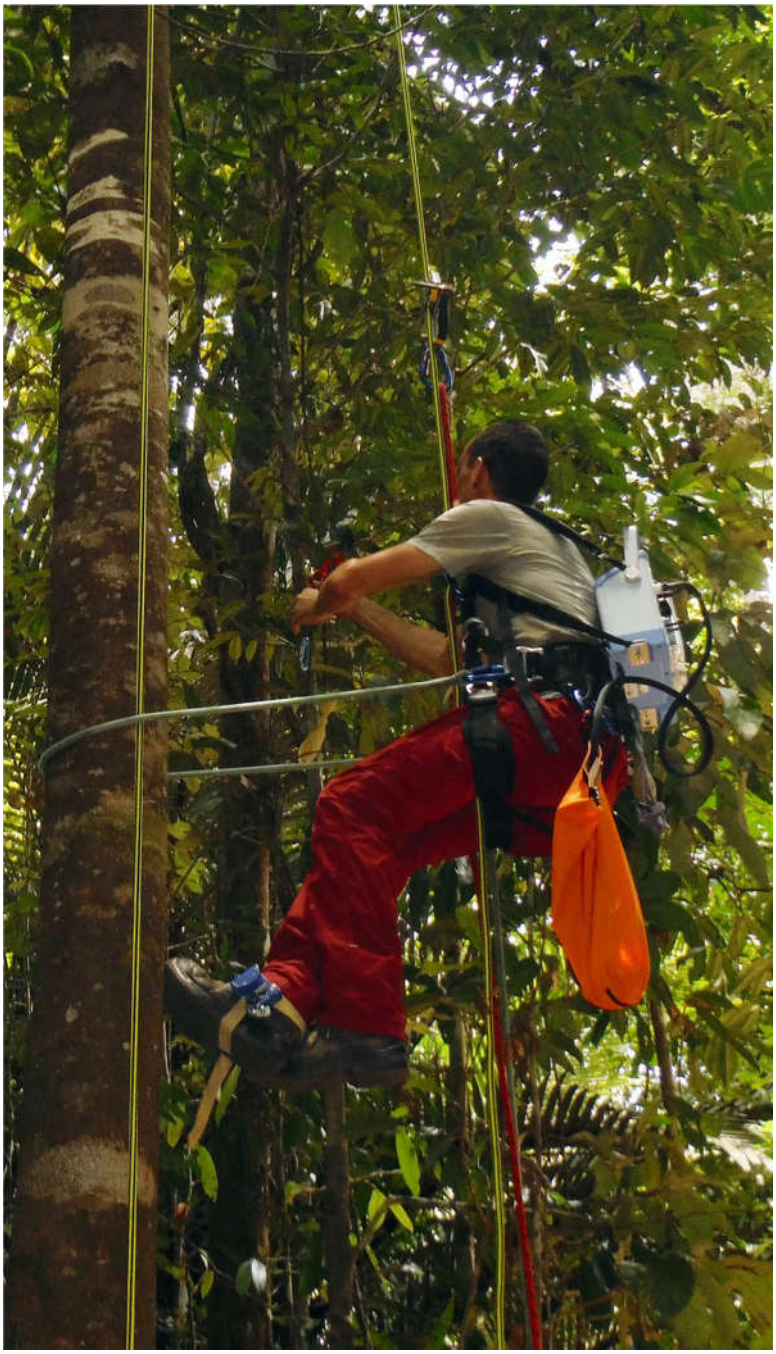
The innovative design of the CIRAS-3 utilizes its system volume to ensure faster equilibration as the most rapid and accurate measurements available. Faster measurements allow the user to the parameters of their research and use their time resources efficiently. Check out the size and of the CIRAS-3 console and leaf cuvettes and you quickly discover why smaller and lighter is better.

Fast Response. Fully Mobile.

The location of the CIRAS-3's IRGAs (Infrared Analyzers) in the main console — right next to the gas mixing system and flow control — allows the 3 to provide an ultra-fast response to changes in "reference" gas, and the fastest and most accurate photosynthesis measurement available. IRGAs in console makes the entire system highly portable, mention the added protection from dirt, dust, and commonly found in and around a leaf cuvette.

Packed with Power

Sound system electronics coupled with powerful battery packs allows operation of the CIRAS-3 for up to 12 hours. An important element of field you will find our batteries allow for a much longer duration of time in the field as well as eliminating need to swap out batteries.



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High-speed CO_2 Ramping For Rapid A/C_i Curves

For many years researchers have been regularly performing steady-state A/Ci curves on a wide variety of vegetation providing very useful information on plant status. PP Systems is excited to announce that the CIRAS-3 is capable of performing rapid A/C_i curves in just a fraction of the time it takes to perform steady-state measurements based on our innovative **High-Speed CO_2 Ramping Technique**. **It is possible to generate A/C_i curves in less than 5 minutes with the CIRAS-3!** However, the actual length of time to perform these measurements is highly dependent on user settings and parameters of interest.

What is the purpose of Rapid A/C_i Measurements?

The purpose of performing rapid A (Assimilation) vs. C_i(Intercellular CO_2) curves is to provide two or sometimes three parameters for photosynthetic characteristics of leaves, which are beyond those derived from any single A and $C_i$measurement. These parameters include:

1. Maximum capacity of the ribulose bis-phosphate carboxylase enzyme
2. Maximum rate of photosynthetic electron transport
3. Maximum rate of triose phosphate utilization

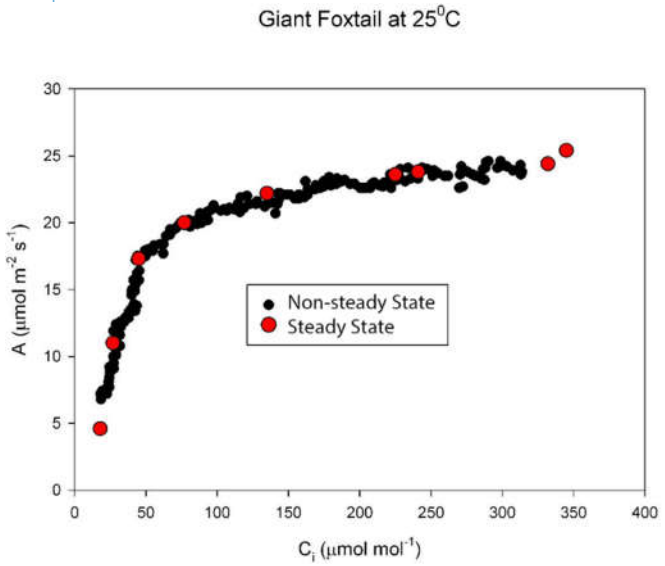
Whether the third parameter can be quantified with this method depends on the metabolic properties of the leaf. The above three parameters, which are all temperature dependent, combined with stomatal conductance values, permit estimation of leaf photosynthesis under any combination of light, temperature, CO_2, and humidity via the Farquhar, von Caemmerer, and Berry photosynthesis model.

One could obtain the same two or three parameters by doing slower, steady-state measurements of A at a range of C_i values, but that is quite time-consuming (generally at least 30 minutes, but sometimes up to one hour, as compared with possibly as little as 5 minutes per leaf with our rapid A vs. C_i method).

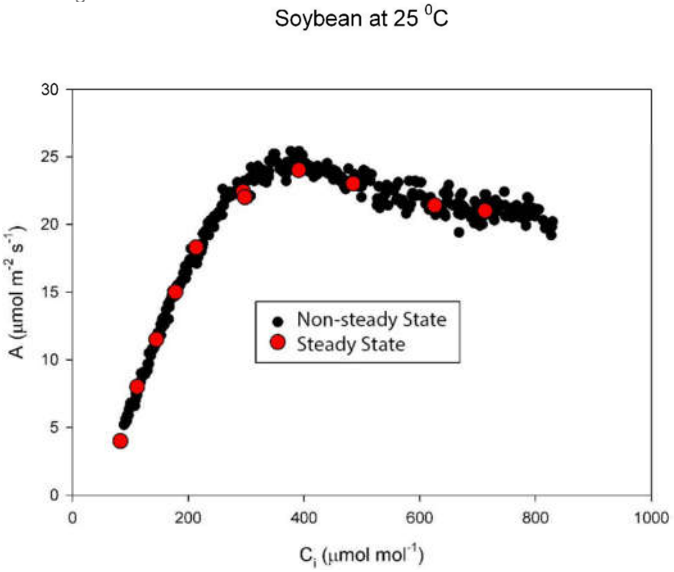
How Does the CIRAS-3 Measure Rapid A/C_i?

The CIRAS-3 features a highly accurate, true differential gas analysis system for both CO_2 and H_2O. It can easily, quickly and accurately linearly ramp the CO_2 concentration in the leaf cuvette in order to produce a complete A vs. C_i curve in just minutes. Our unique stored differential balance feature allows simplified data recordings and straightforward post-processing in Excel. Our response script editor allows users to easily generate and edit linear response scripts to meet their specific requirements.

Comparing Steady State vs. Non-Steady State A/C_i Curves.



Comparison of a Non-Steady State High-Speed A/C$_i$ Ramping (black points) to traditional point-by-point Steady State (red points) for a typical C_4 Giant Foxtail leaf with PAR of 1500 µmol m^{-2} s^{-1} and Cuvette Flow of 300 ml/min. Reference CO_2 ramped from 50 to 500 in 7 minutes. Each Steady State point had an approximate 2 minute acclimation time for total data recording time of 18 minutes.



Comparison of a Non-Steady State High-Speed A/C_i Ramping (black points) to traditional point-by-point Steady State (red points) for a typical C_3 Soybean leaf with PAR of 1500 µmol m^{-2} s^{-1} and Cuvette Flow of 300 ml/min. Reference CO_2 ramped from 100 to 1000 in 10 minutes. Each Steady State point had an approximate 2 minute acclimation time for total data recording time of 22 minutes.

A true differential analyzer for accuracy and reliability

CO_2 and H_2O Gas Analyzers

The heart and soul of any photosynthesis system is the analyzer. Accurate, reliable and stable measurement and control of CO_2 and H_2O are critical for high-level research. The CIRAS-3 is a “true differential analyzer” featuring 4 independent, non-dispersive gas analyzers for accurate, simultaneous measurement and control of both CO_2 and H_2O. This is a significant advantage over “gas switching” systems and a major requirement for most researchers. For enhanced reliability, there are no moving parts such as chopper motors or filter wheels. The gas analyzers include an infrared source, highly polished, gold plated sample cells and detectors that are optimized for CO_2 (4.26 µm) and H_2O (2.60 µm). The analyzers act as absorptiometers measuring infrared absorption only. The optical bench is temperature controlled and pressure compensated ensuring the most accurate measurement of $CO_2$and H_2O under changing ambient conditions.

Measurement Ranges
CO_2: 0-10000 µmol mol^{-1}
H_2O: 0-Dewpoint

Calibration

The design of the CIRAS-3 ensures an inherent calibration stability that has been confirmed by over 35 years of experience in gas analysis technology. The CIRAS-3 features an innovative **Auto-Zero** function that allows for fast warm-up, adaptation to changing ambient conditions and excellent stability. In short, expect accurate, reliable and stable calibration for many years without the need for time-consuming, expensive recalibration. The Auto-Zero function minimizes effects on span (gas sensitivity) of sample, source aging, changes in detector sensitivity and changes in pre-amplifier gain. Periodic system checks are simple and recommended to confirm system integrity and calibration

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Full environmental control:
Automated. Programmable. Standard.

CO_2 and H_2O Gas Analyzers

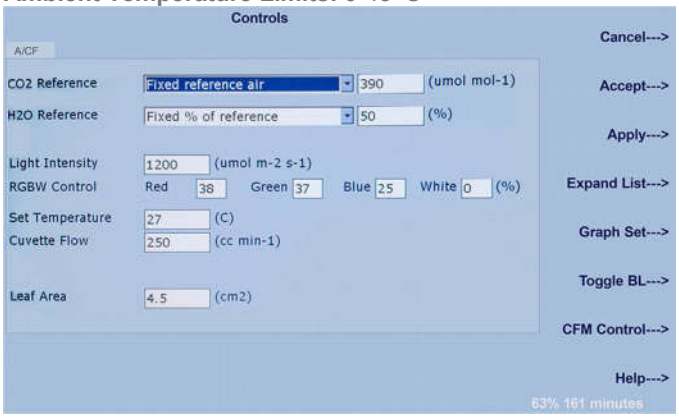
Environmental Control

The level of environmental control in the field with the CIRAS-3 is unsurpassed. The CIRAS-3 offers complete, independent and automatic control of CO_2, H_2O, temperature, and light for response curves (i.e. A/C_i curves, light response, etc.) with fast time response. Control over all environmental parameters can be dynamic or pre-programmed for automated response curve generation. All power required for environmental control is provided by the internal rechargeable Li-ion batteries (**no external power supply is required**).

CO_2 Control – Unlike some systems, automatic CO_2 control is standard with the CIRAS-3. Our innovative, integral gas blender and regulator mixes pure CO_2 provided by mini CO_2cartridges (8 g) with CO_2 free air to provide a very accurate, stable, continuous and constant flow of CO_2. Each CO_2cartridge is capable of providing up to a minimum of 12 hours continuous use. It is very easy to change out cartridges and there is little to no maintenance required for the CO_2 gas blender or regulator.

CO_2 Control Range: 0-2000 µmol mol^{-1}
H_2O Control – On-board, self-indicating desiccants are used for conditioning the H_2O concentrations per user-selected intervals.
H_2O Control Range: 0-Dewpoint
Measurements above ambient are also easily achieved.

Temperature Control – Automatic, accurate and stable temperature control is standard and integral with all leaf cuvettes. Peltier elements are mounted to the head along with heatsink and fans for precise control of temperature over a wide range. The user has the ability to disable temperature control, track ambient or to control at a set temperature.
Temperature Control Range: ~10 °C below ambient to 15 °C above ambient
Ambient Temperature Limits: 0-45 °C



Desiccants for Zero and CO2/H2O Control

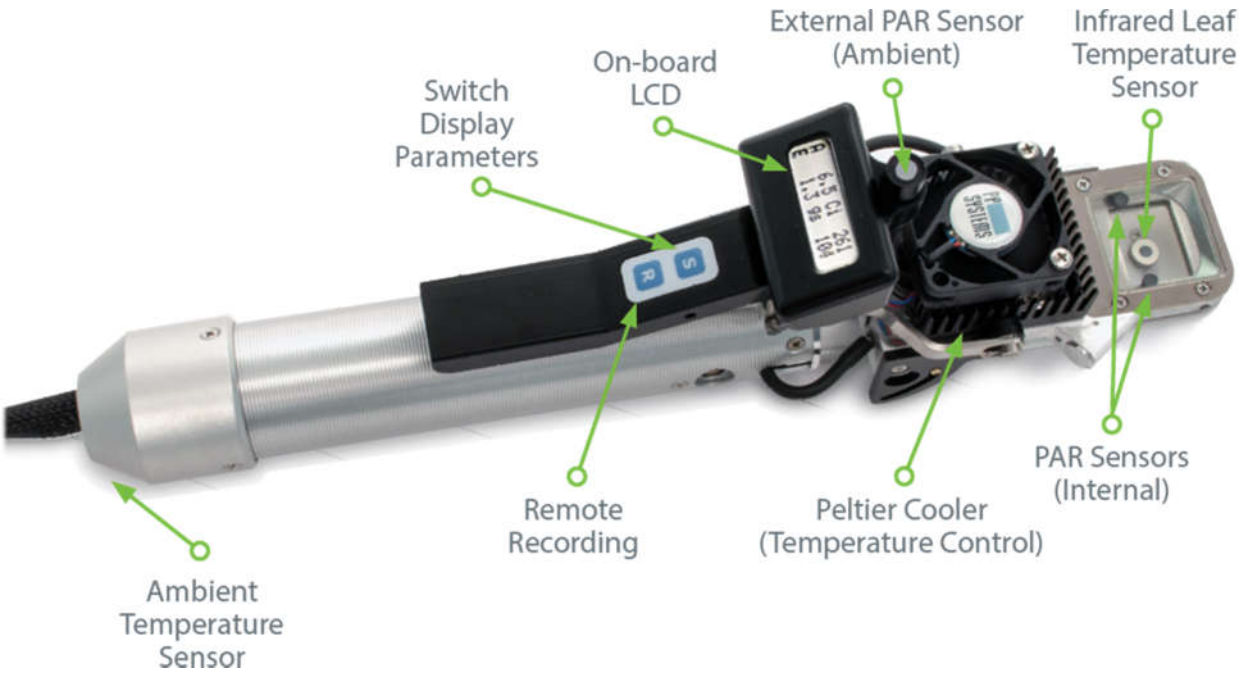
CIRAS-3 back panel featuring CO_2 cartridge holder, gas and electrical connections and desiccants for instrument zero and CO_2/H_2O control.

Light Control (optional)

Automatically control both light intensity and proportion of light by wavelength.

All leaf cuvettes can be supplied with an optional, compact LED light unit for automatic control of light. Each light unit features a bank of red, green, blue and white LEDs (RGBW) allowing for control of both light intensity and proportion of light by wavelength.
Light Control Range: up to 2500 µmol m^{-2} s^{-1} (Depends on Light Unit type)
Wavelength (RGBW)
Red Peak Wavelength: 625 nm +/- 5 nm, FWHM: 15 nm
Green Peak Wavelength: 528 nm +/- 8 nm, FWHM: 40 nm
Blue Peak Wavelength: 475 nm +/- 10 nm, FWHM: 28 nm
White Wavelength: 425-650 nm

Meeting the demands of the serious researcher driving the future of science



CIRAS-3 PLC Leaf Cuvettes

Lightweight. Fast. Precise.

- Truly plug and play
- Automatic temperature control
- Airtight seal without damage to vegetation
- Fastest response to CO_2 and H_20 changes
- Optional LED Light Unit (RGBW) available
- Field-customizable options

PLC3 Universal Leaf Cuvette shown.

Revolutionizing the Research Experience

Our PLC3 leaf cuvettes work seamlessly with the CIRAS-3. The innovative design makes for fast and efficient measurements just about anywhere! No need for assistance or a tripod! Their small size and fast response further enhance the CIRAS-3's capabilities. The CIRAS-3 supports three standard leaf cuvettes (Universal, Narrow, and Conifer) which are truly plug and play. Each cuvette connects directly to the CIRAS-3. No time-consuming, delicate reassembly or adjustment of different heads and sensors.
The leaf cuvette gaskets provide an air-tight seal without causing any damage to vegetation. Automatic temperature control is standard with all leaf cuvettes.

Onboard LCD Display

All PLC3 series leaf cuvettes include an onboard LCD allowing the user to display up to 8 user-defined parameters. Measurements can also be recorded remotely from the leaf cuvette for convenience and ease.

25 mm x 7 mm
Area: 1.75 cm^2

18 mm Diameter
Area: 2.50 cm^2

25 mm x 18 mm

Area: 4.5 cm^2

PLC3 Universal Leaf Cuvette

For flat, broad leaves
Our PLC3 Universal Leaf Cuvette is our most popular leaf cuvette by far. The PLC3 Universal is designed for measurement on most flat, broad leaf plants. It features 3 different windows allowing you to customize the head to accommodate different sized leaves.
Window: IR Filter
Dimensions: See head plates below
Includes 2 miniature silicon photodiode sensors providing a reliable average of PAR inside the cuvette in addition to ambient PAR measured by an external sensor. It also includes an infrared (IR) radiation sensor for accurate, non-contact measurement of leaf temperature. Leaf temperature can also be determined by energy balance.

PLC3 Conifer Leaf Cuvette

For measurement on grasses, cereal crops and short needle conifers. The window is hemispherical making it suitable for 3D structures.
Window: Glass
Window Area: 80 mm (L) x 40 mm (Diameter)
Includes 1 miniature silicon photodiode sensor providing measurement of PAR inside the cuvette in addition to ambient PAR measured by an external sensor. Leaf temperature is calculated based on energy balance or precision thermistor for contact measurement. **An optional head plate can be supplied to easily convert from "conifer" to "narrow".**

PLC3 Narrow Leaf Cuvette

For measurement on grasses, cereal crops, and long needle conifers.
Window: IR Filter
Window Area: 80 mm (L) x 30 mm (W)
Includes 1 miniature silicon photodiode sensor providing measurement of PAR inside the cuvette in addition to ambient PAR measured by an external sensor. Leaf temperature is calculated based on energy balance or precision thermistor for contact measurement. **An optional head plate can be supplied to easily convert from "narrow" to "conifer".**

Measure photosynthesis & chlorophyll fluorescence simultaneously

The CFM-3 Chlorophyll Fluorescence Module

The CFM-3 Chlorophyll Fluorescence Module is capable of both independent measurement of chlorophyll fluorescence as well as simultaneous measurement of photosynthesis and chlorophyll fluorescence.
The CFM-3 is compact and elegantly designed with all light sources and fluorescence detection capability built directly into the light unit. The CFM-3 can be used as an actinic light source for leaf gas exchange and as a pulse-amplitude-modulated (PAM) fluorometer for measurement of chlorophyll fluorescence on both dark and light adapted vegetation.
The CFM-3 is capable of delivering saturating pulses up to 10000 µmol m^{-2} s^{-1} which is extremely useful in accommodating a wider range of ambient light conditions. The CIRAS-3's Multi-Pulse™ technology produces a sequence of saturating light levels for estimation of apparent F_m'.
The CFM-3 Chlorophyll Fluorescence Module is an optional accessory designed exclusively for use with the PLC3 Universal Leaf Cuvette.

Measured and Calculated Fluorescence Parameters
F_o, F_m, F_s, F_o', F_m', F_v/F_m, ϕ_{PSII}, J, F_v'/F_m', qP, qNP, NPQ, qL, ϕNO, ϕNPQ-K, ϕfD and ϕNPQ-G

Powerful & Intuitive Software

The CIRAS-3 main console incorporates a large, full color 7.0” WSVGA transflective display featuring superb readability under all ambient conditions including full sunshine. The display is custom designed with a 30° viewing angle making it easier to read from different positions ensuring measurements can be performed and recorded by just one person. A custom, 27 tactile feel keypad is available for all user input

Data Presentation

Customize the information that you would like to be presented on the LCD under your system preferences. Many of the displays and presentation of data is user definable.

Data Collection and Transfer

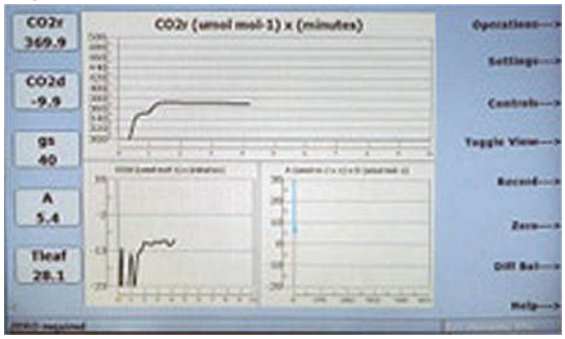
With just a few key presses manual, automatic and response curves can be created, run and saved to internal memory or to a convenient USB thumb drive (memory stick). Data storage is flexible and unlimited and can easily be transferred to your PC for further analysis in your favorite spreadsheet program.

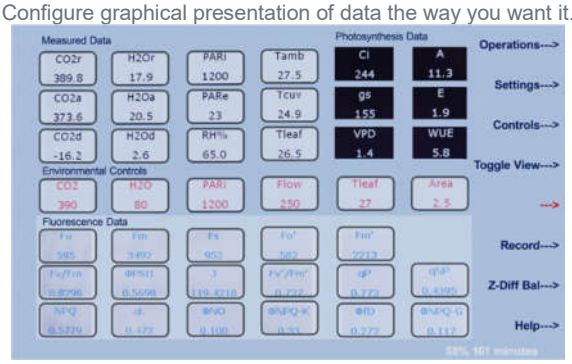
Measured and Calculated Photosynthesis Parameters

CO_2 reference, CO_2 analysis, CO_2 differential, H_2O reference, H_2O analysis, H_2O differential, air temperature, leaf temperature, cuvette temperature, PAR internal, PAR external, relative humidity, atmospheric pressure, flow, Ci, gs, A, E, VPD and WUE.

Programming

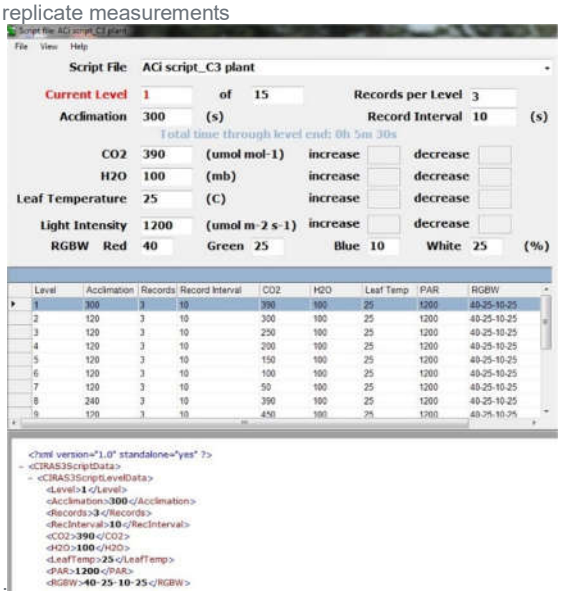
Programming simple or complex experiments could not be any easier. Users can create their own response curves using the popular XML programming language. Once created, programs can be downloaded to the CIRAS-3 or even shared with other CIRAS-3 users.

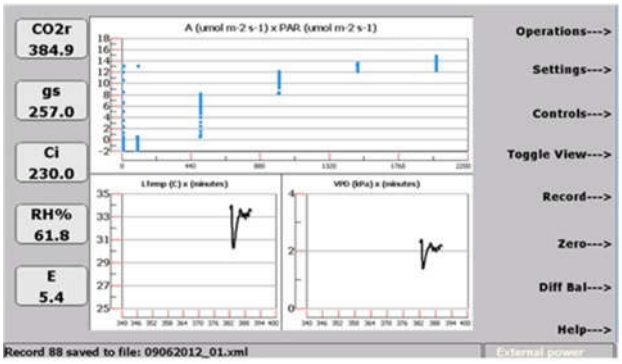




PC Utility Software & Remote Display

Programming simple or complex experiments from a PC could not be any easier. Users can create their own response curve scripts using the popular XML programming language. Once created, programs can be downloaded to the CIRAS-3 console or shared with other researchers that might want to replicate measurements





View CIRAS-3 data remotely from your PC

CIRAS-3 Elevating the high-level field research experience

Product Features

- Small footprint and lightweight–truly mobile, the first of its kind
- Internal, rechargeable Li-ion batteries for up to 12 hours operation
- 4 independent, non-dispersive infrared gas analyzers (IRGAs) for both CO_2 and H_2O
- Automatic and programmable control of CO_2, H_2O, temperature, and light
- Large, full color, 7.0″ transflective LCD for field use and optimized viewing angle
- Unlimited data storage (internal memory and thumb drives)
- Flexible and versatile user interface
- Powerful software
- Range of accessories for chlorophyll fluorescence, soil respiration, and canopy assimilation