

DIVING-PAM Underwater Fluorometer

for photosynthesis research in aquatic environments

Submersible version of the microprocessor-controlled MINI-PAM Fluorometer

Safe operation down to 50 m depth

Special Windows software provided for data analysis

Wide spectrum of chlorophyll fluorescence quenching analysis

Automized recordings of light response curves

Integrated water temperature and depth sensors

External fiber quantum sensor



The DIVING-PAM Underwater Fluorometer is a world-wide unique instrument for studying *in situ* photosynthesis in underwater plants, including macroalgae, sea grasses and corals. It opens the way for a profound analysis of these organisms under natural conditions. Such analysis profits from considerable experience gained during the past ten years from chlorophyll fluorescence studies of terrestrial plants with the standard PAM Fluorometer.

The DIVING-PAM has been derived from the microprocessor-controlled MINI-PAM Fluorometer, which has proven as particularly robust and reliable in field investigations. With the optics, electronics and software being practically identical, a special waterproof housing has been developed, which can be quite comfortably handled underwater. The commands are given with the tip of a finger via a touch-sensitive keypad.

The optical link to the plant sample is achieved via highly flexible fiberoptics and a range of purpose-tailored sample holders.

The instrument is specialized on quick and reliable assessment of the effective quantum yield of photochemical energy conversion. Like all PAM Fluorometers it applies pulse-modulated measuring light for selective detection of the yield of chlorophyll fluorescence. Its operation is very easy and valuable information may be obtained within seconds.

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For assessment of photosynthesis yield just one key needs to be touched (START), while the fiberoptics end piece is clipped to the sample. Then automatically the fluorescence yield (F) and the maximal yield (Fm) are measured, the photosynthesis yield ($Y = \Delta F/Fm'$) calculated, the obtained data displayed and stored for later analysis. Up to 4000 data sets can be kept in the memory which can be readily transferred to a PC.



Special Windows software is provided for data transfer, data analysis and remote instrument control. A number of special routines, like the recording of light response curves, can be chosen from an extensive menu of operation.

Technical Specifications

Underwater Fluorometer DIVING-PAM

Measuring light source: Red LED, emission peak at 650 nm; 12 intensity settings, standard intensity $0.15 \mu\text{mol m}^{-2} \text{s}^{-1}$ PAR; modulation frequency 0.6 or 20 kHz; Auto 20 kHz function; burst-mode, 1/5 integrated intensity

Halogen lamp: 8 V/20 W blue enriched, filtered to give $\lambda < 710 \text{ nm}$; 12 intensity settings, max. intensity $6000 \mu\text{mol m}^{-2} \text{s}^{-1}$ PAR with continuous actinic illumination, max. intensity $18000 \mu\text{mol m}^{-2} \text{s}^{-1}$ PAR during saturation pulses

Signal detection: PIN-photodiode protected by long-pass filter ($\lambda > 710 \text{ nm}$); selective window amplifier (patented)

Microcontroller: CMOS 80C52

Data memory: CMOS RAM 128 kB, providing memory for 4000 data sets

Measured parameters: F_0 , F_m , F_m' , F , F_v/F_m (max. Yield), $\Delta F/F_m'$ (Yield), qP , qN , NPQ, PAR (using fiber quantum sensor), ETR (i.e. $\text{PAR} \times \Delta F/F_m'$), water temperature, water depth

Display: 2 x 24 character alphanumeric LC-display with backlight, character size 4.5 mm

User interface: 1 x 8 touch-sensitive keypad

PAR measurement: 0 to $20000 \mu\text{mol m}^{-2} \text{s}^{-1}$ PAR, in steps of $1 \mu\text{mol m}^{-2} \text{s}^{-1}$ PAR; using fiber quantum sensor

Water temperature measurement: $-10 \text{ }^\circ\text{C}$ to $+60 \text{ }^\circ\text{C}$, in steps of $1 \text{ }^\circ\text{C}$

Water depth measurement: 0 to -70 m , in steps of 0.1 m

PC-terminal operation: Via RS 232 interface using WinControl Software

Data output: Data transfer on PC via RS 232 using WinControl Software

Power supply: Internal rechargeable battery 12 V/2.1 Ah, providing power for up to 1000 yield measurements; Battery Charger MINI-PAM/L (90 to 260 V AC)

Operating temperature: -5 to $+45 \text{ }^\circ\text{C}$

Dimensions: Diameter 19 cm, length 39 cm

Weight: 3.7 kg

Fiberoptics DIVING-F

Design: Randomized $70 \mu\text{m}$ glass fibers forming single plastic shielded bundle with waterproof stainless steel adapter ends

Dimensions: Active diameter 5.5 mm, outer diameter 8 mm, length 150 cm

Weight: 340 g

Accessories (optional)

Dark Leaf Clip DIVING-LC

Design: Clip made of white plastic with gasket contact areas and sliding shutter (closure)

Dimensions: Diameter 32 mm, length 80 mm

Weight: 6.5 g

Magnet Sample Holder DIVING-MLC

Design: Two ring-magnets embedded in plastic holders with buoyancy body and fiberoptics adapter

Dimensions: Diameter 37 mm, height 48 mm

Weight: 60 g; floating underwater

Miniature Fiberoptics DIVING-F1

Design: Single plastic fiber with adapter for DIVING-PAM

Dimensions: Active diameter 2 mm, length 150 cm

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