



Portable Photosynthesis Systems

High-Level Field Research & Basic Research Solutions



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

Field Fit. Lab



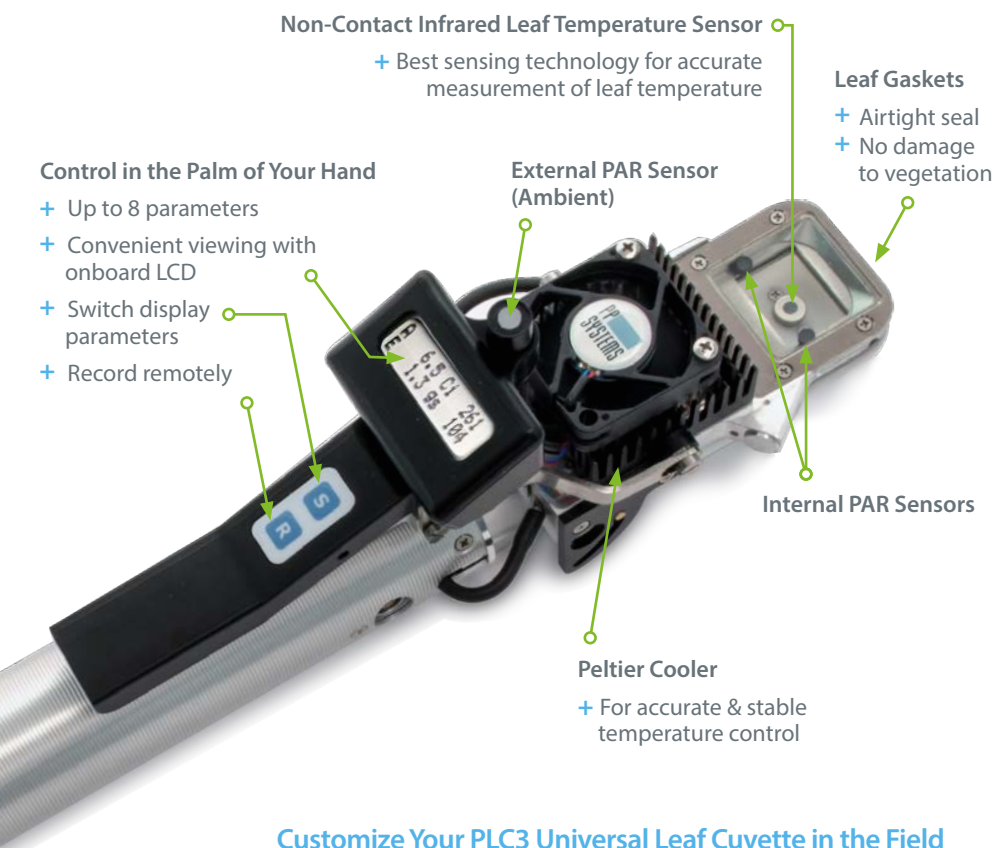
CIRAS-3 Main Console

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

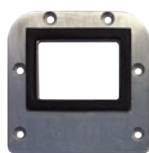
Three interchangeable head plates come standard, making it the go-to cuvette in most situations.



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 CO₂ & H₂O
- + Small system volume optimized for the **fastest, most accurate measurement of photosynthesis available**
- + **Rapid measurement of A/C_i** with our high-speed CO₂ ramp technology
- + **Fully automatic, independent & programmable control** of CO₂, H₂O, 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 desiccants 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 CO₂/H₂O control air supply, the CIRAS-3's unique **H₂O Vapor Equilibrator** incorporates Nafion® gas tubing to ensure accurate, stable and precise control of H₂O 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 CO₂/H₂O IRGA

The CIRAS-3 console can be used independently for accurate, precise and reliable measurement of CO₂ and H₂O. 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⁻¹ resulting in fast response time, higher differentials and lower signal-to-noise ratio on CO₂ and H₂O, 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

CO₂ & H₂O 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 CO₂ and H₂O 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 CO₂ and H₂O under changing ambient conditions. Each gas analyzer includes an IR source, highly polished gold-plated sample cells, and detectors optimized for CO₂ (4.26 μm) and H₂O (2.60 μm).

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 CO₂ and H₂O gas supply.

Our Unique Auto-Zero Technique

No factory recalibration required

Expect nothing less than the most accurate, reliable and stable calibration of CO₂ and H₂O 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.

CO₂ Measurement & Control

Automatic and programmable CO₂ control is standard with the CIRAS-3. PP Systems pioneered the method of controlling CO₂ back in 1992 (CIRAS-1) using mini CO₂ cartridges that are commercially available and easily sourced worldwide. Our proprietary gas mixing technology and CO₂ regulator provide accurate, stable and constant flow of CO₂. Each CO₂ cartridge provides at least 12 hours of continuous use in the field and our CO₂ regulator and cartridge holder are maintenance free.

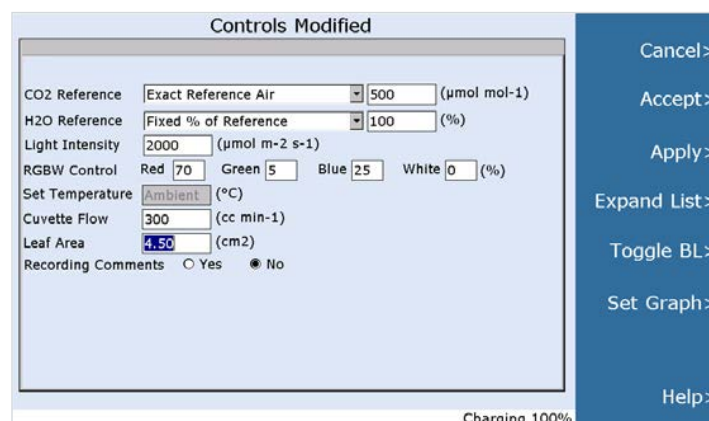
Measurement Range

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 CO₂ source if required. It can also be easily programmed and configured for ambient CO₂ measurements.



Environmental control is fast and easy.

mental controls & the versatility of complete programmability.



H₂O Measurement & Control

PP Systems also pioneered the method of controlling H₂O automatically. Programmable H₂O control is standard with the CIRAS-3. Onboard, self-conditioning desiccants are used for controlling H₂O via user-defined settings. The CIRAS-3 can control H₂O based on a percentage of ambient, VPD (Vapor Pressure Deficit), or to a specific H₂O concentration (mb).

Measurement Range	Control Range
0 – 75 mb	0 – Dewpoint

The CIRAS-3 can easily be configured for above and below ambient H₂O 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_i Curves

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

Our High-Speed CO₂ Ramping Technique

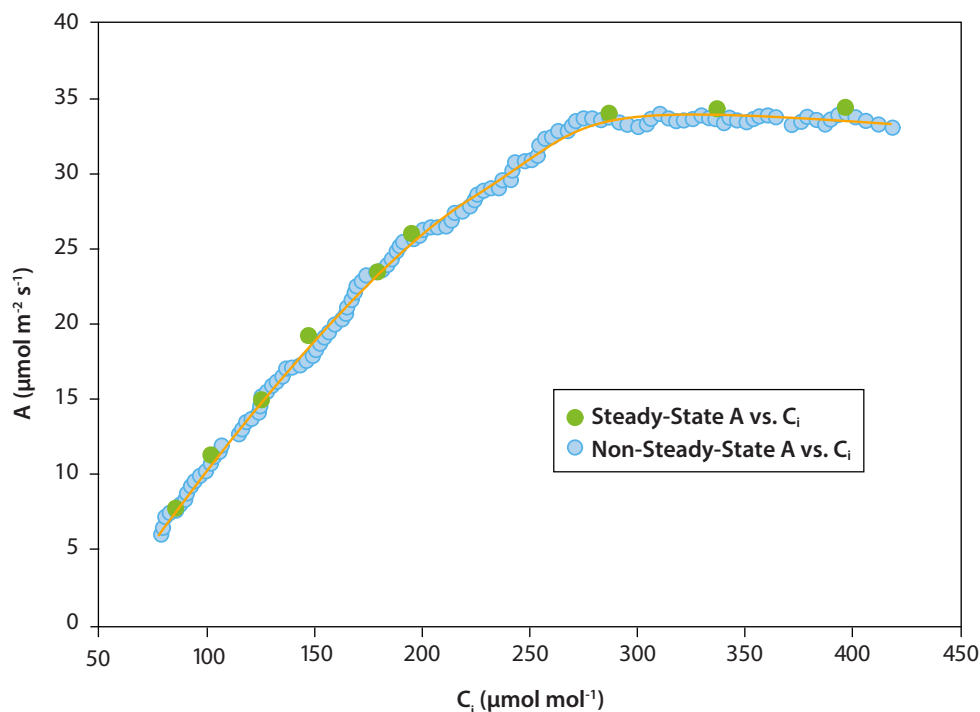
Researchers perform rapid A (Assimilation) vs. C_i (Intercellular CO₂) curves to provide parameters for photosynthetic characteristics of leaves beyond those derived from any single A and C_i measurement including:

- 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 CO₂ and H₂O 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_i in a fraction of the time required for steady-state methods thanks to the CIRAS-3's SDB and our innovative high-speed CO₂ 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_i curve performed in 7 minutes using our high-speed CO₂ ramping technique to a traditional point-by-point steady-state A/C_i curve performed in 35 minutes for a typical C₃ Bean (*Phaseolus vulgaris*) at 25 °C with PAR of 1800 μmol m⁻² s⁻¹.

Bunce, J. (2018). Three Methods of Estimating Mesophyll Conductance Agree Regarding its CO₂ Sensitivity in the Rubisco-Limited C_i 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.

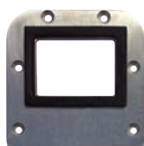
PLC3 Universal Leaf Cuvette Head Plates



25 mm x 7 mm
1.75 cm²



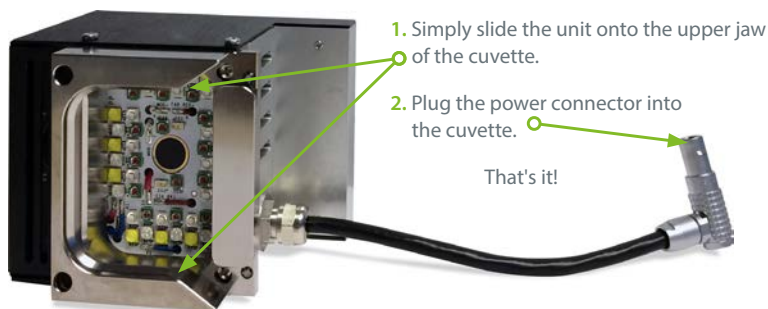
18 mm Diameter
2.5 cm²



25 mm x 18 mm
4.5 cm²



Elegant & Lightweight Design — Ideal for Field Use



Chlorophyll Fluorescence Parameters

Measured		Calculated	
F	F_v	Φ_{PSII}	qL
F_s	F_v/F_m	J	Φ_{NO}
F_o	F_v'	qP	Φ_{NPQ-K}
F_m	F_m'	qNP	Φ_{fD}
F_o'	F_v'/F_m'	NPQ	Φ_{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, CO₂ 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

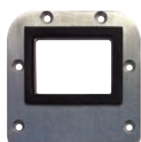
PLC3 Universal Leaf Cuvette



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.

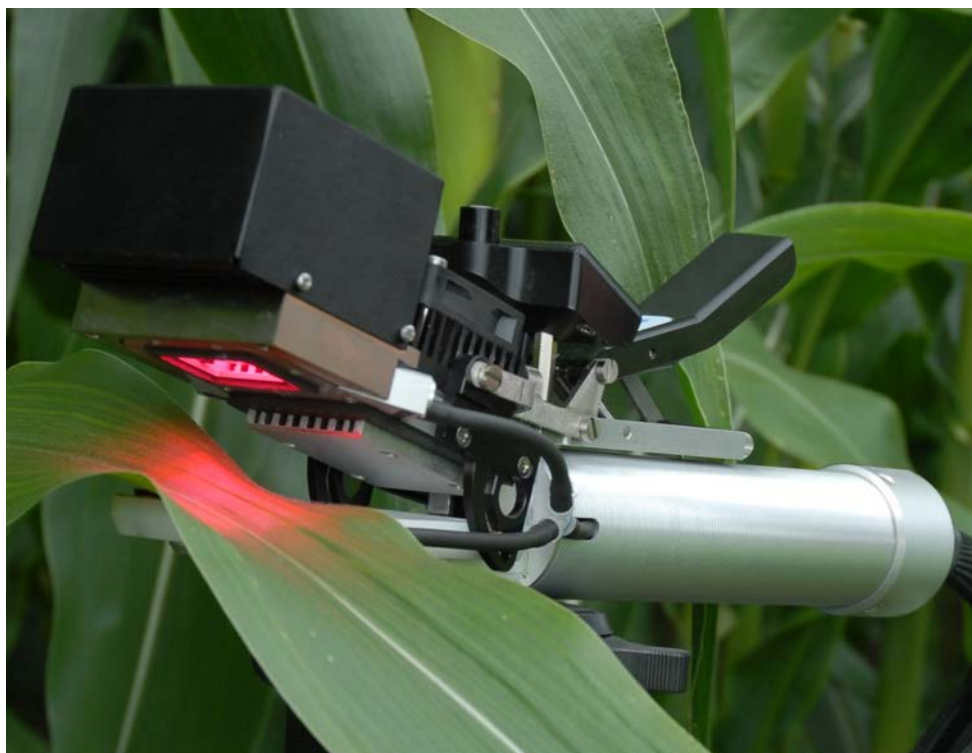
Effortlessly connect our light units to the corresponding leaf cuvette head for use on cloudy days or for controlled light experiments, or remove for ambient measurements.

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]

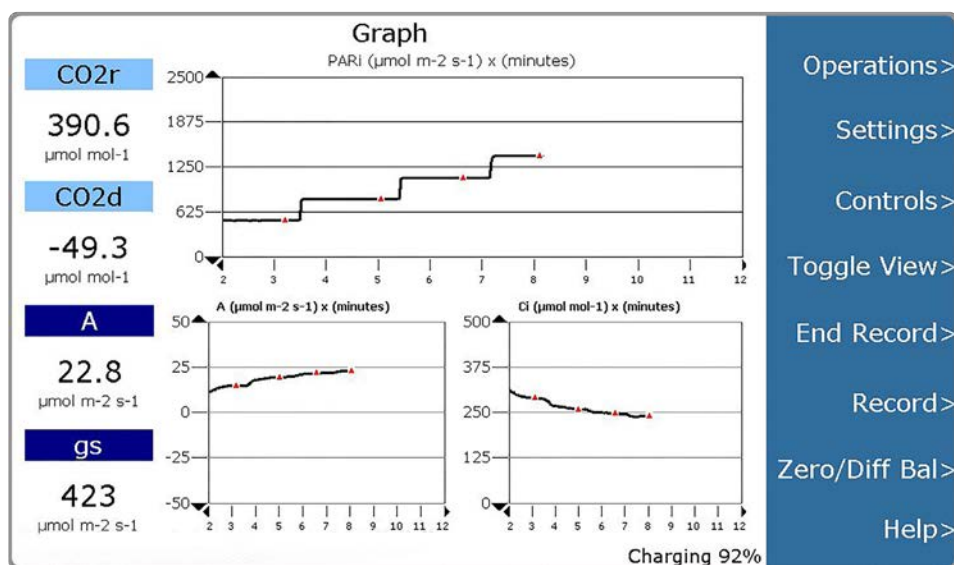
Max [Auto] [Auto] [Auto]

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 - CO₂ Ramp

Application: Gas Exchange - CO₂ 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

CO₂ Start: 100 (umol mol⁻¹) CO₂ End: 1500 (umol mol⁻¹) Fixed % of Reference H₂O: 50 (%)

Temperature: 25 (°C) Light Intensity: 1500 (umol m⁻² s⁻¹)

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 ₂	H ₂ 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 ₂ Reference	Cuvette Temperature
CO ₂ Analysis	Leaf Temperature
CO ₂ Differential	PAR Internal
H ₂ O Reference	PAR External
H ₂ O Analysis	Relative Humidity
H ₂ O Differential	Flow And Leaf Area
Air Temperature	

Calculated

Assimilation (A)
Intercellular CO ₂ (C _i)
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 CO₂ Efflux

The popular **SRC-2 Soil Respiration Chamber** is the industry standard for rapid, accurate survey measurement of soil CO₂ 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.

Dimensions	150 mm (H) x 100 mm (D)	Temperature Sensor (Precision Thermistor)	
Volume	1171 ml	Range	-5 to 50 °C
Area	78 cm ²	Accuracy	± 0.5 °C at 25°C
Cable Length	1.5 meters		
Weight	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 CO₂ Flux

The **CPY-5 Canopy Assimilation Chamber** is ideal for measurement of net canopy CO₂ 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.*

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



Insect Respiration

Our **Insect Respiration Chamber** can be used to measure CO₂ respiration from small insects.

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



Custom Chambers? No Problem.

The CIRAS-3 console can be used as a stand-alone CO₂ and H₂O differential gas analyzer. Custom chambers are easily integrated in the laboratory or field.

Technical Specifications

CIRAS-3 Portable CO₂/H₂O Gas Analysis System

Analysis Method Non-dispersive infrared, configured as an absolute absorptiometer with microprocessor control of linearization. Four independent gas analyzers simultaneously measure absolute CO ₂ and H ₂ O for both the reference and analysis gas streams. All measurements corrected for temperature and pressure.			
CO₂ Measurement Range	0 – 10000 $\mu\text{mol mol}^{-1}$ (Optimized for 0-2000 $\mu\text{mol mol}^{-1}$)	Digital Output	• USB-Mini b (Host) • 2 x USB for use with external devices (USB Flash Drive, USB Mouse, etc.).
CO₂ Precision	0.1 $\mu\text{mol mol}^{-1}$ at 400 $\mu\text{mol mol}^{-1}$	Data Storage	512 MB flash memory for programming and data storage. Unlimited data storage using USB Flash Drive (Thumb Drive).
CO₂ Control Range	0 – 2000 $\mu\text{mol mol}^{-1}$	Microprocessor	800 MHz
H₂O Measurement Range	0 – 75 mb	Display	7.0" WSVGA transfective, color LCD
H₂O Precision	0.01 mb at 10 mb	User Input	• 27 tactile keys • Virtual alphanumeric keypad
H₂O Control Range	0-Dewpoint or 0-100% Ambient	Power Supply	Two internal, rechargeable 7.2 V Li-ion battery packs providing up to 12 hours continuous use.
Pressure Range	55 – 115 kPa	Operating Temperature Range	0 – 50 °C, non-condensing. External air filtration may be required in dusty environments.
Air Sampling	User-adjustable from 50 – 100 cc min ⁻¹ using integral DC pumps. Both analysis and reference pumps fitted with mass flow controllers.	Enclosure	Rugged, ergonomic, lightweight aluminum with polyurethane base.
Cuvette Air Supply Unit (Integral)	0 – 500 cc min ⁻¹ measured and controlled by a mass flow meter.	Dimensions	28 cm (W) x 14.5 cm (D) x 24 cm (H)
Auxiliary Port	For connection to the SRC-2 Soil Respiration Chamber and CPY-5 Canopy Assimilation Chamber.	Weight	4.3 kg (including 1 battery pack) 4.5 kg (including 2 battery packs)

SRC-2 Soil Respiration Chamber

Dimensions	150 mm (H) x 100 mm (Diameter)
Volume	1171 ml
Area	78 cm ²
Cable Length	1.5 meters
Weight	0.9 kg
Temperature Sensor	Precision Thermistor • Range: -5 to 50 °C • Accuracy: ± 0.5 °C at 25 °C

CPY-5 Canopy Assimilation Chamber

Dimensions	145 mm (H) x 146 mm (Diameter)
Area	167 cm ²
Cable Length	1.5 meters
Weight	1.1 kg
Temperature Sensor	Precision Thermistor • Range: -5 to 50 °C • Accuracy: ± 0.5 °C at 25 °C
PAR Sensor	Fully cosine corrected • Range: 0 – 3000 $\mu\text{mol m}^{-2} \text{s}^{-1}$ • Accuracy: ± 5 $\mu\text{mol m}^{-2} \text{s}^{-1}$ • Precision: 1 $\mu\text{mol m}^{-2} \text{s}^{-1}$

Insect Respiration Chamber

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

PLC3 Leaf Cuvettes

Construction	• Handle: Aluminum • Leaf Gasket: Closed cell foam • Impeller: Aluminum fan blade	PAR Sensor (External)	Fully cosine corrected • Response: 400 – 700 nm • Range: 0 – 3000 $\mu\text{mol m}^{-2} \text{s}^{-1}$ • Accuracy: ± 5 $\mu\text{mol m}^{-2} \text{s}^{-1}$ • Precision: 1 $\mu\text{mol m}^{-2} \text{s}^{-1}$
LCD Display	2 x 16 character parameter display	Air Temperature Sensor	Precision Thermistor • Range: -5 °C to 50 °C • Accuracy: ± 0.5 °C at 25 °C
Keypad	2 tactile keys for recording and LCD selection	Temperature Control	-10 °C below ambient to +15 °C above ambient • Control limits: 0 – 45 °C
Dimensions (Handle)	32 cm (L) x 3.8 cm (Diameter)		
Leaf Temperature Sensor Accuracy	± 0.5 °C at 25 °C		
Window	Universal Glass Calflex™ IR Filter • 7 mm x 25 mm (1.75 cm²) • 18 mm diameter (2.5 cm²) • 18 x 25 mm (4.5 cm²)	Narrow Glass Calflex™ IR Filter • 83 mm x 30 mm	Conifer Scratch resistant glass • 83 mm x 40 mm
PAR Sensor (Internal)	2 miniature PAR sensors	1 PAR sensor	1 PAR sensor
Leaf Temperature Sensor Type	IR sensor for non-contact measurement	Precision thermistor	Precision thermistor
Weight	0.75 kg	1.0 kg	1.0 kg

PLC3 LED Light Units (RGBW)

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

CFM-3 Chlorophyll Fluorescence Module

Modulating Beam	625 nm ± 5 nm (Red)
Saturation Light	0 – 10000 $\mu\text{mol m}^{-2} \text{s}^{-1}$
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 cm ² , 2.5 cm ² and 4.5 cm ²
Dimensions	8 cm (L) x 6 cm (W) x 6.2 cm (H)
Weight	0.3 kg

Pioneering the Field Research Experience — *The exception is now the rule*

Innovation has always been synonymous with CIRAS Portable Photosynthesis Systems. Our introduction of automatic and programmable CO₂ and H₂O control and the use of 8g CO₂ cartridges — standard features 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.

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.

TARGAS-1 | Main Console

CO₂ & H₂O Gas Analysis

The **TARGAS-1** console is compact, lightweight (2.1 kg) and is packaged in a rugged, aluminum enclosure with a shock absorbing polyurethane base making it extremely robust and reliable under harsh environmental conditions. It incorporates two non-dispersive infrared gas analyzers for CO₂ and H₂O ensuring accurate measurement and control of both CO₂ and H₂O. An internal air supply unit provides accurately controlled reference air to the leaf cuvette and another pump draws the sample (analysis) air to the gas analyzer. Both pumps are user controlled and accuracy is ensured by two internal electronic flow sensors.

The **TARGAS-1** is perfectly suited for applications that demand portability and a high degree of accuracy and control with minimal maintenance. The design of the instrument ensures an inherent calibration stability that has been confirmed by many years of experience in gas analysis technology.



Rear Panel

The **TARGAS-1** gas analyzers should not require frequent recalibration, although we do recommend periodic checks to confirm system integrity. Both the CO₂ and H₂O gas analyzers employ a non-dispersive, infrared measurement technique, coupled with microprocessor-based signal processing, to achieve excellent stability and specificity to CO₂ and H₂O. Our innovative "Auto-Zero" technology ensures fast warm-up, long term stability, accuracy and analyzer calibration. It also minimizes the effects on span gas sensitivity, sample cell contamination, IR source aging, changes in detector sensitivity and electronics.

All electrical and gas connections, USB interface, power and desiccants are conveniently located on the console rear panel.

Powerful Battery Technology

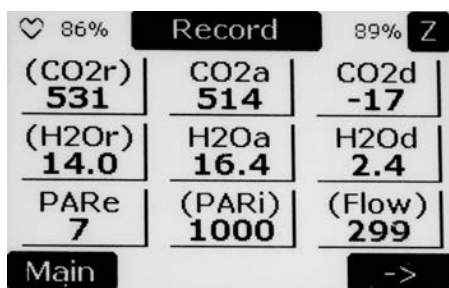
The **TARGAS-1** is supplied with a very efficient, powerful and rechargeable Li-ion battery capable of providing operation in the field for up to 10 hours. The instrument can also be used with an AC power supply (included) for continuous operation from the mains in the laboratory.

Data Storage

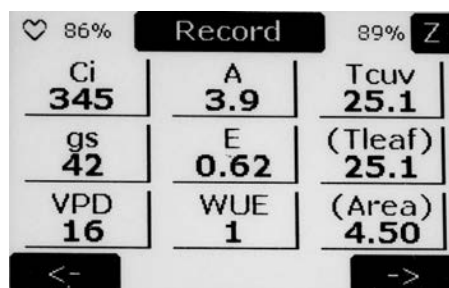
Data storage is virtually unlimited. Data is stored on a USB flash drive (memory stick) for safe storage and easy transfer of data to your PC.

Touch Display

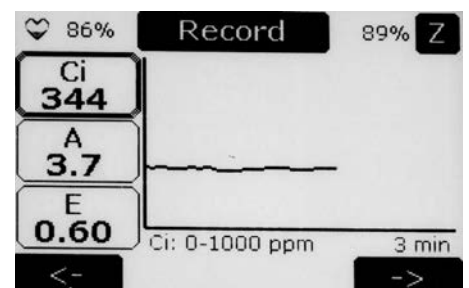
An innovative, large, touch display (EPD) features simple and intuitive system navigation and it offers excellent viewing under high sunlight.



Measured Data



Calculated Data



Graphic Data

PLC Leaf Cuvette



The **PLC Leaf Cuvette** is extremely versatile and light weight (0.7 kg) making it ideal for measurement on a wide variety of vegetation including broad leaves, narrow leaves, grasses and small needle conifers. It includes sensors for measurement of air temperature and PAR. All leaf cuvette materials are carefully selected to minimize influences such as infrared radiation, water sorption, CO₂ effects and leaks. The leaf gaskets provide an air-tight seal without causing damage to vegetation.

Light Unit (Optional)

An optional, low power LED based light unit is available for light control if required. It is a useful option for light response curves and for use on cloudy days. The unit clips onto the head of the PLC5 Leaf Cuvette and it can easily be removed for measurement under ambient conditions.

- Type: LED (white)
- Measurement Range: 0 - 2500 $\mu\text{mol m}^{-2} \text{s}^{-1}$



Chambers for Use with TARGAS-1

Soil Respiration

Our **SRC-2 Soil Respiration Chamber** can be used with the **TARGAS-1** for easy, accurate and rapid measurement of soil CO₂ efflux. The chamber is constructed out of rugged PVC with stainless steel ring (for sealing) and it includes an internal fan for flushing and mixing the air and an air temperature sensor.

- Dimensions: 150 mm (Height) x 100 mm (Diameter)

Collars (optional) are also available for use with the SRC-2 chamber.



Canopy Assimilation

Our **CPY-5 Canopy Assimilation Chamber** can be used with the **TARGAS-1** for easy, accurate and rapid measurement of net canopy CO₂ flux on low lying vegetation. The chamber is transparent and it includes a fan for flushing and mixing the air and sensors for measurement of air temperature and PAR.

- Dimensions: 145 mm (Height) x 146 mm (Exposed Diameter)
- Exposed Area: 167 cm²

Collars (optional) are also available for use with the CPY-5 chamber.



Environmental Sensors

STP-2 Soil Temperature Probe



A rugged, stainless steel probe for accurate measurement of soil temperature. It is commonly used with our SRC-2 Soil Respiration Chamber and CPY-5 Canopy Assimilation Chamber.

Soil Temperature Range

- 0 – 50°C

Full-Spectrum Quantum Sensor



A full-spectrum sensor for accurate measurement of PAR (Photosynthetically Active Radiation) in the lab or in the field under all light sources.

PAR Range

- 0 – 3000 $\mu\text{mol m}^{-2} \text{s}^{-1}$

TRP-3 Temperature/PAR Probe



A single probe for accurate measurement of air temperature and PAR.

Temperature Range

- 0 – 50°C

PAR Range

- 0 – 3000 $\mu\text{mol m}^{-2} \text{s}^{-1}$

Technical Specifications

Main Console

Analysis Method	Two non-dispersive infrared gas analyzers, configured as an absolute absorptiometer with microprocessor control of linearization for both CO ₂ and H ₂ O. All readings are automatically corrected for temperature, pressure and foreign gas broadening.
CO₂ Range	0 – 10000 µmol mol ⁻¹ Precision: 1 µmol mol ⁻¹
H₂O Range	0 – 75 mb
Pressure Compensation Range	80 – 115 kPa
Absolute Accuracy	< 1% of span concentration over the calibrated range but limited by the accuracy of the calibration mixture
Differential Accuracy	+/- 1 µmol mol ⁻¹ for CO ₂ differential up to 50 µmol mol ⁻¹
Linearity	< 1% throughout the range
Stability	Auto-Zero at regular intervals corrects for sample cell contamination, source and detector aging and changes in electronics.
Calibration	User programmable calibration (if required)
Warm-up Time	Approximately 15 minutes
Air Supply Unit	Integral pump for supply of reference air to the leaf cuvette Range: 200 - 500 cc/min CO ₂ and H ₂ O Control: User adjustable from 0 - 100% of ambient. A smoothing volume is recommended for fresh air intake. An internal electronic flow sensor monitors flow rate.
Sampling Pump	Integral pump for sample (Analysis) air Range: 50-200 cc/min An internal electronic flow sensor monitors flow rate.
Sampling Rate	10 Hz. Sample data is averaged and output every 1.0 seconds.
Digital Output	USB
Gas Flow Rate	200-500 cc/min (280-340 cc/min is optimal). An internal electronic flow sensor monitors flow rate.
Terminal Block	10 pin terminal block for system inputs and outputs
Analog Output	0 – 2.5V (CO ₂ range selectable)
Digital Output	One mini USB for connection to external PC
Environmental Sensor Inputs	2 inputs available for use with external chambers and environmental sensors
Alarm	Visual and audible alarm/warnings
Data Storage (USB)	USB Flash Drive port for data storage in multiple formats
Mini USB	For connection to external PC
Touch Display	2.7" electronic paper touch display with 264 x 176 pixel resolution
Power	Internal, rechargeable 7.4V, 8.7 Ah Li-Ion battery provides up to 10 hours of continuous use
Power Consumption	Warm up: 15W (12V @ 1.0A) Normal operation: 7.2W (12V @ 0.6A)
Enclosure	Rugged, ergonomic, lightweight aluminum with polyurethane base
Gas Connections	Two quick connect fittings (inlet and exhaust) for use with 1/8" (.125") ID tubing
Operating Temperature	0 – 50°C, non-condensing External filtration is recommended in dirty/dusty environments.
Dimensions	20 cm L x 20 cm H 10 cm W (Enclosure only)
Weight	2.1 kg

PLC5 Leaf Cuvette

Cuvette Materials	The materials of construction are carefully selected to ensure maximum accuracy and repeatability of gas exchange measurements.
Stirring Fan	High speed fan provides efficient mixing of the air inside the leaf chamber for ensuring rapid measurement and minimal boundary layer resistance.
Cuvette Window	18 mm x 25 mm (4.5 cm ²)
Air Temperature Sensor	Precision Thermistor Range: 0-50 °C Accuracy: ± 0.3 °C at 25 °C
PAR Sensor (External)	Cosine corrected Response: 400 - 700 nm Range: 0 - 3000 µmol m ⁻² s ⁻¹ Accuracy: 10 µmol m ⁻² s ⁻¹
Dimensions	30 cm L x 3 cm (Handle Diameter)
Weight	0.7 kg

Light Unit (Optional)

Type	Low power LED light unit (White LEDs) easily mounts to the PLC5 Broad Leaf Cuvette.
Control Range	0 - 2500 µmol m ⁻² s ⁻¹
Dimensions	6 cm (L) x 6 cm (H) x 5 cm (W)
Weight	0.1 kg

- PP Systems is a registered trademark of PP Systems, Inc.
- PP Systems is continuously updating its products and reserves the right to amend product specifications without notice
- All brand names are trademarks or registered trademarks of their respective owners.

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

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.

For further information, please contact us at:



110 Haverhill Road, Suite 301
Amesbury, MA 01913 U.S.A.

TEL +1 978-834-0505

FAX +1 978-834-0545

EMAIL sales@ppsystems.com



© 2021 PP Systems. All rights reserved.