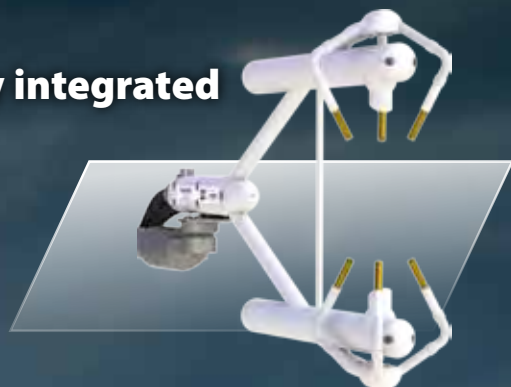




Complete, low-power systems for measuring eddy-covariance fluxes & storage of CO₂ & H₂O

- p. 3-10* Open-Path Eddy-Covariance System Components
- p. 11* CPEC200 Closed-Path Eddy-Covariance System
- p. 13* AP200 Atmospheric-Profile System
- p. 15* Energy-Balance Sensors

**Patented, fully integrated
IRGASON, p. 3**



Micrometeorology

Campbell Scientific's experience in eddy-covariance measurements began over 30 years ago with the CA27 one-dimensional sonic anemometer and CR5 data-logger. In 1985, our first eddy-covariance gas analyzer, the KH20, was introduced and continues to be sold today. Since then, the depth of our product line has increased, and with each new development we've achieved better measurement accuracy and greater system integration for flux applications.

Building on our deep experience developing and manufacturing trace gas analyzers, the EC150 CO₂/H₂O open-path gas analyzer was introduced in 2010, quickly followed by the IRGASON in 2011. The IRGASON is a low-power, open-path infrared gas analyzer (IRGA) and 3D sonic (SON) anemometer integrated into a single sensor designed specifically for eddy-covariance measurements. Integration provides several key advantages, including co-located and synchronized measurement and improved aerodynamics, while requiring power consumption of only 5 W.

For environments with frequent rainfall or when automated zero and CO₂ span are beneficial, Campbell Scientific offers the CPEC200 closed-path eddy-covariance system, also introduced in 2010. This system offers superior frequency response (5.8 Hz half-power bandwidth) compared to other closed-path systems, and impressively low power consumption of 12 W.

The AP200 CO₂/H₂O atmospheric profile system, unveiled in 2012, has up to eight sample intakes for measuring CO₂ and H₂O vapor concentrations along a vertical plane to determine the storage term. The AP200 is often used with eddy-covariance flux data to calculate net flux.

Campbell Scientific's suite of sensors offers complete flux-measurement solutions. Coupled with one of our programmable dataloggers, energy balance and other meteorological sensors can be added to your site, and provide online flux estimates while storing up to 16 GB of high-frequency eddy-covariance time series data.

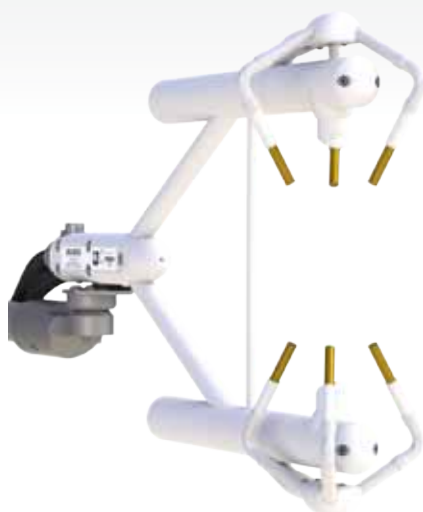
Please feel free to contact us for more information. We look forward to learning about your measurement needs.

Tel: +44 (0)1509 828888

www.campbellsci.eu

sales@campbellsci.co.uk





Patented Design^a

Gas analyzer and sonic anemometer in one sensor

Overview

Campbell Scientific's IRGASON fully integrates the open-path analyzer and sonic anemometer. Designed specifically for eddy-covariance flux measurements, the patented design is easier to install and use than separate sensors and provides increased measurement accuracy.

The IRGASON simultaneously measures absolute carbon dioxide and water vapor, air temperature, barometric pressure, and three-dimensional wind speed and sonic air temperature.

Benefits and Features

- › Combined support structure causes less flow distortion than two separate sensors
- › Truly colocated gas analyzer and sonic anemometer avoids flux loss due to sensor separation
- › Synchronized gas analyzer and sonic anemometer measurements avoid the need to correct for time lag
- › Low power consumption
- › Measurements are temperature compensated without active heat control
- › Low noise
- › Maximum output rate of 50 Hz with 25 Hz bandwidth
- › Angled windows to shed water and are less tolerant to window contamination
- › Field rugged
- › Field serviceable
- › Factory calibrated over wide range of CO₂, H₂O, pressure, and temperature in all combinations encountered in practice
- › Extensive set of diagnostic parameters
- › Fully compatible with Campbell Scientific dataloggers; field set-up, configuration, and field zero and span can be accomplished directly from the datalogger
- › Sonic Temperature: Determined from 3 acoustic paths; corrected for crosswind effects
- › Rain: Innovative signal processing and transducer wicks considerably improves performance of the anemometer during precipitation events

IRGASON Outputs

- | | | |
|--------------------------|--|------------------------------------|
| › U _x (m/s) | › CO ₂ Density (mg/m ³) | › CO ₂ Signal Strength |
| › U _y (m/s) | › H ₂ O Density (g/m ³) | › H ₂ O Signal Strength |
| › U _z (m/s) | › Gas Analyzer Diagnostic | › Source Temperature (°C) |
| › Sonic Temperature (°C) | › Ambient Temperature (°C) | |
| › Sonic Diagnostic | › Atmospheric Pressure (kPa) | |

^aU.S. Patent No. D680455

General Specifications^b

- Operating Temperature Range: -30° to +50°C
- Calibrated Pressure Range: 70 to 106 kPa
- Input Voltage Range: 10 to 16 Vdc
- Power @ 25°C: 5 W (steady state and power up)
- Measurement Rate: 100 Hz
- Output Bandwidth: 5, 10, 12.5, 20, or 25 Hz; user programmable
- Output Options: SDM, RS-485, USB, analog
- Auxiliary Inputs: air temperature and pressure
- Weight
 - IRGASON Head and Cables: 2.8 kg (6.1 lb)
 - EC100 Electronics: 3.2 kg (7.1 lb)
- Cable Length: 3.0 m (10.0 ft) from IRGASON to EC100

Gas Analyzer Specifications^{b,c}

- Path Length: 15.37 cm (6.05 in)

Performance

	CO ₂	H ₂ O
Precision RMS (maximum)^d	0.2 mg/m ³ (0.15 µmol/mol)	0.004 g/m ³ (0.006 mmol/mol)
Calibrated Range	0 to 1000 µmol/mol	0 mmol/mol to 37°C dewpoint
Zero Drift with Temperature (maximum)	±0.55 mg/m ³ /°C (±0.3 µmol/mol/°C)	±0.037 g/m ³ /°C (±0.05 mmol/mol/°C)
Gain Drift with Temperature (maximum)	±0.1% of reading/°C	±0.3% of reading/°C
Cross Sensitivity (maximum)	±1.1 x 10 ⁻⁴ mol CO ₂ /mol H ₂ O	±0.1 mol H ₂ O/mol CO ₂

Sonic Anemometer Specifications^b

Measurement Path

- Vertical: 10.0 cm (3.9 in.)
- Horizontal: 5.8 cm (2.3 in.)

Transducer Diameter

- 0.64 cm (0.25 in.)

Accuracy^e

- Offset Error
 - u_x, u_y : <±8.0 cm s⁻¹
 - u_z : <±4.0 cm s⁻¹

- Gain Error
 - Wind Vector within ±5° of horizontal: <±2% of reading
 - Wind Vector within ±10° of horizontal: <±3% of reading
 - Wind Vector within ±20° of horizontal: <±6% of reading
- Measurement Precision RMS
 - u_x, u_y : 1 mm s⁻¹
 - u_z : 0.5 mm s⁻¹
 - Sonic Temperature: 0.025°C

Barometer Specifications^b

	-BB Basic Barometer	-EB Enhanced Barometer (Vaisala PTB110)
Total Accuracy	±3.7 kPa at -30°C, falling linearly to ±1.5 kPa at 0°C (-30° to 0°C), ±1.5 kPa (0° to 50°C)	±0.15 kPa (-30° to +50°C)
Measurement Rate	10 Hz	1 Hz

Ambient Temperature Specifications^b

- Manufacturer: BetaTherm 100K6A11A
- Total Accuracy: ±0.15°C (-30° to +50°C)

^bSubject to change without notice.

^cA temperature of 20°C and pressure of 101.325 kPa was used to convert mass density to concentration.

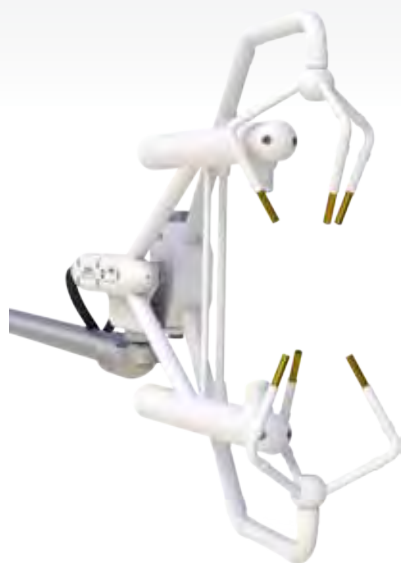
^dNominal conditions for precision verification test: 23°C, 86 kPa, 400 µmol/mol CO₂, 12°C dewpoint, and 20 Hz bandwidth.

^eThe accuracy specification for the sonic anemometer is for wind speeds <30 m s⁻¹ and wind angles between ±170°.



EC150 and CSAT3A

Open-Path CO₂/H₂O Gas Analyzer and Sonic Anemometer



Innovative Design

Use as part of open-path eddy-covariance system

Overview

Campbell Scientific's EC150 is an open-path analyzer specifically designed for eddy covariance flux measurements. Combined with the CSAT3A sonic anemometer as shown above, these two components

of an open-path eddy-covariance system simultaneously measure carbon dioxide, water vapor, air temperature, barometric pressure, and three-dimensional wind speed and sonic air temperature.

Benefits and Features

- › Unique optical configuration gives a slim aerodynamic shape with minimal wind distortion
- › Low power consumption; suitable for solar power applications
- › Low noise
- › Measurements are temperature compensated without active heat control
- › Analyzer and sonic anemometer measurements are synchronized by a common set of electronics
- › Maximum output rate of 50 Hz with 25 Hz bandwidth
- › Tolerant to window contamination
- › Angled windows to shed water
- › Field rugged
- › Field serviceable
- › Factory calibrated over wide range of CO₂, H₂O, pressure, and temperature in all combinations encountered in practice
- › Extensive set of diagnostic parameters
- › Fully compatible with Campbell Scientific dataloggers; field setup, configuration, and field zero and span can be accomplished directly from the datalogger
- › Speed of Sound: Determined from 3 acoustic paths; corrected for crosswind effects
- › Rain: Innovative signal processing and transducer wicks considerably improves performance of the anemometer during precipitation events

Outputs

EC150

- › CO₂ Density (mg/m³)
- › H₂O Density (g/m³)
- › Gas Analyzer Diagnostic
- › Ambient Temperature (°C)
- › Atmospheric Pressure (kPa)
- › CO₂ Signal Strength
- › H₂O Signal Strength
- › Source Temperature (°C)

CSAT3A

- › U_x (m/s)
- › U_y (m/s)
- › U_z (m/s)
- › Sonic Temperature (°C)
- › Sonic Diagnostic

General Specifications^a

- Operating Temperature Range: -30° to +50°C
- Calibrated Pressure Range: 70 to 106 kPa
- Input Voltage: 10 to 16 Vdc
- Power @ 25°C: 5 W (steady state and power up)
- Measurement Rate: 100 Hz
- Output Bandwidth: 5, 10, 12.5, 20, or 25 Hz; user programmable
- Output Options: SDM, RS-485, USB, analog
- Auxiliary Inputs: air temperature and pressure
- Weight
 - EC150 Head and Cables: 2.0 kg (4.4 lb)
 - CSAT3A Head and Cables: 1.7 kg (3.7 lb)
 - EC100 Electronics: 3.2 kg (7.1 lb)
- Cable Length: 3 m (10 ft) from EC150 and CSAT3A to EC100
- Gas Analyzer/Sonic Volume Separation: 5.0 cm (2.0 in.)

Gas Analyzer Specifications^{a,b}

- Path Length: 15.37 cm (6.05 in.)

Performance

	CO ₂	H ₂ O
Precision RMS (maximum)^c	0.2 mg/m ³ (0.15 µmol/mol)	0.004 g/m ³ (0.006 mmol/mol)
Calibrated Range	0 to 1000 µmol/mol	0 mmol/mol to 37°C dewpoint
Zero Drift with Temperature (maximum)	±0.55 mg/m ³ /°C (±0.3 µmol/mol/°C)	±0.037 g/m ³ /°C (±0.05 mmol/mol/°C)
Gain Drift with Temperature (maximum)	±0.1% of reading/°C	±0.3% of reading/°C
Cross Sensitivity (maximum)	±1.1 x 10 ⁻⁴ mol CO ₂ /mol H ₂ O	±0.1 mol H ₂ O/mol CO ₂

Sonic Anemometer Specifications^a

Measurement Path

- Vertical: 10.0 cm (3.9 in.)
- Horizontal: 5.8 cm (2.3 in.)

Transducer Diameter

- 0.64 cm (0.25 in.)

Accuracy^d

- Offset Error
 - u_x, u_y : <±8.0 cm s⁻¹
 - u_z : <±4.0 cm s⁻¹

- Gain Error
 - Wind Vector within ±5° of horizontal: <±2% of reading
 - Wind Vector within ±10° of horizontal: <±3% of reading
 - Wind Vector within ±20° of horizontal: <±6% of reading
- Measurement Precision RMS
 - u_x, u_y : 1 mm s⁻¹
 - u_z : 0.5 mm s⁻¹
 - Sonic Temperature: 0.025°C

Barometer Specifications^a

	-BB Basic Barometer	-EB Enhanced Barometer (Vaisala PTB110)
Total Accuracy	±3.7 kPa at -30°C, falling linearly to ±1.5 kPa at 0°C (-30° to 0°C), ±1.5 kPa (0° to 50°C)	±0.15 kPa (-30° to +50°C)
Measurement Rate	10 Hz	1 Hz

Ambient Temperature Specifications^a

- Manufacturer: BetaTherm 100K6A11A
- Total Accuracy: ±0.15°C (-30° to +50°C)

^aSubject to change without notice.

^bA temperature of 20°C and pressure of 101.325 kPa was used to convert mass density to concentration.

^cNominal conditions for precision verification test: 23°C, 86 kPa, 400 µmol/mol CO₂, 12°C dewpoint, and 20 Hz bandwidth.

^dThe accuracy specification for the sonic anemometer is for wind speeds <30 m s⁻¹ and wind angles between ±170°.

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Campbell Scientific Ltd | 80 Hathern Road | Shepshed | LE12 9GX, UK | 0044 (0)1509 828888 | www.campbellsci.eu
UK | AUSTRALIA | BRAZIL | CANADA | CHINA | COSTA RICA | FRANCE | GERMANY | S AFRICA | S E ASIA | SPAIN | USA

Precision Measurements

Best instrument for flux
and other turbulence
research projects



Overview

Campbell Scientific's CSAT3 3D Sonic Anemometer is the 3D sonic anemometer of choice for eddy-covariance measurements. It has an aerodynamic design, a 10 cm vertical measurement path, operates in a pulsed acoustic mode, and withstands exposure to harsh weather conditions. Three orthogonal wind components (u_x , u_y , u_z) and the speed of sound (c) are measured and output at a maximum rate of 60 Hz. Analog outputs and two types of digital outputs are provided.

Measurements can be triggered from three sources:

- Datalogger's SDM command
- CSAT3's internal clock
- PC-generated RS-232 command

The SDM protocol supports a group trigger for synchronizing multiple CSAT3s.

Benefits and Features

- Innovative design provides precision turbulence measurements with minimal flow distortion
- Can be combined with EC150 or EC155 gas analyzers giving near complete colocation for eddy-covariance measurements
- Compatible with most Campbell Scientific dataloggers
- Measurements can be used to calculate momentum flux and friction velocity
- Campbell Scientific's fine wire thermocouples are an option for fast-response temperature measurements
- Field rugged
- Rain: Innovative signal processing and transducer wicks considerably improves performance of the anemometer during rain events
- Sealed sonic transducers and electronics

Specifications

Measurements

- Outputs: u_x , u_y , u_z , c (u_x , u_y , u_z are wind components referenced to the anemometer axes; c is speed of sound)
- Speed of Sound: Determined from three acoustic paths; corrected for crosswind effects
- Measurement Rate: programmable from 1 to 60 Hz, instantaneous measurements; two over-sampled modes are block averaged to either 20 Hz or 10 Hz

Measurement Precision RMS^a

- u_x , u_y : 1 mm s⁻¹ rms
- u_z : 0.5 mm s⁻¹ rms
- c : 15 mm s⁻¹ (0.025°C) rms

Accuracy^b

- Offset error: $<\pm 8.0$ cm s⁻¹ (u_x , u_y), $<\pm 4.0$ cm s⁻¹ (u_z)
- Gain Error
 - Wind Vector within $\pm 5^\circ$ of horizontal: $<\pm 2\%$ of reading
 - Wind Vector within $\pm 10^\circ$ of horizontal: $<\pm 3\%$ of reading
 - Wind Vector within $\pm 20^\circ$ of horizontal: $<\pm 6\%$ of reading

Output Signals

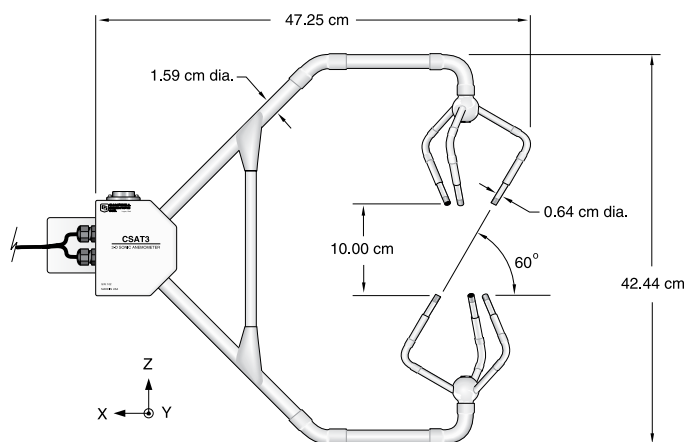
- Digital SDM: CSI 33.3 k baud serial interface for datalogger/sensor communication. Data type is 2 B integer per output plus 2 B diagnostic

Digital RS-232

- Baud rate: 9600, 19200 bps
- Data type: 2-byte integer per output plus 2-byte diagnostic

Analog

- Number of outputs: 4
- Voltage range: ± 5 V
- Number of bits: 12



Anemometer Head

Reporting Range

- Analog Outputs:

Output	Reporting Range	LSB
u_x , u_y	± 30 m s ⁻¹ , ± 60 m s ⁻¹	15 mm s ⁻¹ , 30 mm s ⁻¹
u_z	± 8 m s ⁻¹	4 mm s ⁻¹
c	300 to 366 m s ⁻¹ (-50° to +60°C)	16 mm s ⁻¹ (0.026°C)

SDM and RS-232 Digital Outputs

- Full scale wind: ± 65.535 m s⁻¹ autoranging between four ranges; least significant bit is 0.25 to 2 mm s⁻¹
- Speed of Sound: 300 to 366 m s⁻¹ (-50° to +60°C); least significant bit is 1 mm s⁻¹ (0.002°C)

Physical Description

- Measurement Path Length: 10.0 cm vertical; 5.8 cm horizontal
- Path Angle from Horizontal: 60 degrees
- Transducer: 0.64 cm diameter
- Transducer Mounting Arms: 0.84 cm diameter
- Support Arms: 1.59 cm diameter

Dimensions

- Anemometer head: 47.3 cm (l) x 42.4 cm (h)
- Electronics box: 26 x 16 x 9 cm

Weight

- Anemometer head: 1.7 kg (3.7 lb)
- Electronics box: 3.8 kg (8.4 lb)

Materials

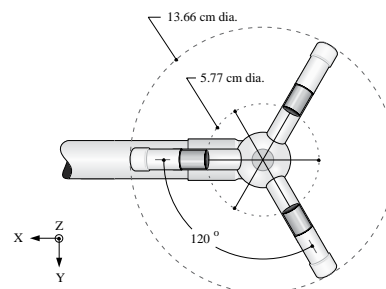
- Anemometer head: stainless steel tubing
- Electronics box: cast aluminum

Environmental

- Operating Temperature: -30° to +50°C

Power Requirements

- Voltage Supply: 10 to 16 Vdc
- Current: 200 mA @ 60 Hz measurement rate; 100 mA @ 20 Hz measurement rate



Lower Transducer Assembly Top View

^aResolution values are for instantaneous measurements made on a constant signal; noise is not affected by sample rate.

^bAccuracy specifications assume -30° to +50°C operating range; wind speeds < 30 m s⁻¹; wind angles between $\pm 170^\circ$.



Fast, Compact Datalogger

Supports complex installations,
built-in keyboard and display

Overview

The CR3000 Micrologger® supports complex applications with many sensors. It is fast and powerful enough to handle extended eddy-co-variance systems with full energy-balance systems. Multiple CR3000s can be configured as a network or units can be deployed individually.

Designed for stand-alone operation in harsh, remote environments. The CR3000 consists of a compact, integrated package with a built-in power supply, a 128-by-64-pixel backlit graphical or eight-line numeric display, and a 16-character keyboard.

Benefits and Features

- › Ideally suited for micrometeorological measurements that require compiling data from an array of sensors, including eddy covariance and biomet sensors
- › Integrated keyboard and display screen let you program, manually initiate data transfers, and view data, all on site
- › Includes a current excitation channel allowing direct connection of PRTs or other sensors that use a current excitation
- › Serial communications with serial sensors and devices supported via I/O port pairs
- › Supports PakBus, Modbus, SDI-12, and DNP3 protocols
- › Communicates via various options: TCP/IP, email, FTP, web server
- › Gas Discharge Tube (GDT) protected inputs
- › 4-MB memory can be expanded with add-on memory systems
- › Flexible power and communication options make it ideal for remote locations
- › Compatible with channel expansion peripherals allowing you to expand your system
- › Battery-backed SRAM and clock that ensure data, programs, and accurate time are maintained while datalogger is disconnected from the main power source
- › Contains custom ASIC chip that expands pulse count, control port, and serial communications capabilities
- › Program with LoggerNet, PC400, or ShortCut to fit your setup
- › Collects and stores data and controls peripherals as the brain of your system

Technical Details

Housed in a portable, self-contained package, the CR3000 Micrologger consists of measurement and control electronics, communication ports, 16-character keyboard, display, power supply, and carrying handle. The integrated display shows 8 lines by 21 characters (64 by 128 pixels).

The CR3000 has a choice of three power-supply base options (alkaline, rechargeable, or no battery). Low power consumption allows the Micrologger to operate for extended time periods on its battery recharged with a solar panel—eliminating the need for AC power. It suspends execution when primary power drops below 9.6 V, reducing the possibility of inaccurate measurements.

The on-board operating system includes measurement, processing, and output instructions for programming the datalogger. The programming language, CRBasic, uses a BASIC-like syntax. Measurement instructions specific to bridge configurations, voltage outputs, thermocouples, and pulse/frequency signals are included. Processing instructions support algebraic, statistical, and transcendental functions for on-site processing. Output instructions process data over time and control external devices.

Specifications

- Maximum Scan Rate: 100 Hz
- Analog Inputs: 28 single-ended or 14 differential, individually configured
- Pulse Counters: 4
- Switched Excitation Channels: 4 voltage, 3 current
- Digital Ports¹: 3 SDM and 8 I/Os or 4 RS-232 COM²
- Continuous Analog Outputs: 2
- Communications/Data Storage Ports: 1 CS I/O, 1 RS-232, 1 parallel peripheral
- Switched 12 Volt: 2
- Input Voltage Range: ± 5 Vdc
- Analog Voltage Accuracy: $\pm(0.04\%$ of reading + offset), 0° to 40°C
- Analog Resolution: 0.33 μ V
- A/D Bits: 16
- Memory: 2 MB Flash (operating system), 4 MB (CPU usage, program storage, and data storage)
- Power Requirements: 10 to 16 Vdc
- Protocols Supported: PakBus, Modbus, DNP3, FTP, HTTP, XML, POP3, SMTP, Telnet, NTCIP, NTP, SDI-12, SDM

- CE Compliance Standards to which Conformity is Declared: IEC61326:2002
- Warranty: 3 years)

Temperature Range³

- Standard: -25° to +50°C
- Extended: -40° to +85°C

Dimensions

- With Low-Profile Base: 24.1 x 17.8 x 7.6 cm (9.5 x 7.0 x 3.0 in.)
- With Alkaline Battery Base: 24.1 x 17.8 x 11.9 cm (9.5 x 7.0 x 4.7 in.)
- With Rechargeable Battery Base: 24.1 x 17.8 x 11.9 cm (9.5 x 7.0 x 4.7 in.)

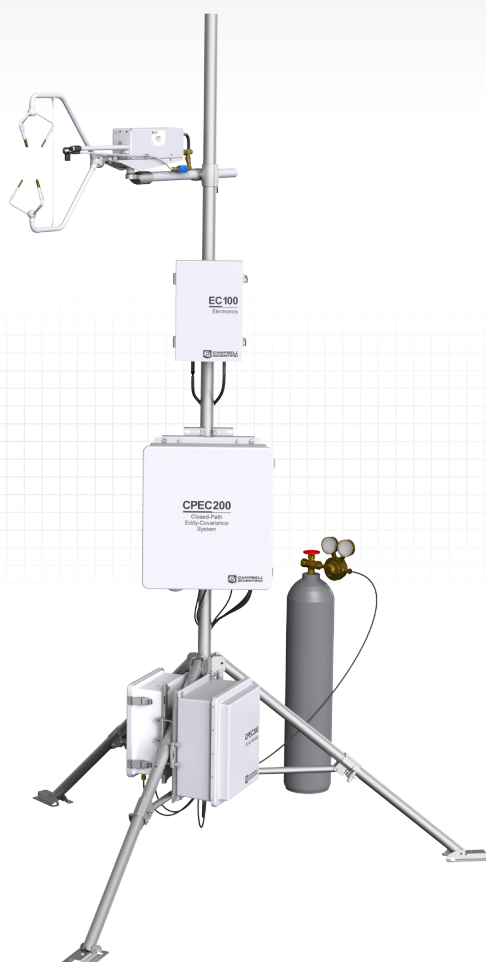
Weight

- With Low-Profile Base: 1.6 kg (3.6 lb)
- With Alkaline Battery Base: 3.8 kg (8.3 lb)
- With Rechargeable Battery Base: 4.8 kg (10.7 lb)

¹ Certain digital ports can be used to count switch closures.

² I/O ports can be paired as transmit and receive for measuring smart serial sensors.

³ Battery bases have different temperature ranges. The rechargeable base option has an operating temperature range of -40° to +60°C. The alkaline base option has a temperature range of -25° to +50°C.



State of the Art

System ideal for top-level research

Overview

The CPEC200 is a turn-key, closed-path eddy-covariance (EC) flux system for long-term monitoring of atmosphere-biosphere exchanges of carbon dioxide, water vapor, heat, and momentum. A complete system consists of a closed-path gas analyzer (EC155), sonic anemometer (CSAT3A), datalogger (CR3000), and sample pump. A valve module is also available for automated zero and span.

The gas analyzer's intake design and small sample cell volume (5.9 ml) provide excellent frequency response (4.3 Hz cutoff frequency) with low total system power (12 W). Additionally, the now-available vortex intake greatly reduces maintenance and maintains frequency response compared to traditional inline filters.

Benefits and Features

- Standard system consists of:
 - Sonic anemometer (CSAT3A)
 - Closed-path gas analyzer (EC155)
 - Datalogger (CR3000)
 - Enclosure with control electronics (CPEC200 enclosure)
 - Pump module
 - Mounting hardware, tubing, cables
- Other available options:
 - Valve Module provides automatic field zero and span, and the CPEC200 Scrub Module provides a convenient source of zero gas
 - Onboard data storage using CompactFlash cards; maximum 16 GB or 16 months at 10 Hz measurement frequency
 - Remote data collection, including direct (Ethernet, RS-232, short haul modem, landline^a) and wireless (RF, cellular^a, satellite^b)
- Excellent system frequency response (see graph on next page)

- Low power
- Ease of use
 - Vortex intake greatly reduces maintenance compared to inline filters
 - Datalogger program requires minimal input from station operator
 - Active system flow control; EC and zero/span flows set by datalogger program variables
 - System operates continuously during inclement weather
 - Heated sample intake prevents condensation
 - Installation requires minimal tools

^a Collecting high frequency time series is possible, but may be cost prohibitive.

^b Only online statistics can be collected using satellite.

Science Measurements

CO₂ and H₂O are measured with an EC155 Closed-Path Gas Analyzer. Three-dimensional wind speed and sonic air temperature are measured with a CSAT3A sonic anemometer head.

CPEC200 System Enclosure

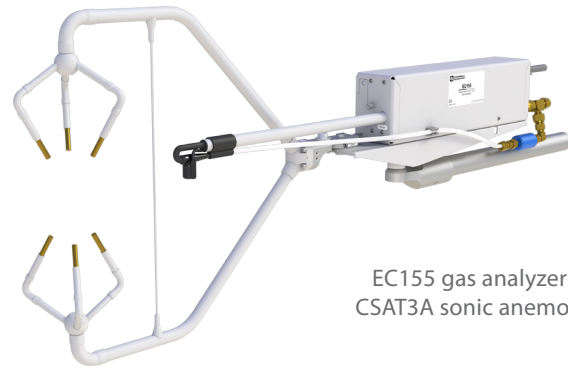
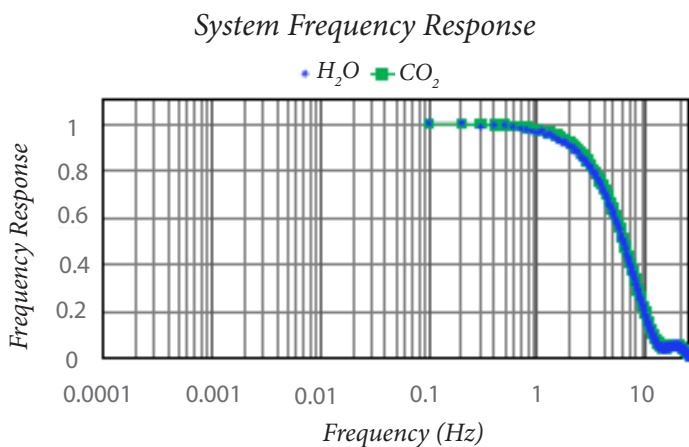
A fiberglass enclosure houses the datalogger, optional data storage peripheral, optional valve module, and the electronics that interface with the CPEC200 pump module. The CPEC200 system enclosure can be mounted to a tripod mast, CM106B tripod leg base, tower legs, or a large diameter pole.

CPEC200 Pump Module

The pump module, a standard component of the CPEC200 system, consists of a small dual-head diaphragm pump with a brushless DC motor mounted inside a fiberglass enclosure. An integral cable connects the pump module to the CPEC200 system enclosure, which provides power, temperature measurement and control, pressure measurement, and pumping speed measurement and control.

Valve Module (Optional)

Campbell Scientific offers two valve module versions, for the CPEC200. The basic three-valve module enables the CPEC200 system to automatically perform zero, CO₂ span, and H₂O span measurements. The six-valve module includes three additional valves to allow more CO₂ span tanks to be measured. The valve module is housed inside the CPEC200 system enclosure. The outlet of the manifold has a proportional valve to automatically control the flow of zero/span gas. The CPEC200 Scrub Module may be ordered to provide a convenient source of zero gas.



EC155 gas analyzer with CSAT3A sonic anemometer.

Specifications^c

- View EU Declaration of Conformity documentation at: www.campbellsci.com/cpec200
- Operating Temperature: -30° to +50°C
- Input Voltage: 10.5 to 16.0 Vdc
- Power
 - Typical: 12 W
 - Maximum (at cold startup): 35 W

System Enclosure

- Dimensions: 52.1 x 44.5 x 29.7 cm (20.5 x 17.5 x 11.7 in)
- Weight
 - Basic System: 11.6 kg (25.5 lb)
 - CR3000: 1.6 kg (3.7 lb)
 - CFM100/NL116: 154 g (5.4 oz)

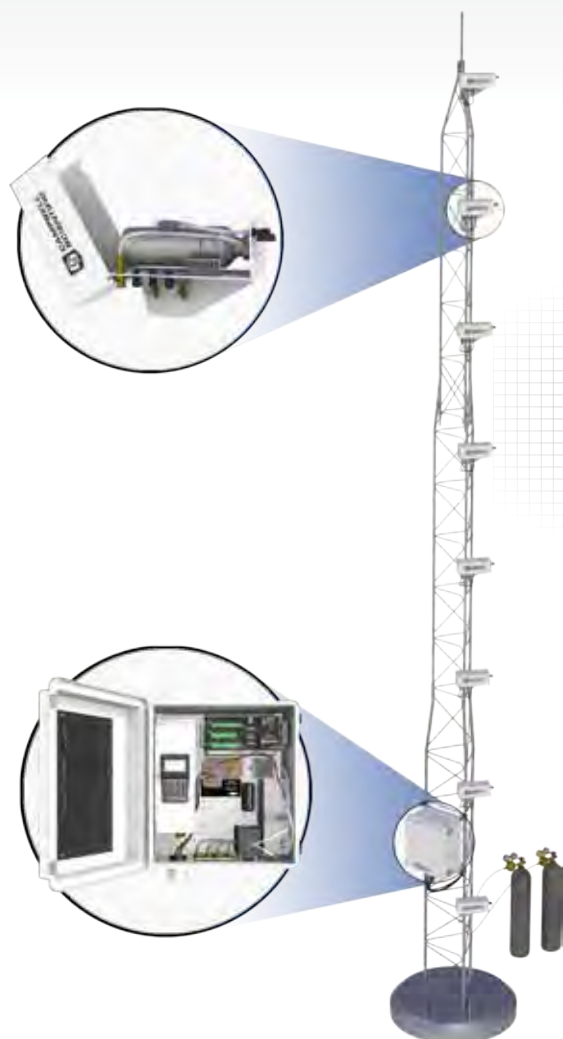
Pump Module

- Cable Length: 3.0 m (10 ft)
- Inlet Connection: 3/8 inch Swagelok®
- Pressure Sensor Range: 15 to 115 kPa
- Pumping Speed: 3 to 9 LPM (automatically controlled at the set-point, typically 7 LPM)
- Dimensions: 35.6 x 29.2 x 13.5 cm (14.0 x 11.5 x 5.3 in)
- Weight without mounting bracket: 5.4 kg (11.8 lb)

Valve Module

- Inlets
 - Three-Valve Module: Zero, CO₂ span, and H₂O span
 - Six-Valve Module: Zero, CO₂ span 1 to CO₂ span 4, and H₂O span)
- Outlets: Analyzer and H₂O bypass
- Connections: 1/4 inch Swagelok®
- Flow Rate: 0.5 to 5 LPM (automatically controlled at user-entered set point)
- Dimensions: 14.0 x 12.7 x 14.0 cm (5.5 x 5.0 x 5.5 in)
- Weight
 - Three-Valve Module: 1.5 kg (3.3 lb)
 - Six-Valve Module: 1.9 kg (4.2 lb)

^cRefer to the EC155 and CSAT3A product brochures for closed-path gas analyzer and sonic anemometer specifications.



Preprogrammed and low power **Complete, Integrated System**

Measurements

Primary:

- CO₂ concentration at each intake
- H₂O concentration at each intake
- System diagnostic word

Secondary:

- Sample flow rate
- Sample cell pressure
- Sample cell temperature
- Other control variables

Overview

The AP200 is a complete, integrated CO₂ and H₂O atmospheric profile system. It measures carbon dioxide (CO₂) and water vapor (H₂O) concentration from up to eight intakes, which are normally spaced along the height of a tower to give a vertical profile.

The AP200 is often used in conjunction with an eddy-covariance system to measure the storage term and give a more complete measure of the surface gas exchange.

Benefits and Features

- › Provides a fully integrated system
- › Requires only 13 W (average at 25°C and 12 Vdc)
- › Contains a Campbell Scientific CR1000 Measurement and Control Datalogger
- › Automatically performs CO₂ span and zero
- › Automated temperature and pressure control
- › Datalogger program included

Key for Typical Installation

- 1 27693 Heated Sample Intake Assemblies (from 4 up to 8)
- 2 9922 20 AWG Power Cable
- 3 28547 AP200 System Enclosure
- 4 15702 Tubing
- 5 Zero/Span Tanks and Regulators (not included)
- 6 Instrument Tower (sold separately)

Specifications

System Enclosure

- Operating Temperature: -30° to 45°C
- Dimensions: 52.1 x 44.5 x 29.7 cm (20.5 x 17.5 x 11.7 in.)

Weight

- AP200 base model: 15.9 kg (35 lb)
- LI-840A: 1 kg (2.3 lb)
- CR1000KD: 0.3 kg (0.7 lb)
- CFM100/NL115: 0.2 kg (0.4 lb)

Power Requirements

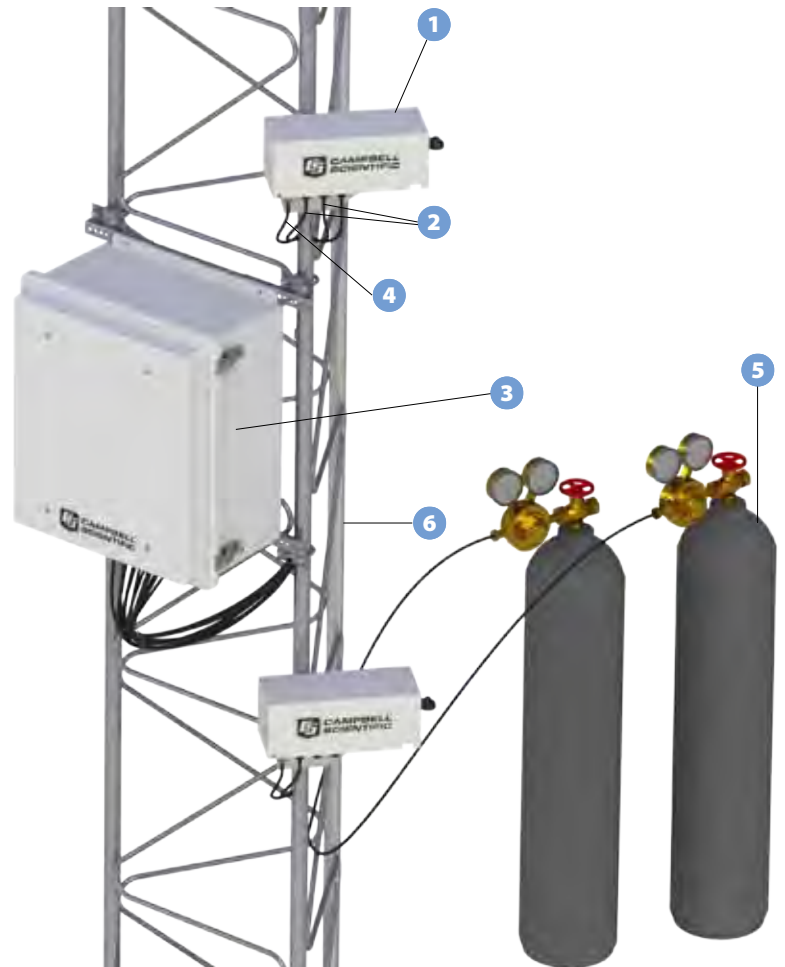
- Voltage: 10 to 16 Vdc
- Average Power (at 25°C)¹: 13 W
- Maximum Power (cold startup): 3.75 A (45 W)

Pump

- Pump type: Dual-head diaphragm pump with a brushless DC motor
- Mounting: Mounted in an insulated, temperature-controlled box inside system enclosure
- Control: Pumping speed is automatically controlled to maintain the pump inlet pressure at the set point
- Maximum Pumping Speed: 9.0 liters per minute (LPM)
- Pressure Sensor Range: 15 to 115 kPa
- Heater: 8.0 W, turns on/off at 2°C
- Warm-up time: ~50 min. from -30° to 2°C
- Fan: 0.7 W (turns on at 50°C and off at 45°C)

Valve Manifold

- Mounting: Mounted inside system enclosure
- Inlets: Eight air sample inlets plus one inlet for zero, one inlet for CO₂ span, and one inlet for H₂O span
- Connections: 0.25-in Swagelok®
- Mass Flow Sensor: 0 to 1.0 standard liters per minute (SLPM)
- Heater: 8.0 W, turns on/off at 5°C
- Warm-up time: ~20 min. from -30° to 4°C
- Fan: 0.7 W (turns on at 45°C and off at 43°C)



Intake Assembly

- Dimensions: 31 x 12.5 x 19 cm (12 x 5 x 7.5 in.)
- Weight: 1.4 kg (3.1 lb)
- Filter: 1.0 in diameter, sintered stainless steel disk filter, 10 micron pore size
- Orifice Inside Diameter: 0.178 mm (0.007 in.)
- Orifice Heater: 2 kohms (0.07 W at 12 Vdc)
- Mixing Volume: 750 ml
- Sample Connection: 0.25 in. Swagelok

Heater Cable Entry Seals

- Number of Connections: 3 (1 in, up to 2 out)
- Cable Diameter: 2.8 to 6.6 mm (0.11 to 0.26 in)

Heater Cable Screw Terminals

- Wire Diameter: 26 to 12 AWG
- Wire Stripping Length: 5.0 mm (0.2 in)
- Screw Tightening Torque: 0.4 N•m

¹ Average power varies from 12.5 W above 35°C to 22.5 W at -30°C.



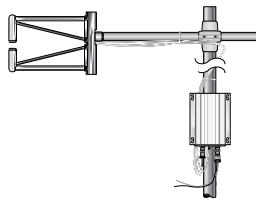
RELIABLE
SINCE 1974
MONITORING

Campbell Scientific offers optional eddy covariance sensors, energy balance sensors, and general meteorological sensors that

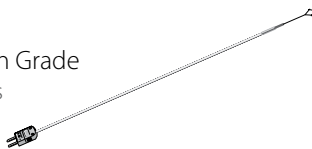
may be added to your flux station. Below are the sensors that are often added to our flux stations:

OPTIONAL EDDY COVARIANCE SENSORS**KH20**

Krypton Hygrometer

*Description*

The KH20 is a highly sensitive hygrometer that measures rapid fluctuations in atmospheric water vapor. It does not measure absolute concentrations.

FW05, FW1 & FW3 | Research Grade
Type E, Fine Wire Thermocouples


Campbell Scientific's FW05, FW1, and FW3 thermocouples measure atmospheric temperature gradients or fluctuations with research-grade accuracy. The diameters of the FW05, FW1, and FW3 thermocouples are 0.0005 in., 0.001 in., and 0.003 in., respectively.

ENERGY BALANCE SENSORS
HC2S3 | Accurate and Rugged
Temperature and Relative
Humidity Probe
*Description*

The HC2S3 is Ideal for long-term, unattended applications. It uses an advanced capacitive sensor to measure relative humidity and a 100 ohm PRT to measure temperature.

NR-LITE2 | Weather Resistant
Net Radiometer


The NR-LITE2 is a rugged net radiometer that includes PTFE-coated absorbers instead of a fragile dome. It measures the energy balance between incoming short-wave and long-wave infrared radiation relative to surface-reflected short-wave and outgoing long-wave infrared radiation.

NR01 | Research Grade
Net Radiometer


The NR01 is a robust, four-way radiometer that requires little maintenance. It measures the energy balance between incoming short-wave and long-wave infrared radiation versus surface-reflected short-wave and outgoing long-wave infrared radiation.

ENERGY BALANCE SENSORS CONT.

CNR4 | WMO Class Quality
Net Radiometer



Description

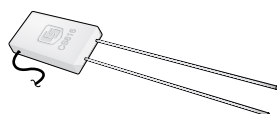
The CNR4 offers a professional solution for scientific-grade energy balance studies. It is a four-way radiometer that contains both an internal thermistor and an internal PT-100 RTD. This net radiometer measures the energy balance between incoming and outgoing radiation.

TCAV
Type E Thermocouple Averaging
Soil Temperature Probes



The TCAV provides the average temperature of the top 6 to 8 cm of soil for energy-balance in flux systems. It parallels four thermocouples together into one, 24-AWG wire. Each member of a thermocouple pair can then be buried at a different depth. The two pairs are separated at a distance of up to 1 m.

CS616 | High Accuracy
and Precision
Water Content Reflectometer
(volumetric soil moisture)



The CS616 is designed for long-term monitoring of volumetric water content from 0% to saturation. The probe outputs a megahertz oscillation frequency, which is scaled down and easily read by a Campbell Scientific datalogger.

CS650 or CS655 | Innovative
Water Content Reflectometer
(volumetric soil moisture)



The CS650 and CS655 use innovative techniques to monitor soil volumetric water content, bulk electrical conductivity, and temperature. These reflectometers make more water content measurements in soils with high electric conductivity without performing a soil-specific calibration. They output an SDI-12 signal that many of our dataloggers can measure. The CS650 has 30-cm rods, and the CS655 has 12-cm rods.

HFP01 | Extreme Accuracy
Soil Heat Flux Plate



The HFP01 measures soil heat flux for energy-balance systems. At least two sensors are required for each site to provide spatial averaging. Sites with heterogeneous media may require additional sensors.

HFP01SC | Extreme Accuracy
Self-Calibrating Soil Heat
Flux Plate



The HFP01SC is a self-calibrating soil heat flux for energy-balance systems. At least two sensors are required for each site to provide spatial averaging. Sites with heterogeneous media may require additional sensors.