



# HANDY PEA

## CHLOROPHYLL FLUORESCENCE SYSTEM

- Compact (170 x 85 x 40mm), lightweight (565gms).
- Large-scale screening capacity up to 1000 full trace data files.
- High time resolution detection for discrimination of fast fluorescence induction kinetics.
- Saturating high intensity focused LED array for accurate determination of Fmax.
- Upload user-defined, repeatable experimental protocols for automatic field execution.
- Interchangeable sensor unit cables with lengths of up to 20 metres.
- Windows® data transfer & analysis software.

### Overview

The Handy PEA chlorophyll fluorimeter consists of a compact, light-weight control unit encapsulating sophisticated electronics providing the high time resolution essential in performing measurements of fast chlorophyll fluorescence induction kinetics.

The chlorophyll fluorescence signal received by the sensor head during recording is digitised within the Handy PEA control unit using a fast Analogue/Digital converter. The chlorophyll fluorescence signal is digitised at different rates dependent upon the different phases of the induction kinetic. Initially, data is sampled at 10µs intervals for the first 300 µseconds.

Simple to configure and operate, the Handy PEA chlorophyll fluorimeter features the capacity to store up to 5 user-defined

protocols for different field applications. Protocols are written using a custom Windows® software package, PEA Plus (supplied). This allows single or multiple measurement assays with optional pre-illumination periods to be defined and uploaded to the memory of Handy PEA via RS232 serial communications.

The use of protocols ensures maximum reproducibility of results during field applications involving large scale screening away from a laboratory environment. A waterproof, tactile keypad allows selections and inputs to be made and a liquid crystal display module presents menu options and data.

Up to 1000 recordings of between 0.1 - 300 seconds may be saved in the memory of Handy PEA chlorophyll fluorimeter.

Saved data may be viewed onscreen in numerical format with calculated parameters or transferred to the PEA Plus software where it may be viewed graphically or exported to external software packages for further statistical analysis.

The sensor unit consists of an array of 3 ultra-bright red LED's optically filtered to a peak wavelength of 650 nm, which is readily absorbed by the chloroplasts of the leaf, at a maximum intensity of  $>3000 \mu\text{mol m}^{-2} \text{s}^{-1}$  at the sample surface. The LED's are focused via lenses onto the leaf surface to provide even illumination over the area of leaf exposed by the leafclip (4mm dia).



LED's have the advantage of being rugged, emitting low levels of heat, and of rising to full intensity very rapidly (typically microseconds) after being switched on. This feature eliminates the inaccuracies of  $F_o$  measurement and the constraints on speed and

reliability associated with a shutter which is a necessary item in systems using filament lamps rather than LED's.

An optical feedback circuit monitors and corrects changes in the output intensity of the LED's. These changes are caused by internal heat build up in the LED's. The circuit also compensates for intensity changes caused by variation in ambient temperature. The light source is calibrated before leaving the factory but may be calibrated by the user at regular intervals using the SQS Serial Quantum Sensor.

The detector is a high performance Pin photodiode and associated amplifier circuit. The optical design and filtering ensure that it responds maximally to the longer wavelength fluorescence signal and blocks the reflected shorter wavelength LED light used as the source of illumination.

The sensor unit is connected to the Handy PEA control unit via a standard connection cable of 1m in length however, connection cables of up to 10m in length are also available on request.

## Leafclips and Sample Dark Adaptation

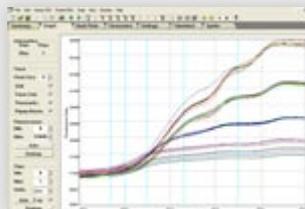
The first step in the measurement process is to cover the sample area to be analysed, with a small, lightweight leafclip. The clip has a small shutter plate which should be closed over the leaf when the clip is attached so that light is excluded and dark adaptation takes place. The body of the clips are constructed from white plastic to minimise the effects of heat build-up on the leaf during the period when the clip is in place. The locating ring section of the clip which interfaces with the fluorimeter optical assembly is constructed from black plastic. This ensures that the measurement is unaffected when measuring during conditions of high ambient light intensity.



The leaf or needle rests on a foam pad whilst in the clip in order to minimise damage to the structure of the leaf. The shutter plate should be closed to exclude light from the sample during dark adaptation.

During dark adaptation, all the reaction centres are fully oxidised and available for photochemistry and any fluorescence yield is quenched. This process takes a variable amount of time and depends upon plant species, light history prior to the dark transition and whether or not the plant is stressed. Typically, 15 - 20 minutes may be required to dark adapt effectively. In order to reduce waiting time before measurement, a number of leaves may be dark adapted simultaneously using several leafclips. Some users even make measurements at night, thus ensuring an adequate supply of readily dark adapted samples and zero waiting time!

## PEA Plus Software



PEA Plus provides a comprehensive tool for in-depth analysis of data recorded by the Pocket PEA chlorophyll fluorimeter. Several different data presentation techniques have been combined in order to effectively demonstrate subtle differences in the fluorescence signature of samples which could be indicative of stress factors affecting the photosynthetic efficiency of the plant.

## Technical Specifications

Dimensions	170 (l) x 85 (w) x 40mm (d). Weight: 565g
Communications	RS232 bi-directional serial communications
Operating Conditions	0 - 40°C. Non-condensing humidity
Battery	3 x rechargeable Ni-MH 3.6V, 1.8Ahr
Battery Charger	Integral switch mode charger 8-13.5V input (nominal 12V input)
Battery Life	Typically 8 - 9 hours when performing 1 second recordings at 120 measurements/hr
Display	8 line x 20 character LCD display
Illumination	Focused array of ultra-bright red LED's with NIR short pass cut-off filters. Peak wavelength 650 nm. Spectral-line half width 22 nm. Max. intensity at leaf surface $>3000 \mu\text{mol m}^{-2} \text{s}^{-1}$
Detector	Fast response PIN photodiode with RG9 long pass filter
Electronics	16 bit microprocessor, 12 bit resolution, A/D 10 $\mu\text{sec}$ acquisition rate, 8 bit DAC for light source control, real time clock
Record Length	0.1 - 300 seconds
Memory	512K battery backed RAM. Sufficient for up to 1000 one second duration recordings with full trace data