

A woman with dark hair tied in a bun, wearing a black and white striped shirt and sunglasses on her head, is using the CIRAS-3 Portable Photosynthesis System in a field. She is holding a blue and silver device with a black hose attached to a plant. The device has two vertical chambers with blue liquid inside. The background is a lush green field with trees.

# CIRAS-3

## Portable Photosynthesis System

## Redefining the Boundaries of Life Science Research

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



# CIRAS-3 Redefining "portability." Meeting the demands of

## Field Fit. Lab

### High-Contrast, Full-Color Transflective LCD

- + Outstanding readability, particularly in bright sunlight
- + User-defined presentation of data (numeric, graphical or custom)
- + Optimized 30° viewing angle

### User-Adjustable Handle

### System Navigation & User Inputs

- + 27 tactile keys for easy user inputs & navigation

### Two Internal Rechargeable Li-ion Battery Packs

- + Up to 12 hours of continuous operation

### Field-Rugged Enclosure

- + Lightweight aluminum enclosure
- + Easy access battery compartment
- + Shock-absorbing polyurethane base

### Ambient Temperature Sensor



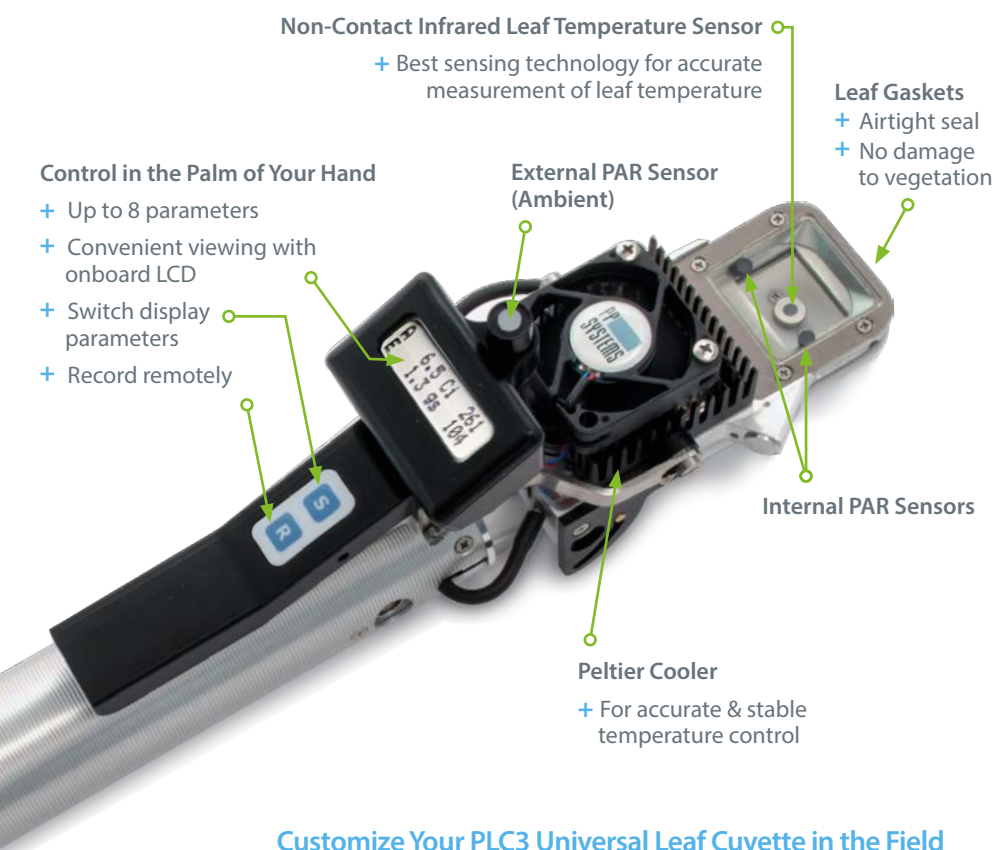
### CIRAS-3 Main Console

Weight: 4.5 kg (including batteries)

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

the serious researcher driving the future of science.

# Accurate. Always Reliable.



## Customize Your PLC3 Universal Leaf Cuvette in the Field

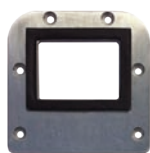
Three interchangeable headplates come standard, making it the go-to cuvette in most situations.



25 mm x 7 mm



18 mm Diameter



25 mm x 18 mm

Works with our CFM-3 Chlorophyll Fluorescence Module, too!

All accessories are field-changeable as well — *virtually plug & play!*

## Laboratory Results in a Field-Portable System

- + **Truly mobile!** Lightweight console (4.5 kg) & leaf cuvette (0.75 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**
- + **Rapid measurement of A/C<sub>i</sub>** with our high-speed CO<sub>2</sub> ramp technology
- + **Fully automatic, independent & programmable control** of CO<sub>2</sub>, H<sub>2</sub>O, temperature & light
- + **Up to 12 hours of continuous use** with two lightweight, energy-efficient Li-ion battery packs
- + **Collect a full range of data in a single measurement**
- + **Simultaneous measurement of photosynthesis & chlorophyll fluorescence**
- + **Unlimited data storage**
- + **Intuitive user interface**
- + **Powerful, highly customizable software**
- + Versatility at it's best with **lightweight, field-ready plug & play accessories** for several applications

## PLC3 Universal Leaf Cuvette

**Weight:** 0.75 kg

**Dimensions:** 32 cm (L) x 3.8 cm (Handle Diameter)



# 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 **4.5 kg** for the CIRAS-3 main console (including both Li-ion battery packs) and **0.75 kg** for the leaf cuvette, field measurements become an entirely new research experience.

## Packed with Power

Advanced system electronics coupled with powerful, efficient Li-ion battery packs allow for continuous system operation up to 12 hours. Our batteries have greater power density allowing for longer battery life, eliminating time-consuming and cumbersome battery changes in the field.

## Minimal Maintenance Required

No need to concern yourself with routine service or maintenance of any electrical or mechanical components on the CIRAS-3 console – **including the optical bench**. Simply maintain easily accessible dessicants and filters and periodically inspect the leaf cuvette head and gaskets for dust, dirt and any debris from vegetation. Simply put, the CIRAS-3 is remarkably low maintenance!





# obstacles while elevating the experience.



## Additional Field-Friendly Features

### + Plug & Play Leaf Cuvettes & Chambers

All accessories are elegantly designed to connect directly to the CIRAS-3. *No assembly or disassembly required.*

### + Two Leaf Cuvettes in One

The PLC3 Conifer and Narrow Leaf Cuvettes are convertible by design. Need both styles? Simply change out the top head plate to convert from one style to the other. The PLC3 Narrow/Conifer LED Light Unit is designed to fit both leaf cuvette styles – *an additional value.*

### + Automatically Control or Create Air Supply Humidity

Built into the CO<sub>2</sub>/H<sub>2</sub>O control air supply, the CIRAS-3's unique **H<sub>2</sub>O Vapor Equilibrator** incorporates Nafion® gas tubing to ensure accurate, stable and precise control of H<sub>2</sub>O above and below ambient levels.

### + CFM-3 Chlorophyll Fluorescence Module

The CFM-3 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 CO<sub>2</sub>/H<sub>2</sub>O IRGA

The CIRAS-3 console can be used independently for accurate, precise and reliable measurement of CO<sub>2</sub> and H<sub>2</sub>O. Do you have your own custom chambers that you would like to use? No problem! *Simply connect the gas lines to the CIRAS-3 and begin your measurements.*

### + Ideal Flow Rates

The CIRAS-3 can be programmed to control flow rates up to 500 cc min<sup>-1</sup> resulting in fast response time, higher differentials and lower signal-to-noise ratio on CO<sub>2</sub> and H<sub>2</sub>O, particularly on small vegetation.

"The people working in my lab and I have been extremely satisfied with the CIRAS-3. We have found all of the CIRAS systems (my first was the CIRAS-1) to be easy to use and highly reliable.

In addition, the technical support and service at PP Systems is impeccable."

— Bruce Schaffer, Ph.D.  
University of Florida

# 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-3 is a *true differential analyzer* featuring 4 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  $\mu\text{m}$ ) and H<sub>2</sub>O (2.60  $\mu\text{m}$ ).

Located in the console, the CIRAS-3's optical bench is safely protected and filtered from even the harshest of environmental conditions, virtually 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 30 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-3. 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.

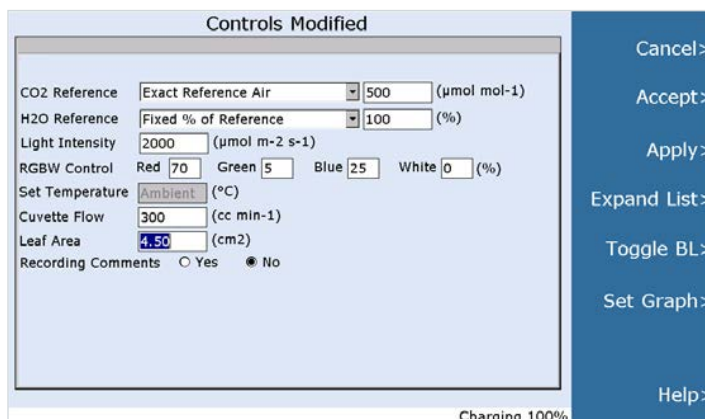
### Measurement Range

0 – 10000  $\mu\text{mol mol}^{-1}$

### Control Range

0 – 2000  $\mu\text{mol mol}^{-1}$

The CIRAS-3 can easily be connected to an external CO<sub>2</sub> source if required. It can also be easily 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-3. Onboard, self-conditioning desiccants are used for controlling H<sub>2</sub>O via user-defined settings. The CIRAS-3 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 (mb).

Measurement Range	Control Range
0 – 75 mb	0 – Dewpoint

The CIRAS-3 can easily be configured for above and below ambient H<sub>2</sub>O measurements.

## Temperature Measurement & Control

The CIRAS-3 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-3 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	-10 °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) light units available for each of our PLC3 leaf cuvettes.

Measurement Range	Control Range
0 – 3000 $\mu\text{mol m}^{-2} \text{s}^{-1}$	0 – 2500 $\mu\text{mol m}^{-2} \text{s}^{-1}$ (PLC3 Universal)
	0 – 2000 $\mu\text{mol m}^{-2} \text{s}^{-1}$ (PLC3 Conifer & Narrow)

Each light unit features a bank of red, green, blue and white LEDs. 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 light types.

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

# 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

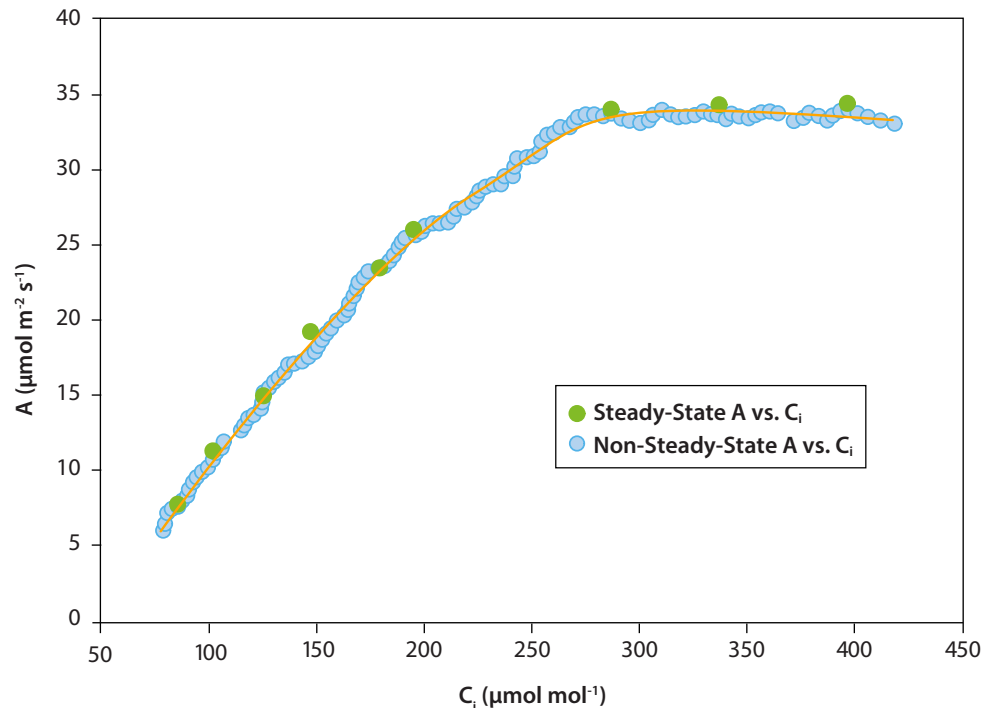
Researchers perform rapid A (Assimilation) vs. C<sub>i</sub> (Intercellular CO<sub>2</sub>) curves to provide parameters for photosynthetic characteristics of leaves beyond those derived from any single A and C<sub>i</sub> measurement including:

- Maximum capacity of the ribulose bis-phosphate carboxylase enzyme (Rubisco-V<sub>cmax</sub>)
- Maximum rate of photosynthetic electron transport (J<sub>max</sub>)
- Maximum rate of triose phosphate utilization (TPU<sub>cmax</sub>)

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-3's SDB and our innovative high-speed CO<sub>2</sub> ramping technique — *revolutionizing the research experience*.

The process is fully automatic and programmable and post-processing of data could not be any easier — 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  $\mu\text{mol m}^{-2} \text{s}^{-1}$ .

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





# Photosynthesis & Chlorophyll Fluorescence

The compact, lightweight & versatile solution  
for both measurements.

## CFM-3 Chlorophyll Fluorescence Module

If your research includes chlorophyll fluorescence, the **CFM-3 Chlorophyll Fluorescence Module** is capable of simultaneously measuring chlorophyll fluorescence and photosynthesis.

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

The CFM-3 is capable of delivering high saturating pulses up to  $10000 \mu\text{mol m}^{-2} \text{s}^{-1}$ . The CIRAS-3 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  $F_m'$ .

### Actinic Light Source — Added Versatility & Value

The CFM-3 is elegantly designed with all light sources and fluorescence detection capability built directly into one lightweight, compact unit.

It can act 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.

### Multiple Leaf Head Plates

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 PLC3 Universal Leaf Cuvette.

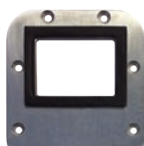
#### PLC3 Universal Leaf Cuvette Head Plates



25 mm x 7 mm  
1.75 cm<sup>2</sup>



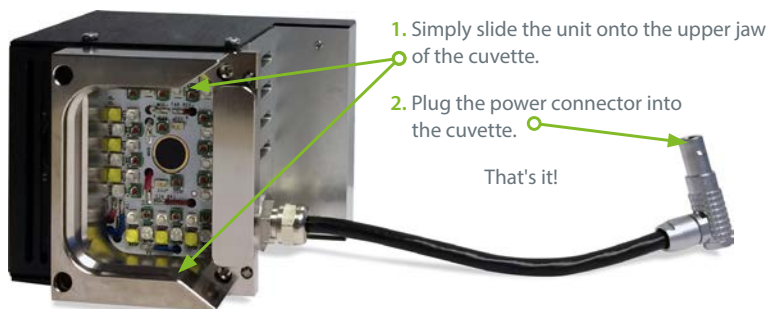
18 mm Diameter  
2.5 cm<sup>2</sup>



25 mm x 18 mm  
4.5 cm<sup>2</sup>



### Elegant & Lightweight Design — Ideal for Field Use



1. Simply slide the unit onto the upper jaw of the cuvette.

2. Plug the power connector into the cuvette.

That's it!

## Chlorophyll Fluorescence Parameters

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

# Lightweight & Field-Adaptable Revolutionizing

## PLC3 Leaf Cuvettes

Each cuvette is truly plug & play! No need for time-consuming delicate reassembly & adjustment of different heads or sensors. All leaf cuvette materials are carefully selected to minimize influences such as infrared radiation, water sorption, CO<sub>2</sub> effects & leaks.

### PLC3 Universal Leaf Cuvette

By far our most popular leaf cuvette, the **PLC3 Universal Leaf Cuvette** measures most flat, broad leaf plants. It 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 in the field.

Two miniature PAR sensors provide a highly reliable average of PAR inside the cuvette in addition to ambient PAR measured by an external sensor. A technologically advanced Infrared (IR) sensor provides accurate, non-contact measurement of leaf temperature. Leaf temperature can also be determined by energy balance.

For flat,  
broad leaves

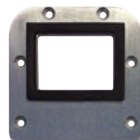
PLC3 Universal Leaf Cuvette



25 mm x 7 mm



18 mm Diameter



25 mm x 18 mm

#### PLC3 Universal Leaf Cuvette Field-Changeable Head Plates

- + Comes standard
- + Easy to swap out in the field
- + Survey multiple types of vegetation

### PLC3 Conifer & Narrow Leaf Cuvettes

An internal PAR sensor provides measurement of PAR inside the cuvette in addition to ambient PAR by an external sensor.

Leaf temperature is calculated using energy balance or measured directly using a precision thermistor for contact measurement.

For grasses,  
cereal crops  
& short needle  
conifers

PLC3 Conifer Leaf Cuvette

#### Need both?

No need to purchase  
two cuvettes.

Optional head plates  
provide the simple  
conversion between  
"narrow" and "conifer".

For grasses,  
cereal crops  
& long needle  
conifers

PLC3 Narrow Leaf Cuvette



the research experience.

## LED Light Units

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

Optional light units are available for automatic control of light for all PLC3 leaf cuvettes. Each light unit features a bank of red, green, blue and white LEDs (RGBW), allowing for automatic control of both light intensity and proportion of light by wavelength. All light units are designed to ensure uniform light distribution over the entire leaf area for accurate results.

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.

### Wavelength (RGBW)

Color	Peak	Full Width at Half Max
Red	625 nm $\pm$ 5 nm	15 nm
Green	528 nm $\pm$ 8 nm	40 nm
Blue	475 nm $\pm$ 10 nm	28 nm
White	425 – 700 nm	

### Light Control Ranges

Universal	0 – 2500 $\mu\text{mol m}^{-2} \text{s}^{-1}$
Narrow/Conifer	0 – 2000 $\mu\text{mol m}^{-2} \text{s}^{-1}$



PLC3 Universal Leaf Cuvette with PLC3 Universal LED Light Unit

## PLC3 Conifer & Narrow LED Light Unit

*A single light unit for both — an added savings in cost, space & weight in the field*

This PLC3 LED Light Unit is uniquely designed as an interchangeable RGBW light source for both the PLC3 Conifer and Narrow Leaf Cuvettes.



PLC3 Conifer & Narrow LED Light Unit

# Powerful, Customizable & Intuitive Software

## Outstanding Readability Under All Lighting Conditions, Particularly High Sunlight

The CIRAS-3 features a large, full-color 7.0" transfective display offering unsurpassed readability even under high sunlight conditions. The brighter the sun, the higher the contrast! The console is ergonomically designed to offer a 30° viewing angle to comfortably view the display from just about any position in the field. A 27-key tactile keypad is available for all user inputs and system navigation.

## Your First Measurements in Minutes

Begin collecting data shortly after your system arrives. Built-in system help and user tutorials are designed to guide even the most inexperienced user every step of the way.



## Details with Your Data

Easily include that detailed, alphanumeric information needed for analysis and post-processing your stored data using the CIRAS-3's virtual keyboard.

RecType	ExcelTime	Comment	CO2r	CO2d
R	5/23/18 1:19 PM	Drought Exp 1A	395.1	3
R	5/23/18 1:23 PM	Drought Exp 1A	395.1	3
R	5/23/18 1:29 PM	Drought Exp 2B	395.1	3
R	5/23/18 1:33 PM	Drought Exp 2B	395.1	3
R	5/23/18 1:36 PM	Drought Exp 2B	395.1	3

Set Graph Modified

Variable 1 [CO2r (Reference)] Variable 3 [A (Assimilation)]  
Variable 2 [CO2d (Differential)] Variable 4 [Pv/Fm]

Graph1 Graph2 Graph3  
Y Axis [CO2r (Reference)] [CO2d (Differential)] [Tleaf (Leaf Temperature)]  
Min [0] [50] [0]  
Max [2200] [50] [35]

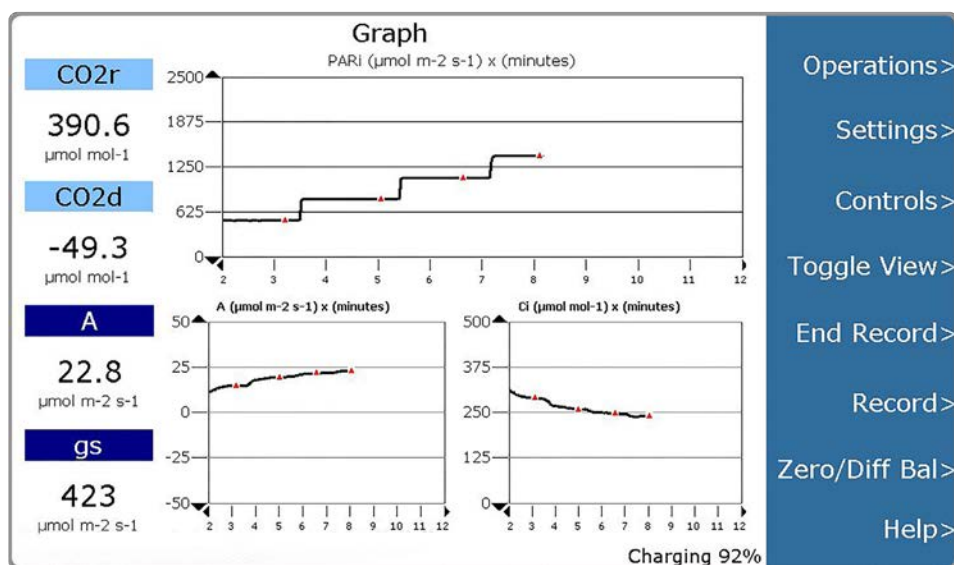
X Axis [Time Span] [Time Span] [Time Span]  
Span [10] [10] [10]  
Min [Auto] [Auto] [Auto]  
Max [Auto] [Auto] [Auto]

Cancel> Accept> Expand List> Clear> Help>

Fully Charged

## Data Presentation

Customize the information that you would like to be presented on the LCD under your system preferences. Many displays, as well as presentation of data, are user-definable including numeric display of information, numeric and graphical presentation of data or customized data for your specific parameters.



"The CIRAS-3 is accurate, reliable, easy to use and extremely robust in greenhouse as well as field conditions. We look forward to continuing to work together to discover new innovations in agriculture."

— Dr. Jeremy Pattison  
Driscoll's Research & Development



with a user interface that's quick to learn & easy to use.



## Data Collection & Transfer

Measurements can be performed manually or automatically based on user-defined time intervals or programmable response curves.

Response scripts can be programmed directly on the CIRAS-3 console or by using our PC Utility.

**Data storage is flexible & virtually unlimited.**

Data can be stored to internal memory or directly to a USB flash drive and is easily



transferred to your PC for further analysis in your spreadsheet program of choice.

## PC Utility

### Response Scripts Editor

Programming experiments from a PC is effortless with PP Systems' **PC Utility**. Easily create, edit and modify your own response curve scripts. Once created, simply upload to the CIRAS-3 console for execution or share with colleagues that may want to replicate your experiment.

Gas Exchange - CO<sub>2</sub> Ramp

Application: Gas Exchange - CO<sub>2</sub> Ramp

Script File: A Ci C3 RAMP

Number of Levels: 226      Acclimation: 120 (s)      Ramp: 6 (min)

Records/Level: 1      Record Interval: 1.6 (s)      Slope: 233.33 (ppm/min)

Environmental Controls

Approximate Reference Air

CO<sub>2</sub> Start: 100 (umol mol<sup>-1</sup>)      CO<sub>2</sub> End: 1500 (umol mol<sup>-1</sup>)      Fixed % of Reference H<sub>2</sub>O: 50 (%)

Temperature: 25 (°C)      Light Intensity: 1500 (umol m<sup>-2</sup> s<sup>-1</sup>)

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

Temperature Control Type per CIRAS-3.      Total Time to Complete Script: 0h 8m 0s

Level	Acclimation	Records	Record Interval	CO <sub>2</sub>	H <sub>2</sub> O	Temp	PAR	RGBW
1	120	1	1	100	50	25	1500	38-37-25-0
2	1	1	1	106	50	25	1500	38-37-25-0
3	1	1	1	112	50	25	1500	38-37-25-0
4	1	1	1	119	50	25	1500	38-37-25-0
5	1	1	1	125	50	25	1500	38-37-25-0
6	1	1	1	131	50	25	1500	38-37-25-0
7	1	1	1	137	50	25	1500	38-37-25-0
8	1	1	1	144	50	25	1500	38-37-25-0
9	1	1	1	150	50	25	1500	38-37-25-0
10	1	1	1	156	50	25	1500	38-37-25-0
11	1	1	1	162	50	25	1500	38-37-25-0
12	1	1	1	168	50	25	1500	38-37-25-0
13	1	1	1	175	50	25	1500	38-37-25-0

### Remote Operation & Display

Presenting information or utilizing the CIRAS-3 as a teaching tool? Operating the CIRAS-3 remotely on a PC is a popular feature for those particular applications, and more.

## 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 And Leaf Area
Air Temperature	

### 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-3 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>	78 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-3 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-3 Experience

With the CIRAS-3, you collect highly accurate data at a rapid pace with the most advanced and mobile instrument of its kind. That makes for an exciting research experience that ignites the desire to explore further and we're with you every step of the way.

## 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-3 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 corrected for temperature and pressure.			
<b>CO<sub>2</sub> Measurement Range</b>	0 – 10000 $\mu\text{mol mol}^{-1}$ (Optimized for 0-2000 $\mu\text{mol mol}^{-1}$ )	<b>Digital Output</b>	<ul style="list-style-type: none"><li>• USB-Mini b (Host)</li><li>• 2 x USB for use with external devices (USB Flash Drive, USB Mouse, etc.).</li></ul>
<b>CO<sub>2</sub> Precision</b>	<ul style="list-style-type: none"><li>• 0.2 <math>\mu\text{mol mol}^{-1}</math> at 300 <math>\mu\text{mol mol}^{-1}</math></li><li>• 0.5 <math>\mu\text{mol mol}^{-1}</math> at 2000 <math>\mu\text{mol mol}^{-1}</math></li><li>• 3.0 <math>\mu\text{mol mol}^{-1}</math> at 10000 <math>\mu\text{mol mol}^{-1}</math></li></ul>	<b>Data Storage</b>	512 MB flash memory for programming and data storage. Unlimited data storage using USB Flash Drive (Thumb Drive).
<b>CO<sub>2</sub> Control Range</b>	0 – 2000 $\mu\text{mol mol}^{-1}$	<b>Microprocessor</b>	800 MHz
<b>H<sub>2</sub>O Measurement Range</b>	0 – 75 mb	<b>Display</b>	7.0" WSVGA transfective, color LCD
<b>H<sub>2</sub>O Precision</b>	<ul style="list-style-type: none"><li>• 0.015 mb at 0 mb</li><li>• 0.020 mb at 10 mb</li><li>• 0.030 mb at 50 mb</li></ul>	<b>User Input</b>	<ul style="list-style-type: none"><li>• 27 tactile keys</li><li>• Virtual alphanumeric keypad</li></ul>
<b>H<sub>2</sub>O Control Range</b>	0-Dewpoint or 0-100% Ambient	<b>Power Supply</b>	Two internal, rechargeable 7.2 V Li-ion battery packs providing up to 12 hours continuous use.
<b>Pressure Range</b>	55 – 115 kPa	<b>Operating Temperature Range</b>	0 – 50 °C, non-condensing. External air filtration may be required in dusty environments.
<b>Air Sampling</b>	User-adjustable from 50 – 100 cc min <sup>-1</sup> using integral DC pumps. Both analysis and reference pumps fitted with mass flow controllers.	<b>Enclosure</b>	Rugged, ergonomic, lightweight aluminum with polyurethane base.
<b>Cuvette Air Supply Unit (Integral)</b>	0 – 500 cc min <sup>-1</sup> measured and controlled by a mass flow meter.	<b>Dimensions</b>	28 cm (W) x 14.5 cm (D) x 24 cm (H)
<b>Auxiliary Port</b>	For connection to the SRC-2 Soil Respiration Chamber and CPY-5 Canopy Assimilation Chamber.	<b>Weight</b>	4.3 kg (including 1 battery pack) 4.5 kg (including 2 battery packs)

## PLC3 Leaf Cuvettes

<b>Construction</b>	<ul style="list-style-type: none"><li>• Handle: Aluminum</li><li>• Leaf Gasket: Closed cell foam</li><li>• Impeller: Aluminum fan blade</li></ul>	<b>PAR Sensor (External)</b>	Fully cosine corrected <ul style="list-style-type: none"><li>• Response: 400 – 700 nm</li><li>• Range: 0 – 3000 <math>\mu\text{mol m}^{-2} \text{s}^{-1}</math></li><li>• Accuracy: <math>\pm 5 \mu\text{mol m}^{-2} \text{s}^{-1}</math></li><li>• Precision: 1 <math>\mu\text{mol m}^{-2} \text{s}^{-1}</math></li></ul>
<b>LCD Display</b>	2 x 16 character parameter display	<b>Air Temperature Sensor</b>	Precision Thermistor <ul style="list-style-type: none"><li>• Range: -5 °C to 50 °C</li><li>• Accuracy: <math>\pm 0.5 \text{ °C}</math> at 25 °C</li></ul>
<b>Keypad</b>	2 tactile keys for recording and LCD selection	<b>Temperature Control</b>	-10 °C below ambient to +15 °C above ambient <ul style="list-style-type: none"><li>• Control limits: 0 – 45 °C</li></ul>
<b>Dimensions (Handle)</b>	32 cm (L) x 3.8 cm (Diameter)		
<b>Leaf Temperature Sensor Accuracy</b>	$\pm 0.5 \text{ °C}$ at 25 °C		
<b>Window</b>	<b>Universal</b> Glass Calflex™ IR Filter <ul style="list-style-type: none"><li>• 7 mm x 25 mm (1.75 cm<sup>2</sup>)</li><li>• 18 mm diameter (2.5 cm<sup>2</sup>)</li><li>• 18 x 25 mm (4.5 cm<sup>2</sup>)</li></ul>	<b>Narrow</b> Glass Calflex™ IR Filter <ul style="list-style-type: none"><li>• 83 mm x 30 mm</li></ul>	<b>Conifer</b> Scratch resistant glass <ul style="list-style-type: none"><li>• 83 mm x 40 mm</li></ul>
<b>PAR Sensor (Internal)</b>	2 miniature PAR sensors	1 PAR sensor	1 PAR sensor
<b>Leaf Temperature Sensor Type</b>	IR sensor for non-contact measurement	Precision thermistor	Precision thermistor
<b>Weight</b>	0.75 kg	1.0 kg	1.0 kg

## PLC3 LED Light Units (RGBW)

<b>LED Specification</b>	<b>Wavelength (RGBW)</b>		<b>Full Width at Half Maximum</b>
	<b>Color</b>	<b>Peak</b>	
	Red	625 nm ( $\pm 5 \text{ nm}$ )	
	Green	528 nm ( $\pm 8 \text{ nm}$ )	
	Blue	475 nm ( $\pm 10 \text{ nm}$ )	
	White	425 – 700 nm	
	<b>Universal</b>		<b>Narrow &amp; Conifer</b>
<b>Automatic Control Range</b>	0 – 2500 $\mu\text{mol m}^{-2} \text{s}^{-1}$		0 – 2000 $\mu\text{mol m}^{-2} \text{s}^{-1}$
<b>Dimensions</b>	6.4 cm (L) x 6 cm (W) x 5.1 (H)		6.5 cm (L) x 10.6 cm (W) x 6 (H)
<b>Weight</b>	0.2 kg		0.3 kg

## SRC-2 Soil Respiration Chamber

<b>Dimensions</b>	150 mm (H) x 100 mm (Diameter)
<b>Volume</b>	1171 ml
<b>Area</b>	78 cm <sup>2</sup>
<b>Cable Length</b>	1.5 meters
<b>Weight</b>	0.9 kg
<b>Temperature Sensor</b>	Precision Thermistor <ul style="list-style-type: none"><li>• Range: -5 to 50 °C</li><li>• Accuracy: <math>\pm 0.5 \text{ °C}</math> at 25 °C</li></ul>

## CPY-5 Canopy Assimilation Chamber

<b>Dimensions</b>	145 mm (H) x 146 mm (Diameter)
<b>Area</b>	167 cm <sup>2</sup>
<b>Cable Length</b>	1.5 meters
<b>Weight</b>	1.1 kg
<b>Temperature Sensor</b>	Precision Thermistor <ul style="list-style-type: none"><li>• Range: -5 to 50 °C</li><li>• Accuracy: <math>\pm 0.5 \text{ °C}</math> at 25 °C</li></ul>
<b>PAR Sensor</b>	Fully cosine corrected <ul style="list-style-type: none"><li>• Range: 0 – 3000 <math>\mu\text{mol m}^{-2} \text{s}^{-1}</math></li><li>• Accuracy: <math>\pm 5 \mu\text{mol m}^{-2} \text{s}^{-1}</math></li><li>• Precision: 1 <math>\mu\text{mol m}^{-2} \text{s}^{-1}</math></li></ul>

## Insect Respiration Chamber

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

## CFM-3 Chlorophyll Fluorescence Module

<b>Modulating Beam</b>	625 nm $\pm 5 \text{ nm}$ (Red)
<b>Saturation Light</b>	0 – 10000 $\mu\text{mol m}^{-2} \text{s}^{-1}$
<b>Far Red Light</b>	2 x 750 nm LEDs
<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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