

Instruction Guide



PolyPen RP 410

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 ABOUT THIS MANUAL

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

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
	Important information, read carefully.
	Complementary and additional information.

Table 1 Used symbols.

2 GENERAL INFORMATION

2.1 DEVICE DESCRIPTION

PolyPen RP410 (in further text PolyPen) is a portable, handheld spectroradiometer. The PolyPen device is equipped with a leaf clip and was primarily designed for measurement of spectral reflectance of plant leaves. The device can be used for indoor as well as field applications.

The PolyPen is a self-contained instrument powered by a Lithium-ion battery which is rechargeable via a PC and a USB cable. However, it does not require a PC for operation. Reflectance spectra and calculated reflectance indices are instantly displayed on the PolyPen touch screen and all stored in the device internal memory. Integrated USB communication allows data transfer to a PC at a later time. Measured spectra and calculated indices can be downloaded to a computer via SpectraPen app for further data management.



Fig. 1 PolyPen RP410

Main features

- PolyPen is equipped with a non-destructive leaf-clip sample holder.

- Optical head of the device contains detector and internal light source. The light source is oriented in 35° to the line intersecting the detector (
- Fig. 2 Schema of measurement with PolyPen device.
-). Two detector versions are available for the device: 1) UVIS and 2) NIR spectral region.

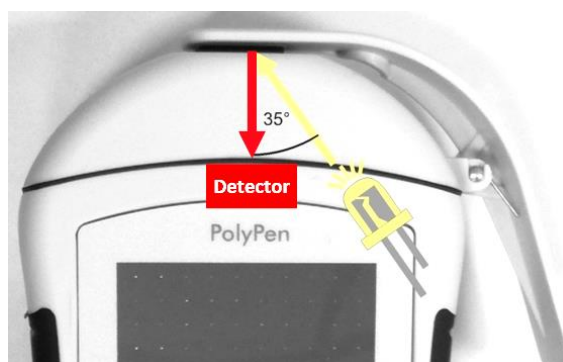


Fig. 2 Schema of measurement with PolyPen device.

- The built-in GPS module and splash-proof case are ideal for field use of the PolyPen and make this device well suited for wide scope of environmental, agricultural and ecological applications.
- Touch screen display can be operated by touch with a finger or stylus.
- When connected to PC via USB cable device charging starts automatically.
- Power button is used as the main switch button.

	The device should be always kept clean and protected when not in use. Any scratches on the surface might interfere with the measurement.
	No sharp objects should be used when operating the PolyPen via touch screen. It is recommended to use the provided stylus when making selections on the touch screen.

2.2 POLYPEN VERSIONS

The UVIS version measures in the visible part of the spectrum and the NIR version measures in near infra red part of the spectrum.

RP 410-UVIS	Spectral response range: 380 to 790 nm
RP 410-NIR	Spectral response range: 640 to 1050 nm

2.3 LIST OF EQUIPMENT AND CUSTOMER INFORMATION

Standard version of the SpectraPen device package contains:

- PolyPen RP410 device
- Reflectance standard
- Carrying Case
- Textile Strap for Comfortable Wearing
- PolyPen Operating Manual and software (on a USB flash disc)

- USB cable
- Stylus
- Other accessories can be provided on request

2.4 WHITE REFERENCE STANDART

The reflectance standard (Fig. 3) is made of Spectralon, a fluoropolymer with exceptionally high diffuse reflectance suitable for spectral calibration of the device. Spectralon® is a registered trademark of Labsphere. The standard is spectrally flat over UV-VIS-NIR spectrum and optically flat to +/- 1 % over the photopic region of the spectrum.



Fig. 3 Spectralon reflectance standard

2.5 MEASURED PARAMETERS

PolyPen measures reflectance and absorbance. Reflectance is indicated as transmittance in the software.

Transmittance is calculated using the formula

$$T = I/I_0,$$

where I_0 is reference light intensity and I is measured light intensity

Absorbance is calculated using the following formula

$$A = \log (I_0/I)$$

where I_0 is reference light intensity and I is measured light intensity

The PolyPen device incorporates formulas of commonly used reflectance indices (e.g., NDVI, NDGI, PRI etc.) directly in its software and displays values of the selected indices instantly. The PolyPen allow calculation of the following pre-defined vegetation indices:

NDVI: Normalized Difference Vegetation Index: $(R780 - R635) / (R780 + R635)$ ▪
SR: Simple Ratio Index: $R780 / R635$ ▪
MCARI1: Modified Chlorophyll Absorption Ratio Index 1: $1.2 * (2.5 * (R780 - R670) - 1.3 * (R780 - R550))$
OSAVI: Optimized Soil - Adjusted Vegetation Index: $(1 + 0.16) * (R780 - R670) / (R780 + R670 + 0.16)$ ▪
G: Greenness Index: $R554 / R677$
MCARI: Modified Chlorophyll Absorption Ratio Index: $((R700 - R670) - 0.2 * (R700 - R550)) * (R700 / R670)$
TCARI: Transformed CAR Index: $3 * ((R700 - R670) - 0.2 * (R700 + R550)) * (R700 / R670)$
TVI: Triangular Vegetation Index: $0.5 * (120 * (R750 - R550) - 200 * (R670 - R550))$
ZMI: Zarco - Tejada & Miller Index: $R750 / R710$ ▪
SRPI: Simple Ratio Pigment Index: $R430 / R680$
NPQI: Normalized Phaeophytinization Index: $(R415 - R435) / (R415 + R435)$

PRI: Photochemical Reflectance Index: $(R531 - R570) / (R531 + R570)$
NPCI: Normalized Pigment Chlorophyll Index: $(R680 - R430) / (R680 + R430)$
Ctrl1: Carter Indices 1: $R695 / R420$ Ctrl2: Carter Indices 2: $R695 / R760$
PSNDa: Pigment specific normalised difference a: $(R780 - R680) / (R780 + R680)$
SIPI: Structure insensitive pigment index: $(R780 - R450) / (R780 - R650)$
GM1: Gitelson and Merzlyak Indices 1: $R750 / R550$ GM2: Gitelson and Merzlyak Indices 2: $R750 / R700$ ▪
ARI1: Anthocyanin Reflectance Index 1: $1 / R550 - 1 / R700$ ARI2: Anthocyanin Reflectance Index 2: $R790 * (1 / R550 - 1 / R700)$
CR1: Carotenoid Reflectance Index 1: $1 / R510 - 1 / R550$ CR2: Carotenoid Reflectance Index 2: $1 / R510 - 1 / R700$
RDVI: Renormalized Difference Vegetation Index: $(R780 - R670) / ((R780 + R670) ^ 0.5)$

Table 2 List of reflectance indices used in PolyPen. Indices measured also by RP 410 NIR are marked with “▪” symbol.

2.6 TECHNICAL SPECIFICATION

Detector	
Spectral range	380 nm – 790 nm (RP 410 UVIS) 640 nm – 1050 nm (RP 410 NIR)
Spectral response half width	8 nm
Spectral straylight	-30 dB
Scanning speed	About 100 ms
Dynamic range	High gain: 1:4300 Low gain: 1:13000
Size of aperture	7 mm
Light source	
Light source spectral range	Xenon incandescent lamp 380-1050 nm
Internal memory capacity	Up to 16 Mbit
Internal data logging	Up to 4,000 measurements
Data transfer	USB cable
PC software (OS)	SpectraPen (Windows 11)
Battery	
Battery type	Li-Ion rechargeable battery
Battery capacity	2600 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
Further notes	
Sample holder	Mechanical leaf clip
Display	Touchscreen 240 x 320 pixel; 65535 colors
Built in GPS module	Ultra-high sensitivity down to -165dBm, accuracy <1.5 m in 50% of trials
Size	150 x 105 x 40 mm

Weight	345 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)
Size (mm)	154 x 100 x 46
Weight (g)	343
Operating conditions	Temperature: 0 to + 55 °C, rel. humidity: 0 to 95 % (non-condensing)
Storage conditions	Temperature: -10 to + 60 °C, rel. humidity: 0 to 95 % (non-condensing)

2.7 HANDLING THE DEVICE AND CLEANING

2.7.1 POLYPEN

- The device should not come in contact with any organic solvents, strong acids or bases
- The device water protection qualifies as splashproof, do not submerge the device in water
- Avoid sharp objects when using touch screen
- Avoid contamination of the reflectance standart. Keep the standart clean and free of dust
- To prolong battery lifespan do not store the device completely discharged, avoid extreme temperatures



Recalibrating the device at least once every two years to maintain optimal performance is recommended.

Clean the surface with soft and wet non-abrasive tissue.

The detector chamber with the clip can be removed for the purpose of cleaning. Unscrew the bolts on the optical head and wipe the inner surfaces carefully with a wet cloth or cotton bud.



Fig. 4 Optical head can be removed for the purpose of cleaning. The part is attached to the device by 2 screws (red arrows)

2.7.2 REFLECTANCE STANDARD

If the material is lightly soiled follow the instructions below:

- Brush with purified water, a detergent and ethanol
- Rinse with purified water
- Let dry in a dust and lint free environment or dry with pressured clean air

For heavier soil, the material can be cleaned by sanding under running water with a 220 - 240 grit waterproof emery cloth until the surface is totally hydrophobic (water beads and runs off immediately). Blow dry with clean air or nitrogen or allow material to air dry.

3 GETTING STARTED

3.1 CHARGING

PolyPen comes with a USB cable that is required for charging the battery. This cable is also used for data transfer to computer. To connect the USB cable to the device follow these instructions (Fig. 5). Take the round connector end of the provided USB cable

1. Insert the round connector end to the round USB socket at the bottom of the device (Fig. 5A-D).
2. Screw and tighten the connector on the cable side (Fig. 5E-F).
3. Connect the other end of the USB cable to a PC, power bank or a USB charger
4. The device starts to charge automatically
5. When switched OFF large charging icon appears on the device display. When ON the battery icon on the display (Fig. 6) indicates the actual charge status.

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.

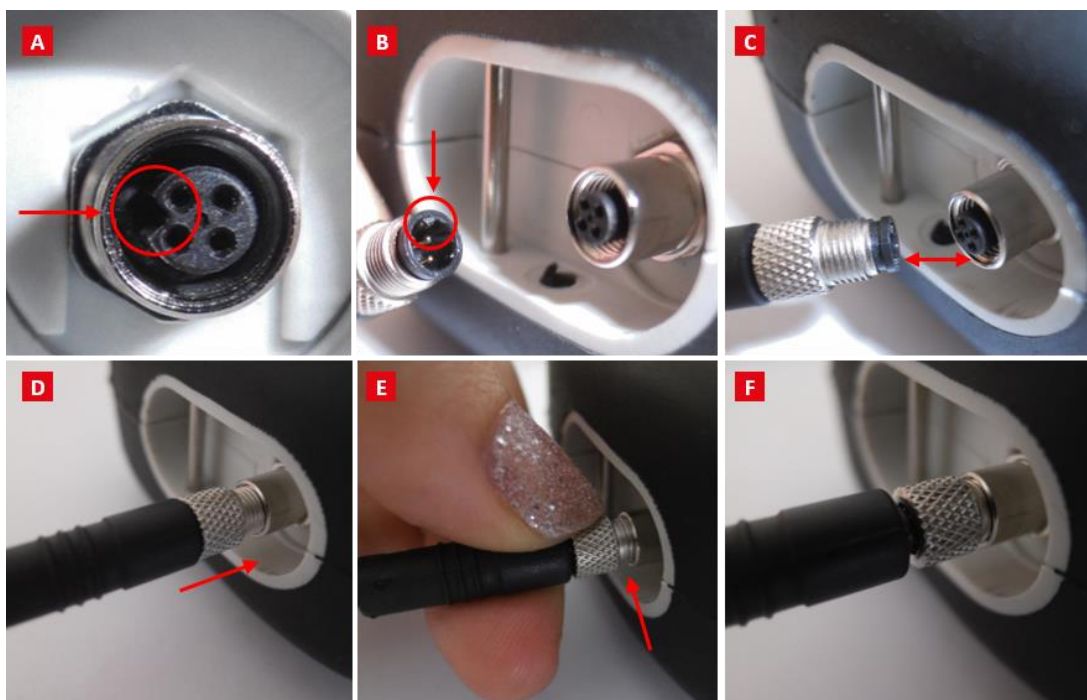


Fig. 5 Picture instructions on how to connect the USB cable to the Spectrapen. A) connector on the SpectraPen device. B) Portion of the USB cable with pins. C – E) Position the cable horizontally and line up the green circled parts of the cable and the connector, plug in the inlet and screw the securing screw. F) Correct connection of the USB cable and Pen device.

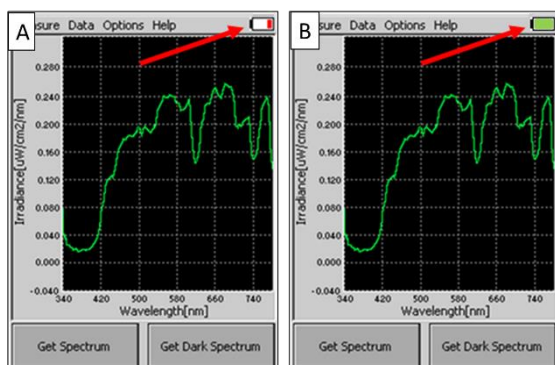


Fig. 6 Battery status indicator showing battery status: discharged A, charged B

	Before use ensure the device is charged. When fully charged around 500 samples can be measured. Avoid storing the device with discharged battery.
	Note that if the <i>Button measure</i> option is enabled in device settings switching the device OFF can be only done by pressing and holding the power button for 2 seconds.

3.2 CALIBRATION AND MEASUREMENT

The device is switched ON by pressing the power button.

The device is switched OFF by pressing the power button again and confirming the dialog on the display by OK button. Alternatively holding the power button for 2 seconds can also switch the device OFF.

3.2.1 WHITE REFERENCE

The calibration with white reference standard is performed upon switching ON the device. The calibration should be renewed when measuring large series of samples after a certain time period or group of samples.

To calibrate follow these instructions:

- Switch on the device and tap Calibrate. When switched on the Calibrate button always appears on the display.
- Open the leaf clip and insert reflectance standard under leaf clip so the white surface is facing the measurement chamber and release the leaf clip.
- Confirm with *OK* to take the white calibration. This value is automatically stored in the device memory.
- Confirm this step with *OK* and proceed to measure plant samples. The *Calibrate* button changes to *Get reflectance* button (Fig. 7).

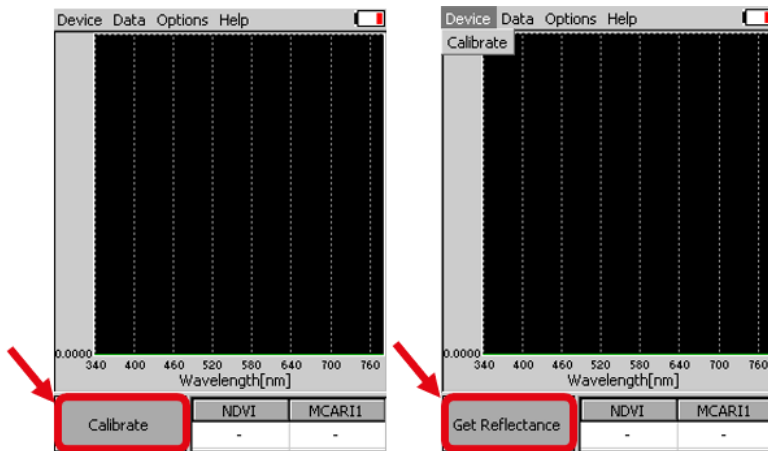


Fig. 7 Calibration and measurement buttons on the PolyPen display

3.2.2 DARK REFERENCE

Dark reference spectrum is measured automatically before each measurement. This feature can not be controlled by the user. The dark calibration proceeds immediately before the light for illumination of the sample comes on.



The dark calibration profile can be exported along with raw reflectance data from the Spectrapen app (*Data download -> Export -> Raw data*). In the exported table the corresponding column is named *Dark* and precedes the raw reflectance values named as *Reference* (reflectance standart) or *Transmittance* (plant sample).

3.2.3 MEASUREMENT

After calibration it is possible to proceed to measure plant samples.

To measure follow these instructions:

- Open the leaf clip and insert a leaf sample with adaxial surface facing and release the leaf clip. The leaf clip helps to immobilize the leaf sample during measurement.
- Tap Get Reflectance and wait.
- When completed, *Spectrum saved ID # ...* appears on the display.
- Confirm with *OK*.
- Measurement is automatically displayed and stored in device memory.

4 DISPLAY MENU

4.1 DEVICE > CALIBRATE OPTION

Calibrate option can be run anytime to recalibrate the white reference. This can be done anytime between measurements by selecting *Device > Calibrate* option (Fig. 8), inserting the calibration standard in the leaf clip and tapping *Get Reflectance*.

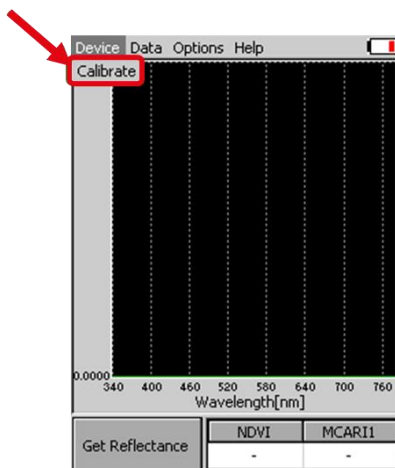


Fig. 8 Repeated calibration of the device.



Each reading is stored with a unique ID. Erasing the last reading does not release the ID number for use in the next measurement. Rather it is marked as "invalid and not shown in the device (firmware) as well as in the computer (Spectrapen software)

4.2 DATA

In the *Data* menu 4 options are available (Fig. 9):

Browse

Displays two data browse dialog windows.

- 1) The Reflectance window shows a table of stored data. The reflectance or absorbance mode of calculation can be chosen in *Options > Settings > > Graph*.
- 2) In Indices window the table shows one index selected in *Options > Settings > > Indices* calculated for each measurement.

Up to 3 sets of collected data can be displayed at once by checking or unchecking items in the last column in the table.

Memory info

Displays info on current status of device memory

Erase all

Erases internal data memory

Erase last marks the actual (last) reading as invalid and removes the reading from the data table

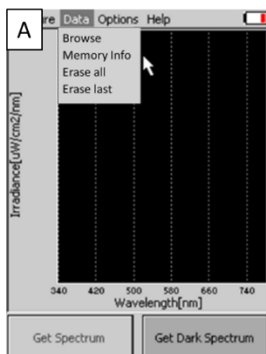


Fig. 9 Data menu

4.3 OPTIONS > SETTINGS

Select *Options* -> *Settings* to open the *Settings* table (Fig. 10). The menu contains 6 groups.

Indices

The PolyPen device calculates most commonly used plant reflectance indices (e.g., NDVI). The last measurement is displayed on the main screen as a transmittance (reflectance) profile and 2 indices. The displayed indices are selected in *Settings* > *Indices* (Fig. 10 A). All indices are calculated and stored in device memory.

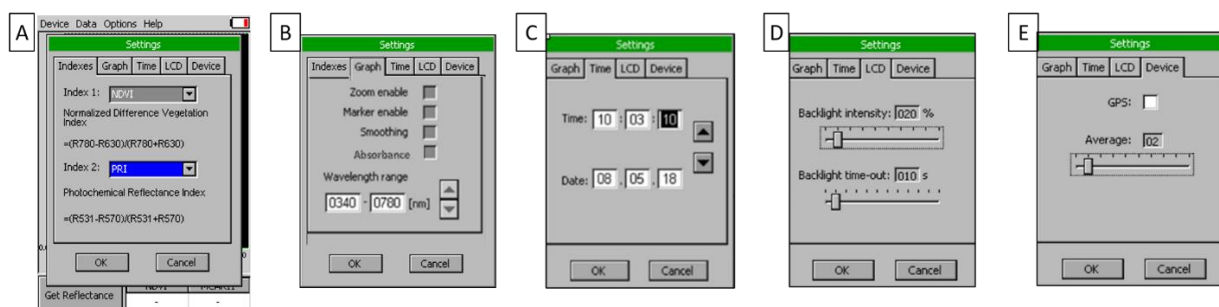


Fig. 10 A) Indexes settings, B) Graph settings, C) Time, D) LCD, E) Device

Graph

Displays settings for graph features displayed on the main screen (Fig. 10 B).

Zoom enable – enables the zoom feature. Select a rectangle by moving the stylus over the graph obliquely in left to right direction. To zoom out back repeat the movements in right to left direction.

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.

Absorbance – select this option for displaying absorbance values instead of transmittance

Wavelength range – defines the range of wavelengths considered for reflected light measurements. Select the wavelength range with the arrows facing up and down.



The wavelength range setting applies only to direct viewing or browsing the intensity values. For data upload the device always saves the whole spectrum.

Time

The time feature is used to date all measured data. To set the time and date use the up and down arrows on the right side of the settings window (Fig. 10 C)

LCD

Two parameters can be adjusted on the LCD display (Fig. 10 D):

Backlight intensity Move slider to adjust backlight 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).

4.4 DEVICE

The Options - > Device menu has 3 items (Fig. 10 E)

GPS

Enable 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 readings for average reading calculation. Averaging of multiple readings results in a higher signal-to-noise ratio but increases the time to obtain the final reading. Only the final reading appears on the screen. Move slider to set a number of measurements to be acquired for calculation of the reading as average of multiple measurements (Fig. 10 E).

Button measure

The button for powering ON/OFF can be used for taking measurements same way as the software Get Spectrum button.

4.5 HELP

In the *Help* menu select *About...* to view information about the device

- name and type
- serial number
- hardware version
- software version

5 SPECTRAPEN APP

5.1 SOFTWARE PREPARATION

5.1.1 INSTALLATION

To download data from the device install *SpectraPen* software on a computer that runs on a Microsoft Windows Operating System. The software installation is done automatically by executing the *SpectrapenPenPackageInstaller.exe* file.

1. **Insert the provided USB stick to the computer** and find the executable file in the *Software* folder. It is also possible to download the exe file from PSI web page at <https://psi.cz/support/downloads/hd001/polp001/>.
2. **Run the installer file** Select the exe file and then select *Open* from the menu after right mouse clicking. Alternatively double click the exe file (Fig. 11) with the left mouse button.
3. **SpectraPen Install Package wizard opens.** Proceed through the steps as is shown in Fig. 11. The Spectrapen app will be stored locally (*C:\Program Files (x86)\PSI\Spectrapen* by default). The USB driver will be updated and a SpectraPen shortcut icon will appear on the desktop.

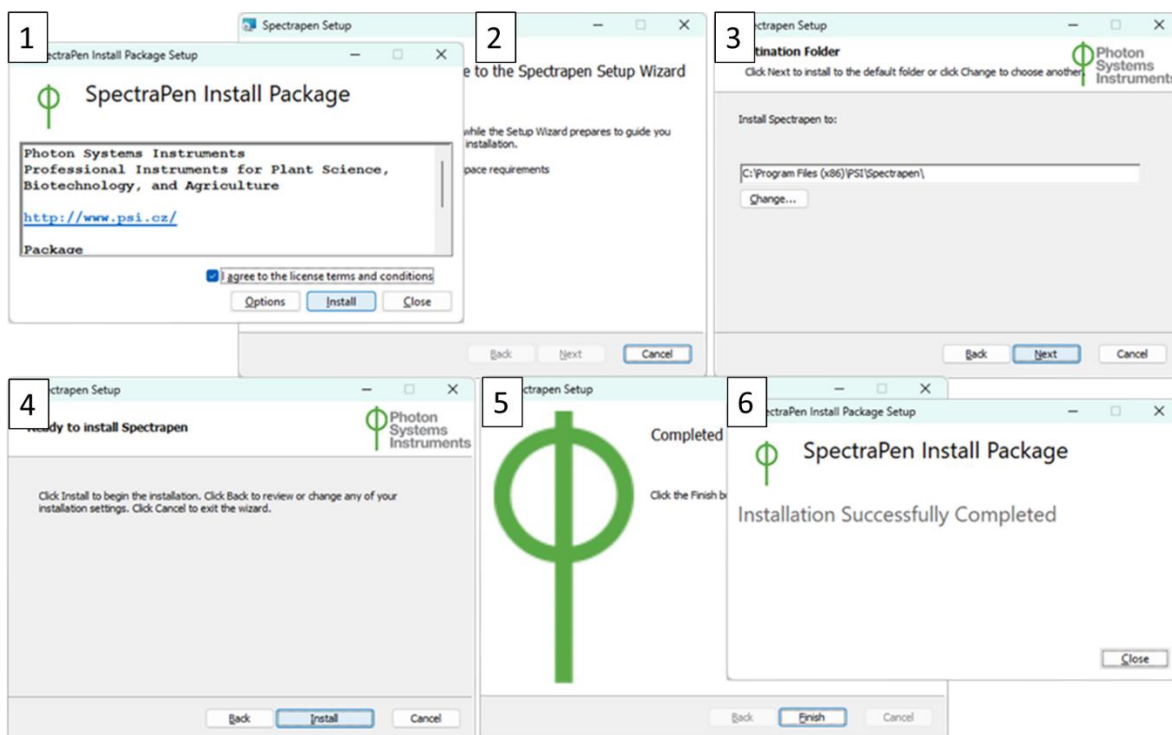


Fig. 11 Spectrapen installation procedure

5.1.2 ESTABLISHING COMMUNICATION

1. Connect the device with USB cable
2. Switch the device ON by pressing the power button
3. Open the Spectrapen application by clicking the Spectrapen.exe file in the *PSI\Spectrapen* folder or the shortcut on the desktop.
4. In the Spectrapen app go to *Device* → *Connect*. The software searches for the device and indicates the status on the bottom bar of the window. This step usually takes several seconds.

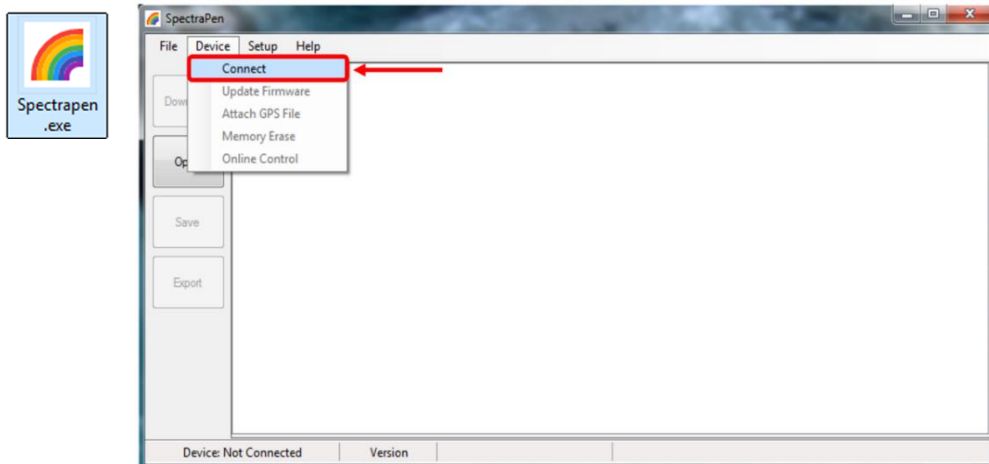


Fig. 12 Connecting the Spectrapen software

5.1.3 DEVICE REGISTRATION

Proceed with device registration (Fig. 13). This step enables downloading data from the device to the computer.

1. Open a text file *Registration code.txt* in the *Software* folder on the USB stick provided with the device
2. Select *Help -> Register* and enter your registration number
3. Click *Register*, the SpectraPen *Download* button activates with the registration.

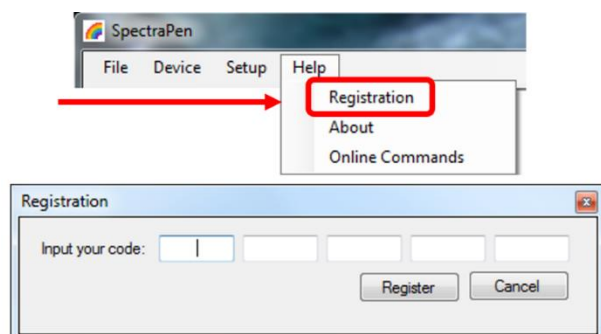


Fig. 13 Software registration.

5.2 MAIN MENU

5.2.1 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.

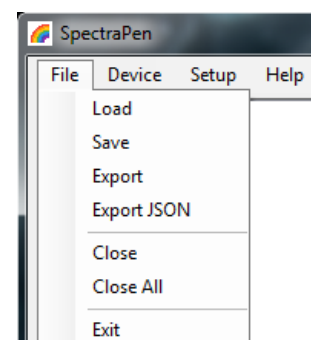
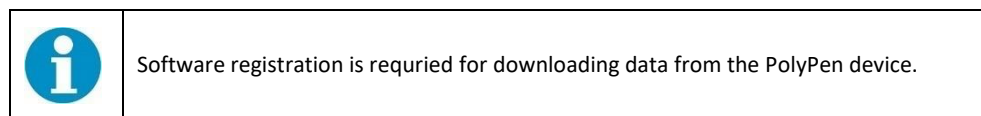


Fig. 14 Menu File.

Exit Exits the program.



5.2.2 DEVICE

Connect Detects and connects the device.

Update Firmware Reinstall device software.

Attach GPS File Download data from the GPS module.

Memory Erase Erases data from the SpectraPen memory.

Online Control Online control of SP device.

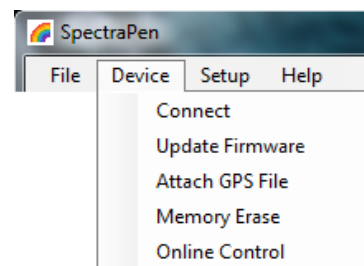


Fig. 15 Menu Device.

5.2.3 SETUP

Update Software Activates when a new version of Spectrapen software is available online

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).

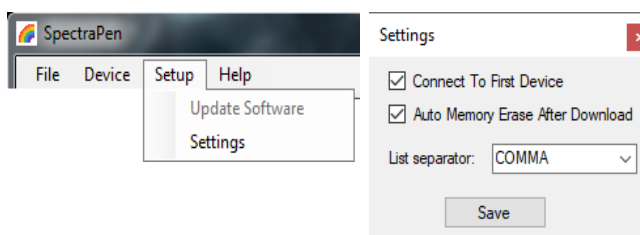


Fig. 16 Menu Setup and Settings options

5.2.4 HELP

Registration Used for device registration.

About Offers basic information about the program.

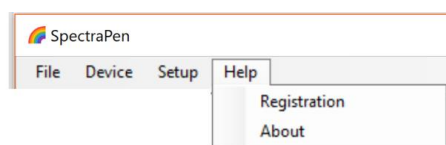


Fig. 17 Menu Help.

5.3 DATA MANAGEMENT

5.3.1 DOWNLOADING DATA AND VISUALIZATION

1. Connect the device to a computer with the provided USB cable.
2. Switch the device ON.
3. Start the SpectraPen software. In the *Device* menu select *Connect*.
4. When connected upload data with the *Download* button or select *Load* in the *File* menu.
5. All data from the PolyPen device will be uploaded and shown in the main window. Individual readings are displayed as time stamps.
6. The data type menu has 3 options (Fig. 18): Absorbance, Transmittance and Scope. *Scope* displays intensities of reflected light with dark current subtracted. For spectrally calibrated reflectance data open the *Transmittance* window.

7. Select measurements displayed in the graph by marking and unmarking selection checkboxes in the list of measured data (Fig. 18).
8. Click with the right mouse button on the measurement item to edit the measurement items in the graph. It is possible to 1) Select or 2) Clear all measured data, 3) Edit measure name or 4) Delete measure name.

	Software registration is required for downloading data from the PolyPen device. If no data is stored in the device the <i>Download</i> button is not active.
	Scope mode represents non-calibrated spectrum.

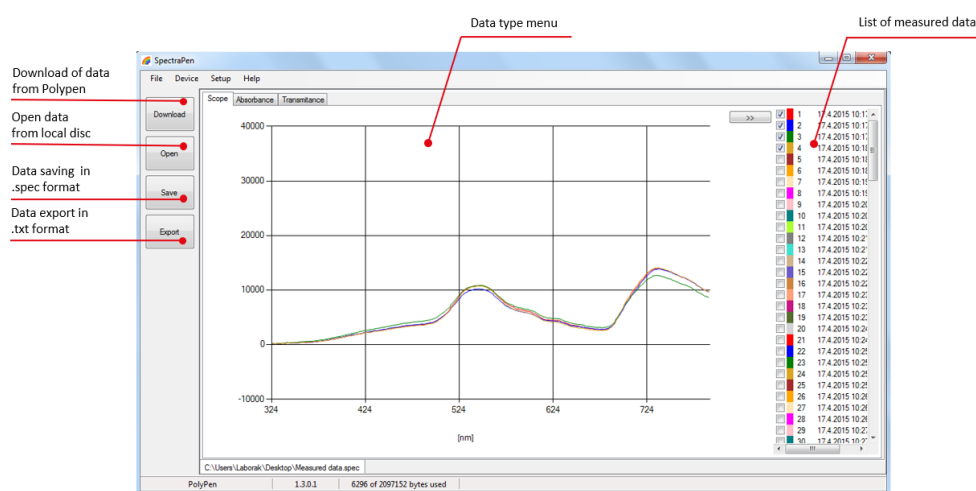


Fig. 18 Scope spectra

9. Right click on the list of measured data to edit data name, delete selected measurement or show and hide all measured data in the graph.

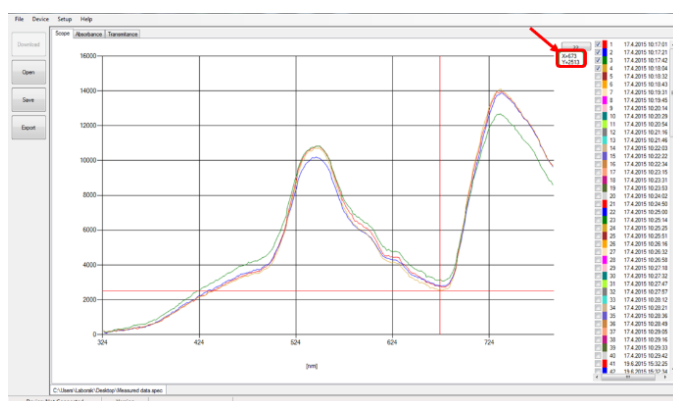


Fig. 19 Marker feature.

10. 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. 19). 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.
11. To **zoom in on the data displayed in the graph** select an area of the displayed graph. To reverse these steps and return to original display use minus icon in the corners of the zoom area marked with green rectangles in Fig. 20.

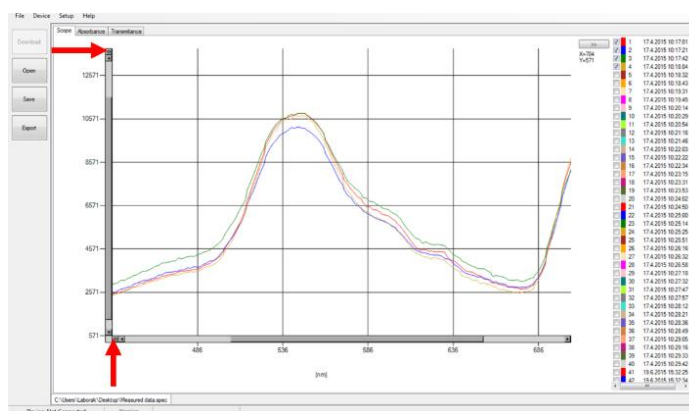


Fig. 20 Zoom function.

To view the spectral data as parameter values click the two arrows button (Fig. 21). Each parameter is separated with colon; the first one is data set, which will be used as source data (leave their Transmittance); the second is name of the created parameter; the third is description of created parameter and the last one is formula of the new parameter. After you edit the Formulas file, restart the SpectraPen software. Your index should appear in the list and also in the exported data.

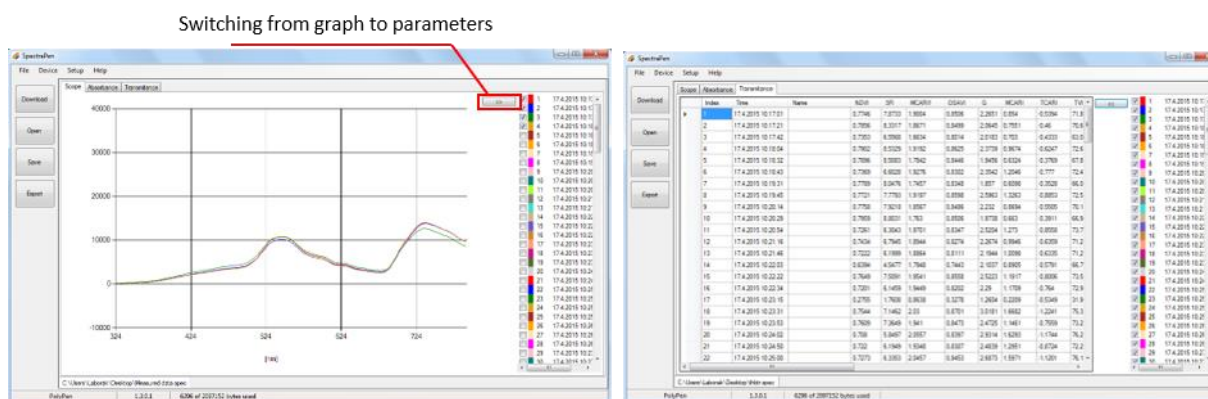


Fig. 21 Switching from graph to calculated values.

12. To Save all data stored in the device select **File > Save** and create a name and path for storing a binary .spec file. This file can be later reopened in the Spectrapen software. All data stored in the device memory will be saved irrespective of the data selection in the SpectraPen softwareData Export.

5.3.2 DATA EXPORT

To export data **File->Export**. The **Export** window allows to select which type of data should be exported (Fig. 22).

Raw Data raw data only, along with light readings dark current readings are exported

Scope light intensities with dark current subtracted, no calibration to irradiance units

Transmittance Reflected intensities are shown as *Transmittance* values. The reason is that the software is designed for use with various spectrometers. In conjunction with the PolyPen device the word "transmittance" should be understood as reflectance. All indices are calculated only from transmittance values.

Absorbance PolyPen RP410 measures reflected light. This type of data has very little use. The absorbance was introduced to the software mainly due to the Polypen-Aqua version of this device.

Computed Data The export of computed data is based on the editable *formulas.txt* file. Three types of computed data can be exported: Transmittance, Absorbance and Scope.

Export interpolation –intensity profiles of measured bands are recalculated to 1 nm wide bands. For each measurement the device interpolates the reflectances measured at bands (e.g. 528.3, 530.2, 532,533.9,...) to distinct wavelength lengths defined by whole numbers (e.g. 528, 529, 530, 531,...).

13. In the Export window click *Export* button. In the *Export File Settings* window (Fig. 22C) select data and file type.

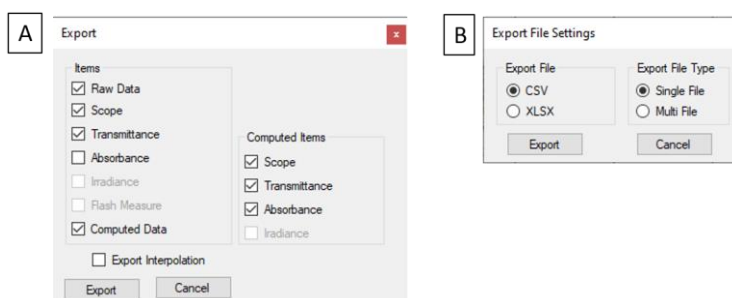


Fig. 22 Export options

5.3.3 PROGRAMMING CUSTOM INDICES

The SpectraPen software enables programming custom indexes in the range of measured spectrum.

1. Open the SpectraPen folder in your PC. Usually the program installs in the Program Files folder (C:\Program Files (x86)\PSI)
2. Open Formulas.txt file located in Config folder (C:\Program Files (x86)\PSI\Spectrapen\Config)
3. Write your index into the .txt file The text file Formulas.txt can be edited to create formulas for different light intensity or light index calculation. The newly defined formulas can be created based on predefined template formulas (see the text in red). When editing new formulas follow a few rules summarized in the appendix of this manual on page 30. Each parameter is separated with colon: the first one is data set, which will be used as source data (Transmittance); the second is name of the created parameter; the third is description of created parameter and the last one is formula of the new parameter. Refer to the list of indices in the appendix, 9.2.
4. Save the txt file and restart the SpectraPen Software.
5. The new index is displayed in the SpectraPen software.



Reflected intensities are shown as *Transmittance* values. The reason is that the software is designed for use with various spectrometers. In conjunction with the PolyPen device the word "transmittance" should be understood as reflectance.

All indices are calculated only from transmittance values. Since PolyPen RP410 measures reflected light, the absorbance recalculation has very little use with this device. The absorbance was actually introduced to the software with the Polypen-Aqua version of the device.

6 ONLINE CONTROL

Menu Online Control

This function can be used for remote - online control of the PolyPen 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. 23)

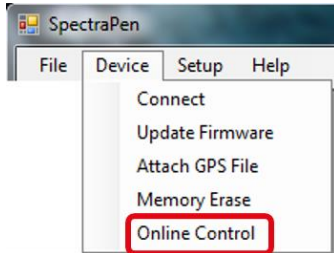


Fig. 23 Online Control.

Remote measurement

For manual remote measurement click *Get* button (Fig. 24 - 1).

1. Setting for automated remote measurement is possible using the button with three dots (Fig. 24 - 3). Here the time interval (Fig. 24 - 5) of the measurement is set. To apply this setting use the option *Use settings* (Fig. 24- 4) and confirm by clicking *OK* (Fig. 24 - 6). The measurement starts immediately and continues until it is manually stopped (*Stop* button).
2. Use the **export** option for exporting the data to .csv file.
3. **Clear** function serves for erasing of data measured by Online Control.



Please note that calibration must be done prior the remote measurement.

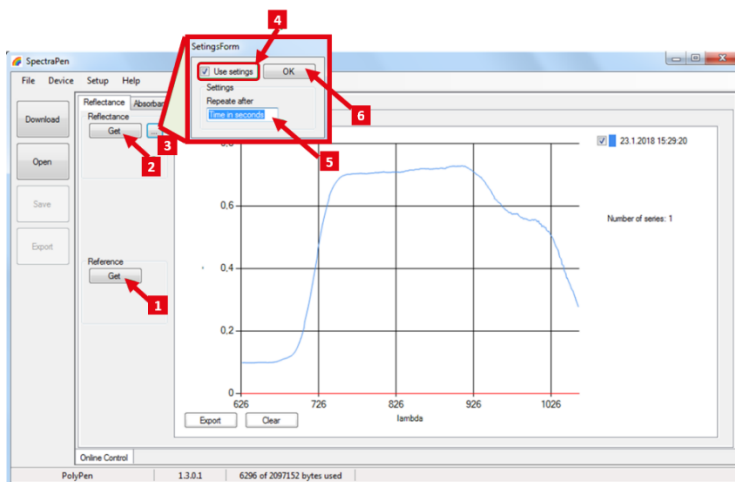


Fig. 24 Setting of reflectance or absorbance measurements in online control.

Settings

The following functions may be set up for remote operation of the PolyPen:

- Time synchronization of the device and PC (Fig. 25 - 1)
- GPS built-in module activation (Fig. 25 - 2)
- Averaging of measurement, set from 1 to 10 measurements (Fig. 25 - 3)

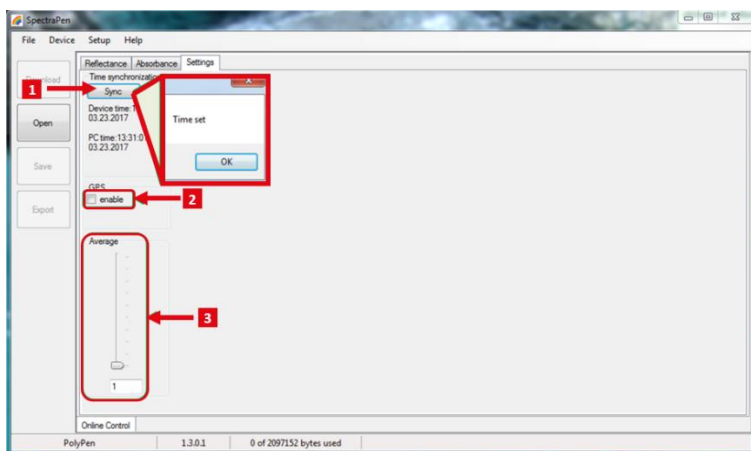


Fig. 25 Settings of online control.

6.1 FIRMWARE UPDATE

In case of certain problems with device function update of device firmware may be necessary. The update is done with a file provided by PSI.

1. Connect the device.
2. In the SpectraPen main menu Select: *Setup -> Update Firmware From File*.
3. Select the provided *.bxn* file and click *Open*.
4. Click *OK* to update the device firmware. The bottom bar indicates the progress.



All data is erased with firmware update.
Incompatible version of firmware can cause device malfunction.

7 GPS MODULE

PolyPen device allows to access to location and timing signals from satellites. The integrated GPS module can be switched on for geotagging the readings with with accuracy around 4 meters. When measuring with activated GPS module geographic coordinates are automatically saved and can be displayed or later downloaded with the readings.



For proper function of the GPS module accurate time settings in the device and the computer is necessary.

Measuring with GPS

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. 26)
 - Wait until the position flag icon in the upper menu stops flashing (Fig. 26). You may need to move to open space area to acquire satellite signal
3. Perform measurements
4. Connect the SpectraPen to the computer and in the SpectraPen software download the measured data. Example of data tagged with GPS coordinates is shown in Fig. 27.

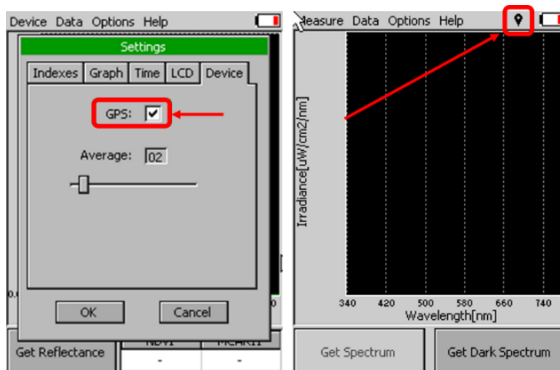


Fig. 26 Activation of GPS

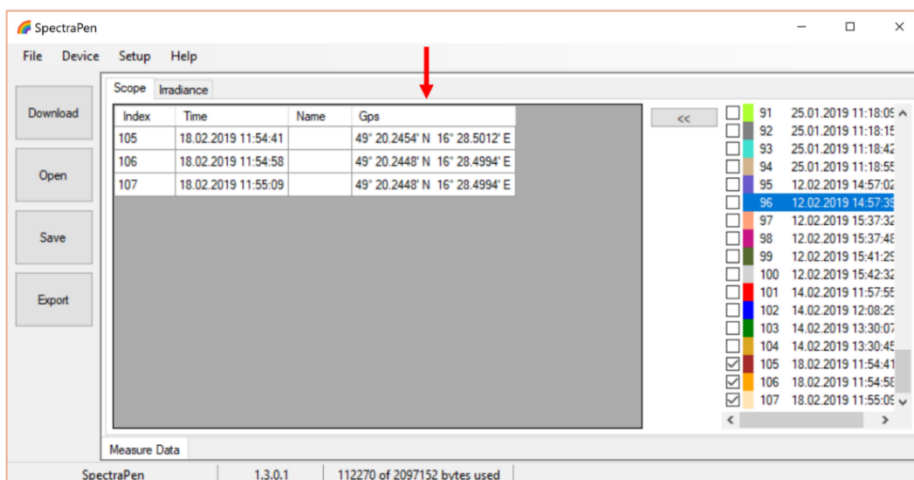


Fig. 27 Data tagged with GPS coordinates.

8 WARRANTY AND SERVICE SUPPORT

8.1 WARRANTY TERMS AND CONDITIONS

This Limited Warranty applies only to the PolyPen 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.

8.2 PRODUCT AND CONTACT INFORMATION

Name of product	PolyPen RM 410
Manufacturer	PSI (Photon Systems Instruments, spol. s r. o.)
Serial number	displayed on the back side of the device
Address	Prumyslova 470, 664 24 Drasov
Country of Origin	Czech Republic
Customer service portal	https://psi.cz/support/service-portal/
E-mail	info@psi.cz , support@psi.cz

8.3 TROUBLESHOOTING AND CUSTOMER SUPPORT

For information about the device

- visit our web page at <https://handheld.psi.cz/products/spectrapen-lm/>
- contact your local distributor
- send an email to info@psi.cz.

In case of problems with the device or Spectrapen software

1. review our FAQs at <https://handheld.psi.cz/faqs/#general-questions> or <https://handheld.psi.cz/faqs/#spectrapen-lm>

2. contact your local distributor or send an email to customer support at *support@psi.cz*.
3. To ensure your questions are addressed promptly, we kindly ask you to use our service portal: <https://psi.cz/support/service-portal/>. Your request will be automatically directed to the appropriate product specialist for faster assistance.

9 APPENDIX

9.1 LIST OF SYNTAX RULES FOR PROGRAMMING NEW INDICES IN *SPECTRAPEN* SOFTWARE

Min, max – minimum or maximum value

min(value1, value2) where value1 or value 2 is a number, variable, function

min(array) where array is an 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 – natural logarithm with base *e*

ln(value) where value is a number, variable, function

example1: ln(5)

example2: ln(Irradiance[760nm])

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

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

log – logarithm with base definition.

log_B(value) where value is a number, variable, function and B is base number

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 number

sqrt(value) where value is a number, variable, function

example1: sqrt(5)

example2: `sqrt(Scope[760nm])`

example3: `sqrt(max(Scope[550nm], Scope[480nm]))`

example4: `sqrt(((5 + 4)*4) + 6)`

^ - exponentiation of a base raised by exponent (power)

value^{*power*} where value is a number, variable, function and power is a 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) where from,to are limit values and function_values are input values for integral compute

example1: `integral(IrradianceL, 360nm, 700nm)`

example2: `integral(IrradianceE, 360nm, 700nm) * IrradianceE[450nm]`

9.2 LIST OF PROGRAMMED INDICES

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[750nm]/Transmittance[710nm]

Transmittance:SPRI:Simple Ratio Pigment Index:Transmittance[430nm]/Transmittance[680nm]

Transmittance:NPQI: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: $\text{Transmittance}[695\text{nm}] / \text{Transmittance}[420\text{nm}]$
 Transmittance: Ctr2: Carter Indices 2: $\text{Transmittance}[695\text{nm}] / \text{Transmittance}[760\text{nm}]$
 Transmittance: PSNDa: Pigment specific normalised difference a: $(\text{Transmittance}[780\text{nm}] - \text{Transmittance}[680\text{nm}]) / (\text{Transmittance}[780\text{nm}] + \text{Transmittance}[680\text{nm}])$
 Transmittance: SIPI: Structure insensitive pigment index: $(\text{Transmittance}[780\text{nm}] - \text{Transmittance}[450\text{nm}]) / (\text{Transmittance}[780\text{nm}] - \text{Transmittance}[650\text{nm}])$
 Transmittance: GM1: Gitelson and Merzlyak Indices 1: $\text{Transmittance}[750\text{nm}] / \text{Transmittance}[550\text{nm}]$
 Transmittance: GM2: Gitelson and Merzlyak Indices 2: $\text{Transmittance}[750\text{nm}] / \text{Transmittance}[700\text{nm}]$
 Transmittance: ARI1: Anthocyanin Reflectance Index 1: $1 / \text{Transmittance}[550\text{nm}] - 1 / \text{Transmittance}[700\text{nm}]$
 Transmittance: ARI2: Anthocyanin Reflectance Index 2: $\text{Transmittance}[790\text{nm}] * (1 / \text{Transmittance}[550\text{nm}] - 1 / \text{Transmittance}[700\text{nm}])$
 Transmittance: CRI1: Carotenoid Reflectance Index 1: $1 / \text{Transmittance}[510\text{nm}] - 1 / \text{Transmittance}[550\text{nm}]$
 Transmittance: CRI2: Carotenoid Reflectance Index 2: $1 / \text{Transmittance}[510\text{nm}] - 1 / \text{Transmittance}[700\text{nm}]$
 Transmittance: RDVI: Renormalized Difference Vegetation Index: $(\text{Transmittance}[780\text{nm}] - \text{Transmittance}[670\text{nm}]) / ((\text{Transmittance}[780\text{nm}] + \text{Transmittance}[670\text{nm}])^{0.5})$

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