LI-6800 Portable Photosynthesis System

The LI-6800 Portable Photosynthesis System measures gas exchange from leaves and other samples. When equipped with the fluorometer, it also measures chlorophyll *a* fluorescence. This document provides performance specifications for a typical LI-6800 and accessories.

Distinguishing specifications

CO_2 gas analyzers

CO_2 Analyzer Precision: Within 0.1 µmol mol^{-1} RMS with 4-second averaging at 400 µmol mol^{-1}

H_2O gas analyzers

H_2O Analyzer Precision: Within 0.01 mmol mol^{-1} RMS with 4-second averaging at 10 mmol mol^{-1}

System

Bulk Flow Rate Range: 680 – 1700 µmol s^{-1} at SATP[1]
Light Source Uniformity: <±10% variation over 90% of aperture
Chamber Temperature Control Range: 10 °C above or below ambient

Fluorometer

Modulation Frequency: 1 Hz – 250 kHz
Measuring Light Peak Wavelength: 625 nm
Red Actinic and Saturating Flash Peak Wavelength: 625 nm
Blue Actinic Peak wavelength: 475 nm
Far-red Peak Wavelength: 735 nm
Actinic Light Output:
0 – 3000 µmol m^{-2} s^{-1} total at 25 °C
0 – 1000 µmol m^{-2} s^{-1} blue at 25 °C
0 – 2000 µmol m^{-2} s^{-1} red at 25 °C
Saturation Light: 0 – 16,000 µmol m^{-2} s^{-1} at 25 °C
Far-red Light: 0 – 20 µmol m^{-2} s^{-1} at 25 °C

Full specifications

CO_2 gas analyzer

Type: Absolute non-dispersive infrared gas analyzer
Measurement range: 0 – 3100 µmol mol^{-1}
Precision (signal noise) at 400 µmol mol^{-1}
RMS with 4-second signal averaging: ≤ 0.1 µmol mol^{-1}
Accuracy: Within 1% of reading at 200 µmol mol^{-1} or above, ±2 µmol mol^{-1} at < 200 µmol mol^{-1}
Orientation sensitivity: ≤±1 µmol mol^{-1} variation at 400 µmol mol^{-1} from any orientation

H_2O gas analyzer

Type: Absolute non-dispersive infrared gas analyzer
Measurement range: 0 – 75 mmol mol^{-1}
Precision (signal noise) at 10 mmol mol^{-1}
RMS with 4-second signal averaging: ≤ 0.01 mmol mol^{-1}
Accuracy: within 1.5% of reading at > 5 mmol mol^{-1}; ±0.08 mmol mol^{-1} at < 5 mmol mol^{-1}

Temperatures

Operating temperature range: 0 – 50 °C
Storage temperature range: -20 °C – 60 °C
Temperature control range
Leaf temperature: ±10 °C from ambient with 3 cm × 3 cm chamber
Setpoint resolution: 0.1 °C
Chamber exhaust air temperature and temperature control block
Type: Thermistor

Range: -10 – 60 °C
Accuracy: ±0.15 °C

Leaf temperature sensor
Type: Type E fine-wire thermocouple
Sensitivity range: -10 – 60 °C
Accuracy: <±0.5 °C total; ±0.2 °C cold junction reference; ±0.3 °C thermocouple when within ±10 °C of cold junction temperature

Air flow rates

Bulk flow rate range: 680 – 1700 µmol s^{-1} at SATP[1]
Leaf chamber flow rate range: 0 – 1400 µmol s^{-1} at SATP

Pressure

Console pressure sensor
Operating range: 50 – 110 kPa
Accuracy: ±0.4 kPa
Resolution: 1.5 Pa typical
Signal noise: ≤ 0.004 kPa peak-to-peak with 4-second signal averaging

Chamber pressure sensor
Range: -2 – 2 kPa
Resolution: < 1 Pa typical
Signal noise: 1 Pa peak-to-peak with 4-second signal averaging
Setpoint resolution: 1.0 Pa
Control range: 0 – 0.1 kPa (dependent on flow rate through the chamber)

Communication

RJ-45 Ethernet; IP/TCP for networks and computers: 1
Head connections: 2
Accessory connections: 2

Batteries

Weight: 0.435 kg
Capacity: 6800 mAh
Type: Lithium ion
Storage: -20 – 60 °C; ≤ 80% RH

CO_2 control

CO_2 control range: 0 – > 2000 µmol mol^{-1} (with pump set to low; dependent on bulk flow rate)
Sources:
8 gram CO_2 cartridge
External tank with optional adapter kit
CO_2 cartridge lifetime: > 8 hours after puncture (dependent on setpoint)
CO_2 scrubber: Soda lime

H_2O control

H_2O control range: 0 – 90% RH (noncondensing)
Humidifier substrate: Pall Stuttgarter Masse ceramic substrate (Pall Corporation)
Desiccant: Sorbead® Orange CHAMELEON® silica gel beads

Light measurement

Chamber and light source PAR sensors:
Detector: Gallium arsenide
Sensitivity range: 0 – 3000 µmol m^{-2} s^{-1}
Resolution: < 1 µmol mol^{-1}
Calibration accuracy: ±5% of reading; traceable to the U.S. National Institute of Technology (NIST)

External LI-190R PAR Sensor:
Detector: Silicon photodiode
Sensitivity: 5 – 10 µA per 1000 µmol s^{-1} m^{-2}
Calibration accuracy: ±5% of reading; traceable to NIST

Console

Processor: Arm® Cortex®[2] A9 Quad Core running at 1 GHz.
Memory: 2 GB RAM; 8 GB Flash memory
Display: Sunlight-readable TFT LCD with capacitive touch screen
Resolution: 1024 × 600 pixels
Dimensions: 26 cm diagonally
Size: 18.5 cm × 27.5 cm × 21 cm; (D × W × H)
Weight: 6.1 kg
Power requirements: 12 to 18 VDC or 24 VDC

Head

Size with 3×3 cm chamber: 37 cm × 11.5 cm × 21.6 cm (L × W × H)
Weight: 2.15 kg without chamber
Display resolution: 128 × 128 pixels
Display dimensions: 3.15 cm diagonally
Sensor head inputs:
Leaf temperature thermocouple: 2
LI-190R light sensor: 1
Sensor head light source connections: 1

Leaf Chambers, Light Sources, and Accessories

The following components may be ordered separately or as a package with the LI-6800.

Fluorometer chamber

Modulated light: Software controlled, selectable frequencies of 1 Hz – 250 kHz
Measuring light peak wavelength: 625 nm
Blue actinic peak wavelength: 475 nm
Red actinic and saturating flash peak wavelength: 625 nm
Far-red peak wavelength: 735 nm

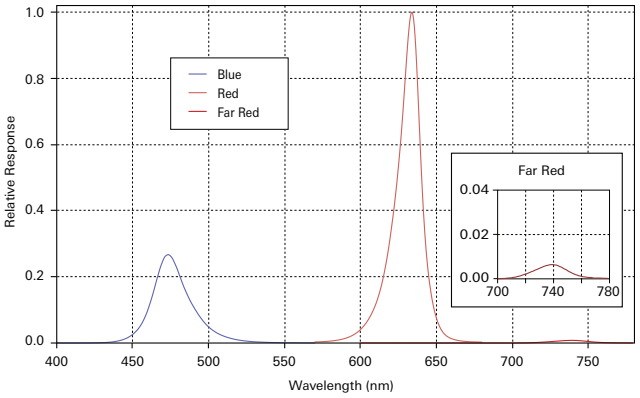


Figure 1. Typical spectral output of the blue, red, and far red LEDs in the fluorometer.

Actinic light output:
0 – 3000 µmol m^{-2} s^{-1} total at 25 °C
0 – 1000 µmol m^{-2} s^{-1} blue at 25 °C
0 – 2000 µmol m^{-2} s^{-1} red at 25 °C
Saturation light: Software controlled intensity; 0 – 16,000 µmol m^{-2} s^{-1} at 25 °C
Far-red light: Software controlled intensity; 0 – 20 µmol m^{-2} s^{-1} at 25 °C
Fluorescence signal temperature dependence: -0.25% per °C
Uniformity:
<±10% over 92% of the aperture with white top gasket
<±10% over 90% of the aperture with black top gasket
Power consumption:
< 18 W at 25 °C with 3000 µmol m^{-2} s^{-1} actinic light
< 60 W at 25 °C with 16,000 µmol m^{-2} s^{-1} saturating flash
Leaf area: 6 cm^2 or 2 cm^2; Round apertures
Dimensions: 16.6 cm × 11.5 cm × 13.6 cm (L × W × H)
Weight: 0.86 kg

Small leaf chamber (3 × 3 cm)

Aperture areas: 9 cm^2 (3 cm × 3 cm), 6 cm^2 (2 cm × 3 cm), 3 cm^2 (1 cm × 3 cm)
Size: 15.4 cm × 11.5 cm × 5.9 cm (L × W × H)
Weight: 0.3 kg

Large leaf and needle chamber (6 × 6 cm)

Maximum leaf area: 36 cm^2
External dimensions: 11.5 cm wide (spring to spring) × 16.8 cm long (front of chamber to back of chamber link) × 5.9 cm tall (bottom of chamber manifold to top of chamber)
Weight: 0.35 kg

Large leaf and needle chamber with conifer sprig blocks

Chamber Volume: 420.8 cm^3 (internal)
Maximum planar leaf area: 36 cm^2
Internal chamber height: 6.7 cm
External dimensions: 11.5 cm wide (spring to spring) × 16.8 cm long (front of chamber to back of chamber link) × 7.2 cm tall (bottom to top of chamber)

Small plant chamber

Chamber volume: 193.2 cm^3 (internal)
Internal dimensions: 7 cm diameter; 4.46 cm deep
External dimensions: 8.4 cm wide (chamber block) × 12.7 cm long (chamber manifold interface to tip of chamber) × 6.47 cm (bottom of chamber manifold to top of chamber)
Weight: 0.60 kg

Bryophyte chamber

Chamber volume: 193.2 cm^3 (internal)
Internal dimensions: 7 cm diameter; 4.45 cm deep
External dimensions: 8.4 cm wide (chamber block) × 12.7 cm long (chamber manifold interface to tip of chamber) × 6.47 cm (bottom of chamber manifold to top of chamber)
Weight: 0.60 kg

Insect respiration chamber

Chamber volume: 49.9 cm^3 (not including tubing)
Exterior dimensions: 11.25 cm length; 3 cm diameter
Weight: 0.07 kg

Small light source (3 × 3 cm)

The small light source is compatible with the small leaf chamber.
Total output range: 0 – >2000 µmol m^{-2} s^{-1} at 25 °C
Blue output range: 0 – > 400 µmol m^{-2} s^{-1} at 25 °C
Red output range: 0 – > 1600 µmol m^{-2} s^{-1} at 25 °C
Red peak wavelength: 660 nm
Blue peak wavelength: 453 nm

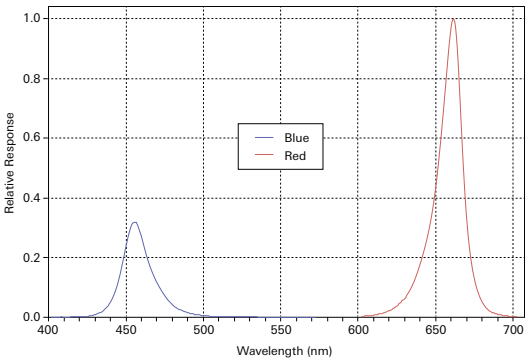


Figure 2. Typical spectral output of the LEDs in the 3×3 cm light source.

Uniformity:
±10% over 90% of the aperture with white top gasket, typically
±10% over 77% of the aperture with black gasket, typically
Power consumption at 2000 µmol m^{-2} s^{-1}**:** < 5 W
Operating temperature range: 0 – 50 °C
Size: 6.6 cm × 5.9 cm × 5.8 cm (L × W × H)
Weight: 0.21 kg

Large light source (6 × 6 cm)

The large light source is compatible with the large leaf chamber, small plant chamber, sprig adapter kit, and the bryophyte chamber.
Total output range: 0 – >2500 µmol m^{-2} s^{-1} at 25 °C
Blue output range: >2000 µmol m^{-2} s^{-1} at 25 °C
Green output range: >1000 µmol m^{-2} s^{-1} at 25 °C
Red output range: >2400 µmol m^{-2} s^{-1} at 25 °C
White output range: >1500 µmol m^{-2} s^{-1} at 25 °C
Blue peak wavelength: 453 nm
Green peak wavelength: 523 nm
Red peak wavelength: 660 nm
White color temperature: 4000 K

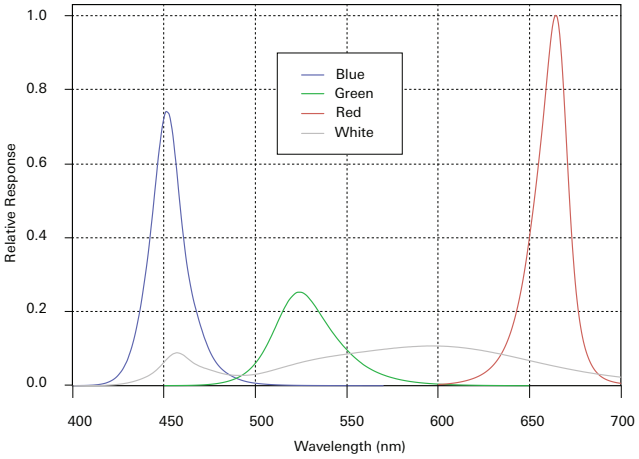


Figure 3. Typical spectral output of the blue, green, red, and white LEDs in the 6×6 cm large light source.

Uniformity: ±10% over 90% of the aperture
Power consumption: 15 W at 2000 µmol m^{-2} s^{-1} equal parts red, green, blue, and white
Operating temperature range: 0 – 50 °C
Operating relative humidity range: 0 – 85%
Size: 11.7 cm × 11 cm × 13 cm (L × W × H)
Weight: 0.54 kg

Aquatic chamber

Sample volume: >0 to 20 mL; 15 mL recommended
Wetted materials: 316 stainless, float glass, Viton, PTFE, silicone, acetal
Operating temperature range: Non-freezing to 50 °C with no solar load
Sample temperature control: User supplied water bath
Storage temperature range: -20 to 60 °C with clean and dry chamber
Sample salinity range: 0 to 35 ‰
pH probe port
pH probe opening 12 mm diameter O-ring sealed port
Compatible probe type: Passive glass-electrode based pH probe
BNC Connector: Nominal -59mV/pH slope, integrated amplifier with user-settable calibration
Septum port
Material: Silicone-PTFE
Size: 3/8" diameter

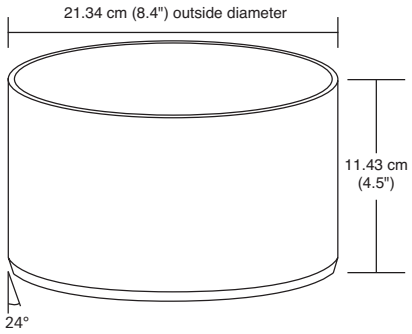
Soil chamber

System

Chamber volume: 4244 cm^3
IRGA volume: 57 cm^3
Soil area: 317.8 cm^2
Air temperature thermistor:
Operating range: -20 to 45 °C
Accuracy: ±0.5 °C over 0 °C to 70 °C

Soil Collars

Inside diameter: ~20 cm
Outside diameter: ~21 cm
Height: 11.43 cm



[1] SATP is defined as Standard Ambient Temperature (25 °C) and Pressure (100 kPa).
[2] Arm and Cortex are registered trademarks of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

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