

# Instruction Guide



## SpectraPen LM 510

Please read the Guide before operating this product



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The contents of this manual have been verified to correspond to the specifications of the device. However, deviations cannot be ruled out. Therefore, a complete correspondence between the manual and the real device cannot be guaranteed. The information in this manual is regularly checked, and corrections may be made in subsequent versions.

The visualizations shown in this manual are only illustrative.


This manual is an integral part of the purchase and delivery of equipment and its accessories and both Parties must abide by it.

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## 1 INFORMATION BEFORE USING SPECTRAPEN DEVICE

Read this manual carefully before operating the device. If you are not sure about something in the manual, contact the manufacturer for clarification.

	<p>By accepting the device, the customer agrees to follow the instructions in this guide.</p>
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Always follow corresponding manuals while working with the SpectraPen device or doing the maintenance. It is forbidden to interfere with the hardware or software of the SpectraPen device in any way without previous agreement with the manufacturer.

The following table presents basic highlight symbols used in this manual:



Symbol	Description
	<p>Important information, read carefully.</p>
	<p>Complementary and additional information.</p>

Table 1 Used symbols.

## 2 GENERAL DESCRIPTION

**SpectraPen** LM 510 is a handheld portable spectroradiometer that is ideal as a general-purpose instrument for research and for agricultural applications. SpectraPen LM 510 measures in radiometric or photometric units the intensity of the light irradiance and is calibrated for visible light in the range of 340 – 790 nm for UVIS version and 640 – 1,050 nm for NIR version. SpectraPen is used for irradiance measurements, illuminance measurements and CIELAB chromaticity diagram measurements. SpectraPen is especially useful for rapid measurements of spectral light quality, for monitoring of artificial lighting and for quantification of light radiation.

The SpectraPen is powered by a built-in, rechargeable Li-Ion battery and does not require a PC or any other bulky accessory for operation. The SpectraPen touch screen displays continuously the wavelength and intensity readings and their spectral traces including correlated color temperature index. All recorded data are automatically stored in the internal memory of the device. The SpectraPen includes a comprehensive software package (for a PC) comprising full system control, data acquisition and data processing.

The built-in GPS module and splash-proof case are ideal for field use of the SpectraPen and make this device well suited for wide scope of environmental, agricultural and ecological applications such as monitoring of artificial lighting used in horticulture industry or light source testing.

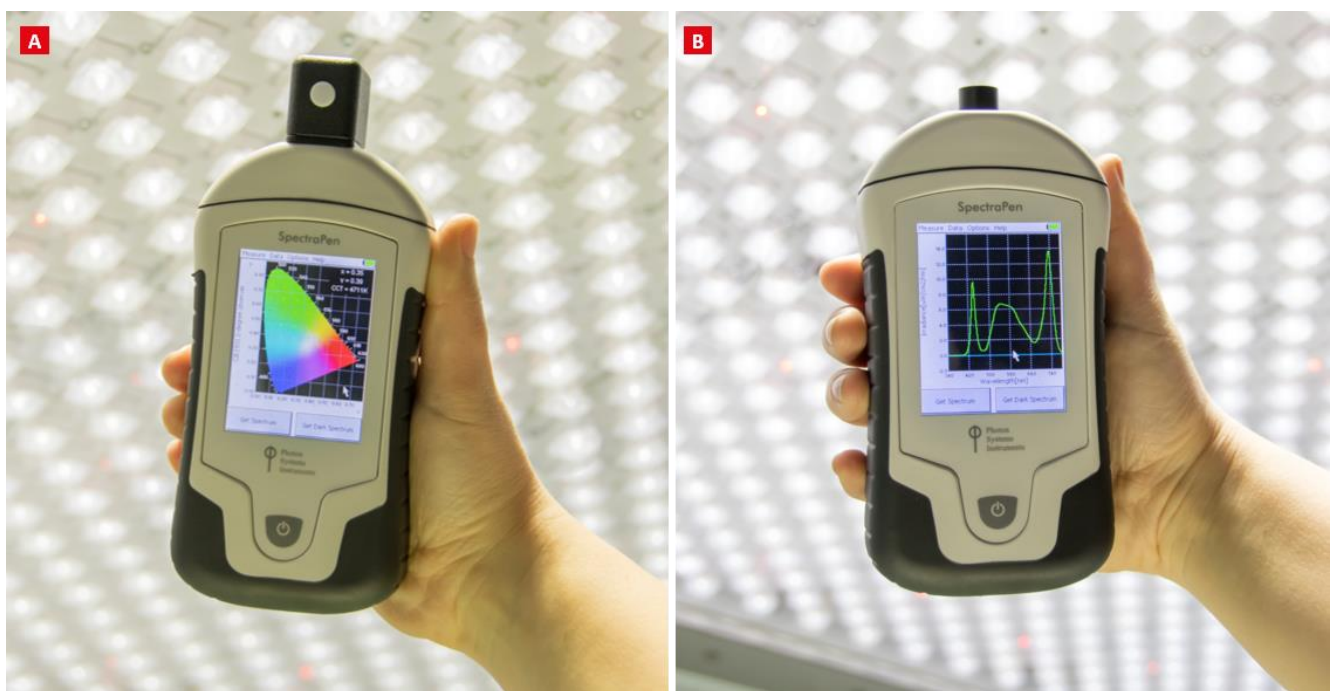
**SpectraPen measures:**

Scope - quantitative light intensity at different wavelengths
Irradiance spectrum [ $\mu\text{W}\cdot\text{cm}^{-2}\cdot\text{nm}^{-1}$ ] Photon flux density spectrum [ $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}\cdot\text{nm}^{-1}$ ]
Light Meter - absolute light intensity at defined range of wavelengths of the electromagnetic spectrum
Irradiance [ $\text{W}\cdot\text{m}^{-2}$ ] in user defined range of the electromagnetic spectrum Photon flux density [ $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ ] in user defined range of the electromagnetic spectrum Illuminance [Lux] - total luminous flux incident on a surface, per unit area PAR [ $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ ]*
Chromaticity Diagram CIE1931 - quality of color space and color temperature of the light source
CIE color coordinates* Correlated color temperature – for LED * Color rendering index
Users defined formulas in SpectraPen software

\* Valid only for LM 510-UVIS version of SpectraPen LM 510

**SpectraPen versions:**

LM 510-H/UVIS (Fig. 1A)	Cosine corrector facing up (horizontal position); limited space measurement; wavelength range 340 – 790 nm.
LM 510-H/NIR (Fig. 1A)	Cosine corrector facing up (horizontal position); limited space measurement; wavelength range 640 – 1,050 nm.
LM 510-V/UVIS (Fig. 1B)	Cosine corrector facing front (vertical position); field measurement; tripod mount; wavelength range 340 – 790 nm.
LM 510-V/NIR (Fig. 1B)	Cosine corrector facing front (vertical position); field measurement; tripod mount; wavelength range 640 – 1,050 nm.



**Fig. 1 A) SpectraPen LM 510-H. B) SpectraPen LM 510-V.**

## 2.1 TECHNICAL SPECIFICATION

Spectral range	340 nm – 790 nm (LM 510 UVIS) 640 nm – 1050 nm (LM 510 NIR)
Spectral response half width	9 nm
FWHM bandwidth	7 nm
Wavelength reproducibility	+/- 0.5 nm
Spectral Straylight	-30 dB
Integration time	Set automatically From 5 ms to 10 s
Number of pixel	256
Dimension of pixel	0.5 x 15.8 mm
Internal memory capacity	Up to 16 Mbit
Internal data logging	Up to 4,000 measurements
Data transfer	USB cable
PC software	SpectraPen 1.1 (Windows 7 and higher)
Battery type	Li-Ion rechargeable battery
Battery capacity	2,600 mAh
Max. charging current	0.5 A
Charging	Via USB port - PC, power bank, USB charger, etc.
Battery life	48 hours typical with full operation Low battery indicator
Optical entrance	Cosine corrector
Display	Touchscreen 240 x 320 pixel; 65535 colors
Built in GPS module	Ultra-high sensitivity down to -165dBm High accuracy of <1.5 m in 50 % of trials
Size	180 x 75 x 40 mm
Weight	300 g
Operating conditions	Temperature: 0 to +55 °C Relative humidity: 0 to 95 % (non-condensing)
Storage conditions	Temperature: -10 to +60 °C Relative humidity: 0 to 95 % (non-condensing)
Warranty	1 year parts and labor

### 3 DEVICE DESCRIPTION



Fig. 2 Device description

#### Cosine corrector

The optical sensor of the SpectraPen and the cosine corrector, is placed inside of the black box positioned on the front panel which protects the optics from dirt or moisture. The sensor is covered with a teflon ring placed either on top (horizontal position) or in front (vertical position) of the optical head depending on the device version.

Integration time of the detector is set automatically according to the ambient light intensity up to a maximum integration time of ten seconds.

Each SpectraPen device is calibrated with the certified light source AvaLight - DH-BAL-CAL. Calibration certificate is provided by the manufacturer for each device.



The sensor should be always dust and dirt free and protected when not in use, as any scratches on the surface might interfere with measurements and results.

#### Color touch screen display

The SpectraPen is operated via touch screen by using provided stylus. Instructions on how to operate the unit are provided on page 12.



No sharp objects should be used when operating the SpectraPen via touch screen. It is recommended to use provided stylus when making selections on the touch screen.

**Connector for USB cable**

USB connector on the device together with the USB cable provided, is used for re-charging the device battery and for operation of the SpectraPen directly from a PC via the SpectraPen software (downloaded to PC).


**Power button**

Power button is the main Switch ON/OFF button.

### 3.1 LIST OF EQUIPMENT AND CUSTOMER INFORMATION

**Standard version of the SpectraPen device package consists:**


- SpectraPen
- Carrying Case
- Textile Strap for Comfortable Wearing
- SpectraPen Operating Manual (on a USB flash disc)
- SpectraPen software and driver (on a USB flash disc)
- USB cable
- Stylus
- Other Accessories or Optional Features (according to your specific order)

	<p>For data download via USB connection, the USB driver needs to be installed on the PC. It can be found on the installation disk (USB driver folder).</p> <p>If any item is missing, please, contact the manufacturer. Also check the carton for any visible external damage. If any damage is found, notify the carrier and the manufacturer immediately. The carton and all packing materials should be retained for inspection by the carrier or insurer.</p> <p>For customer support, write to: <a href="mailto:support@psi.cz">support@psi.cz</a></p>
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### 3.2 CARE AND MAINTENANCE

**SpectraPen device**

- Never submerge the device in water!
- The device should not come in contact with any organic solvents, strong acids or bases.
- Keep the optical sensor cover clean and dry. If cleaning is needed, use soft, non-abrasive tissue.
- Do not use sharp objects for touch screen operation.

	<p>It is recommended to re-calibrate the device by the manufacturer every 2 years.</p>
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**Li-ion battery**

- Avoid fully discharging of the battery.
- Do not keep the battery at full charge for long periods of time. Allow for it to discharge.
- High temperatures shorten battery life.
- If the battery can no longer be charged, please contact PSI for replacement battery and installation instructions.



## 4 GETTING STARTED

**Switch on** the device by pressing the **Power button** and follow next steps to perform the measurements. In case the device battery is not charged connect the SpectraPen to the PC or to USB adaptor (not included) via the USB cable and charge the battery. Before any parameters are measured with SpectraPen device **dark spectrum** scan must be performed. Dark spectrum scan must be performed every time the device is switched on or periodically during prolong operation period of the device. A dark spectrum scan is the equivalent of zeroing the instrument and the user should perform a dark scan each time changes are made in the Setup menu.



The measurements with the SpectraPen cannot be made until the dark spectrum calibration is performed.

### 4.1 DARK SPECTRUM CALIBRATION

Dark spectrum calibration is an essential step for zeroing of the device before live spectrum is obtained.

- On the opening screen of the device select Get Dark Spectrum >press OK (Fig. 3).
- Cover the cosine corrector head (optical sensor) completely with a dark cloth to ensure that it is in total darkness during the calibration step. It is important that no outside light reaches the detector and interferes with the measurement.

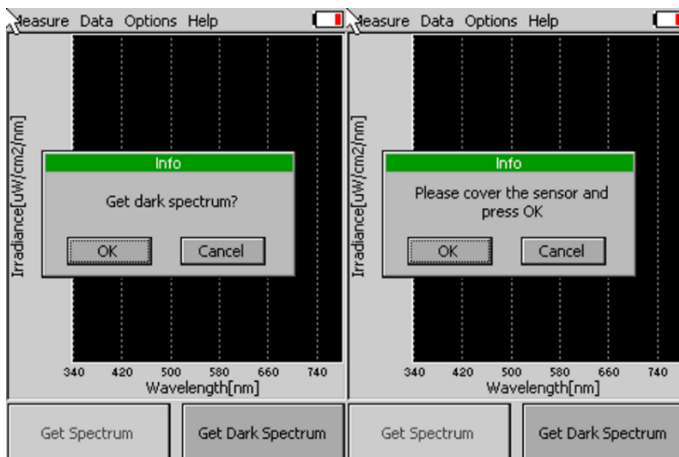


Fig. 3 Dark spectrum calibration - part 1.

- Press OK and wait until the Dark spectrum calibration step is completed Fig. 4). Please note that the sensor head must be covered throughout the entire process of calibration.
- Dark spectrum is automatically stored into the device memory and used for background subtraction. Dark spectrum calibration scan is normalized to the surrounding temperature and is relative to the detector integration time.

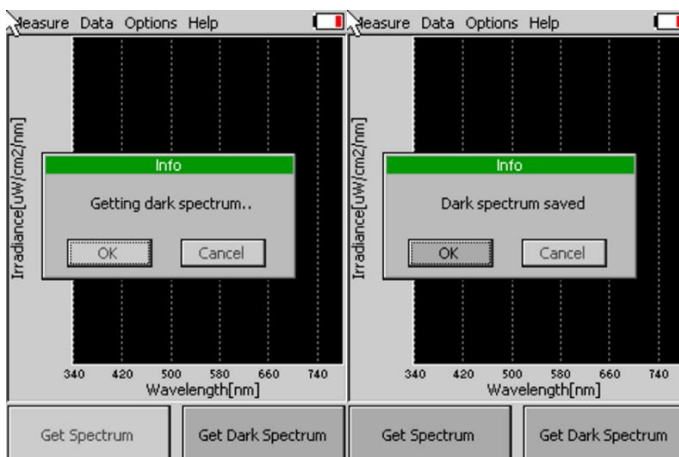


Fig. 4 Dark spectrum calibration - part 2.



In case surrounding temperature is rapidly changed during the calibration step or during the measurement, the SpectraPen will automatically ask for new dark spectrum calibration.

## 4.2 MEASUREMENT

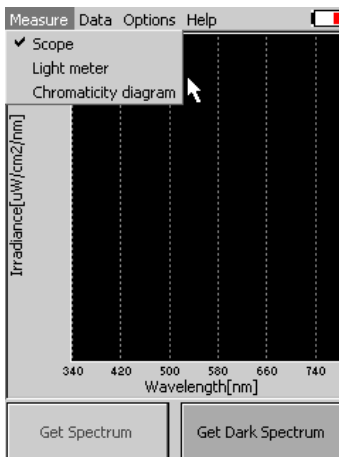
SpectraPen can calculate a number of parameters that are derived from measurements of:

- Light intensity at different wavelengths (Scope)
- Absolute light intensity at defined range of wavelengths of the electromagnetic spectrum (Light meter)
- Quality of color space and color temperature of the light source (Chromaticity diagram)



Please note that for proper lights spectra measurement, the SpectraPen device should be perpendicular to the light source for LM 510-H version and parallel with the light source for LM 510-V version.

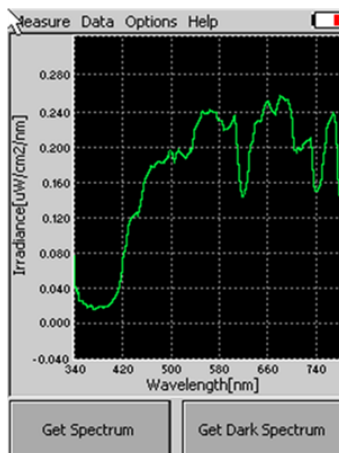
To perform the individual measurements please follow the next steps:



- In the opening screen select Measure and the desired function (Fig. 5)
- Scope (for Irradiance measurements over the range of the device)
- Light meter (absolute light intensity averaged over the user specified range of wavelengths)
- Chromaticity diagram (measurement of light color and correlated color temperature (CCT))

Fig. 5 Selection of type of measurement.

### Scope



Scope function is used for measurement of light intensity at different wavelengths (Fig. 6). Irradiance measurements display units as photon flux density in ( $\mu\text{mol}/\text{m}^2/\text{s}/\text{nm}$ ) or as irradiance in  $\mu\text{W}/\text{cm}^2/\text{nm}$ .

To perform the measurement, select from the top menu of the main screen:  
**Measure>Scope>Get Spectrum**

The spectra of the light source will be acquired, stored to the device memory and displayed on the screen. To change the displayed units go to **Options>Settings**.

Fig. 6 Scope.

## Light meter

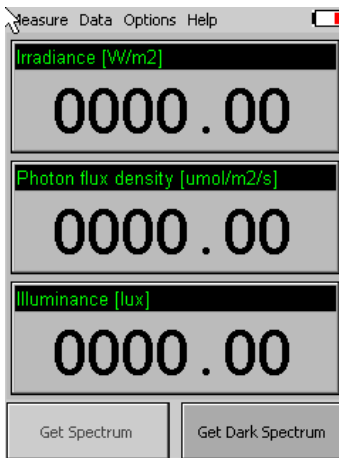


Fig. 7 Light meter window.

Light meter function is used for measurements of absolute light intensity at defined range of wavelengths (Fig. 7). Photon flux density measurements display units in micromoles per square meter per second, irradiance measurements are displayed in Watts per square meter and illuminance measurements are displayed in units of Lux.

To perform the measurement, **select from the top menu of the main screen Measure>Light Meter>Get Spectrum.**

Light intensity of the light source will be acquired, stored to the device memory and displayed on the screen as shown in Fig. 7.

**Please note** that the Light Meter integrates the value based on the wavelength range defined. For LM 510/UVIS this is in range 340-780 nm. The user can define the wavelength range to be measured and use this tool to measure specific spectral regions of interest by going to **Options>Settings** and setting the required range (find more on page 18). To measure photosynthetically active radiation (PAR) change the settings and set the values from 400 to 700 nm.

## Chromaticity diagram

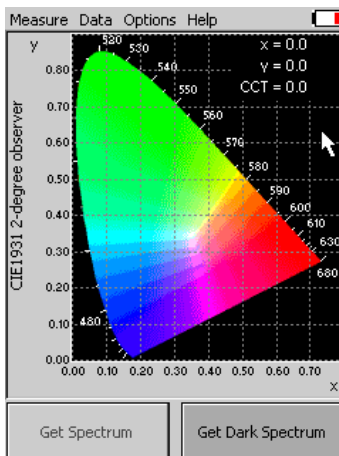


Fig. 8 Chromaticity diagram function.

Chromaticity diagram function is used for measurement of light color and correlated color temperature (CCT) using the International Commission on Illumination (CIE) techniques (Fig. 8). Chromaticity diagram function uses standard coordinates of the 1931 CIE colorimetric system by which all possible colours can be uniquely identified. A color space is a uniform representation of visible light. It maps all of the colors visible to the human eye onto an x-y grid and assigns them measurable values. This allows us to make uniform measurements and comparisons between colors.

To perform the measurement, **select from the top menu of the main screen: Measure >Chromaticity diagram> Get Spectrum**

The color of the light source in the CIE1931 colorimetric system is marked by black cross. The x- and y- coordinates of the measured light source will be determined and the CCT value will be calculated and displayed on the screen.



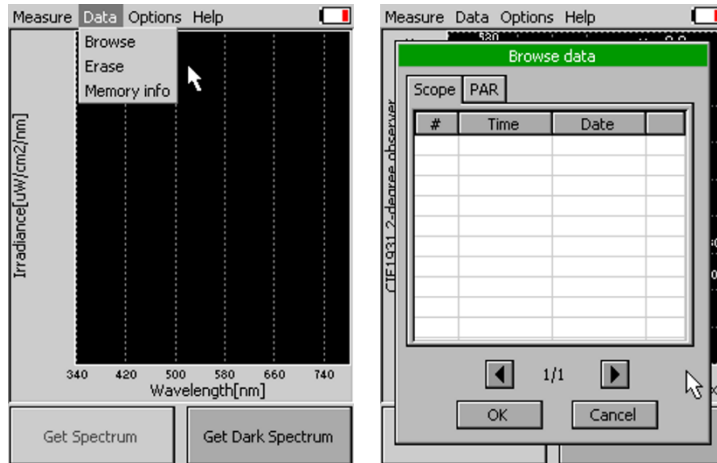
Please note that the CCT values are not automatically stored.

## 5 MENU DESCRIPTION

### Measure

This option is described in the Chapter 4.2.

### Data



- **Browse** (Fig. 9) – displays data browse dialog box. The user can browse the list of stored data, select the set of data files and view the light spectra in **Scope** mode. Color classification of each data file helps the user to discriminate between individual measurements. PAR bookmark allows the user to view the light intensity in PAR spectral region for the acquired data. **PAR** is photosynthetically active radiation integrated in range 400-700nm.
- **Erase** – erase function is used to erase internal data memory (Fig. 10-A).
- **Memory info** (Fig. 10-B) – displays info on current amount of used internal memory in the SpectraPen device.

Fig. 9 Data browse.

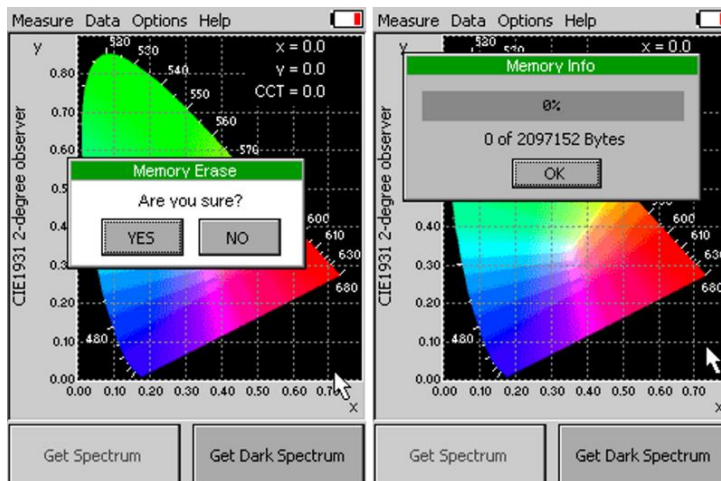


Fig. 10 A) Memory erase function B) Memory info.

### Options

- Settings–this function is used to set various variable for the light measurements and for the device operation
  - **Graph** – displays options for setting the wavelength range and graph features (Fig. 11-A)
    - **Zoom enable** – enables the zoom feature. With the stylus select an area (in the right-down direction) of the displayed graph which you want to zoom in. Reverse these steps if you want to return to the original display.
    - **Marker enable** – enables to display exact numeric value for the point selected in the Scope graph window. Exact wavelength and light irradiance are displayed for the point touched on the graphical display. In top right corner of the LCD display the exact value of wavelength in nm is displayed for the user selected position of the spectrum. In addition, light irradiance for the given nm is shown.
    - **Smoothing** – enables noise reduction of the graphical display by Smoothing the noise in the spectrum at the expense of spectral resolution.
    - **Wavelength range** – defines the range of wavelengths considered for light meter measurements of Irradiance and Photon flux density. Desired wavelength range can be adjusted by selecting the wavelength and by using the arrows up and down.
  - **Time** - displays actual time and date (all data files are stored by time and date signature). To change time and/or date specifications touch on one of the values and adjust it using the arrows (Fig. 11-B).

	<p>Please note that the wavelength range setting applies only for light meter. Light intensity measured in selected range is shown only on the SpectraPen display. The device saves to the memory the whole spectrum and light intensity calculated from the whole spectrum.</p>
	<p>The wavelength range setting is not active for Illuminance.</p>

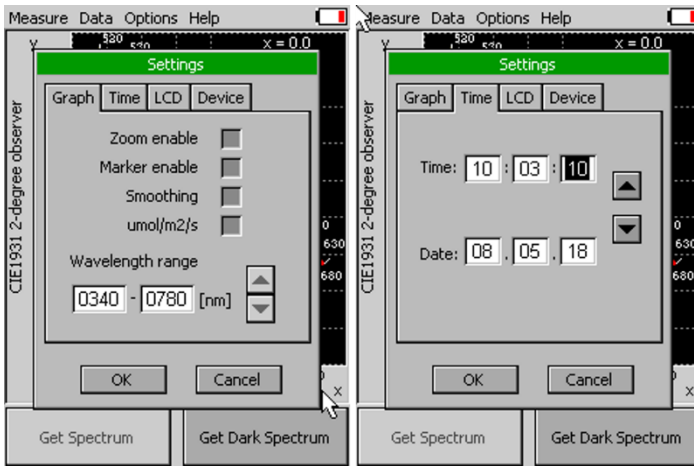


Fig. 11 A) Graph settings B) Time setting.

- **LCD** – is used to adjust LCD display control settings (Fig. 12-A)
  - **Backlight intensity** – move slider to adjust back light intensity in percentage
  - **Backlight time-out** – move slider to adjust backlight time-out between 5 and 60 s (time of inactivity required before backlight will dim out to save battery life).
- **Device** (Fig. 12-B)
  - **GPS** – activates the GPS built-in module. The GPS coordinates cannot be displayed on the device display, but they are exported together with data and visualized in SpectraPen software on the computer after download.
  - **Average** –Average function is used for adjusting the number of scans for each reading. Averaging of more scans results in a higher signal-to-noise ratio but increases the time required for each reading that appears on the screen. Move slider to set the number of measurements to be acquired for averaged values.

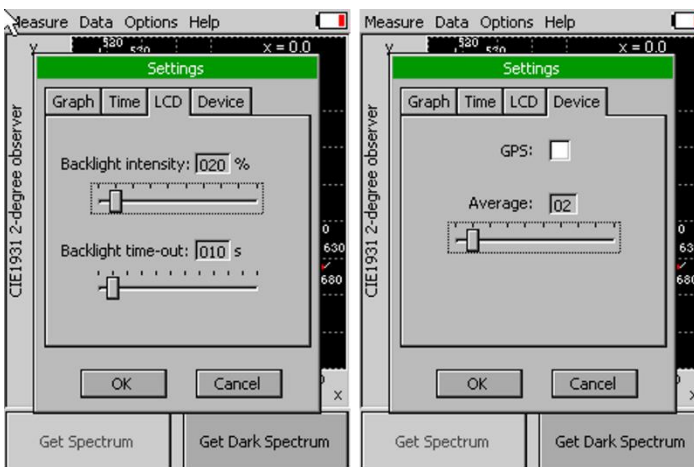


Fig. 12 A) LCD settings B) Device settings.

## Help

- **About...**- information about the device, hardware and software version (Fig. 13).

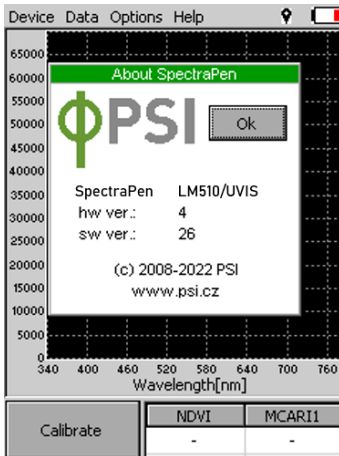



Fig. 13 Information about the device.

## 6 PC COMMUNICATION

### 6.1 USB CONNECTION

SpectraPen comes with the USB cable that is required for charging of the Li-ion battery and can also be used for data transfer to the PC after completion of measurements. To connect the USB cable with the SpectraPen device follow the picture instructions below. Please note that a lock in system is used to secure the USB cable to the SpectraPen and extreme caution has to be used when setting up this connection to avoid damage to the cable pins.

	<p>When connecting the USB cable take extra caution to prevent damage to the cable connector pins. Ensure correct orientation of the cable as shown in the pictures below so the circled portion of the plug and the cable in photo A and B are perfectly lined up prior to pushing them together. Once this connection is achieved the cable may be secured in position by turning the metal cover of the cable and locking the cable in position.</p>
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To connect SpectraPen with your computer please follow steps below in Fig. 14



Fig. 14 How to connect SpectraPen with PC.

A) connector on the SpectraPen device. B) Portion of the USB cable with pins. C – E) Position the cable horizontally and line up the green circled parts of the cable and the connector, plug in the inlet and screw the securing screw. F) Correct connection of the USB cable and Pen device.

## 6.2 DRIVER INSTALLATION

For successful USB connection of the SpectraPen to the PC computer the USB driver and the SpectraPen software, included on the USB disk, need to be first installed on the PC. Without the driver installed the SpectraPen device will not be recognized by the computer and the connection to the software will be not possible.

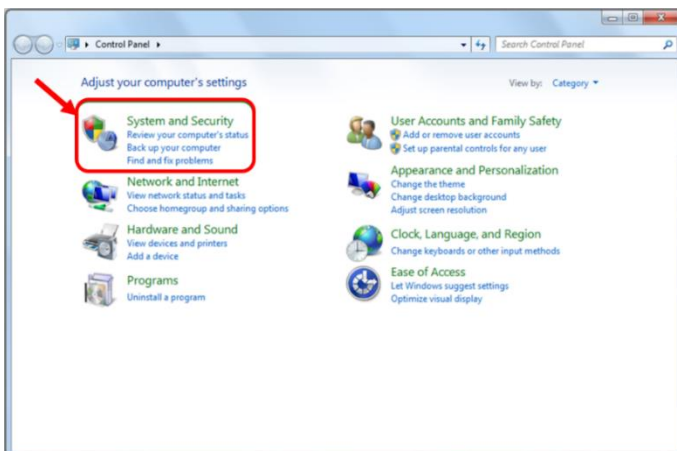


Fig. 15 Control panel.

- Press Start and Select Control Panels (Fig. 15)

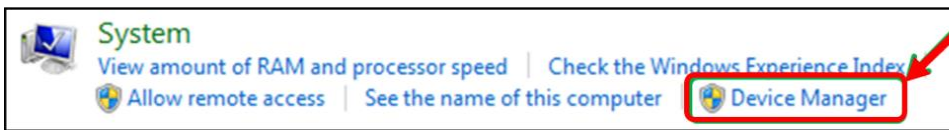


Fig. 16 System window.

- Navigate through **System and security, System to Device manager** (Fig. 16)
- Connect the SpectraPen to the PC. You should see that **PSI USB Device** appears in the list. Right click on it and select **Update Driver Software** (Fig. 17)

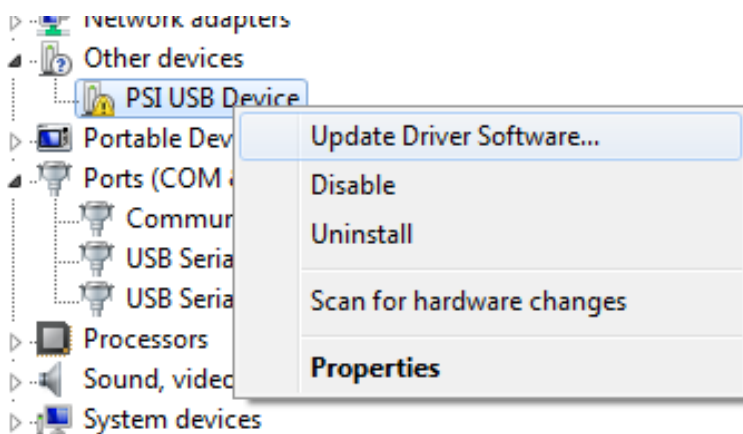


Fig. 17 PSI USB device

- Click **Browse** my computer for driver software and select Driver folder on the SpectraPen installation disk. Allow the installation even if the warning message appears (Fig. 18)

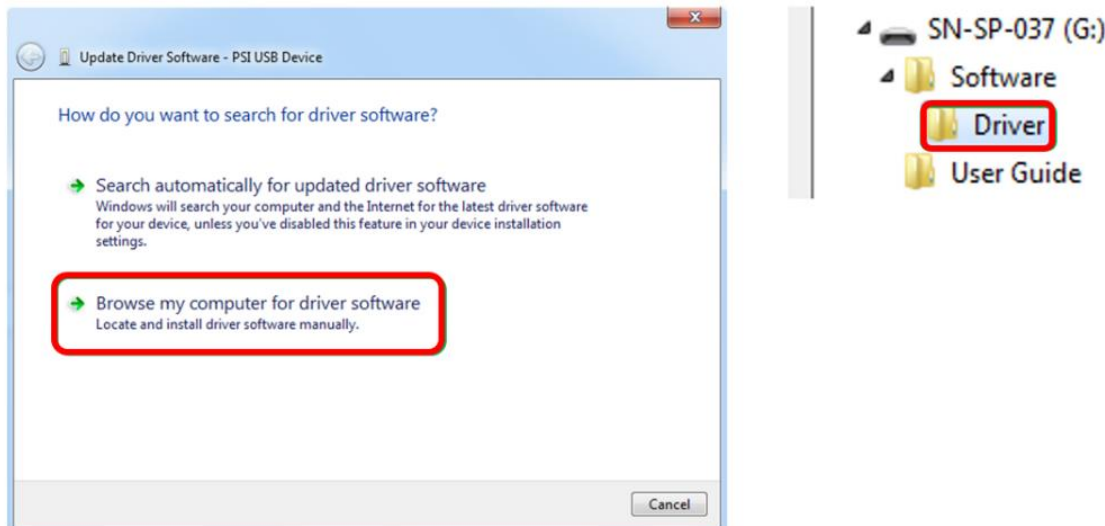


Fig. 18 Choose the driver from the USB disc.



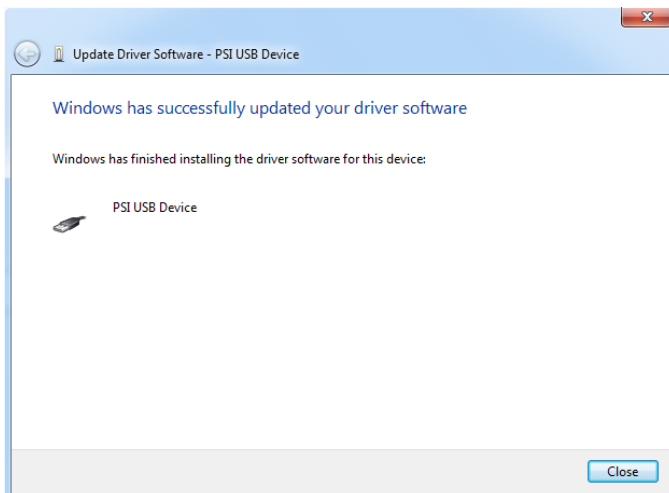



Fig. 19 Complete installation.

- Installation of the driver is now complete (Fig. 19)

	<p>In case this driver installation is not successful the driver may be downloaded directly from PSI websites <a href="http://www.psi.cz">www.psi.cz</a>.</p>
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Once the device is properly connected to the computer, the indicating icon appears on the SpectraPen device display Fig. 20.

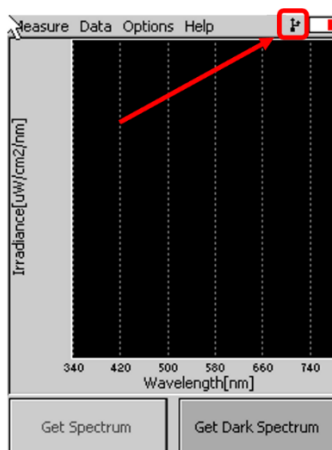


Fig. 20 Icon on the SpectraPen device display indicating the proper USB connection.

## 7 SPECTRAPEN SOFTWARE

### 7.1 SOFTWARE INSTALLATION

1. Copy the SpectraPen software provided on the USB flash disk to your computer and launch the SpectraPen program.
2. To connect and recognize the SpectraPen device in the SpectraPen software, proceeds first with the registration of the SpectraPen software (Fig. 21).
  - Select: Help > **Register**
  - Enter: your serial registration number (found in a text file on the USB flash disk drive included with the device).
  - Select: OK

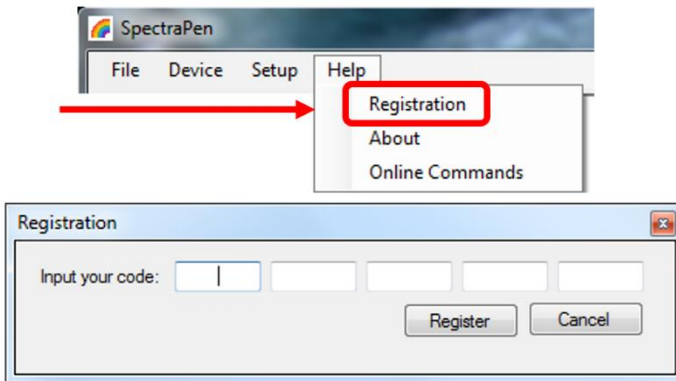



Fig. 21 Software registration.

	<p>Please note that the serial (registration) number for the SpectraPen may be found in the file SN.txt, which is included on the enclosed USB flash disk.</p> <p>Please Note: it is not possible to download data from the SpectraPen device without software registration.</p>
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3. Connect the USB cable to the computer. Then switch on the SpectraPen by pressing the Power button for a couple of seconds.
4. Ensure the PC and the SpectraPen are properly paired (see chapter 6).
5. Connect SpectraPen device in SpectraPen software, **Device > Connect** (Fig. 22)

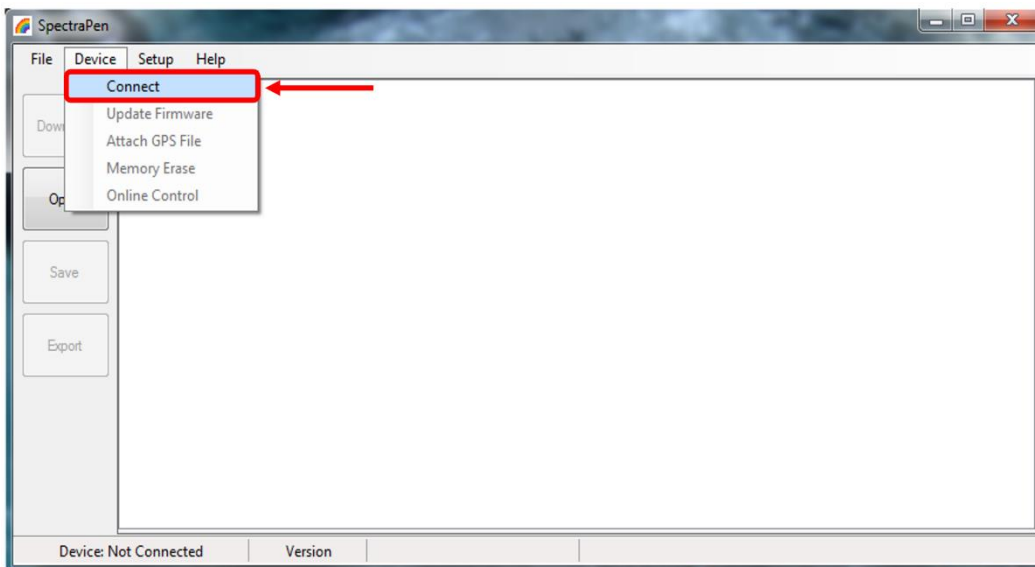


Fig. 22 Connect.

6. When the device is properly connected the left bottom corner of the SW window will display "SpectraPen" (Fig. 23). Otherwise notification "Device: Not Connected" is displayed (Fig. 24).

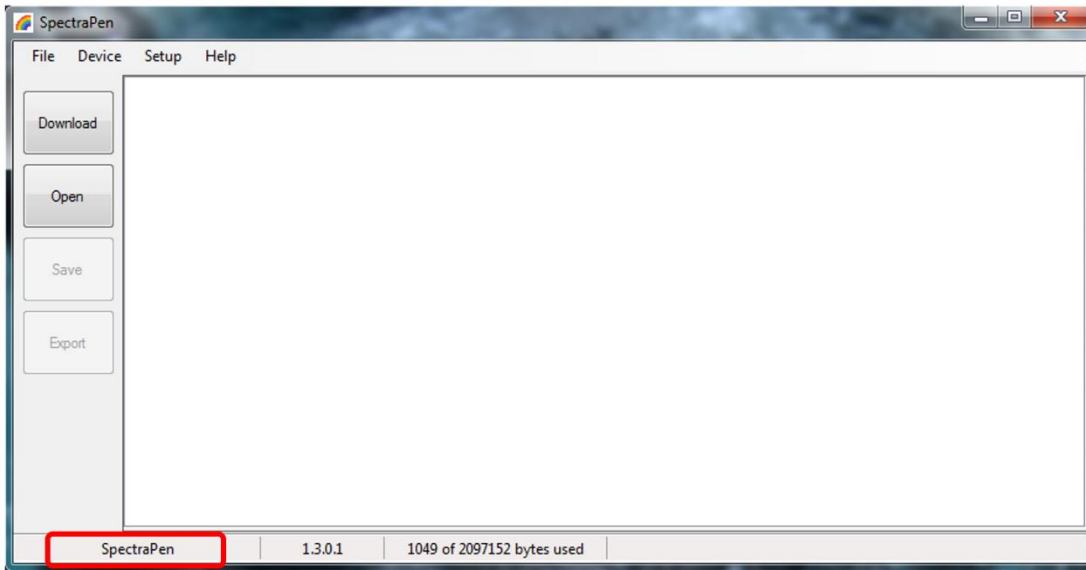


Fig. 23 SpectraPen connected.

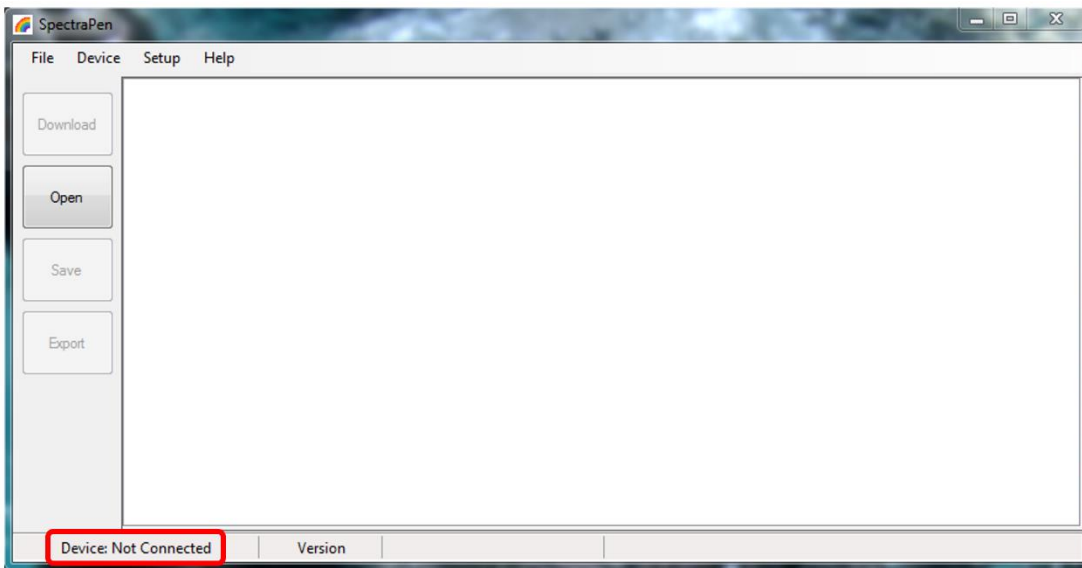


Fig. 24 SpectraPen not connected.

## 7.2 SOFTWARE MENU

### MENU: File

<b>Load</b>	Loads previously saved data files.
<b>Save</b>	Saves data to hard disc.
<b>Export</b>	Exports data in .txt format.
<b>Export to JSON</b>	Exports data in JavaScript Object Notation.
<b>Close</b>	Closes the current experiment.
<b>Close All</b>	Closes all open experiments.
<b>Exit</b>	Exits the program.

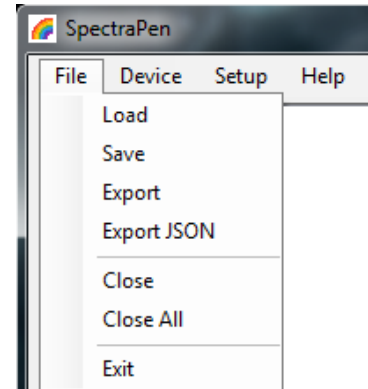


Fig. 25 Menu File.

### MENU: Device

<b>Connect</b>	Detects and connects the device.
<b>Update Firmware</b>	Used for firmware updates. *
<b>Attach GPS File</b>	Used to download data from the GPS module of the old version of the SpectraPen - LM 500.
<b>Memory Erase</b>	Erases data from the SpectraPen memory.
<b>Online Control</b>	Online control of SP device.

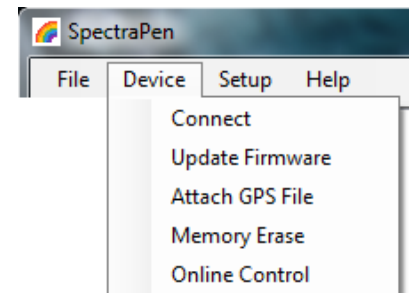


Fig. 26 Menu Device.

\* For more information on firmware updating, see Chapter 7.5 of this Operation Manual.

### MENU: Setup

<b>Update Software</b>	Used for software updates.
<b>Settings</b>	On/Off – Auto memory erase after download. Selection of separator for the csv file after its export and following opening in Excel (TAB, SEMICOLON, COMMA, SPACE).

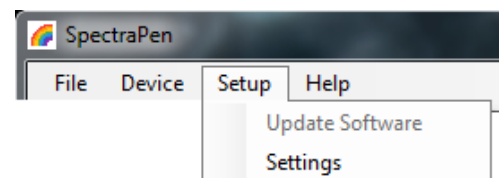


Fig. 27 Menu Setup.

### MENU: Help

<b>Registration</b>	Used for the SpectraPen software registration.
<b>About</b>	Offers basic information about the program.

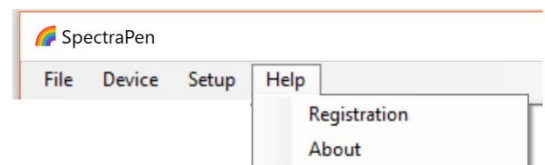




Fig. 28 Menu Help.

### 7.3 DATA TRANSFER AND VISUALIZATION

1. After completion of measurement SpectraPen may be connected to PC for data download and further analysis.
2. Launch the SpectraPen software on the computer and connect the device. Go to Device> Connect.
3. To transfer your data from the SpectraPen device to your PC use the Download function. Select icon on left side of screen or go to File and select Load if you want to process data stored on PC.
4. All data stored currently in the SpectraPen device will be downloaded and shown in the main window view. The data are store and displayed/listed with the time stamp of measurement.

	Please note that if there are no data stored in the memory, the download function is not active.
---	--

5. Visualization modes: Scope mode window is always displayed as the default. To view irradiance data, go to Irradiance tab (Fig. 29).

	Scope mode represents non-calibrated spectrum.
---	--

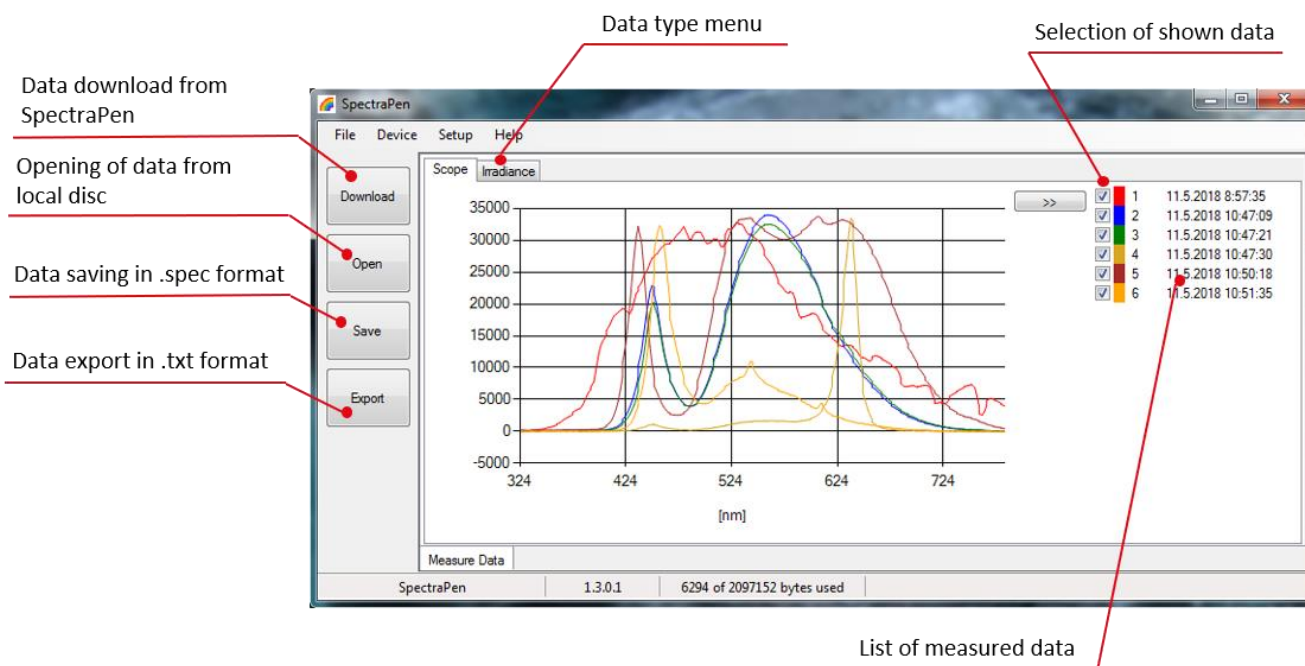


Fig. 29 Scope spectra.

6. All data that are downloaded are displayed in the Scope window after download from the SpectraPen. The user can select the set of measurements to be displayed by marking and unmarking the data from the selection list (Fig. 29).
7. Right click on list of measured data enables edit data name, delete selected measurement or show and hide all measured data in the graph– Select all measure and clear all measure (Fig. 30).

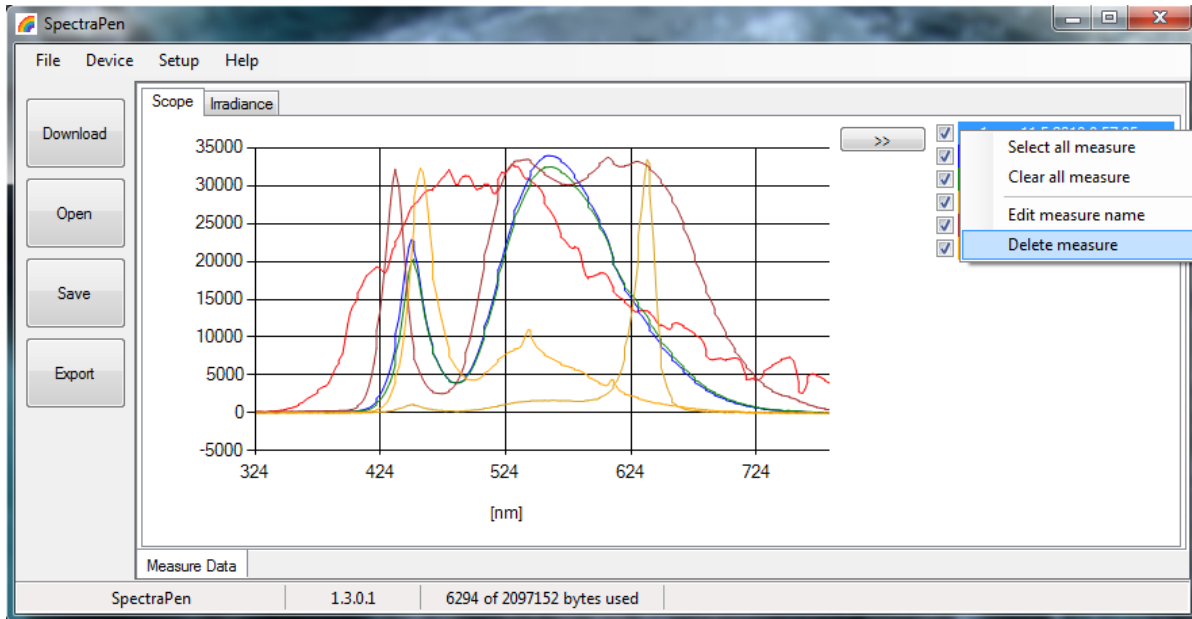


Fig. 30 Options for list of data.

- In the graph **marker** feature is available, which enables display of the numeric values for wavelength and light irradiance for the selected wavelength of the scan (Fig. 31). Use the mouse to select the given point. In top right corner of the graph (red rectangle) is displayed exact value for the selected point on the x-axis and y-axis.

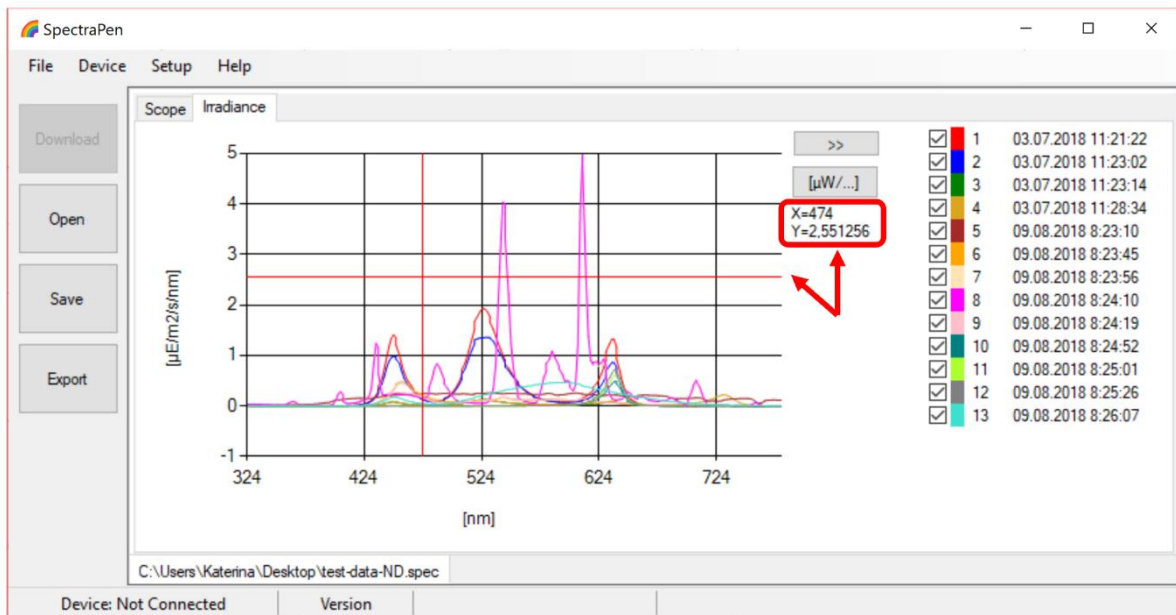


Fig. 31 Marker feature.

- To **zoom in on the data displayed in the graph** select an area of the displayed graph (Fig. 32). To reverse these steps and return to original display use minus icon in the corners of the zoom area marked with red rectangles in Fig. 32.

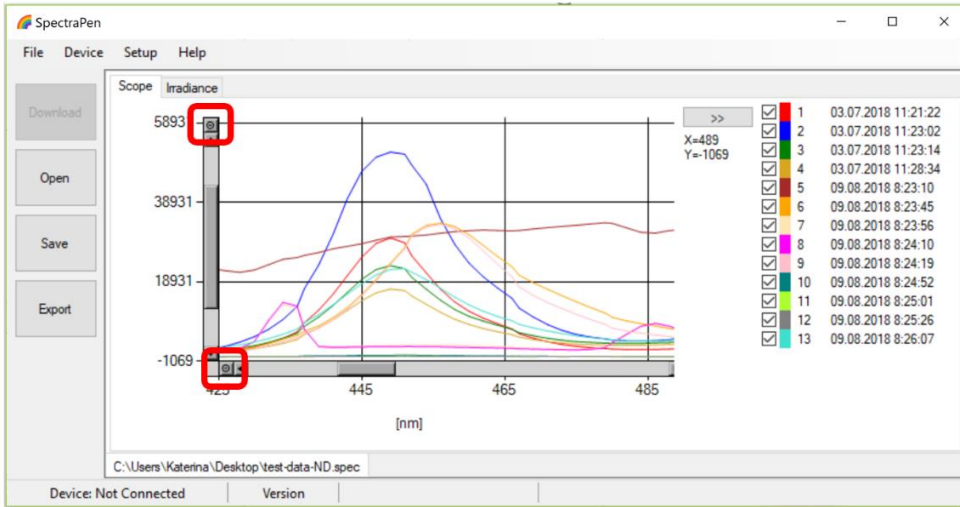


Fig. 32 Zoom function.

10. Select **Irradiance** tab to view the irradiance data stored either as  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}\cdot\text{nm}^{-1}$  or per  $\mu\text{W}\cdot\text{cm}^{-2}\cdot\text{nm}^{-1}$ . To change the units in which the spectra is displayed click on the unit icon as shown in Fig. 33.

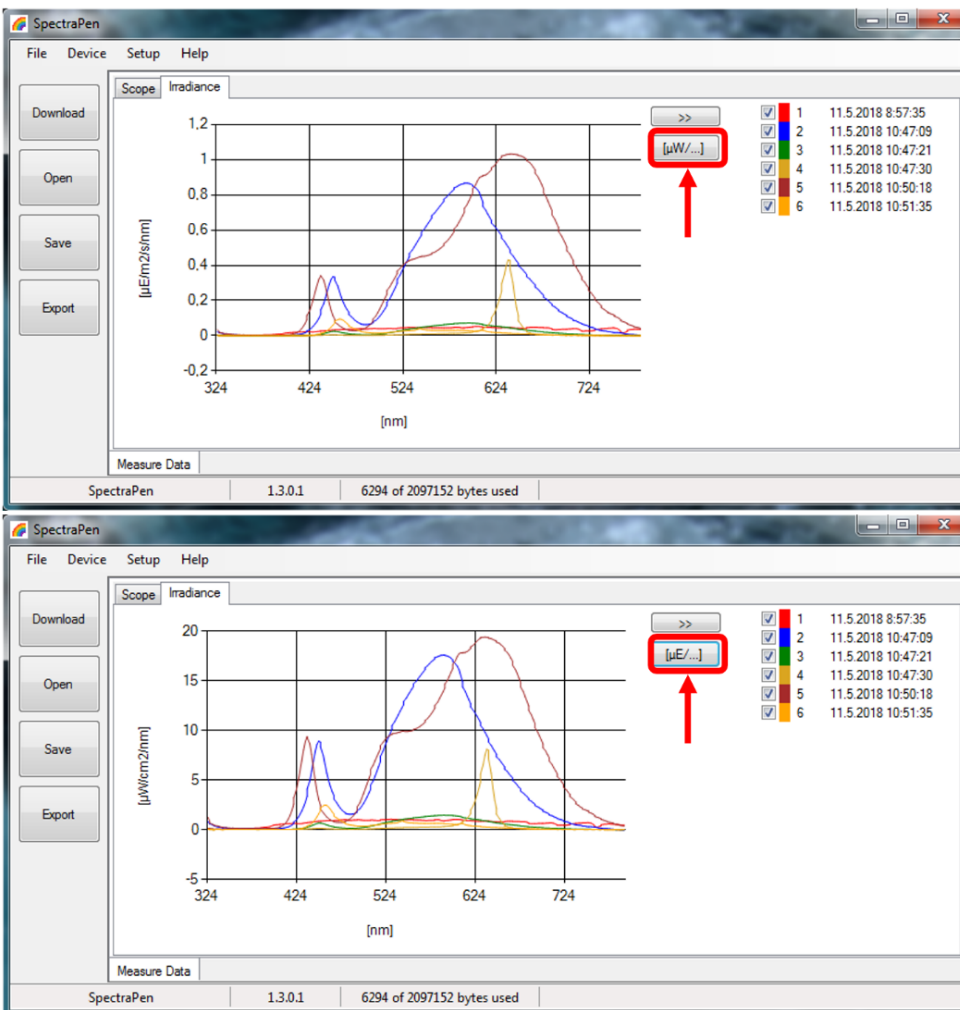


Fig. 33 Irradiance shown in different units.

11. To view the light meter data for the spectral scans acquired click on the unit icon as depicted by red arrow in Fig. 34. Irradiance and illuminance **light meter numerical values** for each scan are displayed as LUX, PAR or IRRADIANCE values (Fig. 34).

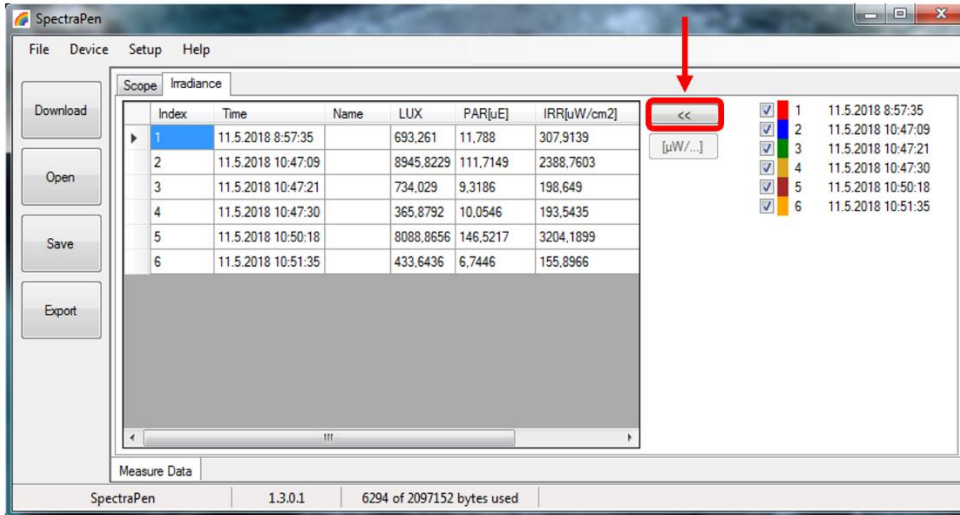


Fig. 34 Numerical values of measured light intensities.

12. To Save the experiment select **File>Save**. All data stored in the device memory will be saved irrespective of the data selection in the SpectraPen software. The file will be stored as .spec. Spec files stores all Scope and Light meter data.

13. Select **File>Export** to export the data in .txt format. Export function allows the user to specify the type of data. The options are:

**Spectrum** (Fig. 35) – all raw scope data for entire range of measured wavelengths are exported including data for the dark scan.

**Spectrum scope** – scope data normalized to dark spectrum scan are exported for all acquired scans or set of selected measurements.

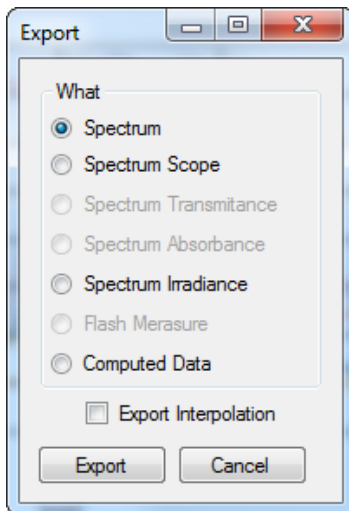


Fig. 35 Export options.

**Spectrum Irradiance** – irradiance data for all measurements are exported. The user can choose to export the numeric values either in  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}\cdot\text{nm}^{-1}$ ,  $\mu\text{W}\cdot\text{cm}^{-2}\cdot\text{nm}^{-1}$  or both (Fig. 36).



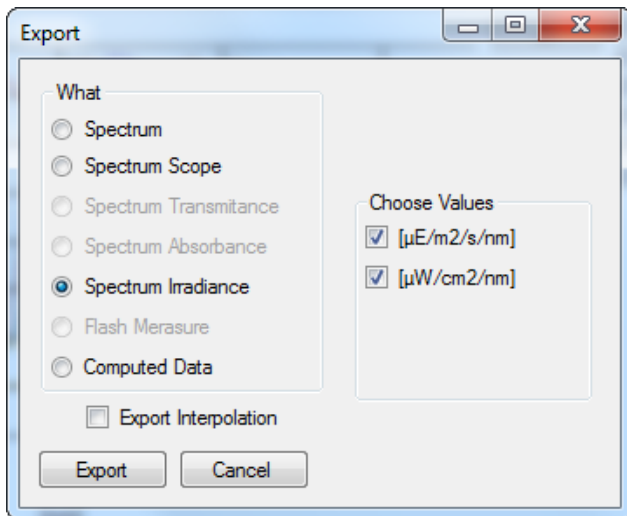


Fig. 36 Export of Irradiance spectrum.

**Computed Data** – computed numeric values for Scope and Irradiance are exported for all measurements. The user can choose if only Scope numeric values or Irradiance numeric values are exported. For irradiance values, numeric data for Photon flux density and PAR in  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  units, irradiance in  $\mu\text{W}\cdot\text{cm}^{-2}$  units and illuminance in LUX units are exported (Fig. 37).

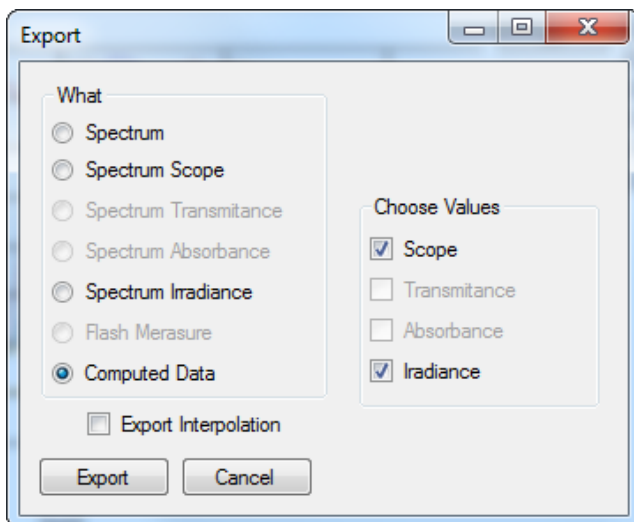


Fig. 37 Export of computed values.

**Export interpolation** – if this option is marked the spectrum is exported with step of 1 nm.

## 7.4 ONLINE CONTROL

### Menu Online Control

This function can be used for remote - online control of the SpectraPen device after connection with the PC. Online control enables to make changes in device setting and also perform remote measurement using PC.

Select: **Menu > Device > Online Control** (Fig. 38)

### Remote measurement (Fig. 39)

Using this function **Irradiance, Photon flux density and PAR** can be measured.

- For manual remote measurement click on Get button.
- Setting for automated remote measurement is possible using the button with three dots (next to "Get" button in the window of the software). Here the time interval of the measurement is set. To apply this setting use the option Use settings (in "Settings Form" window) and confirm by clicking OK. The measurement starts immediately and continues until it is manually stopped (Stop button).
- Use the export option for exporting the data to .csv file.
- Clear function serves for erasing of data measured by Online Control.

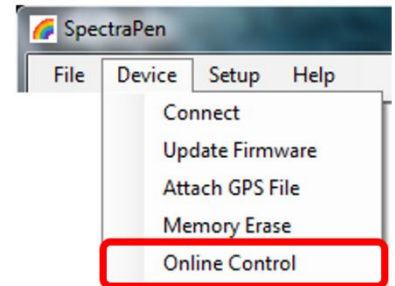

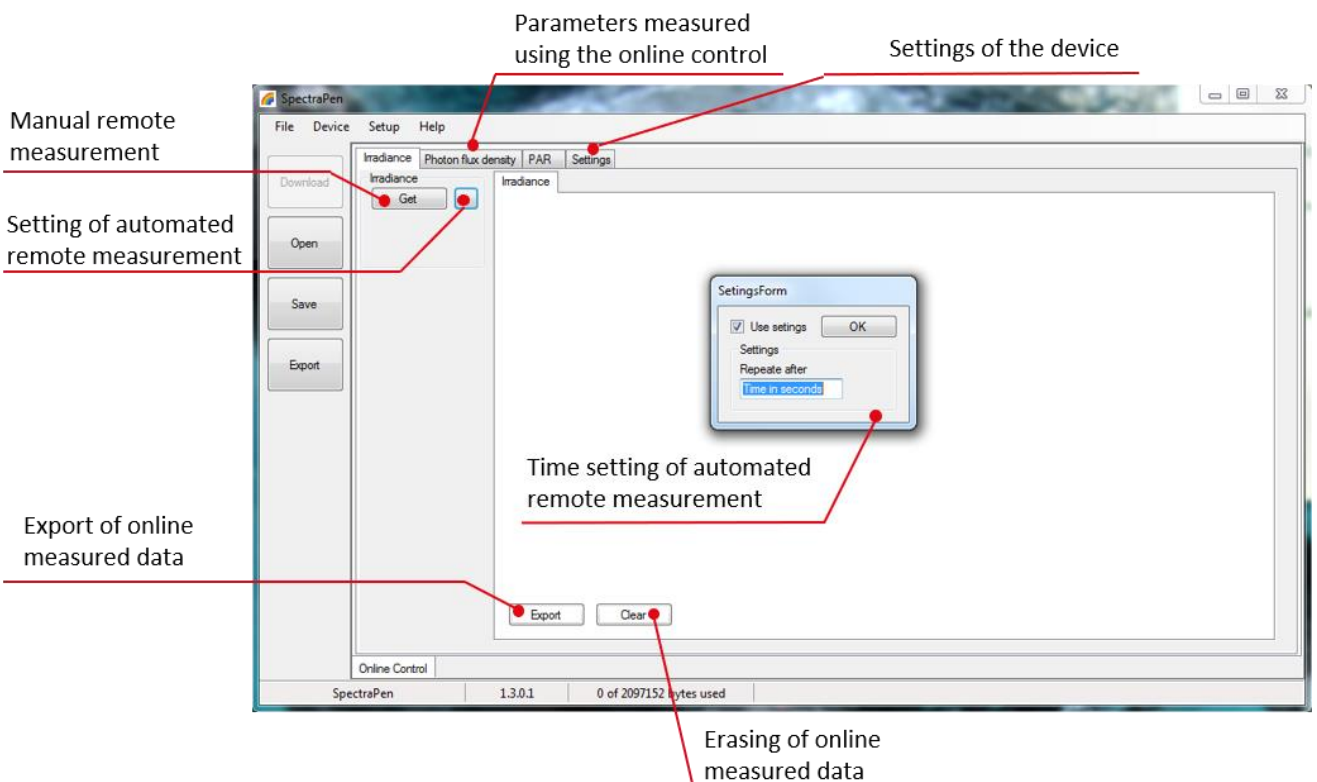


Fig. 38 Online control.



Please note that the Dark Spectrum Calibration should be done manually prior the remote measurement. Otherwise error ID:1 appears.



The screenshot shows the SpectraPen software interface with several annotations:

- Manual remote measurement:** Points to the 'Get' button in the 'Irradiance' tab.
- Setting of automated remote measurement:** Points to the button with three dots next to the 'Get' button.
- Export of online measured data:** Points to the 'Export' button at the bottom of the main window.
- Erasing of online measured data:** Points to the 'Clear' button at the bottom of the main window.
- Parameters measured using the online control:** Points to the 'Irradiance', 'Photon flux density', and 'PAR' tabs.
- Settings of the device:** Points to the 'Settings' tab.
- Time setting of automated remote measurement:** Points to the 'Repeat after' field in the 'SettingsForm' dialog box.

Fig. 39 Remote measurement.

### Settings (Fig. 40)

Here the following functions may be set up for remote operation of the SpectraPen:

- Time synchronization of the device and PC
- GPS built-in module activation (more information about the GPS module in chapter 8)
- Averaging of measurement (1 – 10 measurements)
- Selection of the wavelength range for measurements
- Integration time (0 – 10 s)

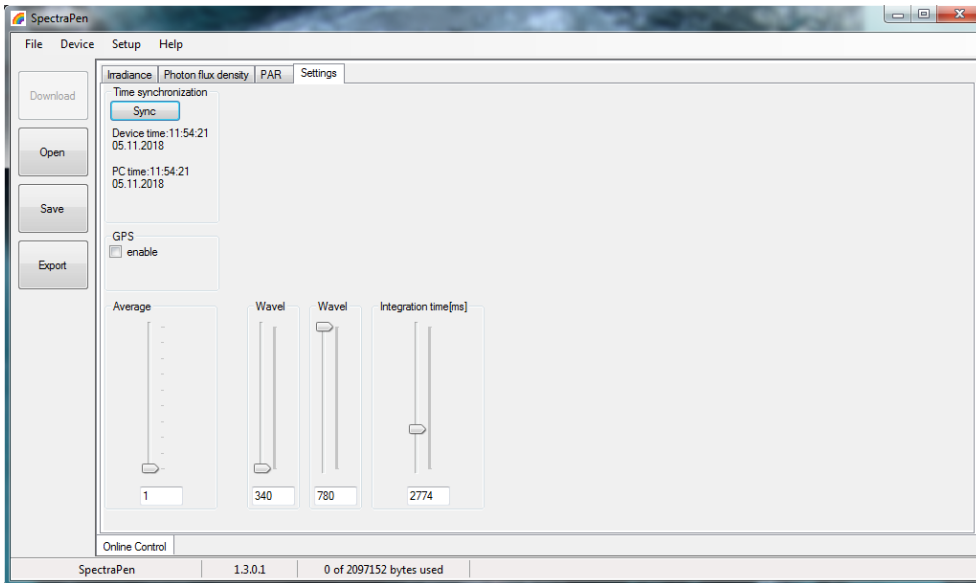




Fig. 40 Online control settings.

## 7.5 FIRMWARE UPDATE

	<p>All data in the SpectraPen memory are erased during the firmware update!</p> <p>Before starting any firmware update, download all your data from the SpectraPen memory to the computer and save!</p>
	<p>Before firmware update ask the manufacturer for appropriate version of the firmware for your particular device. Incompatible firmware version can cause device malfunction.</p>

1. Starting Update
  - Select: Setup > Update Firmware From File
7. Selecting .bxn file
  - Find firmware update file: Binary file (with the extension .bxn)
  - Select: Open.
8. Finishing Upload
  - Select: OK to start uploading of the update
  - The bottom bar indicates the upload progress (Fig. 41)

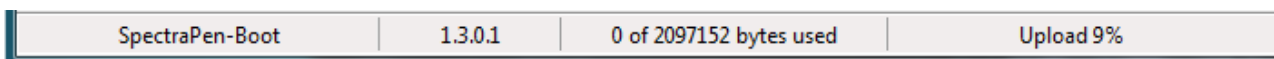


Fig. 41 Firmware update running.

## 8 GPS MODULE

SpectraPen device LM 510 has integrated GPS module which may be turned on during the measurement for mapping of the collected data to specific field position. When GPS module is turned on, the map coordinates will be automatically saved with all collected data and will be downloaded during data download.



For proper GPS reading, the time in your SpectraPen and in your computer must be synchronized. Preset time and time zone must correspond to GPS time (time zone) in your location.

### 8.1 GPS/SPECTRAPEN OPERATION

1. Check the time setting on the SpectraPen device: **Settings > Date & Time**
2. Switch the GPS module "ON" on the SpectraPen device by following these steps in the SpectraPen menu:
  - Select: **Options > Settings > Device**
  - Click on the check box for GPS (Fig. 42-A)
  - Wait until the GPS position is found. The GPS module is ready when the icon of the position flag, in upper menu, stops flashing (Fig. 42-B).

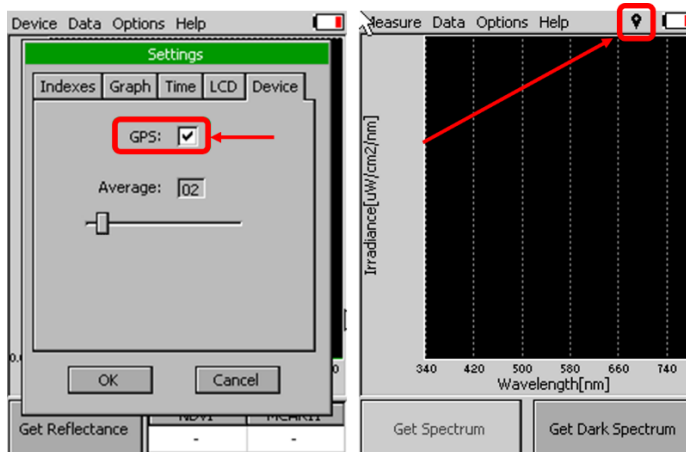


Fig. 42 A) Activation of GPS B) GPS active.



For proper function of the GPS module the SpectraPen device may need a clear view of the sky to acquire satellite signal.

3. Perform the selected measurements
4. Connect the SpectraPen to the computer and open the SpectraPen software to proceed with download of the measured data. Data measured with activated GPS module are downloaded with GPS coordinates (Fig. 43).

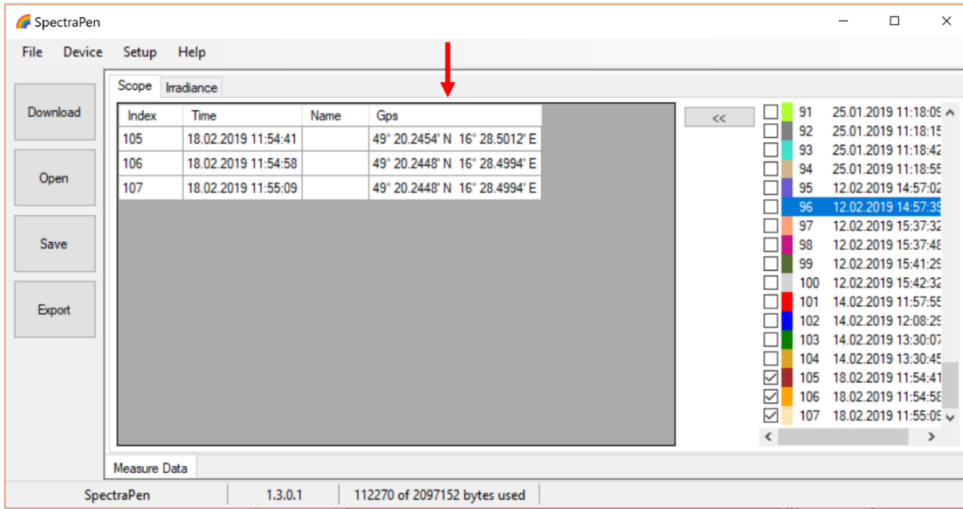


Fig. 43 Data with GPS coordinates.

## 9 WARRANTY TERMS AND CONDITIONS

- This Limited Warranty applies only to the SpectraPen device. It is valid for one year from the date of shipment.
- If at any time within this warranty period the instrument does not function as warranted, return it and the manufacturer will repair or replace it at no charge. The customer is responsible for shipping and insurance charges (for the full product value) to PSI. The manufacturer is responsible for shipping and insurance on return of the instrument to the customer.
- No warranty will apply to any instrument that has been (i) modified, altered, or repaired by persons unauthorized by the manufacturer; (ii) subjected to misuse, negligence, or accident; (iii) connected, installed, adjusted, or used otherwise than in accordance with the instructions supplied by the manufacturer.
- The warranty is return-to-base only and does not include on-site repair charges such as labor, travel, or other expenses associated with the repair or installation of replacement parts at the customer's site.
- The manufacturer repairs or replaces faulty instruments as quickly as possible; the maximum time is one month.
- The manufacturer will keep spare parts or their adequate substitutes for a period of at least five years.
- Returned instruments must be packaged sufficiently so as not to assume any transit damage. If damage is caused due to insufficient packaging, the instrument will be treated as an out-of-warranty repair and charged as such.
- PSI also offers out-of-warranty repairs. These are usually returned to the customer on a cash-on-delivery basis.
- Wear & Tear Items (such as sealing, tubing, padding, etc.) are excluded from this warranty. The term Wear & Tear denotes the damage that naturally and inevitably occurs as a result of normal use or aging even when an item is used competently and with care and proper maintenance.

## 10 TROUBLESHOOTING AND CUSTOMER SUPPORT

In case of problems with the SpectraPen visit [FAQ](#) on our websites (<http://psi.cz/support/faq>) or contact customer support by email to [support@psi.cz](mailto:support@psi.cz) , or contact your local distributor.

# 11 APPENDIX

## 11.1 PROGRAMMING CUSTOM INDEX IN SPECTRAPEN

The SpectraPen software enables programming custom indexes, which can be used for wide range of calculation based on the measured spectrum.

1. Go to the main **SpectraPen** folder in your PC (Usually in Program Files).
2. Open the file **Config > Formulas.txt**.
3. Write your index into this .txt file and save it (Fig. 44).
  - Index example:
  - *Scope:PSIindex:PSI test index:Scope[600nm]/Scope[500nm]*
  - *Scope* – the index is placed in the bookmark Scope in data in the software
  - *PSIindex* – name of the index in the SpectraPen software and in exported data
  - *PSI test index* – full name of the index (not showed)
  - *Scope[600nm]/Scope[500nm]* – equation for calculation; calculated from 500 and 600 nm of Scope spectra



```
Formulas - Poznámkový blok
Soubor Úpravy Formát Zobrazení nápověda
Transmittance:NDVI:Normalized Difference Vegetation Index:(Transmittance[780nm]-Transmittance[630nm])/((Transmittance[780nm]+Transmittance[630nm]))
Transmittance:SR:Simple Ratio Index:Transmittance[780nm]/Transmittance[630nm]
Transmittance:MCARI1:Modified Chlorophyll Absorption Ratio Index 1:1.2*(2.5*(Transmittance[780nm]-Transmittance[670nm])-1.3*(Transmittance[780nm]-Transmittance[550nm]))
Transmittance:OSAVI:Optimized Soil-Adjusted Vegetation Index:(1+0.16)*(Transmittance[780nm]-Transmittance[670nm])/((Transmittance[780nm]+Transmittance[670nm]+0.16))
Transmittance:G:Greenness Index:Transmittance[554nm]/Transmittance[677nm]
Transmittance:MCARI:Modified Chlorophyll Absorption Ratio Index:((Transmittance[700nm]-Transmittance[670nm])-0.2*(Transmittance[700nm]-Transmittance[550nm]))*(Transmittance[700nm]/Transmittance[670nm])
Transmittance:TCARI:Transformed CAR Index:3*((Transmittance[700nm]-Transmittance[670nm])-0.2*(Transmittance[700nm]+Transmittance[550nm]))*(Transmittance[700nm]/Transmittance[670nm])
Transmittance:TVI:Triangular Vegetation Index:0.5*(120*(Transmittance[750nm]-Transmittance[550nm])-200*(Transmittance[670nm]-Transmittance[550nm]))
Transmittance:ZMI:Zarco-Tejada & Miller Index:Transmittance[430nm]/Transmittance[710nm]
Transmittance:SPRI:Simple Ratio Pigment Index:Transmittance[430nm]/Transmittance[680nm]
Transmittance:NPOI:Normalized Phaeophytinization Index:(Transmittance[415nm]-Transmittance[435nm])/((Transmittance[415nm]+Transmittance[435nm]))
Transmittance:PRI:Photochemical Reflectance Index:(Transmittance[531nm]-Transmittance[570nm])/((Transmittance[531nm]+Transmittance[570nm]))
Transmittance:NPCI:Normalized Pigment Chlorophyll Index:(Transmittance[680nm]-Transmittance[430nm])/((Transmittance[680nm]+Transmittance[430nm]))
Transmittance:Ctr1:Carter Indices 1:Transmittance[695nm]/Transmittance[420nm]
Transmittance:Ctr2:Carter Indices 2:Transmittance[695nm]/Transmittance[760nm]
Transmittance:Lic1:Lichtenthaler Indices 1:(Transmittance[780nm]-Transmittance[680nm])/((Transmittance[780nm]+Transmittance[680nm]))
Transmittance:Lic2:Lichtenthaler Indices 2:Transmittance[440nm]/Transmittance[690nm]
Transmittance:SIP1:Structure Intensive Pigment Index:(Transmittance[780nm]-Transmittance[450nm])/((Transmittance[780nm]+Transmittance[650nm]))
Transmittance:GM1:Gitelson and Merzlyak Indices 1:Transmittance[750nm]/Transmittance[550nm]
Transmittance:GM2:Gitelson and Merzlyak Indices 2:Transmittance[750nm]/Transmittance[700nm]
Transmittance:ARI1:Anthocyanin Reflectance Index 1:1/Transmittance[550nm]-1/Transmittance[700nm]
Transmittance:ARI2:Anthocyanin Reflectance Index 2:Transmittance[790nm]*(1/Transmittance[550nm]-1/Transmittance[700nm])
Transmittance:CRI1:Carotenoid Reflectance Index 1:1/Transmittance[510nm]-1/Transmittance[550nm]
Transmittance:CRI2:Carotenoid Reflectance Index 2:1/Transmittance[510nm]-1/Transmittance[700nm]
Transmittance:RDVI:Renormalized Difference Vegetation Index:(Transmittance[780nm]-Transmittance[670nm])/((Transmittance[780nm]+Transmittance[670nm])^0.5)
Irradiance:LUX:683*integral(IrradianceL,360nm,780nm)
Irradiance:PAR[uE]:PAR[uE]:integral(IrradianceE,400nm,700nm)
Irradiance:IRR[uW/cm2]:Irradiance[uW/cm2]:integral(IrradianceW,340nm,780nm)
Irradiance:IRR_NTP[uW/cm2]:Irradiance[uW/cm2]:integral(IrradianceW,640nm,1050nm)
Scope:PSIindex:PSI test index:Scope[600nm]/Scope[500nm]
```

Fig. 44 New index in the Formulas file.

4. Restart the SpectraPen Software.
5. The new index appears in the selected bookmark in the data (Fig. 45).
6. For export of this index choose the option “Computed values” and selected spectrum in the export table.

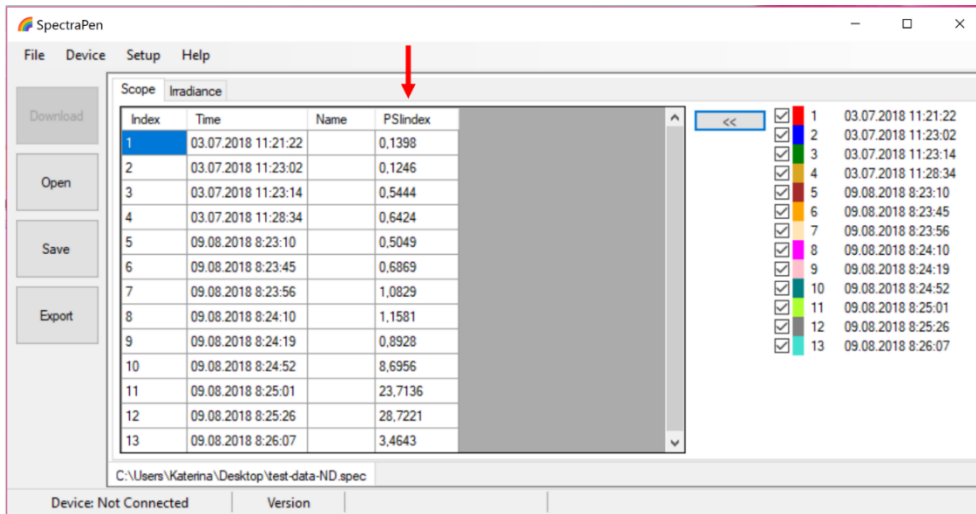


Fig. 45 New index.

### 11.1.1 FUNCTION DESCRIPTION

Different mathematical functions can be used in SpectraPen software syntax to create new custom formulas.

#### min, max -

min(value1, value2)

value1 - number, variable, function

value2 - number, variable, function

- only one value can be function!

min(array)

array - array of numbers

**example1:** max(Scope)

**example2:** min(Irradiance)

**example3:** min(Scope[760nm], max(Scope[450], Scope[680]))

**example4:** max(Irradiance[550nm], (5+4)\*4)

---

#### ln - the natural (base e) logarithm of specified number

ln(value)

value - number, variable, function

**example1:** ln(5)

**example2:** ln(Irradiance[760nm])

**example3:** ln(max(Irradiance [550nm], Irradiance[480nm]))

**example4:** ln((5+4)\*4)

---

#### log - the logarithm of specified number in a specified base.

logB(value)

B - base - number

value - number, variable, function

**example1:** log2(5)

**example2:** log5(Scope[760nm])

**example3:** log10(max(Scope[550nm], Scope[480nm]))

**example4:** log10((5+4)\*4)

---

#### sqrt - the square root of a specified number

sqrt(value)

value - number, variable, function



**example1:** sqrt(5)  
**example2:** sqrt(Scope[760nm])  
**example3:** sqrt(max(Scope[550nm], Scope[480nm]))  
**example4:** sqrt(((5+4)\*4) + 6)

---

**^** - specified number raised to the specified power  
value^power  
value – number, variable, function  
power – number, variable, function

**example1:** Irradiance[760nm]^ Irradiance[550nm]  
**example2:** min(Irradiance[760nm], Irradiance[550nm])^max(Irradiance[435nm], Irradiance[430nm])  
**example3:** Transmittance[760nm]^0.5

---

**integral** - express the area under the curve of a graph of the function in the interval  
integral(function\_values, from, to)  
function\_values – input values for integral compute  
from,to – limit values

**example1:** integral(IrradianceL, 360nm, 700nm)  
**example2:** integral(IrradianceE, 360nm, 700nm) \* IrradianceE[450]

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