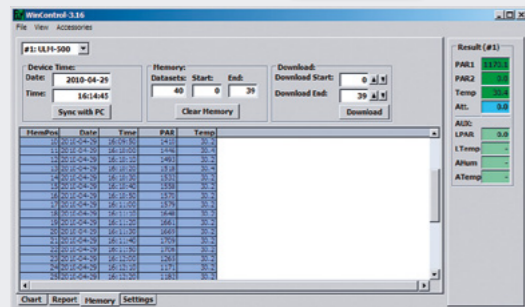


# WinControl-3 Software

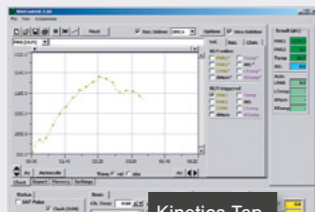
WinControl-3 represents the latest version of the WinControl software family. Presently, WinControl-3 operates the Universal Light Meter ULM-500 and JUNIOR-PAM fluorometers as well as the MONITORING-PAM system.

If the ULM-500 is controlled by this software, the computer can be used as continuing data acquisition unit powering the ULM-500, so that its internal batteries will not be used up.

Report Tap



Kinetics Tap



WinControl-3 is capable of long-term data acquisition (up to several months) allowing the user to define different sampling frequencies.

Experimental protocols can be performed automatically with programmable batch-files.

The WinControl-3 software can also be used to enter calibration factors and sensor names in the ULM-500.

In addition, the predefined application settings for the field use can be changed conveniently.

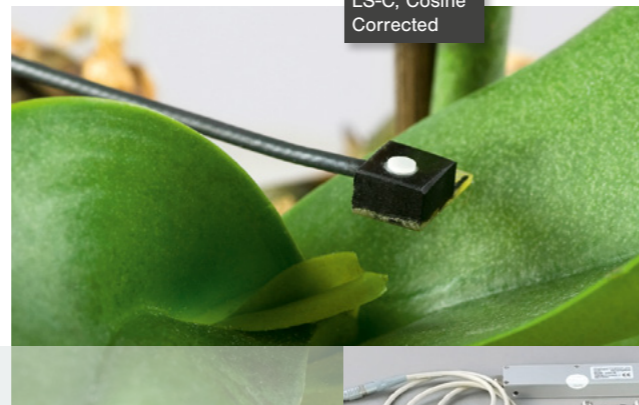
# Accessories

## Spherical Micro Quantum Sensor US-SQS/L

The US-SQS/L is designed for light measurements in suspensions and cuvettes in units relevant for chloroplasts or algae. The US-SQS/L measures photosynthetically active radiation (PAR) between 400 and 700 nm.

## Adapter for Leaf Clip Holder 2030-B and 2060-M

By the use of this adapter, the leaf temperature and light sensors of the Leaf Clip Holder 2030-B and the Micro Quantum Temperature Sensor 2060-M can be readout with the ULM-500.



LS-C, Cosine Corrected

## Mini Quantum Sensor LS-C

The Mini Quantum Sensor LS-C is a miniaturized, flat sensor that can be placed close to leaves in small spaces, for example within cuvettes.

The LS-C measures photosynthetically active radiation (PAR). The sensor is well suited for light incident perpendicular to the surface between -30° and +30°.



Sensor Set 2060-M and Adapter Cable

## Cosine Corrected Mini Quantum Sensor MQS-B

The MQS-B is designed for light measurements in units relevant for plant leaves. For photosynthesis research, sensors with spectral and directional sensitivity relevant for plants are required.

The MQS-B sensor detects photosynthetically active radiation (PAR).

# Specifications

**Design:** Light grey plastic housing with connectors, membrane keyboard and a white illuminated LCD graphic display

**Dimensions:** 12 x 7.5 x 3.5 cm

**Weight:** 210 g (including 4 AAA 1.5 V batteries)

**Power supply:** 4 AAA-type batteries or 5 V DC from USB voltage source when connected to the computer

**Working conditions:** 35 to 85 % rH (avoid condensation), -20° to +50°C ambient temperature

**Time resolution:** PAR channel #1: 100 samples / second, PAR channel #2 and other channels: 5 samples / second

**Operation time:** 10 days or ca. 100 days automated logging with sleep mode (1 meas. / 5 min). Unlimited working time via USB connection (PC-software WinControl-3 – no sleep mode)

**Memory:** Flash memory used as ring buffer for 50000 lines (1 line / single measurement)

### Inputs:

- Two BNC-connectors for the connection of two PAR-sensors with individual calibration factors between -50.0 and -9999.9 (memory for 10 calibration factors), range switchable in 5 steps 250 nA to 0.6 mA
- Connector for Monitoring Leaf-Clip JUNIOR-B; an adapter is available for the connection of the Leaf-Clip Holder 2030-B and the Micro Quantum/Temp.-Sensor 2060-M
- Connector for additional digital sensors (still under development)
- USB-Connector for connection with computer (software: WinControl-3)

**Display:** White illuminated graphic display with 5 different display modes (1: all data; 2-4: two selected sensors in big letters; 5: chart mode for channel no. 1, with maximum, minimum and average indicated), resolution: 0.1  $\mu\text{mol m}^{-2} \text{s}^{-1}$

# ULM-500

## Universal Light Meter and Data Logger



PAR-Measurement and Monitoring

# General Features

Originally, we produced PAR-sensors as accessories for our PAM Chlorophyll Fluorometers. Now, we also offer a fast data logger with a high dynamic range and adequate PAR-sensors for independent PAR-measurements or PAR-monitoring.

Our data-logger and sensors are capable of resolving the saturating light pulse of PAM Chlorophyll Fluorometers or fast light flecks in nature.

## Time Resolution – Chart Mode

Channel no. 1 of the ULM-500 is optimized for high time resolution. In the chart mode a time course of 1.2 s (or 2.4 s) is shown, which contains 120 data points (max. 100 Hz). The minimum, maximum and average are indicated.

With the triggered chart function a saturating light pulse changing from dark to several thousand  $\mu\text{mol m}^{-2} \text{s}^{-1}$  can be resolved. This is usually not possible with standard light meters. The ULM-500 can be connected to the software WinControl-3 for continuous fast recording of light flecks.

## Connectors

The ULM-500 has two BNC-connectors for light or PAR-sensors. Furthermore it has one connector for the Monitoring Leaf-Clip JUNIOR-B, which can also

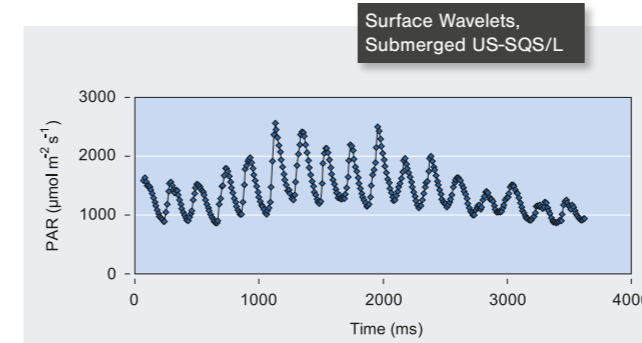
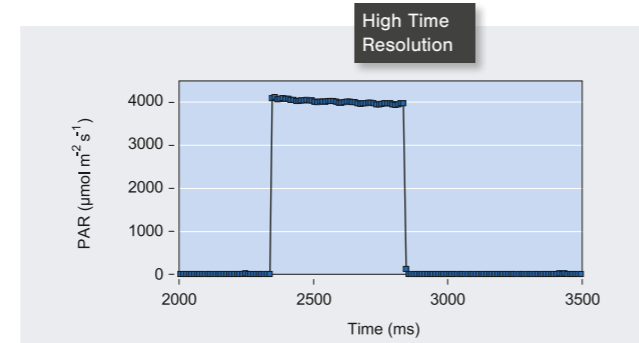
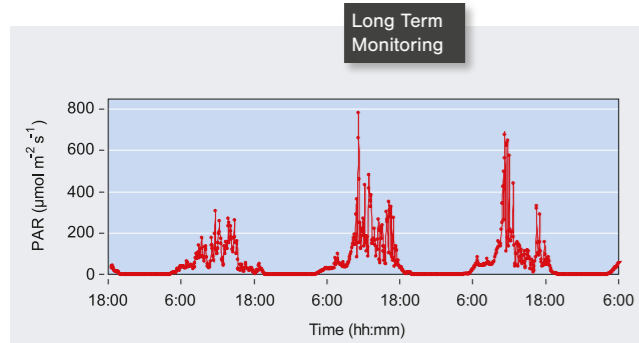
be used to connect the Leaf-Clip 2030-B via an additional adapter.

With the leaf clips not only PAR but also leaf temperature is measured and displayed.

## Stand-alone Light Measurement

The ULM-500 can continuously measure values triggered by an internal timer. For this purpose no additional computer is necessary. To conserve battery power, the instrument features a 'sleep mode', meaning

it awakens only a short time for each measurement. Using the ULM-500 for a continuous measurement (e.g. one data point every 5 min), the batteries would last for at least 3-4 months (depending on the temperature conditions).



## Light Measurement

The main purpose of the ULM-500 is light-measurement. Light sensors contain a photodiode producing a current when illuminated. Depending on the spectral sensitivity these sensors can also be called PAR-sensor or pyranometer.

The ULM-500 has two BNC-connectors for the connection of two light-sensors. It measures a current and indicates the corresponding value in the units  $\mu\text{mol m}^{-2} \text{s}^{-1}$  for photon dependent PAR-sensors and  $\text{W m}^{-2}$  for pyranometers.

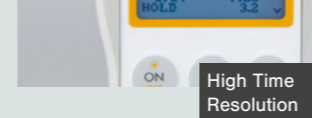
We offer different PAR-sensors suitable for the usage with the ULM-500.



## Dynamic Range

The ULM-500 has 5 sensitivity ranges with fast automatic switching. As a result it has a high dynamic range reaching up to 99 999  $\mu\text{mol m}^{-2} \text{s}^{-1}$  and may detect signals down to 0.1  $\mu\text{mol m}^{-2} \text{s}^{-1}$  – even with the smallest sensor we offer.

The range-switching can be set to automatic for convenient measurements or to manual for fast time resolution.



## Data Storage

The ULM-500 can be used as simple light meter for single light measurements or as data logger for continuous measurements.

It can store up to 50 000 data points. Stored data can be downloaded with the software WinControl-3.

## Operation

The ULM 500 can be operated with its internal batteries or power can be supplied via USB-connector. Display illumination with white LED backlight renders readability in the dark.

The ULM-500 is a stand-alone instrument, but can also be connected to a computer and operated with the software WinControl-3.



Storage of several sensor calibration data is possible (10 different calibration values with probe names via WinControl-3 software).

## Combination with PAM Instruments

For some of our PAM instruments, we provide sensors for the light-list calibration or for light and temperature measurements during an experiment.

If just these sensors shall be used, it can be advantageously to have a small separate instrument like the Universal Light Meter ULM-500 to read-out these sensors independently of a PAM.

In combination with the IMAGING-PAM system the ULM-500 can be used for calibration purposes and the recording of the incident light during the experiment.

Additionally the ULM-500 is fast enough to determine the intensity of the saturating light pulses.