



# CIRAS-4

## Portable Photosynthesis System

*Elevate your research experience.*

- Photosynthesis
- Chlorophyll Fluorescence
- Soil Respiration
- Canopy Assimilation
- Insect Respiration

# CIRAS-4 The 4<sup>th</sup> generation portable powerhouse elevating

The demands of high-level field research have changed.  
Researchers have a lot of data to collect and analyze and not a lot of time.

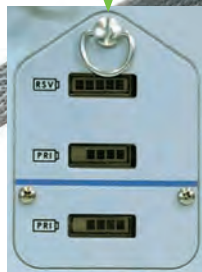
## High-Contrast Full-Color Sunlight-Readable Touchscreen

- + Outstanding readability, particularly in bright sunlight
- + Advanced fast response touch navigation for all system operations
- + User-defined presentation of data (numeric, graphical or custom)
- + Optimized 30° viewing angle

## Adjustable Handle + Ergonomic grip

## Easy Access Battery Compartment

- + View battery power status from the exterior of the console



## CIRAS-4 Portable Photosynthesis System

## Field-Rugged Enclosure

- + Lightweight aluminum enclosure
- + Shock-absorbing polyurethane base

## Three High Capacity Li-ion Battery Packs

- + 16+ hours of continuous operation
- + Uninterrupted, long operation
- + Charge all three batteries simultaneously

## CIRAS-4 Main Console

**Weight** 4.8 kg (including two battery packs)

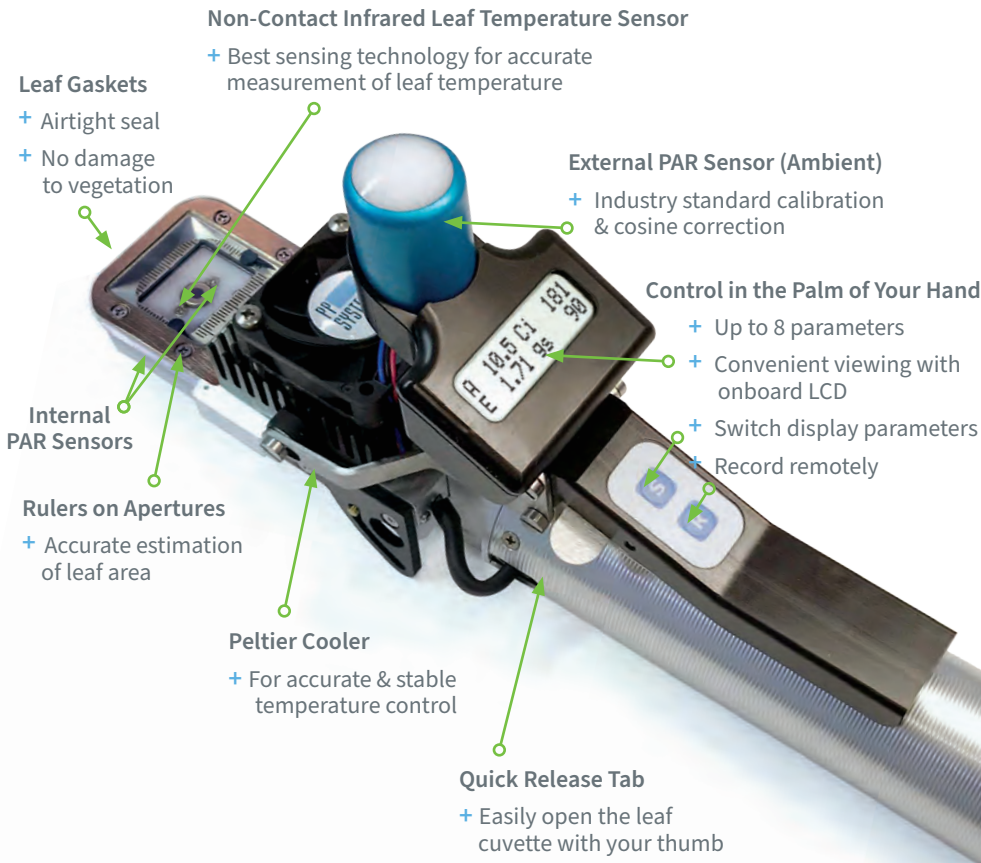
**Dimensions** 28 cm (W) x 14.5 cm (D) x 24 cm (H)

# the high-level research experience worldwide.

Today's research demands fast response technology and the most precise data available.  
True portability, speed, and accuracy are key.

## Unrivalled performance, portability & power

- + **Truly portable!** Lightweight console (4.8 kg) & leaf cuvette (0.7 kg)
- + **True differential gas analyzer** featuring four independent, non-dispersive infrared gas analyzers for both CO<sub>2</sub> & H<sub>2</sub>O
- + Small system volume optimized for the **fastest, most accurate measurement of photosynthesis** available
- + **Automated & rapid A/C<sub>i</sub>** measurement based on both upward & downward CO<sub>2</sub> ramps are quick & easy with our CO<sub>2</sub> ramping technique
- + **Fully automatic, independent & programmable control** of CO<sub>2</sub>, H<sub>2</sub>O, temperature & light
- + **16+ hours of continuous use** with three lightweight, energy-efficient Li-ion battery packs



### Non-Contact Infrared Leaf Temperature Sensor

- + Best sensing technology for accurate measurement of leaf temperature

- Leaf Gaskets**
- + Airtight seal
- + No damage to vegetation

### External PAR Sensor (Ambient)

- + Industry standard calibration & cosine correction

### Control in the Palm of Your Hand

- + Up to 8 parameters
- + Convenient viewing with onboard LCD
- + Switch display parameters
- + Record remotely

### Internal PAR Sensors

- Rulers on Apertures**
- + Accurate estimation of leaf area

### Peltier Cooler

- + For accurate & stable temperature control

### Quick Release Tab

- + Easily open the leaf cuvette with your thumb

### Ambient Temperature Sensor

## Customize Your PLC4 Universal Leaf Cuvette in the Field

Three interchangeable head plates come standard, making it the go-to cuvette for most applications.



25 mm x 7 mm



18 mm Diameter



25 mm x 18 mm

Works with our CFM-4 Chlorophyll Fluorescence Module, too!  
All head plates are secured by magnets — *No tools necessary!*

- + Graph up to six parameters at once & customize X & Y axis for each
- + Simultaneous measurement of photosynthesis & chlorophyll fluorescence
- + 32 GB data storage
- + Powerful, highly customizable software
- + Versatility at it's best with lightweight, field-ready plug & play accessories for several applications

## PLC4 Universal Leaf Cuvette

**Weight** 0.7 kg (not including cable)  
**Dimensions** 27.5 cm (L) x 3.75 cm (Handle Diameter)  
Head: 4.5 cm (L) x 4.5 cm (W) x 2.3 cm (H)

# Fully Mobile & Fast Response

Eliminating the

## Size & Weight Matter

Portability is critical, particularly when field research takes you to remote sites. Having a system that is lightweight with a small footprint results in less site disturbance, greater access to hard-to-reach places and reduced fatigue. At just **4.8 kg** for the CIRAS-4 main console (including two Li-ion battery packs) and **0.7 kg** for the leaf cuvette, field measurements become an entirely new research experience.

## Packed with Power

Advanced system electronics coupled with three powerful, efficient Li-ion battery packs allow for continuous system operation for 16 hours or more. Collect a day's-worth of data without the interruption of swapping out batteries.

## Minimal Maintenance

The CIRAS-4 is remarkably low maintenance! Don't concern yourself with routine service or maintenance of any electrical or mechanical components on the CIRAS-4 console—including **the optical bench**. Simply maintain easily accessible desiccants and filters and periodically inspect the leaf cuvette head and gaskets for dust, dirt and any debris from vegetation.



# obstacles while taking your research to the next level.



## Additional Field-Friendly Features

### + Plug & Play Accessories

All accessories are elegantly designed to connect directly to the CIRAS-4. *No assembly or disassembly required.*

### + Changing Head Plates in the Field is Quick & Easy

All PLC4 Leaf Cuvette head plates are secured with magnets for quick and easy change out in the field.

### + Two Different Cuvettes Offer a Total of Six Options

Working with multiple types of vegetation? The PLC4 Universal Leaf Cuvette comes standard with three different head plates. Need something larger? The PLC4 Broad/Narrow/Conifer Leaf Cuvette comes with three interchangeable heads.

### + Automatically Control Light Intensity & Far-Red

The PLC4 Light Units are quick and easy to attach. You can automatically control light intensity up to  $2,500 \mu\text{mol m}^{-2} \text{s}^{-1}$  and proportion of red, green, blue, and white LEDs. The unique light unit design also includes far-red LEDs which allow users up to 30% control of PAR light intensity.

### + Automatically Control or Create Air Supply Humidity

Built into the  $\text{CO}_2/\text{H}_2\text{O}$  control air supply, the CIRAS-4's unique  **$\text{H}_2\text{O}$  Vapor Equilibrator** incorporates Nafion<sup>®</sup> gas tubing to ensure accurate, stable and precise control of  $\text{H}_2\text{O}$  above and below ambient levels.

### + CFM-4 Chlorophyll Fluorescence Module

The CFM-4 provides both dark- and light-adapted chlorophyll fluorescence measurement parameters as well as OJIP fast induction kinetics. It can be used as both a fluorometer and as an actinic light source. All light sources and fluorescence detection capability is built into one single, compact module.

### + Stand-Alone $\text{CO}_2/\text{H}_2\text{O}$ IRGA

The CIRAS-4 console can be used independently for accurate, precise and reliable measurement of  $\text{CO}_2$  and  $\text{H}_2\text{O}$ . Do you have your own custom chambers that you would like to use? No problem! *Simply connect the gas lines to the CIRAS-4 and begin your measurements.*

### + Ideal Flow Rates

The CIRAS-4 can be programmed to control flow rates up to  $500 \text{ cc min}^{-1}$  resulting in fast response time, higher differentials and lower signal-to-noise ratio on  $\text{CO}_2$  and  $\text{H}_2\text{O}$ , particularly on small vegetation.

# You're in Control

## The certainty of automated environ

### CO<sub>2</sub> & H<sub>2</sub>O Gas Analyzers

*The heart & soul of any leaf gas exchange system*

The backbone and most critical part of any leaf gas exchange system is the gas analysis system. The CIRAS-4 is a *true differential analyzer* featuring four independent, non-dispersive infrared gas analyzers (IRGAs) ensuring the most accurate and reliable measurement and control of CO<sub>2</sub> and H<sub>2</sub>O available. For high-level research, this is a critical requirement and a major advantage over gas switching systems. For enhanced reliability, there are no moving parts and the optical bench is temperature controlled and pressure compensated for the most accurate and reliable measurement of CO<sub>2</sub> and H<sub>2</sub>O under changing ambient conditions. Each gas analyzer includes an IR source, highly polished gold-plated sample cells, and detectors optimized for CO<sub>2</sub> (4.26 μm) and H<sub>2</sub>O (2.60 μm).

Located in the console, the CIRAS-4's optical bench is safely protected and filtered from even the harshest of environmental conditions, eliminating the need for any user maintenance or cleaning. The IRGAs are located close to the internal gas mixing system, providing tight control of gas flow and ultra-fast response to changes in the reference CO<sub>2</sub> and H<sub>2</sub>O gas supply.

### Our Unique Auto-Zero Technique

*No factory recalibration required*

Expect nothing less than the most accurate, reliable and stable calibration of CO<sub>2</sub> and H<sub>2</sub>O for many years without the need for inconvenient, time-consuming and costly return-to-factory calibration. Our innovative, proprietary **Auto-Zero** measurement technique ensures an inherent calibration stability that has been confirmed by more than 35 years of experience in gas analysis technology. It allows for very fast warm-up, quick adaptation to changing ambient conditions and excellent long-term stability. Auto-Zero also minimizes effects on span gas sensitivity, IR source aging, as well as changes in detector sensitivity and electronics. Simple, periodic system checks are recommended to confirm system integrity and calibration.

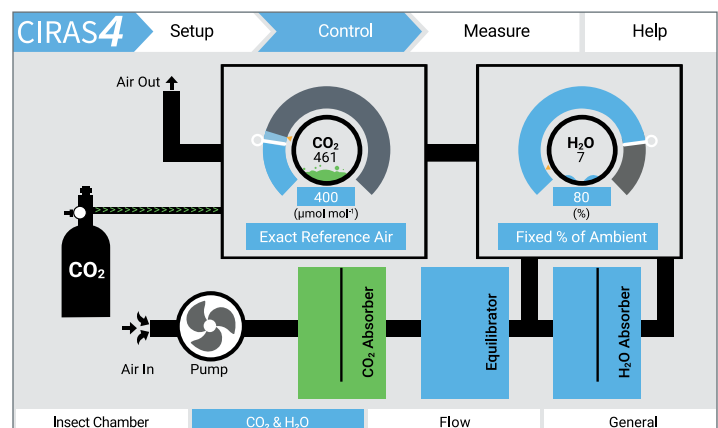
### CO<sub>2</sub> Measurement & Control

Automatic and programmable CO<sub>2</sub> control is standard with the CIRAS-4. PP Systems pioneered the method of controlling CO<sub>2</sub> back in 1992 (CIRAS-1) using mini CO<sub>2</sub> cartridges that are commercially available and easily sourced worldwide. Our proprietary gas mixing technology and CO<sub>2</sub> regulator provide accurate, stable and constant flow of CO<sub>2</sub>. Each CO<sub>2</sub> cartridge provides at least 12 hours of continuous use in the field and our CO<sub>2</sub> regulator and cartridge holder are maintenance free.

**Measurement Range**  
0 – 10000 μmol mol<sup>-1</sup>

**Control Range**  
0 – 2000 μmol mol<sup>-1</sup>

If required, the CIRAS-4 can easily be connected to an external CO<sub>2</sub> source as well as programmed and configured for ambient CO<sub>2</sub> measurements.



Environmental control is fast and easy.

mental controls & the versatility of complete programmability.



## H<sub>2</sub>O Measurement & Control

PP Systems also pioneered the method of controlling H<sub>2</sub>O automatically. Programmable H<sub>2</sub>O control is standard with the CIRAS-4. Onboard, self-conditioning desiccants are used for controlling H<sub>2</sub>O via user-defined settings. The CIRAS-4 can control H<sub>2</sub>O based on a percentage of ambient, VPD (Vapor Pressure Deficit), or to a specific H<sub>2</sub>O concentration.

Measurement Range	Control Range
0 – 75 mmol m <sup>-1</sup>	0 – Dewpoint

The CIRAS-4 can easily be programmed for H<sub>2</sub>O measurements above and below ambient, and can also be configured for ambient H<sub>2</sub>O measurements.

## Temperature Measurement & Control

The CIRAS-4 features the widest range, as well as the fastest and most reliable temperature control in the industry. Each leaf cuvette's integral automatic temperature control is highly accurate and stable. Peltier coolers with heat sink and fan are mounted on all cuvette heads for precise control over a wide range of temperatures. The CIRAS-4 can be programmed to control to a specific leaf temperature, a specific cuvette air temperature or to track leaf to ambient. Temperature control can also be disabled.

Control Limits	Control Range
0 – 45 °C	12 °C below ambient to 15 °C above ambient

## Light Measurement & Control

Automatic control of light intensity is achieved with our compact, low-power lightweight LED (RGBW-FR) light units available for each of our PLC4 Leaf Cuvettes.

Measurement Range	Control Range
0 – 3000 μmol m <sup>-2</sup> s <sup>-1</sup>	0 – 2500 μmol m <sup>-2</sup> s <sup>-1</sup>

Each light unit features a bank of red, green, blue and white LEDs as well as far-red LEDs to allow users control of up to 30% of PAR light intensity. In addition to controlling light intensity, you can also control the proportion of light by wavelength, which can be especially useful for research on plant responses to different wavelengths.

Trusted accuracy & reliability provide the  
freedom to focus on the important work to be done.

# Photosynthesis & Chlorophyll Fluorescence

The compact, lightweight & versatile solution  
for both measurements.

## CFM-4 Chlorophyll Fluorescence Module

If your research includes chlorophyll fluorescence, the **CFM-4 Chlorophyll Fluorescence Module** can measure chlorophyll fluorescence and photosynthesis simultaneously.

### MultiPulse™ Technology for Accurate Estimation of $F_m'$

The CFM-4 is capable of delivering high-saturating pulses up to  $10000 \mu\text{mol m}^{-2} \text{s}^{-1}$ . The CIRAS-4 is the only system available that features our innovative MultiPulse™ technology. MultiPulse™ produces a sequence of user-defined, lower-saturating pulse light levels, avoiding the risk of photodamage to the leaf while accurately estimating apparent  $F_m'$ .

A pulse-amplitude-modulated (PAM) fluorometer, the CFM-4 provides both dark- and light-adapted chlorophyll fluorescence measurement parameters including photochemical vs. non-photochemical quenching and electron transport rate.



### Three Instruments in One!

The CFM-4 is elegantly designed with all light sources and fluorescence detection capability built directly into one lightweight, compact unit. The CFM-4 can also act as an actinic light source for leaf gas exchange as well as a stand-alone fluorometer when leaf gas exchange data is not required.

### OJIP Fast-Induction Kinetics

The CFM-4 provides OJIP fast-induction kinetics. OJIP-related data are easily stored and exported for further analysis providing additional fluorescence-related calculations.

### Multiple Leaf Apertures

The compact module is lightweight (**0.3 kg**), truly plug and play, and allows the user to measure chlorophyll fluorescence over the entire leaf area using any of the three leaf head plates that come standard with the PLC4 Universal Leaf Cuvette.

### Automatic Control

Users can automatically control temperature and light intensity as well as proportion of red, blue, green, white and far-red LEDs.

#### Temperature Control Range

12 °C below ambient to  
15 °C above ambient

#### Light Control Range

0 – 2500  $\mu\text{mol m}^{-2} \text{s}^{-1}$

#### Far-Red Control Range

0 - 30% of PAR



## Chlorophyll Fluorescence Parameters

Measured	Calculated		
$F$	$F_v$	$\Phi\text{PSII}$	$q_L$
$F_s$	$F_v/F_m$	$J$	$\Phi\text{NO}$
$F_o$	$F_v'$	$qP$	$\Phi\text{NPQ-K}$
$F_m$	$F_m'$	$qNP$	$\Phi\text{D}$
$F_o'$	$F_v'/F_m'$	$\text{NPQ}$	$\Phi\text{NPQ-G}$



# Ultra-Fast A/C<sub>i</sub> Curves

The game-changing technology & technique that generates the fastest & easiest measurements available.

## Our High-Speed CO<sub>2</sub> Ramping Technique

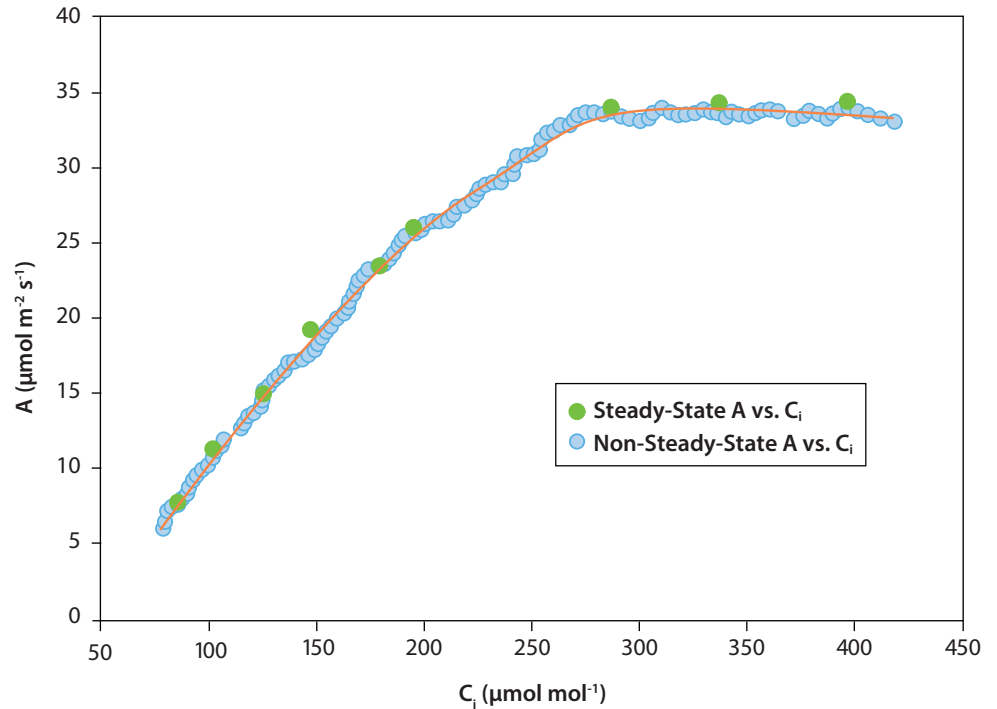
Researchers perform rapid A (Assimilation) vs. C<sub>i</sub> (Intercellular CO<sub>2</sub>) curves to provide parameters for photosynthetic characteristics of leaves beyond those derived from any single A and C<sub>i</sub> measurement including:

- Maximum capacity of the ribulose bis-phosphate carboxylase enzyme (Rubisco- $V_{cmax}$ )
- Maximum rate of photosynthetic electron transport ( $J_{max}$ )
- Maximum rate of triose phosphate utilization ( $TPU_{cmax}$ )

For years, researchers have optimized survey time without sacrificing accuracy by utilizing our proprietary gas mixing system for performing **Stored Differential Balance (SDB)**. Our unique SDB self-calibration routine lets you accurately measure and store CO<sub>2</sub> and H<sub>2</sub>O concentrations over a series of levels, eliminating steady-state response interruptions to balance or match reference and analysis gas analyzers.

This allows you to experience incredibly fast, non-steady-state measurement of A/C<sub>i</sub> in a fraction of the time required for steady-state methods thanks to the CIRAS-4's SDB and our innovative high-speed CO<sub>2</sub> ramping technique — *revolutionizing the research experience*.

The fully automatic and programmable CO<sub>2</sub> ramping process is built into the software, creating an even further simplified set up and rapid A/C<sub>i</sub> measurements based on both upward and downward ramps — more measurements and data points in a much shorter period of time!



Comparison of a non-steady-state A/C<sub>i</sub> curve performed in 7 minutes using our high-speed CO<sub>2</sub> ramping technique to a traditional point-by-point steady-state A/C<sub>i</sub> curve performed in 35 minutes for a typical C<sub>3</sub> Bean (*Phaseolus vulgaris*) at 25 °C with PAR of 1800 μmol m<sup>-2</sup> s<sup>-1</sup>.

Bunce, J. (2018). Three Methods of Estimating Mesophyll Conductance Agree Regarding its CO<sub>2</sub> Sensitivity in the Rubisco-Limited C<sub>i</sub> Range. *Plants*, 7 (3), 62. doi:10.3390/plants7030062

### Benefits of upward & downward ramps

Running increasing CO<sub>2</sub> ramps allows you to stop them when the apparent assimilation rate is no longer increasing with CO<sub>2</sub>, rather than waiting for the CO<sub>2</sub> to get to the maximum programmed value—saving significant time per ramp.

The advantage of running decreasing CO<sub>2</sub> scripts is that information is obtained at a lower range of CO<sub>2</sub> values, compared with increasing CO<sub>2</sub> ramps.

# Lightweight & Field-Flexible Revolutionizing field

## PLC4 Leaf Cuvettes

### Fast equilibration & response time

Overall small system volume means almost immediate response times and fast equilibration.

### Head plates secured by magnets

All head plates are secured in place by magnets for quick and easy change out in the lab or field.

### Rulers on apertures

Rulers are available on larger head plates to assist with better leaf area approximation.

### Minimal boundary layer resistance

Advanced air mixing inside the chamber reduces boundary layer resistance.

### Temperature control

All PLC4 Leaf Cuvettes offer a temperature control range of approximately 12°C below ambient up to 15°C above ambient with 0.1°C precision.

### PAR

Two miniature PAR sensors provide a highly reliable average of PAR inside the cuvette. Ambient PAR is measured by an external sensor with industry standard calibration and cosine correction.

### Easy & accurate leak diagnosis

Direct pressure measurement inside the cuvette allows for easy and accurate leak diagnosis.



PLC4 Universal Leaf Cuvette

## PLC4 Universal Leaf Cuvette

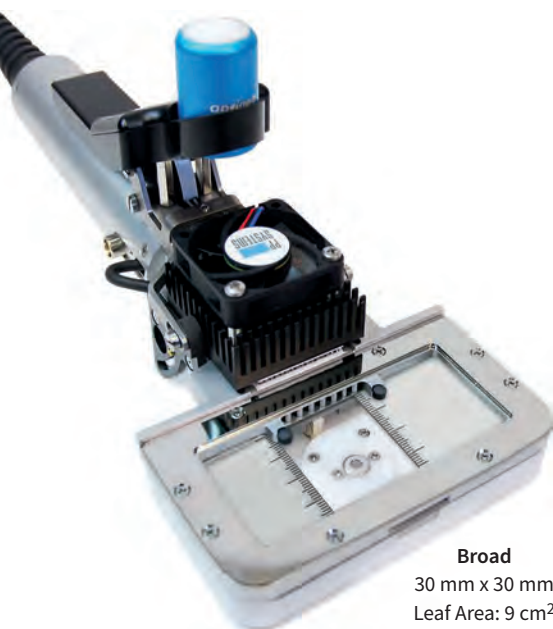
The PLC4 Universal Leaf Cuvette measures most flat, broad leaf plants and comes standard with three interchangeable window head plates that are easy to swap out, allowing you to accommodate a wide range of different leaf sizes. A technologically advanced infrared (IR) sensor provides accurate, non-contact measurement of leaf temperature. Leaf temperature can also be determined by energy balance.



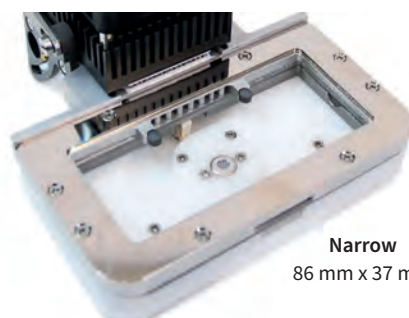
25 mm x 7 mm    18 mm Diameter    25 mm x 18 mm

### PLC4 Universal Leaf Cuvette Field-Changeable Head Plates

- + Secured with magnets
- + Easy to swap out in the field
- + Survey multiple types of vegetation



**Broad**  
30 mm x 30 mm  
Leaf Area: 9 cm<sup>2</sup>



**Narrow**  
86 mm x 37 mm



**Conifer**  
86 mm x 37 mm

## PLC4 Broad/Narrow/Conifer Leaf Cuvette

The PLC4 Broad/Narrow/Conifer Leaf Cuvette comes with three interchangeable heads for measurement on large, flat broad leaves, narrow leaves, grasses, and conifers. Leaf temperature is measured via the non-contact infrared (IR) sensor, directly using a precision thermistor or calculated using energy balance.

# research experience.

## PLC4 LED Light Units (RGBW-FR)

*Automatically control both light intensity & proportion of light by wavelength*

Optional light units are available for automatic control of light for all PLC4 leaf cuvettes. Each light unit features a bank of red, green, blue, white, and far-red LEDs (RGBW-FR) allowing for automatic control of both light intensity up to  $2500 \mu\text{mol m}^{-2} \text{s}^{-1}$  and proportion of light by wavelength. All light units are designed to ensure uniform light distribution over the entire leaf area for accurate results.

### Far-red

Our PLC4 LED light units also include 4 far-red LEDs. CIRAS-4 users can control far-red up to 30% of PAR, allowing users to more accurately recreate the natural light environment.

#### Wavelength (RGBW)

Color	Peak	Full Width at Half Max	Light Control Range
Red	625 nm $\pm$ 5 nm	15 nm	0 – 2500 $\mu\text{mol m}^{-2} \text{s}^{-1}$
Green	528 nm $\pm$ 8 nm	40 nm	
Blue	475 nm $\pm$ 10 nm	28 nm	
White	425 – 700 nm		
Far-red	730 nm $\pm$ 5 nm	31 nm	



## PLC4 Broad/Narrow/Conifer LED Light Unit (RGBW-FR)

*A single light unit for all three heads*

*— saving cost, space & weight in the field*

The PLC4 Broad/Narrow/Conifer LED Light Unit is uniquely designed as an interchangeable RGBW-FR light source for all three heads of the PLC4 Broad/Narrow/Conifer Leaf Cuvette. Effortlessly connect our light units to the corresponding leaf cuvette head for use on cloudy days or for controlled light experiments, or remove for ambient measurements.

### Why is far-red important?

Far-red photon flux (700-750 nm) is approximately 18% of the PAR (400-700 nm) photon flux in sunlight. Far-red makes up an even larger fraction of the photon flux in understory conditions.

Recent research shows that this far-red light is photosynthetically active. Taking photosynthesis measurement with a light spectrum that does not include far-red (e.g., white or red/green/blue LEDs) will result in lower photosynthetic rates compared to photosynthetic rates under sunlight (with the same PAR). The ability to control the amount of far-red light during photosynthesis measurements more accurately mimics rates under sunlight or understory conditions.

Zhen, S., M.W. van Iersel, and B. Bugbee. 2021 Why far-red photons should be included in the definition of photosynthetic photons and the measurement of horticultural fixture efficacy. *Frontiers in Plant Science* 12:693445.

Zhen, S. and M.W. van Iersel. 2019. Far-red light enhances photochemical efficiency in a wavelength-dependent manner. *Physiologia Plantarum* 167:21-33.

Zhen, S. and M.W. van Iersel. 2017. Far-red light is needed for efficient photochemistry and photosynthesis. *Journal of Plant Physiology* 209:115-222.

Zhen, S., & Bugbee, B. (2020). Far-red photons have equivalent efficiency to traditional photosynthetic photons: Implications for redefining photosynthetically active radiation. *Plant, Cell & Environment*, 43(5), 1259-1272.

Zhen, S., & Bugbee, B. (2020). Substituting far-red for traditionally defined photosynthetic photons results in equal canopy quantum yield for CO<sub>2</sub> fixation and increased photon capture during long-term studies: Implications for re-defining PAR. *Frontiers in Plant Science*, 1433.



# Powerful, Customizable & Intuitive Advanced



The highly accurate CIRAS-4 Portable Photosynthesis System is a lightning-fast portable powerhouse that will elevate your research experience.

Its advanced software is exceptionally intuitive and customizable, offering the ultimate user experience. Manage environmental controls—and how you view your data—all from the touchscreen. It's so easy to use, you can begin taking measurements right out of the box.

## The Ultimate User Experience

### Advanced touch navigation & outstanding readability

The CIRAS-4 offers highly responsive advanced touch navigation for all system operations from its large, full-color sunlight-readable touchscreen offering unsurpassed readability even under high sunlight conditions. Its ergonomically designed console offers a 30° viewing angle to comfortably view the display from just about any position in the field.

### Your first measurements in minutes

Got a question? Built-in system help and user tutorials are designed to guide even the most inexperienced user every step of the way.

Simply tap on a control tile to edit.

CO <sub>2</sub> r	CO <sub>2</sub> a	CO <sub>2</sub> d	A	Ci
400.0 μmol mol <sup>-1</sup>	385.0 μmol mol <sup>-1</sup>	-15.0 μmol mol <sup>-1</sup>	6.0 μmol m <sup>-2</sup> s <sup>-1</sup>	338
H <sub>2</sub> O <sub>r</sub>	H <sub>2</sub> O <sub>a</sub>	H <sub>2</sub> O <sub>d</sub>	gs	
7.00 mmol mol <sup>-1</sup>	14.44 mmol mol <sup>-1</sup>	7.44 mmol mol <sup>-1</sup>	273 mmol m <sup>-2</sup> s <sup>-1</sup>	
Tamb	Tcuv	Tleaf	VPD	
22.5 °C	25.0 °C	23.8 °C	1.5 kPa	
PARI	PARe	RH%	Flow	
1500 μmol m <sup>-2</sup> s <sup>-1</sup>	0 μmol m <sup>-2</sup> s <sup>-1</sup>	46.0 %	300 cc min <sup>-1</sup>	

0	Range	2000
CO <sub>2</sub> r		
400.0		
399.5		
μmol mol <sup>-1</sup>		
1	2	3
4	5	6
7	8	9
-	0	.

## Program Experiments & Share with Colleagues from Anywhere

### CIRAS-4 Response Script Editor

Programming experiments from any PC is effortless with the CIRAS-4 Response Script Editor. Easily create, edit and modify your own response curve scripts. Once created, simply upload to the CIRAS-4 console for execution or share with colleagues that may want to replicate your experiment.

### Remote operation & display

Presenting information or utilizing the CIRAS-4 as a teaching tool? Operating the CIRAS-4 remotely on any PC is a popular feature for those particular applications, and more.

Script file: A CI C3

Application: Photosynthesis

Script File: A CI C3

**Levels**

Level 1 of 13

Acclimation 300 (s)

Records per Level 3

Recording Interval 10 (s)

**Environmental Controls**

CO<sub>2</sub> (μmol mol<sup>-1</sup>) 400

H<sub>2</sub>O (mmol mol<sup>-1</sup> or % ambient) 50

Temp (°C) 25

PAR (μmol m<sup>-2</sup> s<sup>-1</sup>) 1500

RGBW (%) 38 Red 37 Green 25 Blue 0 White Far-Red (%) 0

Time to Complete Script: 0h 35m 20s

**Chlorophyll Fluorescence**

Record to File:  Raw Fluorescence

Initial Fluorescence Fv/Fm

Dark Adapt Period 30 (min)

Repeated Fluorescence ΦPSII-SP

Concluding Fluorescence Fo'

Dark Adapt Period 30 (min)

Modulating Light Gain 50 (%) Level 3

**Saturating Light**

Single Pulse Duration 1 (s) Intensity 9000 (μmol m<sup>-2</sup> s<sup>-1</sup>)

MultiPulse™ Duration 0.3 (s)

Steps: (μmol m<sup>-2</sup> s<sup>-1</sup>)

9000 9000 9000

Step 1 Step 2 Step 3 Step 4 Step 5

Level	Acclimation	Records per Level	Recording Interval	CO <sub>2</sub>	H <sub>2</sub> O	Temp	PAR	RGBW	Far-Red
1	300	3	10	400	50	25	1500	38-37-25-0	0
2	120	3	10	300	50	25	1500	38-37-25-0	0
3	120	3	10	250	50	25	1500	38-37-25-0	0
4	120	3	10	200	50	25	1500	38-37-25-0	0
5	120	3	10	150	50	25	1500	38-37-25-0	0

# software that's quick to learn & easy to use.

## Your Data Your Way

It's all about the data. Not only can you trust the CIRAS-4 to provide highly accurate data quickly, you can customize your entire data collection and research experience all from the touchscreen.

### Data files & comments that are uniquely yours

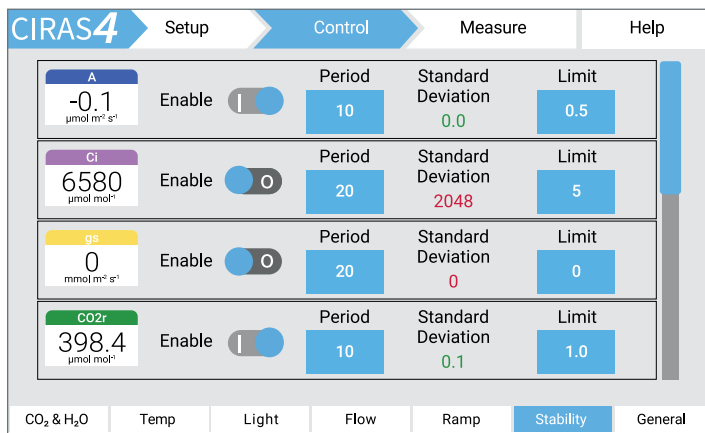
Create your own unique file names using letters, numbers and symbols and adding comments for further detail is quick and easy.

### Unique multi-user profile system

Set up to eight unique profiles based on application, user, experiment, etc.—very useful when multiple users share a single system.

### Stability criteria

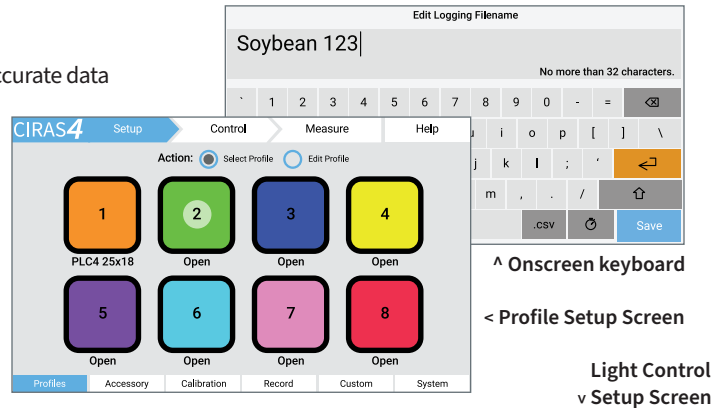
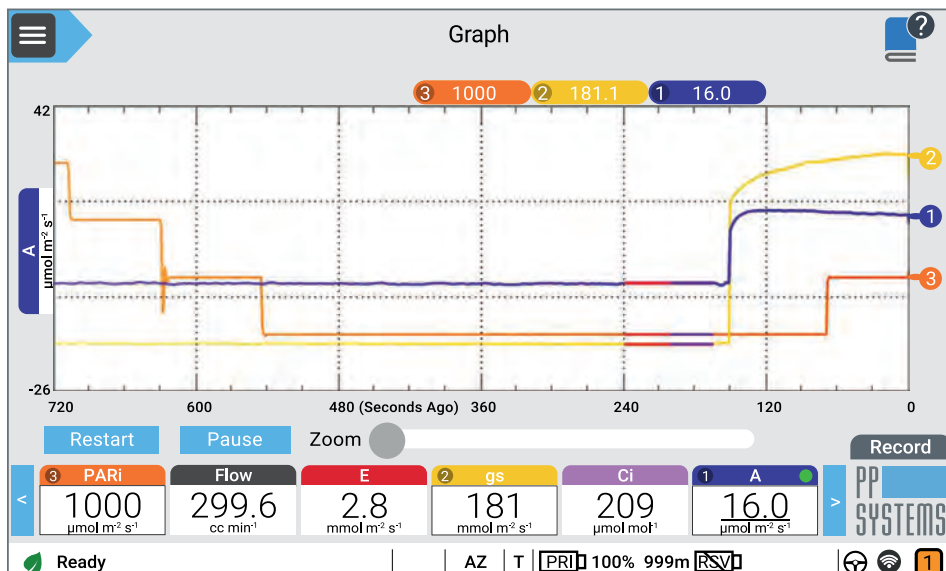
Set your own stability criteria for up to 12 parameters to alert you and the system when measurements are stable and ready to record.



Stability Criteria Setup Screen

### Choose how you view your data

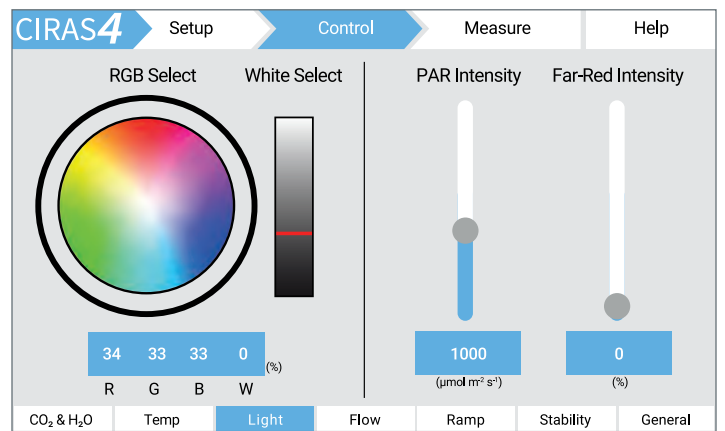
Graph up to six parameters at a time including zoom, pause, and resume, and easily customize the X and Y axis for each parameter.



Onscreen keyboard

< Profile Setup Screen

Light Control v Setup Screen



### Data storage & transfer



Store your data using the CIRAS-4's 32 GB of internal memory. Easily transfer your data to your PC via a USB flash drive for further analysis in your spreadsheet program of choice.

## Parameters

### Measured

CO <sub>2</sub> Reference	Cuvette Temperature
CO <sub>2</sub> Analysis	Leaf Temperature
CO <sub>2</sub> Differential	PAR Internal
H <sub>2</sub> O Reference	PAR External
H <sub>2</sub> O Analysis	Relative Humidity
H <sub>2</sub> O Differential	Flow
Air Temperature	Leaf Area

### Calculated

Assimilation (A)
Intercellular CO <sub>2</sub> (C <sub>i</sub> )
Stomatal Conductance (gs)
Evaporation/Transpiration (E)
Vapor Pressure Deficit (VPD)
Water Use Efficiency (WUE)

# Valuable Versatility

A single instrument capable of multiple applications.

Expand your measurement capabilities with field-ready plug & play accessories. All CIRAS-4 accessories are lightweight & designed to connect directly to the console, further enhancing the process of discovery.

## Soil CO<sub>2</sub> Efflux

The popular **SRC-2 Soil Respiration Chamber** is the industry standard for rapid, accurate survey measurement of soil CO<sub>2</sub> efflux. The lightweight chamber is constructed of rugged PVC with a convenient handle for placement on the soil surface. A stainless steel ring provides a good seal on the soil surface or on collars.\* A built-in temperature sensor measures air temperature near the soil surface.

<b>Dimensions</b>	150 mm (H) x 100 mm (D)	<b>Temperature Sensor (Precision Thermistor)</b>	
<b>Volume</b>	1171 ml	<b>Range</b>	-5 to 50 °C
<b>Area</b>	77.6 cm <sup>2</sup>	<b>Accuracy</b>	± 0.5 °C at 25°C
<b>Cable Length</b>	1.5 meters		
<b>Weight</b>	0.9 kg		



\* Optional collars are available for the CPY-5 Canopy Assimilation Chamber & the SRC-2 Soil Respiration Chamber from PP Systems.

## Net Canopy CO<sub>2</sub> Flux

The **CPY-5 Canopy Assimilation Chamber** is ideal for measurement of net canopy CO<sub>2</sub> flux on low-lying vegetation and fruit. Constructed of rugged polycarbonate, the interior of the transparent chamber includes a user-adjustable PAR (Photosynthetically Active Radiation) sensor and an air temperature sensor near the soil surface. An aluminum ring provides a good seal on the soil surface or on collars.\*

<b>Dimensions</b>	145 mm (H) x 146 mm (D)	<b>Temperature Sensor (Precision Thermistor)</b>	
<b>Area</b>	167 cm <sup>2</sup>	<b>Range</b>	-5 to 50 °C
<b>Cable Length</b>	1.5 meters	<b>Accuracy</b>	± 0.5 °C at 25°C
<b>Weight</b>	1.05 kg	<b>PAR Sensor</b>	Fully cosine corrected
		<b>Range</b>	0-3000 μmol m <sup>-2</sup> s <sup>-1</sup>
		<b>Accuracy</b>	± 5 μmol m <sup>-2</sup> s <sup>-1</sup>
		<b>Precision</b>	1 μmol m <sup>-2</sup> s <sup>-1</sup>



## Insect Respiration

Our **Insect Respiration Chamber** can be used to measure CO<sub>2</sub> respiration from small insects.

<b>Chamber Dimensions</b>	15.1 cm (L) x 25 cm (D)
<b>Chamber Volume</b>	33 cm <sup>3</sup> (not including gas tubing)
<b>Chamber Weight</b>	65 g



## Custom Chambers? No Problem.

The CIRAS-4 console can be used as a stand-alone CO<sub>2</sub> and H<sub>2</sub>O differential gas analyzer. Custom chambers are easily integrated in the laboratory or field.

# Training & Technical Support

With you in the field & for the life of your system.

We want you to have the best possible experience & fully utilize your instrument's capabilities from day one.

## Hands-On Training



Our goal with any of our instruments is that you not only understand basic operating procedures, but that you use the instrument to its fullest capacity.

We will get you up to speed quickly as well as provide valuable tips and tricks to further enhance your user experience.

Our instructor-to-student ratio is intentionally kept low to guarantee personalized attention. True hands-on training ensures the maximum benefit of attending the course.

"The training provided by PP Systems was exceptional. The training covered aspects ranging from basic setup to advanced techniques of chlorophyll fluorescence. The step-by-step instruction made disseminating the knowledge gained with my other lab members quite easy."

— Lauren Pile  
Clemson University

## Technical Support

Prompt service and support is paramount and we are highly responsive to all requests.

Direct technical support is available from our U.S. headquarters as well as through our extensive network of certified factory-trained distributors.

"Whenever we had issues or concerns, the team at PP Systems has been very responsive and helpful troubleshooting and providing solutions."

— Dr. Alan N. Lakso  
Cornell University

## Pioneering the Field Research Experience

*The exception has become the rule*

Innovation has always been synonymous with CIRAS Portable Photosynthesis Systems. Our introduction of automatic and programmable CO<sub>2</sub> and H<sub>2</sub>O control as well as the use of 8g CO<sub>2</sub> cartridges — features that have been standard on all CIRAS systems dating back to 1992 — have since become the industry standard and we wouldn't have it any other way.

Our constant innovation is centered around designing scientific instruments that eliminate obstacles and elevate the research experience.

### The CIRAS-4 Experience

With the CIRAS-4, you collect highly accurate data at a rapid pace with the most advanced and mobile instrument of its kind, making for an exciting research experience that ignites the desire to explore further and we're with you every step of the way. Let's elevate your research.

## Trusted & Tested Technology

*Since 1984*

PP Systems has proudly designed and manufactured instrumentation to meet the technology needs of plant and soil scientists since 1984.

Our extensive experience working closely with scientists to provide the best possible research tools, along with our drive to constantly enhance the research and educational experience has afforded us the honor of being one of the most highly referenced global standards in more than 100 countries worldwide.

# Technical Specifications

## CIRAS-4 Portable CO<sub>2</sub>/H<sub>2</sub>O Gas Analysis System

<b>Analysis Method</b>			
Non-dispersive infrared, configured as an absolute absorptiometer with microprocessor control of linearization. Four independent gas analyzers simultaneously measure absolute CO <sub>2</sub> and H <sub>2</sub> O for both the reference and analysis gas streams. All measurements ARE corrected for temperature and pressure.			
<b>CO<sub>2</sub> Measurement Range</b>	0 – 10000 μmol mol <sup>-1</sup> (Optimized for 0-2000 μmol mol <sup>-1</sup> )	<b>USB Flash Drive</b>	Two USB flash drive ports for transferring stored data files, response curve scripts, and updating system firmware and software.
<b>CO<sub>2</sub> Accuracy</b>	± 3 μmol mol <sup>-1</sup> at 300 μmol mol <sup>-1</sup> Within 1% of reading > 300 μmol mol <sup>-1</sup>	<b>Internal Memory</b>	32 GB
<b>CO<sub>2</sub> Precision</b>	0.1 μmol mol <sup>-1</sup>	<b>Microprocessor</b>	528 MHz ARM® Cortex™
<b>CO<sub>2</sub> Control Range</b>	0 – 2000 μmol mol <sup>-1</sup>	<b>Touch Display</b>	7.0" capacitive touch LCD display (800 x 480 pixels). Sunlight readable.
<b>H<sub>2</sub>O Measurement Range</b>	0 – 75 mmol mol <sup>-1</sup>	<b>Power Supply</b>	Two internal, rechargeable 7.2V Li-ion battery packs (Primary) provide up to 16 hours of continuous use. A third interchangeable battery pack (Reserve) further extends operation time. The power supply/charger can charge all three batteries simultaneously.
<b>H<sub>2</sub>O Accuracy</b>	± 0.08 mmol mol <sup>-1</sup> up to 5 mmol mol <sup>-1</sup> Within 1.5% of reading > 5 mmol mol <sup>-1</sup>	<b>Operating Temperature Range</b>	-5 to 50 °C, non-condensing. External air filtration may be required in dusty environments.
<b>H<sub>2</sub>O Precision</b>	0.01 mmol mol <sup>-1</sup>	<b>Enclosure</b>	Rugged, ergonomic, lightweight aluminum with polyurethane base.
<b>H<sub>2</sub>O Control Range</b>	0-Dewpoint or 0-100% Ambient	<b>Dimensions</b>	28 cm (W) x 14.5 cm (D) x 24 cm (H)
<b>Pressure Range</b>	55 – 115 kPa	<b>Weight</b>	4.8 kg (including 2 battery packs) 5.2 kg (including 3 battery packs)
<b>Air Sampling</b>	User-adjustable from 50 – 100 cc min <sup>-1</sup> using integral DC pumps. Both analysis and reference pumps are fitted with mass flow controllers.		
<b>Cuvette Air Supply Unit (Integral)</b>	0 – 500 cc min <sup>-1</sup> measured and controlled by a mass flow meter.		
<b>Auxiliary Port</b>	For connection to the SRC-2 Soil Respiration Chamber and CPY-5 Canopy Assimilation Chamber.		

## PLC4 Leaf Cuvettes

<b>Construction</b>	<ul style="list-style-type: none"> <li>Handle: Aluminum</li> <li>Leaf Gasket: Closed cell foam</li> </ul>	<b>PAR Sensor (External)</b>	Filtered silicon cell quantum sensor (cosine corrected). <ul style="list-style-type: none"> <li>Response: 400 – 700 nm</li> <li>Range: 0 – 3000 μmol m<sup>-2</sup> s<sup>-1</sup></li> <li>Accuracy: ± 5 μmol m<sup>-2</sup> s<sup>-1</sup></li> <li>Precision: 1 μmol m<sup>-2</sup> s<sup>-1</sup></li> </ul>
<b>LCD Display</b>	2 x 16 character display	<b>Air Temperature Sensor</b>	Precision thermistor <ul style="list-style-type: none"> <li>Range: -10 to 50 °C</li> <li>Accuracy: ± 0.5 °C at 25 °C</li> </ul>
<b>Keypad</b>	2 tactile keys for recording and parameter selection.	<b>Temperature Control</b>	12 °C below ambient to 15 °C above ambient. <ul style="list-style-type: none"> <li>Control limits: 0 – 45 °C</li> <li>Setpoint resolution: 0.1 °C</li> </ul>
<b>PAR Sensors (Internal)</b>	2 silicon photodiode sensors. <ul style="list-style-type: none"> <li>Range: 0 – 3000 μmol m<sup>-2</sup> s<sup>-1</sup></li> <li>Precision: 1 μmol m<sup>-2</sup> s<sup>-1</sup></li> </ul> For use with LED light unit.	<b>Broad/Narrow/Conifer</b>	Air mixing fan plus two additional miniature air mixing fans <ul style="list-style-type: none"> <li><b>Broad / Narrow:</b> Glass</li> <li><b>Conifer:</b> Scratch resistant glass</li> <li><b>Broad:</b> 30 mm x 30 mm (9 cm<sup>2</sup>)</li> <li><b>Narrow:</b> 86 mm x 37 mm</li> <li><b>Conifer:</b> 86 mm x 37 mm</li> </ul>
<b>Leaf Temperature Sensor Accuracy</b>	± 0.5 °C at 25 °C		
<b>Cuvette Stirring</b>	Universal Air mixing fan		
<b>Window</b>	Glass		
<b>Apertures</b>	<ul style="list-style-type: none"> <li>25 mm x 7 mm (1.75 cm<sup>2</sup>)</li> <li>25 x 18 mm (4.5 cm<sup>2</sup>)</li> <li>18 mm Diameter (2.5 cm<sup>2</sup>)</li> </ul>		
<b>Leaf Temperature Sensor Type</b>	Infrared sensor for accurate, non-contact measurement.		
<b>Dimensions</b>	27.5 cm (L) x 3.75 cm (Handle Diameter) Head: 4.5 cm (L) x 4.5 cm (W) x 2.3 cm (H)		
<b>Weight</b>	0.7 kg (not including cable)		

## PLC4 LED Light Units (RGBW-FR)

<b>Automatic Control Range</b>	0 – 2500 μmol m <sup>-2</sup> s <sup>-1</sup>		
<b>LED Specification</b>	<b>Wavelength (RGBW)</b>		
	<b>Color</b>	<b>Peak</b>	<b>Full Width at Half Maximum</b>
	Red	625 nm (± 5 nm)	15 nm
	Green	528 nm (± 8 nm)	40 nm
	Blue	475 nm (± 10 nm)	28 nm
	White	425 – 700 nm	
	Far-Red	730 nm (± 5 nm)	31 nm
	<b>Universal</b>		
<b>Dimensions</b>	6.4 cm (L) x 6.0 cm (W) x 5.1 (H)		
<b>Weight</b>	0.2 kg		
	<b>Broad/Narrow/Conifer</b>		
	6.5 cm (L) x 11.2 cm (W) x 6.0 cm (H)		
	0.4 kg		

## SRC-2 Soil Respiration Chamber

<b>Construction</b>	Rugged PVC with a convenient handle for placement on the soil surface.
<b>Soil Ring</b>	Aluminum. Provides good seal directly on soil or on soil collars (available from PP Systems)
<b>Volume</b>	1171 ml
<b>Area</b>	77.6 cm <sup>2</sup>
<b>Cable Length</b>	1.5 m
<b>Temperature Sensor</b>	Precision thermistor <ul style="list-style-type: none"> <li>Range: -10 to 50 °C</li> <li>Accuracy: ± 0.5 °C at 25 °C</li> </ul>
<b>Dimensions</b>	150 mm (H) x 100 mm (Diameter)
<b>Weight</b>	0.9 kg

## CPY-5 Canopy Assimilation Chamber

<b>Construction</b>	Rugged polycarbonate
<b>Soil Ring</b>	Aluminum. Provides good seal directly on soil or on soil collars (available from PP Systems)
<b>Area</b>	167 cm <sup>2</sup>
<b>Cable Length</b>	1.5 m
<b>Temperature Sensor</b>	Precision thermistor <ul style="list-style-type: none"> <li>Range: -10 to 50 °C</li> <li>Accuracy: ± 0.5 °C at 25 °C</li> </ul>
<b>Quantum Sensor</b>	Filtered, silicon cell sensor (cosine corrected) for PAR. <ul style="list-style-type: none"> <li>Response: 400 – 700 nm</li> <li>Range: 0 – 3000 μmol m<sup>-2</sup> s<sup>-1</sup></li> <li>Accuracy: ± 5 μmol m<sup>-2</sup> s<sup>-1</sup></li> <li>Precision: 1 μmol m<sup>-2</sup> s<sup>-1</sup></li> </ul>
<b>Dimensions</b>	145 mm (H) x 146 mm (Diameter)
<b>Weight</b>	0.9 kg


## Insect Respiration Chamber

<b>Construction</b>	Clear acrylic
<b>Gas Connections</b>	Barb fittings for connection to 1/8" flexible tubing.
<b>Chamber Volume</b>	33 cm <sup>3</sup> (not including gas tubing)
<b>Dimensions</b>	15.1 cm (Length) x 25 cm (Diameter)
<b>Weight</b>	65 g

## CFM-4 Chlorophyll Fluorescence Module

<b>Modulating Beam</b>	625 nm ± 5 nm (Red)
<b>Saturation Light</b>	0 – 10000 μmol m <sup>-2</sup> s <sup>-1</sup>
<b>Far Red Light</b>	730 nm (± 5 nm)
<b>Detector</b>	PIN photodiode with >700 nm filter
<b>Detector Method</b>	Rapid pulse peak tracking
<b>Leaf Area</b>	1.75 cm <sup>2</sup> , 2.5 cm <sup>2</sup> , and 4.5 cm <sup>2</sup>
<b>Dimensions</b>	8 cm (L) x 6 cm (W) x 6.2 cm (H)
<b>Weight</b>	0.3 kg

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