CIRAS-4

Portable Photosynthesis System

Elevate your research

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

PP SYSTEMS

ppsystems.com

CIRAS-4 The 4th generation portable powerhouse elevating

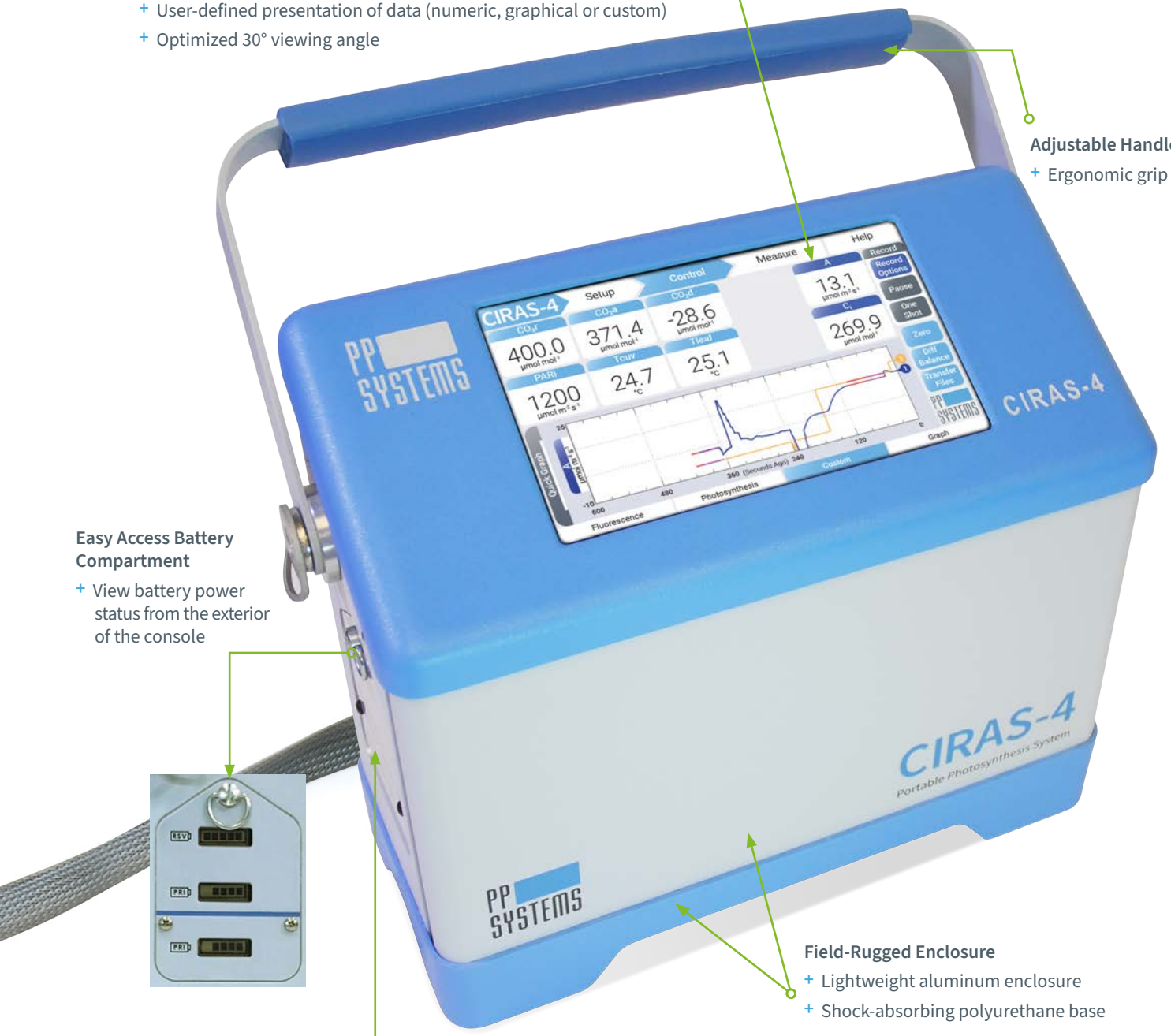
High-level field research has changed.
Researchers have a lot of data to collect and analyze, and not a lot of time.

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

Field-Rugged Enclosure

+ Lightweight aluminum enclosure
+ Shock-absorbing polyurethane base

Three High Capacity Li-ion Battery Packs

+ 16+ hours of continuous operation
+ Uninterrupted power
+ Charge all three internal 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)

high-level research experiences worldwide.

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

Unrivaled 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_2 & H_2O
+ Small system volume optimized for the **fastest, most accurate measurement of photosynthesis available**
+ **Automated & rapid A/C_i** measurement based on both upward & downward CO_2 ramps in real time without post processing with our Single-Step CO_2 Response ($SSCO_2R^{™}$) Method
+ **Fully automatic, independent & programmable control** of CO_2, H_2O, temperature & light
+ **Far-red LEDs** allow users control of up to 30% of Photon Flux Density (PFD)
+ **16+ hours of continuous use** with three lightweight, energy-efficient Li-ion battery packs
+ **Graph up to six parameters at once & customize X & Y axis for each**
+ **Simultaneous measurement of photosynthesis & chlorophyll fluorescence**
+ **32 GB data storage**
+ **Highly customizable settings**
+ Versatility at it's best with **lightweight, field-ready plug & play accessories for several applications**

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!*

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 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and proportion of red, green, blue, and white LEDs. Our unique light unit design allows users to add up to 750 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of far-red light.

+ **Automatically Control or Create Air Supply Humidity**
  Built into the CO_2/H_2O control air supply, the CIRAS-4's unique **H_2O Vapor Equilibrator** incorporates Nafion® gas tubing to ensure accurate, stable, and precise control of H_2O 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 CO_2/H_2O IRGA**
  The CIRAS-4 console can be used independently for accurate, precise, and reliable measurement of CO_2 and H_2O. 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 $cc \cdot min^{-1}$ resulting in fast response times, high differentials, and low signal-to-noise ratio on CO_2 and H_2O, particularly on small vegetation.

You're in Control

The certainty of automated environ

CO_2 & H_2O 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_2 and H_2O 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_2 and H_2O under changing ambient conditions. Each gas analyzer includes an IR source, highly polished gold-plated sample cells, and detectors optimized for CO_2 (4.26 µm) and H_2O (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_2 and H_2O gas supply.

Our Unique Auto-Zero Technique

No factory recalibration required

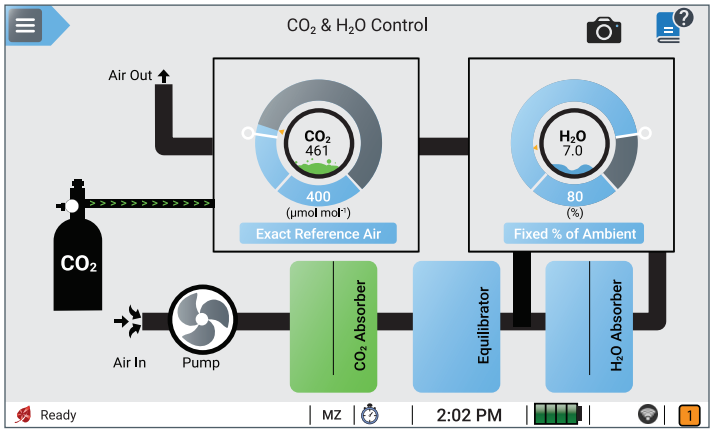
Expect nothing less than the most accurate, reliable, and stable calibration of CO_2 and H_2O for many years without the need for inconvenient, time-consuming, and costly return-to-factory calibration. Our innovative, proprietary **Auto-Zero** measurement technique ensures an inherent calibration stability confirmed by more than 40 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 and 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_2 Measurement & Control

Automatic and programmable CO_2 control is standard with the CIRAS-4. PP Systems pioneered the method of controlling CO_2 back in 1992 (CIRAS-1) using mini CO_2 cartridges that are commercially available and easily sourced worldwide. Our proprietary gas mixing technology and CO_2 regulator provide accurate, stable, and constant flow of CO_2. Each CO_2 cartridge provides at least 12 hours of continuous use in the field and our CO_2 regulator and cartridge holder are maintenance free.

Measurement Range	Control Range
0 – 10000 µmol · mol^{-1}	0 – 2000 µmol · mol^{-1}

If required, the CIRAS-4 can easily be connected to an external CO_2 source as well as programmed and configured for ambient CO_2 measurements.



Environmental control is fast and easy.

mental controls & the versatility of complete programmability.

H_2O Measurement & Control

PP Systems also pioneered the method of controlling H_2O automatically. Programmable H_2O control is standard with the CIRAS-4. Onboard, self-conditioning desiccants are used for controlling H_2O via user-defined settings. The CIRAS-4 can control H_2O based on a percentage of ambient, VPD (Vapor Pressure Deficit), or a specific H_2O concentration.

Measurement Range	**Control Range**
0 – 75 mmol · m^{-1}	0 – Dewpoint

The CIRAS-4 can easily be programmed for H_2O measurements above and below ambient, and can also be configured for ambient H_2O 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^{-2} · s^{-1}	0 – 2500 µmol · m^{-2} · s^{-1}

Each light unit features a bank of red, green, blue, and white LEDs. Far-red LEDs allow users to add up to 750 µmol · m^{-2} · s^{-1} of far-red light. 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 measuring both simultaneously.

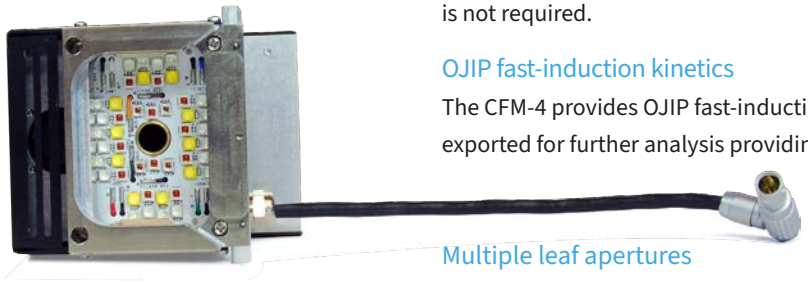
CFM-4 Chlorophyll Fluorescence Module

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

MultiPulse™ technology for accurate estimation of F_m'

The CFM-4 is capable of delivering high-saturating pulses up to 10000 · µmol · m^{-2} · 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.



Light source & fluorescence detection in one accessory!

The CFM-4 is elegantly designed with all light sources and fluorescence detectin capabilities 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.

Chlorophyll Fluorescence Parameters

Measured		Calculated	
F	F_v	ΦPSII	qL
F_s	F_v/F_m	J	ΦNO
F_o	F_v'	qP	ΦNPQ-K
F_m	F_m'	qNP	ΦfD
F_o'	F_v'/F_m'	NPQ	ΦNPQ-G

Temperature Control Range	Light Control Range	Far-Red Control Range
12 °C below ambient to 15 °C above ambient	0 – 2500 µmol · m^{-2} · s^{-1}	0 – 750 µmol · m^{-2} · s^{-1}

Ultra-Fast A/C_i Curves

The fastest method available for rapid measurement of A/C_i. Generate data in real time—no post processing.

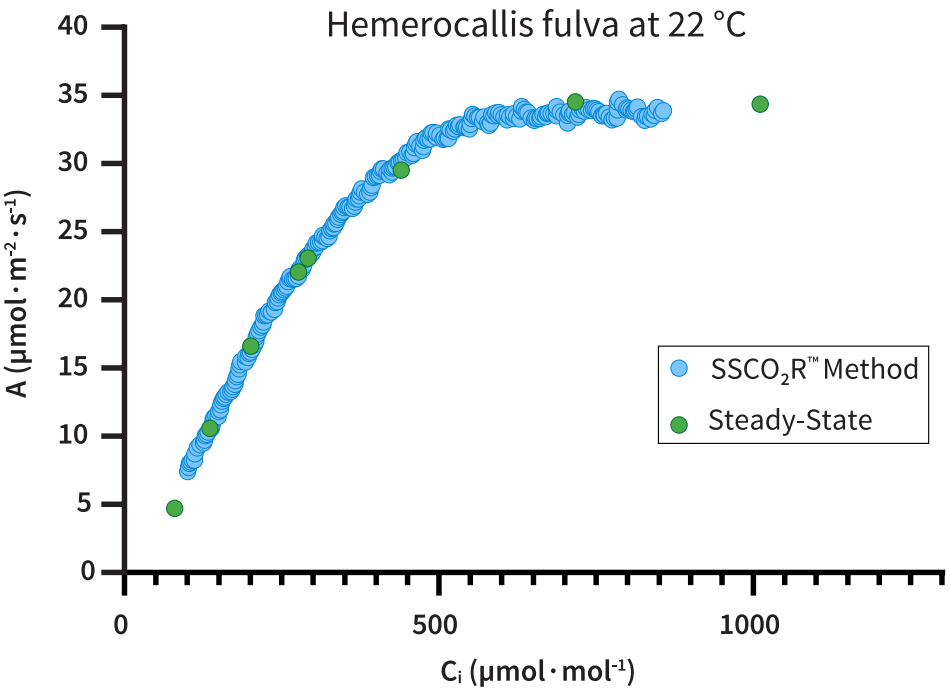
The $SSCO_2R^{™}$ Method

Highly accurate rapid A/C_i curves in real time & no post processing!

The **Single-Step CO_2 Response ($SSCO_2R^{™}$) Method** is a new high-speed CO_2 ramping technique that eliminates all post processing and can generate data for A vs. C_i directly on the CIRAS-4 console in real time.

With the $SSCO_2R^{™}$ Method, reference and analysis channels have identical time responses to a CO_2 ramp and delta CO_2 would be zero during the empty chamber test, eliminating the need for any corrections to A or C_i.

If your research includes the measurement of non-steady-state A/C_i curves, the $SSCO_2R^{™}$ Method is the fastest, most accurate, streamlined method available for the rapid measurement of A/C_i — *more measurements and data points in a much shorter period of time!*



Comparison of a non-steady-state A/C_i curve performed in five minutes using the $SSCO_2R^{™}$ Method to a traditional point-by-point steady-state A/C_i curve performed in 25 minutes for Hemerocallis fulva at 22 °C with PPFD of 1500 µmol · m^{-2} · s^{-1}, flow rate of 350 ml · min^{-1} and VPD of 1.0 kPa. Both curves were run outdoors using the CIRAS-4 and PLC4 Universal Leaf Cuvette with the 18 mm circular window.

Researchers perform rapid A (Assimilation) vs. C_i (Intercellular CO_2) 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 to perform our unique **Stored Differential Balance (SDB)**. The SDB is a self-calibration routine to accurately measure and store CO_2 and H_2O concentrations over a series of levels, eliminating steady-state response interruptions to balance or match reference and analysis gas analyzers.

Our High-Speed CO_2 Ramping Technique: A proven & reliable process*

The CIRAS-4's SDB and our High-Speed CO_2 Ramping Technique allow users to experience incredibly fast, non-steady-state A/C_i measurements based on both upward and downward ramps in minutes. The fully automatic and programmable process is built into the software, further simplifying setup.

Benefits of upward & downward ramps

Increasing CO_2 ramps can be stopped when the apparent assimilation rate is no longer increasing with CO_2, rather than waiting for the CO_2 to get to the maximum programmed value—saving significant time per ramp.

The advantage of running decreasing CO_2 ramps is that information is obtained at a lower range of CO_2 values, compared with increasing CO_2 ramps.

Bunce, J.A. (2024). Photosynthetic acclimation to temperature is affected by night temperature in Zea mays. Photosynthetica, 62(1), 112-115. doi: 10.32615/ps.2024.008

* Bunce, J. (2018). Three Methods of Estimating Mesophyll Conductance Agree Regarding its CO_2 Sensitivity in the Rubisco-Limited C_i Range. *Plants, 7* (3), 62. doi:10.3390/plants7030062

Lightweight & Field-Flexible

Revolutionizing the

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.

Broad
30 mm x 30 mm
Leaf Area: 9 cm^2

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

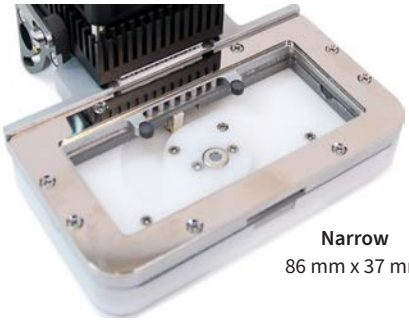
25 mm x 18 mm

PLC4 Universal Leaf Cuvette
Field-Changeable Head Plates

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

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 IR sensor, directly using a precision thermistor or calculated using energy balance.



Narrow
86 mm x 37 mm

Conifer
86 mm x 37 mm

field 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 µmol · m^{-2} · 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 Photon Flux Density (PFD), for a more accurate recreation of the natural light environment.

Wavelength (RGBW-FR)

Color	*Peak*	*Full Width at Half Max*	**Light Control Range**
Red	660 nm ± 10 nm	20 nm	0 – 2500 µmol · m^{-2} · s^{-1}
Green	527 nm ± 7 nm	38 nm	0 – 2500 µmol · m^{-2} · s^{-1}
Blue	447 nm ±7 nm	18 nm	0 – 2500 µmol · m^{-2} · s^{-1}
White	400 – 730 nm		0 – 2500 µmol · m^{-2} · s^{-1}
Far-red	730 nm ±10 nm	32 nm	0 – 750 µmol · m^{-2} · s^{-1}

Why is far-red important?

Far-red (700 – 750 nm) is equivalent to approximately 18% of the photosynthetic 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 measurements 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 PFD). 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.

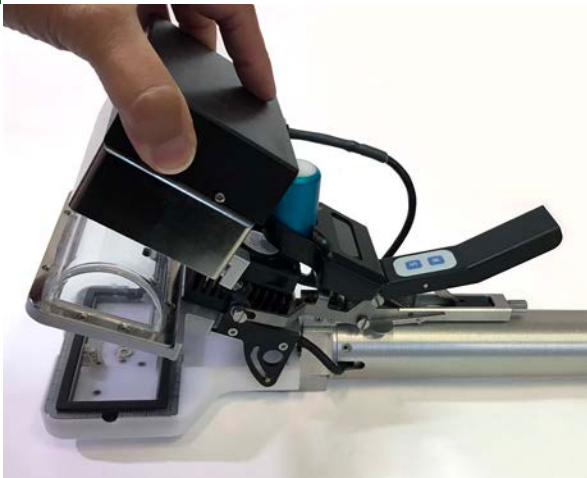
Zhen, S., & Bugbee, B. (2020). Far-red photons have equivalent efficiency to traditional photosynthetic photons: Implications for redefining photosynthetically active radiation. *Plant, Cell & Environment,* 43(5), 1259-1272.

Zhen, S., & Bugbee, B. (2020). Substituting far-red for traditionally defined photosynthetic photons results in equal canopy quantum yield for CO_2 fixation and increased photon capture during long-term studies: Implications for redefining PAR. *Frontiers in Plant Science*, 1433.

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.



Powerful, Customizable & Intuitive Advanced

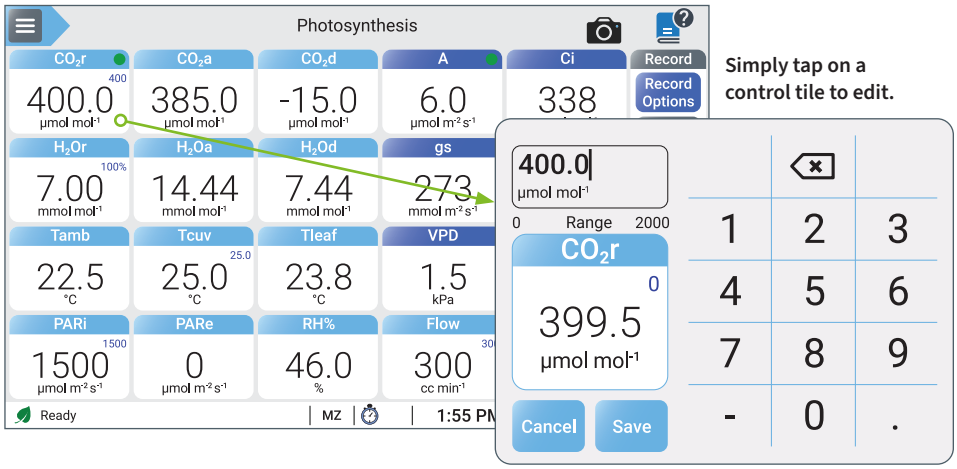
The highly accurate CIRAS-4 Portable Photosynthesis System is a lightning-fast portable powerhouse that will elevate your research experience.

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.



Simply tap on a control tile to edit.

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.

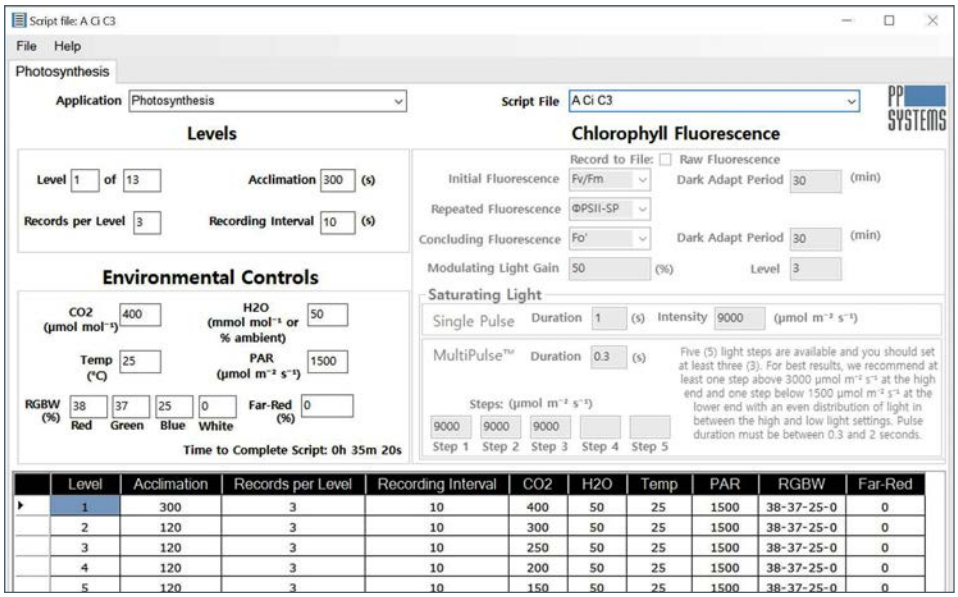
Program Experiments & Share with Colleagues from Anywhere

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.



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

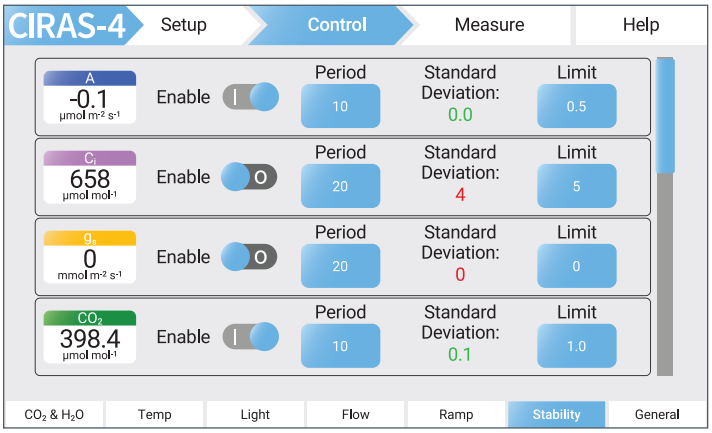
Create your own unique file names using letters, numbers, and symbols and adding comments for further detail is quick and easy.

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.

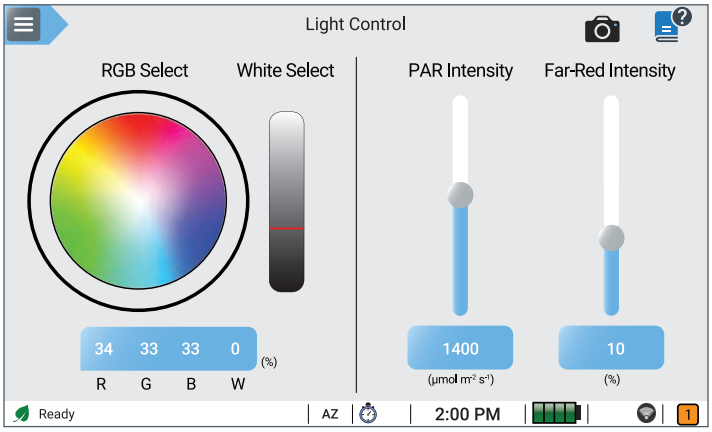


Stability Criteria Setup Screen

^ Onscreen Keyboard

< Profile Setup Screen

Light Control Setup Screen

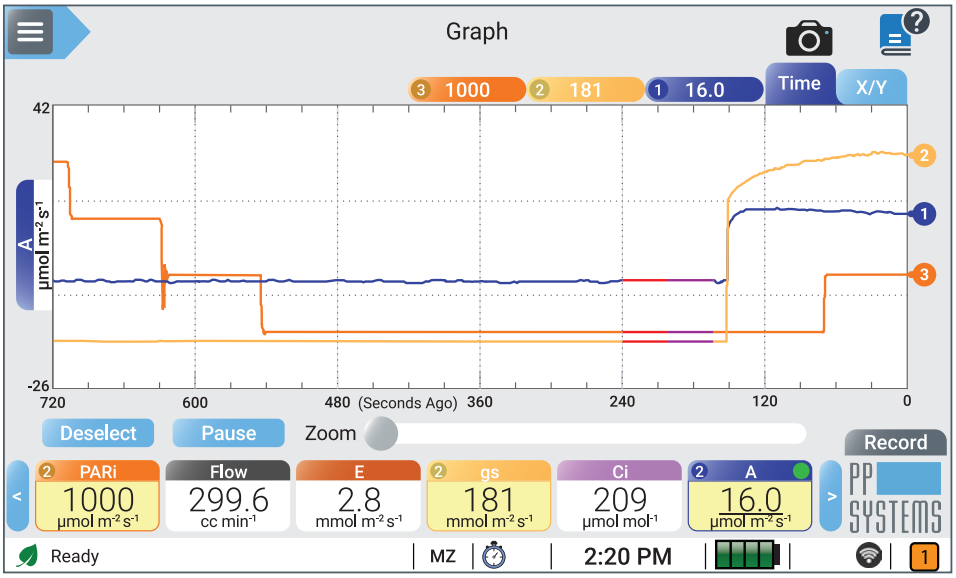


Data storage & transfer

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.

Choose how you view your data

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



Parameters

Measured

CO_2 Reference	Cuvette Temperature
CO_2 Analysis	Leaf Temperature
CO_2 Differential	PAR Internal
H_2O Reference	PAR External
H_2O Analysis	Relative Humidity
H_2O Differential	Flow
Air Temperature	Leaf Area

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-4 accessories are lightweight & designed to connect directly to the console, further enhancing the process of discovery.

Soil CO_2 Efflux

The popular **SRC-2 Soil Respiration Chamber** is the industry standard for rapid, accurate survey measurement of soil CO_2 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)
Volume	1171 ml
Area	77.6 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

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

Net Canopy CO_2 Flux

The **CPY-5 Canopy Assimilation Chamber** is ideal for measurement of net canopy CO_2 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)
Area	167 cm^2
Cable Length	1.5 meters
Weight	1.05 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 $\mu mol \cdot m^{-2} \cdot s^{-1}$
Accuracy	± 5 $\mu mol \cdot m^{-2} \cdot s^{-1}$
Precision	1 $\mu mol \cdot m^{-2} \cdot s^{-1}$

Insect Respiration

Our **Insect Respiration Chamber** can be used to measure CO_2 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-4 console can be used as a stand-alone CO_2 and H_2O 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 with PP Systems was great, especially because my students needed some specific information to assist them with data collection! They covered everything from set up to elegant measurements. Their step-by-step instructions made it a breeze for everyone, and I think more people should take advantage of this opportunity."
>
> — Rhuanito Ferrarezi, PhD
> University of Georgia

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.

> "PP Systems is fully focused on the user experience. It feels like their team is with me and ready to troubleshoot or provide advice every step of the way when I'm out in the field collecting data."
>
> — Ashley Hull, MS
> Plant Physiologist
> Horizon Ag-Products

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_2 and H_2O control as well as the use of 8g CO_2 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_2/H_2O 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_2O for both the reference and analysis gas streams. All measurements ARE corrected for temperature and pressure.

CO_2 Measurement Range	0 – 10000 µmol · mol^{-1} (Optimized for 0 – 2000 µmol · mol^{-1})
CO_2 Accuracy	± 3 µmol · mol^{-1} at 300 µmol · mol^{-1} Within 1% of reading > 300 µmol · mol^{-1}
CO_2 Precision	0.1 µmol · mol^{-1}
CO_2 Control Range	0 – 2000 µmol · mol^{-1}
H_2O Measurement Range	0 – 75 mmol · mol^{-1}
H_2O Accuracy	± 0.08 mmol · mol^{-1} up to 5 mmol · mol^{-1} Within 1.5% of reading > 5 mmol · mol^{-1}
H_2O Precision	0.01 mmol · mol^{-1}
H_2O Control Range	0-Dewpoint or 0-100% Ambient
Pressure Range	55 – 115 kPa
Air Sampling	User-adjustable from 50 – 200 cc · min^{-1} using integral DC pumps. Both analysis and reference pumps are fitted with mass flow controllers.
Cuvette Air Supply Unit (Integral)	0 – 500 cc · min^{-1} measured and controlled by a mass flow meter.
Auxiliary Port	For connection to the SRC-2 Soil Respiration Chamber and CPY-5 Canopy Assimilation Chamber.
USB Flash Drive	Two USB flash drive ports for transferring stored data files, response curve scripts, and updating system firmware and software.
Internal Memory	32 GB
Microprocessor	528 MHz ARM® Cortex™
Touch Display	7.0" capacitive touch LCD display (800 x 480 pixels). Sunlight readable.
Power Supply	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.
Operating Temperature Range	-5 to 50 °C, non-condensing. External air filtration may be required in dusty environments.
Enclosure	Rugged, ergonomic, lightweight aluminum with polyurethane base.
Dimensions	28 cm (W) x 14.5 cm (D) x 24 cm (H)
Weight	4.8 kg (including 2 battery packs) 5.2 kg (including 3 battery packs)

PLC4 Leaf Cuvettes

Construction	• Handle: Aluminum • Leaf Gasket: Closed cell foam
LCD Display	2 x 16 character display
Keypad	2 tactile keys for recording and parameter selection.
PAR Sensors (Internal)	2 silicon photodiode sensors. • Range: 0 – 3000 µmol · m^{-2} · s^{-1} • Precision: 1 µmol · m^{-2} · s^{-1} For use with LED light unit.
Leaf Temperature Sensor Accuracy	± 0.5 °C at 25 °C
PAR Sensor (External)	Filtered silicon cell quantum sensor (cosine corrected). • Response: 400 – 700 nm • Range: 0 – 3000 µmol · m^{-2} · s^{-1} • Accuracy: ± 5 µmol · m^{-2} · s^{-1} • Precision: 1 µmol · m^{-2} · s^{-1}
Air Temperature Sensor	Precision thermistor • Range: -10 to 50 °C • Accuracy: ± 0.5 °C at 25 °C
Temperature Control	12 °C below ambient to 15 °C above ambient. • Control limits: 0 – 45 °C • Setpoint resolution: 0.1 °C

	Universal	Broad/Narrow/Conifer
Cuvette Stirring	Air mixing fan	Air mixing fan plus two additional miniature air mixing fans
Window	Glass	• *Broad / Narrow:* Glass • *Conifer:* Scratch resistant glass
Apertures	• 25 mm x 7 mm (1.75 cm^2) • 25 x 18 mm (4.5 cm^2) • 18 mm Diameter (2.5 cm^2)	• *Broad:* 30 mm x 30 mm (9 cm^2) • *Narrow:* 86 mm x 37 mm • *Conifer:* 86 mm x 37 mm
Leaf Temperature Sensor Type	Infrared sensor for accurate, non-contact measurement.	Infrared sensor for accurate, non-contact measurement and thermistor for direct measurement.
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)	27.5 cm (L) x 3.75 cm (Handle Diameter) Head: *Broad/Narrow:* 6.0 cm (L) x 10.9 cm (W) x 2.5 cm (H) *Conifer:* 6.0 cm (L) x 10.9 cm (W) x 5.0 cm (H)
Weight	0.7 kg (not including cable)	0.9 kg (not including cable)

PLC4 LED Light Units (RGBW-FR)

Automatic Control Range	0 – 2500 µmol · m^{-2} · s^{-1}
LED Specification	**Wavelength (RGBW)**

Color	*Peak*	*Full Width at Half Maximum*
Red	660 nm (±10 nm)	20 nm
Green	527 nm (± 7 nm)	38 nm
Blue	447 nm (± 7 nm)	18 nm
White	400 – 730 nm	
Far-Red	730 nm (± 10 nm)	32 nm

	Universal	Broad/Narrow/Conifer
Dimensions	6.4 cm (L) x 6.0 cm (W) x 5.1 (H)	6.5 cm (L) x 11.2 cm (W) x 6.0 cm (H)
Weight	0.2 kg	0.4 kg

SRC-2 Soil Respiration Chamber

Construction	Rugged PVC with a convenient handle for placement on the soil surface.
Soil Ring	Aluminum. Provides good seal directly on soil or on soil collars (available from PP Systems)
Volume	1171 ml
Area	77.6 cm^2
Cable Length	1.5 m
Temperature Sensor	Precision thermistor • Range: -10 to 50 °C • Accuracy: ± 0.5 °C at 25 °C
Dimensions	150 mm (H) x 100 mm (Diameter)
Weight	0.9 kg

CPY-5 Canopy Assimilation Chamber

Construction	Rugged polycarbonate
Soil Ring	Aluminum. Provides good seal directly on soil or on soil collars (available from PP Systems)
Area	167 cm^2
Cable Length	1.5 m
Temperature Sensor	Precision thermistor • Range: -10 to 50 °C • Accuracy: ± 0.5 °C at 25 °C
Quantum Sensor	Filtered, silicon cell sensor (cosine corrected) for PAR. • Response: 400 – 700 nm • Range: 0 – 3000 µmol · m^{-2} · s^{-1} • Accuracy: ± 5 µmol · m^{-2} · s^{-1} • Precision: 1 µmol · m^{-2} · s^{-1}
Dimensions	145 mm (H) x 146 mm (Diameter)
Weight	0.9 kg

Insect Respiration Chamber

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

CFM-4 Chlorophyll Fluorescence Module

Modulating Beam	625 nm ± 5 nm (Red)
Saturation Light	0 – 10000 µmol · m^{-2} · s^{-1}
Far Red Light	730 nm (± 5 nm)
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

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