Manual

Mini-Quantum/Temp.-Sensor 2060-M
and 2065-M

Arabidopsis Leaf Clip 2060-B

Fiberoptics Holder for Surfaces 2060-A

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Contents

1 Safety Instructions

- Read safety instructions and the operating instructions prior to operation of the device.
- Pay attention to all safety warnings.
- Keep electronic amplifier unit away from water or high moisture areas.
- Keep the device away from dust, sand and dirt.
- Do not put the device near sources of heat.
- Connect the device only to the power source indicated in the operating instructions.
- Ensure that neither liquids nor foreign bodies get inside the device.
- The device should only be repaired by qualified personnel.

2 Extent of Delivery

Table 1: Extent of Delivery

	Part number	Device
❑	2060-B	Arabidopsis Leaf Clip
❑	2060-A	Fiberoptics Holder for Surfaces
❑	2060-M	Mini Quantum/Temp.-Sensor. Analog version. For DUAL-PAM-100/DUAL-PAM/F, MINI-PAM, MULTI-COLOR-PAM, PAM-2500, ULM-500
❑	2065-M	Mini Quantum/Temp.-Sensor. Digital version. For MINI-PAM-II

Date Signature

3 Introduction

- The present manual introduces the 2060-M and 2065-M measuring instruments. Both devices possess the same light and temperature sensor. They differ in signal processing: the 2060-M produces an analog signal but the 2065-M signal is digital. Acquisition of data requires connection to a PAM fluorometer or the ULM-500 data logger. Currently, only the MINI-PAM-II processes the digital signal of the 2065-M device.
- Light is measured by a mini quantum sensor. This sensor records photosynthetically active radiation (PAR) which is the flux density of quanta in the visible spectral range (400 to 700 nm). The sensor is well suited for light incident perpendicular to the surface between -30° and + 30°.
- Temperature is measured by a flexible thermocouple. In contact with a leaf, the leaf surface temperature can be recorded.
- This manual also introduces two devices which hold the light and temperature sensors of the 2060-M or 2065-M devices in defined positions: (1) The 2060-B Arabidopsis Leaf Clip which is designed for very small leaves, and (2) 2060-A Fiberoptics Holder for Surfaces which is suited for bulky samples.

4 Components

4.1 2060-M and 2065-M Light and Temperature Sensors

Both units (2060-M and 2065-M) use the same PAR and temperature sensors. These sensors are connected by 30 cm cables to an amplifier unit (Fig. 1, page 6). The amplifier unit of the 2060-M device outputs analog data via a 110 cm cable and a 7-pole plug. The amplifier unit of the 2065-M device gives out digital data via a 110 cm cable and a 4-pole plug. Table 2 (page 7) gives an overview on Walz devices and the socket to which the 2060-M or 2065-M device should be connected.

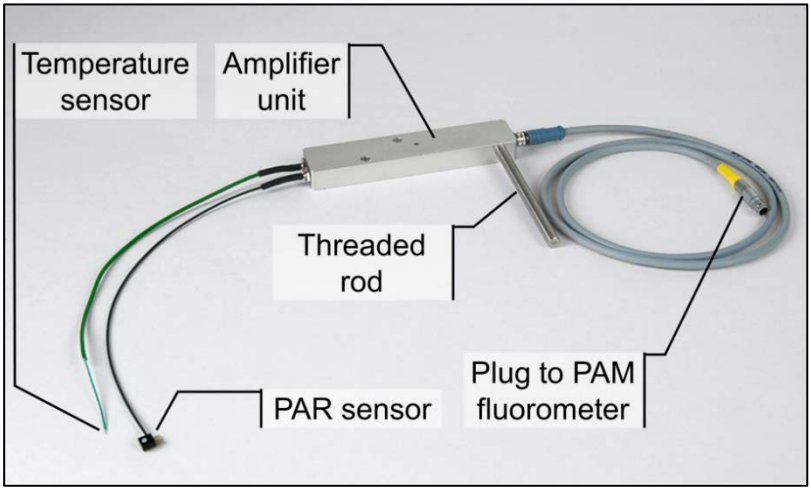

Fig. 1: Mini Quantum/Temp.-Sensor 2065-M.

Note Great caution should be exercised to prevent dirt or foreign matter from entering the plugs and sockets. Do not force a plug into the wrong socket. Orientate each plug so that the red dot on the plug coincides with the red dot of the socket. Do not try to disconnect a plug by pulling at the cable. Disconnect plug by pulling at the rippled bushing of the plug.

Table 2: Connection to Walz Devices

Sensor	Walz Device	Socket	Comment
2060-M	DUAL-PAM-100 DUAL-PAM/F	AUX	Cover light sensor, right-click on numeric PAR display of DualPAM software, carry out “Auto Zero” procedure.
2060-M	MULTI-COLOR-PAM	EXT. SENSOR	Cover light sensor, select “Light Calibration” from “Options” menu of PamWin software and carry out “Auto Zero” procedure.
2060-M	PAM-2500	LEAF CLIP	Same as MULTI-COLOR-PAM
2060-M	MINI-PAM	LEAF CLIP	Standalone operation: Cover light sensor, go to menu item 40 “LIGHT-OFFS.” and manually set offset until PAR=0. WinControl-3 operation. Cover light sensor, go to System Settings and manually set offset until PAR=0.
2060-M	ULM-500	4-pole female socket	Requires adapter cable. Select “Sensor Settings” = Leaf Clip and “Leaf Clip Type”=Mini-PAM LC.
2065-M	MINI-PAM-II	LEAF CLIP	Offset adjustment normally not required, the factory offset sored on the 2065-M.

Sensor Calibration

For light and temperature sensors, the software or firmware of the Walz devices listed in Table 2 (page 7) displays the currently active calibration factors, which are slope and offset of calibration curves.

The amplifier boxes of the 2060-M unit is adjusted so that PAR slope=1, Temp. Offset=0, and Temp. Slope=1. These three settings correspond to the default settings of the software and, usually, changes of these three values are not required. The PAR Offset, however, should be adjusted at first use of the 2060-M unit and later at regular intervals: the column “Comment” of Table 2 provides corresponding instructions.

Generally, the stability of light calibration depends on keeping the sensor’s diffuser disk clean. Calibration can be checked by comparison with a standard quantum sensor. Any deviation can be corrected by adjusting calibration factors. A substantial increase of the calibration factor “PAR slope” may indicate dirt deposition on the diffuser, which may be reversed by gentle cleaning using a cotton tip applicator moistened with mild detergent.

Mini-Quantum-Sensor

A mini quantum sensor monitors the photosynthetic active radiation (PAR) to which the sample is exposed. The mini-quantum-sensor measures incident PAR in µmol quanta m^{-2} s^{-1}, i.e. in units of flux density. Hence, the measured parameter PAR is identical to PPFD (photosynthetic photon flux density). The sensor's typical spectral response is depicted below (Fig. 2, page 9).

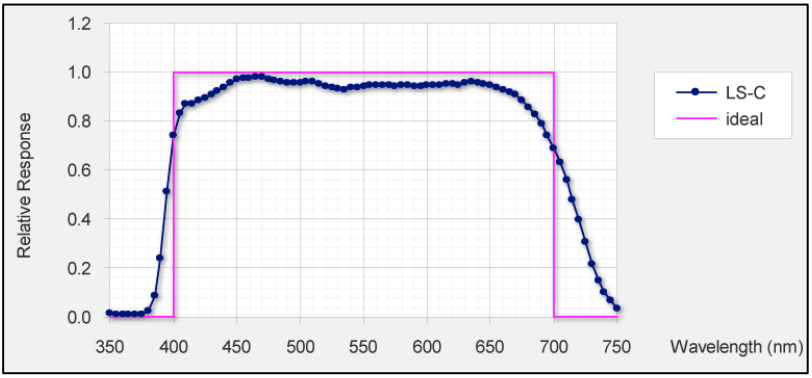

Fig. 2: Typical spectral response against photosynthetically active radiation (quantum flux density between 350 nm and 750 nm) of the mini quantum sensor. Solid line, ideal response. Dots, actual response.

Essential optoelectronic elements of this mini-quantum-sensor are:

- A 3 mm ∅ diffusing disk.
- High stability silicon photovoltaic detector with filter set for PAR correction.
- Cosine response characteristics (Angular dependence: Error < 3 % for angle between -30 ° and +30 ° from normal axis).

See below (Fig. 3, page 10), for a typical angular response curve

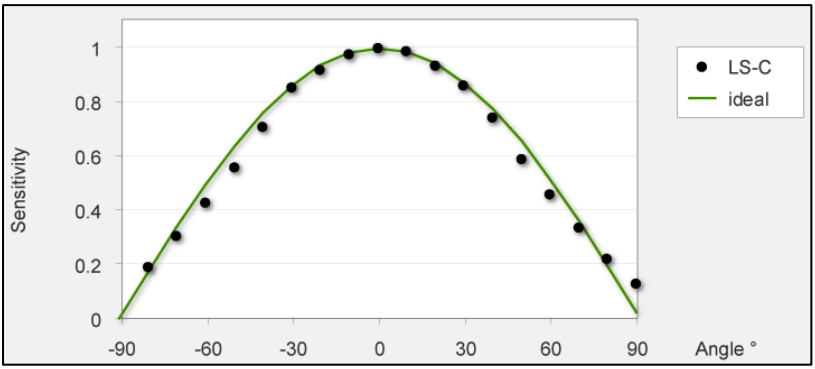

Fig. 3: Typical angular response curve of the mini quantum sensor. The mini quantum sensor uses a plastic diffuser to obtain an angular response error of less than ± 3% (-30...30 ° angle). Dots, actual angular response. Line, ideal cosine response.

Thermocouple

Temperature is sensed by a NiCr-Ni thermocouple. The reference couple is located on the circuit board of the amplifier unit. The relationship between thermovoltage and temperature is almost linear. With decreasing temperatures there is a small decline of ΔV/°C. Calibration was performed at 25 °C. At 0 °C or -15 °C the deviation amounts to 0.5 or 0.8 °C, respectively.

4.2 2060-B Arabidopsis Leaf Clip

The 2030-B clip has a small measuring area designed to position small leaves below the fiberoptics. The aluminum plate with measuring area and the aluminum part below form a clip to fix a small leaf. The 60 degree fiberoptics adapter displayed in Fig. 4 (page 11) can be replaced by the Fiberoptics Adapter 90° 2030-B90. To replace the adapter, remove the two Phillips screws fixing the adapter to the aluminum body.

Supplied with the 2060-B clip are two stainless steel rings of 2 and 4 mm height, respectively. They can be combined with the 60° and 90° adapters. These rings increase the distance between fiberoptics tip and sample level if they are placed on top of a fiberoptics port.

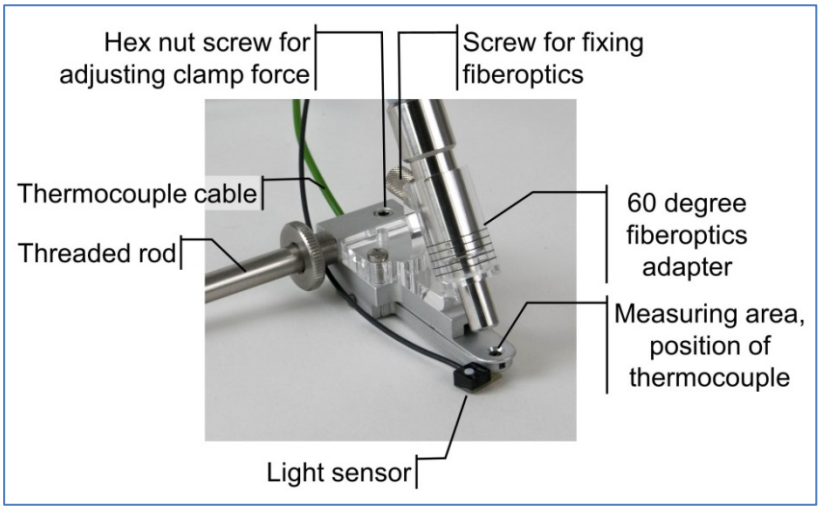

Fig. 4: 2060-B Arabidopsis Leaf Clip equipped with PAR and temperature sensors.

The light and temperature sensors of 2060-M/2065-M can be attached to the 2060-B clip so that PAR at leaf level and leaf temperature can be measured.

The light sensor is screwed on laterally of the viewing area (cf. Fig. 4, page 11). The temperature sensor is inserted from the back into a groove of the lower part of the clip. When the thermocouple is in position below the measuring area (cf. Fig. 4), the cable of the temperature sensor can be locked by tightening the aluminum plate across the groove.

4.3 2060-A Fiberoptics Holder for Surfaces

The holder positions the fiberoptics of PAM fluorometers on bulky samples. Supplied with the 2060-A holder are two stainless steel rings of 2 and 4 mm height, respectively. These rings increase the distance between fiberoptics tip and sample level if the fiberoptics tip is inserted into one or both rings before introducing the tip to the fiberoptics holder. Similarly as described above (0), the light and temperature sensors of 2060-M or 2065-M devices can be attached to the 2060-A holder (Fig. 5, page 13).

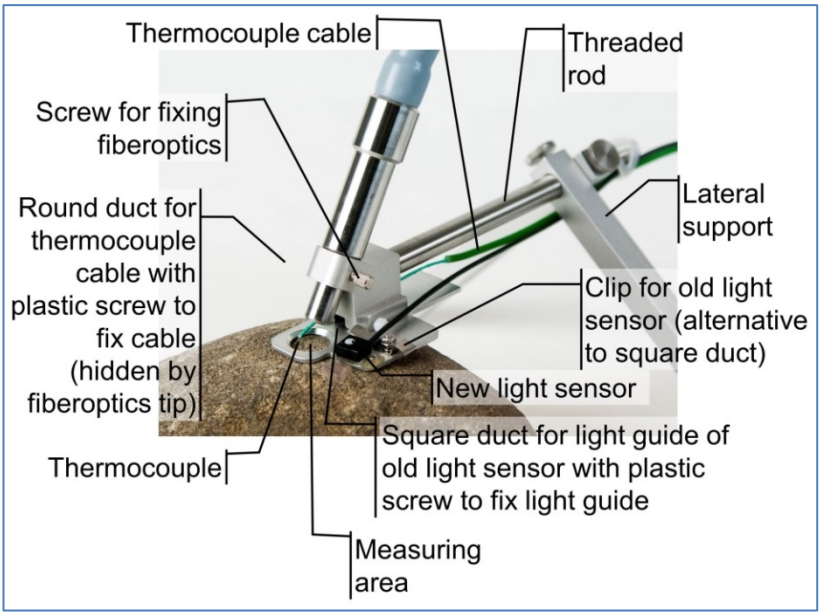

Fig. 5: 2060-A Fiberoptics Holder for Surfaces equipped with light and temperature sensors. The 2060-A clip can also hold first generation “micro” quantum sensors (“old light sensors”).

4.4 Note to MINI-PAM-II Users

Calibration of the internal light sensor for the sample levels of the 2060-B Arabidopsis Leaf Clip or the 2060-A Fiberoptics Holder for Surfaces requires correct positioning of the light sensor of the 2065-M device. In case of the 2065-B Arabidopsis clip, simply fix the sensor between upeer and lower clip parts. Make sure that the sensor is in the center of the viewing area so that the entire diffusing disk of the sensor is exposed to light from the MINI-PAM-II.

In case of the 2060-A Fiberoptics Holder, the light sensor is positioned using a special Perspex frame (Fig. 6, page 14). For light calibration, attach sensor to frame and position 2060-A Fiberoptics Holder so that the sensor's diffusing disk is entirely illuminated.

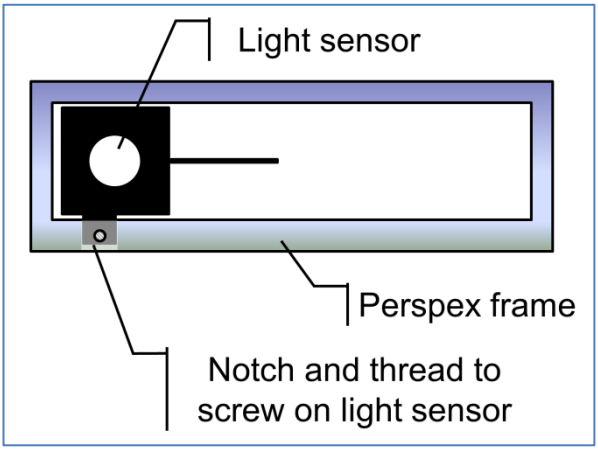

Fig. 6: Light Sensor Positioner for 2060-A Fiberoptics Holder for Surfaces.

5 Specifications

5.1 Mini Quantum/Temp.-Sensor 2060-M

Mini quantum sensor: LS-C sensor, selective PAR measurement, 0 to 20000 µmol m-2 s-1 PAR

Thermocouple: Ni-CrNi, 0.1 mm diameter, -20 to +60 °C

Output: PAR, high sensitivity range: 0 to 1000 µmol/(m2·s); normal sensitivity range: 0 to 20000 µmol m-2 s-1 PAR (output 0 to 2.5 V for each range). Leaf temperature, -20 to +60 °C (0 to 0.8 V)

Power supply: PAM-2500 leaf clip socket (5 V/4 mA)

Length of power cable: 100 cm

Length of sensor cables: 30 cm

Dimensions: 16 cm x 3 cm x 1.7 cm (L x W x H)

Weight: 220 g

5.2 Mini Quantum/Temp.-Sensor 2065-M

Design: Mini quantum and temperature sensors connected by 30 cm cables to an electronic unit for signal amplification, digitization and storage of calibration factors. A 10 cm steel rod can be laterally screwed-on to the electronic unit. A 110 cm cable connects the 2065-M unit with the fluorometer

Mini quantum sensor: LS-C sensor for selective PAR measurement, range 0 to 7000 µmol m-2 s-1, cosine corrected for light incident at angles between -30 ° to +30 from surface normal

Thermocouple: Ni-CrNi, wire diameter 0.1 mm, -20 to +60 °C

Dimensions of electronic unit: 15 cm x 3.3 cm x 2.5 cm (L x W x H)

Weight: 125 g (excluding cable)

5.3 Arabidopsis Leaf Clip 2060-B

Design: Aluminum clip with 3.2 mm diameter viewing area designed to position small leaves below the fiberoptics of the PAM-2500, prepared to accommodate PAR and temperature sensors of the Mini Quantum/Temperature-Sensor 2060-M

Dimensions: 7.6 cm x 3.0 cm (max.) x 5.2 cm (max.) (L x W x H)

Weight: 55 g

5.4 Fiberoptics Holder for Surfaces 2060-A

Design: Aluminum plate (6.0 x 3.3 cm max.) with 11 mm diameter circular hole (measuring area) and aluminum port to position fiber at an angle of 60° relative to the aluminum plate. With port for temperature sensor of 2060-M unit to measure surface temperature and thread to mount the PAR sensor of the 2060-M unit. Connected to a 10 x 0.8 cm (L x Ø) steal rod with two lateral aluminum supports (12 cm x 1 cm x 1 cm, L x W x H) which are lockable by knurled screws

Dimensions (without aluminum supports): 15 cm x 3.3 cm x 2.5 cm (L x W x H)

Weight: 125 g

- Subject to change without prior notice -

6 Warranty

All products supplied by the Heinz Walz GmbH, Germany, are warranted by Heinz Walz GmbH, Germany to be free from defects in material and workmanship for two (2) years from the shipping date (date on invoice).

6.1 Conditions

This warranty applies if the defects are called to the attention of Heinz Walz GmbH, Germany, in writing within two (2) years of the shipping date of the product.

This warranty shall not apply to

- any defects or damage directly or indirectly caused by or resulting from the use of unauthorized replacement parts and/or service performed by unauthorized personnel.
- any product supplied by the Heinz Walz GmbH, Germany which has been subjected to misuse, abuse, abnormal use, negligence, alteration or accident.
- to damage caused from improper packaging during shipment or any natural acts of God.
- to batteries, cables, calibrations, fiberoptics, fuses, gas filters, lamps, thermocouples, and underwater cables.

Submersible parts of the DIVING-PAM or the underwater version of the MONITORING-PAM have been tested to be watertight down to the maximum operating depth indicated in the respective manual. Warranty shall not apply for diving depths exceeding the maximum operating depth. Further, warranty shall not apply for

damage resulting from improper operation of devices, in particular, the failure to properly seal ports or sockets.

6.2 Instructions

To obtain warranty service, please follow the instructions below:

- The Warranty Registration form must be completed and returned to Heinz Walz GmbH, Germany.
- The product must be returned to Heinz Walz GmbH, Germany, within 30 days after Heinz Walz GmbH, Germany has received written notice of the defect. Postage, insurance, and/or shipping costs incurred in returning equipment for warranty service are at customer expense. Duty and taxes are covered by Walz. Accompany shipment by the Walz Service and Repair form available at: http://www.walz.com/support/repair_service.html
- All products being returned for warranty service must be carefully packed and sent freight prepaid.
- Heinz Walz GmbH, Germany is not responsible or liable, for missing components or damage to the unit caused by handling during shipping. All claims or damage should be directed to the shipping carrier.

7 Index