LIGHTING UNIT

Fiber Illuminator FL-460
and
Special Fiberoptics 460-F

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1 Introduction

A source of artificial light is often required when investigating the process of photosynthesis. The light source should have a similar spectrum to sunlight, have sufficient light intensity and should illuminate the object under investigation as uniformly as possible. There is hardly a light source that adequately fulfils all of these characteristics. High intensities with a light spectrum similar to sunlight can normally be obtained using halogen lamps, although these have the disadvantage that they produce considerable heat and have an inhomogeneous light distribution.

The newly developed lighting unit uses a halogen lamp as the light source, but distributes the light using a fiberoptics unit. This enables the advantages of the halogen lamp, namely high light intensity and a light spectrum similar to sunlight, to be utilized. The fiberoptics provides good light distribution and this is complemented by almost complete filtering out of the infrared radiation. The light intensity can be regulated in a number of ways. These advantages make the lighting unit not only highly suitable for our gas exchange chambers but also for many other applications.

2 Component description

The lighting unit consists of two components, the Fiber Illuminator FL-460 (KL 2500 LCD from Schott) and the Special Fiberoptics 460-F.

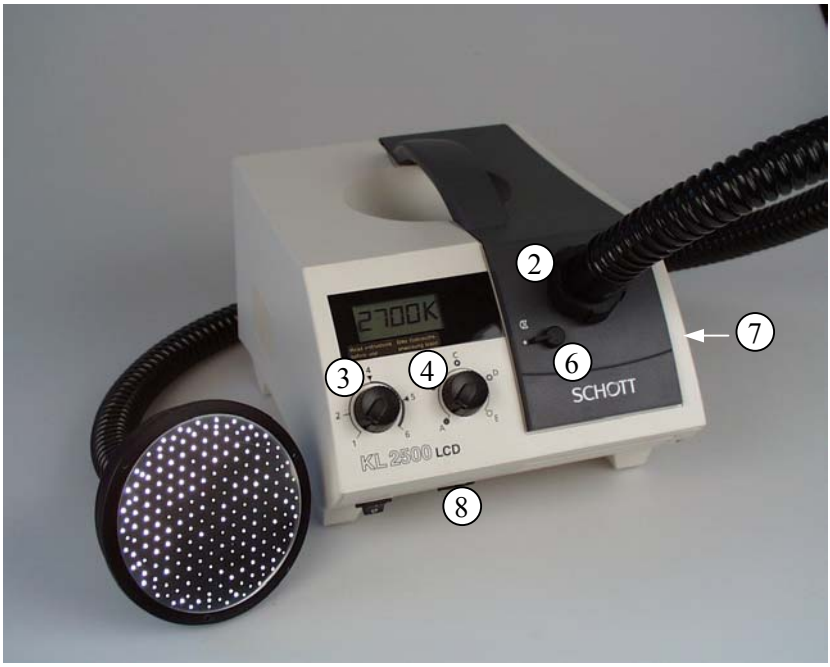

Fig. 1: Fiber Illuminator FL-460 with Special Fiberoptics 460-F (2: light guide connection; 3: electronic adjustment; 4: mechanical aperture; 6: supplementary optics; 7: filter wheel; 8: connection socket for remote operation; the numbers agree with those in the original manual)

2.1 Fiber Illuminator FL-460

For the Fiber Illuminator FL-460 (KL 2500 LCD) an original manual is available from Schott. Please refer to this manual for getting familar with the KL 2500 LCD and for getting information

on maintenance, technical specifications and trouble shooting. Our manual contains only the information on how to optimally use the fiber illuminator in combination with the Special Fiberoptics 460-F. In this connection, it is especially described how light intensity and light quality depend on the various settings. The FL-460 is additionally equipped with two neutral density filters (NG5 and NG11).

2.2 Special Fiberoptics 460-F

The flexible special fiberoptics, approximately 120 cm in length, consists of over 200 individual plastic fibers 1 mm in diameter. The fibers are closely together at the light inlet, but at the light outlet they are arranged in grid formation in a circle with a diameter of 95 mm. A higher density of fibers at the edge ensures even distribution of light. The flange at the light outlet has three threads, which are used to mount an adapter plate. This adapter plate can be drilled with additional holes for flanching the special fiberoptics to a measuring chamber, stand, etc.

3 Startup

3.1 General notes

The fiber illuminator is offered in a 120 V version and in a 230 V version. Before you start up for the first time, please make sure that the mains voltage goes with the version of the fiber illuminator. Pay attention to the safety information in the original manual.

3.2 Operation of the fiber illuminator

Fiberoptics with different diameters can be connected to the Fiber Illuminator FL-460. On delivery a socket adapter is in the light guide connection (2), which must be taken out. The outer black ring must be turned counter-clockwise until it can be removed. Then the socket adapter has to be pulled out and the black ring must be screwed on again. Now the Special Fiberoptics 460-F can be connected.

The two neutral density filters should be inserted in the filter wheel (7) of the fiber illuminator (please refer to the original manual how to insert filters). The filter wheel will not overheat using these filters.

The light intensity may be regulated manually by electronic adjustment (knob 3), mechanical aperture (knob 4) or by bringing the neutral density filters into the optical path (filter wheel 7). The lever for supplementary optics (6) should be in position "•".

The homogeneity of the light distribution and the maximum achievable light intensity depend on the distance between the light outlet of the fiberoptics and the level of the object. The fiberoptics

performs optimally at a distance of 3.5 cm, but provides satisfactory light distribution and light intensity over greater distances.

Changing the light intensity via electronic adjustment results in a shift of the light spectrum. Changing the light intensity via the mechanical aperture or via neutral density filters hardly affects the light spectrum. It should be noted that changing the spectrum too much is undesirable for many experiments.

If a spectrum shift should be avoided completely, then first a starting position of the electronic adjustment has to be chosen. For this the mechanical aperture has to be opened completely (knob 4: positon E) and no neutral density filters should be in the optical path. Then the electronic adjustment has to be adjusted so that the desired maximum light intensity can be achieved. If the electronic adjustment remains in this starting position and the light intensity is varied using only the neutral density filters or the mechanical aperture, then the light spectrum is hardly affected. In this case the light intensity can be changed in defined steps which are described in chapter 4.1.

If experiments require light intensities inbetween these steps and the spectrum shift should be kept small, then one should choose a starting position of the electronic adjustment knob as described above. With the electronic adjustment being in this starting position, the desired light intensity is approached as close as possible using the mechanical aperture and the neutral density filters. Then the fine adjustment is made using the electronic adjustment knob. This procedure ensures that the electronic adjustment needs to be varied within a small range around the starting position resulting in only small spectrum shifts.

Instead of the manual electronical adjustment, the light intensity can be adjusted via the remote control connection (pin assignment is described in chapter 6.3, please refer also to the original manual).

4 Light intensity and light spectrum

The following chapters describe light intensity and light spectrum of the Fiber Illuminator FL-460 in combination with the Special Fiberoptics 460-F. It should be noted that the light intensities can be different for each lighting unit, since they are influenced by the age of the lamp and the fiberoptics. For this reason, the indicated absolute values are to be considered only as guidelines. When stating the light intensities as a percentage, however, the deviations between different lighting units will only be small, since they depend largely on the small tolerance limits of the neutral filters or the electronics.

4.1 Light intensity in dependance on electronic adjustment, neutral density filters and mechanical aperture

Table 1 shows the light intensity at different settings of the electronic adjustment with the mechanical aperture being in position "•" and no neutral density filters being in the optical path. The distance between fiber optics outlet and sample is 35 mm.

Table 1

Electronic adjustment	Light intensity, [µmol m^{-2} s^{-1}]	Light intensity, relative [%]
6	2875	100.0
5	2280	79.3
4	1450	50.4
3	1101	38.3
2	750	26.1
1	559	19.5

Table 2 shows the light intensity as a function of the neutral density filters and the mechanical aperture. The distance between the

object level and the light outlet orifice is 3.5 cm and electronic adjustment is in position 6. The indication of the absolute light intensity values should only be considered as guidelines. In order to achieve the values for the user's individual unit, an average value should be detected at a defined distance and a defined position of the electronic adjustment. Subsequently, the values for the individual unit result from a multiplication with the percentage indication.

Table 2

Aperture	Filter	Light intensity, [µmol m^{-2} s^{-1}]	Light intensity, relative [%]
E	none	2875	100.0
E	NG11	1685	58.6
D	none	1630	56.7
D	NG11	955	33.2
C	none	880	30.6
E	NG5	860	29.9
C	NG11	516	17.9
D	NG5	487	16.9
B	none	439	15.2
C	NG5	263	9.1
B	NG11	257	8.9
A	none	197	6.8
B	NG5	131	4.6
A	NG11	115	4.0
A	NG5	59	2.1

4.2 Light spectrum as a function of lamp power

Fig. 2 shows the light spectra for different positions of the electronic adjustment. The spectra were recorded at the light outlet orifice of the fiberoptics at a distance of 3.5 cm using a spectroradiometer. The optical path did not hold neutral density filters and the mechanical aperture was in position E.

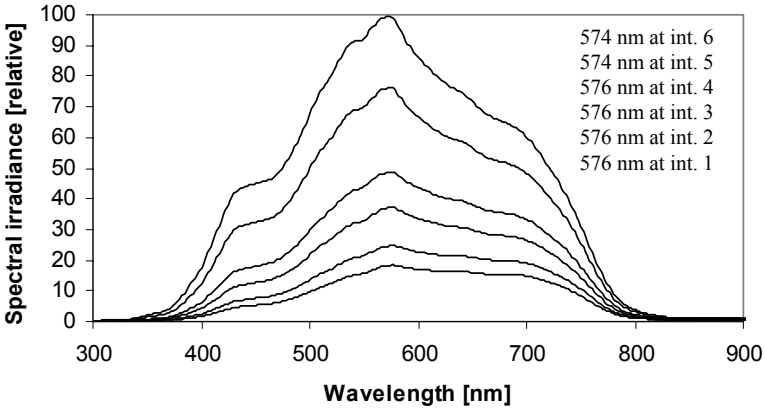

Fig. 2: Spectra at settings of the electronic adjustment 1-6. In addition to this, the wavelength, at which the maximum is situated, is indicated for each setting of the electronic adjustment.

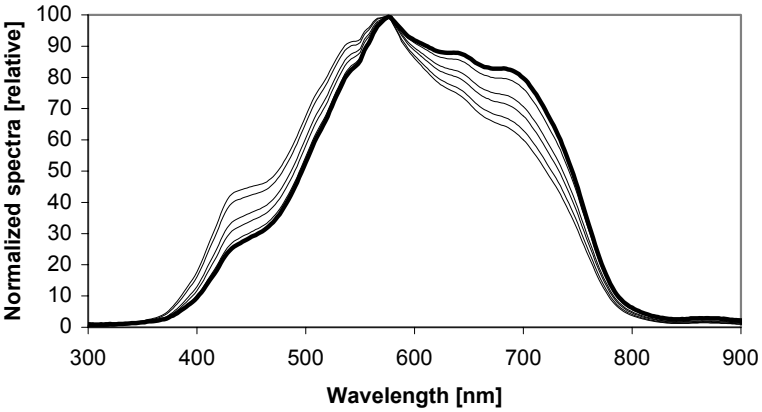

Fig. 3: Normalized spectra at settings of the electronic adjustment 1-6. The spectrum at setting 1 is indicated by a bold line. The spectra at setting 2-6 follow in sequence.

Fig. 2 shows that only a small shift in the peak wavelength occurs over the whole range of the electronic adjustment. Compared with that Fig. 3 shows clearly the shift in light quality. When the lamp output is decreased by electronic adjustment, then the portion of blue light is decreasing accompanied by an increase of the portion of red light.

5 Maintenance

5.1 Fiber Illuminator FL-460

Please refer to the original manual in regard to maintenance of the Fiber Illuminator FL-460 (KL 2500 LCD).

5.2 Handling of the fiberoptics

Do not bend or kink the fiberoptics excessively. Please avoid scratching the light inlet and outlet surfaces. If necessary clean these surfaces with a normal plastic cleanser. Never use other cleansing agents.

6 Technical data

6.1 Fiber Illuminator FL-460

Please refer to the original manual of the Fiber Illuminator FL-460 (KL 2500 LCD) in regard to the technical data.

6.2 Special Fiberoptics 460-F

General data:

Length of the fiberoptics:	120 cm
Weight:	0.85 kg
No. of individual plastic fibers:	Approx. 200 with 1 mm dia.

Adapter at light inlet orifice:

External diameter:	18 mm
Diameter of the light inlet orifice:	16 mm

Flange at the light outlet orifice:

Diameter:	95 mm
Threaded holes:	3 x M3 with 120 °; pitch diameter 102 mm

6.3 Pin assignment of the remote control connection

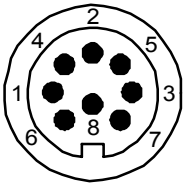

Fig. 4: Pin assignment (figure shows view of plug from solder side!)

PIN #	Description	Function
PIN 1	Stand-by or tilt	If connected with ground (PIN 2) "Stand-by"-mode: lamp "off", fan "lower number of revolutions", display shows "Stand-by"
PIN 2	Ground (GND)	
PIN 3	Input voltage (U_{in})	External control of light intensity by variation of voltage. Please see below for further details.
PIN 4	No connection	
PIN 5	No connection	
PIN 6	Reference voltage (U_{ref} Max)	See below
PIN 7	Reference voltage (U_{ref} Min)	See below
PIN 8	+10.5 V	Low level power supply for external accessories (Schott usage only). "Remote" in display

- The external input voltage U_{in} must be driven with low resistance due to overdrive the internal control voltage, i.e. directly through the output of an OP AMP LM 358 or 324.
- The external input voltage U_{in} must be adjusted between the two reference voltages U_{ref} Max and U_{ref} Min. These two reference voltages are the result of the individual adjustment of each circuit board and vary between light sources.

- If U_{ref} Max will be exceeded lamp failure will occur (halogen lamp will burn out or thermo switch will be activated or malfunction of display).
- If U_{ref} Min will be fallen below malfunction of the light source will occur.

A module, which can be connected to the socket for remote operation, is available in order to control the KL 2500 LCD via RS 232.

7 Warranty conditions

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 one (1) year from the shipping date (date on invoice).

The warranty is subject to the following conditions:

1. This warranty applies if the defects are called to the attention of Heinz Walz GmbH, Germany, in writing within one year (1) of the shipping date of the product.
2. 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.
3. This warranty shall not apply to any product supplied by the Heinz Walz GmbH, Germany which has been subjected to misuse, abuse, abnormal use, negligence, alteration or accident.
4. This warranty does not apply to damage caused from improper packaging during shipment or any natural acts of God.
5. This warranty does not apply to underwater cables, batteries, fiberoptic cables, lamps, gas filters, thermocouples, fuses or calibrations.

To obtain warranty service, please follow the instructions below:

1. The Warranty Registration form must be completed and returned to Heinz Walz GmbH, Germany.
2. 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, custom duties,

and/or shipping costs incurred in returning equipment for warranty service are at customer expense.

3. All products being returned for warranty service must be carefully packed and sent freight prepaid.

4. 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.