Introduction

Avantes is a cooperation of the Dutch company TOP Sensor Systems BV and the German company Mikropack GmbH. Avantes is producing, developing and selling products in the field of fiber optic spectroscopy, such as spectrometers, light sources, software, fiber optics, accessories and Thin-Film-Measurement systems.

With the combined effort of the two companies, with more than 10 years experience in the field of fiber optic spectroscopy, new applications can be realized, for example in the industrial, chemical, biomedical, semiconductor, food processing and many other fields.

At Top Sensor Systems in the Netherlands the main focus will be on the pan-European marketing activities as well as the production of fiber optics, fiber optic accessories and the continuing development of our comprehensive SpectraWin software package.

At Mikropack in Germany the main focus will be on production of light sources and accessories as well as development and integration of new spectrometer systems and applications.

The European distribution network consists of more than 25 distributors in over 20 European countries. The local distributors will support your custom specific applications with their long-time experience and know-how.

Please contact your local distributor for support or look on our website to be updated for the newest information.

This manual provides users with directions on configuring your A/D converter with your computer and operating the AVS-S2000, AVS-PC2000 and AVS-USB2000 Miniature Fiber Optic Spectrometer. For abbreviated directions on setting up your system, turn to the instructions beginning in Chapter 1: Quick start. In addition, this manual covers instructions for using some of our most popular spectroscopic components including light sources, sampling chambers, sampling optics, fiber optic probes, and optical fiber assemblies. The final section in this manual provides specific directions on taking absorbance, transmission, relative irradiance, and reflection measurements in the Experiment Tutorial section. There is a separate manual for SpectraWin Spectrometer Software.

Wavelength Calibration Data Sheet and File

In your shipment box you will find your Avantes spectrometer in a silver-gray anti-static bag. Also inside this bag is a Wavelength Calibration Data Sheet. This calibration sheet is unique to your spectrometer. The SpectraWin-Basic or full version diskette(s) contains a spectrometer configuration file that has the same data as the Wavelength Calibration Data Sheet. On the bottom of your spectrometer you will find a label with the serial nr, spectrometer configuration (grating and wavelength range) and installed options.

The data from the spectrometer configuration file is installed with the SpectraWin software.

Upgrades

Customers sometimes find that they need Avantes to make a change to or to upgrade their system. In order for Avantes to make these changes, the customer must first contact us and obtain a Return Merchandise Authorization (RMA) number. Please contact the Avantes Technical Services for specific instructions when returning a product.

If you still have problems with your installation, do not hesitate to contact us:
Avantes Technical Support
Soerense Zand 4a
NL-6961 LL Eerbeek
The Netherlands
Tel. +31-(0)313-670170, Fax. +31-(0)313-670179
Email: info@avantes.com

1 Quick Start

The AVS-S2000 is easy to set up, allowing the user to start collecting data within minutes. The three pages in this section provide *brief* instructions on setting up your system, installing your A/D converter, installing and configuring the software and connecting sampling optics. If you prefer step-by-step directions for setting up and operating any part of your system, check the **Table of Contents** to find instructions on a specific component.

1.1 Installing the A/D Converter

1.1.1 ADC 1000 or PC2000

1. The default settings for our A/D products are a Base Address (or input/output Range) of 768 decimal and an IRQ of 7. You will need to match Base Address and IRQ settings on the A/D card to available settings in your computer. First determine which settings are not in use by other hardware devices.
   - If you have Windows 95/98, go to **Start | Settings | Control Pane**l. Double-click the **System** icon. Choose the **Device Manager** tab and double-click on "Computer" at the top of the list of devices. Under **View Resource**s, note available settings -- numbers unassigned to hardware. Remember that these I/O settings are expressed in hexadecimal and correspond to our Base Address, which is given in decimal, followed by the hexadecimal equivalent in parenthesis.
   - If you have Windows NT, go to **Start | Programs | Administrative Tools (Common) | Windows NT Diagnostic**s. Click on the **Resources** tab. Select the **IRQ** button. Find an available IRQ. Select the **I/O Port** button. Find an available I/O Range (Base Address).
2. Note these available settings. When you first run SpectraWin, you must enter these values in the "Setup Hardware" dialog box.
3. Turn off the computer and take off the computer cover. Ground yourself to the computer chassis or power supply and remove the A/D card from its static-shielded bag.
4. If necessary, change the position of the switches on the A/D board. For the ADC1000 and PC2000, there is only one bank of switches on the A/D board: the Base Address may be changed via the first 6 switches and the IRQ may be changed via the last 3 switches. (See **paragraph 3.1.1** for switch positions.)
5. Insert the A/D card into the ISA-bus slot and connect the necessary cables from the A/D card to the spectrometer. Make sure the connections are snug and restart your computer.

1.1.2 DAQ-700 A/D converter

1. Install NI-DAQ version 6 CD Driver Software -- the device driver library necessary for Windows 95/98 and NT systems to properly use the DAQ-700 on your computer.
2. Insert the DAQ-700 into any available PCMCIA slot.
3. Find the IRQ and Base Address values.
   - If you have Windows 95/98, select **Start** | **Settings | Control Pane**l. Double-click the **System** icon. Select the **Device Manager** tab. Double-click the hardware group named **Data Acquisition Device**s. Double-click **DAQCard-70**0. Click the **Resources** tab. Find the check box next to **Use Automatic Setting**s. Clear that check box (deselect it). Now change the settings for either (or both) the input/output Range or the Interrupt Request. To make this change, double-click either **input/output Range** or **Interrupt Reques**t. A dialog box giving the current hardware setting appears. Use the two small arrows to the right side of the **Value** box to change the hardware interface parameters. Choose values that say **No devices are conflictin**g. Click **O**K. Click **Yes** at the "Creating a Forced Configuration" message box.
   - If you have Windows NT, go to **Start | Programs | Administrative Tools (Common) | Windows NT Diagnostic**s. Click on the **Resources** tab. Select the **IRQ** button. Find the IRQ

that your computer assigned to the A/D converter. Select the **I/O Port** button. Find the I/O Range (Base Address) that your computer assigned to the DAQ-700.

4. Note these values. When you first run SpectraWin, you must enter these values in the "Configure Hardware" dialog box.

1.1.3   SAD500 A/D converter

If your A/D converter is the SAD500 and is mounted onto the spectrometer, connect the cable from the SAD500 to your PC. If you ordered your SAD500 in its own housing, attach another cable from the spectrometer to theSAD500. Note the serial port number (also called COM Port) on the PC to which you are interfacing. Plug the PC12V/1.25A 12VDC wall transformer into an outlet and connect it to the SAD500.

1.1.4   AVS-USB2000 spectrometer for Windows98 only

First install the SpectraWin software, before you connect your AVS-USB2000 spectrometer to your computer, if you connect the AVS-USB2000 first you will not be able to use your spectrometer.
After installing SpectraWin connect the AVS-USB2000 with the USB cable that came with the shipment, insert the USB cable to your computer's USB port.
Now you can start the SpectraWin program. First enter the setup hardware box and make sure your spectrometer type is S2000/PC2000 and A/D type is USB2000.
If you accidentally connected the AVS-USB2000 to your PC before installing SpectraWin, or if you use an older version of SpectraWin, you will get a message that Windows has not installed a driver for the device. To rectify an incorrect installation follow these steps:

1. Navigate to the Device Manager. If you have Windows98, select **Start** | **Settings | Control Pane**l. Double-click the **System** icon. Select the **Device Manager** tab. For Windows2000 systems, right click on **My Computer,** select **Properties,** select **Hardware** tab and click on **Device Manager** button.
2. Scroll down until you see **Other devices**
3. Under **Other devices** you will see UB2000 with a large question mark, hit the **remove** button.
4. A warning box will appear to ask if it is OK to remove the USB2000 device, click **OK**.
5. Unplug the AVS-USB2000 from your PC and reinstall (newer version of) the SpectraWin software.
6. Now you can plug the AVS-USB2000 in again and start the SpectraWin software.

1.2   Installing SpectraWin software

SpectraWin BASIC version 4.2 is a 32-bit application and can be installed under the USB supported operating systems, such as Windows 98.

Running the Setup program
SpectraWin BASIC version 4.2 needs to be installed by executing the file SETUP.EXE on the first installation diskette. After going through several dialogs, described below, the installation program will ask for the second diskette.
After all files have been installed, Windows needs to be restarted.

Installation Dialogs
The setup program will check the system configuration of the computer. If no problems are detected, the first dialog is the "Welcome" dialog with some general information. The next dialog shows information about the existence of a FULL SpectraWin version and where to search for it.
In the next dialog, the destination directory for the SpectraWin software can be changed. The default destination directory is C:\SWBasic. If you want to install the software to a different directory, click the Browse button, select a new directory and click OK. If the specified directory does not exist, it will be created.

In the next dialog, the name for the program manager group can be changed. The default name for this is "AVANTES Software".

After this, the "Start Installation" dialog is shown. After clicking the "next" button, the installation program starts installing files until it requests to insert the second installation diskette. After all files have been installed, the "Installation Complete" dialog shows up. After clicking the "Finish" button, the last dialog is shown which contains the following information: "This system must be restarted to complete the installation. Press the OK button to restart the computer. Press Cancel to return to Windows without restarting.

Launching the software

SpectraWin can be started from Windows Start Menu. Under Start-programs, the group "AVANTES Software" has been added. This group contains two icons. With the red "V" icon, SpectraWin is started. The SpectraWin Help icon can be used to activate the SpectraWin helpfiles (these helpfiles can also be activated from the Help menu after starting SpectraWin).

The first time SpectraWin is started, the hardware needs to be set up correctly. Clicking the menu option Setup-Hardware can do this. In this dialog, the Spectrometer Type, ADC-card, IRQ and base address can be entered. If these parameters have been filled in correctly, data collection can be activated by clicking the green start button.

If SpectraWin BASIC came together with a spectrometer, the spectrometer calibration coefficients have already been entered into the software. This can be verified by checking the menu option Setup Wavelength Calibration Coefficients. If SpectraWin BASIC has been downloaded from our website, default wavelength calibration coefficients are used. The correct calibration coefficients need to be entered then in the wavelength calibration coefficient dialog.

1.3   Measuring and saving a spectrum

1. After starting SpectraWin, the green Start button needs to be clicked to start measuring.
2. Connect a fiber or probe to the light source and to the Spectrometer input port(s) and set up the experiment for taking a reference spectrum.
3. Adjust the Smoothing Parameters in the Setup menu to optimize smoothing for the Fiber/Slit diameter that is used.
4. Now turn on the light source. Usually some sort of spectrum may be seen on the screen, but it is possible that too much or too little light reaches the spectrometer at the present data collection settings. Too much light means that, over a certain wavelength range, the signal is overloaded; shown as a straight line at any arbitrary height, even near zero. This can usually be solved by selecting "Data Collection Parameters" under Setup and entering a shorter integration time. Try to adjust the integration time, such that the maximum count over the wavelength range is around 3500 counts. When at minimum integration the signal is still too high, an attenuator (FHSA-TTL), a neutral density filter or fibers with a smaller diameter may be used. When not enough light reaches the spectrometer, likewise a longer integration time should be entered.
5. When a good spectrum is displayed, turn off the light source.
6. Now save the Dark data. This is be done by File-Save-Dark from the menu or by clicking the black square on the left top of the screen with the mouse. Always use Save Dark after the integration time has been changed.
7. Turn on the light source again. Save the present spectrum as a reference by choosing File Save-Reference from the menu or by clicking at the white square (next to the black one). Always use Save Reference after the integration time has been changed. Now the Transmittance/reflectance (T button) or Absorbance (A button) spectra can be obtained online. To have a better look at the amplitude versus wavelength, the cursor button in the right top corner of the screen can be clicked. A vertical line is displayed in the graph. Moving this line by using the arrow buttons shows the corresponding values of wavelength and amplitude on the main screen. By clicking the red stop button, the data acquisition is stopped and clicking the red stop button shows the last acquired spectrum shown in

static mode. The data acquisition can be started again by clicking the same button, which now shows a green 'Start'.

8. To save the spectrum (in the mode chosen before), choose File-Save-Experiment from the menu, or click the Save Experiment button from the button bar.

9. To improve the Signal/Noise ratio, a number of spectra may be averaged. To do this, select "Data Collection Parameters" under "Setup" and enter a number in "Number of scans to average". The spectrum then seen on the screen, is the average over the number that has been entered

The following are typical configurations for absorbance, transmission, irradiance, and reflection experiments.

1.4 Measurement Setup
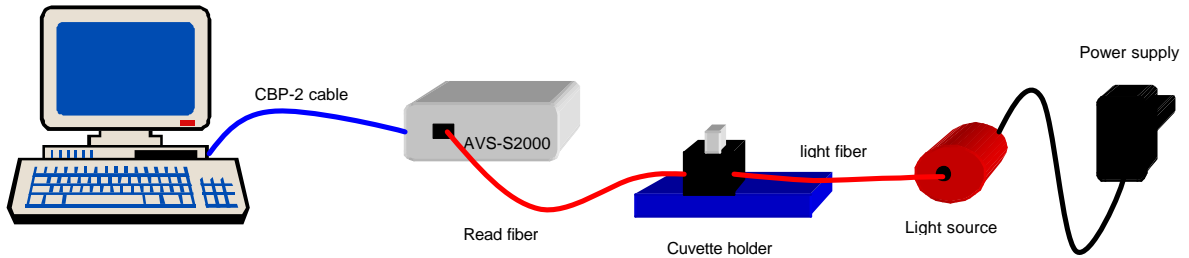
Absorbance/Transmission Setup
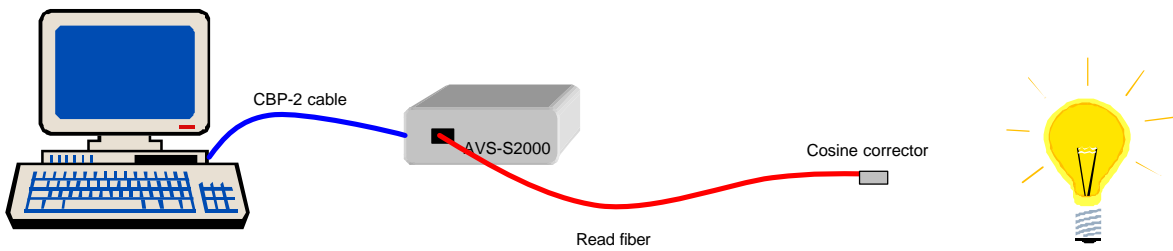
Irradiance Setup
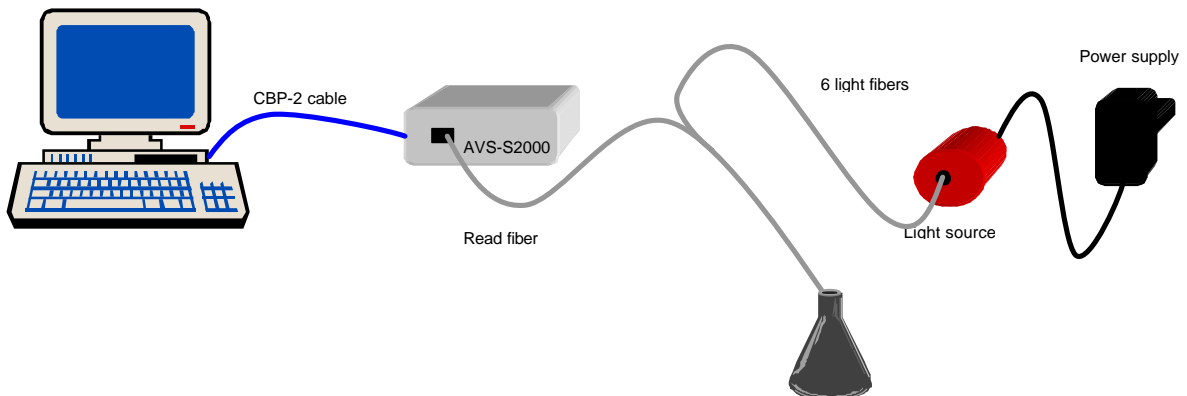
Reflection / Dip-probe Setup

2   Miniature Fiber Optic Spectrometers

2.1   AVS-S2000

The miniature fiber optic spectrometer, the AVS-S2000, couples a low-cost, high-performance 2048-element linear CCD-array detector with an optical bench that's small enough to fit into the palm of your hand. The AVS-S2000 is a high-sensitivity, low-cost UV-VIS-Short-wave NIR spectrometer making it especially useful for fluorescence and other low light level applications that demand high detector sensitivity. The AVS-S2000 accepts light energy transmitted through single-strand optical fiber and disperses it via a fixed grating across the linear CCD array detector, which is responsive from 200-1100 mm. Up to seven spectrometer channels can be added to expand wavelength range, perform multiple

tasks or provide reference monitoring. The master and slave channels are all accessed through a single program for near synchronous operation. In addition, an SMA 905 connector allows for easy coupling to an extensive line of fiber optic light sources, sampling chambers, optical fibers, probes, chemical sensors, and other spectro-photometric accessories.

Operating performance will vary according to a number of factors, including the spectrometer configuration -- especially the groove density of the grating and the size of the entrance optics -- as well as the application itself.

Optical resolution -- measured as Full Width Half Maximum(FWHM) -- of a monochromatic source depends on the groove density (lines/mm) of the grating and the diameter of the entrance optics (optical fiber or slit).

Resolution (nm) for chosen grating and width of the light beam

Beam width (mm) Grating (lines/mm)	8	10	25	50	100	200	400	600
300	1.6	1.6	2.4	4.0	8.0	15	30	45
600	1.0	1.0	1.5	2.5	5.0	10	20	30
1200	0.5	0.5	0.8	1.3	2.5	5.0	10	15
1800	0.4	0.4	0.5	0.8	1.7	3.3	6.7	10
2400	0.3	0.3	0.4	0.6	1.3	2.5	5.0	7.5
3600	0.2	0.2	0.3	0.4	0.8	1.7	3.3	5.2

2.1.1 AVS-S2000 Specifications

Absolute Maximum Ratings

Vcc	+ 5.5 VDC
Voltage on any pin	Vcc+ 0.2 VDC

Physical Specifications

Physical dimensions (no enclosure)	138 x 99 x 23 mm LWH (master only)
Physical dimension (enclosure)	140 x 105 x 40 mm LWH (master only)
Weight	200 g (master only, no enclosure)

Power

Power requirement (master)	130 mA at +5 VDC
Power requirement (slave)	70 mA at +5 VDC
Supply voltage	4.5 – 5.5 V
Power-up time	3 msec

Spectrometer

Design	asymmetric crossed Czerny-Turner
Focal length (input)	42 mm
Focal length (output)	68 mm (75, 83 and 90 mm focal lengths are also available)
Input fiber connector	SMA 905
Gratings	14 different gratings
Entrance slit	5, 10, 25, 50, 100, or 200 μm slits. (Slits are optional. In the absence of a slit, the fiber acts as the entrance slit.)
Detector	Sony ILX511 CCD
Filters	2nd order rejection, long pass (optional)

Spectroscopic

Integration time	3 – 730.000 msec (only up to 60 seconds is supported by SpectraWin)
Dynamic range	2×10^{8}
Signal-to-Noise	250:1 single acquisition
Readout noise single dark spectrum)	(3.5 counts RMS, 20 counts peak-to-peak
Resolution (FWHM)	0.3 – 10.0 nm varies by configuration
Stray light	<0,05% at 600 nm; <0,10% at 435 nm
Spectrometer channels	8 (master plus up to 7 slaves)

Environmental Conditions

Temperature	-30° - +70° C Storage; -10° - +60° C Operation

2.1.2 AVS-S2000 Board Layout and connections

- **J1** A/D Converter interface cable connection
- **J2** Accessory Cable connection
- **H1** Header Block connecting Master to other Slaves
- **H2** Header Block containing digital control signals
- **JP2** Channel Identification (M/S1..S7)
- **JP3** Jumper Block controlling of external strobing of a light source
- **JP4** Jumper Block controlling external triggering of the spectrometer
- **JP5** Reserved -- do not short
- **JP6** Reserved -- do not short
- **RV1** Potentiometer controlling the baseline
- **RV2** Potentiometer controlling the gain

J1 Dsub 25 interface to ADC (35-pin)

Pin	Description	Pin AD board
1	Analog Channel 0	37
2	Analog Channel 1	36
3	Analog Channel 2	35
4	Analog Channel 3	34
5	Analog Ground	19
6	Reserved	
7	N/C	
8	N/C	
9	Digital Ground	7
10	A/D Trigger	25
11	Master Clock	20
12	Digital Ground	Not in Cable
13	+5VDC	1
14	Analog Channel 4	33
15	Analog Channel 5	32
16	Analog Channel 6	31
17	Analog Channel 7	30
18	Analog Ground	Not in Cable
19	N/C	
20	Continuous Strobe In	8 (or use internal jumpers)
21	Ext. Software Trig. Out (DO3)	5
22	Spectrometer Mode Input S1	4
23	Integration Time Clock In	2
24	Strobe Enable, Mode Input S0	23
25	Enable Read In	3

J2 (D-SUB-15) Accessory Connector

Pin	Function	Description
1	Single Strobe	TTL output signal used to pulse a strobe that is high at the start of each integration period.
2	Continuous Strobe	TTL output signal used to pulse a strobe that is divided down from Master Clock signal.
3	Vcc	The positive supply voltage +5VDC
4	External Hardware Trigger	TTL trigger signal (rising edge trigger input) used in the External Hardware Trigger mode.
5	External Synchronization Trigger	TTL signal used to define the integration time (time between rising edges) when using the External Synchronization Trigger mode.
6	Channel 7	The analog signals that correspond to the output from the 8 spectrometer channels.
7	Channel 6	The analog signals that correspond to the output from the 8 spectrometer channels.
8	D3 or External Software Trigger	Active high TTL input signal used to trigger the acquisition system in the External Software Trigger mode. The input from J1-8 is passed unbuffered to this line.
9	Channel 1	The analog signals that correspond to the output from the 8 spectrometer channels.
10	GND	Ground (supply voltage return) or case ground.
11	Channel 4	The analog signals that correspond to the output from the 8 spectrometer channels.
12	Channel 5	The analog signals that correspond to the output from the 8 spectrometer channels.
13	S0 and S1	TTL inputs used to determine the triggering mode: S1 S0 Mode L X Normal or Continuous Scan L X External Software Trigger H L External Synchronization Trigger H H External Hardware Trigger X = does not matter In the first 2 modes, S0 is also used to enable/disable light sources.
14	Channel 3	The analog signals that correspond to the output from the 8 spectrometer channels.
15	Channel 2	The analog signals that correspond to the output from the 8 spectrometer channels.

H1 Header Block connecting Master to other Slaves

Pin	Description
1	Analog Channel 0
2	Analog Channel 1
3	Analog Channel 2
4	Analog Channel 3
5	Analog Channel 4
6	Ground
7	Reserved
8	Analog Channel 7
9	Analog Channel 6
10	Analog Channel 5

H2 Header Block connecting Master to other Slaves

Pin	Description
D	N/C
C	A/D Trigger
B	Digital In 3 (D3)
A	S1
1	Ground
2	+5 VDC
3	Phi A/D clock
4	Phi Read Out Gate
5	Reserved
6	Temperature (optional)
7	Read Enable
8	S0
9	Strobe Single flash
10	Strobe Multiple Flash
11	Integration Clock
12	Master Clock

JP3 Jumper Block controlling of external strobing of a light source

Jumper Position	Divisor	DAQ700 Flash Rate	ADC500, SAD500 Flash Rate	ADC1000 Flash Rate
1	Buffered input from D25, pin 20			
2	2^{10}	97.6 Hz	488.0 Hz	976.0 Hz
3	2^{12}	24.4 Hz	122.0 Hz	244.0 Hz
4	2^{14}	6.1 Hz	30.5 Hz	61.0 Hz
5	2^{16}	1.5 Hz	7.6 Hz	15.2 Hz

Jumper Block 4 (JP4) Controlling External Hardware Trigger Integration Time

Integration Time with DAQ700	Integration Time with ADC500, SAD500	Integration Time with ADC1000	JP4 Pins 1-2	JP4 Pins 3-4
44 ms	8.8 ms	4.4 ms	open	open
133 ms	27.5 ms	13.3 ms	open	shorted
275 ms	55.0 ms	27.5 ms	shorted	open
675 ms	137.5 ms	67.5 ms	shorted	shorted

2.1.3 Baseline adaptation, potentiometer RV-1

The DAQ700 PCMCIA converter card has a differential input of –5V to +5VDC, whereas the ADC500/ADC1000/SAD500 have a single ended input of 0-10 VDC.
Whenever the preset AD platform (DAQ or ADC) is changed the baseline of each AVS-S2000 spectrometer channel needs to be adapted.

Procedure to change baseline level of AVS-S2000 spectrometers, when changing from DAQ700 to ADC500/ADC1000/SAD500 or from ADC500/ADC1000/SAD500 to DAQ700:

1. Open AVS-S2000 Spectrometer by loosening the 2 screws on the backside
2. Slide out AVS-S2000 board of the housing, then connect interface cable to AD board and start SpectraWin.
3. Select shortest integration time (40 ms for DAQ700, 8ms for ADC500, 3 ms for ADC1000)
4. Make sure options as subtract saved dark and correct for dynamic Dark are out.
5. Block light path of the entrance of the spectrometer.
6. To change from DAQ700 to ADC500/ADC1000/SAD500: Now turn the potentiometer RV1, farthest away from the optical bench (=next to header H1) clockwise to increase the baseline (which is at beginning not visible) till ca. 60-100 counts.
    To change from ADC500/ADC1000/SAD500 to DAQ700: Now turn the potentiometer RV1, farthest away from the optical bench (=next to header H1) counterclockwise to decrease the baseline from ca. 2100 counts till ca. 60-100 counts.
7. Close SpectraWin
8. Shut off computer, disconnect interface cable and put back the housing of the AVS-S2000

Note: When you have a multiple channel spectrometer, procedure 5-6 needs to be executed for each single channel (make sure you select the view mode for the right channel)

2.2 AVS-PC-2000 Plug-in spectrometer

The AVS-PC2000 plug-in spectrometer is a combination of the AVS-S2000 and ADC1000. Most technical data can be found in either chapter 2.1 AVS-S2000 or in chapter 3.1 ADC-1000.
The table below gives the H1 header 1 connection pin outs, the J2 (D-sub-15) connector pin outs are given under 2.1.2.

H1 Header Block connecting Master to other Slaves

Pin	Description
1	Analog Channel 1 (slave1)
2	Analog Channel 2
3	Analog Channel 3
4	Analog Channel 4
5	Analog Channel 5
6	Analog Channel 6
7	Analog Channel 7
8	GND
9	GND
10	S0
11	Reserved
12	Multiple Strobe
13	Single Strobe
14	Reserved
15	F read (ROG)
16	F clock

2.3 AVS-USB2000 spectrometers


J2 accessory
connector

The AVS-USB2000 is a true plug- and play spectrometer, designed for use with PC and notebooks that run under Windows98 or Windows2000. For installation instructions see 1.4.

The AVS-USB2000 has several advantages over the other spectrometers, such as that it does not need any additional power supply and that the calibration coefficients and serial number are installed in the EEPROM memory chip in the spectrometer. The design of the optical bench is identical to the AVS-S2000, so all 14 gratings and options can be installed.

2.3.1 AVS-USB2000 pin description

Listed below is the pin description for the AVS-USB2000 Accessory connector (J2):

Pin	Description
1	V_{USB} or $5V_{in}$
2	RS232 Tx
3	RS232 Rx
4	Lamp enable
5	Continuous Strobe
6	Ground
7	External Trigger in
8	Single Strobe
9	I^2C SCL
10	I^2C SDA

```
10  8  6  4  2
 9  7  5  3  1
```
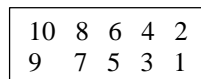
Pin Diagram

2.3.2 AVS-USB2000 specifications

Absolute Maximum Ratings

Vcc	8,0 VDC
Voltage on any pin	7,0 VDC

Physical Specifications

Physical dimensions (no enclosure)	89 x 64 x 34 mm LWH
Weight	200 g (without cable), 270 grams with cable

Power

Power requirement	100 mA at +5 VDC
Supply voltage	3,9 – 8,0 V

Spectrometer

Design	asymmetric crossed Czerny-Turner
Focal length (input)	42 mm
Focal length (output)	68 mm
Input fiber connector	SMA 905
Gratings	14 different gratings
Optional Entrance slit	5, 10, 25, 50, 100, or 200 µm slits. (In the absence of a slit, the fiber acts as the entrance slit.)
Detector	Sony ILX511 CCD
Optional Filters	2nd order rejection, long pass (optional)
Optional Collection lens	Cylindrical lens improves light-collection efficiency by ~5x
Optional Sorting coatings	Blocks 2nd and 3rd order effects for grating #1,#2 only
Optional UV detector upgrade	Detector upgrade for enhanced sensitivity in UV < 360nm

Spectroscopic

Integration time	3 – 60 seconds
Dynamic range	2×10^{8}
Signal-to-Noise	250:1 single acquisition
Readout noise single dark spectrum)	(3.5 counts RMS, 20 counts peak-to-peak
Resolution (FWHM)	0.3 – 10.0 nm varies by configuration
Stray light	<0,05% at 600 nm; <0,10% at 435 nm

Environmental Conditions

Temperature	-30°C to +70°C Storage; -10°C to +50°C Operation

3   A/D Converters

This section covers the basic installation instructions for our A/D converters: ADC500[1], ADC1000 (and AVS-PC2000), SAD500, and DAQ700. Because A/D converter installation goes hand-in-hand with software installation, you will find directions for installing SpectraWin-Basic Spectrometer Operating Software included in this section. The A/D converters we offer are:

- **ADC1000 ISA-BUS A/D CONVERTER** is a high-speed, 12-bit, 8-channel, single-ended, half-length card that fits into a slot in a desktop PC and has 1000 kHz sampling frequency.
- **AVS-PC2000 PC PLUG-IN** is an AVS-S2000 mounted on an ADC1000 A/D card. This combination fits easily into an ISA-bus slot in the PC; has 1000 kHz sampling frequency.
- **SAD500 SERIAL PORT INTERFACE** is a 12-bit, 8-channel A/D converter for serial port connection for interfacing to desktop or notebook PCs and has 500 kHz sampling frequency.
- **DAQ-700 PCMCIA A/D CONVERTER** from National Instruments is a 12-bit, 16-channel, single-ended card that fits into a credit card-size slot in a notebook PC and has 100 kHz sampling frequency.

Our software includes drivers that support the A/D converters we offer. Other A/D converters can be used with our spectrometers if the following conditions are met:
1. the ADC sampling rate is at least 100 kHz
2. external triggering of the A/D conversions is supported
3. there are a sufficient number of clocks and digital output lines to operate the spectrometer
4. a suitable software driver has been written
5. a suitable cable has been fabricated

3.1   ADC1000 ISA-bus A/D Converter (and AVS-PC2000)

The **ADC1000 ISA-BUS A/D CONVERTER** is a 12-bit, 8-channel, single-ended A/D card that connects our spectrometers to desktop PCs. The AVS-PC2000 has a 2048-element linear CCD-array fiber optic spectrometer mounted onto an ADC1000. This sturdy combination fits easily into a slot in the PC. The following are directions for installing your ADC1000 and PC2000. Because A/D converter installation goes hand-in-hand with software installation, you will find directions for installing SpectraWin Spectrometer Operating Software included in this section as well.

Each device in or connected to your computer is assigned specific settings; it's similar to giving each device its own name so that your computer will know what to call and how to recognize the device. In order for your ADC1000 or AVS-PC2000 to work as a device in your computer, it has to be assigned a Base Address setting and an IRQ setting. The default settings for each are:

<div align="center">

Base Address (I/O Range): 768 decimal (300 hexadecimal)
**IRQ (Interrupt Request): 07**

</div>

These default values are set on the A/D converter. There are dipswitches on the A/D board and their positions determine the values. These default values are set in the operating software as well. Most of the time, these default settings will work with your computer. However, if you have many devices installed in your computer, you may have a conflict; other devices may be using these settings. If there is a conflict with another device in your computer, you must change the positions of the switches on the A/D board. For the ADC1000 and PC2000, there is only one bank of switches on the A/D board: the Base Address may be changed via the first 6 switches and the IRQ may be changed via the last 3 switches. To first check your computer to see which settings are available, follow the instructions for the Windows system that you use.

---

[1] Discontinued since August 2000

3.1.1 ADC-1000/AVS-PC2000 installation

#### For Windows 95 and Windows 98 Users: Find Available Base Address and IRQ Settings

1. Go to **Start | Settings | Control Panel** and double-click on the **System** icon.
2. Choose the **Device Manager** tab and double-click on "Computer" at the top of the list.
3. Under **View Resource**s, find available settings -- numbers unassigned to hardware. Note these available settings for both the Interrupt request (IRQ) and the Input/output (Base Address). When you first run SpectraWin, you must enter these values in the "Setup Hardware" dialog box. (Remember that Input/output settings are expressed in hexadecimal.)
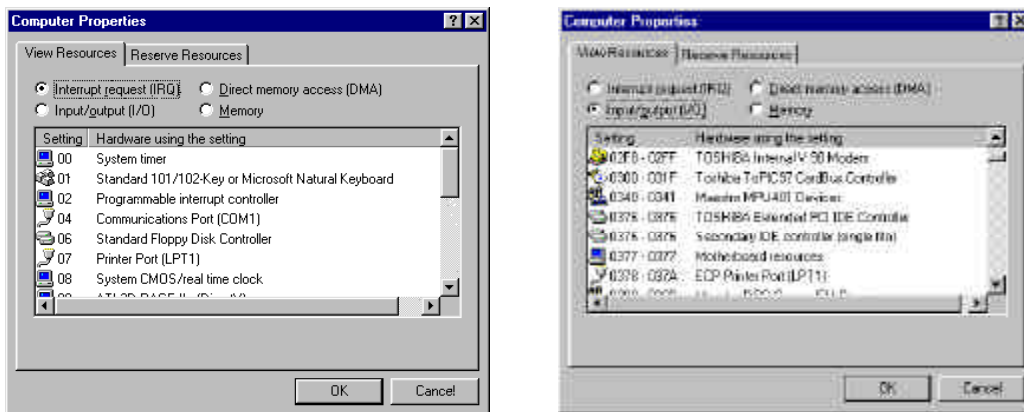
For most computers, the default settings work well. In the picture above left, it appears that the Printer occupies IRQ 07, so the IRQ needs to be changed to 05. All computers have multiple Base Address (Input/output) settings from which to choose.

For Windows NT Users: Find Available Base Address and IRQ Settings

1. Go to **Start | Programs | Administrative Tools (Common) | Windows NT Diagnostic**s.
2. In the "Windows NT Diagnostics" dialog box, click on the **Resources** tab.
3. Select the **IRQ** button. Find an available IRQ -- a number unassigned to a device.
4. Select the **I/O Port** button. Find an available I/O Range (Base Address) -- a number or range of numbers unassigned to a device. (The number is in hexadecimal.)
5. Note these available settings. When you first run SpectraWin, you must enter these values in the "Setup Hardware" dialog box. With Windows NT, devices cannot share IRQ 's; each device must be assigned a unique IRQ.

<div align="center">
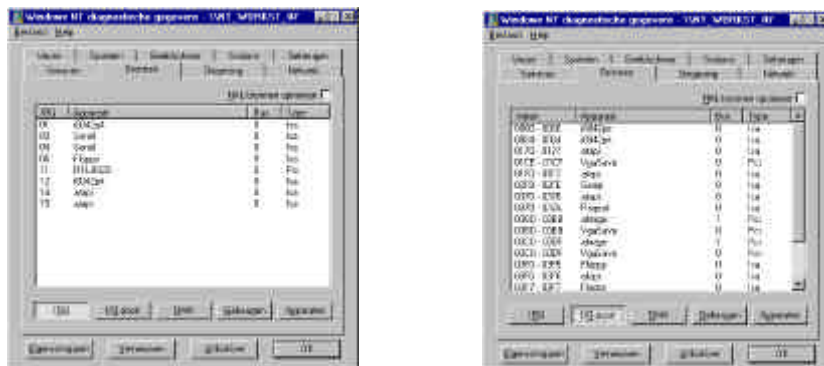
ADC-1000/AVS-PC2000 hardware installation

</div>

Installation of the ADC1000 is similar to that of any PC card installation:
1. Ground yourself to the computer chassis or power supply.
2. Turn off and unplug the computer. Then take off the computer cover.
3. Remove the ADC1000 from its static-shielded bag.
4. If necessary, change the position of the switches on the A/D board. Position the switches to match the available settings you found in the previous section -- numbers not being used by other hardware devices. The Base Address may be changed via the bank of switches labeled SW1 and the IRQ may be changed via the bank of switches labeled SW2.
5. See Table below for switch setting positions
6. Find an open ISA-bus slot and remove the slot protector.
7. Insert the ADC1000 into an available expansion slot on the motherboard connector by *gently* rocking the card into the slot. Make sure the ADC1000 is fully seated in the motherboard before screwing the tab on the ADC1000 to the computer.
8. Reinstall the cover and reconnect the computer power cord.
9. For the ADC-1000: Connect the D37 end of the interface cable to the ADC1000 and the D25 end of the interface cable to the spectrometer.

<div align="center">

Base Address (SW1)

</div>

To change the Base Address settings on the ADC1000 board, see the bank of 6 dip switches labeled SW1. Switches in the ON position have a value of zero. Switches in the OFF position have the decimal values shown. The Base Address is the sum of the values of the switches. In the default setting, switches 5 and 6 are added to give a total of 768. A few of the many combinations for Base Address settings are below.

Example: 768 decimal = Hex300 = 0x300 (Default Setting)

Switch #	1	2	3	4	5	6
on	■	■	■	■		
off					■	■

Example: 784 decimal = Hex310 = 0x310

Switch #	1	2	3	4	5	6
on		■	■	■		
off	■				■	■

Example: 800 decimal = Hex320 = 0x320

Switch #	1	2	3	4	5	6
on	■		■	■		
off		■			■	■

Example: 816 decimal = Hex330 = 0x330

Switch #	1	2	3	4	5	6
on			■	■		
off	■	■			■	■

Switch is in the on-upward position   ■

<div align="center">

IRQ Interrupt Request Settings (SW2)

</div>

To change the IRQ settings on the ADC1000/AVS-PC200 board, see the bank of 3 dipswitches labeled SW2. In the default setting, the IRQ is set to 7. Other combinations for IRQ settings follow.

IRQ 7 (Default Setting)

Switch #	7	8	9
on	■	■	
off			■

IRQ 3

Switch #	7	8	9
on			
off	■	■	■

IRQ 4

Switch #	7	8	9
on	■		
off		■	■

IRQ 5

Switch #	7	8	9
on		■	
off	■		■

IRQ 9

Switch #	7	8	9
on			■
off	■	■	

IRQ 10

Switch #	7	8	9
on	■		■
off		■	

IRQ 11

Switch #	7	8	9
on		■	■
off	■		

Switch is in the on-upward position ■

Software Installation

SpectraWin BASIC version 4.2 is a 32-bit application and can be installed under the following operating systems:

- Windows 95 or Windows 98

- Windows NT

Running the Setup program
SpectraWin BASIC version 4.2 needs to be installed by executing the file SETUP.EXE on the first installation diskette. After going through several dialogs, described below, the installation program will ask for the second diskette.
After all files have been installed, Windows needs to be restarted.

Installation Dialogs
The setup program will check the system configuration of the computer. If no problems are detected, the first dialog is the "Welcome" dialog with some general information. The next dialog shows information about the existence of a FULL SpectraWin version and where to search for it.
In the next dialog, the destination directory for the SpectraWin software can be changed. The default destination directory is C:\SWBasic. If you want to install the software to a different directory, click the Browse button, select a new directory and click OK. If the specified directory does not exist, it will be created.
In the next dialog, the name for the program manager group can be changed. The default name for this is "AVANTES Software".
After this, the "Start Installation" dialog is shown. After clicking the "next" button, the installation program starts installing files until it requests to insert the second installation diskette. After all files have been installed, the "Installation Complete" dialog shows up. After clicking the "Finish" button, the last dialog is shown which contains the following information: "This system must be restarted to complete the installation. Press the OK button to restart the computer. Press Cancel to return to Windows without restarting.

Setup Hardware Dialog Box

The first time SpectraWin is started, the hardware needs to be set up correctly. Clicking the menu option Setup-Hardware can do this. The parameters in this dialog box are usually set only once -- when SpectraWin is first installed and the software first runs.

1. Under **Spectrometer Typ**e, choose your spectrometer.
2. Under **A/D Converter Typ**e, choose ADC-1000/PC2000.
3. Choose **Base Address** as selected in the previous section.
4. Choose **IRQ** as selected in the previous section.
5. For your setup, only these parameters apply to your system. (Ignore the other settings; they apply to other A/D converters.) Click **OK**.
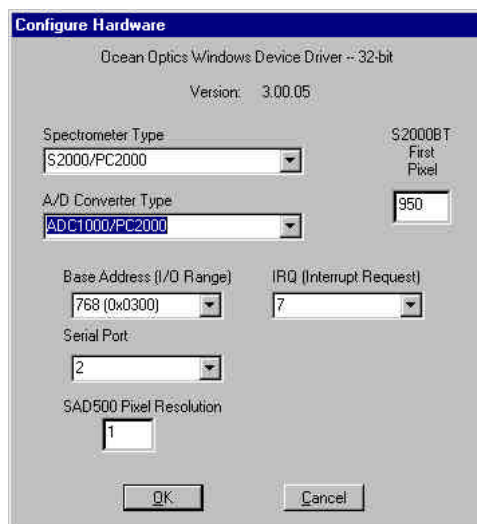
3.1.2 SAD500 Serial Port Interface Installation

The **SAD500 SERIAL PORT INTERFACE** is a microprocessor-controlled A/D converter for serial port connection or stand-alone operation. The SAD500 can be used to interface to desktop or portable PC's, PLC's, and other devices that support the RS-232 communication protocol. The following are directions for setting up your SAD500.

Because A/D converter installation goes hand-in-hand with software installation, you will find directions for installing SpectraWin Spectrometer Operating Software included in this section as well.

Interface the SAD500 to your PC

Interfacing the SAD500 to a desktop or portable PC is simple.
1. If you ordered your SAD500 mounted onto your spectrometer, simply connect the 6-pin DIN end of the serial cable to the SAD500 and the DB9 end to your PC. If you ordered your SAD500 in its own housing, attach the 25-pin conductor ribbon cable from the spectrometer to the SAD500. Then connect the 6-pin DIN end of the serial cable to the SAD500 and the DB9 end to your PC.
2. For either configuration, note the serial port number (also called COM Port) on the PC to which you are interfacing. (Older PCs may not have numbered ports.)
3. Plug the +12VDC wall transformer into an outlet and connect it to the SAD500.

Software Installation
Running the Setup program
SpectraWin BASIC version 4.2 needs to be installed by executing the file SETUP.EXE on the first installation diskette. After going through several dialogs, described below, the installation program will ask for the second diskette.
After all files have been installed, Windows needs to be restarted.

Installation Dialogs
The setup program will check the system configuration of the computer. If no problems are detected, the first dialog is the "Welcome" dialog with some general information. The next dialog shows information about the existence of a FULL SpectraWin version and where to search for it.
In the next dialog, the destination directory for the SpectraWin software can be changed. The default destination directory is C:\SWBasic. If you want to install the software to a different directory, click the Browse button, select a new directory and click OK. If the specified directory does not exist, it will be created.
In the next dialog, the name for the program manager group can be changed. The default name for this is "AVANTES Software".
After this, the "Start Installation" dialog is shown. After clicking the "next" button, the installation program starts installing files until it requests to insert the second installation diskette. After all files have been installed, the "Installation Complete" dialog shows up. After clicking the "Finish" button, the last dialog is shown which contains the following information: "This system must be restarted to complete the installation. Press the OK button to restart the computer. Press Cancel to return to Windows without restarting.

Setup Hardware Dialog Box

The first time SpectraWin is started, the hardware needs to be set up correctly. Clicking the menu option Setup-Hardware can do this. The parameters in this dialog box are usually set only once -- when SpectraWin is first installed and the software first runs.

1. Under **Spectrometer Typ**e, choose your spectrometer.
2. Under **A/D Converter Typ**e, choose SAD500.
3. Under **Serial Por**t, choose the COM port number your computer is using to interface to your SAD500. See the **Troubleshooting** section to determine the COM Port
4. Under **Baud Rat**e, select the speed at which the SAD500 will operate.
5. Under **SAD Pixel Resolutio**n, enter resolution values from1 to 500. This value specifies that every n $_{th}$ pixel of the spectrometer is transmitted from the SAD500 to the PC. Your resolution value depends on your experiment. By sacrificing resolution, you gain speed. The transfer of one complete spectra requires ~0.4 seconds when communicating at 115,200 baud rate. If you need your information in <0.4 seconds, increase the resolution or enable data compression (see below).
6. Enable the **Compress SAD500 Data** function to minimize the amount of data transferred over the RS-232 connection. Transmission of spectral data over the serial port is a relatively slow process. Enabling this function ensures that every scan transmitted by the SAD500 will be compressed, greatly increasing the data transfer speed of the SAD500.
7. For your setup, only these parameters apply to your system. (Ignore the other settings; they apply to other A/D converters.) Click **OK**.
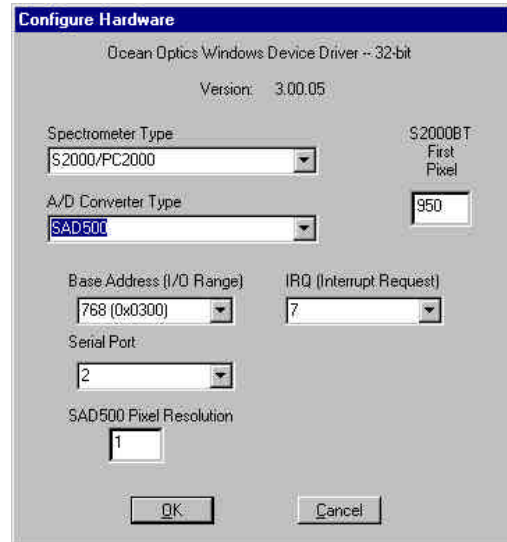
Trouble shooting

If the spectrometer gets stuck, here are some tips to get it running:
1. Turn on and off the power to the SAD-500
2. In Windows 95/98 you can find the COM port by selecting **Start | Settings | Control Panel.** Then double-click on the **System** and select **Device Manager.** Double click on **Ports,** this will display the COM ports, make sure there is no red warning next to the COM port you are trying to use.
3. The default Baud rate is 57.600. If your computer does not support this baud rate, choose under setup-hardware in SpectraWin a lower SAD500 baud rate.

Specifications

A/D resolution, sampling frequency	12 bit @ 500 kHz
Communication (baud rate)	RS-232 (2400-115.200)
Input voltage/current	10-24 V / 130 mA
Interface cable	9-pin to PC, 25-pin to spectrometer
Spectrometer Integration time	5 ms - 60 seconds

3.1.3 DAQ-700 PCMCIA A/D Converter

The **DAQ-700 PCMCIA A/D CONVERTER** is a 12-bit analog-to-digital converter card that connects our spectrometers to notebook PCs. This 16-channel single-ended, 8-channel differential card -- also known

by its National Instruments DAQCard-700 designation -- fits into a credit card-size slot in a notebook PC. It has a 100 kHz sampling frequency.

Before using your spectrometer, you must first configure your computer to properly detect and use the DAQ-700 and then follow several steps to use it as an interface to your Avantes spectrometer. The following are directions for setting up your DAQ-700. Because A/D converter installation goes hand-in-hand with software installation, you will find directions for installing SpectraWin Spectrometer Operating Software included in this section as well.

Install NI-DAQ

Windows 95/98 and NT users must install NI-DAQ Driver Software -- the device driver library necessary for Windows 95/98/NT systems to properly use the DAQ-700.

1. Insert your NI-DAQ version 6 CD into your CD-ROM drive.
2. After you insert your CD, a setup program should automatically start. If it does not, run the **Setup.exe** program from the CD.
3. The installation program has an option called **Install NI-DAQ**. Select that option.
4. In the "Select Components" dialog box, make sure **NI-DAQ Driver Files (Minimal Install)** is checked. Choose any of the other options you wish to install. Click **Next**>.
5. Accept the default destination directory and the default Program Group.
6. In the "Ready to Install" dialog box, click **Next**>. When prompted to do so, restart your computer. **You must restart your computer at this time.**

Install the DAQ-700

1. After the computer restarts, wait until all disk drive activity stops -- that is, wait until your computer is *completely* restarted. Connect the spectrometer cable between your DAQ-700 and your spectrometer.
2. Insert the DAQ-700 into any available PCMCIA slot.
3. Windows 95/98 and NT will play a sound consisting of two tones of increasing pitch. If you do not hear this sound, and you do have internal speakers in your notebook computer, try turning the speaker volume up and reinserting the DAQ-700. If you still do not hear the "happy" sound, contact our Technical Support Department.
4. To find IRQ and Base Address values, follow the instructions for the Windows system that you use.

For Windows 95/98 Users: Configure the DAQ-700

1. If you hear the "happy" sound, click **Start**, and select **Settings | Control Panel**.
2. Double-click the **System** icon. Select the **Device Manager** tab.
3. In the "Device Manager" dialog box, find the hardware group named **Data Acquisition Device**s. Either double-click the group or select the group and click **Propertie**s.
4. Under the Data Acquisition Devices group, find the entry for your DAQ-700. Either double-click **DAQCard-70**0, or select the entry and click **Propertie**s
5. Once you have selected your DAQCard-700 from the Device Manager, click the **Resources** tab. The entries here control the hardware interface to your DAQ-700.
6. In this dialog box, find the check box next to **Use automatic setting**s. Clear that check box (deselect it). We need to know the settings of the hardware before any Avantes software product starts.
7. In the same dialog box, you will see entries for input/output Range and Interrupt Request. The input/output Range corresponds to the Base Address, and the Interrupt Request corresponds to the IRQ in our software. By deselecting the **Use automatic settings** box in the previous step, you disabled Plug-and-Play for the DAQ-700. But in order to *fully* disable Plug-and-Play, you must also change the settings for either (or both) the input/output Range or the Interrupt Request. To make this change, double-click either **input/output Range** or **Interrupt Reques**t. A dialog box giving the current hardware setting appears. On the right side of the **Value** box are two small arrows: one up and one down. You must use these arrows to change the hardware interface parameters of either the input/output Range or the Interrupt Request.
8. While making this change, notice the **Conflict information** area at the bottom. Make sure you choose a value that says **No devices are conflictin**g. If it shows a conflict, you must select a different value. After selecting values with no conflicts, click **OK**. You will then see the "Creating a Forced Configuration" message box. Click **Ye**s.
9. Note your values of both the input/output Range (Base Address) and the Interrupt Request (IRQ). When you first run SpectraWin, you must enter these values in the "Setup Hardware" dialog box.

For Windows NT Users: Find the IRQ and I/O Range

1. If you hear the "happy" sound, go to **Start | Programs | Administrative Tools (Common) | Windows NT Diagnostic**s.
2. In the "Windows NT Diagnostics" dialog box, click on the **Resources** tab.
3. Select the **IRQ** button. Find the IRQ that your computer assigned to the A/D converter you are using to interface to your spectrometer. *Note this numbe*r.
4. Select the **I/O Port** button. Find the I/O Range (Base Address) that your computer assigned to the DAQ-700 to interface to your spectrometer. *Note this numbe*r. (This number is in hexadecimal.)

Software Installation

Running the Setup program

SpectraWin BASIC version 4.2 needs to be installed by executing the file SETUP.EXE on the first installation diskette. After going through several dialogs, described below, the installation program will ask for the second diskette.
After all files have been installed, Windows needs to be restarted.

Installation Dialogs

The setup program will check the system configuration of the computer. If no problems are detected, the first dialog is the "Welcome" dialog with some general information. The next dialog shows information about the existence of a FULL SpectraWin version and where to search for it.
In the next dialog, the destination directory for the SpectraWin software can be changed. The default destination directory is C:\SWBasic. If you want to install the software to a different directory, click the Browse button, select a new directory and click OK. If the specified directory does not exist, it will be created.
In the next dialog, the name for the program manager group can be changed. The default name for this is "AVANTES Software".
After this, the "Start Installation" dialog is shown. After clicking the "next" button, the installation program starts installing files until it requests to insert the second installation diskette. After all files have been installed, the "Installation Complete" dialog shows up. After clicking the "Finish" button, the last dialog is shown which contains the following information: "This system must be restarted to complete the installation. Press the OK button to restart the computer. Press Cancel to return to Windows without restarting.

Setup Hardware Dialog Box

The first time SpectraWin is started, the hardware needs to be set up correctly. Clicking the menu option Setup-Hardware can do this. The parameters in this dialog box are usually set only once -- when SpectraWin is first installed and the software first runs.

6. Under **Spectrometer Typ**e, choose your spectrometer.
7. Under **A/D Converter Typ**e, choose DAQ700.
8. Choose **Base Address** as selected in the previous section.
9. Choose **IRQ** as selected in the previous section.
10. For your setup, only these parameters apply to your system. (Ignore the other settings; they apply to other A/D converters.) Click **OK**.

Specifications

Type	PCMCIA Type II
A/D resolution, sampling frequency	12 bit @ 100 kHz
Channels	16-channel single ended, 8-channels differential
Interface cable	50 Pin connector to PCMCIA slot, 25-pin to spectrometer

4 SpectraWin-Basic manual

The SpectraWin-Basic software is delivered
with every Avantes spectrometer. The
SpectraWin full version software contains many
additional features and applications. The
SpectraWin full version comes with a separate
manual.

SpectraWin-Basic features user friendly, mouse
oriented pull down menus. Mouse clicks control
movements of a data cursor for instantaneous
readout of wavelength, pixel and y-axis
magnitude. Mouse dragging is a fast and elegant
way to zoom in both x and y direction at the same time. Buttons in the main window are available for on-line/off-line spectral analyses (start/stop), for easy saving of reference, dark and experiment spectra, printing, changing the view to absorbance, transmittance, irradiance or raw scope data, rescaling the y-axis, set scale for x- and y-axis and peak/valley searching. The user sets the data collection parameters, such as CCD detector integration time, auto-dark correction, signal averaging and spectral smoothing in common dialog boxes.
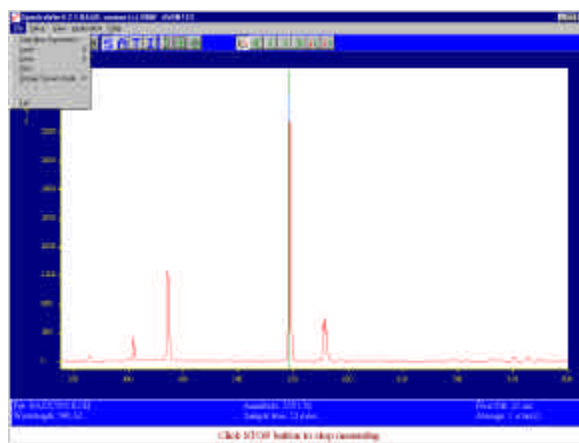
For the full version of SpectraWin the saving of spectra can be done episodically (the user enters number of spectra to be saved and the time interval in between), or by external trigger control. To each saved graph, a comment line can be added, which shows up in later printings or views. Up to twenty earlier saved spectra can be shown in one graph on screen or on paper. The saved graphical data can be exported to ASCII- or Jcamp files, to be read in by Excel and other data processing programs.

Auto-calibration is a standard option in the SpectraWin 4.2 full version. In combination with a Mercury-Argon Light Source, a number of peaks can be detected automatically. These peaks are then compared with the wavelengths where they should have been detected, and a quadratic regression fit is performed to calculate the best calibration coefficients.

The SpectraWin full version also contains a 'correct for drift' option. That is, if a master and one or more slave cards of about the same wavelength range are available, one of the cards can be used to correct the other card data for changes in the light source.

Other features implemented in the full version are some options, like the FWHM and the calculate integral option. If enabled, the Full Width Half Max value in nanometers of the highest peak in the selected wavelength region is on-line shown on screen. In the integral option the total spectral relative energy is calculated.

Special attention has been given to an option to follow the time dependence of self-defined functions (for example to describe a concentration). After entering a function in a dialog box, this function's output can be followed in a graph against the time. Up to four functions can be followed simultaneously. The results are saved to an ASCII-file.

SpectraWin contains a useful option for checking the raw scope data. If selected, this option checks if there is too much light exposed to the spectrometer card. For measurements in transmittance, absorbance, irradiance mode, or in time series measurements data may be misinterpreted if the spectrometer is overexposed.

4.1   Buttons in Main Window: Contents

Start/Stop button

The Start/Stop button can be used to display data real-time or to take a snapshot

Cursor and Arrow buttons

After clicking the cursor button at the top right of the menu bar, a vertical line is displayed in the graph, and a number of arrow buttons appear next to the cursor button. Using this arrow buttons can move the green line. The single arrow keys will move the green line by one (CCD) pixel at the time while the double arrow keys move the cursor line 20 pixels at the time. While moving this line, the corresponding values for wavelength and amplitude are updated in the main screen.

In Single view mode, two additional arrow buttons are shown at the right. By clicking these buttons, the peak finder will be activated. The vertical line will be moving to the left or right, depending which of the arrow keys has been pushed, until a peak is recognized. At that position it stops and shows corresponding values for wavelength and amplitude. As an alternative, peaks can also be found by a right mouse click, as described later in this section.

 Save Reference button

This is the white button at the left top of the screen. It needs to be clicked to save the reference data. The same result can be achieved with the option File-Save Reference.

 Save Dark button

This is the black button at the left top of the screen. It needs to be clicked to save the dark data. The same result can be achieved with the option File-Save Dark.

 Save Experiment button

By clicking the Save Experiment button an experiment is saved. The same result can be achieved with the option File-Save Experiment.

 Print button

By clicking the Print button a graph that is displayed on the monitor will be printed. The same result can be achieved with the option File-Print.

Scope button

By clicking the S button, the data will be presented in Scope Mode. The same result can be achieved with the option View-Scope Mode.

Absorbance button

By clicking the A button, the data will be presented in Absorbance Mode. The same result can be achieved with the option View-Absorbance Mode.

Transmission button

By clicking the T button, the data will be presented in Transmittance Mode. The same result can be achieved with the option View-Transmittance Mode.

Irradiance button

By clicking the I button, the data will be presented in Irradiance Mode. The same result can be achieved with the option View-Irradiance Mode.

Autoscale Y-axis button

By clicking this button, the graph will be rescaled on-line. A maximum signal will be shown at about 75% of the vertical scale. The same result can be achieved with the option View-Autoscale Y-axis

Change Graph Scale button

By clicking this button, a dialog will be shown in which the range can be changed for both X- and Y-axis. The same result can be achieved with the option View-Change Graph Scale

Graphic Reset button

By clicking this button, the X- and Y-axis will be reset to their default values. The same result can be achieved with the option View-Graphic Reset

Zoom in by dragging Left Mouse

This option allows a selected region to be expanded to the full graph. To select this region, click the left mouse button in the graph and drag it from one end of the region to be selected to the other end. After releasing the left mouse button within the graphic display, both the X-and Y-axis will be rescaled to the new values of the selected region. To zoom out, use the option View-Graphic Reset or click the reset button in the menu bar.

Find peaks by right mouse button click

This option can be used in all Measure-modes (Scope, Absorbance, Transmittance or Irradiance) and in all View-modes (Single to Quadruple). When the right mouse button is clicked in the white graphical region, SpectraWin will follow the following procedure to run to the closest peak:

1) The wavelength is determined from the position the mouse click occurred.
2) The data from closest pixel is retrieved
3) The direction to search for the peak is determined from the neighbor pixels. If both neighbor pixels have a lower value at the Y-axis then the current pixel, the current pixel is already a peak. If only one of the neighbor pixel values is higher then the current pixel value, the peak will be searched into the direction of this higher pixel. If both neighbor pixels have a higher value at the Y-axis then the current pixel, the current pixel is in a valley. The peak will in this case be searched into the direction of this neighbor pixel with the highest value.
4) The cursor starts moving into the direction, as determined under 3), until it reaches a pixel of which the value is not higher than the last one evaluated. At this pixel the cursor stops.
5) The amplitude and wavelength are displayed in the panel at the bottom (in Single or Quadruple View-mode) or to the right (in Dual or Triple View-mode) of the white graphical region.

The same procedure can be applied to search for valleys, also by clicking the right mouse button. To enable the Valley Search Option, the Peakfinder Parameters Dialog needs to be activated (under the Set up – Options Menu), and the radio button "Search for Valleys" needs to be clicked.

4.2 Menu Options

In sections 4.2.1 to 4.2.3 the three main menu options (File, Setup and View) and their submenus are described in detail.
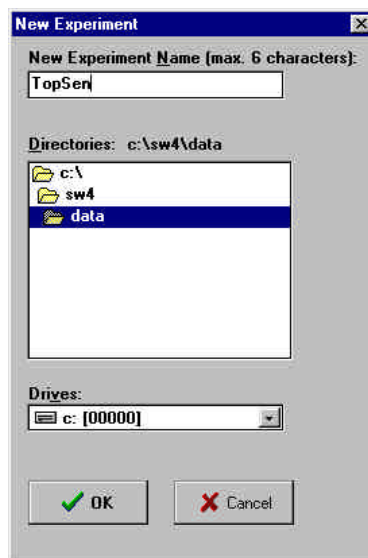
4.2.1 File Menu
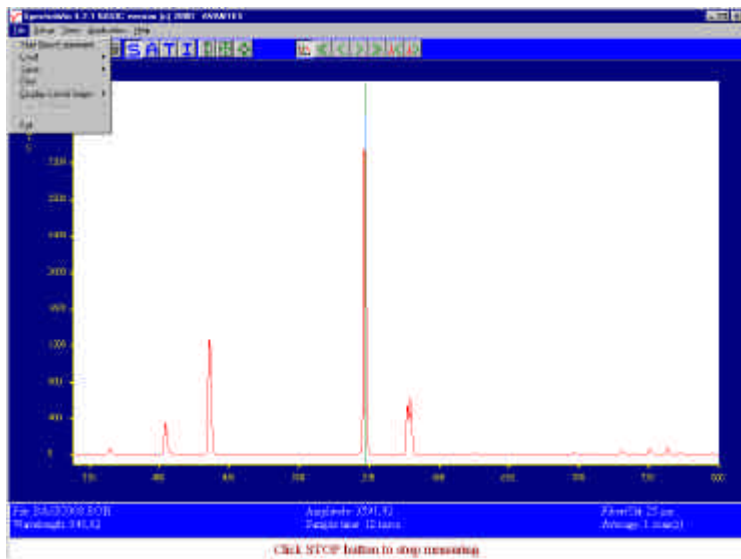
File Menu: Start New Experiment

After selecting this option, a dialog box appears in which an experiment name, a directory and a drive can be entered. An experiment name of maximal six characters can be entered in the edit box on top.

The number of characters used for the experiment name determines the number of graphic files that can be saved under the same experiment name in the same directory. The filename (extension excluded) that is used for saving graphics is always 8 characters, and built up from the experiment name and a sequence number. The more characters are used by the experiment name, the less remain for the sequence number. Example: if the experiment name is TOP, then 99995 graphics can be saved with this experiment name in the same directory. The automatically generated filenames will be TOP00001.* until TOP99995.*. If a new experiment name is for instance: TOPSEN, then 95 graphics can be saved: TOPSEN01.* until TOPSEN95.*. For detailed information on graphic filenames, see File-Save Experiment.

In the directory list box the experiment name, a directory and a drive can be opened to which all data files will be saved. If SpectraWin is started for the first time, the default experiment name is TOP and the path is the directory from which SpectraWin has been started, followed by the subdirectory: \data. To open another directory, double click on the directories displayed in the directory list box. In the drive-box below of the directory list box, a drive name can be picked. Press OK to confirm the new experiment path and name, CANCEL to return to the old settings. After

closing the dialog box, the new experiment name, followed by its sequence number, is displayed in the lower left of the status bar.

File Menu: Load Dark

With this option, dark data can be loaded, that has been saved before. If SpectraWin is in static mode, the dark data that will be loaded are shown on the screen first.

File Menu: Load Reference

With this option, reference data can be loaded, that has been saved before. If SpectraWin is in static mode, the reference data that will be loaded are shown on the screen first.

File Menu: Load Experiment

With this option, an experiment name can be loaded, that has been used before. This experiment name has the file extension "*.kon". After choosing this option, a dialog box shows all experiments that were saved earlier in the current experiment directory. If the experiment name that needs to be loaded is in this directory, select it in the left box with *.kon files by double clicking. If the experiment name that needs to be loaded is in another drive and/or directory, use the drive and directory list boxes to move to this directory and double click in the left box the experiment name that needs to be loaded.
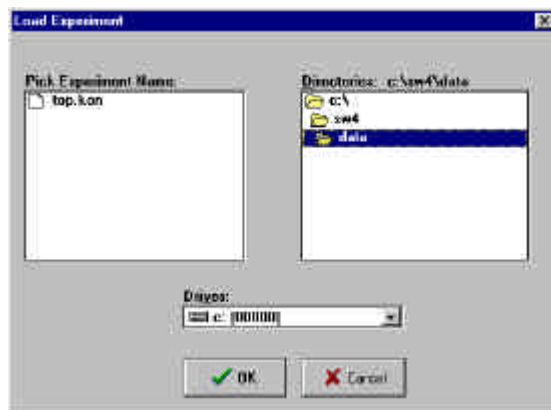
File Menu: Save Dark

With this option, dark data are saved. The name of the dark data file is "dark*.dat", where * represents the number of the slave channel for which the dark data has been saved (*=0 represents the master channel).

The dark data files will be saved in the experiment directory that has been picked by the option File-Load-Experiment or File-Start New-Experiment.

File Menu: Save Reference

With this option, reference data are saved. The name of the reference data file is "ref*.dat", where * represents the number of the slave channel for which the reference data has been saved (*=0 represents the master channel).

The reference data files will be saved in the experiment directory that has been picked by the option File-Load-Experiment or File-Start New-Experiment.

File Menu: Save Experiment

With this option, graphic files are saved. All graphic files will be saved in the experiment directory that has been picked by the option File-Load-Experiment or File-Start New-Experiment.

Saving graphic files in single view mode
First, a window appears in which a line of comments can be entered to the saved graph. Next two files will be saved: the first file contains the saved spectrum data. The name of this first file starts with the experiment name, directly followed by the sequence number of the saved spectrum. The extension of this first file depends on the current measuring mode, as shown below:

Extension	Mode
ROH	Scope Mode
ABS	Absorbance
TRM	Transmittance/Reflectance
IRR	Irradiance

The second file contains the line of comments, which may have been added to this graph. The name of this second file is, except for the extension, the same as the name of the first file (experiment name and sequence number). The extension of this second file also depends on the measuring mode, as shown below:

Extension	Mode
RCM	Scope Mode
ACM	Absorbance
TCM	Transmittance/Reflectance
ICM	Irradiance

Example: suppose the name of our experiment is "top". Then, saving one spectrum in scope mode, one in absorbance mode and two in transmittance mode results in the following files:

top00001.roh: spectrum data in scope mode

top00001.rcm: comments for the spectrum saved in top00001.roh

top00001.abs: spectrum data in absorbance mode

top00001.acm: comments for the spectrum saved in top00001.abs

top00001.trm: spectrum transmittance mode

top00001.tcm: comments for the spectrum saved in top00001.trm

top00002.trm: spectrum data in transmittance mode

top00002.tcm: comments for the spectrum saved in top00002.trm

After leaving the application and opening SpectraWin the next time, saving graphics in scope, absorbance and transmittance mode, will then result in respectively the data-files top00002.roh, top00002.abs and top00003.trm, as well as the comment files top00002.rcm, top00002.acm and top00003.tcm.

Before saving, the name of the graphic file is displayed in the light blue panel at the bottom of the screen. After saving, the sequence number is automatically increased by one.

Saving graphic files in multiple view mode

If graphic files are saved while more than one channel is viewed at the same time (see option View-Channel), then the graphic filename for each channel that is displayed gets a different sequence number. For example, the result of saving one experiment in triple view mode is three graphic data files and three comment files, for instance:

top00002.roh: spectrum data in scope mode (e.g. Master Channel)

top00003.roh: spectrum data in scope mode (e.g. Slave1 Channel)

top00004.roh: spectrum data in scope mode (e.g. Slave2 Channel)

top00002.rcm: comments for the spectrum saved in top00002.roh

top00003.rcm: comments for the spectrum saved in top00003.roh

top00004.rcm: comments for the spectrum saved in top00004.roh

For each channel a different comment line needs to be entered.

To make it easier to select the graphic files later on with the option File-Display Saved Graph, all comment lines start with a short name for the channel at which the graph has been saved: M for Master, S1 for Slave1 and so on.

After saving, the sequence numbers in this example (triple view mode) will automatically have been increased to 00005, 00006 and 00007, for respectively the channel viewed in the top, the middle and the bottom graph.

File Menu: Print

In graphic mode (see option File-Display Saved Graph), the saved spectra will be printed after pressing the OK button in a window in which the printer settings (e.g. portrait or landscape printing, printing quality etc.) can be changed. The comments that were saved earlier for these spectra will be printed as well. With a color printer, SpectraWin will print the (multiple) spectra in graphic mode in the same colors as the colors displayed on the screen.
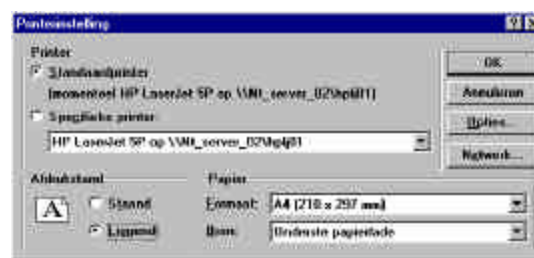
If a spectrum is printed directly, without saving the experiment, a window appears first in which a line of comments can be added to the graph.

File Menu: Display Saved Graph-New

This option requires that graphic files were saved earlier by using the option File-Save Experiment. After choosing this option, a window shows all files with the extension *.trm, *.abs, *.roh and *.irr that were saved earlier in the current experiment directory. The comment line for a selected file appears in the title box above the file list box. The directory list box and drive box can be used to switch to another directory in which (also) graphic files have been saved.
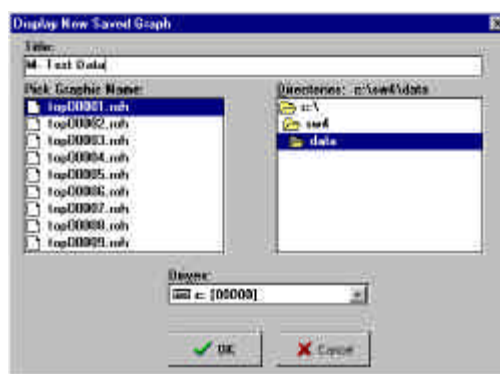
After a selected file has been double clicked, or after clicking the OK button, the selected graph will be displayed full scale. On the displayed graph, all scaling features can be applied, like zooming with the mouse, autoscale, changing the scale for X- and Y-axis etc.

By clicking the legend button that appears next to the print button the comment line for the displayed graph is shown.

If the graphic file has been saved in transmittance mode or absorbance mode, then the S, A or T button can be clicked to view the same dataset in respectively Scope, Absorbance or Transmittance mode. If saved in Irradiance mode, the same dataset can be viewed in all other modes (Scope, Absorbance or Transmittance) as well.

If more graphic files need to be shown in the same graph, in addition to the one already displayed, the option File-Display Saved Graph-Next needs to be chosen.

File Menu: Display Saved Graph-Next

Next Graphic adds graphs to already displayed graphs. This way up to 20 graphs can be compared simultaneously.

After choosing this option, a window shows all files with the same file extension as the graphic file that already has been chosen with the option File-Display Saved Graph-New. The comment line for a selected file appears in the title box above the file list box. The directory list box and drive box can be used to switch to another directory in which (also) graphic files have been saved.

After a selected file has been double clicked, or after clicking the OK button, the selected graph will be displayed. By clicking the legend button (next to the print button), the comment lines for all graphics displayed in the graph are shown.

If the graphic file has been saved in transmittance mode or absorbance mode, then the S, A or T button can be clicked to view the same dataset in respectively Scope, Absorbance or Transmittance mode. If saved in Irradiance mode, the same dataset can be viewed in all other modes (Scope, Absorbance or Transmittance) as well.

To clear the graph and start with a new graphic, the option File-Display Saved Graph-New needs to be chosen.

File Menu: Exit

Closes SpectraWin.

4.2.2 Setup Menu
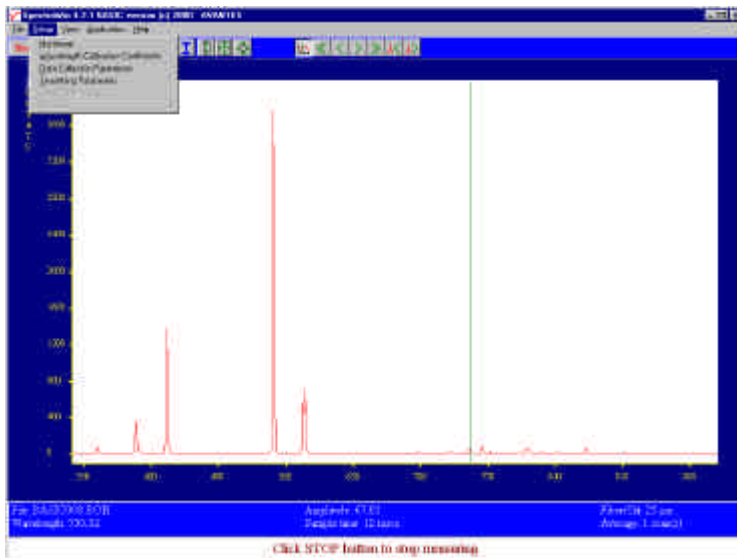
Setup Menu: Hardware

After clicking this option, a dialog is shown in which a number of hardware parameters can be set.

Spectrometer Type

The Spectrometer Type. The following options are available:

- S1000/PS1000/PC1000. This Spectrometer Type was available from the start until the year 1998. It contains 1100 pixels and is a lot less sensitive than the 2000 series spectrometers

- S2000/PC2000. The 2000 series spectrometers use a 2048 pixels CCD array. This type should also be selected for multi-channel 2000 series spectrometers (SD2000, MC2000)

- The S2000BT (BT = Beta Test) is one of the first S2000 systems, which uses only 1100 pixels, starting with the first pixel entered in the edit box below of the S2000BT radio button. For a normal S1000 or S2000, the 'First Pixel' edit box is not relevant.

- S1024DW. Deep Well detector spectrometer. This spectrometer type always uses the SAD500 as converter type
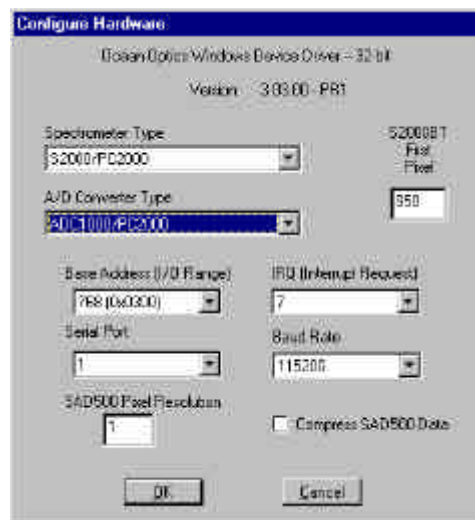
A/D Converter

There are six possible converters to choose from: the ADC500/PC1000, ADC1000/PC2000, DAQ-700, SAD500, serialUSB2000 and USB2000. The NONE option can be selected if no converter is connected in which case the driver simulates the data acquisition.

If an SAD500 or (serial)USB2000 converter is used, the Base Address and IRQ are not relevant.

IRQ-Interrupts

The A/D converter of the spectrometer uses an interrupt request (IRQ) line on the PC bus. The default is IRQ7, but when there are conflicts, this needs to be changed. If an ADC500/PC1000 or ADC1000/PC2000 converter is used, the dip switches on the card have to be changed as well.

Base Address

The A/D converter of the spectrometer uses a default base address of 300 hex (768 decimal). If there are conflicts, this may need to be changed. If an ADC500/PC1000 or ADC1000/PC2000 converter is used, the dip switches on the card have to be changed also.

Serial Port

Sets the serial (COM) port for the SAD500 A/D converter.

Baud Rate

Sets the baud rate for the SAD500

SAD500 pixel resolution

Sets the pixel resolution for the SAD500 A/D converter.

Compress SAD500 data

Sets the data compression mode for the SAD500

Setup Menu: Wavelength Calibration Coefficients

If SpectraWin BASIC has been downloaded from our website, default wavelength calibration coefficients are used. The correct calibration coefficients need to be entered for all available spectrometer channels in the wavelength calibration coefficient dialog, as shown at the right. The calibration coefficients can be found on the calibration coefficients sheet of the spectrometer.

Setup Menu: Data Collection Parameters

After clicking this option, a window is shown in which a number of data collection parameters can be set. The meaning of these parameters is described below:

Integration time

This option changes the CCD readout frequency and therefore the exposure- or integration time of the CCD detector. The longer the integration time, the more light is exposed to the detector during a single scan, so the higher the signal. If the integration time is set too long, too much light reaches the detector. The result is that, over some wavelength range, the signal extends the 4096 counts or in extreme case shows as a straight line at any arbitrary height, even near zero. Entering a shorter integration time can usually solve this. Try to adjust the integration time, such that the maximum count over the wavelength range is around 3500 counts. When at minimum integration the signal is still too high, an attenuator, a neutral density filter or fibers with a smaller diameter may be used. When not enough light reaches the spectrometer, likewise a longer integration time should be entered.
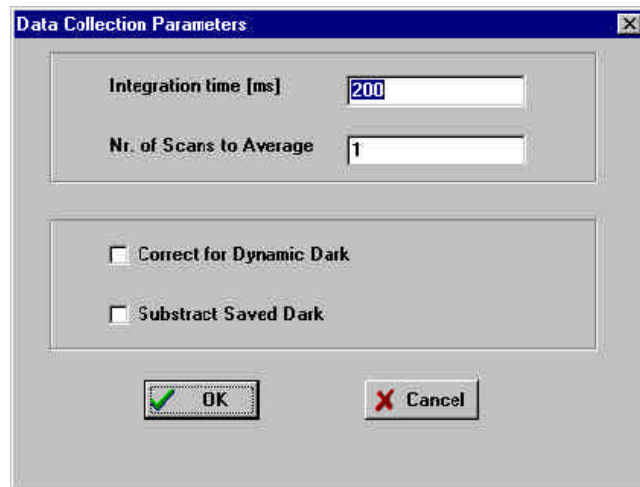
Nr. of scans to Average

With this option, the number of scans to average can be set. A spectrum will be displayed after every # scans. This spectrum is the average of the # scans.

Correct for Dynamic Dark

The pixels of the CCD detector are thermally sensitive, which causes a small dark current, even without light exposure. To get an approximation of this dark current, the signal of the first 16 pixels of the CCD-detector can be taken and subtracted from the raw scope data. This will happen if the correct for dynamic dark option is enabled. Since the signal of these 16 pixels can change in time, the correction is dynamic.

Note that this option is different from the dark current that needs to be saved before any transmittance or absorbance measurements can be taken (File-Save Dark). However, if the correct for dynamic dark option has been changed, it will be necessary to save a new dark and reference spectrum because the raw data has been changed.

To correct the raw scope data for the saved dark spectrum, check the box 'subtract saved dark'.

Subtract Saved Dark

This option is used to subtract the dark spectrum that has been saved (File-Save Dark) from the raw scope data. After starting up SpectraWin, this option is always unchecked, because a dark spectrum needs to be saved or loaded before it can be subtracted.

Setup Menu: Smoothing Parameters
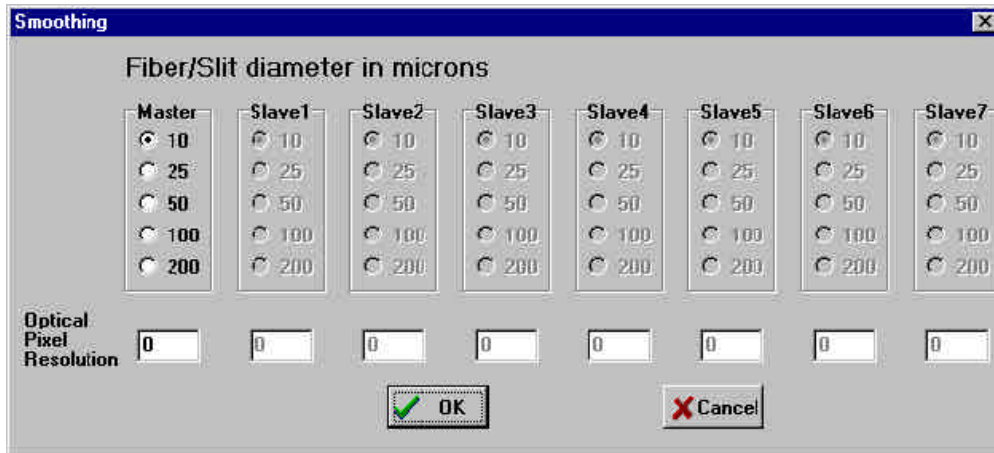
In order to get an optimal smoothing without loosing information it is important to set in the software the right size of fiber that is plugged into the spectrometer. When a slit has been installed the slit width needs to be entered. The smoothing parameters can be set separately for master and slave cards.

After clicking the smoothing parameter option, a dialog box is shown in which the smoothing parameters can be set for master and slaves. For each channel, clicking the fiber or slit diameter by the radio buttons results in a corresponding number of pixels used for smoothing in the edit box below of the radio buttons.

For example: clicking a fiber or slit diameter of 200 results in an Optical Pixel Resolution (OPR) of 8 pixels. The value 8 is then used for smoothing: for each pixel in the CCD array, with an exception for the dead (16) and OPR (in this example 8) pixels on the edge, the number of counts is averaged with the signals of 8 pixels to the left and 8 pixels to the right.

The Optical Pixel Resolution can be changed by clicking the edit box below of the radio buttons as well. The number of neighbor pixels to be used for smoothing can then be entered by hand.

Note that the value of the fiber/slit diameter that is entered here, is displayed in the main screen right behind the word "Fiber/slit:". If none of the default diameters (10, 25, 50, 100 or 200 micron) is used, no diameter is displayed.

4.2.3 View Menu
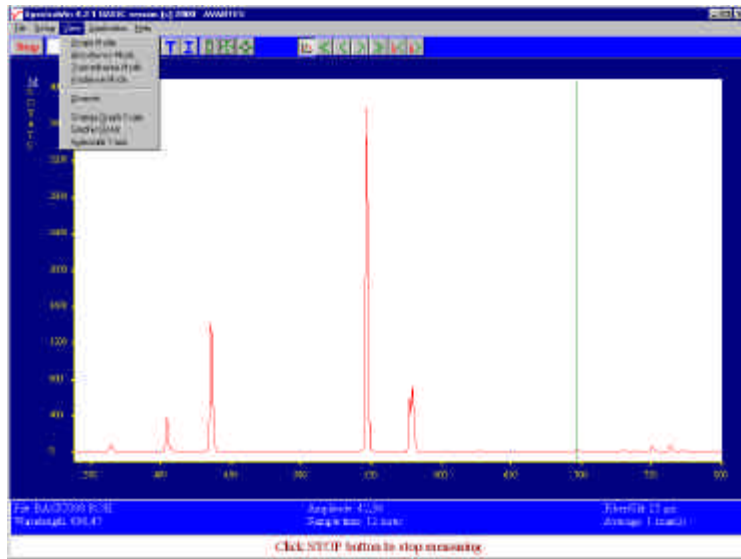
View Menu: Scope Mode

The display is set to Scope Mode, showing a real time raw data signal, with on the Y-axes the read out of the AD-converter (10 VDC = 4096 counts) and on the X-axes the calculated wavelength.

View Menu: Absorbance Mode

In Absorbance Mode, the absorbance at pixel n is calculated using the current sample, reference and dark data sets in the following equation:

$$A_n = -\log\left(\frac{sample_n - dark_n}{ref_n - dark_n}\right)$$

View Menu: Transmittance Mode

In Transmittance Mode, the transmittance at pixel n is calculated using the current sample, reference and dark data sets in the following equation:

$$T_n = 100 * \left(\frac{sample_n - dark_n}{ref_n - dark_n}\right)$$

The percentage of transmittance is mathematically equivalent to the percentage of reflectance and can also be used for reflectance experiments.

View Menu: Irradiance Mode

For relative irradiance measurements, a light source of known color temperature is needed as a reference, for example the HL2000 or HL-2000-LL with color temperatures of respectively 2960K and 2800K. The **relative** radiance energy at wavelength λ is then calculated using the current sample, the reference and the dark data sets:

$$S_1 = B_1 * \left(sample_1 - dark_1 \right)$$

Where *B1* is the computed component of the spectral distribution of the blackbody radiant emmittance (at user selected temperature in degrees Kelvin), divided by the current reference data at wavelength λ

How to take relative irradiance measurements with SpectraWin

1. Start the SpectraWin software, and click the Start button in the main window.

2. Connect a fiber to the Spectrometer input port.

3. Adjust the Smoothing Parameters in the Setup menu to optimize smoothing for the Fiber/Slit diameter that is used.

4. Set up the experiment such that the other end of the fiber points at the sample of light to be determined (use a fixture for the best results). Usually some sort of spectrum may be seen on the screen, but it is possible that too much or too little light reaches the spectrometer at the present data collection settings. Too much light means that, over a certain wavelength range, the signal is overloaded shown as a straight line at any arbitrary height, even near zero. This can usually be solved by selecting "Data Collection Parameters" under Setup and enter a shorter integration time. Try to adjust the integration time, such that the maximum count over the wavelength range is around 3500 counts. When not enough light reaches the spectrometer likewise a longer integration time should be entered.

5. When a good spectrum is displayed, turn off the light source.

6. Now save the Dark data. This is done by File-Save Dark from the menu or by clicking the black square on the left top of the screen with the mouse.

7. Turn on the **reference light source of known color temperature** (2960K for HL2000) and set up the fiber end that is not connected to the spectrometer, so that a good spectrum is displayed on the screen. Note that the integration time or fiber type may not be changed while measuring the reference data. If there is too much light, adjust the focussing of the light source, so less light is coupled into the fiber. As long as only light from the reference light source and no ambient light is coupled into the fiber, this will not influence the spectral distribution, only its height. Try to set up the fiber such that the maximum count over the wavelength range is around 3500 counts.

8. Save the Reference data. This is done by File-Save Reference from the menu or by clicking the white square on the left top of the screen with the mouse.

9. Note that the whole operation of saving a reference file does not need to be carried out each time a new experiment is started. The reference data are saved in a file called ref*.dat and can be loaded next time by choosing the option File-Load Reference. After saving or loading reference and dark the irradiance mode can be chosen by clicking the 'I' button or by the menu option View-Irradiance mode. First a message box appears in which the value of the color
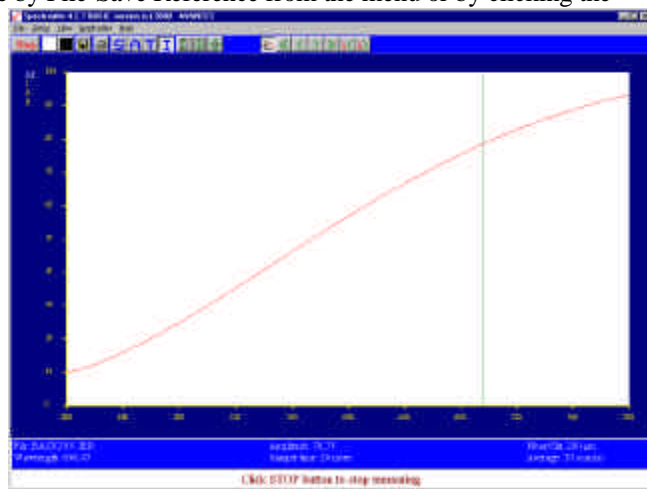
temperature in Kelvin of the light source that has been used as a reference can be entered. If light from the reference light source is viewed, the Planck-curve for the color temperature of the reference light source is displayed. The maximum of the reference Planck-curve has been set to 100.
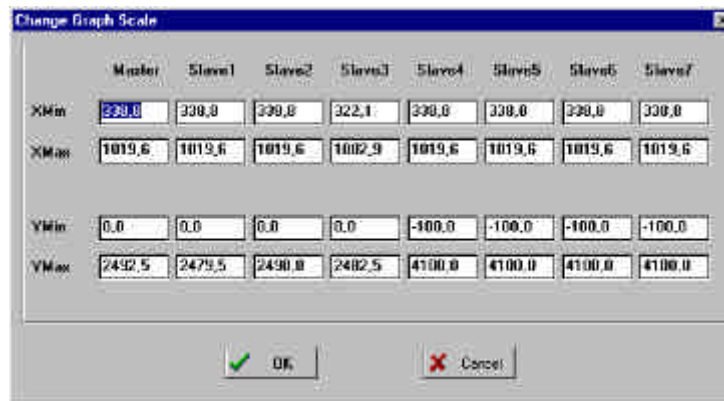
View Menu: Channel

After selecting this option, a dialog is presented in which the channels to be displayed can be checked. Depending on the spectrometer type that is used, up to four channels can be viewed simultaneously.

View Menu: Change Graph Scale

After selecting this option, a dialog is presented in which the range for all available channels in the spectrometer can be changed. This is possible for both X- and Y-axis. To switch to the default scale, the View-Graphic Reset option is used.

View Menu: Graphic Reset

When selecting this option, the graph will be reset for all available channels in the spectrometer. This means that both the default X- and Y-axes will be shown.

View Menu: Autoscale Y-axis

By using this option, the graph will be rescaled on-line. A maximum signal will be shown at about 75% of the vertical scale. This will be realized for all channels in the current view mode.

4.2.4 Help Menu

The information in this manual can also be found in the help menu. Further, a lot of additional features that are standard in the FULL version of SpectraWin are described in this help file, as well as the add-ons that are available with this FULL version, like color, process control, absolute irradiance and oxygen measurement.
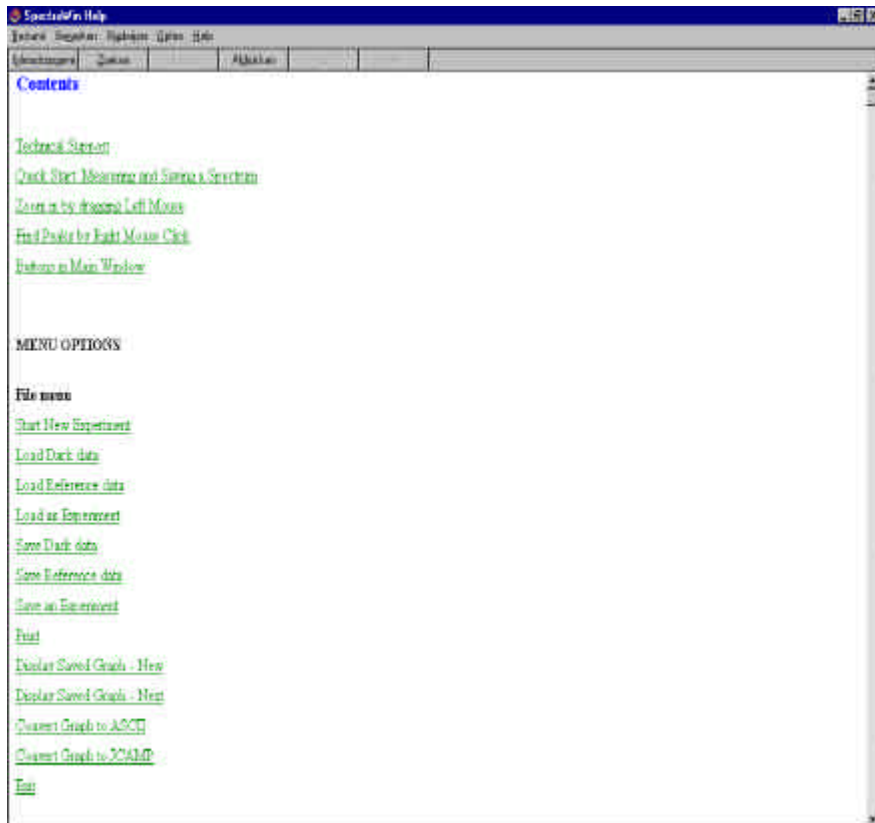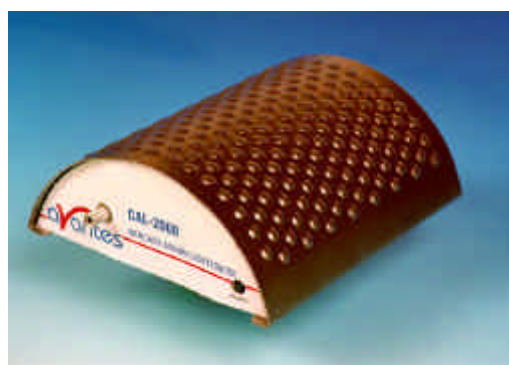
5   Light Sources

Avantes offers a variety of UV/VIS/NIR and Calibration light sources. In the following paragraphs you will find the technical documentation on the following light sources:

- HL-2000 Tungsten halogen light source
- HL-2000-FHSA Tungsten halogen light source with filter holder and shutter
- HL-2000-CAL Calibrated Tungsten halogen light source
- Mini-D2 Miniature Deuterium Halogen light source
- XE-2000 Xenon pulsed light source
- DH-2000 Deuterium Halogen light source
- DH-2000-FHS Deuterium Halogen light source with filter holder/shutter
- CAL-2000 Mercury Argon calibrated light source

All of these light sources easily couple to our wide range of spectrometers and accessories through SMA905 coupled fiber optics, which are described in chapter 6.

5.1 HL-2000 Tungsten Halogen light source

The numbers in brackets () refer to the numbers in the HL-2000 drawing on the next page.

Starting up

1. Plug in the power supply (1).
2. Plug in the connector (2) of the power supply (1) into the socket (3) of HL-2000.
3. Connect the SMA-connectors of your fibers to the SMA-plugs (4)
4. Switch on the Halogen lamp with the backside switch (5).

Adjustment of optical power

The HL-2000 is factory adjusted to couple maximum power into a 200µm fiber. If lower optical power is recommended or a different fiber (bundle) diameter is used, the optical power can be adjusted.
1. Connect your fiber optic spectrometer or your optical power meter to a fiber to the HL-2000 SMA socket (4) .
2. Loosen blocking-screw (6) with delivered Allen key (1,3mm).
3. By shifting the SMA socket you can optimize your optical power.
4. Secure position by tightening the blocking screw (6).

In case additional power decrease is necessary additional filters may be put in the 3,5mm slit (9).

Changing the light source bulb

1. Plug out the power connector (2) from the socket (3).
2. Loosen backside screws (10) with delivered Allen key (2,5mm).
3. Take out backside and electronics board, be careful not to pull and disconnect Fan-wires (11).
4. Disconnect screw from the bottom plate (7) with delivered Allen key (1,3mm).
5. Take out the bulb
6. Disconnect the wires from the connection block (14)
7. Replace the bulb and connect the wires to the connection block (14)
8. Slide the lamp in the housing and lock with bottom screw (7)
9. Slide electronic board back in, be careful not to have the wires come in the fan.

Specifications / Parts List

Wavelength range	360-1100 nm
Stability	± 0,5%
Time to stabilize	Ca. 5 min.
Output to bulb	5 VDC/ 1,4A
Bulb life time	1.500 hrs (normal version)
	10.000 hrs LL version
Bulb output (in 800µm fiber)	17 mW
Bulb color temperature	2.960 K (normal version)
	2.800 K (LL- version)
Power requirements	12 VDC / 1,4A
Dimensions	140 x 58 x 59 mm
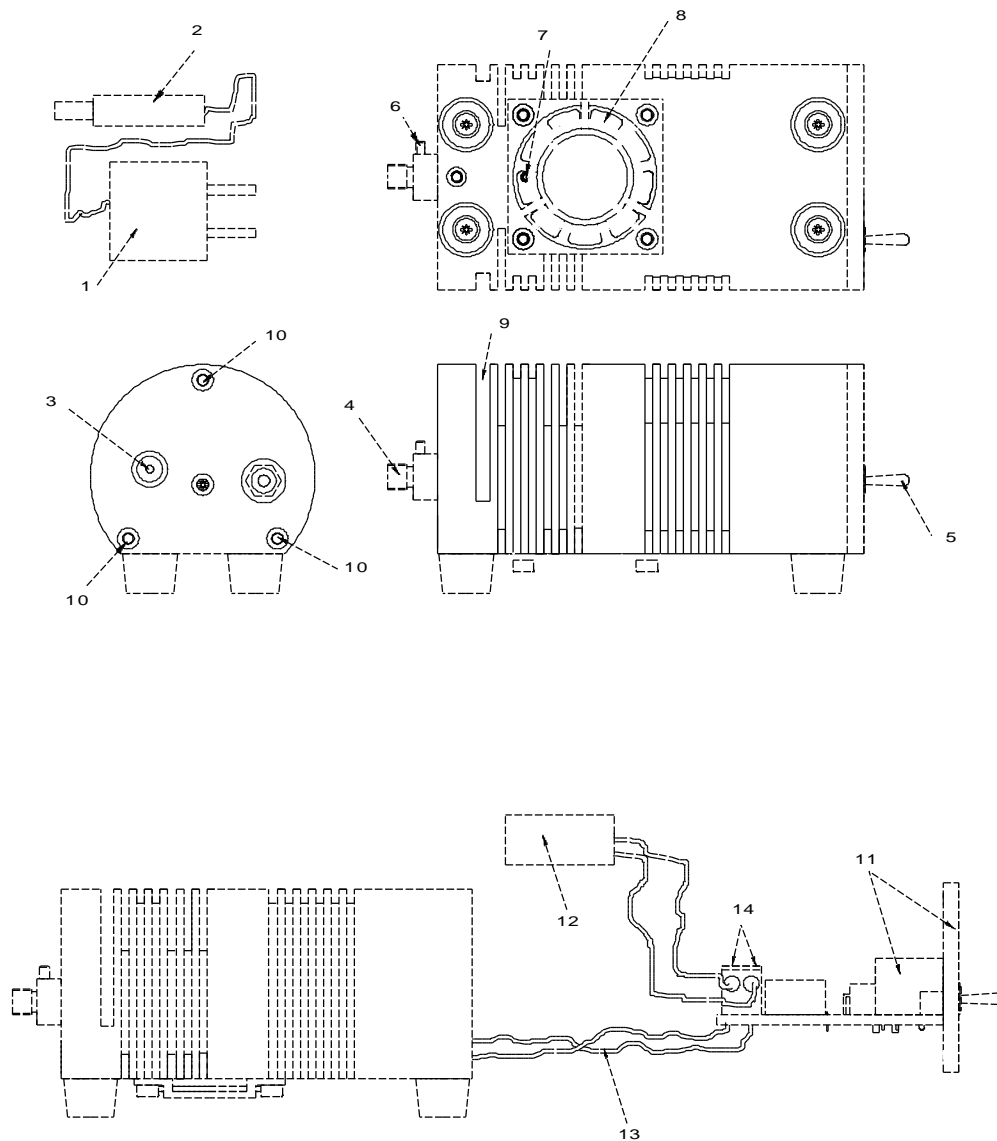
Ordering information

Catalogue number	Description
HL-2000	Tungsten Halogen light source, fan cooled
HL-2000-LL	Tungsten Halogen light source, fan cooled, long life
HL-2000-B	Tungsten Halogen spare bulb 2.960K/ 1.500 hrs
HL-2000-LL-B	Tungsten Halogen spare bulb 2.800K / 10.000 hrs

5.2 HL2000-FHSA manual

The numbers in brackets () refer to the numbers in the HL-2000 drawing on the next page.

Starting up

1. Plug in the power supply (1).
2. Plug in the connector (2) of the power supply (1) into the socket (3) of HL-2000
3. Connect the SMA-connectors of your fibers to the SMA-plugs (4)
4. Switch on the Halogen lamp with the backside switch (5).
5. For automatic TTL-shutter control insert IC-DB-15-2 plug in connector (15)
6. Choose operating mode for the mode-switch (17):
   OPEN: Shutter open
   CLOSE: Shutter closed
   TTL: Controlled by external TTL (High = open, Low = close)

For Automatic save-dark use SpectraWin 4.1 or higher

Optimizing the optical power output

The HL-2000-FHSA is factory adjusted to couple maximum power into a 200µm fiber. If lower optical power is recommended or a different fiber (bundle) diameter is used, the optical power can be adjusted:

1. Connect your fiber optic spectrometer or your optical power meter to a fiber to the HL-2000-FHSA SMA socket (4) .
2. Loosen blocking-screw (6) with delivered Allen key (1,3mm).
3. By shifting the SMA socket you can optimize your optical power.
4. Secure position by tightening the blocking screw (6).

Attenuating the optical power output

1. To attenuate the optical output of the HL-2000-FHSA the attenuation-screw (16) can be turned clockwise.
2. Make sure the Shutter is in position open by mode switch (17)
3. Loosen the fixture screw (18) first with Allen Key (2,0mm), before turning the attenuation screw (16)
4. After adjusting the optical power, tighten the fixture screw (18)

Changing the light source bulb

1. Plug out the power connector (2) from the socket (3).
2. Loosen backside screws (10) with delivered Allen key (2,5mm).
3. Take out backside and electronics board, be careful not to pull and disconnect Fan-wires (13).
4. Disconnect screw from the bottom plate (7) with delivered Allen key (1,3mm).
5. Take out the bulb
6. Disconnect the wires from the connection block (14)
7. Replace the bulb and connect the wires to the connection block (14)
8. Slide the lamp in the housing and lock with bottom screw (7)
9. Slide electronic board back in, be careful not to have the wires come in the fan.
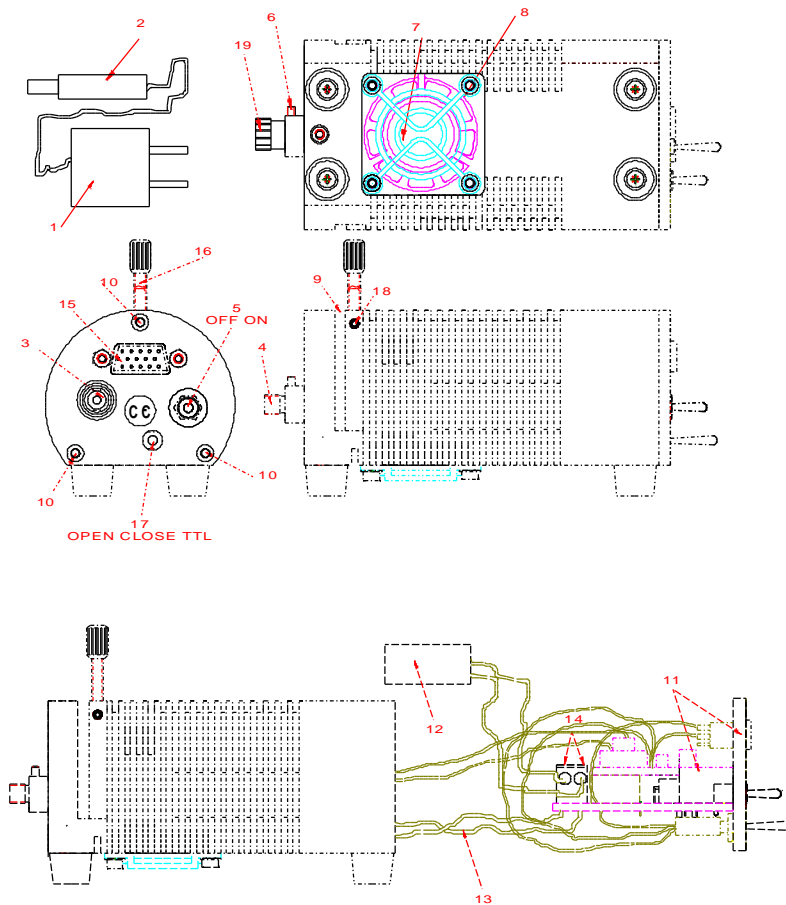
HL-2000-FHSA Basic elements

Specifications / Parts List

Wavelength range	360-1700 nm
Stability	± 0,5%
Time to stabilize	Ca. 5 min.
Output to bulb	5 VDC/ 1,4A
Bulb life time	1.500 hrs (normal version)
	10.000 hrs LL version
Bulb output (in 800µm fiber)	17 mW
Shutter	Max. 5Hz / 60dB
DB-15 connector	Pin 13 = TTL, Pin 10= ground
Bulb color temperature	2.960 K (normal version)
	2.800 K (LL- version)
Power requirements	12 VDC / 1,4A
Dimensions	150 x 60 x 62 mm

Ordering information

Catalogue number	Description
HL-2000-FHSA	Tungsten Halogen light source with filter holder/shutter and attenuator, fan cooled
HL-2000-FHSA-LL	Tungsten Halogen light source, fan cooled, long life
HL-2000-B	Tungsten Halogen spare bulb 2.960K/ 1.500 hrs
HL-2000-LL-B	Tungsten Halogen spare bulb 2.800K / 10.000 hrs
IC-DB-15-2	Interface cable S2000 for auto save dark/ lamp off

5.3 HL-2000-CAL Calibrated Tungsten Halogen light source

Parts Included

1. HL-2000-CAL Calibrated Tungsten Halogen light source
2. CC3-UV Calibrated cosine corrector, mounted in the HL-2000-CAL
3. Printed Calibration sheet in µW/cm²nm
4. Diskette with Calibrated output as *.lmp file, to be read in directly by SpectraWin-IRRAD
5. PS-12V/1.25A power supply, should have been ordered separately.

Starting up

1. Plug in the power supply.
2. Plug in the connector of the power supply into the socket of HL-2000-CAL.
3. Connect the SMA-connectors of your fibers to the SMA-plugs
4. Switch on the Halogen lamp with the backside switch.

Changing of the bulb

Since the light source and cosine corrector are calibrated, the bulb exchange and recalibration can only be done in our calibration lab.

N.B. The HL-2000-CAL cannot be used as a light source for standard reflection/absorption spectroscopy.

Quick Start: How to take absolute irradiance measurements with SpectraWin

1. Start the SpectraWin software, and click the Start button in the main window.

2. Connect a fiber to the Spectrometer input port.

3. Adjust the Smoothing Parameters in the Systems menu to optimize smoothing for the Fiber/Slit diameter that is used.

4. Set up the experiment such that the other end of the fiber with CC-3 cosine corrector points at the light source to be measured (use a fixture for the best results). Try to adjust the integration time, such that the maximum count over the wavelength range is around 3500 counts. It's also possible to let SpectraWin search for an optimal integration time by clicking the '?AC' button, or by using the menu option Setup-Options-Auto Configure Integration time. The integration time that is used in this experiment does not necessarily needs to be the same as the integration time that is used during the intensity calibration. If the experimental integration time is different from the integration time during the calibration, the accuracy of the measurements can be improved by calibrating the spectrometer to correct for the nonlinearity of the CCD detector. SpectraWin-Irrad comes together with a software program, which can be used for this non-linearity calibration.

5. Turn on the reference light source (e.g. HL-2000-CAL) and connect the other end of the fiber to it. If a cosine corrector is used at the end of the fiber, mount it directly on the reference light source.

6. Try to adjust the integration time while looking at the reference light, such that the maximum count over the wavelength range is around 3500 counts. It's also possible to let SpectraWin search for an optimal integration time by clicking the '?AC' button, or by using the menu option Setup-Options-Auto Configure Integration time. If a non linearity correction needs to be done, be sure to include the integration time needed in the measurements and the integration time needed for the calibration light source in the range of integration times that needs to be specified in the non linearity software.

7. Select the calibration lamp and enter the diameter of the fiber that is used.

8. Verify that the calibration lamp is ON for at least 15 minutes, and perform an intensity calibration.

9. Switch to irradiance mode to view the intensity of the calibration light source. Note that small changes in integration time will have no effect on the intensity curve, although it does effect the scope data. With an integration time shorter than the integration time during calibration, the noise will increase. With an integration time longer than the integration time during calibration, be careful not to overexpose the spectrometer. If a the integration time used in the experiment is different from the integration time during the calibration, the dark spectrum in the experiment needs to be saved.

10. To measure irradiance output in the experiment, set up the same experiment as under point 4, enter the integration time that was found under point 4 (or determine a new one in Scope mode), block the light path to the spectrometer, and save a dark spectrum. Then select one of the irradiance output parameters. If the irradiance of the light to be measured needs to be displayed against time, use the time measurement set up.

The intensity calibration as performed under point 5 to 8 can be loaded in future experiments by selecting the option "Load Intensity Calibration". After loading an intensity calibration, a dark spectrum needs to be saved before switching to Irradiance mode.

Technical Data

Power requirement	12 VDC / 1.4A
Calibration Accuracy	$\pm 6 \%$
Calibration valid for	60 hrs
Time to stabilize	Ca. 15 Min.
Bulb Output (bare fiber)	$1,5 \mu W/cm^2 nm$ (@800nm)
Bulb Output (CC-3)	$120 \mu W/cm^2 nm$ (@800nm)
Dimensions (mm)	58 x 59 x 140

5.4   Mini-D2 Miniature Deuterium-Halogen Light Source

Safety Instructions

➔   **Instructions:** All the safety and operating instructions should be read before the unit is operated. Before using the power supply for the first time check for transport damage.

➔   **Warning:** All warnings on the unit and in the operating instructions should be adhered to.

Unpacking Instructions:

Your package should contain:

- Mini-D2 Deuterium-Halogen light source
- 12V/DC-Poweradapter
- This manual

1. Unpack your new power supply and Mini-D2 carefully. Although the deuterium lamp is rigidly mounted dropping this instrument can cause permanent damage.
2. Inspect the outside of the instrument and make sure that there is no damage to your unit. In case of damage contact the dealer immediately and DO NOT USE THE INSTRUMENT!
3. Send in the registration card, for your guarantee and support
4. Use this instrument in a clean laboratory environment

Moisture
The unit is designed for operation in dry rooms only.

Heat
The unit should be situated away from radiators, hot bodies, ovens or other heat sources.
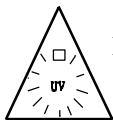
Power Sources
The unit should be connected to a power supply only of the type described in the operating instructions or as marked on the unit.
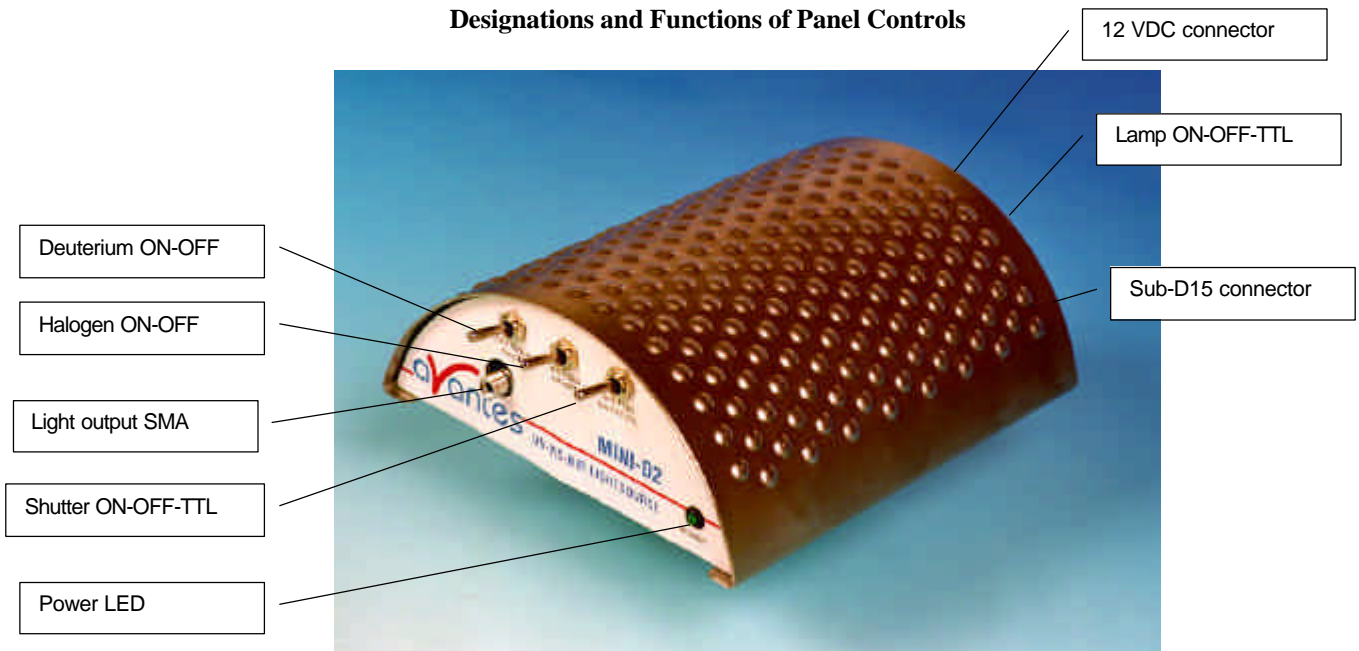
Object and Liquid Entry
Care should be taken that objects do not fall, or liquids spilled into the enclosure through openings.

Caution:

This lamp produces ultra violet radiation that can be harmful to the eyes. DO NOT LOOK INTO THE LIGHT BEAM. THIS CAN CAUSE PERMANENT EYE DAMAGE - WEAR PROTECTIVE EYE WEAR - CALL YOUR LOCAL LAB SUPPLY HOUSE FOR GLASSES OR GOGGLES.

Designations and Functions of Panel Controls

- 12 VDC connector
- Lamp ON-OFF-TTL
- Sub-D15 connector
- Deuterium ON-OFF
- Halogen ON-OFF
- Light output SMA
- Shutter ON-OFF-TTL
- Power LED

Front Panel

SMA-Connector / Protection Cap

The protection cap is only to avoid that the user could not unintentional look directly into the fiber optic connector. The connector is for use only with SMA-Fiber connectors. **Connect your Fiber optic Cable first before starting the Deuterium Lamp**. **Please be sure to avoid direct radiation of skin and eyes at the other fiber end.**

Caution: This lamp produces ultra violet radiation, which can be harmful to the eyes. Lamps must not be viewed directly without suitable approved eye protection being used.

Deuterium ON-OFF

This switch is used to turn the deuterium light on and off.

Halogen ON-OFF

This switch is used to turn the halogen light on and off.

Shutter ON-OFF-TTL

This switch is used to open (ON) or close (OFF) the electromechanical Shutter or to use the backside DB-15 connector TTL signal, Pin 13 (High = Open, Low = Close).

Power LED

When the 12V/DC connector is supplied to the unit automatically switches to the basic operating mode. The LED indicator is lighted up at this time.

Rear Panel

Power Input Connector
Insert the 12VDC-power supply plug of the adapter into the unit.

Lamp ON/OFF/TTL Switch
When switch is turned ON the Lamp starts by turning front switches. In the OFF Position the circuit is in power status, but the deuterium and halogen-light bulbs does not work. When Switch is turned to TTL, the lamp could be controlled by the SUB-D-15 connector, the front panel switches are overruled.

Table of DB-15 connector

Pin	Description
1	Deuterium ON/OFF
2-4	N/C
5	Halogen ON/OFF
6-12	N/C
13	Shutter Open/Close
14-15	N/C

Replacement of Lamps

In the earlier versions of the mini-D2, the deuterium- and halogen-light-bulbs could NOT be changed by unauthorized personal. These changes must be done at the producing factory ! There is a board-upgrade-replacement service, please contact your local dealer.

Technical Data

	Deuterium Light Source	Halogen Light Source
Wavelength Range	200 - 400 nm	360 - 1700 nm
Stability	0,3 %	0,3 %
Warm-up time	10 min	1 min
Lamp Power	2,5 Watt	2,5 Watt
Lamp Lifetime	1000 hours	2000 hours
Temperature Range	5°C - 35°C	
Power Requirements	12VDC / 420mA	
Dimensions / Weight	130 x 125 x 50 / ca. 250g	

5.5   XE-2000 Xenon Pulsed Light source

The **XE-2000 Pulsed Xenon Lamp** is a high flash rate, short-arc xenon lamp for applications requiring absorbance, reflection, fluorescence and phosphorescence measurements. The XE-2000 operates at speeds up to 220 Hz and offers critical pulse-to-pulse stability.

<div align="center">Parts Included</div>

1. XE-2000 Pulsed Xenon Lamp
2. 15-pin cable for connecting the XE-2000 to the spectrometer
3. 12V DC wall transformer for supplying power to the XE-2000

<div align="center">Caution! UV Radiation and High Voltage!</div>

- Never look directly into the light source. **The ultraviolet radiation coming from the light source is capable of causing serious eye injury.**
- The XE-2000 uses high voltages. Never operate the XE-2000 without its housing intact.
- The SMA connector will get **HOT** during operation. Handle with care.

<div align="center">Operation</div>

The lamp is triggered with TTL pulses delivered through the 15-pin connector located at the rear of the unit. These pulses are supplied by our AVS-S2000-series spectrometers and SpectraWin software, or any other source of TTL signals. The lamp is powered by a 12V DC transformer, or from a 12V battery if field use is desired.

1. Plug the 12 VDC wall transformer. Plug the other end of the cord into the jack at the rear of the XE-2000.
2. Install the 15-pin cable into the rear of the XE-2000. Connect the other end to the 15-pin connector on an AVS-S2000 spectrometer. Connect an optical fiber to the SMA-terminated fiber optic port on the front panel.
3. Turn the power switch located at the rear of the source to the "ON" position.
4. Select either "MULTIPLE" or "SINGLE" flash mode by moving the toggle on the rear of the source.
5. SpectraWin software automatically operates the XE-2000 and gives one flash per scan in single flash mode. The flash should fire with a clearly audible "ping."

<div align="center">Application Tips</div>

Single flash mode
Using the Single flash mode results in one flash per integration cycle. Since the XE-2000 has a maximum repetition rate of 220 Hz, the minimum integration time is 5 milliseconds.

Multiple flash mode
When using the Multiple flash mode the user needs to ensure that a constant number of flashes occur for every integration cycle by setting the pulse rate and integration time. This achieves a continuous and stable signal. The pulse rate is determined by a jumper setting inside the AVS-S2000 (JP3). The integration time is controlled via the operating software.

To achieve a constant number of flashes per integration cycle, the integration time must be a multiple of that shown in the following table:

AVS-S2000 JP3 setting	Integration time must be a multiple of...		
	SAD500	ADC1000	DAQ700
2^{16} (factory default)	128	64	512
2^{14}	32	16	128
2^{12}	8	4	32
2^{10}	N/A	N/A	8 (with a minimum value of 24 ms)

The XE-2000 repetition rate is controlled via the AVS-S2000 (JP3), but is also dependent upon the master frequency of your A/D card. The table below shows the rep rate for the various combinations of hardware and jumper settings. (Note that the default setting from the factory is 2^{16})

JP3 Post #	Function	Frequency (Hz)		
		SAD500	ADC1000	DAQ700
1	Not enabled - for future software control			
2	Divide by 2^{10}	Too fast	Too fast	98
3	Divide by 2^{12}	122	Too fast	24
4	Divide by 2^{14}	30	60	6.1
5	Divide by 2^{16}	7.6	15.2	1.5

15 pin dB Connector Pinout XE-2000

Pin	Description
1	Strobe single fire
2	Strobe multiple fire
10	GND

Specifications

Power requirement	12 VDC/1000 mA (12 W)
Power output (max.)	45 mJ per pulse, 9.9 W(average)
Synchronization Input	15 pin sub D connector, TTL level
Pulse Duration	5 µsec (at 1/3 height)
Pulse duration	6 µsec
Pulse rate (max.)	220 Hz
Bulb Life	min. 10^9 pulses
Spectral Output	220 nm to 750 nm
Connector	SMA-905 connector
Dimensions	105 x 140 x 40 mm

5.6   DH-2000 Deuterium Halogen Light Source

Safety Instructions

Warning: All warnings on the unit and in the operating instructions should be adhered to.

Unpacking Instructions:

Your package should contain:
1 - DH-2000 (D-2000) Deuterium-Halogen light source
1 - Power Cord
1 - This manual

1)   Unpack your deuterium lamp carefully. Although the deuterium lamp is rigidly mounted dropping this instrument can cause permanent damage.

2)   Inspect the outside of the instrument and make sure that there is no damage to your unit. In case of damage contact the dealer immediately and DO NOT USE THE INSTRUMENT!

3)   Send in the registration card, for your guarantee and support.

4)   Use this instrument in a clean laboratory environment.

Moisture
The unit is designed for operation in dry rooms only.

Ventilation
The unit should be situated so that its location or position does not interfere with its proper ventilation.

Heat
The unit should be situated away from radiators, hot bodies, ovens or other heat sources and direct sun radiation.

Power Sources
The unit should be connected to a power supply only of the type as marked on the unit.

Object and Liquid Entry
Care should be taken that objects do not fall, or liquids spilled into the enclosure through openings.

Caution:
This lamp produces ultra violet radiation, which can be harmful to the eyes. DO NOT LOOK INTO THE LIGHT BEAM. THIS CAN CAUSE PERMANENT EYE DAMAGE - WEAR PROTECTIVE EYE WEAR - CALL YOUR LOCAL LAB SUPPLY HOUSE FOR GLASSES OR GOGGLES. This unit is supplied with a mechanical safety device - Do Not Remove This Safety Device!
Do not use this device in clinical situations.

Designations and Functions of Panel Controls

(10) Halogen ON-OFF

(9) Deuterium ON-OFF

(1) Deuterium LED

(2) Power LED

(3) Halogen LED

(4) SMA connector

(8) Fuse

(6) Power switch

Front Panel

(4)   Mechanic Protection / SMA-Connector

The mechanic protection is only to avoid that the user could not unintentional look directly into the Fiber optic connector. The connector is for use only with SMA-Fiber connectors. **Connect your Fiber optic Cable first before starting the Deuterium Lamp** (see Pictures 1-2-3). **Please be sure to avoid direct radiation of skin and eyes at the other fiber end.**

Caution: This lamp produces ultra violet radiation that can be harmful to the eyes. Lamps must not be viewed directly without suitable approved eye protection being used.

1   2   3
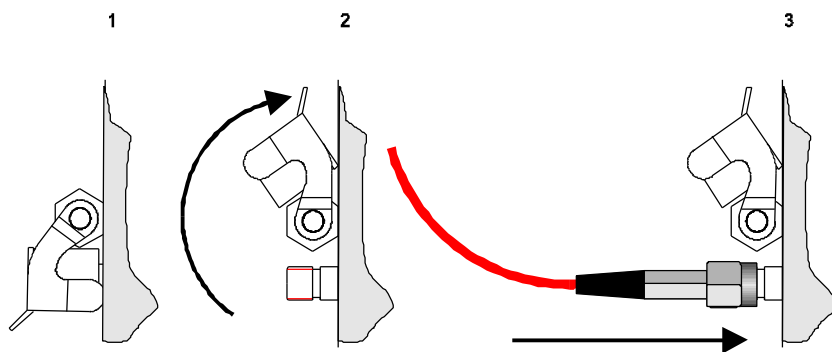
(9)   Deuterium Start

By pressing the keypad (9) the Deuterium lamp is preheated. After a warm-up time of 20 sec. the Deuterium lamp would ignite automatically.

After successful ignition the Two-Color-LED (1) lights up green and indicates that the Deuterium lamp is in operation. Should the Deuterium lamp not ignite the Two-Color-LED (1) lights up red. This indicates a malfunction of the lamp. See chapter 7 "Trouble shooting". Press keypad (9) again to reset the Error lamp.

N.B. The Halogen light turns off automatically after the Deuterium is started, in order to have both on simultaneously, press Halogen start button after Deuterium is started.

(9)   Deuterium Stop

By pressing the keypad (9) the Deuterium lamp switches off.

(10)   Halogen Start

By pressing the keypad (10) the Halogen lamp switches on. The LED (3) indicates the operation mode.

(11)   Halogen Stop

By pressing the keypad (10) the Halogen lamp switches off.

Rear Panel

(6)   Power Switch ON/OFF

When the power switch is turned ON, power is supplied to the unit. The unit automatically switches to the basic operating mode. The LED (2) indicator is lighted up at this time.

(8)   Fuse

This compartment contains the fuse to protect the unit against overload.
Type: Miniature fuse 5 x 20 mm, 1 Amp slow blow (Version EUROPE)
Type: Miniature fuse 5 x 20 mm, 2,5 Amp slow blow (Version USA)

(7)   Input Terminal for Power Cord

Input voltages AC 230..240V, 50/60 Hz (Version EUROPE)
Input voltages AC 110..115V, 50/60 Hz (Version USA)

Type Sign
Information about: - Type
   - Version
                                      - Order-No.
                                      - Serial-No.
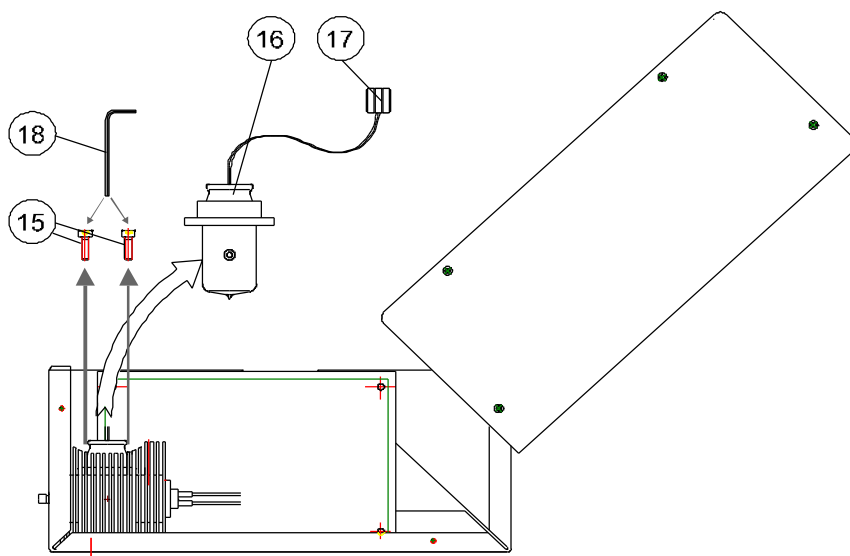   - Mains connection
                                      - Max. amb. temperature
                                      - Warnings
                                      - CE-Marking

Replacement of Deuterium Lamp

Disconnect the unit from mains connections (7) !

Warning: Connection of the power cord to the Deuterium Lamp MUST only be done when the power switch (6) is turned OFF. As the output of the power supply is not galvanically separated from the line voltage the connecting lead for the Deuterium lamp can carry a voltage >42 V when the power switch is turned ON.

Warning: During operation the lamp envelope reaches a temperature of approx. 250°C. Should you intend to change the lamp please wait for at least 20 minutes for cooling before touching the lamp. The lamp envelope (quartz glass) should not be touched with bare fingers, because lifetime will go down in this case.
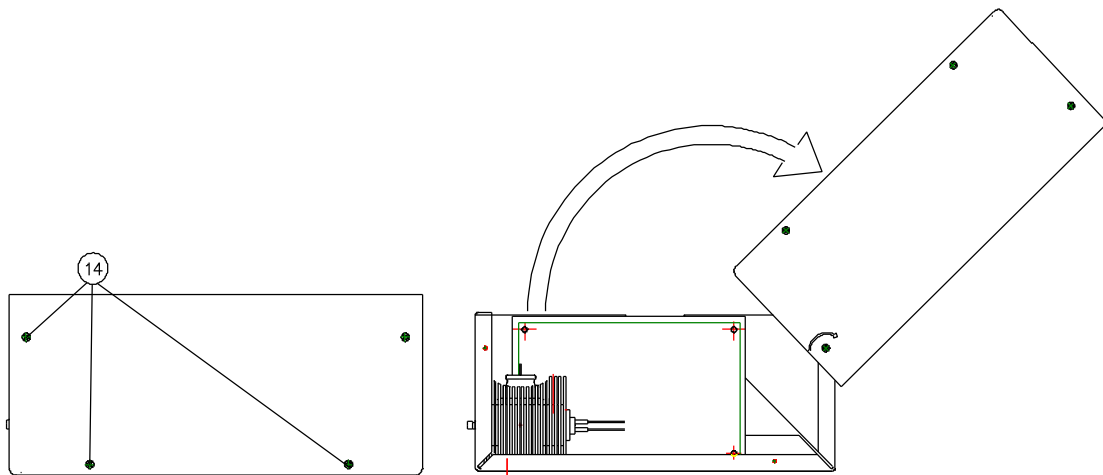
Open the six slotted screw's (14) and open the casing cover.
Open the screw's (15) by the tool (18), which is delivered with the spare bulb (16). Disconnect and connect the Deuterium lamp only with the original delivered connection plugs (17).

Replacement of Halogen Lamp

Disconnect the unit from mains connections (7)!

Warning: Connection of the power cord to the Deuterium Lamp MUST only be done when the power switch (6) is turned OFF

Warning: During operation the lamp envelope reaches a temperature of approx. 250°C. Should you intend to change the lamp please wait for at least 20 minutes for cooling before touching the lamp. The Lamp envelope should not be touched with bare fingers.

Open the unit. See chapter 3.
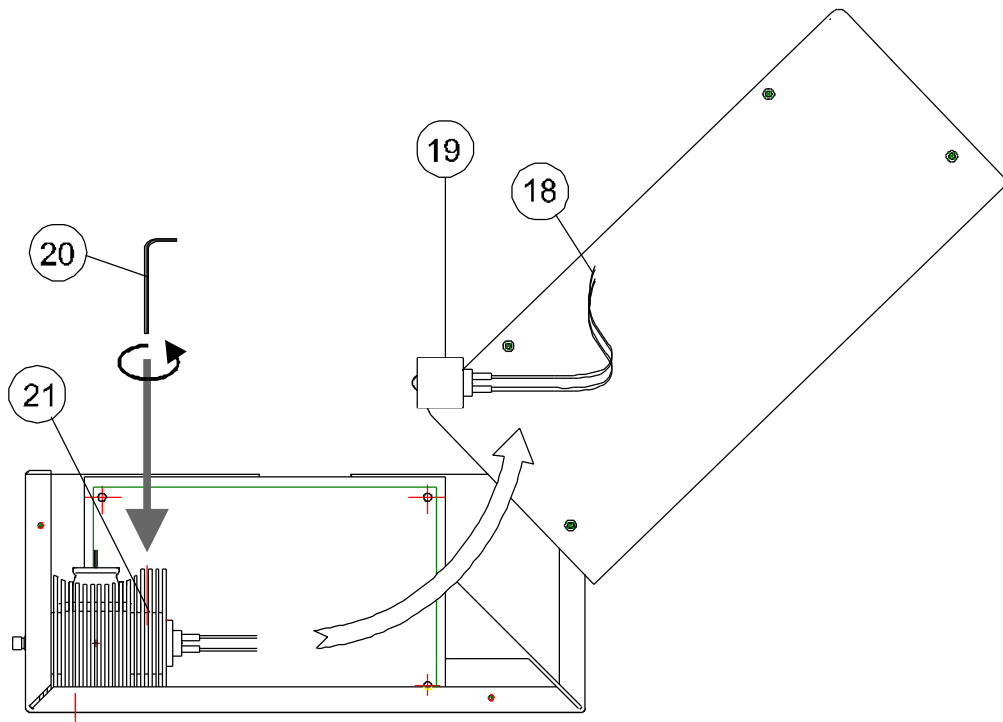
Open the screw (21) by the tool (20), which is delivered with the spare bulb (19). Disconnect and connect the Halogen lamp only with the original delivered connection plugs (18). Open the screws of the cable-clamp on the lamp-side. Remove the defective Halogen lamp module. Put in the new Halogen lamp module and close the screw (21). Fix the two cables of the Halogen lamp module in the cable-clamp.

Operating Instructions

Caution: The unit must work in a horizontal position, see graph chapter 3.
After connecting the power supply to line voltage, turn on the power switch (6). The LED (2) indicates power on status.

Connect the Fiber Optic Cable Connector to DH-2000 unit
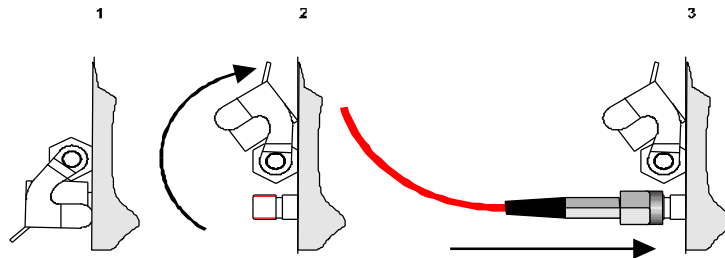
Deuterium Lamp

Starting the lamp
By pressing the keypad (9) the Deuterium lamp is preheated. After a warm-up time of 20 sec. the Deuterium lamp would ignite automatically.
After successful ignition the Two-Color-LED (1) lights up green and indicates that the Deuterium lamp is in operation. Should the Deuterium lamp not ignite the Two-Color-LED (1) lights up red. This indicates a malfunction of the lamp. See chapter 7 "Trouble shooting". Press keypad (9) again to reset the Error-lamp.
Caution: This lamp produces ultra violet radiation, which can be harmful to the eyes. Lamps must not be viewed directly without suitable Protective eyewear being used.

Switch off the lamp
The Deuterium lamp can be switched off by pressing the keypad "Deuterium" (2).

Lamp warm-up
The Deuterium-Lamp needs 10 - 15 minutes to reach a thermal equilibrium. During this time the intensity of the UV-output varies. If applications require extreme intensity stability, the lamp should be warmed-up for a further 30 - 45 min. After that the lamp will reach the specified drift values.

Halogen Lamp (DH-2000 only)

Starting the lamp
By pressing the keypad (10) the Halogen-Lamp is directly switched on.
The LED (3) lights up and indicates that the Halogen-Lamp is in operation. Should the LED (3) not light up, this indicates a malfunction of the internal power supply. See chapter 7 "Trouble shooting".
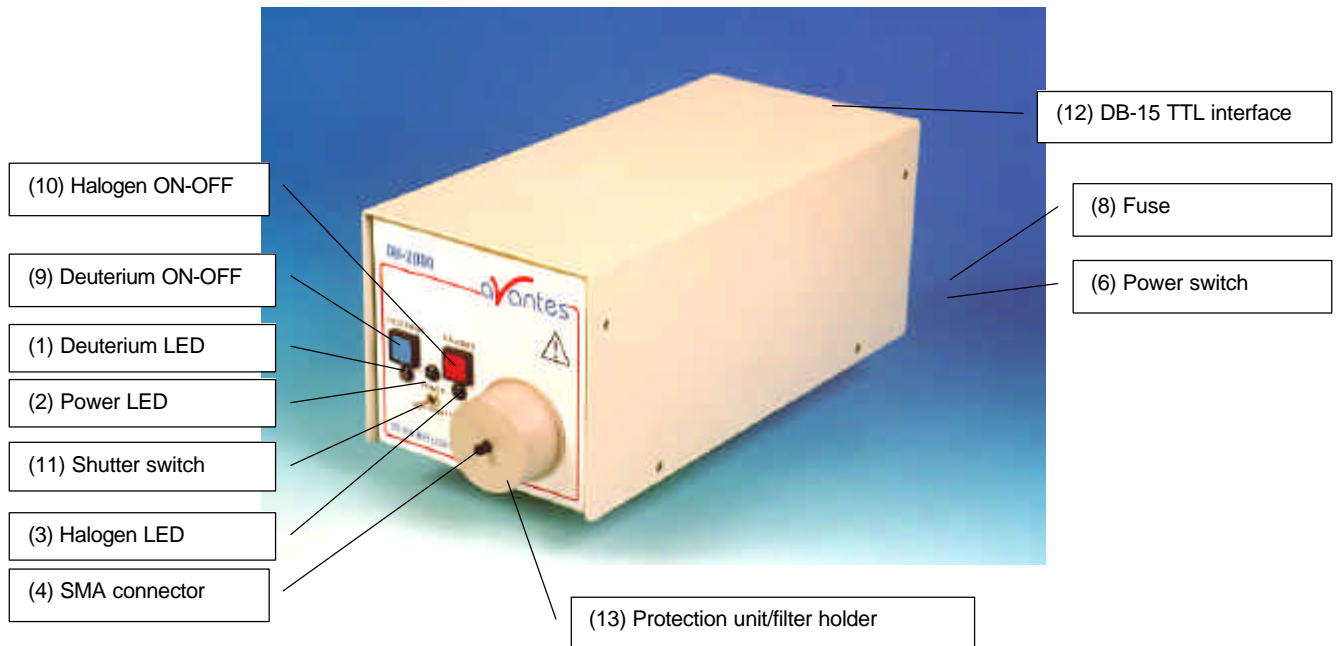
Switch off the lamp
The Halogen-Lamp can be switched off by pressing the keypad "Halogen" (10).

Lamp warm-up

The Halogen-Lamp needs 5 to 10 minutes to reach a thermal equilibrium. During this time the intensity of the output varies. If applications require extreme intensity stability, the lamp should be warmed-up for a further 15 min. After that the lamp will reach the specified drift values.

5.7   DH2000-FHS Instructions

(12) DB-15 TTL interface

(8) Fuse

(6) Power switch

(10) Halogen ON-OFF

(9) Deuterium ON-OFF

(1) Deuterium LED

(2) Power LED

(11) Shutter switch

(3) Halogen LED

(4) SMA connector

(13) Protection unit/filter holder

Operating instructions

Operating instructions see DH-2000 manual
Remove covers (4) from SMA connectors.
For automatic operation connect SUB-D 15-pol. TTL Input in connector (12)
Choose operation modus with switch (11) with the following positions:

OPEN: Shutter open
CLOSE: Shutter closed
TTL: Control via external TTL Signal (HIGH=OPEN, LOW=CLOSE), this option can be used with SpectraWin auto save dark and IC-DB-15 interface cable.

How to insert a filter

Open the protection unit (13) by turning it, so that the filter slit becomes free to enter a filter.
Insert a filter (max. diameter 1" round or square 1" x 1") in the filter slit.
Close the filter slit by turning the protection unit (13).

Specifications / Parts List

	Deuterium Light Source	Halogen Light Source
Wavelength Range	215* - 400 nm	360 - 1700 nm
Current- Voltage- Stability	$< 5x10^{-6}$ p-p (0.1-10Hz)	0.4% of voltage
Current- Voltage- Drift	± 0,01 % / h	-
Warm-up time	30 min	20 min
Lamp Voltage Lamp Current	Ignition 580±20V Operating 85 V / 0.3A	12V DC / 1.64A
Lamp Lifetime	1000 hours	900 hours
Radiation characteristic	Aperture 0.5mm 26° (13°)	focussed
Filter holder with protection unit (for -FHS only)	For 1"-Filter (D_{max} = 25,4 mm) round or square, Max. thickness 3 mm (for smaller filters max 5mm)	
Shutter electrical input (for -S/-FHS only)	TTL-input, max. 5 Hz	
Pin connection Sub-D-15 poles (for -S/-FHS only)	Pin 13: TTL Pin 10: Ground	
Performance guaranteed temperature	5°C - 35°C	
Humidity	5 - 95% without condensation at 40°C	
Power Consumption Internal	78 W / 0.35A max.	20 W / 1.64A
Driving Voltage Internal	84. . . 264 V 50/60 Hz	12VDC / 8A
Total Power / Maximal Power Consumption	100 Watt/190 Watt (Heating D-Lamp for 20sec)	
Power Requirements	Version Europe: 230...240 V 50/60Hz Version USA: 110...115V 50/60Hz	
Markings, Directives	CE; VDI/VDE 0160; EN61010	
Weight	ca. 6 kg	
Dimensions	150 x 135 x 319mm	

* 190-400 nm for DUV version
Modification of specification and design to improve the device are possible without notice

Trouble Shooting
Deuterium Lamp Only

If the power supply or lamp does not seem to functioning properly, check the following:

FAULT	POSSIBLE CAUSE	REMEDY
Power switch on, however none of the LED's (1...3) lights	Line power not present	Check line voltage
	Fuse (8) defective	Check fuse
Deuterium Lamp does not ignite. The Two-Color-LED (1) lights up red (ERROR)	Deuterium Lamp too hot	Allow Deuterium Lamp to cool down. Press keypad (9) again to reset the Deuterium lamp, then press the key (9) to restart.
	Lifetime of Deuterium Lamp is over	Replace Deuterium Lamp
	Deuterium Lamp internal connection plug is not closed right	Open Unit (See chapter7) and close connector plug
Deuterium Lamp extinguishes during operation	When this fault appears always switch off the power (Power Switch (6) OFF) and then - after cool down - restart	

Halogen Lamp Only

FAULT	POSSIBLE CAUSE	REMEDY
Halogen Lamp does not work after switching on (10)	Deuterium Lamp is preheating	Wait until the Deuterium Lamp has ignite and try again
	Halogen Lamp defective	Replace Halogen Lamp
	The Two-Color-LED (1) light up red (Deuterium Lamp-ERROR)	Press keypad (9) to reset the Deuterium lamp, then press the key (10) to restart Halogen lamp.
LED(3) does not light up after switching on (10) Halogen lamp	Internal Power Supply is defective	Disconnect the unit from mains power and inform your dealer

5.8   CAL-2000 Calibration Light Source

Safety Instructions

Instructions: All the safety and operating instructions should be read before the unit is operated. Before using the power supply for the first time check for transport damage.

Warning: All warnings on the unit and in the operating instructions should be adhered to.

Unpacking Instructions:

Your package should contain:

1 - CAL-2000
1 - This manual
! You need a Power Supply 12VDC, we recommend our PS-12VDC/1.25A

1)   Unpack your lamp assembly carefully. Although the lamp is rigidly mounted dropping this instrument can cause permanent damage.

2)   Inspect the outside of the instrument and make sure that there is no damage to your unit. In case of damage contact the dealer immediately and DO NOT USE THE INSTRUMENT!

3)   Use this instrument in a clean laboratory environment.

Moisture
The unit is designed for operation in dry rooms only.

Ventilation
The unit should be situated so that its location or position does not interfere with its proper ventilation.

Heat
The unit should be situated away from radiators, hot bodies, ovens or other heat sources.

Power Sources
The unit should be connected to a power supply only of the type described in the operating instructions or as marked on the unit. 12 VDC 1000mA analogue regulated (Code: PS 12VDC/1.25A)

Object and Liquid Entry
Care should be taken that objects do not fall, or liquids spilled into the enclosure through openings.
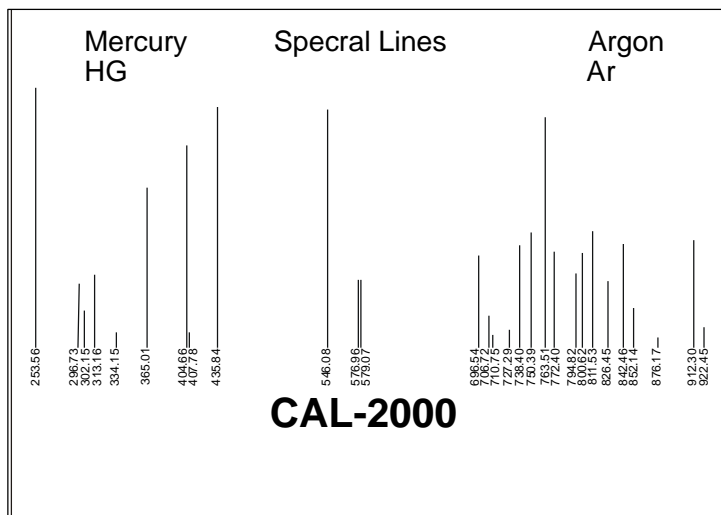
Caution:
This lamp produces ultra violet radiation, which can be harmful to the eyes. DO NOT LOOK INTO THE LIGHT BEAM. THIS CAN CAUSE PERMANENT EYE DAMAGE - WEAR PROTECTIVE EYE WEAR - CALL YOUR LOCAL DISTRIBUTOR FOR GLASSES OR GOGGLES. This unit is supplied with a mechanical safety device - Before removing this Safety Device be sure that the power is off, and screw in the fiber optic cable first before starting the instrument.

Designations and Functions of Panel Controls

SMA Connector

Power LED
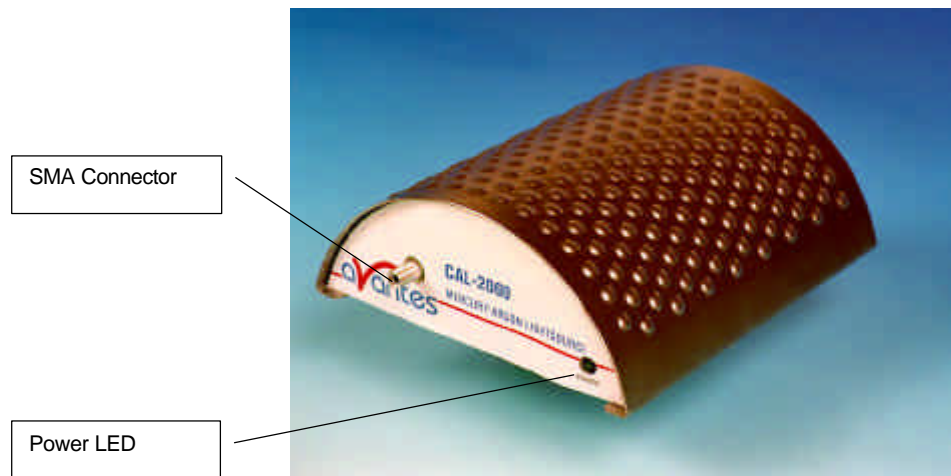
1)	Front side:	Fiber optic Connector SMA 905 compatible LED shows ON/OFF Status of Lamp
2)	Backside:	Power Input 12VDC ON/OFF-Switch
3)	Battery compartment:	Use only 9V E-Block Battery 6 LR 61, 6 AM 6, MN 1604

Dimensions of the housing: 141 x 124 x 53 mm

Mercury HG   Specral Lines   Argon Ar

253.56 296.73 302.15 313.16 334.15 365.01 404.66 407.78 435.84 546.08 576.96 579.07 696.54 706.72 710.75 727.29 738.40 750.39 763.51 772.40 794.82 800.62 811.53 826.45 842.46 852.14 876.17 912.30 922.45

CAL-2000

Replacement of Lamp

Please order replacement bulb: Order Code CAL-2000B
The curved napped top of Lamp could be removed by screwing out four screws from the bottom side.
The Lamp could then be replaced when loosing the screws at the two legs of the lamp.

6   Fiber optics

General Information

Core

For existing sensor applications, generally, **multi-mode step index silica fibers** are used. These range in core thickness from 50 microns to 1 mm. The core is made out of pure silica. Other fiber cores with much higher absorption are made out of certain glass types or plastics. These are not offered in this catalog.

First a distinction is made between silica with high or low OH content. Silica fibers with high OH (600-1000 PPM) are used in the UV/VIS wavelength range because of the low absorption in the UV. They are referred to as **UV/VIS fibers.** For Deep-UV applications special solarization resistant fibers can be used.

The OH content causes strong absorption peaks in the NIR wavelength range. In order to get good fibers for the NIR range, the "water" is removed from the silica. This results in low OH fibers (<2 PPM) with low absorption in the NIR. They are referred to as **VIS/NIR fibers**.
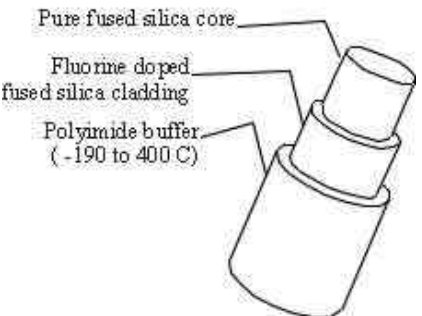
Cladding

In order to get the light guiding effect the core is cladded with a lower index of refraction material. For the highest quality fibers with the lowest absorption this is a fluorine doped silica, the so-called **silica-silica or all-silica fibers** with a numerical aperture (NA) of 0,22.
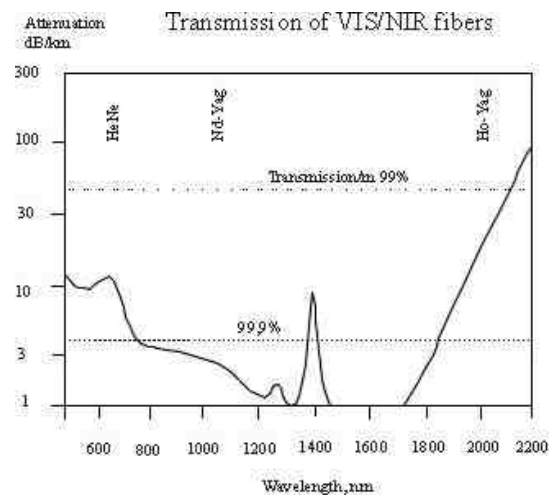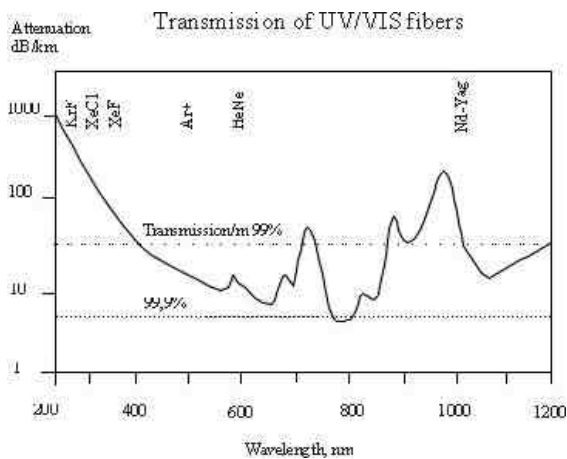
Buffers

Without further protection fibers would easily break, because of small scratches or other irregularities on the surface. Therefore a next layer, the buffer, is added. This buffer also determines under what circumstances the fiber can be used. Temperature range, radiation, vacuum, chemical environment and bending are factors to be considered.

Polyimide buffers offer a wide temperature range (-100 to 400 °C) and superior solvent resistance. Also, this material is non flammable. Drawbacks are sensitivity to micro bending and the difficulty to remove it.

For extreme temperatures (-190 to 750 °C) a **gold buffer** is used. Gold coated fibers are virtually inert to all environments and make hermetically sealed high pressure feed trough's possible. (See: pressure feed trough's). The same is true for **aluminum buffers** for temperatures from -190 up to about 500°C. Low outgassing makes them also excellent for use in vacuum.

Properties

- Step index profile
- Pure silica core
- Numerical aperture: 0,22 ± 0,02
- Laser damage resistant core transmits 1,3 kW/mm2 CW at 1060 nm, up to 10 J, pulsed
- Bend radius: momentary 100 x clad radius, long term 600 x clad radius
- Polyimide's high NA (1,78) strips cladding modes
- Standard prooftest: 70 kpsi

Solarization Resistant Fibers for Deep UV applications

Most spectroscopic applications with fiber optics have been restricted to wavelength ranges above 230nm, because standard silica fibers with an undoped core and fluorine doped cladding are frequently damaged by exposure to deep-UV light (below 230nm). This solarization effect is induced by the formation of "color centers" with an absorbance band of 214 nm. These color centers are formed when impurities (like Cl) exist in the core fiber material and form unbound electron pairs on the Si atom, which are affected by the deep UV radiation.

Not long ago, solarization resistant fibers, which were hydrogen loaded, were developed (UVI). The disadvantage for these fibers is the limitation on smaller fiber diameters and limited lifetime, caused by the H_2 outgass from the fiber.

Recently, with the availability of a modified core preform, a new fiber became available (UVM). This fiber provides long term stability at 30-40% transmission (for 215nm). All fiber optic probes, cables and bundles with core diameters of 100µm, 200µm, 400µm and 600µm can be delivered with solarization resistant fibers. All assemblies, made by us, are pre-solarized for an 8-hrs period, to have a constant transmission of 30-40% @ 215nm.

6.1 Sleeving material

For different applications we can offer different sleeving material. Standard all of our fiber optic cables and bifurcated cables are protected by a Kevlar reinforced polypropylene innertubing with PVC red outer jacket. All of our reflection probes are standard protected by a flexible chrome-plated brass outer tube, with hooked profile for optimal strain relief with a PVC-XY or PTFE inner tubing. For waterproof and some medical applications a stainless steel spiral tubing with glassilk and gray outer silicon rubber coating can be provided. Inside this tubing a PVC-XY or PTFE inner tubing is used as well. Especially for small, flexible, endoscopic probes we use a PVC rubber sleeving. Some specifics on the sleevings can be found in the following technical information.

Standard - Kevlar reinforced PVC

ME - Chrome plated brass

MS - Silicon coated stainless steel

Technical Data

Sleeve material	Kevlar reinforced PVC	Chrome plated brass	Silicon coated stainless steel	PVC
Inner Tubing	Polypropylene	PVC-XY/PTFE	PVC-XY/PTFE	n.a.
Outer dimensions	3,8 mm	5,0 mm	5,8 mm	2,0 mm
Temperature Range	-20°C to +65°C	-40°C to +120°C (PVC-XY) -65°C to +250°C (PTFE)	-40°C to +120°C (PVC-XY) -60°C to +180°C (PTFE)	-20°C to +65°C
Tensile Strength	150 N	350 N	70 N	n.a.
Application	Standard	Heavy Industrial	Waterproof IP67	Medical

6.2 Fiber optic cables

Fiber optic cables can be made in different lengths with different type of connectors, like SMA905, ST or FC-PC connectors. The fibers are also available in different wavelength regions, like Deep UV solarization resistant fibers, UV/VIS fibers and VIS/NIR fibers.

We offer different shielding, like Kevlar reinforced PVC sleeving with PTFE inner tubing (standard) or metal shielding with PVC-XY or PTFE inner tubing for higher temperature and more industrial applications.
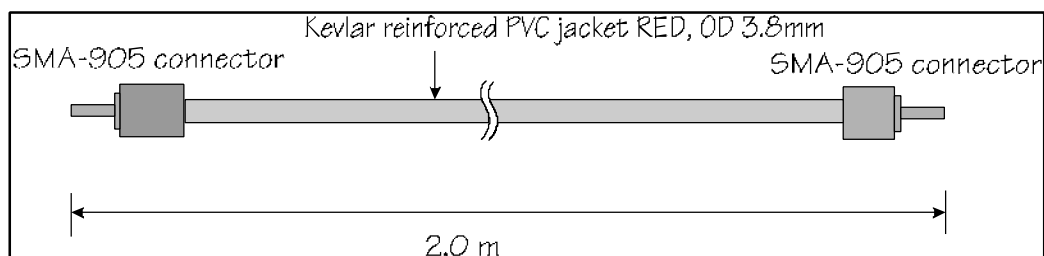
Depending on the intended wavelength range a UV/VIS (200-750 nm) or a VIS/NIR (500-1000 nm) fiber is used. In the following table replace xx by respectively UV or IR. For deep UV use specify –SR (solarization resistant).

6.2.1. Patch cords

Patch cords are standard delivered in 2m length with SMA-905 terminations. One side of each patchcord fiber has an extended ferrule in order to allow easily connecting into the 2000 series spectrometers optical bench.

Please follow the next rules:
1. Gently remove the plastic protection caps from the fiber SMA connectors.
2. Inspect the fibers if light is transmitted, note that for small fiber diameters the transmitted light energy may be low, so it is hard to see.
3. Do not bend the fiber too tightly, the minimum recommended bending radius of a fiber is 600 times the core/cladding diameter (i.e. 12 cm for a 200µm fiber), further bending may induce losses in optical transmittance. Bending the fiber below a radius of 200 times the fiber diameter may cause irreversible damage.
4. Keep connectors and tips protected by the plastic caps when not in use.
5. When necessary the fiber end can be cleaned with soft tissue and alcohol or acetone, avoid scratching.
6. Do not exceed temperature specifications.

In our standard quality assurance procedure, each fiber optic assembly is labeled with a serial nr, and some standard test are being carried out with a spectrometer and CAL-2000 Line source and registered:
1. Spectral attenuation at 253 nm for UV/VIS fibers, spectral attenuation at 763 nm for VIS/NIR fibers.
2. Symmetries of the connector for both sides; the maximal peak value is allowed to move as many nm as the registered resolution of the fiber / spectrometer.
3. Optical inspection of scratches on the surface.
4. A Deep-UV burn-in of 8 hours to pre-solarize the -SR assemblies, the attenuation at 215nm is registered.

There is always a label attached to the fiber optic cable or assembly that will tell you the serial nr, so the QA data can be retraced.
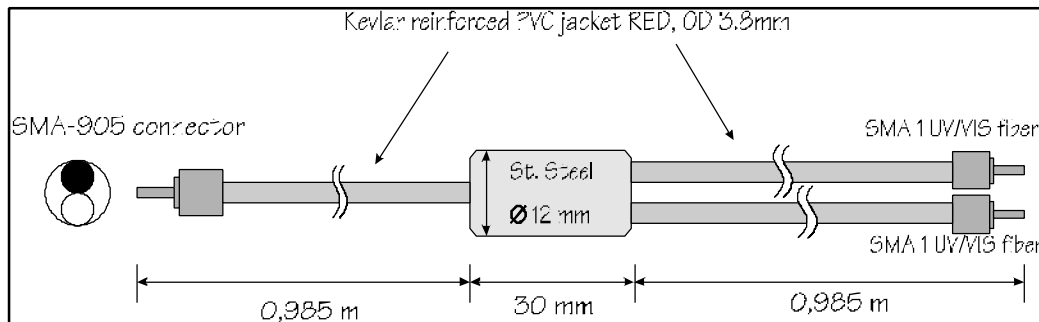
6.2.2   Bifurcated cables

Typically bifurcated fibers will have 2m length with the splitting point in the middle (1m) of the assembly.
Note that for the bifurcated fibers the light is entered into 2 different fibers that split up into the 2 different legs, the fibers are located next to each other.
Please follow the next rules:
1. Gently remove the plastic protection caps from the fiber SMA connectors.
2. Inspect the fibers if light is transmitted, note that for small fiber diameters the transmitted light energy may be low, so it is hard to see.
3. Do not bend the fiber too tightly, the minimum recommended bending radius of a fiber is 600 times the core/cladding diameter (i.e. 12 cm for a 200µm fiber), further bending may induce losses in optical transmittance. Bending the fiber below a radius of 200 times the fiber diameter may cause irreversible damage.
4. Keep connectors and tips protected by the plastic caps when not in use.
5. When necessary the fiber end can be cleaned with soft tissue and alcohol or acetone, avoid scratching.
6. Do not exceed temperature specifications.

In our standard quality assurance procedure, each fiber optic assembly is labeled with a serial nr, and some standard test are being carried out with a spectrometer and CAL-2000 Line source and registered:
1. Spectral attenuation at 253 nm for UV/VIS fibers, spectral attenuation at 763 nm for VIS/NIR fibers.
2. Symmetries of the connector for both sides; the maximal peak value is allowed to move as many nm as the registered resolution of the fiber / spectrometer.
3. Optical inspection of scratches on the surface.
4. A Deep-UV burn-in of 8 hours to pre-solarize the -SR assemblies, the attenuation at 215nm is registered.
There is always a label attached to the fiber optic cable or assembly that will tell you the serial nr, so the QA data can be retraced.
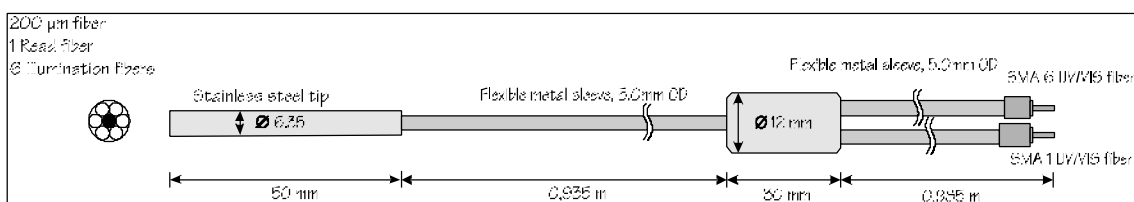
6.3 Fiber optic Reflection probes

We can make almost any type of arrangement as fiber optic reflectance probe. The standard configuration is a 6 illumination around 1 read fiber, which is 2 meters long. All probes can be delivered with UV/VIS or VIS/NIR fibers.

Technical data

Fibers	7 or 19 fibers 200 µm or 400 µm core, 6 or 17 light-fibers, 1 or 2 read fiber, n.a.= 0,22. Standard 2m length, splitting point in the middle.
Wavelength range	200-800 nm (UV/VIS) or 350-1100 (VIS/NIR)
Connectors	Standard SMA905 connectors (2x)
Probe end	Stainless steel cylinder, 50 mm long x 6,35 mm diameter.
Tubing	The optical fibers are protected by a PVC inner tube and a flexible chrome plated brass outer tubing. The tubing also gives stress relieve. OD: 5,0 mm
Temperature	-40 °C to 100 °C. (High Temperature Probes available on request)
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 60 mm

Please follow the next rules:

1. Gently remove the plastic protection caps from the fiber SMA connectors.
2. Inspect the fibers if light is transmitted, note that for small fiber diameters the transmitted light energy may be low, so it is hard to see.
3. Do not bend the fiber too tightly, the minimum recommended bending radius of a fiber is 600 times the core/cladding diameter (i.e. 12 cm for a 200µm fiber), further bending may induce losses in optical transmittance. Bending the fiber below a radius of 200 times the fiber diameter may cause irreversible damage.
4. Keep connectors and tips protected by the plastic caps when not in use.
5. When necessary the fiber end can be cleaned with soft tissue and alcohol or acetone, avoid scratching.
6. Do not exceed temperature specifications.

In our standard quality assurance procedure, each fiber optic assembly is labeled with a serial nr, and some standard test are being carried out with a spectrometer and CAL-2000 Line source and registered:

1. Spectral attenuation at 253 nm for UV/VIS fibers, spectral attenuation at 763 nm for VIS/NIR fibers.
2. Symmetries of the connector for both sides; the maximal peak value is allowed to move as many nm as the registered resolution of the fiber / spectrometer.
3. Optical inspection of scratches on the surface.
4. A Deep-UV burn-in of 8 hours to pre-solarize the -SR assemblies, the attenuation at 215nm is registered.
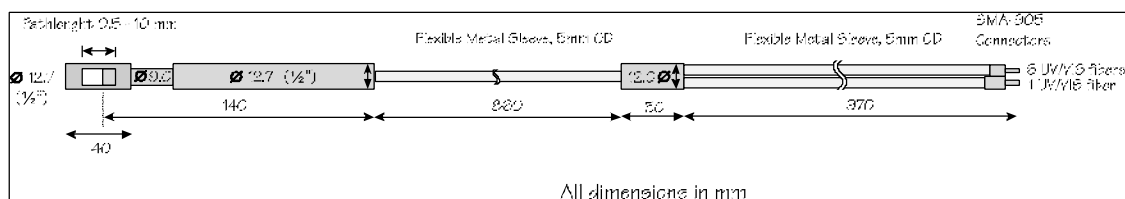
There is always a label attached to the fiber optic cable or assembly that will tell you the serial nr, so the QA data can be retraced.

6.4   Fiber optic Transmission Dip probes

For in-line absorption measurement as fiber optic transmission dip probe is used. The transmission dip probes come with either fixed path length or variable path length. The standard configuration is a 6 illumination around 1 read fiber, which is 2 meters long. All probes can be delivered with UV/VIS or VIS/NIR fibers.

Technical data

Fibers	7 fibers 200 µm core, 6 light-fibers, 1 read fiber, n.a.= 0,22.
Wavelength range	200-800 nm (UV/VIS) or 350-1100 (VIS/NIR)
Connectors	Standard SMA905 connectors (2x)
Optical Path	0.25 - 10 mm spacing, i.e. an optical path of 0.5-20 mm
Probe end	Stainless steel or PEEK cylinder , 140-160 mm long x 12,7 mm (1/2") diameter. Waterproof
Tubing	The optical fibers are protected by a PVC inner tube and a flexible chrome plated brass outer tubing. The tubing also gives stress relieve. OD: 5,0 mm Optionally a waterproof, steel reinforced, silicon tubing can be provided
Temperature	-40 ℃ to 100 ℃. (High Temperature Probes available on request)
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 60 mm

Please follow the next rules:
1. Gently remove the plastic protection caps from the fiber SMA connectors.
2. Inspect the fibers if light is transmitted, note that for small fiber diameters the transmitted light energy may be low, so it is hard to see.
3. Do not bend the fiber too tightly, the minimum recommended bending radius of a fiber is 600 times the core/cladding diameter (i.e. 12 cm for a 200µm fiber), further bending may induce losses in optical transmittance. Bending the fiber below a radius of 200 times the fiber diameter may cause irreversible damage.
4. Keep connectors and tips protected by the plastic caps when not in use.
5. When necessary the fiber end can be cleaned with soft tissue and alcohol or acetone, avoid scratching.
6. With the probe a 1,5mm wrench allyn key is delivered, so the set screw of the variable path can be loosened, before changing the path length. Afterwards the set screw needs to be tightened.
7. Since the optical reflector at the end of the probe is a diffuse reflecting material, a calibration of absorption values versus concentration needs to be done for all the chosen path lengths.
8. Do not exceed temperature specifications.

In our standard quality assurance procedure, each fiber optic assembly is labeled with a serial nr, and some standard test are being carried out with a spectrometer and CAL-2000 Line source and registered:
1. Spectral attenuation at 253 nm for UV/VIS fibers, spectral attenuation at 763 nm for VIS/NIR fibers.

2. Symmetries of the connector for both sides; the maximal peak value is allowed to move as many nm as the registered resolution of the fiber / spectrometer.
3. Optical inspection of scratches on the surface.
4. A Deep-UV burn-in of 8 hours to pre-solarize the -SR assemblies, the attenuation at 215nm is registered.

There is always a label attached to the fiber optic Dip probe that will tell you the serial nr, so the QA data can be retraced.

6.5 Fiber optic accessories

All fiber optic accessories are delivered with SMA905 connectors to allow easy coupling to our fiber optic cables and probes.
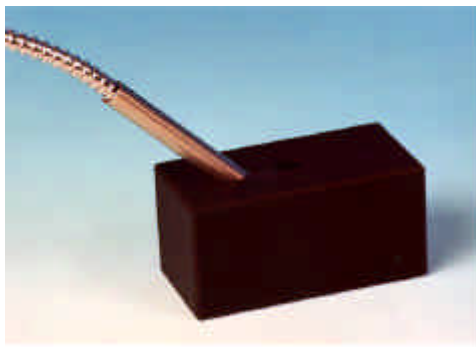
6.5.1 Collimating lenses

The COL-UV and COL-VIS collimating lenses screw onto the end of an SMA fiber and convert the divergent beam of radiation light into a parallel beam. Collimating lenses can be used in any optical setup that requires parallel beams of light at the illumination source or at the entrance optics or at both sides. The COL-UV-90 is used to focus the exit light under 90 °.
Standard optical fibers have a n.a. of 0,22, which is an acceptance angle of 25°. The collimating lenses are adjustable, providing an acceptance angle of near 0° to 45°.
Please follow the below instructions to adjust the focus of your collimating lens:
1. Connect the fiber between the collimating lens and the light source.
2. Turn on the light source and focus the light in a white paper in ca. 100 mm distance.
3. Loosen the set screw with the Allen Wrench key 1,27 mm on the barrel and slide the inner barrel until you see a sharp focussed spot without light intensity and color variations across the beam spot.
4. Tighten the set screw with the Allen Wrench key 1,27 mm.

Technical Data

	COL-UV / COL-UV-90	COL-VIS
Lens Diameter	5 mm	
Lens confocal length	6 mm	
Lens Material	Suprasil 1	Silica
Wavelength range	200-2000nm	360-2000nm
Fiber connection	SMA 905, UNS 1/4"	
Mirror reflectivity (for COL-UV-90)	>90% (200-1100nm)	n.a.
Housing Material	Aluminum black anodized	
Thread	UNF 3/8"-24	
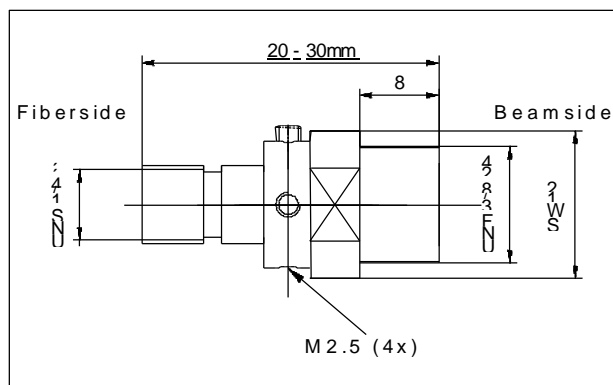
Drawing COL-UV/VIS   **Drawing COL-UV-90**
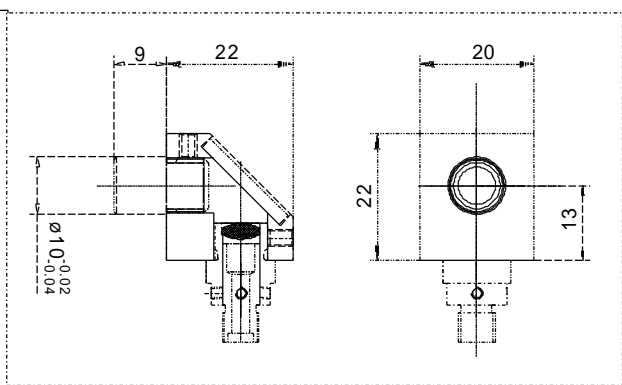
6.5.2 Cosine corrector

The CC-3 cosine corrector is a spectro radiometric sampling optic designed to collect radiation (light) at 180°, thus eliminating optical interface problems associated with the light collection sampling geometry inherent to other sampling devices.

The CC-3-UV cosine corrector has Teflon® diffusing material and is optimized for applications from 200-1100 nm.

The CC-3-UV cosine corrector screw on to the end of any SMA-terminated optical fiber. When coupled to a miniature fiber optic spectrometer, these cosine correctors can be used to measure UV-A and UV-B solar radiation, environmental light fields, lamps and other emission sources.

Each Cosine Corrector has a 0.25" O.D. barrel with a smooth yet rugged black oxide finish. The diffusing material is a thin disk that sits at the end of the barrel (the Teflon material is 0.30" thick).

Technical specifications

|	CC-3-UV
Diffusing material	Teflon (200-1100 nm)
Barrel dimension	0.25" O.D.
Sampling geometry	accepts light at/from 180° FOV
Connector	SMA 905
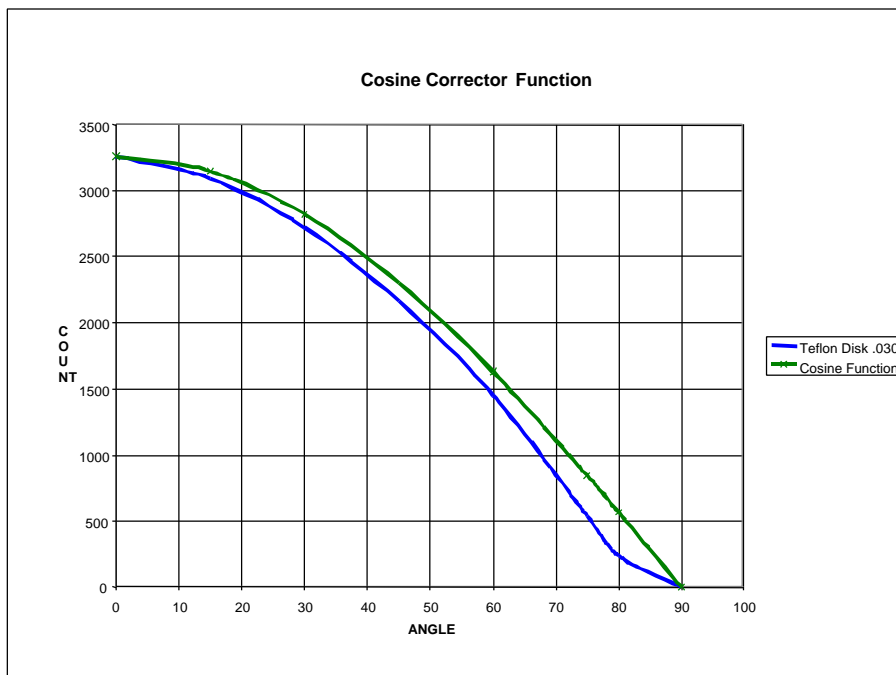
6.5.3   Vacuum feed through

The FC-VFT vacuum feed trough's are designed for use of fiber optics in vacuum chambers, such as for plasma monitoring. The vacuum feed through consists of an M12 housing with Viton® O-ring and 2 SMA fiber optic interconnects to allow easily coupling to fiber optic cables and probes. The vacuum feed through can be delivered for all fiber diameters, such as 50µm, 100µm, 200µm, 400µm and 600µm, for UV/VIS as well as for VIS/NIR.

Technical Data

Fibers	1 fiber, diameter 50µm/100µm/200µm/ 400µm or 600µm
Wavelength range	200-800 nm (UV/VIS) or 350-1100 (VIS/NIR)
Connectors	Standard SMA905 connectors (2x)
Wall thickness of vacuum chamber	5-40 mm
Vacuum	Max. 10^{-7} mbar
Temperature	-40 ℃ to 100 ℃. (High Temperatures available on request)
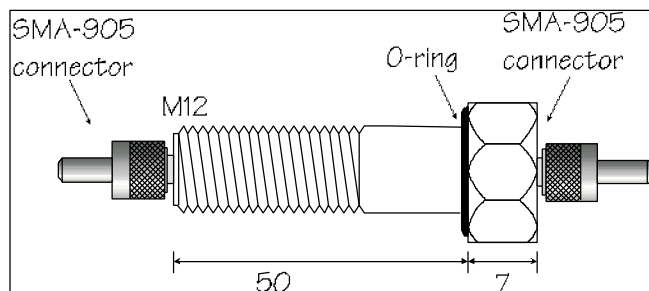
6.5.4   Fiber optic interconnect

The ME-FI-SM-MM fiber interconnect and ME-SM-BC are accessories for SMA-terminated optical fibers. Each connector consists of ¼"-36 outside-thread female adapter for easy connection to any SMA-terminated optical fiber. The ME-FI-SM-MM fiber interconnect may be useful for coupling patch cords to fiber optic probes and other devices, or for any multiple-fiber application where coupling of standard optical fibers and accessories is preferable to creating costly and complex fiber optic assemblies.

6.5.5   Reflection probe Holder

The Reflection probe holder is to fix a FCR standard reflection probe under an angle of 90 or 45 degrees, the holes have a 6,5 mm diameter and contain a setscrew to fix the probe in its position. The RPH measures 60 x 30 x 30 mm.
The reflection probe holder was developed for 2 types of reflection, specular and diffuse:
1. Specular reflection: Put the probe in the 90° aperture, adjust the distance from the measurement surface and tighten the setscrew with the 1,5 mm Allyn Wrench. Connect the 6 fiber leg to the light source and the read fiber to the spectrometer.
2. Diffuse reflection (for color measurements) : Put the probe in the 45° aperture, adjust the distance from the measurement surface and tighten the setscrew with the 1,5 mm Allyn Wrench. Connect the 6 fiber leg to the light source and the read fiber to the spectrometer.

7 Accessories

A complete program for fiber optic SMA 905 coupled sampling accessories is available, such as integrating spheres, cuvette holders, filter holders, shutters, attenuators, integrated sampling systems and flow cells.
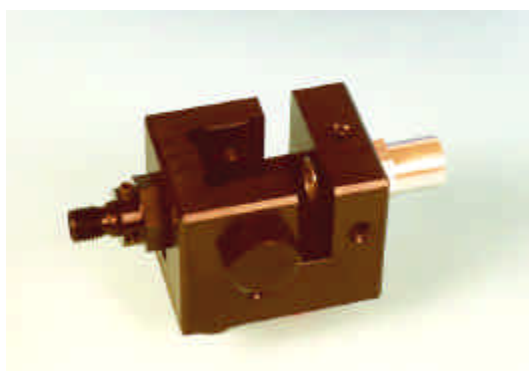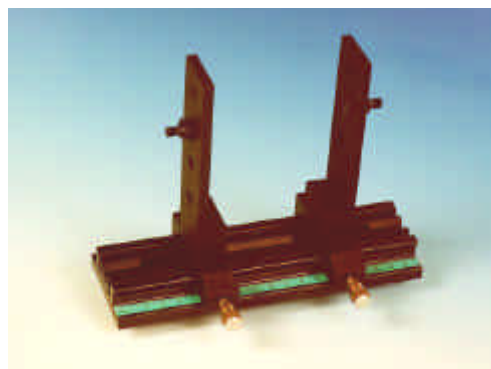
7.1   Integrating spheres

The integrating sphere family ISP-XX-8 can be delivered with an active diameter of 30, 50 or 80 mm (XX means the active diameter) and an SMA port at 90 degrees for both irradiance and reflection measurements, the reflection sphere has an additional SMA- connector port at 8 degrees. Both versions have a sample port diameter of 8 mm or 6 mm for the 30 mm diameter sphere. The irradiance version of the integrating sphere can be used to measure light sources (Laser, LED, and Halogen Lamps). The reflection version is used to measure reflective surfaces, as well as for color measurement and fluorescence spectroscopy. A light source may be connected to SMA-connector port through a fiber optic bundle to make the integrating sphere an ideal uniform light source. The integrating sphere is made out of highly reflective diffuse material, it's surface is reflecting the light diffuse with more then 95% in the spectral range from 200-2000 nm.

Operating instructions for the irradiance spheres

1. Connect an optical fiber between the SMA terminated measurement port (1) of the sphere and the spectrometer.
2. Insert your emission source (Laser, LED, and Halogen Lamps, or light fiber) into the sphere sample port (3).
3. To collect diffuse radiation (light) from a 180° field of view, eliminating direct light collection by the detection fiber, it is important not to insert your light to deep into the sphere. Basically you should only enter the light so much, so that all radiation is captured.
4. Measurements should be done in SpectraWin's relative or absolute irradiance mode, see the appropriate documentation.

Operating instructions for the reflection spheres

Since the reflection sphere has 2 SMA ports, one under 8° and one under 90°, the sphere can be connected for reflection measurements in 2 ways:
1. Direct illumination, indirect measurement or
2. Indirect illumination and direct measurement

We always recommend to use the first method of directly illuminating and indirect measurement. This method has the advantage that the white light of the source directly illuminates the object. The diffuse and specular reflection is indirectly measured by the sample port. In the second method the illumination is indirect and therefore the object surface becomes a part of the sphere, so the illumination of the object is actually not white light anymore, depending on the color of the object. Such method requires a second spectrometer channel to measure the illumination in the sphere.
The operating instructions refer to the first method of direct illumination and indirect measurement:
1. Connect an optical read fiber between the SMA terminated measurement port (1) on the side of the sphere and the spectrometer.
2. Connect an optical illumination fiber or bundle between the SMA terminated illumination port (2) on the top of the sphere and the light source. We recommend a 600um fiber or a bundle of 7 fibers of 200um. A bigger bundle will result in a collimated measurement spot, which is bigger than the sample port (3) and will therefore make the measurement less accurate.
3. Loosen the set screw of the collimating lens with the Allen Wrench key 1,27 mm on the barrel and slide the inner barrel until you see a sharp focussed spot without light intensity and color variations across the beam spot. Focus the illumination spot on the sample port, the optimal focussing point diameter is ca. 10-15 times the fiber diameter. The best way to see the spot is to put a white paper on the sample port and hold the sphere upside down.

4. Now you can put your sphere on the object you would like to measure, do not forget to take dark and reference (on a WS-2 white tile) first.
5. The maximum angle of diffuse reflection is 120° field of view.
6. Measurements should be done in SpectraWin's reflectance or color parameter mode, see the appropriate documentation.

Technical Data

	ISP-30	ISP-50	ISP-80
Internal diameter (mm)	30	50	80
Sample port diameter (mm)	6	8	8
External Housing dimensions	59 mm diameter 58 mm height	80 mm diameter 78 mm height	107 mm diameter 117 mm height

(2) Illumination port (Reflectance spheres only)

(1) Measurement port

(3) Sample port
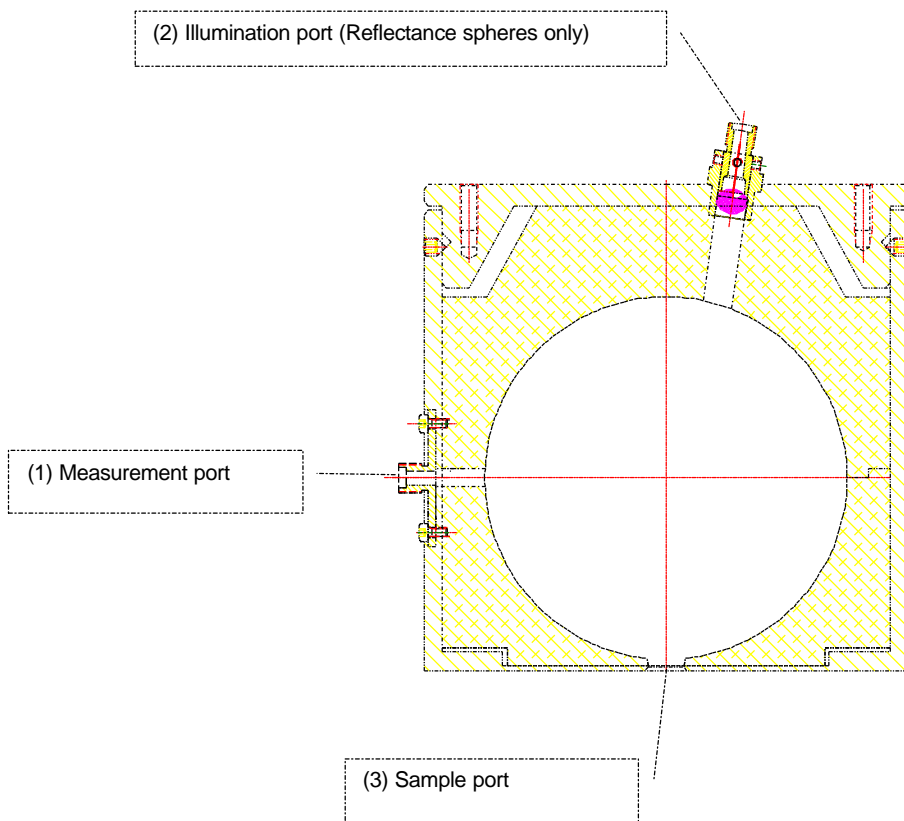
7.2 Cuvette Holders

All types cuvette sample holders are designed for transmission/fluorescence measurements using a 10 x 10 mm cuvette. They feature adjustable clamping to hold non-uniform cuvettes at a repeatable location. All cuvette sample holders have 6 mm wide slit for filters.

In the following paragraphs the operation instructions for the different cuvette holders are given.

7.2.1 CUV-UV / CUV-VIS

The CUV-UV and CUV-VIS come with 2 focusing collimating lenses to maximize the light throughput.
Operating instructions:
1. Attach an SMA terminated optical fiber between the cuvette holder and the light source
2. Attach an SMA terminated optical fiber between the cuvette holder and the spectrometer
3. Optionally install a filter by loosening the filter screw and insert the filter into the filter slot, max filter size is 6 mm.
4. The cuvette holders are designed to hold 10 mm cuvettes, 2 ball plunger screws can be adjusted to secure an optimal reproducible cuvette position
5. Focussing of the 2 lenses: Loosen the set screw of the collimating lens with the Allen Wrench key 1,27 mm on the barrel and slide the inner barrel until you see the optimal signal for your spectrometer in raw data intensity counts.

Technical Data

	CUV-UV	CUV-VIS
Cuvette Dimensions	10 x 10 mm	
Fiber connection	2 x COL-UV, SMA	2 x COL-VIS, SMA
Filter slit	Max 6 mm wide	
Water connection	n.a.	
Overall dimensions	140 x 55 x 60 mm	

7.2.2 CUV-UV-FL

The CUV-UV-FL has 2 focussing lenses, under 90 degrees for fluorescence measurements.
Operating instructions:
1. Attach an SMA terminated optical fiber between the cuvette holder and the light source
2. Attach an SMA terminated optical fiber between the 90° port on the side of the cuvette holder and the spectrometer
3. Optionally install a filter by loosening the filter screw and insert the filter into the filter slot, max filter size is 6 mm.
4. The cuvette holders are designed to hold 10 mm cuvettes, 2 ball plunger screws can be adjusted to secure an optimal reproducible cuvette position
5. Focussing of the 2 lenses: Loosen the set screw of the collimating lens with the Allen Wrench key 1,27 mm on the barrel and slide the inner barrel until you see the optimal signal for your spectrometer in raw data intensity counts.

7.2.3 CUV-ALL

For the CUV-ALL a built-in water path is incorporated for temperature stabilization, using circulating water.
The CUV-ALL has 4 collimating lenses, 2 x COL-UV, 2 x COL-VIS in 2 optical paths, one UV/VIS, one VIS/NIR. The CUV-ALL can be used to do simultaneously measurements with a dual channel spectrometer, such as AVS-SD2000.
Operating instructions:
1. Attach an SMA terminated optical fiber between the UV port of the cuvette holder and the UV light source.
2. Attach an SMA terminated optical fiber between the opposite UV port the cuvette holder and the spectrometer's UV channel.
3. Attach an SMA terminated optical fiber between the VIS port of the cuvette holder and the VIS light source.
4. Attach an SMA terminated optical fiber between the opposite VIS port the cuvette holder and the spectrometer's VIS channel.
5. Optionally install a filter by loosening the filter screw and insert the filter into the filter slot, max filter size is 6 mm.
6. The cuvette holders are designed to hold 10 mm cuvettes, 2 ball plunger screws can be adjusted to secure an optimal reproducible cuvette position. Focussing of the 2 lenses: Loosen the set screw of the collimating lens with the Allen Wrench key 1,27 mm on the barrel and slide the inner barrel until you see the optimal signal for your spectrometer in raw data intensity counts.

The CUV-ALL can be used for fluorescence applications as well, for fluorescence follow these instructions:
1. Attach an SMA terminated optical fiber between the cuvette holder and the light source
2. Attach an SMA terminated optical fiber between the 90° port on the side of the cuvette holder and the spectrometer
3. Optionally install a filter by loosening the filter screw and insert the filter into the filter slot, max filter size is 6 mm.
4. The cuvette holders are designed to hold 10 mm cuvettes, 2 ball plunger screws can be adjusted to secure an optimal reproducible cuvette position
5. Focussing of the 2 lenses: Loosen the set screw of the collimating lens with the Allen Wrench key 1,27 mm on the barrel and slide the inner barrel until you see the optimal signal for your spectrometer in raw data intensity counts.

7.2.3 CUV-DA

The CUV-DA direct attachment cuvette holder can be coupled easily to all our fiber optic light sources.
The CUV-DA can be used for absorbance and fluorescence measurements. It comes with a 90 degree and 180 degree 3/8"-24 thread that allows the COL-UV collimating lens to be mounted for absorbance or fluorescence setups. An a aluminum mirror with 3/8"-24 thread screw is delivered with the CUV-DA to mount in the other thread, to make the fluorescence signal even stronger.
The CUV-DA also has a 6 mm wide filter slot.
The CUV-DA can be used for 2 types op applications, absorbance and fluorescence

For **absorbance measurements** follow these instructions:
1. Attach the cuvette holder directly to the SMA port of the light source
2. Attach an SMA terminated optical fiber between the cuvette holder 180 degree port and the spectrometer.
3. Optionally install a filter by loosening the filter screw and insert the filter into the filter slot, max filter size is 6 mm.

4. The cuvette holders are designed to hold 10 mm cuvettes, 2 ball plunger screws can be adjusted to secure an optimal reproducible cuvette position
5. Focussing of the lens: Loosen the set screw of the collimating lens with the Allen Wrench key 1,27 mm on the barrel and slide the inner barrel until you see the optimal signal for your spectrometer in raw data intensity counts.

The CUV-DA can be used for **fluorescence applications** as well, for fluorescence follow these instructions:
1. Attach the cuvette holder directly to the SMA port of the light source
2. Move the SMA connector from the 180° position to the 90° position and screw the aluminum mirror into the 180° position.
3. Attach an SMA terminated optical fiber between the 90° port on the side of the cuvette holder and the spectrometer
4. Optionally install a filter by loosening the filter screw and insert the filter into the filter slot, max filter size is 6 mm.
5. The cuvette holders are designed to hold 10 mm cuvettes, 2 ball plunger screws can be adjusted to secure an optimal reproducible cuvette position
6. Focussing of the 2 lenses: Loosen the set screw of the collimating lens with the Allen Wrench key 1,27 mm on the barrel and slide the inner barrel until you see the optimal signal for your spectrometer in raw data intensity counts.

Technical Data

Wavelength range	200-1100nm
Path length	10 mm
Fiber connection	1 x COL-UV, SMA 905 connectors
Filter slit	Max 6 mm wide, max. round 1" or 2x2" square
Dimensions	30 x 27 x 37 mm

7.3 FHSA-TTL Filter Holder with Attenuator / Shutter

The cuvette sample- and filter holder is designed for transmission measurements using a 10 x 10 mm cuvette. It features adjustable 0-100% attenuation to correct light intensity, especially useful for the AVS-S2000-series spectrometers. An electronic TTL-Shutter for dark correction, which can be opened and closed manually as well, is included in the new design. The FHSA comes with 2 UV/VIS/NIR focusing collimating lenses to maximize the light throughput and with SMA sockets. A PS-12V/1.25A power supply should be ordered with the product.

Operating instructions

1. Plug in the power supply (1) .
2. Plug in the connector (2) of the power supply (1) in the socket (3) of FHSA-TTL.
3. Remove caps (17) of SMA-connectors (6).
4. Connect the SMA-connectors of your fibers to the SMA-plugs (5)+(6)
5. Plug in your IC-DB15-2 plug in connector (7) for automatic TTL-operation.
6. Set the operating mode by (8) with the following positions:
   - OPEN: Shutter open
   - CLOSE: Shutter closed
   - TTL: operation by external TTL- signal (HIGH=OPEN, LOW=CLOSE)

For Automatic save-dark use SpectraWin 4.1 or higher

Adjustment of optical power

The FHSA-TTL is factory adjusted to maximum power. If lower optical power is recommended, you can adjust the optical power by turning the attenuation screw (9) clockwise for decreasing power up to 0%.
1. Opening of the shutter by switch (8) position OPEN.
2. Connect your fiber optic spectrometer or your optical power meter with connection (6)
3. Loosen blocking-screw (10) before turning the attenuation-screw (9) by hexagon socket screw key (SW 2.0 mm).
4. By turning the attenuation-screw (9) you can optimize your optical power.
5. Blocking of attenuation screw by blocking screw (10).

Conversion from filter-holder to cuvette-holder

1. Turn the filter-thumb wheel (11) till you reach the end.
2. Loosen part (12) and screw out including COL-UV (13).
3. Screw out COL-UV (13) out of part (12).
4. Screw in COL-UV (13) in part (14).
5. Screw in part (14) including COL-UV (13) in the FHSA-TTL by hand.
6. Loosen the screws (15) by hexagon socket screw key (SW 2.0 mm).
7. Replace the filter-holder by the cuvette-holder (16)
8. Screw down the cuvette-holder (16) by one of the screws (15).

Operation: Filter-holder
Put in your filter in the filter slit (see picture 2) and fix it by the filter thumb-wheel (11).
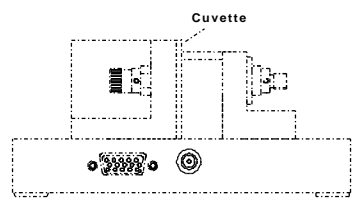
Operation: Cuvette-holder
Put in your cuvette in the cuvette-holder (see picture 3) and adjust carefully the cuvette by the plastic tip screws (18).

Picture 1: Description of parts Filter Holder Shutter Attenuator
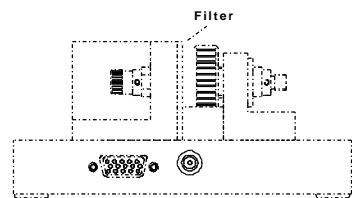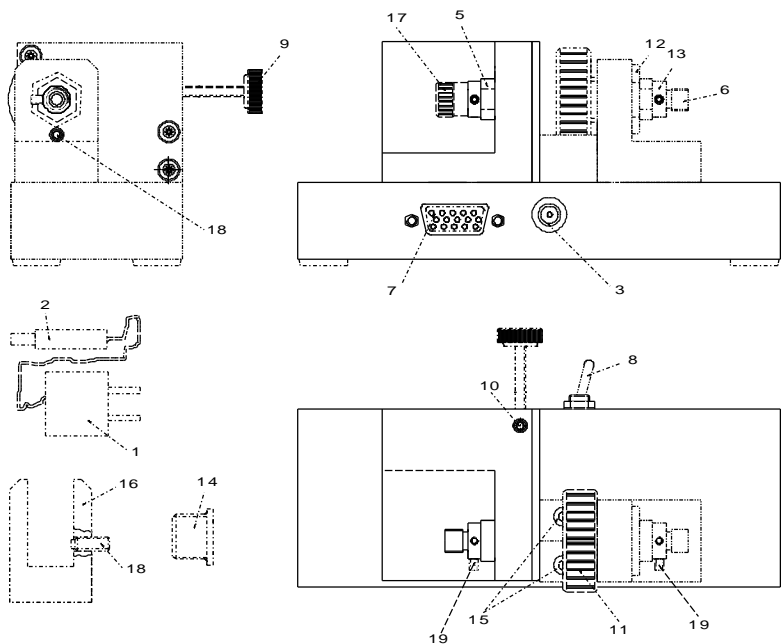
Picture 2: Filter Holder

Picture 3: Cuvette Holder

Specifications

Wavelength range	200-1100 nm
Shutter	TTL max. 5Hz / 60dB
Repeatability Attenuator	0,5%
PIN description	PIN 13: TTL, PIN 10: Ground
Filter-holder	Round and rectangular, Width up to 7 mm
Cuvette-holder	Standard (10 x 10 mm)
Power requirements	12 VDC
Power consumption	max. 100mA
Weight	ca. 600 g
Dimensions	140 x 50 x 50 mm

7.4 ISS-2000 Integrated sampling system

The ISS-2000 integrated sampling system contains both an HL-2000 tungsten halogen light source and a 10 mm CUV-DA direct attachment cuvette holder. The ISS has a 6mm for 2" x 2" square filters up to 6 mm thick and needs an extra PS-12V/1.25A 12 VDC power adapter.

Operating instructions

1. Plug in the power supply.
2. Plug in the connector of the power supply into the socket of ISS-2000.
3. Connect the SMA-connectors of your fibers to the SMA-plug of the cuvette holder
4. Switch on the Halogen lamp with the backside switch.
5. Attach an SMA terminated optical fiber between the cuvette holder 180 degree port and the spectrometer.
6. Optionally install a filter by loosening the filter screw and insert the filter into the filter slot, max filter size is 6 mm.
7. The cuvette holders are designed to hold 10 mm cuvettes, 2 ball plunger screws can be adjusted to secure an optimal reproducible cuvette position
8. Focussing of the lens: Loosen the set screw of the collimating lens with the Allen Wrench key 1,27 mm on the barrel and slide the inner barrel until you see the optimal signal for your spectrometer in raw data intensity counts.

Technical Data

Cuvette Dimensions	10 x 10 mm
Fiber connection	1 x COL-VIS, SMA
Filter slit	Max 6 mm wide
Power requirement	12 VDC, 1.4A
Output to bulb	7 W
Time to stabilize	Ca 5 min.
Bulb Life	1500 hrs
Bulb Color Temperature	2.960 °K
Overall dimensions	180 x 58 x 59 mm

7.5 Flow cells

7.5.1 1/4" and 1/2" flow cells

The 1/4" and 1/2" flow cells are developed for in-line absorption measurements. The flow cells consist of a Swagelok union cross tube fittings and 2 UV/VIS/NIR collimating lenses with 10 mm optical path and SMA905 connectors for easy coupling to our comprehensive line of fiber optic cables and bundles.

Technical Data

Wavelength range	200-2000nm
Fiber connection	2 x SMA905 connectors
Collimating optics	Plano Convex, focal length 8,7 mm
Optical path	10 mm for all versions
Material	Stainless steel for the fitting, black anodized aluminum for the SMA905 connectors
Overall dimensions	55 x 45 x 15 mm

7.5.2 Micro flow cells

The micro flow cells are Z-cells that can be easily coupled by 1,5mm PTFE tubing with 0,5mm inner diameter for in-line absorption measurements and HPLC applications. For the micro HPLC cell a temperature control is possible through Peltier element via the RS-232 interface with the computer. The Z-flow cells can be coupled with 2 special fiber optic cables (see below) , the Micro HPLC directly by SMA adapters.

Technical Specifications

Flow Cell Type	Micro flow Z-cell	Micro HPLC cell
Wavelength Range	200-2200nm	280-2500 nm
Optical path length	1,5 mm / 10 mm	5 mm / 10 mm
Sample volume	3 µl / 18 µl	1 µl / 2 µl
Tubing OD connection	1,5mm (1/16")	1,5mm (1/16")
Pressure rating	10 bar	30 bar
Fiber optic coupling	1,6 mm ferrule	SMA connector
Temperature regulation	-	10-40°C ± 0,1°C
Dimensions / material	32 x 38 x 13 mm / PEEK	40 x 70 x 46 mm / Aluminum

7.6 WS-2 White reflective tile

The WS-2 white reference tile is made out of a white diffuse plastic material, meeting the highest demands with regard to high grade diffuse reflectance, mostly used in colorimetry applications where a reference signal has to be obtained during a reflection measurement. Thanks to most accurate preparation of the PTFE and its processing to an amorphous structure, the tile reflects light from 400-1500 nm with ca 98% and from 250-2000nm more than 95%. The material offers along term stability, even in deep UV applications, the plastic is hydrophobic and chemically inert.
The material can be delivered as custom designed items, contact us for more information.

General Care

WS-2 is an optical standard and should be handled in much the same way as other optical standards. Although the material is very durable, care should be taken to prevent contaminants such as finger oils from contacting the material's surface, because this causes a loss of reflectivity especially in the UV region. Always wear clean gloves when handling WS-2!

Cleaning Instructions

If the material is lightly soiled, it may be air brushed with a jet of clean dry air or nitrogen. DO NOT use Freon. For heavier soil, the material can be cleaned by using a ultrasonic bath with double distilled or deionized water for 2 hours at 40 to 60°C. After this dry the WS-2 piece at 60° C for a 12 hour period (If possible at a vacuum of 1 Torr or less, then purge the vacuum oven with clean dry air or nitrogen). Caution!! Never use soap-water, alcohol, and organic or any other cleaners for WS-2. This will cause a big loss of reflectivity in the UV reflectance.

Reflectance Factor WS-2
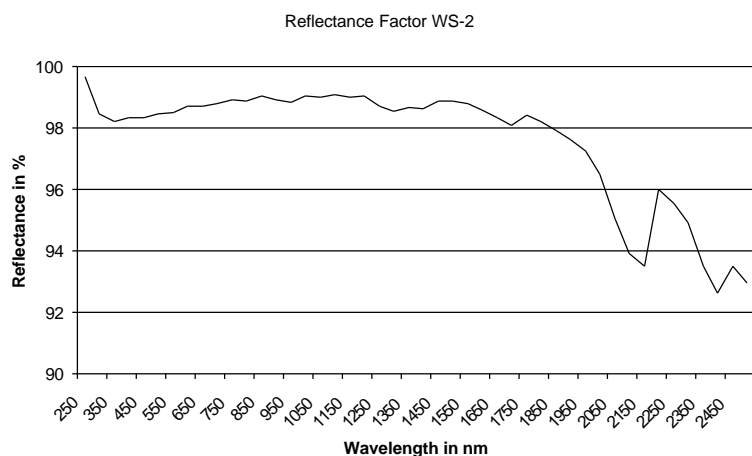
Technical Specifications

Reflectivity	98% (400-1500nm)
(see curve)	95% (250-2000nm)
Max. temperature	280 °C
Dimensions tile	32mm diameter / 10mm thick
Housing	38 mm diameter, black anodized

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