

Instruction Guide



SpectraPen SP 110

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.

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

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

Symbol	Normal Style - Description
	Important information, read carefully.
	Complementary and additional information.

Tab. 1 Used symbols.

2 GENERAL DESCRIPTION

SpectraPen SP 110 is a handheld portable spectroradiometer that is ideal as a general-purpose instrument for research and for agricultural applications. SpectraPen is especially useful for rapid measurements of solar irradiance and monitoring of spectral light quality. External light source and sample holder enable to use SpectraPen also for measurements of absorption, reflectance, transmittance, emission, color and fluorescence of various samples.

Li-Ion rechargeable battery, splash-proof case and integrated GPS module make SpectraPen an ideal tool for environmental, agricultural and ecological applications such as monitoring of artificial lighting used in horticulture industry or light source testing. Spectrum of measured light source is instantly displayed on the SpectraPen touch screen. All recorded data are automatically stored into the device internal memory. The SpectraPen also includes a comprehensive software package comprising full system control, data acquisition and data processing.

SpectraPen measures:

Scope – rough light spectrum
Transmittance – calculated using the following formula $T = I/I_0$ Where: I_0 is reference light intensity I is measured light intensity
Absorbance – calculated using the following formula $A = \log(I_0/I)$ Where: I_0 is reference light intensity I is measured light intensity
Users defined formulas in SpectraPen software

SpectraPen versions:

SP 110 UVIS	Wavelength range from 340 to 790 nm
SP 110 NIR	Wavelength range from 640 to 1050 nm

2.1 TECHNICAL SPECIFICATION

Spectral range	340 nm – 790 nm (SP 110 UVIS) 640 nm – 1,050 nm (SP 110 NIR)
Spectral response half width	9 nm (SP 110 UVIS) 8 nm (SP 110 NIR)
Wavelength reproducibility	+/- 0.5 nm
Spectral Straylight	-30 dB
Integration time	From 5 ms to 10 s
Number of pixels	256
Dynamic range	High gain: 1:4300 Low gain: 1:13000
Optical entrance	SMA905 to 0.22 numerical aperture single-stand optical fiber
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
Display	Touchscreen 240 x 320 pixel; 65,535 colors
Built in GPS module	Ultra-high sensitivity down to -165dBm High accuracy of <1.5 m in 50% of trials
Size	150 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. 1 Device description.

3.1 LIST OF EQUIPMENT AND CUSTOMER INFORMATION

Standard version of the SpectraPen device package consists:


- SpectraPen SP 110
- 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, please write to: support@psi.cz</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.

	It is recommended to re-calibrate the device by the manufacturer every 2 years.
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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 DEVICE OPERATING INSTRUCTION

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.

Main display (Fig. 2-A)

- Get spectrum - measure and save the spectrum to the device internal memory.
- Integration time - move the slider to set measuring time.

Measure (Fig. 2-B)

- Scope – rough spectrum data
- Absorbance – calculated data
- Transmittance – calculated data

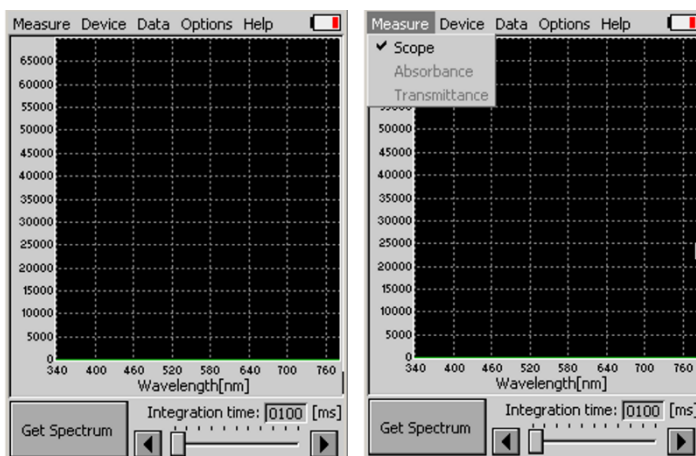


Fig. 2 A) Main display B) Measure menu.



For absorbance and transmittance calculation a reference needs to be obtained first. Measure light source without the sample in the optical path as a reference.

Device (Fig. 3)

- **Preview** – if checked, spectrophotometer continuously measures and displays current data, data is stored only after Get Spectrum button is pressed.
- **High Gain** – if checked, high sensitivity mode is enabled.
- **Auto Sensitivity** – if checked, integration time and gain is set automatically to reach optimal signal/noise ratio.
- **Get Dark Current** – check to get dark current. After that, dark current is automatically subtracted from measured data.
- **Get Reference** – check to get reference spectrum without the sample in the optical path. A reference needs to be obtained for absorbance or transmittance measurements.

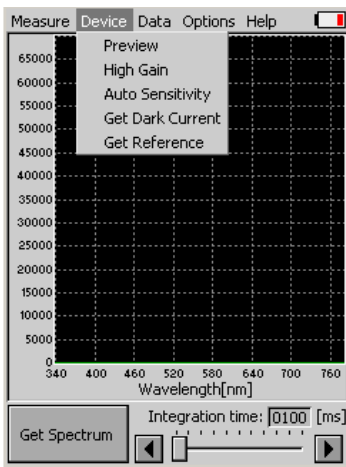


Fig. 3 Device menu.

Data

- **Browse (Fig. 4)**– 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, Absorbance or Transmittance mode. Color classification of each data file helps the user to discriminate between individual measurements.

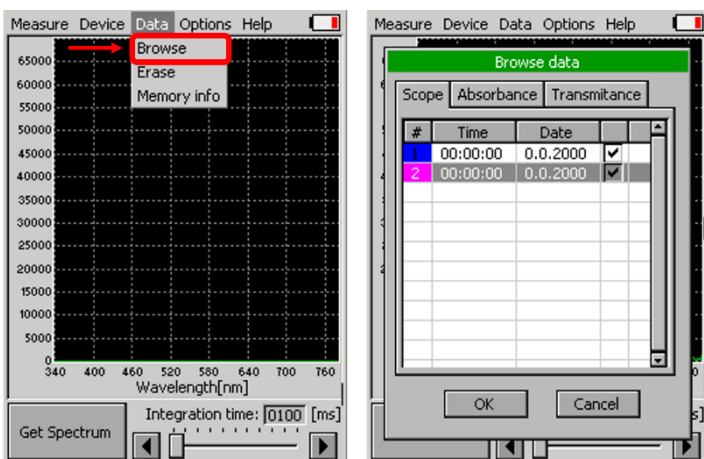


Fig. 4 Browse data.

- **Erase** – use this to erase internal data memory
- **Memory info (Fig. 5)** – displays info on currently used memory

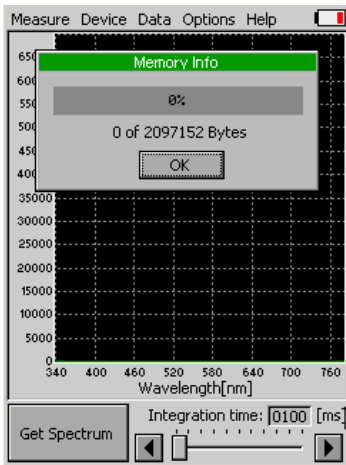


Fig. 5 Memory info.

Options

- **Settings**—this function is used to set various variable for the light measurements and for the device operation
 - **Graph** (Fig. 6-A) – displays options for setting the wavelength range and graph features
 - **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 display of the numeric coordinates of the point touched on the graphical display (in the right hand corner).
 - **Autoscale** - enables the auto scale of the y-axis. The Y axis is automatically adjusted according to measured values.
 - **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. Desired wavelength range can be adjusted by selecting the wavelength and by using the arrows up and down.
 - **Time** (Fig. 6-B)- 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.

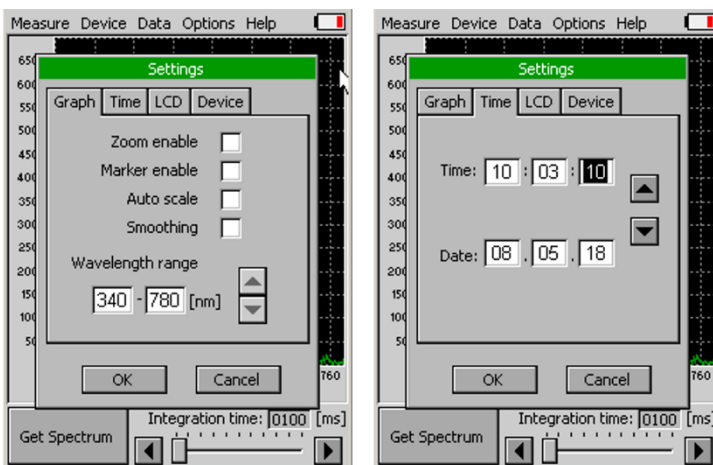


Fig. 6 A) Settings – Graph B) Settings - Time.

- **LCD** (Fig. 7-A)– is used to adjust LCD display control settings.
 - **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. 7-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 measurement to be acquired for averaged values.

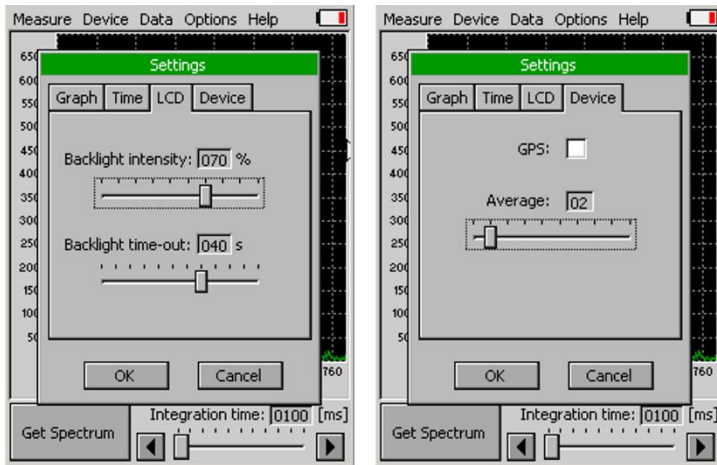


Fig. 7 A) Settings – LCD B) Settings - Device.

Help

- **About** - information about the device, hardware and software version.

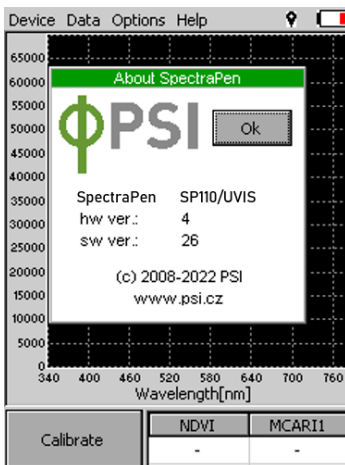



Fig. 8 About.

5 PC COMMUNICATION

5.1 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 SpetraPen with your computer please follow steps below in Fig. 9:



Fig. 9 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.

5.2 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.

- Press Start and Select Control Panels (Fig. 10)

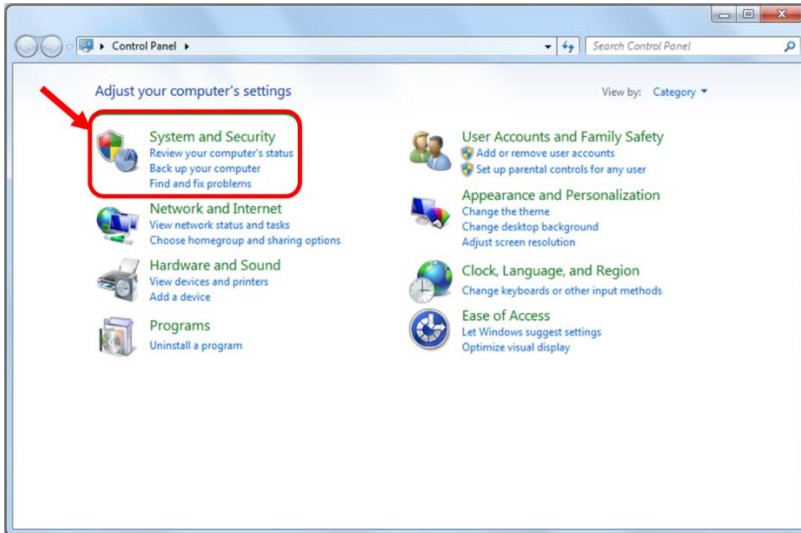


Fig. 10 Control panel.

- Navigate through System and security, System to Device manager (Fig. 11)

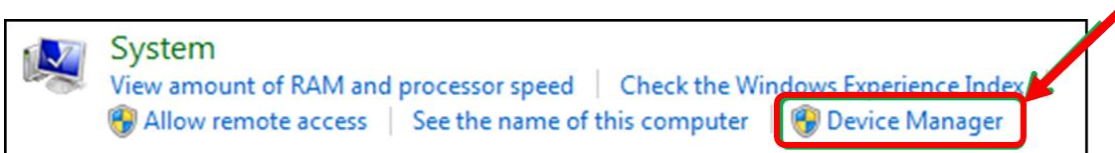


Fig. 11 System window.

- 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. 12).

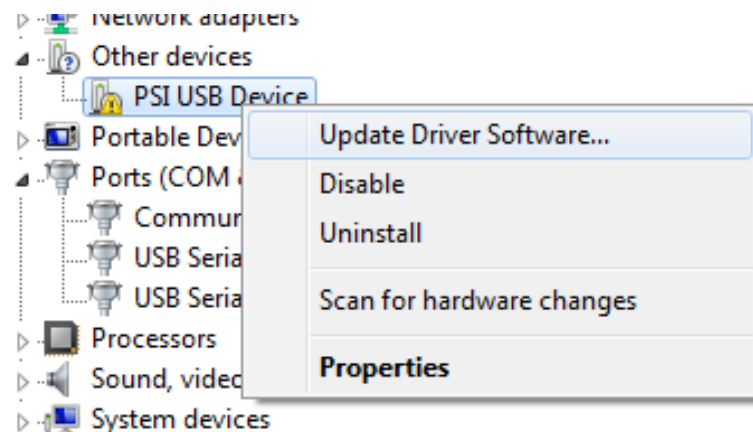


Fig. 12 PSI USB device.

- 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. 13)

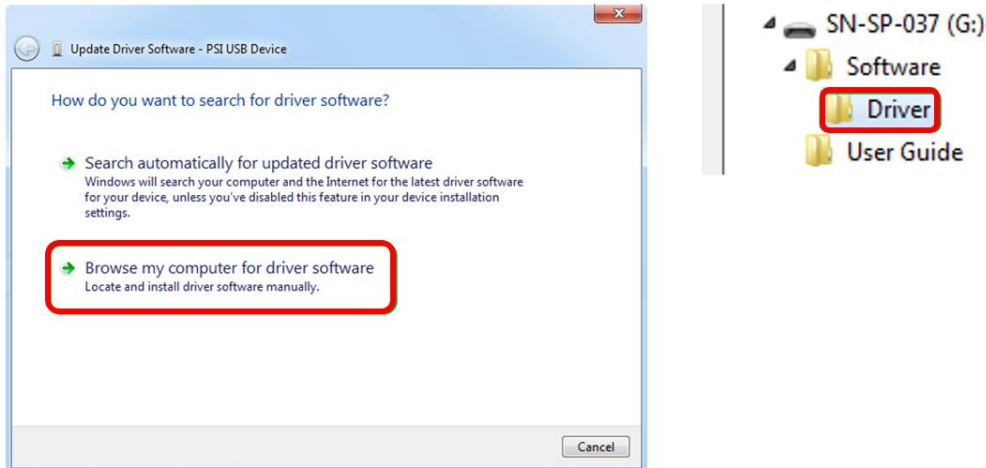


Fig. 13 Choose the driver from the USB disc.

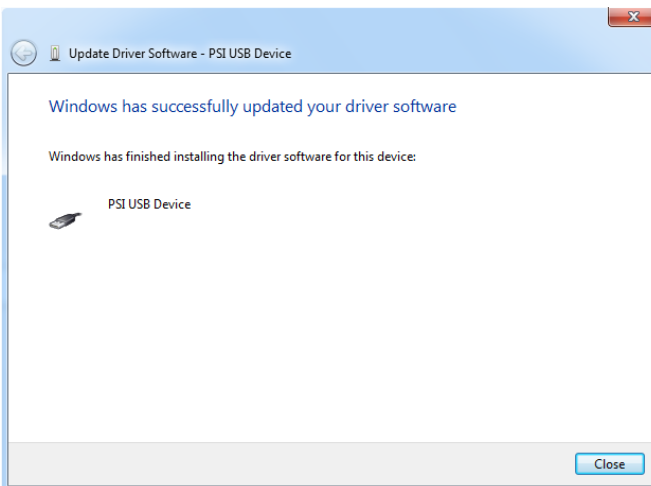



Fig. 14 Complete installation.

Installation of the driver is now complete (Fig. 14)

	<p>In case this driver installation is not successful the driver may be downloaded directly from PSI websites www.psi.cz.</p>
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Once the device is properly connected to the computer, the indicating icon appears on the SpectraPen device display Fig. 15.

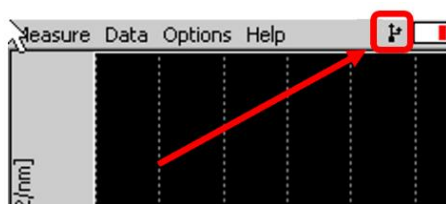


Fig. 15 Icon on the SpectraPen device display indicating the proper USB connection.

6 SPECTRAPEN SOFTWARE

6.1 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. 16).
 - 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

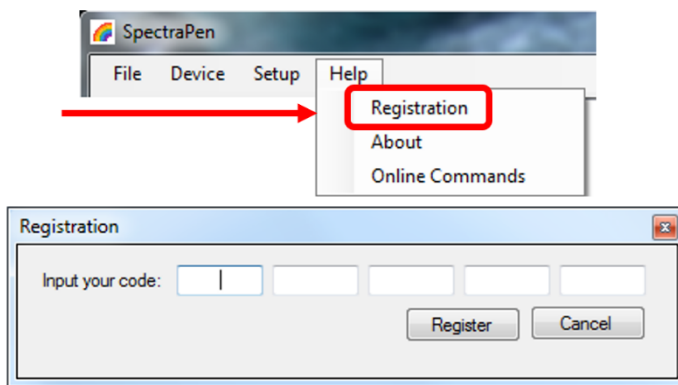


Fig. 16 Software registration.



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.
Please Note: it is not possible to download data from the SpectraPen device without software registration.

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 SpetraPen are properly paired (see chapter 5).
5. Connect SpectraPen device in SpectraPen software, **Device > Connect** (Fig. 17)

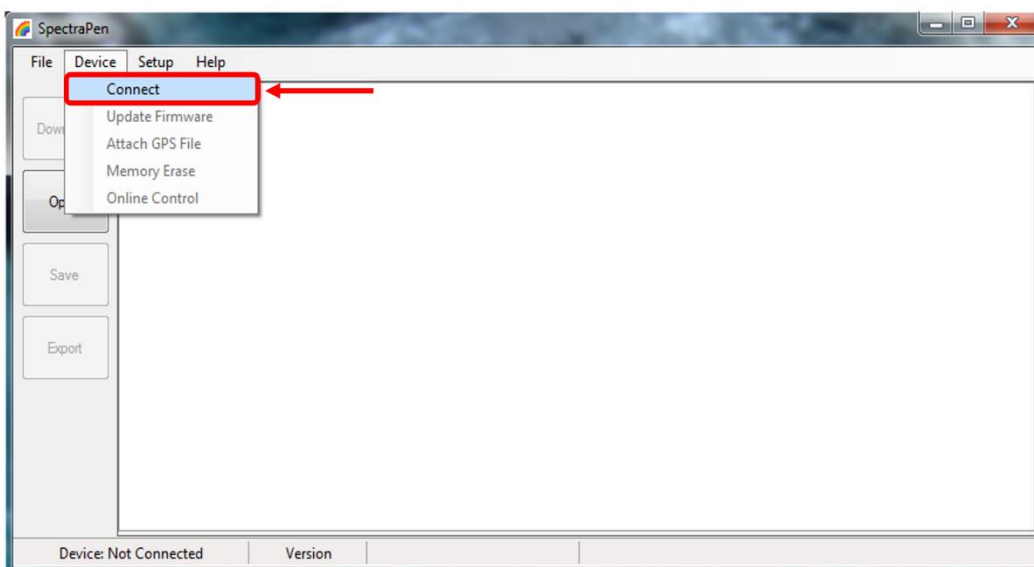


Fig. 17 SW connection.

6. When the device is properly connected the left bottom corner of the SW window will display "SpectraPen" (Fig. 18). Otherwise notification "Device: Not Connected" is displayed (Fig. 19).

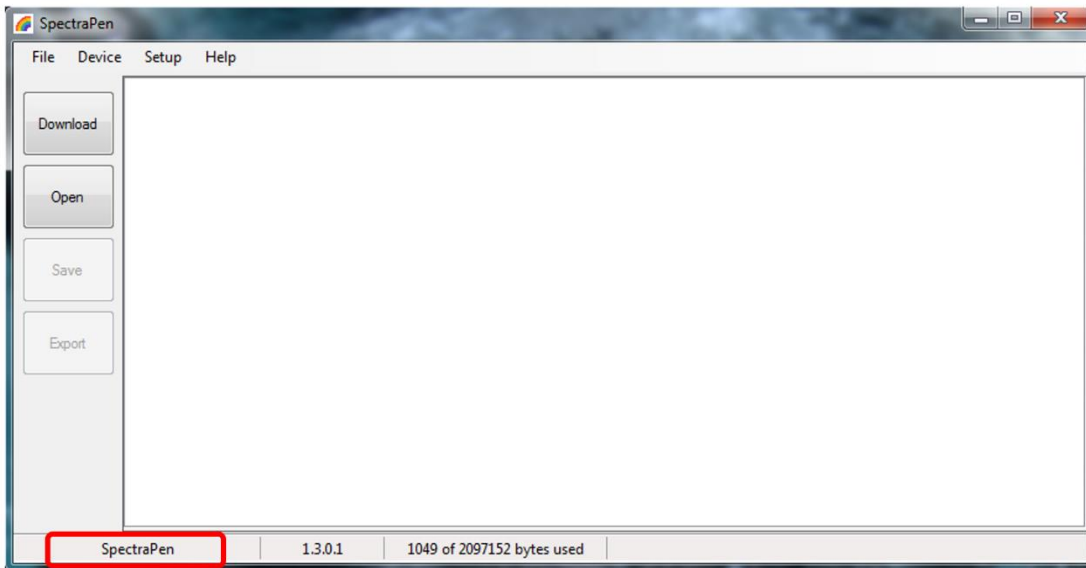


Fig. 18 SpectraPen connected.

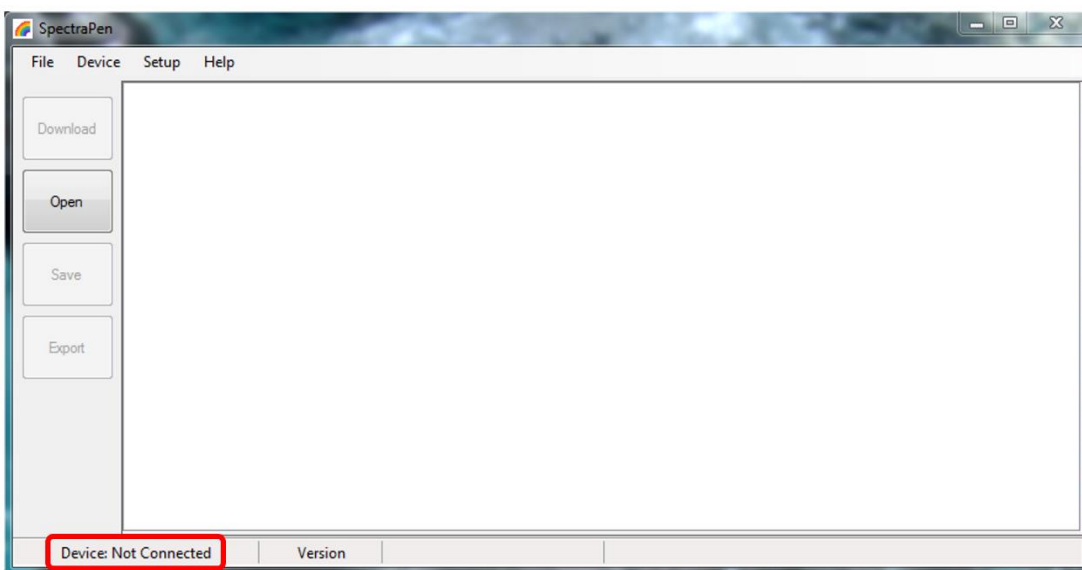


Fig. 19 SpectraPen not connected.

6.2 SOFTWARE MENU

MENU: File

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

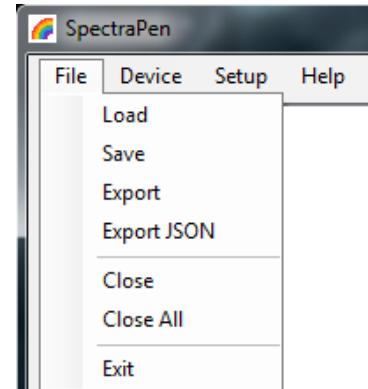


Fig. 20 Menu File.

MENU: Device

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

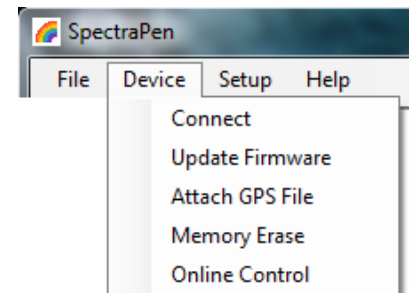


Fig. 21 Menu Device.

* For more information on firmware updating, see Chapter 6.5 of this Operation Manual.

MENU: Setup

Update Software	Used for software updates.
Settings	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).

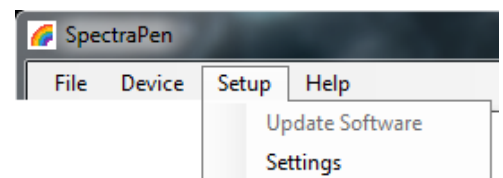


Fig. 22 Menu Setup.

MENU: Help

Registration	Used for the SpectraPen software registration.
About	Offers basic information about the program.

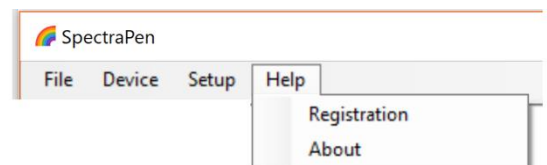


Fig. 23 Menu Help.

6.3 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 calculated spectrum go to **Absorbance** or **Transmittance** tab (Fig. 24).

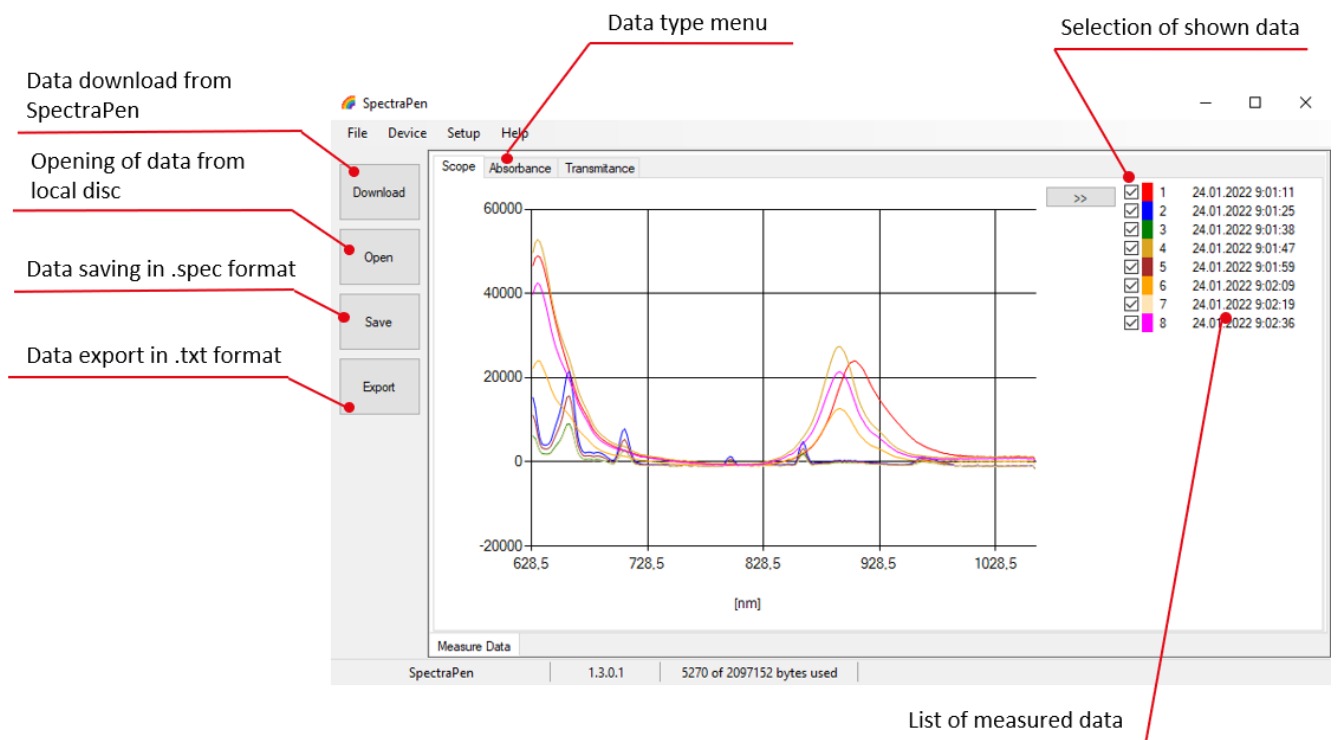


Fig. 24 Scope spectra.

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. 24).
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. 25).

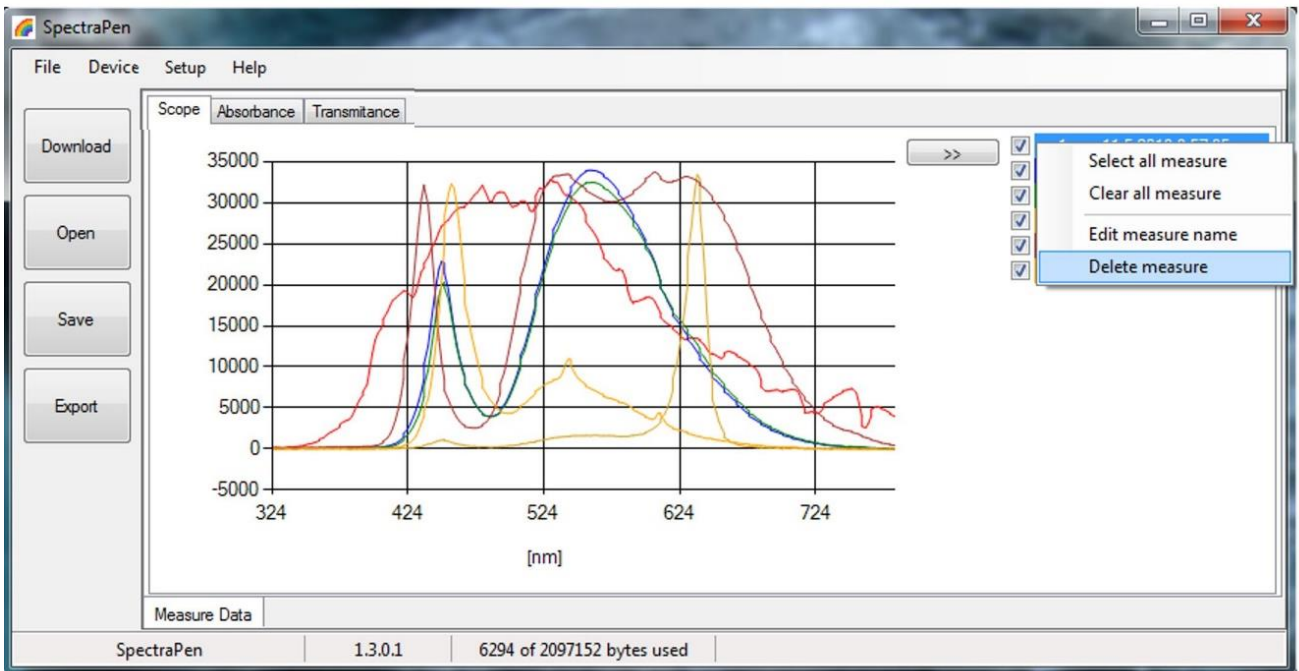


Fig. 25 Options for list of data.

- In the graph **marker** feature is available, which enables display of the numeric values for wavelength for the selected wavelength of the scan (Fig. 26). Use the mouse to select the given point. In top right corner of the graph (green rectangle) is displayed exact value for the selected point on the x-axis and y-axis.

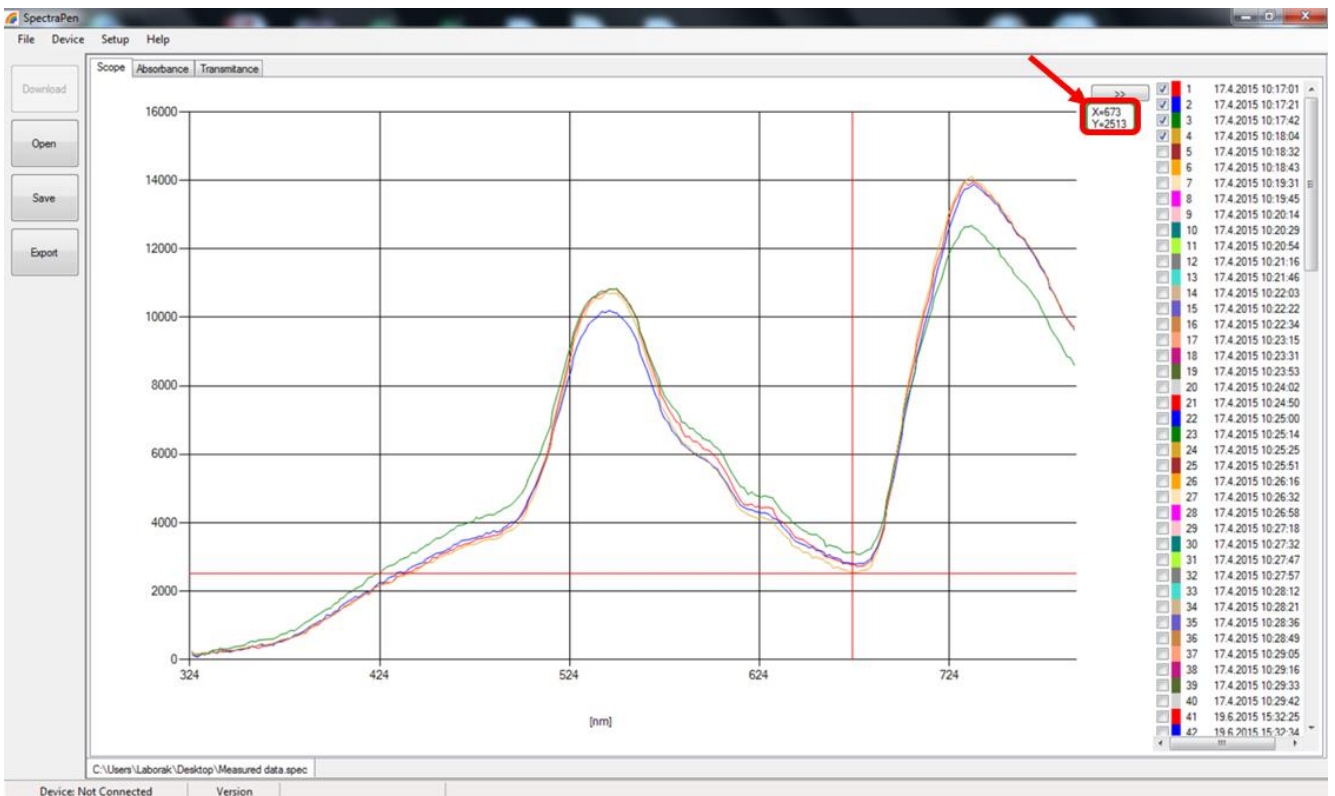


Fig. 26 Marker feature.

9. To **zoom in on the data displayed in the graph** select an area of the displayed graph (Fig. 27). 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. 27.

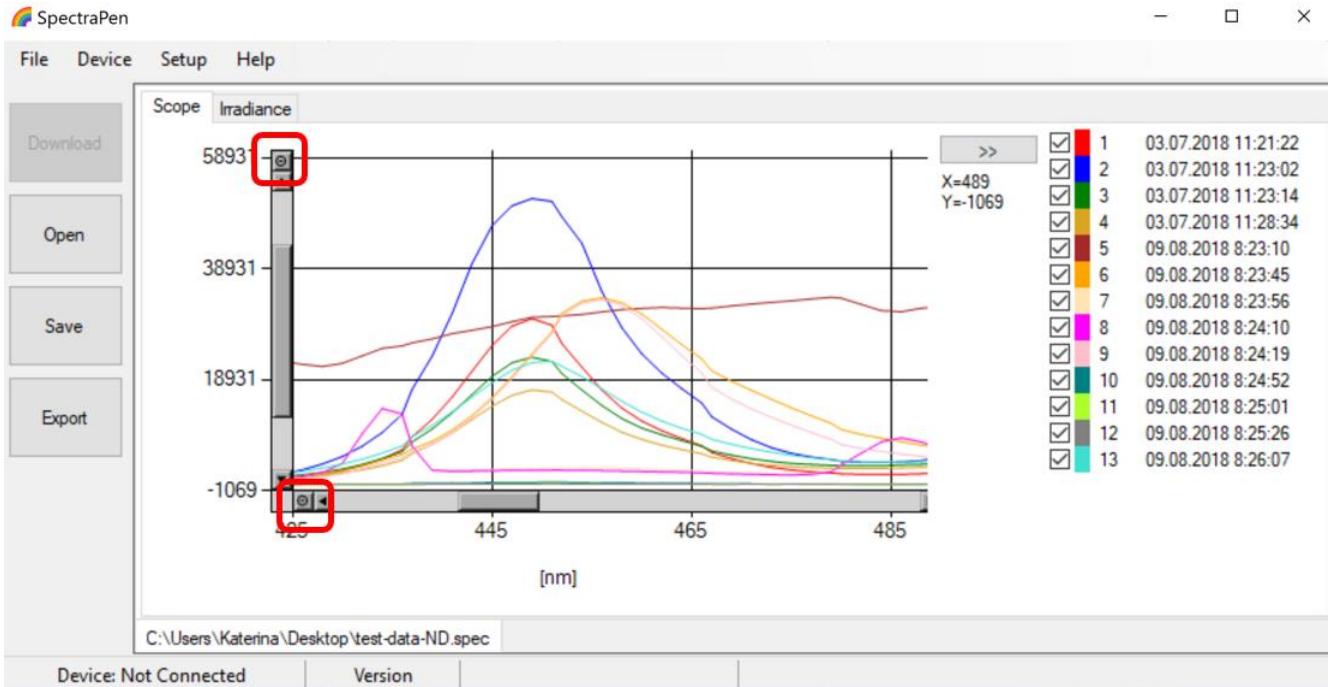


Fig. 27 Zoom function.

10. To view **calculated values**, use double arrow in the top right corner (Fig. 28, in red rectangle).

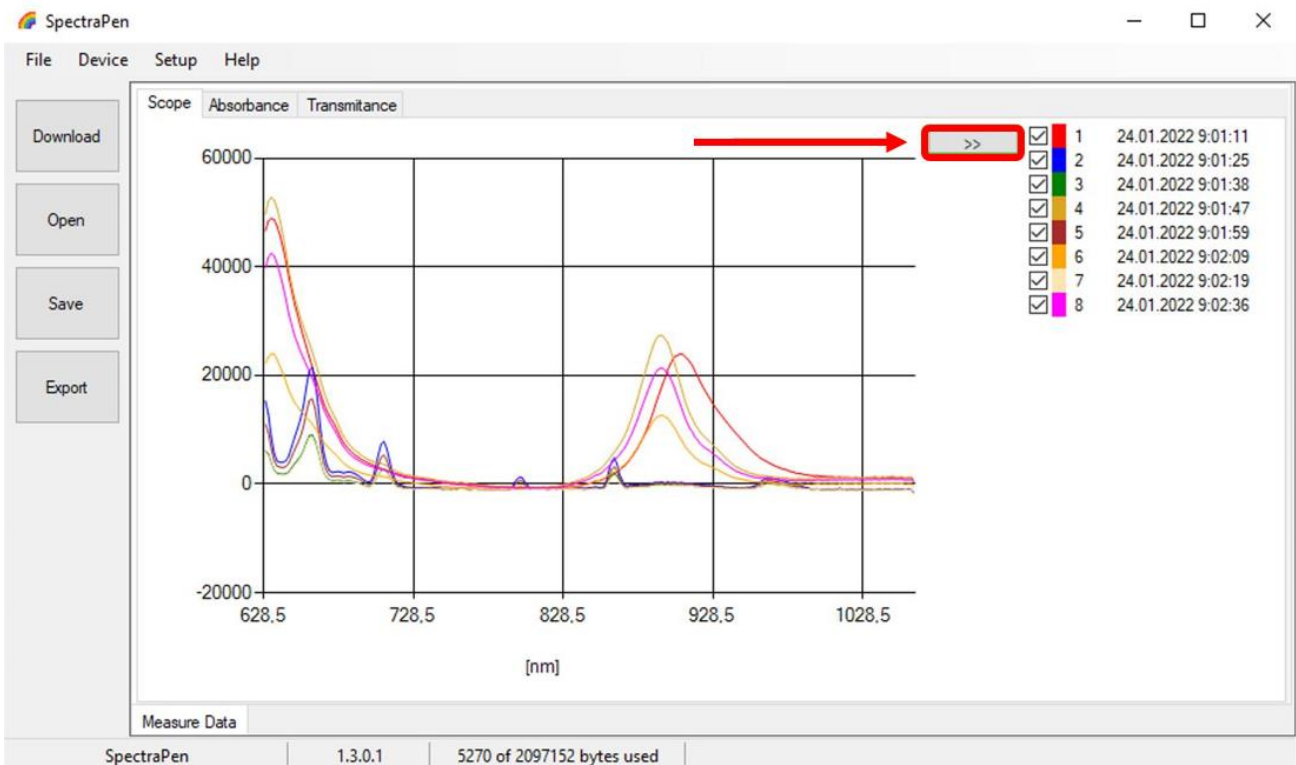


Fig. 28 Numerical values calculated from spectra.



Please note that SP 110 does not have default predefined calculations from the manufacturer. The user can create formulas based on own requirements. For more information please see chapter 10.1

11. 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 data.
12. 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. 29) – all raw scope data for entire range of measured wavelengths.
 - **Spectrum scope** – scope data normalized to dark spectrum scan are exported for all acquired scans or set of selected measurements.

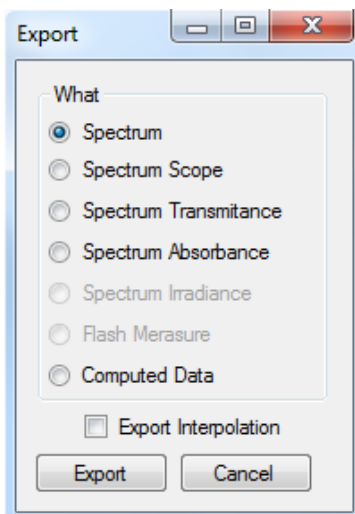


Fig. 29 Export table.

- **Spectrum Transmittance** – transmittance data for all measurements are exported.
- **Spectrum Absorbance** – absorbance data for all measurement are exported.
- **Computed Data** (Fig. 30) – export of the calculated values from Scope, Transmittance or Absorbance spectra of all of the measurements. SP 110 does not contain default formulas for calculated values. This feature exports calculations based on user's predefined formulas. More in chapter 10.1.
- **Export interpolation** – interpolated data are read every 1 nm, they are the same such as raw data.

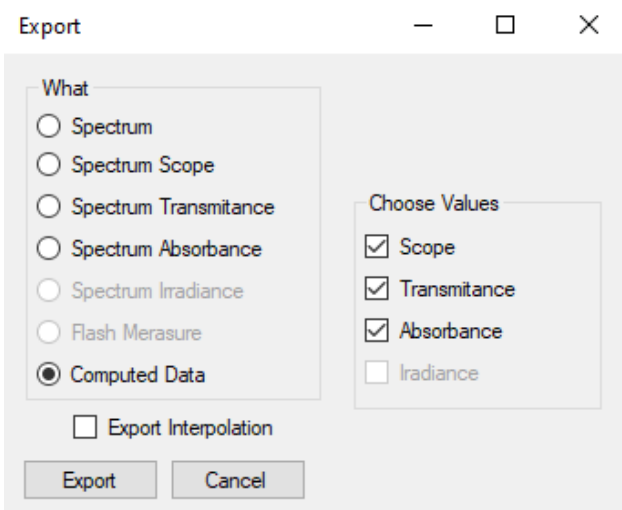


Fig. 30 Export of computed values.

6.4 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. 31)

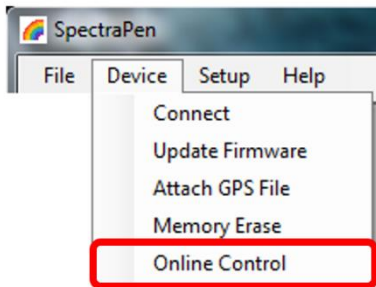


Fig. 31 Online control.

Remote measurement (Fig. 32)

Using this function **Scope**, **Absorbance** and **Transmittance** 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** 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

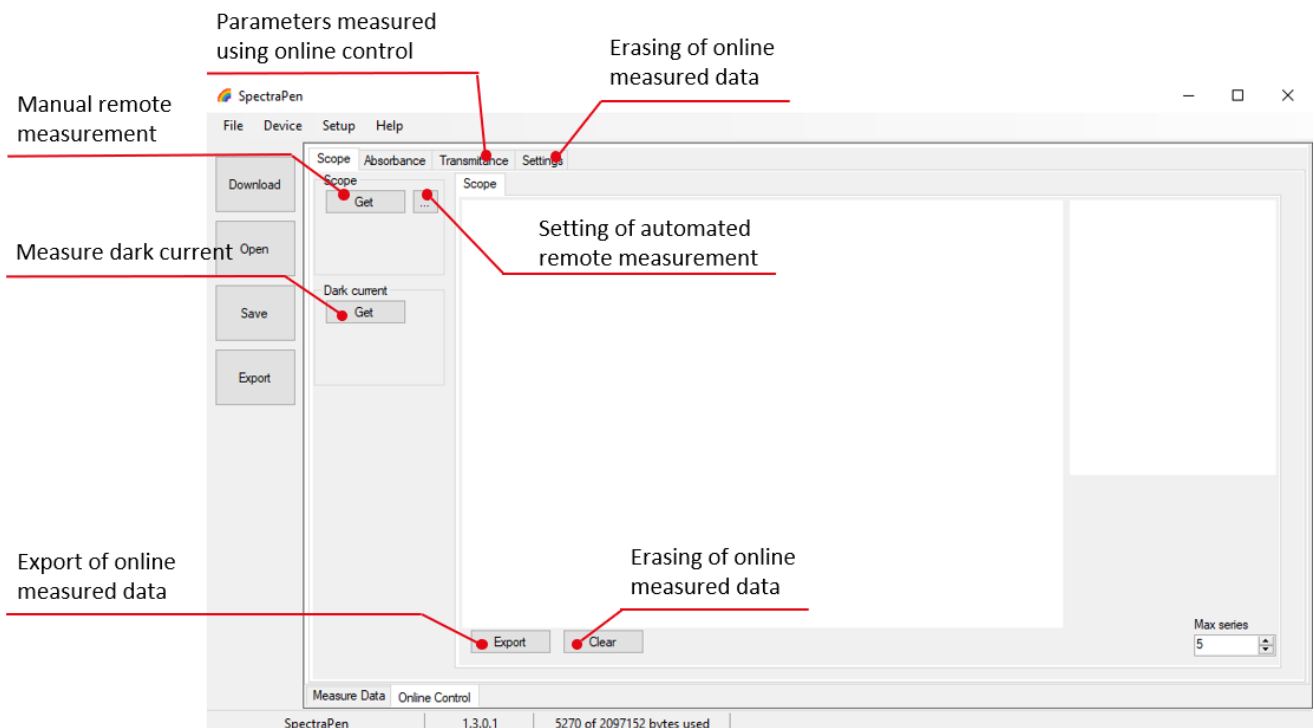


Fig. 32 Remote measurement.

Settings (Fig. 33)

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 7)
- Averaging of measurement (1 – 10 measurements)
- Integration time (0 – 10 s)

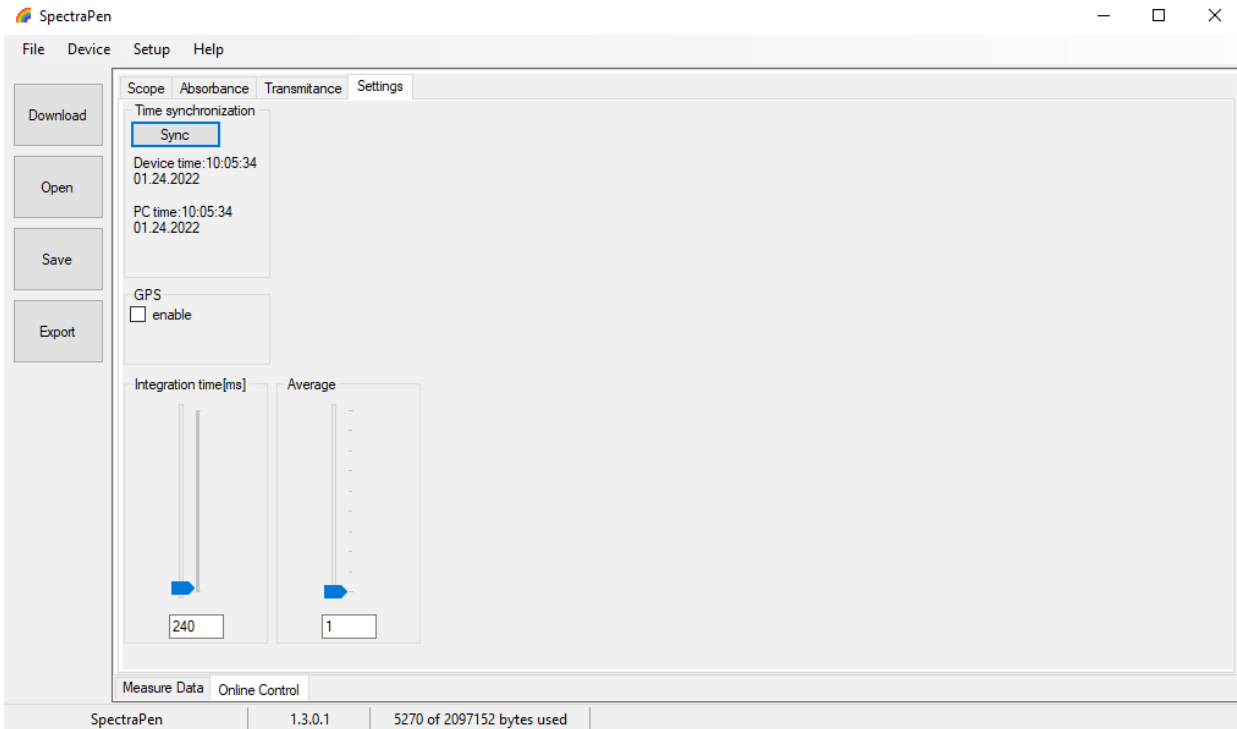


Fig. 33 Online control settings.

6.5 FIRMWARE UPDATE

	<p>All data in the SpectraPen memory are erased during the firmware update! 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

2. Selecting .bxn file

- Find firmware update file: Binary file (with the extension .bxn)
- Select: Open.

3. Finishing Upload

- Select: OK to start uploading of the update
- The bottom bar indicates the upload progress (Fig. 34)

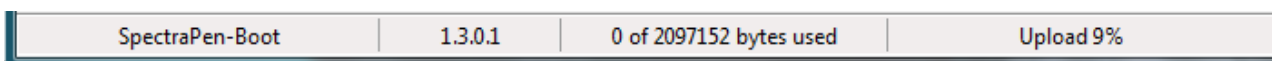


Fig. 34 Firmware update running.

7 GPS MODULE

SpectraPen device SP 110 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.

7.1 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. 35 - A)
 - Wait until the GPS position is found. The GPS is ready when the icon of the position flag, in upper menu, stops flashing (Fig. 35-B).

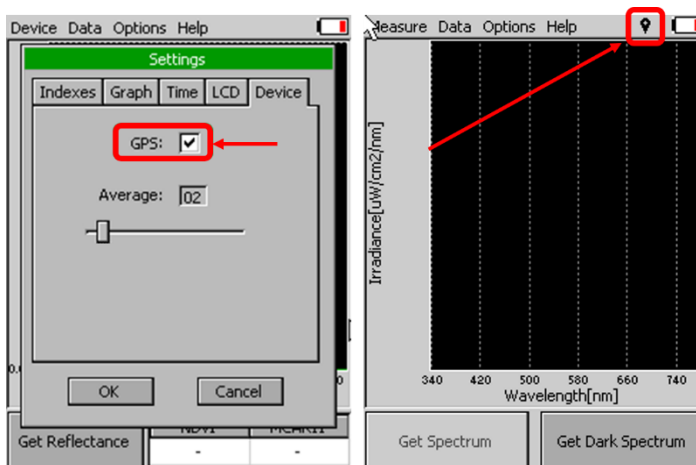


Fig. 35 A) Activation of GPS B) GPS active.



For proper function of the GPS 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. 36).

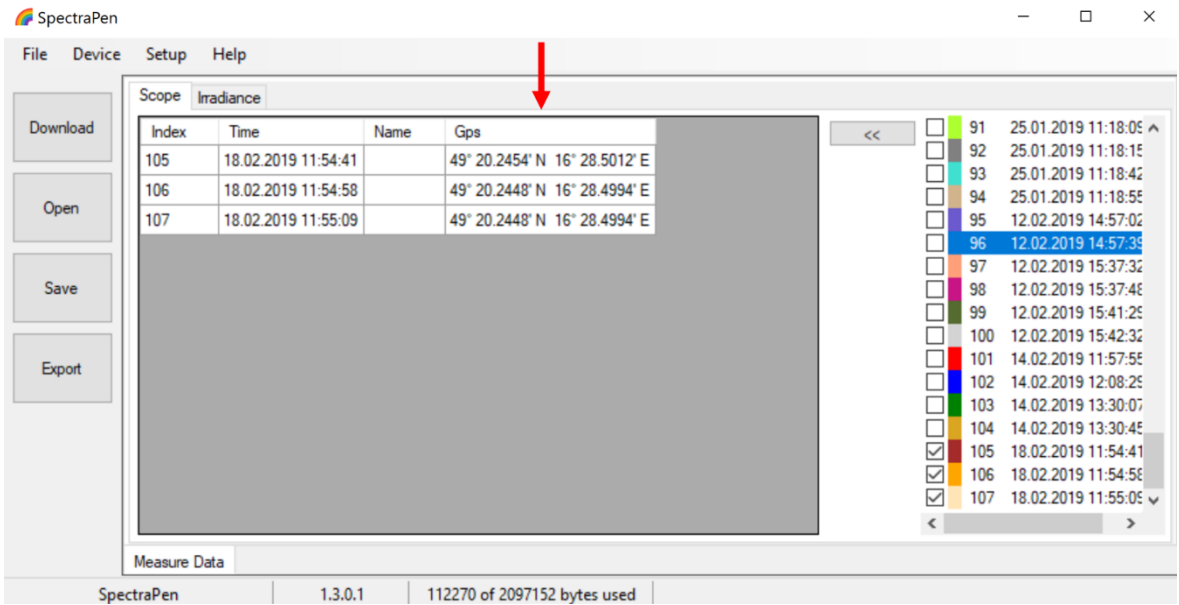


Fig. 36 Data with GPS coordinates.

8 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.

9 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, or contact your local distributor.

10 APPENDIX

10.1 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. 37).
 - 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



Fig. 37 New index in the Formulas file.

4. Restart the SpectraPen Software.
5. The new index appears in the selected bookmark in the data (Fig. 38).
6. For export of this index choose the option "Computed values" and selected spectrum in the export table.

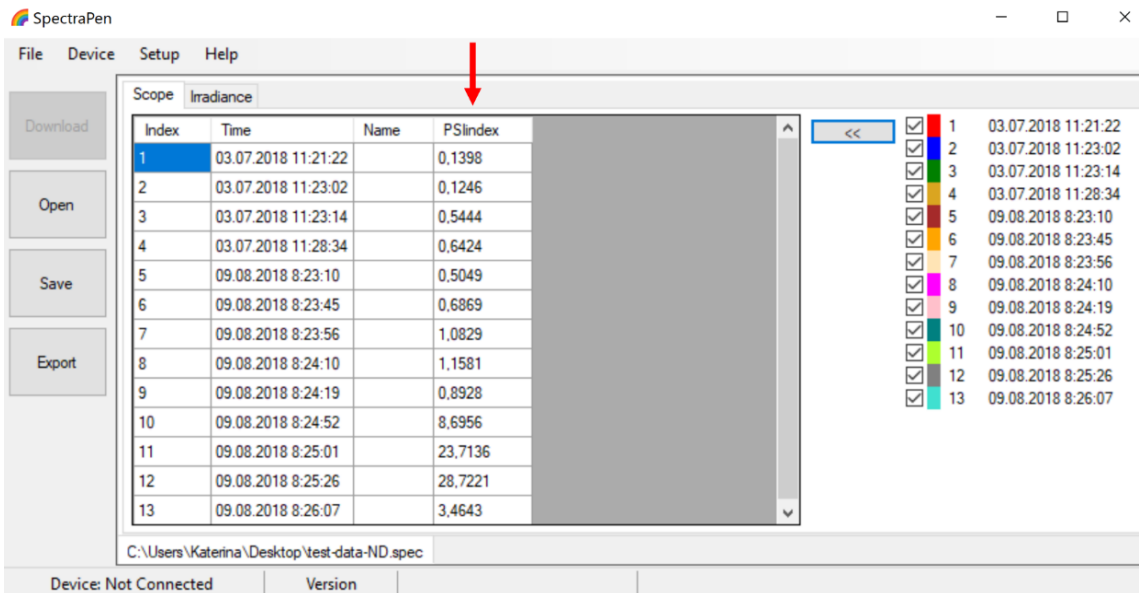


Fig. 38 New index.

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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