



CIRAS-3

Portable Photosynthesis System

- Photosynthesis
- Chlorophyll Fluorescence
- Soil Respiration
- Canopy Assimilation

PP 
SYSTEMS
www.ppsystems.com

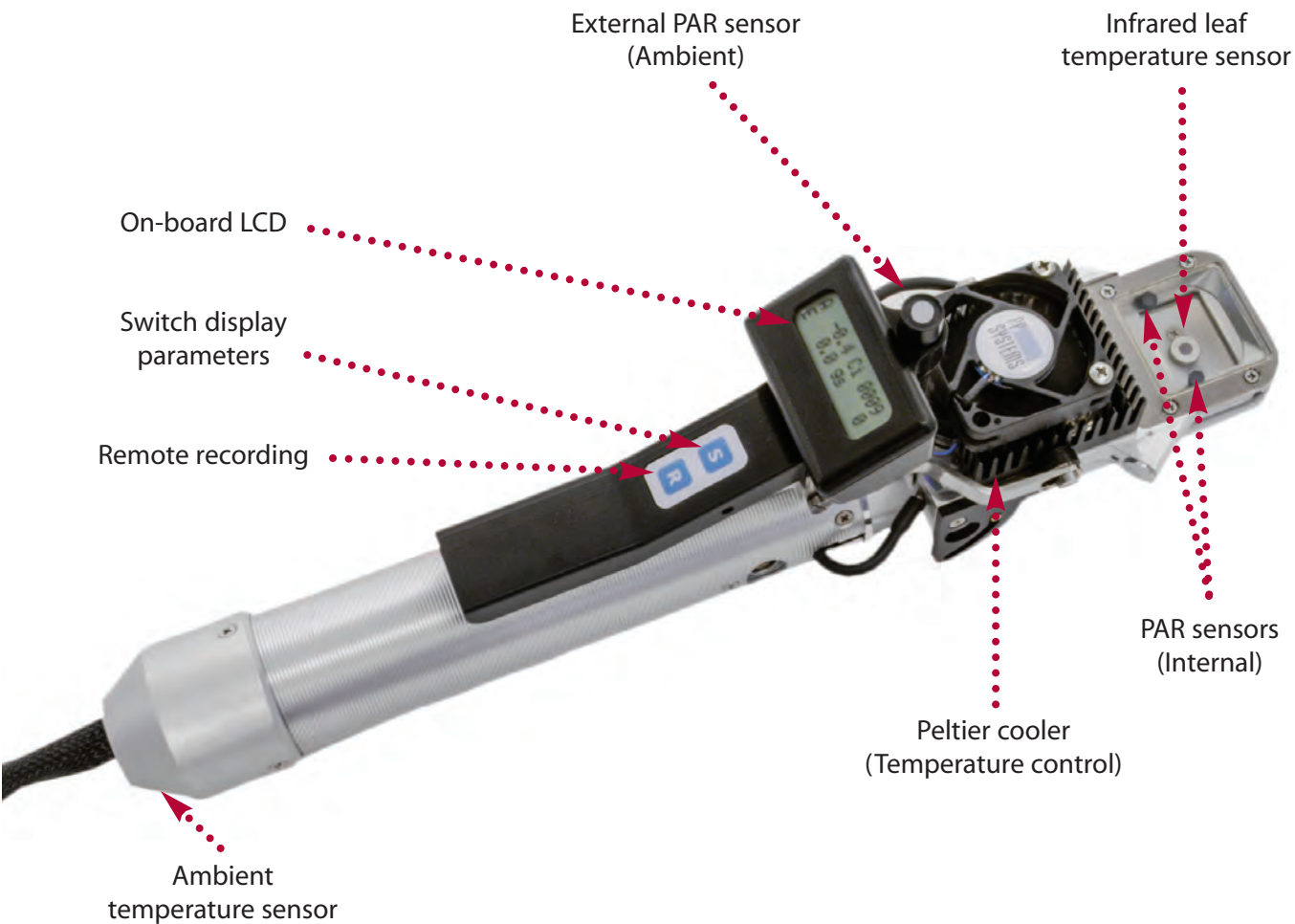
CIRAS-3... The New Sta



CIRAS-3 Main Console

Weight: 4.3 kg (including battery)
Dimensions: 28.0 cm (W) x 14.5 cm (D) x 24 cm (H)

Standard For Field Research



PLC3 Universal Leaf Cuvette

Weight: 0.75 kg
Dimensions: 32 cm (L) x 3.8 cm (Handle diameter)

Interchangeable Head Plates for PLC3 Universal Leaf Cuvette



Experience

3rd Generation Photosynthesis System

For High Level Research

PP Systems is considered a world leader in the manufacture and design of instrumentation for high level plant and soil science research. Our experience in photosynthesis measurements over the past 30+ years has yielded an instrument that includes state of the art design and unsurpassed performance without sacrificing portability. Many of the features that have been incorporated into the CIRAS-3 system are the result of numerous discussions and research performed by some of the world's most prominent photosynthesis experts over many years.

The CIRAS-3 is the perfect choice for measurement of:

- Photosynthesis
- Chlorophyll Fluorescence
- Soil Respiration
- Canopy Assimilation

Our Mission

**Aiding scientific research
with versatile, proven
technology.**

PP Systems is proud to have supported the technology needs of plant and soil scientists since 1984. Our photosynthesis systems have been proven and tested by thousands of customers from over 100 countries worldwide. We are recognized as a leader in the design and manufacture of photosynthesis measurement instrumentation for high level research.

Trusted and tested technology

Pioneering Leaf Gas Exchange Measurements

Our Proud History

CIRAS-1 (1992)

1st portable system to feature integral control of CO₂ (using mini CO₂ cartridges) and H₂O. Soon thereafter we introduced a range of leaf cuvettes that included automatic control of temperature and light for response curves.



CIRAS-2 (1999)

1st portable system to feature integral, simultaneous measurement of photosynthesis and chlorophyll fluorescence.



CIRAS-3... The Evolution Continues

Experience true portability



- Small footprint and lightweight (just 4.3 kg)
- Internal, rechargeable Li-ion battery providing up to 8 hours use
- 4 independent, non-dispersive infrared gas analyzers for both CO₂ and H₂O
- Automatic control of CO₂, H₂O, temperature and light
- Simultaneous measurement of photosynthesis and chlorophyll fluorescence
- Large, full color 7.0" transreflective LCD for field use with optimized viewing angle
- Unlimited data storage (internal memory and use of thumb drives)
- Flexible and versatile user interface
- Powerful software and programming capability

CIRAS-3 - Main Console



As reported by many researchers, there is a big difference between “portable” and “transportable.” At PP Systems, our goal has always been to provide researchers with the most portable system possible without sacrificing performance. Our reputation for doing just that is unsurpassed. The light weight (4.3 kg) and small footprint of the CIRAS-3 console means reduced fatigue, less site disturbance of fragile vegetation, and access to “hard to reach” places. The console is constructed out of a rugged, ergonomic aluminum enclosure with custom designed polyurethane cover and shock absorbing base. The system is powered by a very efficient and powerful internal Li-Ion battery providing up to 8 hours operation in the field eliminating or reducing the requirement to change out batteries.

The CIRAS-3 console can be used as a stand-alone CO₂ and H₂O differential gas analyzer for use with custom chambers in the laboratory or field if required. Quickly change between open and closed system analysis for measurement of soil CO₂ efflux and net canopy CO₂ flux.

CO₂/H₂O Gas Analysis

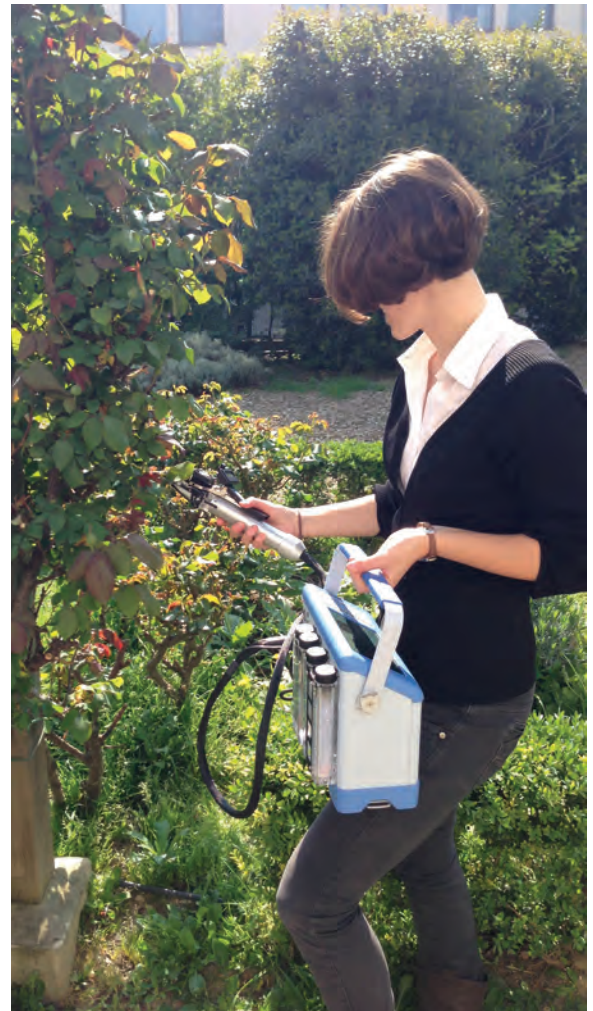
A major part of any photosynthesis system is the gas analyzer. Accurate, reliable and stable measurement and control of CO₂ and H₂O is critical for high level research. The CIRAS-3 is a “true differential analyzer” featuring 4 independent, non-dispersive gas analyzers for accurate, simultaneous measurement and control of both CO₂ and H₂O. For high level research and greatest accuracy, 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 and gold plated sample cells and detectors that are optimized for CO₂ (4.26 μ m) and H₂O (2.60 μ m). The analyzers act as absorptimeters measuring infrared absorption only. The optical bench is temperature controlled and pressure compensated ensuring the most accurate CO₂ and H₂O measurements under changing ambient conditions.

Measurement Ranges

- CO₂: 0-10000 μ mol mol⁻¹
- H₂O: 0-75 mb

Calibration, Accuracy and Long Term Stability

The design of the CIRAS-3 ensures an inherent calibration stability that has been confirmed by over 30 year's 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, you can expect your calibration to be accurate, reliable and stable 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.



Environmental Control – CO₂, H₂O, Temperature & Light

The level of environmental control in the field with the CIRAS-3 is unsurpassed. The CIRAS-3 offers complete, independent and automatic control of CO₂, H₂O, temperature and light for response curves (i.e. A/Ci curves, light response, etc.) with fast time response. Control of all environmental parameters can be dynamic or preprogrammed for automated response curve generation. All power required for environmental control is provided by the internal Li-Ion battery (no external power supply is required).



Replaceable CO₂ cartridge

CO₂ Control

Unlike some systems on the market today, automatic CO₂ control is standard with the CIRAS-3. Our innovative, integral gas blender and regulator mixes pure CO₂ provided by mini CO₂ cartridges (8 g) with CO₂ free air to provide a very accurate, continuous and constant flow of CO₂. Each CO₂ cartridge is capable of providing at least one full day of operation. It is very easy to change out cartridges and there is little to no maintenance required for the CO₂ gas blender or regulator.

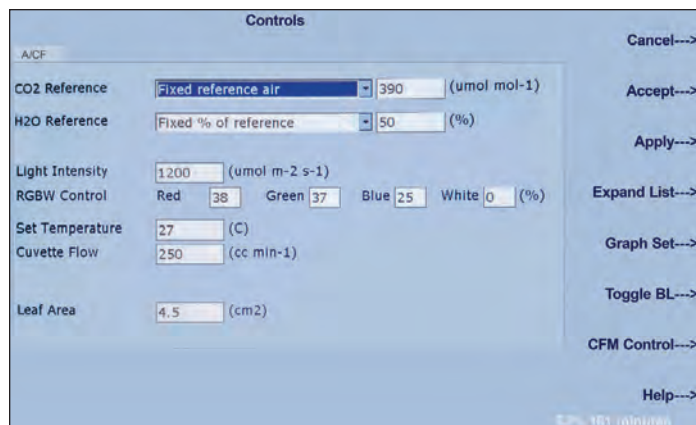
- CO₂ Control Range: 0-2000 $\mu\text{mol mol}^{-1}$

The system can easily be configured for ambient measurement of CO₂ if required.

Temperature Control

Automatic, accurate and stable temperature control is standard and integral with all leaf cuvettes. Peltier coolers are mounted to the cuvette head along with heat sink and fans for precise control of temperature over a wide range. Several controlling features can be selected by the user including cuvette temperature, leaf temperature, tracking cuvette to ambient and tracking leaf to ambient. Temperature control can also be disabled if required.

- Temperature Control Range: ~ 10 °C below ambient to 15 °C above ambient
- Temperature Control Limits: 0-45 °C



Environmental Control Setup Screen



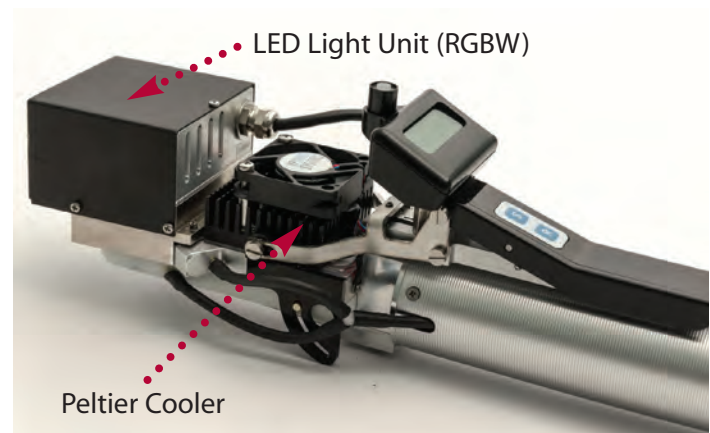
Desiccants for zero and CO₂/H₂O control

H₂O Control

On-board, self-indicating desiccants are used for conditioning the H₂O concentrations per user selected levels.

- H₂O Control Range: 0-Dewpoint

The system can easily be configured for ambient measurement of H₂O if required.



Light Control (Optional)

All leaf cuvettes can be supplied with an optional, compact LED light unit for automatic control of light. Each LED light unit features a bank of red, green, blue and white LEDs (RGBW) allowing for control of both light intensity and proportion of red, green, blue and white light.

- Light Control Range: 0-2500 $\mu\text{mol m}^{-2} \text{s}^{-1}$
(range varies depending on light unit type)

Controlling light intensity up to 2500 $\mu\text{mol m}^{-2} \text{s}^{-1}$ allows oversaturating and induced photoinhibition replicating extreme light environments (i.e. high elevation, desert).

Leaf Cuvettes

The CIRAS-3 can be supplied with 3 standard leaf cuvettes (Universal, Narrow and Conifer) which are truly plug and play. Each cuvette can be connected directly to the CIRAS-3 without the need for time consuming, delicate reassembly and adjustment of different heads and sensors. All leaf cuvette materials are carefully selected to minimize influences such as infrared radiation, water sorption, CO₂ effects and leaks. The leaf cuvette gaskets provide an air-tight seal without causing any damage to vegetation. Automatic temperature control is standard with all leaf cuvettes.

PLC3 Universal



... 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
- Window Area: 25 mm x 7 mm / 18mm Diameter / 25 mm x 18 mm

The **PLC3 Universal Cuvette** includes 2 miniature silicon photodiode sensors providing a reliable average of PAR inside the cuvette in addition to ambient PAR measured by an external, cosine corrected PAR sensor. It also includes an infrared radiation sensor for accurate, non-contact measurement of leaf temperature. Leaf temperature can also be calculated based on energy balance.

PLC3 Narrow



... For grasses, long needles and narrow leaves

For measurement on grasses, cereal crops and long needle conifers.

- Window: IR Filter
- Window Area: 83 mm (L) x 30 mm (W)

The **PLC3 Narrow Cuvette** includes 1 miniature silicon photodiode sensor providing measurement of PAR inside the cuvette in addition to ambient PAR measured by an external, cosine corrected PAR sensor. Leaf temperature is determined by use of a leaf thermistor or calculated based on energy balance. An optional head plate can be supplied to easily convert from PLC3 Narrow to Conifer.

PLC3 Conifer



... For conifers and short needle vegetation

For measurement on grasses, cereal crops and short needle conifers. The window is hemispherical making it suitable for 3D structures.

- Window: Glass
- Window Area: 83 mm (L) x 40 mm (Height)

The **PLC3 Conifer Cuvette** includes 1 miniature silicon photodiode sensor providing measurement of PAR inside the cuvette in addition to ambient PAR measured by an external, cosine corrected PAR sensor. Leaf temperature is determined by use of a leaf thermistor or calculated based on energy balance. An optional head plate can be supplied to easily convert from PLC3 Conifer to Narrow.

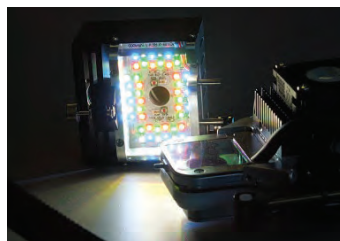
LED Light Unit - RGBW (Optional)

An innovative, compact, RGBW light unit is available for each leaf cuvette as an optional accessory. For field use, the LED based light source is ideal because it features low power consumption, minimal heat generation and can easily be installed or removed from the cuvette head. This is highly recommended for users that want to perform light response curves either manually or automatically. Not only can it automatically control light intensity up to $2500 \mu\text{mol m}^{-2} \text{s}^{-1}$ (range varies depending on light unit type), the user can also control the proportion of red, green, blue and white light in any combination up to 100%. The light source can also be removed for ambient measurements if required.

- Automatic control of light intensity up to $2500 \mu\text{mol m}^{-2} \text{s}^{-1}$
- Select red, green, blue or white light and any combination up to 100%
- Uniform light distribution within the chamber
- Lightweight and simple connection to the leaf cuvette head



PLC3 Universal Light Unit



RGBW Specification

Red Peak Wavelength:

625 nm +/- 5 nm

Green Peak Wavelength:

528 nm +/- 8 nm

Blue Peak Wavelength:

475 nm +/- 10 nm

White: 425-700 nm

Leaf Cuvette LCD Display



All leaf cuvettes include an on-board LCD display simplifying field measurements. Researchers can display user defined parameters on the 2 x 16 character display. It can display up to 4 parameters simultaneously but users can toggle between different displays for more parameters. This is ideal in those "hard to reach" sampling locations that prohibits users from reading the console. Having the data on the cuvette LCD allows the user to focus on the vegetation and it also lets them know when readings are stable and ready to be recorded. Two tactile feel keys are available on the cuvette to allow the user to toggle the LCD and to record measurements remotely.



The CIRAS-3 main console incorporates a large, full color 7.0" WSVGA transfective display featuring superb readability under ambient conditions especially under high sunlight. The display is custom designed with a 30° viewing angle making it easier to read from various positions ensuring measurements can be performed and recorded by just one person. A custom, 27 tactile feel keypad is available for all user inputs and system navigation.



Simple, intuitive, menu-driven controls for setup, operation, recording routines and management of data are all designed into the graphical user interface (GUI). On-line system help is available to guide you every step of the way.

Users can customize the information presented on the LCD. Many of the displays and presentation of data are user defined.

With just a few key presses data files can be created and measurements executed 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 a PC for further analysis.



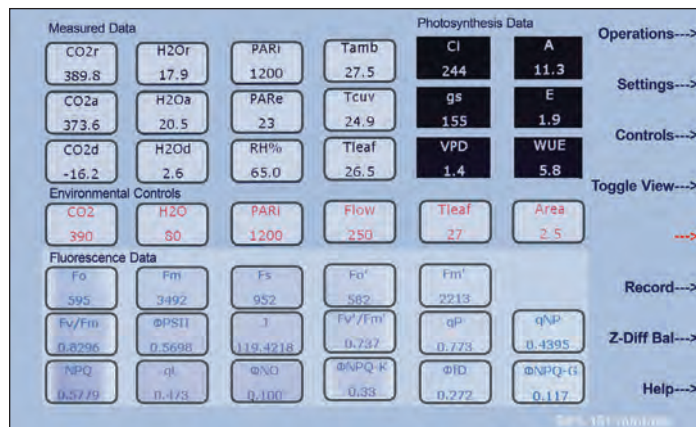
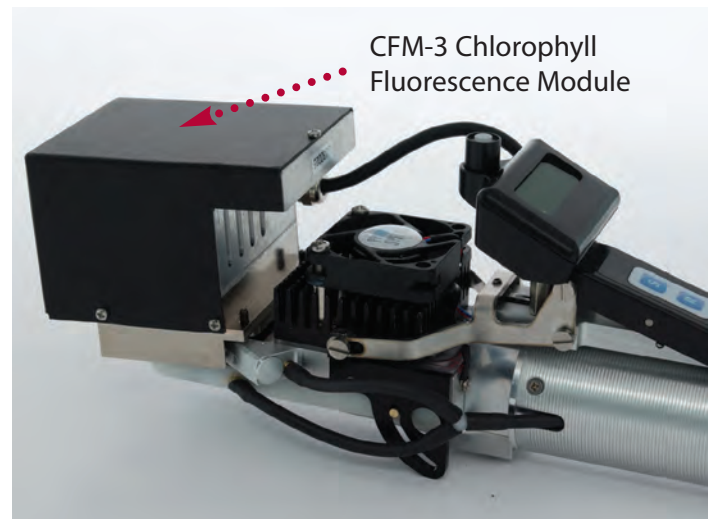
CO₂ reference, CO₂ analysis, CO₂ differential, H₂O reference, H₂O analysis, H₂O differential, air temperature, leaf temperature, cuvette temperature, PAR internal, PAR external, relative humidity, atmospheric pressure, flow, Ci, qs, A, E, VPD and WUE

Response curves can easily be executed manually or automatically. Users can either load factory default response curve scripts or they can modify, edit or create their own. Response curve scripts can also be shared between users making it easy to duplicate experiments.



CFM-3 Chlorophyll Fluorescence Module (Optional)

The CFM-3 Chlorophyll Fluorescence Module is an optional accessory for use with the PLC3 Universal Leaf Cuvette for simultaneous measurement of photosynthesis and chlorophyll fluorescence. Independent measurement of chlorophyll fluorescence is also possible. 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 light unit 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 $10000 \mu\text{mol m}^{-2} \text{s}^{-1}$ which is extremely useful in accommodating a wider range of ambient light conditions. The system is also capable of producing a "Multi-Pulse" sequence of saturating light levels for estimation of apparent F_m' . Leaf cuvettes can also be modified for use with commercially available fluorometers.



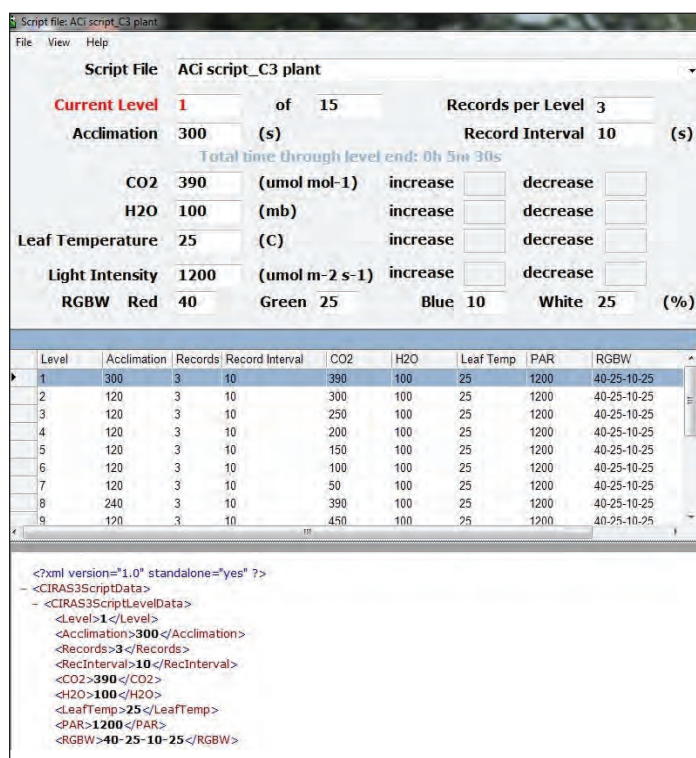
Measured and Calculated Chlorophyll Fluorescence Parameters

F_o, F_v, F_m, F_s, F_{o'}, F_{m'}, F_v/F_m, ΦPSII, J, F_v/F_{m'}, qP, qNP, NPQ, qL, ΦNO, ΦNPQ-K, ΦID and ΦNPQ-G

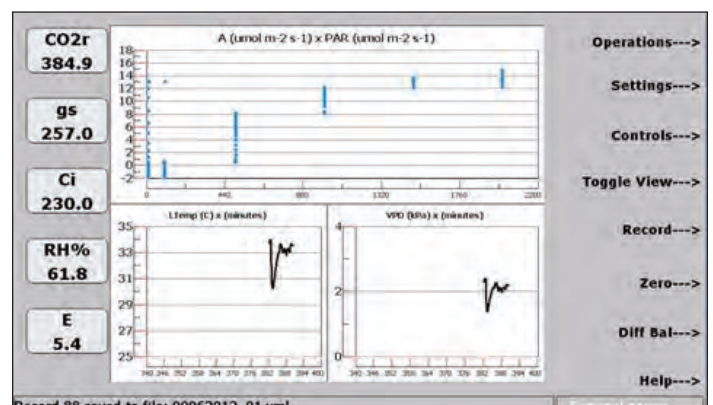
Photosynthesis and chlorophyll fluorescence data can be displayed on one screen. Graphical presentation of data is also available.

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 or shared with other researchers that might want to replicate measurements. Data can also be displayed remotely from a PC making it ideal for teaching and demonstration purposes.



Response Curve Scripts Editor



Remote Display

Soil Respiration and Net Canopy CO₂ Flux

Soil CO₂ Efflux

The popular SRC-1 Soil Respiration Chamber can be used with the CIRAS-3 for rapid, accurate measurement of closed system soil CO₂ efflux.

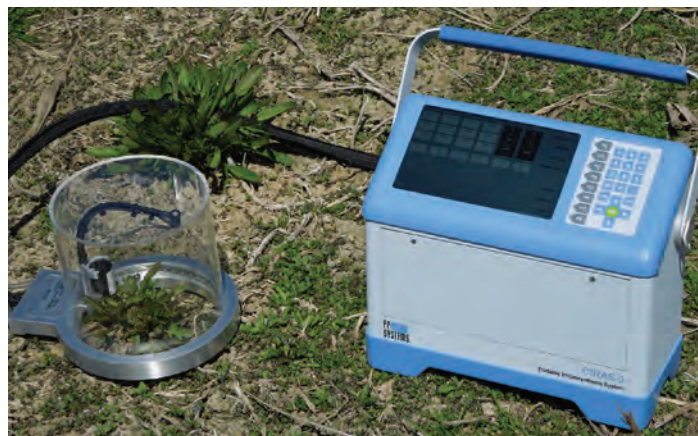
The chamber is constructed out of rugged PVC with a stainless steel ring providing a good seal.



Net Canopy CO₂ Flux

Our CPY-4 Canopy Assimilation Chamber is ideal for measurement of net canopy CO₂ flux on low lying vegetation.

The chamber is transparent and includes sensors for measurement of PAR and air temperature.



Headquarters

Situated in the heart of New England, PP Systems is headquartered in the Boston North Technology Park (BNTTP) which is located in Amesbury, MA (USA).



For international visitors, Boston's Logan International airport is most convenient and is approximately a 40 minute drive to Amesbury. If you are ever in our area, please feel free to stop in for a visit.

Training & Support

Our track record for offering the highest level of technical support is second to none. All new customers are eligible to receive a **FREE** training course on the CIRAS-3 Portable Photosynthesis System. Our experienced technical staff provides full product training at our Amesbury, MA (USA) factory several times each year.

Class size is small to guarantee that each customer receives the personal attention required and deserved. Customers come away from the course feeling well trained and comfortable with all aspects of the system from an operational and maintenance standpoint.

Technical Specification

Main Console

Analysis Method

Non-dispersive infrared, configured as an absolute absorptiometer with microprocessor control of linearization. Four independent gas analyzers simultaneously measure absolute CO₂ and H₂O for both the reference and analysis gas streams. All measurements corrected for temperature and pressure.

CO₂ Measurement Range

- 0-10000 $\mu\text{mol mol}^{-1}$

CO₂ Precision

- 0.2 $\mu\text{mol mol}^{-1}$ at 300 ppm
- 0.5 $\mu\text{mol mol}^{-1}$ at 1,750 ppm
- 3.0 $\mu\text{mol mol}^{-1}$ at 10000 ppm

CO₂ Control Range

- 0-2000 $\mu\text{mol mol}^{-1}$

H₂O Measurement Range

- 0-75 mb

H₂O Precision

- 0.015 mb at 0 mb
- 0.020 mb at 10 mb
- 0.030 mb at 50 mb

H₂O Control Range

- 0-Dewpoint.

Pressure Range

- 65-115 kPa

Air Sampling

User adjustable from 50-100 cc min⁻¹ using integral DC pumps. Both analysis and reference pumps fitted with mass flow controllers.

Cuvette Air Supply Unit

0-500 cc min⁻¹ measured and controlled by a mass flow meter.

Auxiliary Port

For connection to external devices (i.e. soil respiration chamber, canopy chamber).

Digital Output

- USB-Mini b (Host)
- 2 Ea. USB for use with external devices (mouse, memory stick).

Data Storage

512 MB flash memory for programming and data storage. Unlimited data storage using USB thumb drives (memory sticks).

Microprocessor Speed

800 MHz

Display

7.0" WSVGA transfective color LCD

User Input

27 tactile keys.

Power Supply

Internal, rechargeable 7.2V Li-Ion battery providing up to 8 hours continuous use. Power supply/charger included.

Operating Temperature Range

0-50 °C, non-condensing. In dirty environments, external air filtration may be required.

Enclosure

Rugged, ergonomic, lightweight aluminum with polyurethane base.

Dimensions

28 cm W x 14.5 cm D x 24 cm H

Weight

4.3 kg

PLC3 Leaf Cuvette

Construction

Handle: Aluminum

Leaf Gasket: Closed cell foam

Impeller: Stainless Steel

Window

PLC3 Universal: Glass IR interference filter

PLC3 Universal Window Sizes

- 25 mm x 7 mm (1.75 cm²)
- 18 mm Diameter (2.5 cm²)
- 25 mm x 18 mm (4.5 cm²)

PLC3 Narrow: Glass IR interference filter

PLC3 Conifer: Scratch resistant glass

LCD Display

2 x 16 character LCD for display of user defined parameters

Keypad

Two tactile feel keys for recording and LCD selection

PAR Sensor (Internal)

PLC3 Universal: 2 Miniature, silicon photodiode sensors

PLC3 Narrow: 1 Miniature, silicon photodiode sensor

PLC3 Conifer: 1 Miniature, silicon photodiode sensors

- Response: 400-700 nm
- Range: 0-3000 $\mu\text{mol m}^{-2} \text{s}^{-1}$
- Precision: 10 $\mu\text{mol m}^{-2} \text{s}^{-1}$

PAR Sensor (External) Filtered silicon cell (cosine corrected)

- Response: 400-700 nm
- Range: 0-3000 $\mu\text{mol m}^{-2} \text{s}^{-1}$
- Precision: 10 $\mu\text{mol m}^{-2} \text{s}^{-1}$

Air Temperature Sensor

- Range: -10 °C – 50 °C
- Precision thermistor
- Accuracy: +/- 0.5 °C at 25 °C

Temperature Control

~10 °C below ambient to +15 °C above ambient. Temperature Control Limits: 0 °C to 45 °C.

Leaf Temperature Sensor

PLC3 Universal: Radiation sensor for non-contact measurement

- Accuracy: +/- 0.5 °C at 25 °C

PLC3 Narrow and Conifer: Precision Thermistor

- Accuracy: +/- 0.5 °C at 25 °C

Dimensions

32 cm (L) x 3.8 cm (Handle diameters)

Weight:

0.750 kg

Distributor

CFM-3 Chlorophyll Fluorescence Module (Optional)

Modulating Beam	625 nm +/- 5 nm (Red)
Saturation Light	0-10000 $\mu\text{mol}^{-2} \text{s}^{-1}$
Far Red Light	2 x 750 nm LEDs
Detector	PIN Photodiode with >700 nm filter
Detector Method	Rapid pulse peak tracking
Leaf Area	1.75 / 2.5 / 4.5 cm ²