Evaluation Line

Spectrometer Unit LOE-USB

Instruction Manual

Document: **ump_LOE-USB_120e.doc**
Version 1.20_E (Evaluation Line)

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LU. Spectrometer Unit LOE-USB

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1 Safety Instructions

Please switch off the power and disconnect the main power cable when opening the instrument.

Hazardous UV light can be emitted from the optical outputs of a deuterium lamp or Xe flash lamp unit! Prevent direct contact, especially with the eyes. For inspection purposes wear protective eyeglasses or power off the light source!

Keep the SMA connectors closed all the time, in case no optical fiber is attached put on protection cap! Otherwise dust may penetrate the connectors and will degrade the optical performance of the system!

2 Description

2.1 General

LOE-USB is a compact, high quality diode array spectrometer unit for measurements in research, development and industry. For mobile operation, the version LOE-USB BV with an integrated battery pack is offered. The standardized SMA-connector at the front side allows the connection of light fibres and various probes.

The unit is connected to the PC via USB interface (USB 1.1 or USB 2.0). The electronics provides the sensor control, spectral data acquisition and transmission of the spectral data to the host computer.

As an option, a separate UV/VIS light source (Deuterium/Halogen Shine Through lamp or Xe flash lamp) is offered.
Various external input and output signals allow control of scan synchronized illumination, shutter operation and external triggering of the sensor scan event.

Picture 1: LOE-USB / MMS x front view

The spectrometer unit consists of tec5 operating electronics, a Zeiss MMS spectral sensor and the power supply.

2.2 Operating Electronics

The electronics consist of a USB Interface Electronics board with Front End Electronics mounted on top. Depending on the version, the functionality is extended by an electronic Spectral Sensor-Multiplexer and / or a battery pack with charging controller.
Detailed information about the electronic components can be found in the corresponding technical documentations.

2.2.1 USB Interface Electronics PD-USB01V1

By means of the USB Interface Electronics PD-USB01V1 the host PC controls the Frond End Electronics (FEE) to which the sensor is connected. The analog video signal of the sensor is digitized by the Front End Electronics and transmitted to the PC's USB port via the USB Interface Electronics.

The data acquisition controller on the interface board provides autonomous management of different software controlled readout cycles. For acquiring spectral data, the desired readout cycle has to be selected, parameterized and started by the PC. During the spectral data acquisition the PC is able to perform other jobs.

This device provides the following functionality:

- sensor control
- spectral data acquisition
- transfer of the spectral data via USB to the host computer

External control possibilities:

- illumination control, scan synchronized
- external triggering of the sensor scanning event
- control of peripheral devices (i.e. shutter or light sources) via the TTL digital I/O signals (two inputs, two outputs)
- I^2C-Bus
- power supply output for peripheral devices (like Evaluation Line light sources)

The PD-USB01V1 contains a USB interface compliant to the USB versions 1.1 and 2.0 specifications.

The firmware of the micro controller is loaded to the interface electronics during initialization of the USB Interface Electronics. This procedure may lead to delays when the operating mode is changed, because an alternative firmware module has to be downloaded to the on-board or internal memory (actual upload time at USB1.1: approx. 4s). The firmware modules are a part of the tec5 USB software driver. For this reason, operation of the PD-USB01V1 is only possible with this driver.

2.2.2 Front End Electronics

The Front End Electronics (FEE) type FEE-HS /EMB performs the linking of the sensor unit to the USB Interface Electronics. It generates the signals for managing the diode array within the Spectral Sensor and conditions the analog video signal including the 15 bit analog-to-digital conversion.

2.2.3 Electronic Spectral Sensor Multiplexer

In the dual-channel version of LOE-USB, an additional Electronic Sensor Multiplexer (type MUX-4P or MUX-8A) is integrated within the housing, which offers alternative or parallel operation of two N-MOS based sensor units.

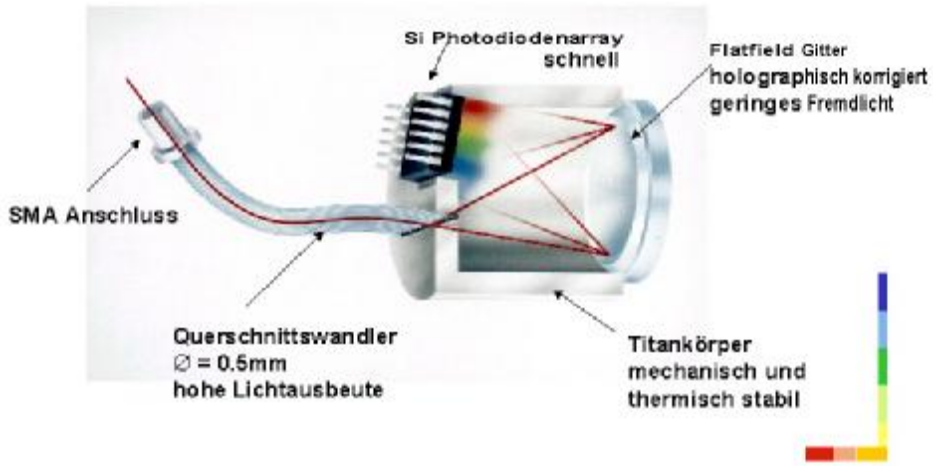
In the 'sequential mode of operation', the electronic Multiplexer is used like an interface switch with two input channels. The software selects the access to the Sensors and data acquisition of channel 1 or 2 is possible alternatively The size of a spectral data array is equal to the pixel number of the active Sensor.

In the 'simultaneous mode of operation', data acquisition is almost concurrent for both Spectral Sensors (e.g. reference and sample channel). The Multiplexer interleaves the spectral data of the single sensors pixel by pixel. The size of the resulting spectral data array is equal to the sum of the pixel numbers of both active channels.

2.3 Spectral Sensor

The ‚Evaluation Line' product family is equipped with an integrated Spectral Sensor from the MMS series of Carl Zeiss (not MMS_NIR). Main features are high signal-to-noise ratio, outstanding wavelength accuracy and long-term stability.
The fiber input of the internal Spectral Sensor is lead to the front panel of the unit.

In the other versions, an electrical Sub-D connector for the external connection of the sensor is placed on the front panel. Beside the operation of MMS Spectral Sensors this allows evaluation of other types of Spectral Sensors like type MCS of Carl Zeiss or Linear Image Arrays via a tec5 preamplifier electronics (i.e. DZA-S3901-4).



2.4 Power Supply

The units for mains operation are supplied by an external triple voltage wall power supply with DC-voltages of $+5V_{DC}$ und $\pm 12V_{DC}$.
For autonomous operation, the version LOE-USB BV with an integrated battery pack (12V / 1300mAh) and a recharging unit is offered. It allows operation of the unit for approximately four hours. For recharging, the external $24V_{DC}$ power supply has to be connected to the LOE-USB BV.

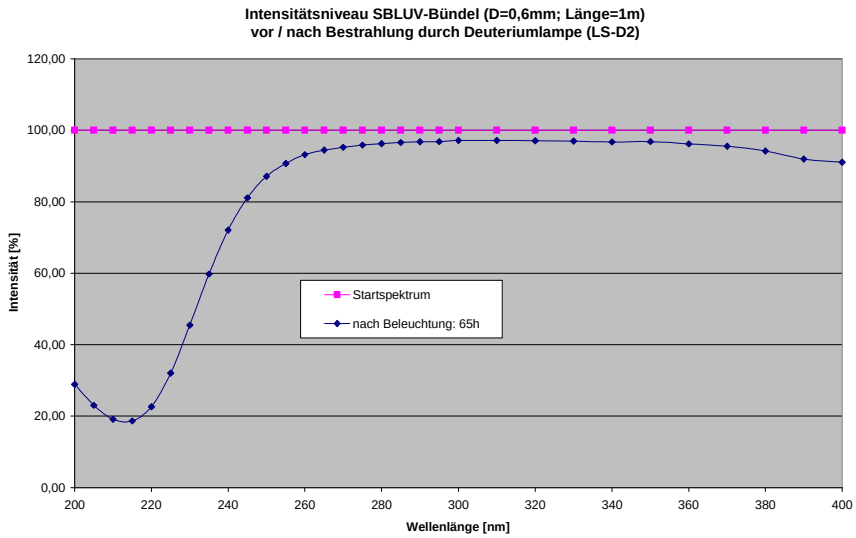
2.5 Handling of Fibre Optic Cables

Note: Optical fibres are fragile components, so please handle with care, especially do not bend, twist or stretch!

- Tighten the SMA connectors with care!
- Do not press installing the cable!
- If you do not use the fibre optic cover it by end caps.
- Mind the minimum bend radius. Do not bend the fibre optics directly at the end of the ferrule or hard tube and branches. The fibre may brake!

Solarisation:
UV-light shows an effect on fibre optic cables which is called „solarisation“. The intensity can go down dramatically between 200nm and 260nm, depending on the used fibre optic type. This effect is caused by “hard” UV light, especially the part below 200nm. After 50 operating hours this effect is going to stabilize. For that reason it can be necessary in the first operating hours to take reference measurements in shorter periods.

Changes of Intensity at 215nm with a SBLUV fibre optic bundle



Intensity level before and after ultraviolet irradiation using a Deuterium lamp

3 Versions

The unit is available in several versions. In the ‚Evaluation Line' family, a MMS spectral sensor from Carl Zeiss is integrated in the housing. In all other versions, the spectral sensor modules or sensor units are connected to the front panel of LOE-USB. In addition, units for two channel operation or with integrated accumulator are available (see table 1).

Unit name	MMS Spectral Sensor of type	Front Panel Connector for external Sensor module(s)	Number of Channels	Battery Pack
Evaluation-Line (One-channel version with integrated MMS Spectral Sensor)				
LOE-USB / MMS 1 NIR enh.	MMS 1 NIR enh.	Not available	1	without
LOE-USB / MMS 1 VIS	MMS 1 VIS	Not available	1	without
LOE-USB / MMS UV-VIS	MMS UV-VIS	Not available	1	without
LOE-USB / MMS UV-VIS II	MMS UV-VIS II	Not available	1	without
LOE-USB / MMS UV	MMS UV	Not available	1	without
LOE-USB BV / MMS 1 NIR enh	MMS 1 NIR enh	Not available	1	with
LOE-USB BV / MMS 1 VIS	MMS 1 VIS	Not available	1	with
LOE-USB BV / MMS UV-VIS	MMS UV-VIS	Not available	1	with
LOE-USB BV / MMS UV-VIS II	MMS UV-VIS II	Not available	1	with
LOE-USB BV / MMS UV	MMS UV	Not available	1	with
Units with connector(s) for external operation of sensor modules				
LOE-USB	Not available	yes	1	without
LOE-USB 2CH	Not available	yes, two connectors	2	without
LOE-USB BV	Not available	yes	1	with
LOE-USB BV 2CH	Not available	yes, two connectors	2	with

4 Software Support

For operation of LOE-USB using a PC with 32 bit Microsoft Operating System Windows 2000 or XP, different software modules and application programs are available. The test software AdminTool and the device drivers are always included in the hardware package. All other software modules need a license code for installation which has to be ordered from tec5.

4.1 Device Driver for Windows 2000/XP

The functionality is provided by a WDM driver for Windows 2000/XP. Windows NT doesn't support USB communication. The installation procedure starts automatically as soon as the USB Interface Electronics is connected to a PC for the first time.

4.2 AdminTool

The AdminTool is a test program for tec5 Operating Electronics and spectrometer systems. It allows the acquisition and display of pixel associated data as well as the setting of the sensor parameters (calibration coefficients, pixel count, sensor type) and their storage on the hardware. The acquired data can be exported as an ASCII file for further data processing. The AdminTool is based on the function library SDACQ32MP.

4.3 SDACQ32MP Programmer Interface

The function library SDACQ32MP is the basis of all tec5 software products. It provides a number of functions for setting the hardware parameters, acquiring spectral data and supporting additional hardware functions (e.g. digital I/O). The acquired pixel-related data is transferred to the application and is made accessible for further processing.

Each individual board of the tec5 Operating Electronics contains an EEPROM, a memory chip that stores identification information and calibration coefficients. The function library makes this information available for the application software i.e. for automatic hardware configuration or sensor calibration.

For fast and easy integration into customer specific applications, a Programmer Interface for the software languages C / C++ / Visual Basic and Delphi is available. It offers direct support for all listed languages in the form of definitions of functions, parameters and constants. In addition, several program examples in MSVC, MSVB and Delphi are included.

4.4 LabVIEW Instrument Driver

The product LabVIEW™ from National Instruments is used as a graphical tool for developing process application software. For the direct integration of tec5 Operating Electronics, LabVIEW™ instrument drivers are available. These instrument drivers consist of a number of subroutines (virtual instruments or VIs), which provide most of the functions of the library SDACQ32MP. In addition to these functions, tec5 offers a variety of Sub-VIs for processing spectral data.

For each tec5 Interface Electronics, specifically adapted sample applications are provided, which show the setting of hardware parameters as well as the acquisition and processing of spectral data.

4.5 MultiSpec Pro / MultiSpec Lite

Based on the LabVIEW™ programming environment, MultiSpec Pro offers extensive measurement and data processing capabilities. The base package contains, among other functions:

- full tec5 hardware support
- calculation and display of absorbance, transmission and intensity data
- automatic averaging of spectral data
- export of spectral data to ASCII and JCAMP format
- measurement cycles with automatic storage of data or results
- display charts
- output of results to standard interfaces

As an option, the following add-on modules for data processing are available (to be added into the MultiSpec Pro base package):

- multi channel module
- chemometric module (The Unscrambler™ online predictor OLUP)
- color module
- security package (including log file, user management and lamp intensity monitoring)

To run MultiSpec*Pro* the LabVIEW run-time machine 6.1 is needed, which is part of the delivery.
The software is specified for Windows NT/2000 and XP.

For evaluation purposes, a 30 day trial version of MultiSpec Pro is available free of charge.

In addition to the full version of MultiSpec Pro, tec5 offers the application software package MultiSpec Lite. It provides a subset of the functionality of MultiSpec Pro at a very economic price.

The major limitations of MultiSpec Lite are:

- no expansion possibilities by add-in modules
- no spectral data result processing functions
- no output of measurement results to standard interfaces (‚Outputs')

5 Contents of Delivery

The delivery of the LOE-USB contains:

1 LOE-USB (desktop electronics housing) with integrated components
- § USB Interface Electronics PD-USB01V1
- § Front End Electronics type FEE-HS /EMB
- § For Evaluation Line units: Spectral Sensor type MMS x
- § For two-channel units: Electronic Multiplexer MUX-4P or MUX-8A
- § For mobile units: battery pack and recharging electronics

1 Either Triple Output wall outlet power supply +5V_{DC} and ± 12V_{DC} (mains voltage typically 85 … 264 V_{AC} to)
Or For battery buffered units: Single Output wall outlet power supply +24V_{DC} (mains voltage typically 85 … 264 V_{AC} to)

1 USB 2.0 - cable, length 1,8 m

1 For Evaluation Line units: Manual (incl. Zeiss test certificate with calibration coefficients)

1 tec5 tools CD with
- -- software components, drivers and Admin-Tool
- -- documentation

6 Start Instructions for LOE-USB with AdminTool

Preparation of LOE-USB:

Step L1: Connection of Spectral Sensor(s) (for units with external sensor only)
Connect the end of the connecting cable with the SMB and 10-pin MICA connector to the Spectral Sensor or the preamplifier board, respectively. Then the Sub-D connector with the coaxial connections has to be attached to the LOE-USB, connector 'Spectrometer Channel x'.

Step L2: Installation of USB link cable between PC and LOE-USB
Connect PC and LOE-USB with the included standard USB 2.0 cable.
(USB connector of LOE-USB at the units rear panel)

Step L3: Connection of the power supply
The included power supply has to be connected to the
5-pin or 2-pin connector 'Power supply' on the rear panel of the LOE-USB.
Plug in the power supply to a wall outlet.

Note: Check the specification of mains input voltage range of the power supply with the voltage at your location.

Step L4: Turning on LOE-USB
Turn on power on LOE-USB by pushing the button at front panel ‚Power on')
- the green LED is illuminated (+5V supply voltage present)

Installation of Device Driver and AdminTool, Start of operation:

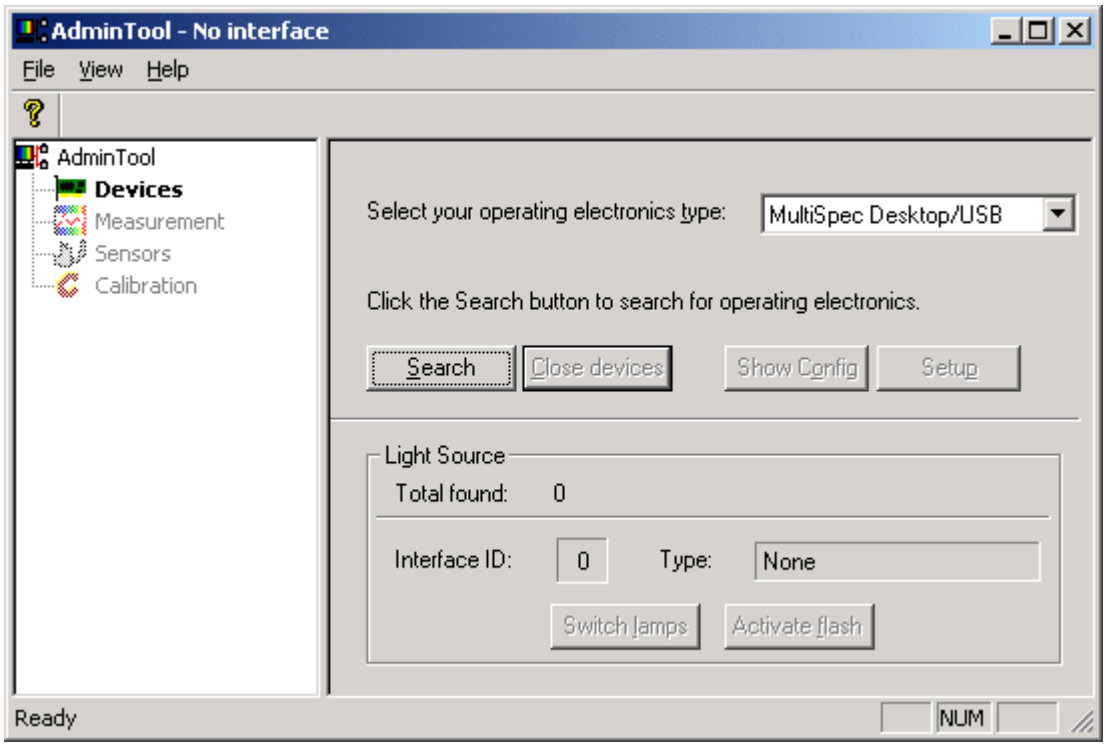
Step PC1: Installation of LOE-USB Device Driver
Note: Necessary only at the first connection of LOE-USB to the PC.

After the first connection of the USB Interface Electronics automatically you will be asked for the location of the device driver. Proceed as follows:
- Insert ‚tec5 tools'-CD into your CD-ROM drive,
  select the recommended option and choose CD-ROM drive.
- Change to directory ‚Software & Drivers'
- Change to directory 'Operation Electronics driver'
- Change to directory 'USB-Card – MultiSpecDesktop_USB'
- Change to directory 'Windows 2000-XP'
- Start program 'Setup.exe' and follow the instructions of the setup program
  Now Windows will install the WDM driver.

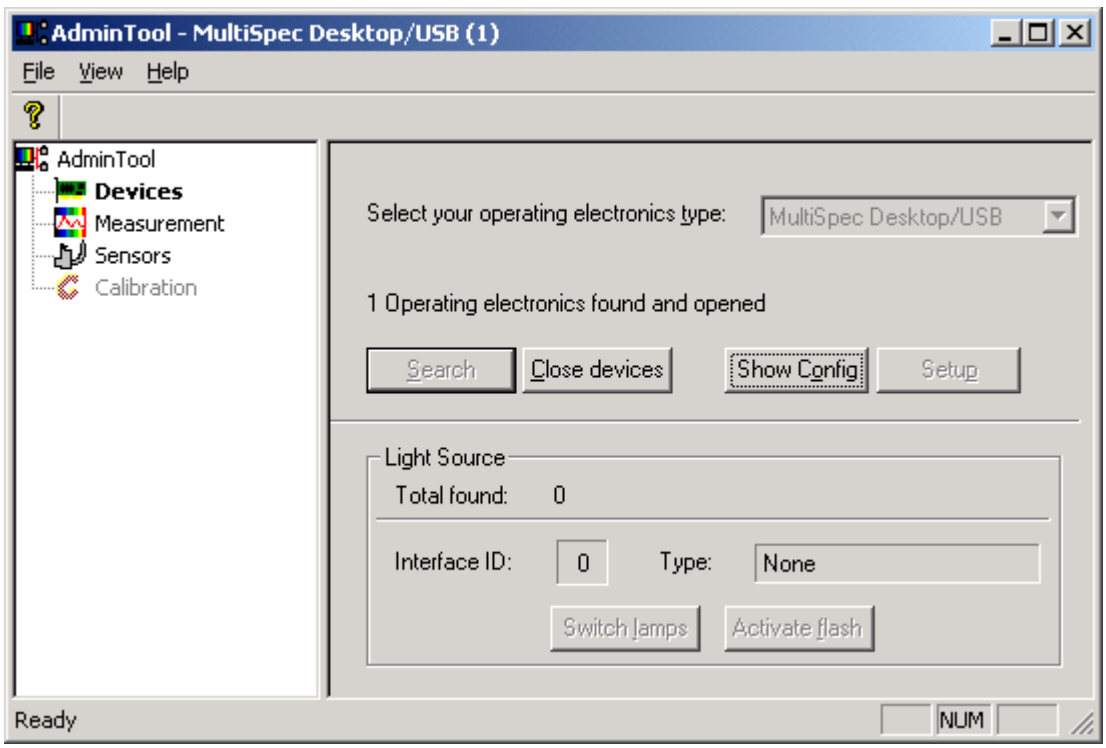
Step PC2: Installation of AdminTool
- Insert ‚tec5 tools'-CD
- Change to directory ‚Software & Drivers'
- Change to directory 'Software-Tools'
- Change to directory 'Admin-Tool'
- Start program 'sdacq32at.exe'
- Follow the instructions of the setup program

Schritt PC3: Starting AdminTool
- Start the application software AdminTool via
  Start / Programs / tec5 SDACQ32 AdminTool/ SDACQ32Admin
  Or click on Shortcut Icon (if installed)

Step PC4: Selecting the interface electronics



- Select 'MultiSpec Desktop/USB'
  in ‚Select your operation electronics type' - window
- Click to the ‚Search' button



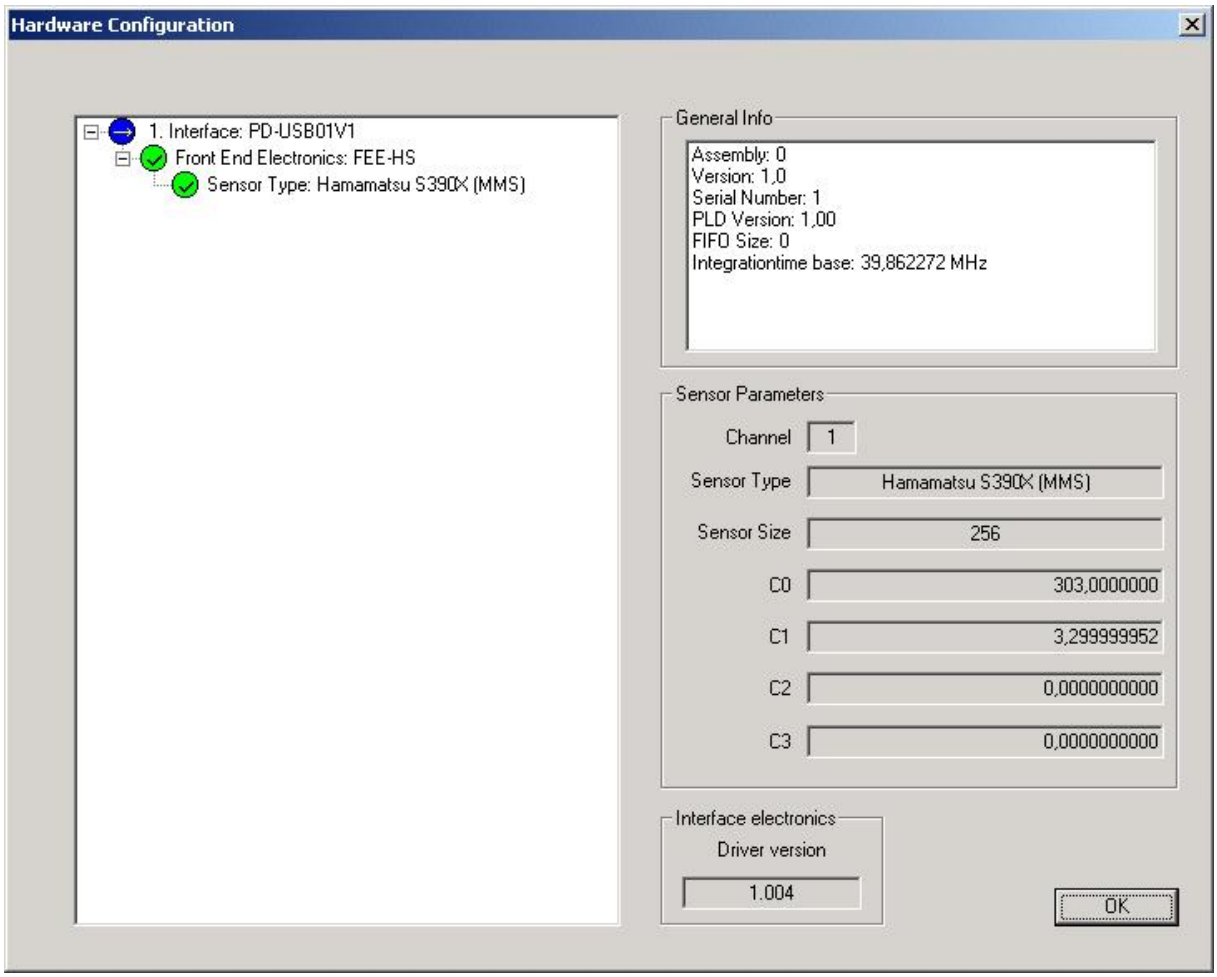
- Reaction: 'Searching …', followed of displayed message
  - '1 Operating electronics found and opened'

or, if an error occurs,

- 'No Operating electronics found'
  Check …
  -- LOE-USB power status
  -- USB data connection cable between PC and LOE-USB
  -- USB device properties by means of the 'windows device manager' in the group 'usb controller'

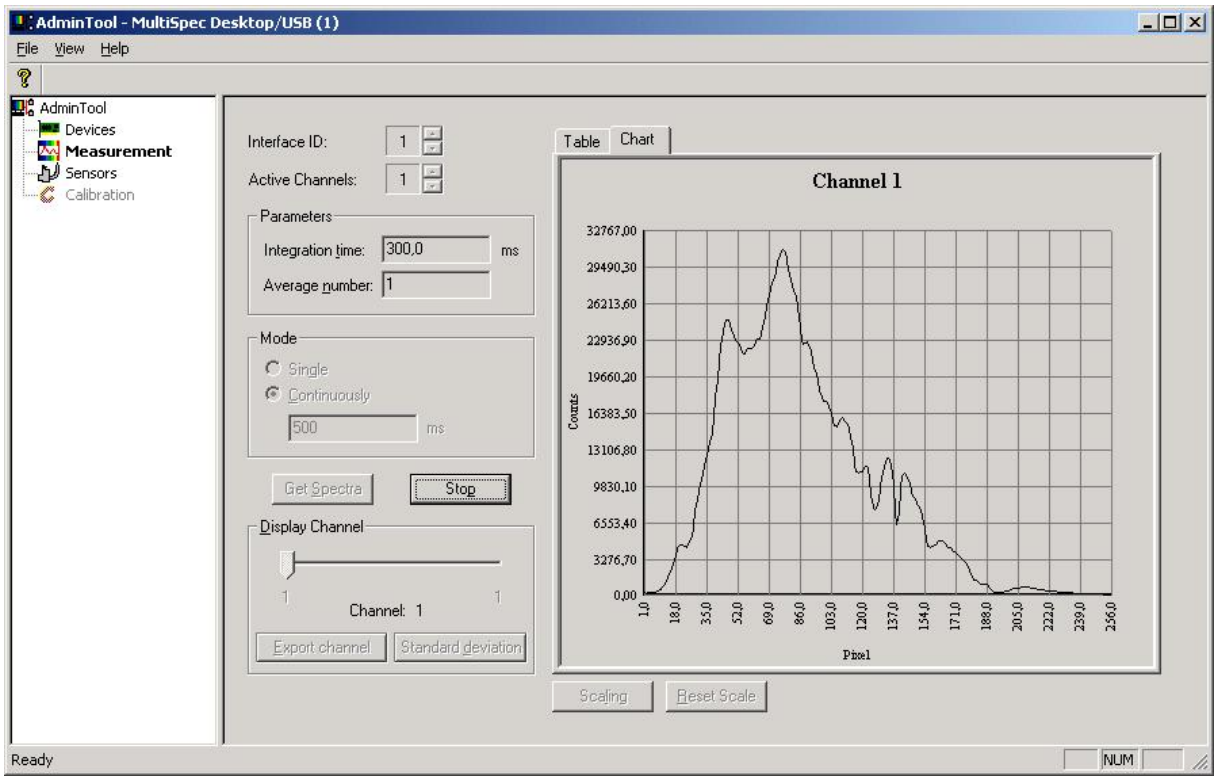
Step PC5: Display Configuration

- Click the ‚Show Config' button



Step PC6: ‚Measurement' – Acquisition and display of spectral data

The **‚Measurement'** window allows to perform a first test measurement and to visualize the resulting data. All spectral data are available in pixel related format only.



Parameter settings:

- Set integration time (i.e. 300 ms)
- Set number of spectra to average (i.e. 1)
- Set mode (i.e. ‚continuously')
- Set delay time between two successive spectra acquisitions (i.e. 500 ms)
- Select display type ‚Table' or ‚Chart'
- Start acquisition via Button ‚Get spectra'
- Stop acquisition via Button 'Stop''

The resulting data may be visualized graphically in a graphics window or numerically in a text window in a tabular format.

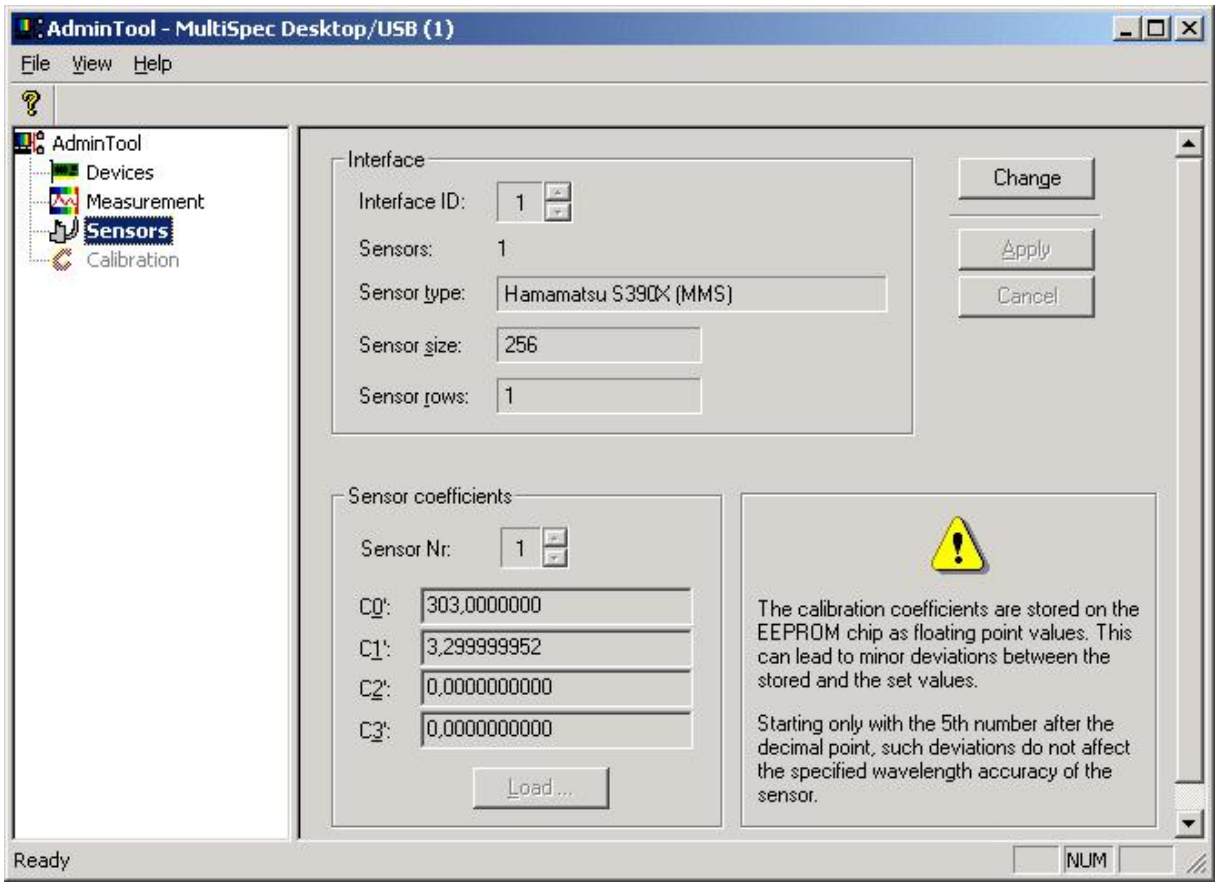
In addition, the Admin Tool allows to export the acquired spectral data of one channel in an ASCII table format with optional header line.

The program offers two modes for data acquisition. In ‚Single Mode' spectra data are recorded once, in ‚Continuous Mode' new spectra data are recorded periodically at the selected intervals.

The button ‚Standard Deviation' allows to measure the standard deviation per pixel based on 20 scans. The minimum, maximum and the average values of standard deviations for all pixels are displayed.

Step PC7: ‚Sensors'- Parameters for Spectral Sensors

The window **‚Sensor'** shows the current configuration of the measurement channels. All parameters of the spectral sensors are read (if supported by the Interface Electronics) and may be modified, if required. Relevant parameters are the sensor type, the array pixel count and calibration coefficients.



It is recommended to check if the stored calibration coefficients are as shown on the specification sheet of the spectral sensor manufacturer. Please refer to parameters C0' through C3'.

Important note: The sensor data are stored in an internal EEPROM memory. The coefficients are formatted as floating point numbers. For this reason, minor differences may appear starting at the fifth position after the decimal point between the numbers on the specification sheet and the stored numbers. These differences do not impair the specified accuracies of the sensor.

For changing coefficients or settings, please click on the ‚Change' button. Sensor type and number of pixels may be selected from a list and new sensor coefficients may be entered.

To activate changes, click on the ‚Apply' button; abort by the button ‚Cancel'

For further details please refer to the operating instructions manual of the AdminTool, which is available in pdf format on the tec5 tools – CD in the installation folder for the AdminTool.

7 Operating Elements

LOE-USB has two operating elements:

- **On/Off Switch**
  On the front panel you find the on/off switch of the unit designated with ‚Power-on'.

- **ID-Rotary Switch**
  By means of the hexadecimal rotary ID switch the identification number of the device is set. The ID number allows clear recognition of this unit by the PC in a USB network with more than one identical unit connected to the USB port.

  Default position of the ID switch = 0

  ID = 0 means, the ID value stored in the internal Boot-EEPROM of the Interface Electronics (default value 1) will be used as the unit's id number for the announcement at the PC.
  ID = 1…F means the selected value 1 to 15 will be used directly as the unit's ID value.

  Note:
  The tec5 function library SDACQ32MP supports only ID values between 1 and 4. Units with ID values greater 4 or several units connected to the USB with the same ID value are not supported by the function library SDACQ32MP.

  ID adjustment:
  The rotary switch is located on the back panel of the unit. For adjustments please remove the black cap and turn the arrow to the appropriate value. The new ID value is valid only after a power off / power on sequence of the LOE-USB.

7.1 LED Indicators

The status of LOE-USB is shown by a green LED designated ‚Power' on the front panel of the unit. This LED is on if the power of the unit is switched on.

Units with integrated battery pack have two more LEDs displaying the status of the recharging electronics located on the rear panel of the unit (detailed description see chapter 11).

- LED green: ‚Ext. DC in', external power for operation and charging available
- LED yellow: ‚Fast charge', fast charging operation running

8 Technical Data LOE-USB

Spectral Sensor:

	MMS 1 UV/VIS enh.	**MMS UV-VIS**	**MMS UV-VIS II**	**MMS UV**	**MMS 1 NIR enh.**
Spectral range [nm]	310 - 1100	190 - 735	250 - 785	190 - 390	310 - 1100
Specified range [nm]	360 - 900	220 - 720	250 - 785	220 – 390	400 - 1100
Spectral resolution [nm] (Rayleigh-criterion)	< 10	< 7	< 7	< 3	< 10
Spectral distance of pixels [nm]	approx. 3,3	approx. 2,2	approx. 2,2	approx. 0,8	approx. 3,3
Wavelength accuracy absolute[nm]	0,3	0,2	0,2	0,2	0,3
Diode array producer and type, 256 pixel	Hamamatsu S3904-256Q	Hamamatsu S3904-256Q	Hamamatsu S3904-256Q	Hamamatsu S3904-256Q	Hamamatsu S4874-256Q
Optical entrance, Fiber bundle cross section converter, SMA-coupling	Ø 0,5 mm, NA 0,22	Ø 0,5 mm, NA 0,22	Ø 0,5 mm, NA 0,22	Ø 0,5 mm, NA 0,22	Ø 0,5 mm, NA 0,22

Spectral Data Acquisition / A/D-Conversion:

Resolution: 15 Bit
Readout time: 1,4 ms (for sensors with 256 pixel)
Standard deviation: typically 1,4 counts
(20 dark spectra with integration time of 10 ms)

Attention:
While the battery charging process is active, the standard deviation may be higher !

Power Supply:

Mains input voltage range typically 85 … 264 V_{AC}
(see identification plate of power supply device)

Typical Power Consumption (1 channel version without Electronic Sensor Multiplexer):

+5V : typically 330 mA (with fuse 3 x 500 mA on USB Interface Electronics)
+12V: typically 40 mA (with fuse 200 mA on USB Interface Electronics)
-12V: typically 30 mA (with fuse 200 mA on USB Interface Electronics)

$+5V_{USB:}$ typically 5 mA (load only LED on USB Interface Electronics)

Temperature Range:

Operation: 0 °C ... + 50 °C (limited by the temperature range of the spectral sensor)
Storage: - 40 °C ... + 60 °C

Humidity:

Operation: 10% to 90%
Storage: 5% to 95%
(not condensing)

Dimensions: 220 x 150 x 72 [mm]

Weight: ca. 1.5 kg (Std.-version)

9 External I/O Signals

A 15-pin Sub-D connector designated ‚External in/out' mounted to the back panel provides control signals for the following functions:

- illumination control, scan synchronized
- external triggering of sensor scanning
- two digital TTL inputs for universal use
- two digital TTL outputs for universal use
- I^2C-Bus
- power supply output for peripheral devices (like Evaluation Line light sources)

9.1 External Illumination Control

Two signals are intended for controlling a light source (e.g. a flash light):

- Illumination control voltage input VCC_FLASH (Input for voltage level for External Light Control Output) and
- Control output FLASH (External Light Control Output).

The voltage level of the signal FLASH is +5V (internal +5V, if VCC_FLASH voltage is below +5V) or VCC_FLASH, depending on an external voltage applied to VCC_FLASH.
The flash output can be locked or released by software command. Also, the signal for the flash trigger pulse may be selected by software. Either the rising slope of the EOS or the rising slope of the STSCAN may be selected as the internal triggering event for the flash output. In addition, the polarity of the flash trigger signal may be selected.
The pulse width of the flash is preset to approx. 60 µs by an internal timer.

9.2 External Triggering of Sensor Scanning

For starting a readout scan, the TTL trigger input signal #EXT_TRIG may be used.

For external trigger, pulse or dual slope triggering may be selected. In case of dual slope triggering, both rising and falling slope of the signal applied will trigger a readout scan, in case of pulse triggering only the falling slope of the active low signal will trigger a readout scan.
The external trigger signal is processed by the microcontroller via interrupt. So, there is a time delay between the external trigger event and the start of the measurement cycle of about 8 … 30 µs.

9.3 TTL Input and Output

DI1 and DI2 are two universal digital TTL inputs for free usage.
DO1 and DO2 are two universal digital TTL outputs for free usage.

9.4 I^2C Bus

The I²C Bus (I²C data signal and I²C clock signal) is used to exchange control and status data between LOE-USB and further peripheral components.

The micro controller CY7C68013 includes an internal I²C bus controller, which is addressed by the controller firmware. In addition, the interface board contains two I²C bus EEPROMs of type PCF 8582C-2T (Philips), one EEPROM contains the data for USB bus enumeration, the other one contains tec5 specific information about the electronics. The external I²C bus is only available at the I^2C connector after initialization of the electronics.
Additional information for the connection of customer specific I²C bus users as well as the using of addresses and memory space are given in a dedicated technical note.

9.5 Power Supply Output for Peripheral Devices

The actual version of LOE-USB provides a $+12V_{DC}$ power output for supplying peripheral devices like light source units of the Evaluation Line.

The $+12V_{DC}$ (pins 8 and 15) and GND (pins 7 and 14) lines are connected to two pins each. The maximum output current depends on the technical data of the used external power supply unit (the internal power consumption of LOE-USB has to be considered).

10 Connectors

10.1 External I/O – Power

Type on rear panel: 15-pin Sub-D connector (female contacts)
External in/out

External in/out 15 Pin Sub-D Connector Pin #	**Signal Indication**	**Input / Output**	**Comment**
1	DI1	TTL Input	Digital Input 1
2	#EXT_TRIG	TTL Input	External scan trigger input
3	FLASH	Output	External Light Control Output
4	DO2	TTL Output	Digital Output 2
5	GND	Logic Ground	Ground
6	I²C_SCL	Bidirectional	I²C bus clock signal
7	GND (Power)	Power supply output return	Power output for peripheral devices (not fused)
8	$+12V_{DC}$ (Power)	Power supply output	
9	VCC_FLASH	Supply voltage input	Input for voltage level for External Light Control Output
10	DO1	TTL Output	Digital Output 1
11	+5V	Power supply output	+5V- power supply output for peripheral devices, I_{MAX} = 500 mA (fused on USB Interface Electronics)
12	DI2	TTL Input	Digital Input 2
13	I²C_SDA	Bidirectional	I²C bus data signal
14	GND (Power)	Power supply output return	Power output for peripheral devices (not fused)
15	$+12V_{DC}$ (Power)	Power supply output	

10.2 Spectrometer Channel 1 or 2

Type on front panel: 10-pin Sub-D connector with center coaxial contact (female contacts, coaxial connector pin contact)
Spectrometer Channel 1 or Spectrometer Channel 2

Sub-D Connector (10-pin) Pin-#	**Signal Indication**	**Input / Output**	**Comment**
1	Reserved (GND)	Reserved	
2	START	Output	Signal ‚Start of Scan'
3	0V – Digital Ground	Supply	
4	PHI2 – Sensor Clock	Output	Clock signal for Line Image Array
5	0V – Digital Ground	Supply	
6	/EOS – End of Scan	Input	Signal ‚End of Scan'
7	0V – Digital Ground	Supply	
8	-5VDC	Supply	
9	0V – Digital Ground	Supply	
10	+5VDC	V Supply	
SMB-contact	Video analog	Input	Shield: Ground Middle Contact: Signal

11 LOE-USB BV Battery Version

In addition, the following components are integrated in the desktop housing:

- LOE-1 AKKU-PSU
  (Battery recharging controller with DC/DC converter and voltage filter)
- Battery pack

Instead of the triple voltage power supply of the standard version a special power supply of only one voltage for the supply of the operation electronics and the recharging process is included. In case this power supply is in use the power is directly provided by means of this supply. The battery is recharged simultaneously. A set of charged batteries in good condition allows autonomous operation of the unit for four hours approximately (LOE-USB, 1-cannel version, including Spectral Sensor).

Recharging Process
For recharging, the external power supply has to be connected to the LOE-USB via the phone plug and to mains supply. The correct supply of the external voltage is indicated by the green LED mounted on the rear panel of the LOE-USB. The connection to the mains supply activates a recharging process performed in three phases: The rapid recharging phase is indicated by the yellow LED ‘fast charge’ mounted on the rear panel. This phase lasts about one hour in case of an empty battery. After this phase the charging status of the battery is almost 90%. Next, the mode is switched to the phase ‘DC top-off’ which provides a constant charging current of approx. 200 mA until the full battery capacity is reached. The final phase preserves the charge. For this a charging current of approx. 50 mA is applied continuously. We recommend to fully discharge the battery pack before recharging. This improves the lifetime of the batteries and preserves charge capacity in the best way.

Attention:
While the battery charging process is active, the standard deviation may be higher !

Connectors / Indicators

The front panel does not show any modification with respect to the standard version. On the rear panel, the socket for the 3 voltage supply is not available. The related port hole is closed by a cap.

In addition to standard version, the back panel contains:

- a phone plug, diameter 5.5 mm, male, 2 mm pin
  for connection of the external single output power supply unit
- two 3 mm LEDs,
  LED green: ‘Ext. DC in’, External supply / recharge voltage applied
  LED yellow: ‘Fast charge’, Rapid recharging active

Technical Data

Battery operation	
	4 hours typ. (LOE-USB, 1-channel version, MMS-Spectral Sensor)
	Note: older batteries have lower capacity and shorter operation time !
Battery Pack	
Type:	Nickel-Metal-Hybrid, 12 cells, type AA,
	Integrated temperature sensor (NTC) and safety switch (breaker)
Nominal voltage:	14.4 V
Nominal capacity:	1300 mAh
Single Output Power Supply	
Input:	typically 85 ... 264 V_{AC} (see identification plate)
	Featuring standard mains connector
Output:	+24 VDC, 1.88 A

Recharging Procedure

1. Rapid Charging

Start: with each connection to external power
End: initiated by battery voltage kink, battery temperature or recharging time
Maximum recharging time: 1 h
Current: approx. 1.4 A

The rapid recharging takes place only in the temperature range of approx. 8.5 °C and 45 °C. In case of a different temperature phase 2 is performed initially, until the temperature range is achieved.

2. 'DC top-off'

Recharging with constant current of approx. 200 mA

3. Charge preservation ('Pulse tickle or voltage regulation')

Recharging with constant current of approx. 50 mA

Breaker

Temperature controlled switch within the battery pack
Security circuit breaker of batteries from charging electronics / load if temperature of batteries exceeds 60 °C approximately. Automatic reconnection upon cooling to below 60°C approximately.

12 Attachments

(only with 'Evaluation Line' units)

A: Zeiss Calibration Certificate