

PlantPen NDVI & PRI

Manual and User Guide

Please read this manual before operating this product



© PSI (Photon Systems Instruments), spol. s r. o. (hereinafter PSI), 2018

This document and its parts can be copied or provided to a third party only with the express permission of PSI.

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.

TABLE OF CONTENTS

1	Information Before Using PlantPen Device.....	6
2	Technical Specification.....	7
3	General Information	8
3.1	Device Description.....	9
4	List of Equipment and Customer Information	10
5	Care and Maintenance.....	11
6	Principle of Measurement	12
7	How to Get Started	13
7.1	PRI Measurement.....	13
7.1.1	Calibration	13
7.1.2	Measurement.....	13
7.2	NDVI Measurement.....	14
7.2.1	Calibration	14
7.2.2	Measurement.....	14
8	Control Menu Tree.....	15
9	USB Connection	20
10	Bluetooth Connection.....	21
10.1	Bluetooth Pairing.....	21
11	FluorPen Software	25
11.1	Software Installation	25
11.2	Menu and Icon Explanation.....	26
11.2.1	Main Menu	26
11.2.2	Menu Settings.....	27
11.2.3	Menu Online Control	28
11.3	Data Transfer and Visualization.....	29
11.4	Firmware Update.....	31
12	GPS Module	33
12.1	GPS / PlantPen Operation	33
12.2	Data Download.....	34

13 Warranty Terms and Conditions 35

14 Troubleshooting and Customer Support 36

1 INFORMATION BEFORE USING PLANTPEN DEVICE

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

	By accepting the device, the customer agrees to follow the instructions in this guide.
---	--

Always follow corresponding manuals while working with the PlantPen device or doing the maintenance.

It is forbidden to interfere with the hardware or software of the PlantPen 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.

Tab. 1 Used symbols.

2 TECHNICAL SPECIFICATION

Protocols	
PlantPen PRI 210	Photochemical Reflectance Index $PRI = (R531 - R570) / (R531 + R570)$ Reference: Sellers et al. (1985)
PlantPen NDVI 310	Normalized Difference Vegetative Index $NDVI = (R740 - R660) / (R740 + R660)$ Reference: Rouse et al. (1974)
LED lighting	
PlantPen PRI 210	Dual wavelength light source R531 = 531 nm, R570 = 570 nm
PlantPen NDVI 310	Dual wavelength light source VIS = 635nm, NIR = 760nm
Detector	
Type	PIN photodiode with bandpass filters
Wavelength range	From 500 to 600 nm (PRI 210) From 620 to 750 nm (NDVI 310)
Data storage and transfer	
Internal memory capacity	Up to 16 Mb
Internal data logging	Up to 100,000 measurements
Data transfer	USB cable Bluetooth (transfer up to 3Mbps for distance up to 20m)
PC software	FluorPen 1.1 (Windows 7 and higher)
Battery	
Type	Li-Ion rechargeable battery
Capacity	2000 mAh
Max. charging current	0.5 A
Charging	Via USB port - PC, power bank, USB charger, etc.
Battery life	70 hours typical with full operation Low battery indicator
Other	
Sample holder	Mechanical leaf-clip
Display	Graphical display
Keypad	Sealed, 2-key tactile response Turns off after 5 minutes of no use
Built in GPS module	Ultra-high sensitivity down to -165dBm High accuracy of <1.5 m in 50% of trials
Size	135 x 65 x 33 mm
Weight	188 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 GENERAL INFORMATION

The PlantPen model **PRI 210** measures **Photochemical Reflectance Index** (PRI) in two narrow wavelength bands centered close to 531 nm and 570 nm. The photochemical reflectance index ($PRI = (R_{531} - R_{570}) / (R_{531} + R_{570})$) correlates with the epoxidation state of xanthophyll cycle pigments and photosystem efficiency in many studies under diverse conditions, such as different ¹. PRI is sensitive to changes in carotenoid pigments that are indicative of photosynthetic light use efficiency, the rate of carbon dioxide uptake, or as a reliable water-stress index. As such, it is used in studies of vegetation productivity and stress.

The PlantPen model **NDVI 310** measures **Normalized Difference Vegetation Index**, which is an important indicator of chlorophyll content in plants. The pigment in plant leaves, chlorophyll, strongly absorbs visible light (from 0.4 to 0.7 μm) for use in photosynthesis. The cell structure of the leaves, on the other hand, strongly reflects near-infrared light (from 0.7 to 1.1 μm). The differences in plant reflectance in the visible and near-infrared wavelengths is used to calculate NDVI index as follows: $NDVI = ((NIR - VIS) / ((NIR + VIS)))$, where VIS and NIR stand for the spectral reflectance measurements acquired in the visible (red) and near-infrared regions, respectively. NDVI is directly related to the photosynthetic capacity and hence energy absorption of plant canopies ². The **NDVI 310** device compares reflected light at two distinct wavelengths, 635 and 760 nm.

PlantPen can be operated as a stand-alone instrument and thus is ideal for field studies. Measured data are sequentially stored in the internal PlantPen memory. Data transfer is via USB or Bluetooth communication. Comprehensive FluorPen 1.1 software provides data transfer routines and many additional features for data presentation in tables and graphs.

¹ John Gamon, Josep Penuelas, and Christopher Field (1992). A narrow-waveband spectral index that tracks diurnal changes in photosynthetic efficiency. *Remote Sensing of environment*, 41, 35-44.

² Sellers, P. J. (1985) 'Canopy reflectance, photosynthesis, and transpiration', *International Journal of Remote Sensing*, 6, 1335-1372.

3.1 DEVICE DESCRIPTION



Fig. 1 Device description.

4 LIST OF EQUIPMENT AND CUSTOMER INFORMATION

Standard version of the PlantPen device package consists:

- **PlantPen PRI 210 or PlantPen NDVI 310**
- **Carrying Case**
- **FluorPen software and driver** (on a USB flash disc)
- **Operation Manual** (PDF on a USB flash disc)
- **USB Cable**
- **Self-Adhesive Rubber Pads for Optics Protection**
- **Other Accessories or Optional Features** (according to your specific order)



For USB connection you need to have the USB driver installed in your PC. You find the driver on the installation disk (USB driver folder). For more information go to

If any item is missing, please, contact the manufacturer. Also check the carton for any visible external damage. If you find any damage, notify the carrier and the manufacturer immediately. The carton and all packing materials should be retained for inspection by the carrier or insurer.

For customer support, please write to: support@psi.cz

5 CARE AND MAINTENANCE

- Never submerge the device in water!
- The device should not come in contact with any organic solvents, strong acids or bases.
- Keep the optical part clean and dry. If cleaning is needed, use soft, non-abrasive tissue.
- Battery life is approximately 48 hours when the FluorPen is operated continuously.

6 PRINCIPLE OF MEASUREMENT

PlantPen is a reflectance-based device that provides a convenient method of measuring the relative chlorophyll content of a leaf sample.

The **PlantPen** model **PRI 210** (Fig. 2) measures **Photochemical Reflectance Index (PRI)** by comparing leaf reflectance in two narrow wavelength bands centered close to 531 nm and 570 nm. PRI is sensitive to changes in carotenoid pigments that are indicative of changes in photosynthetic light use efficiency, the rate of CO₂ uptake and as a reliable water-stress index. As such, it is used in studies of vegetation productivity and stress.



Fig. 2 PlantPen PRI 210.

The **PlantPen** model **NDVI 310** (Fig. 3) measures **Normalized Difference Vegetation Index (NDVI)**, which is an important indicator of chlorophyll content in plants. The pigment in plant leaves, chlorophyll, strongly absorbs visible light (from 0.4 to 0.7 μm) for use in photosynthesis. The cell structure of the leaves, on the other hand, strongly reflects near-infrared light (from 0.7 to 1.1 μm). The differences in plant reflectance in the visible and near-infrared wavelengths are used to calculate NDVI index. NDVI is directly related to the photosynthetic capacity and hence energy absorption of plant canopies.



Fig. 3 PlantPen NDVI 310.

7 HOW TO GET STARTED

For more detailed information on particular steps of PlantPen operation please refer to chapter 8.

The device works on Li-Ion battery or is charged via USB cable from PC or grid.

The PlantPen is controlled using two buttons:

- Use the **MENU** key to scroll through sequential menu options on the digital display.
- Use the **SET** key to select a menu option based on cursor (>) position.

7.1 PRI MEASUREMENT

7.1.1 CALIBRATION

Calibration assures you that your measurements are accurate within the specification limits that led you to select the instrument in the first place. It is better to calibrate your device before every set of samples. For Calibration of PlantPen use white reflectance standard. The calibration of the white reflectance standard is an indispensable part of a correct calculation of PRI.



It is necessary to calibrate PlantPen after every switch ON.

Prior PRI measurement perform the calibration as follows:

- For calibration use white reflectance standard (It is part of leaf clip)
- Turn ON device – hold **SET** button for 1 sec.
- Close the leaf clip (white standard is on bottom part of the leaf clip)
- Go to **Calibration** (“Insert white sample” appears on display)
- Press **SET** button to confirm the calibration and wait until the calibration step is completed.
- Calibration is automatically stored into the device memory.
- The device is now ready to measure other samples.

7.1.2 MEASUREMENT

The PlantPen model **PRI 210** measures The PlantPen model **PRI 210** measures **Photochemical Reflectance Index** (PRI) in two narrow wavelength bands centred close to 531 nm and 570 nm. The photochemical reflectance index ($PRI = (R531 - R570) / (R531 + R570)$) correlates with the epoxidation state of xanthophyll cycle pigments and photosystem efficiency in many studies under diverse conditions, such as different. PRI is sensitive to changes in carotenoid pigments that are indicative of photosynthetic light use efficiency, the rate of carbon dioxide uptake, or as a reliable water-stress index. As such, it is used in studies of vegetation productivity and stress.

Please follow these instructions to perform a measurement:

- Insert a leaf sample into the leaf clip. The leaf clip is important for the sample stabilization.
- Go to **Measurement**

- Press **SET** to confirm.
- PlantPen measure **PRI**
- Value of **PRI** appears on display after measuring.
- During the measurement all data are stored into the device memory.

7.2 NDVI MEASUREMENT

7.2.1 CALIBRATION

Calibration assures you that your measurements are accurate within the specification limits that led you to select the instrument in the first place. It is better to calibrate your device before every set of samples. For Calibration of PlantPen use white reflectance standard. The calibration of the white reflectance standard is an indispensable part of a correct calculation of NDVI.



It is necessary to calibrate PlantPen after every switch ON.

Prior NDVI measurement perform the calibration as follows:

- For calibration use white reflectance standard (It is part of leaf clip)
- Turn ON device – hold **SET** button for 1 sec.
- Close the leaf clip (white standard is on bottom part of the leaf clip)
- Go to **Calibration** (“Insert white sample” appears on display)
- Press **SET** button to confirm the calibration and wait until the calibration step is completed.
- Calibration is automatically stored into the device memory.
- The device is now ready to measure other samples.

7.2.2 MEASUREMENT

The PlantPen model **NDVI 310** measures **Normalized Difference Vegetation Index**, which is an important indicator of chlorophyll content in plants. The pigment in plant leaves, chlorophyll, strongly absorbs visible light (from 0.4 to 0.7 μm) for use in photosynthesis. The cell structure of the leaves, on the other hand, strongly reflects near-infrared light (from 0.7 to 1.1 μm). The **NDVI 310** device compares reflected light at two distinct wavelengths, 635 and 760 nm.

Please follow these instructions to perform a measurement:

- Insert a leaf sample into the leaf clip. The leaf clip is important for the sample stabilization.
- Go to **Measurement**
- Press **SET** to confirm.
- PlantPen measure **NDVI**
- Value of **NDVI** appears on display after measuring.
- During the measurement all data are stored into the device memory.

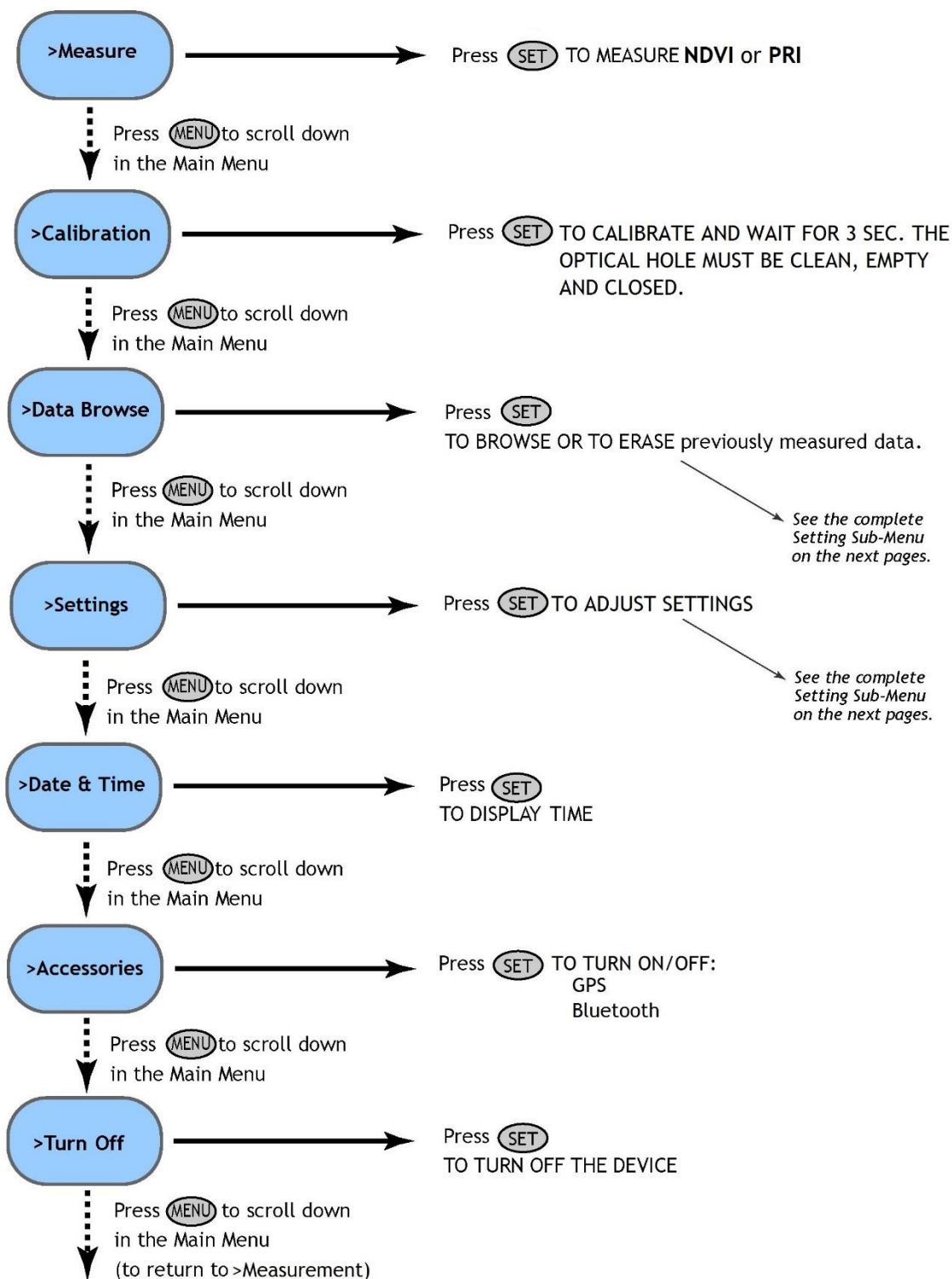
8 CONTROL MENU TREE

The next pages show the structure of the operation scheme, which includes the Main Menu, first-level Sub-Menus and second-level Sub-Menus.

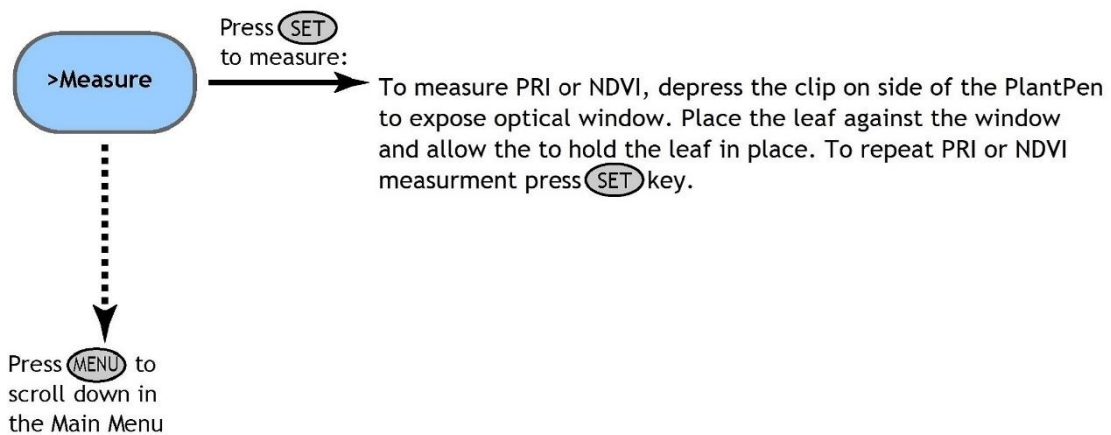
- The blue color represents the Main Menu and its Options.
- The yellow color represents the first-level Sub-Menus and their Options.
- The green color represents the second-level Sub-Menus and their Options.
- Full-line arrows are used for the **SET** key.
- Dashed-line arrows are used for the **MENU** key.

Main Menu

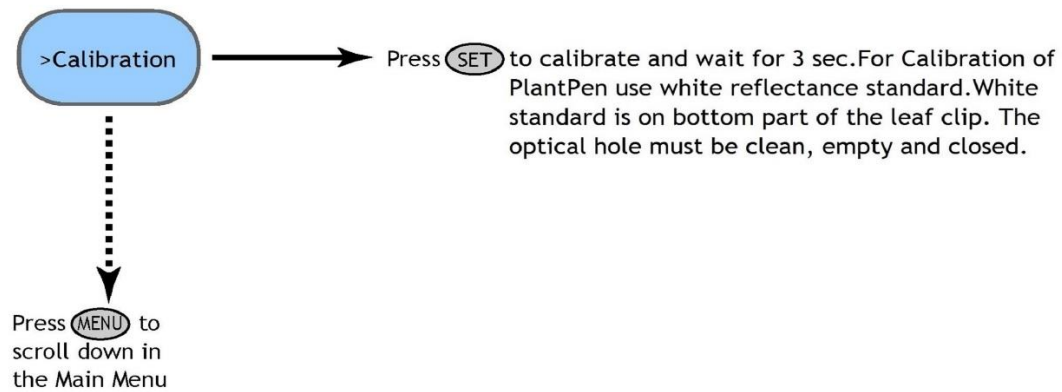
To start hold the SET key for 1 second.



Measure Sub-Menu

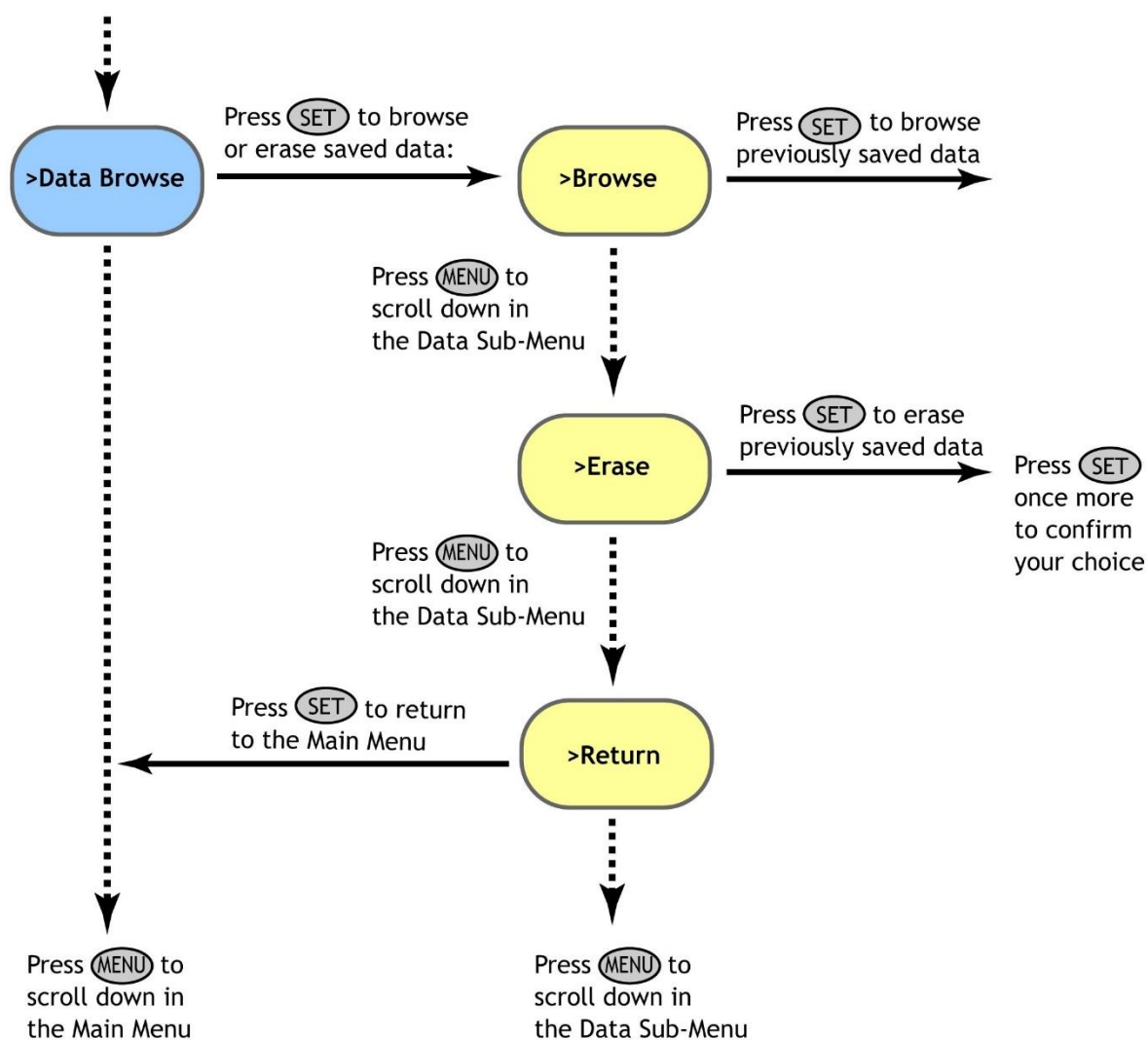


Calibration Sub-Menu



Data Sub-Menu

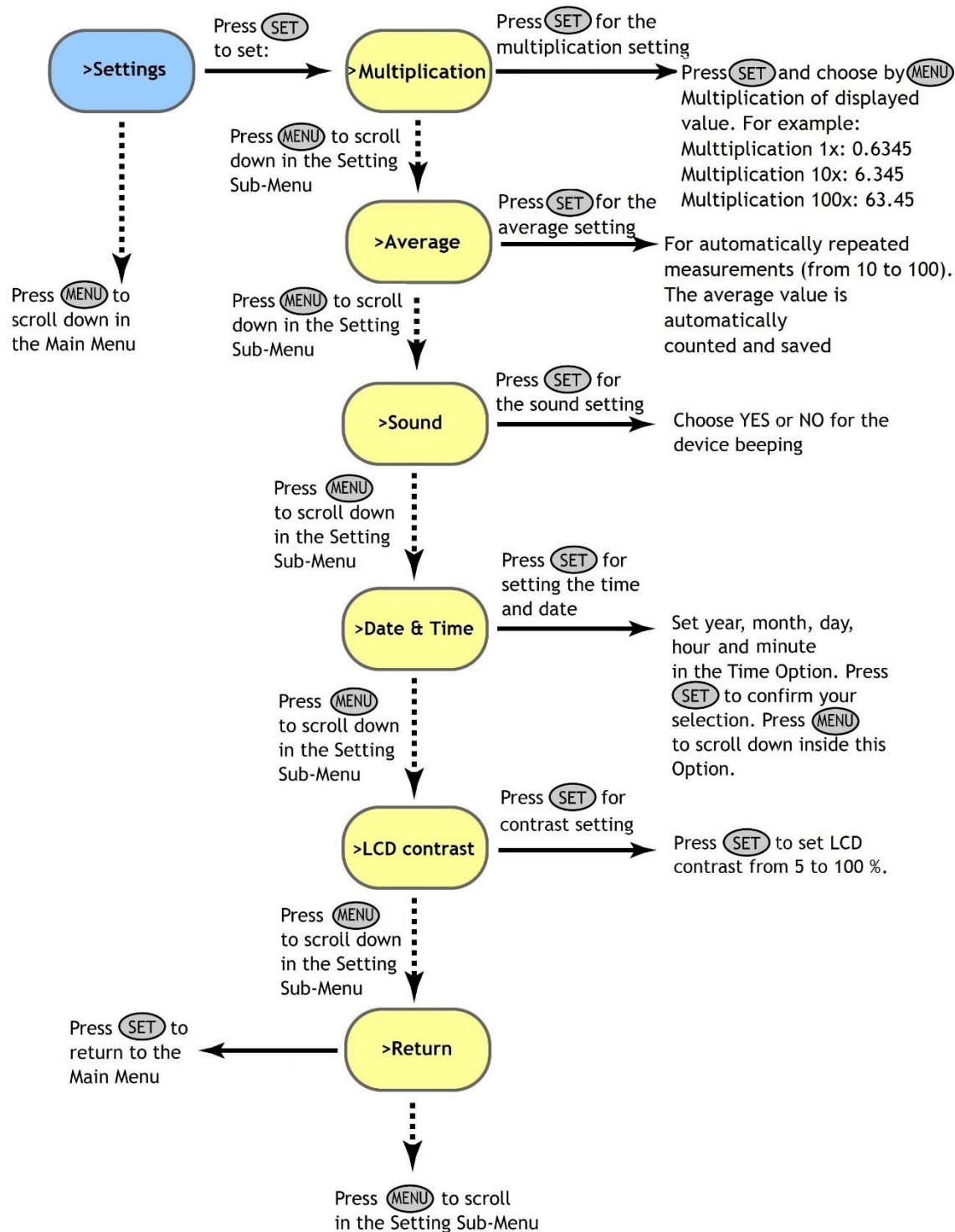
Use the Data Sub-Menu when browsing or erasing previously measured data.



IMPORTANT NOTE: Be aware that it is not possible to erase single data.
All stored data are erased!

Setting Sub-Menu - Part 1

Use the Setting Sub-Menu to set the light color, light intensity, number and frequency of measurements, date, time, or the sound mode.



9 USB CONNECTION

Connect the USB cable with the PlantPen device. Please note that lock in system is used.



Pay attention when connecting the USB cable not to damage the outlet connector on the Pen device. Make sure that you orient the cable correctly prior connecting the inlet with the outlet and the cable is upright towards the device.

To connect PlantPen with your computer please follow steps below in Fig. 4:

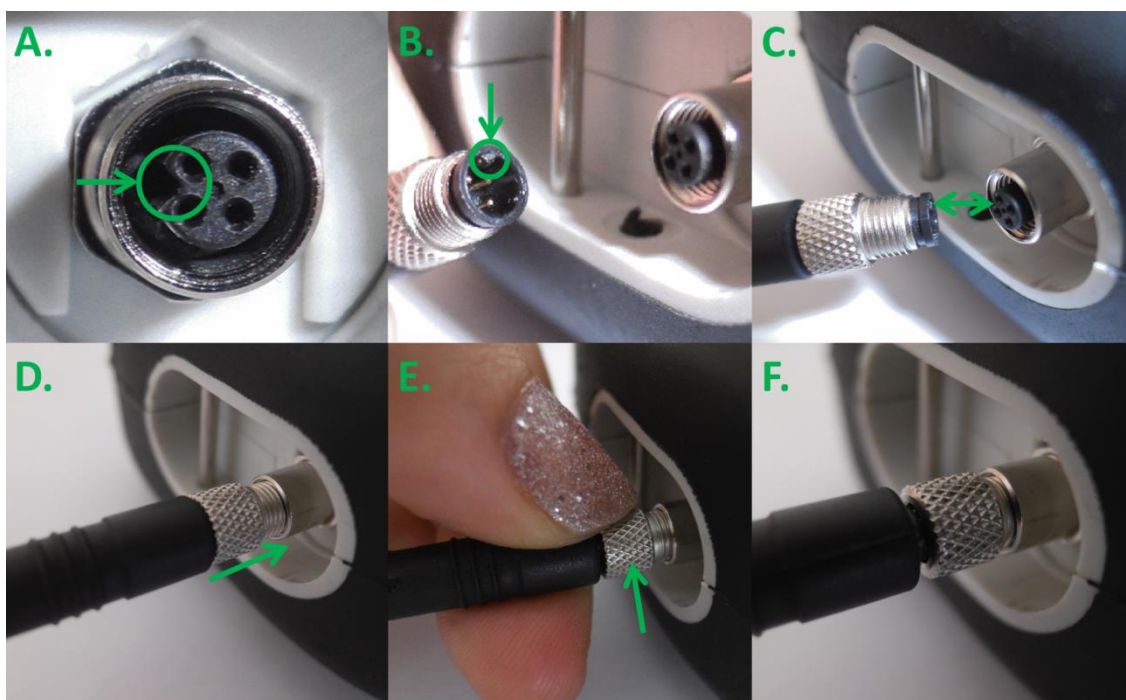


Fig. 4 How to connect PlantPen with PC.

A) Outlet connector on PlantPen device. B) Inlet part on the USB cable. C – E) Position the cable horizontally, plug in the inlet and screw the securing screw. F) Correct connection of the USB cable and Pen device.

Connect the USB cable to a computer. The PlantPen **switches ON** automatically after connecting the cable to the PC. For USB connection you need to have the USB driver installed in your PC. You find the driver on the installation disk (USB driver folder). If you check the Device Manager in Windows you should see the USB serial port in the device tree. In case of missing driver, you may download it from PSI websites. When the driver is installed correctly you should be able to connect to the device in the FluorPen software menu Setup > Device ID.

For more information about FluorPen software see chapter 11.

10 BLUETOOTH CONNECTION

Before you set up the Bluetooth connection between the PlantPen and your PC, make sure you have these components:

1. Bluetooth enabled PC

The PC with which you connect must have Bluetooth wireless technology, either built-in or through a Bluetooth card. Make sure that the PC's Bluetooth setting is "discoverable" (meaning that it shows up when other devices search for nearby Bluetooth connections). Consult the user guide for your PC or Bluetooth card to learn how to do this.

2. Bluetooth configuration software properly set up on PC

Before you can download files to your PC, you will need to set up the Bluetooth software that came with your PC, or your PC's Bluetooth card. This software varies by manufacturer. Please consult your PC's Bluetooth documentation for more information.

3. Bluetooth must be switched on visible on both devices

To pair the PlantPen with another Bluetooth device, such as a computer, you will need to ensure that Bluetooth is switched on visible on both devices.

10.1 BLUETOOTH PAIRING

1. Enabling Bluetooth in the PlantPen

- Switch ON the PlantPen (press and hold the **SET** key).
- Scroll to the **Accessories** menu (press the **MENU** key, then press the **SET** key).
- Select Bluetooth On (press the **MENU** key, then press the **SET** key) to enable Bluetooth.



Keep in mind that the PlantPen turns off automatically after about 8 minutes of no action.
Turning off the PlantPen always turns off Bluetooth.

2. Starting Bluetooth Application on Your PC

Be aware that this description is working on Windows 7; some of the steps may be different on your PC.

- Select: **Start > Devices and Printers** (Fig. 5).
You may also start your Bluetooth application via the Control Panel: **Start > Control Panel > Hardware and Sound > Devices and Printers**.

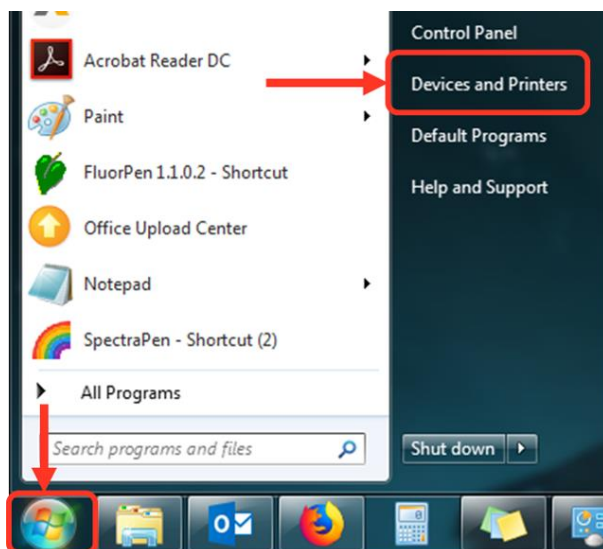


Fig. 5 Start Bluetooth Application.

3. Opening the Add Bluetooth Device Application

- Select: "Add a device" to start searching new Bluetooth device. Be sure that the PlantPen is in discoverable mode (see step 1).



Fig. 6 Add a device.

4. Selecting the PlantPen

- Select: PSI PlantPen icon.
- Select: Next (Fig. 7).

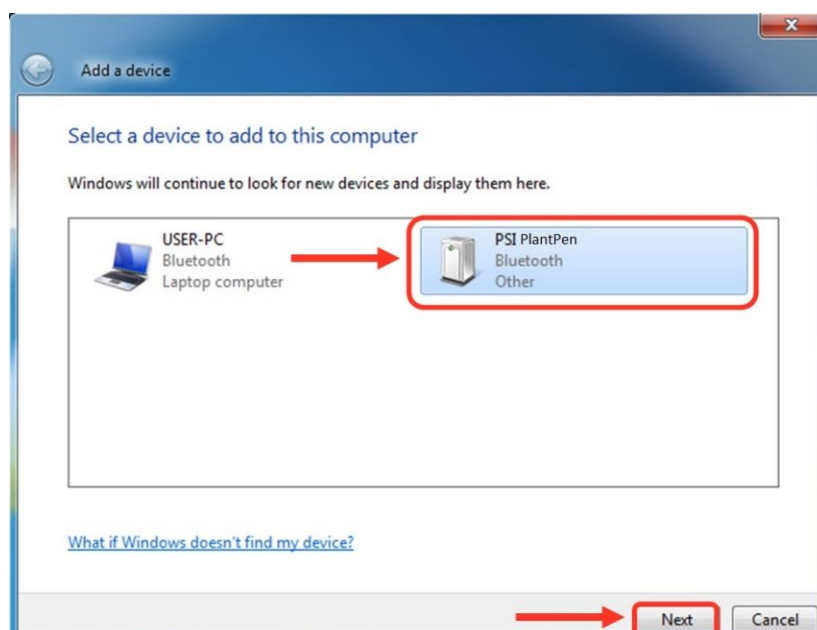


Fig. 7 Select the PlantPen.

5. Starting the Pairing Process

This step is different for old and new version of Bluetooth module.

Old version:

Your Bluetooth Pairing Code is: 0000

- Select: "Enter the device's pairing code".
- Enter: **0000** (four digits).
- Select: Next (Fig. 8).

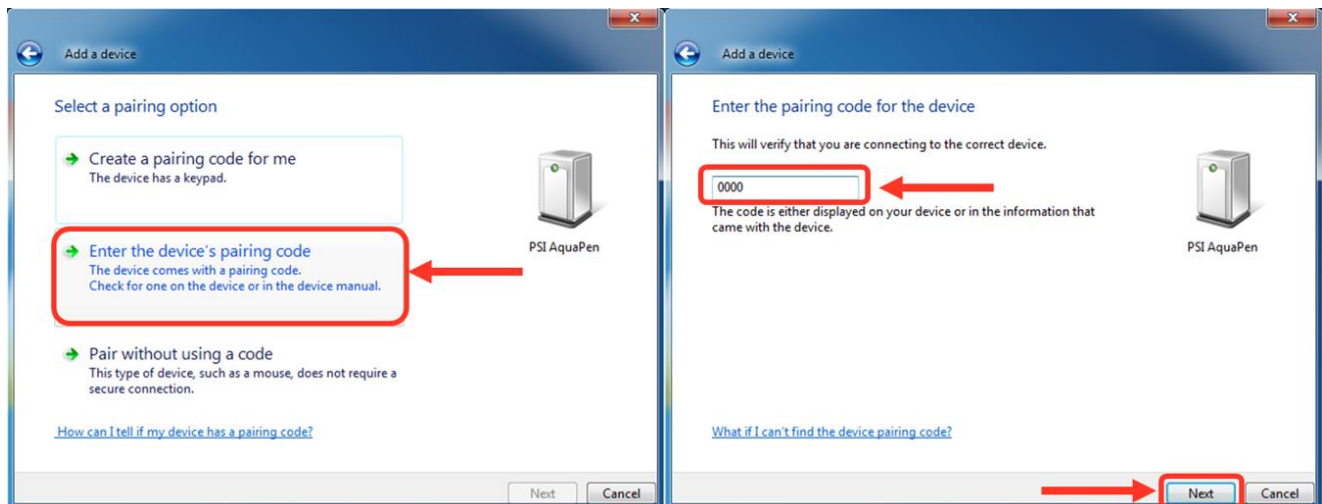


Fig. 8 Pairing process.

New version:

- Select: Yes (Fig. 9). **Please note that the PlantPen device does not display the verification number. The verification code is not important for the BT connection.**
- Select: Next.

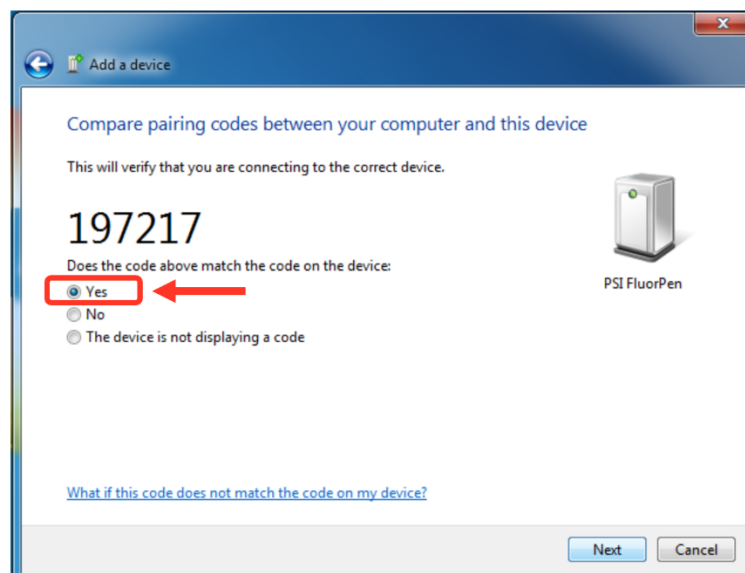


Fig. 9 Verifying of the BT pairing.

6. Completing the PlantPen Pairing

- Select: Close (Fig. 10).

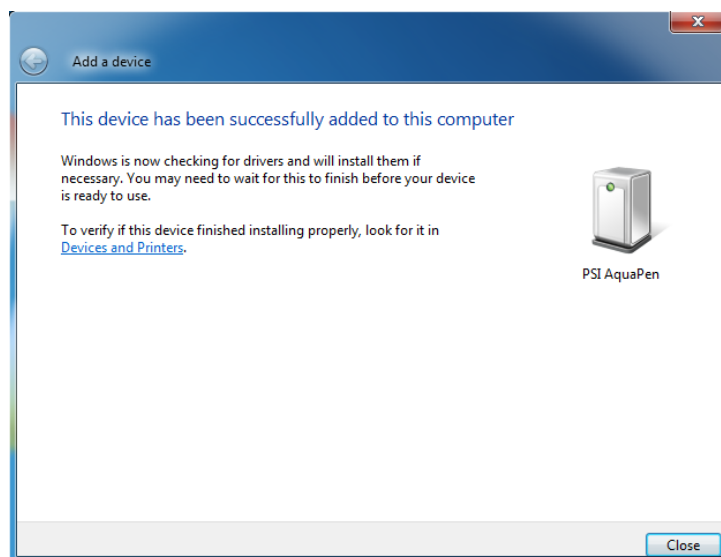


Fig. 10 Finishing.

On computer run the program FluorPen 1.1. For more information about FluorPen software see chapter 11.

11 FLUORPEN SOFTWARE

11.1 SOFTWARE INSTALLATION

1. Save the FluorPen software provided on the USB flash disk to your computer and launch the FluorPen program.
2. To connect and recognize your PlantPen device in the FluorPen software proceeds first with the registration of your FluorPen software (Fig. 11).
 - Select: Help > Register
 - Enter: your serial registration number.
 - Select: OK



Fig. 11 Software registration.

	Please note that you will find your serial (registration) number in the file SN.txt, which is included on the enclosed USB flash disk. Please remember: it is not possible to download data from the PlantPen device without software registration.
---	--

3. Switch on the PlantPen and enable Bluetooth or connect USB cable to the PC.
4. Make sure that your PC and the PlantPen are properly paired (see chapter 9 and **Error! Reference source not found.** for complete information on USB and Bluetooth pairing).
5. Select: **Setup > Device ID (Ctrl+I)**. If properly connected, the message "Device: PlantPen" appears in the bottom part of the screen (Fig. 12).

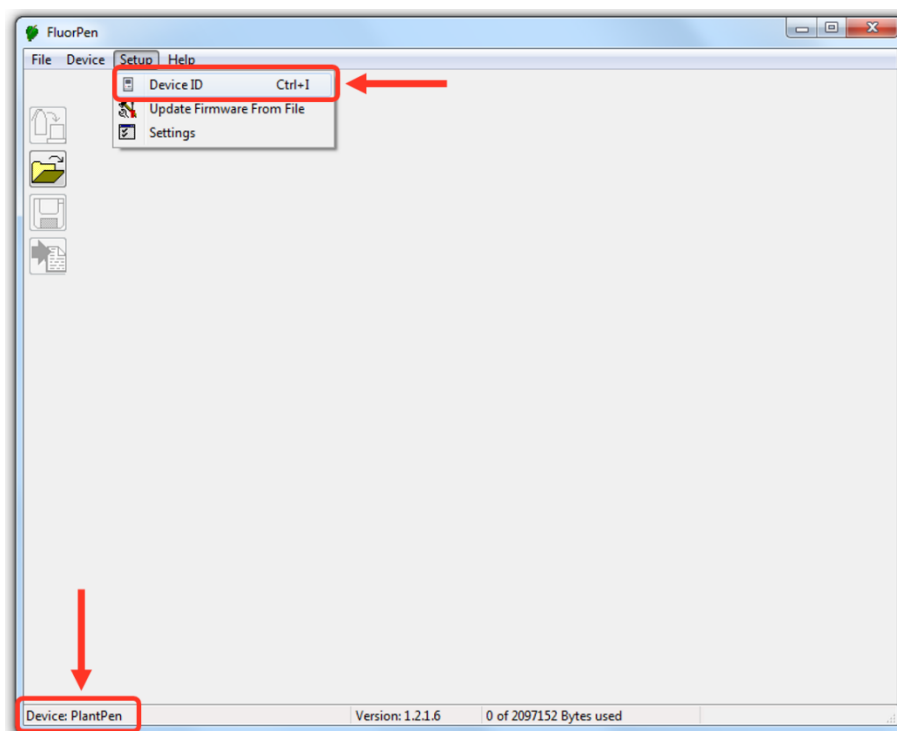


Fig. 12 Connecting PlantPen with Software.

11.2 MENU AND ICON EXPLANATION

11.2.1 MAIN 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 running experiments.
Exit	Exits the program.



MENU: Device

Download	Downloads data from the PlantPen to your PC.
Erase Memory	Erases data from the PlantPen memory.
Online Control	Online control of AP device.
Attach GPS File	Used for download data from GPS module (active only in PlantPen version AP 100).



MENU: Setup

Device ID	Detects the connected device.
Update Firmware	Used for firmware updates.
Settings	Used for modification of the program settings.



MENU: Help

About	Offers basic information about the program.
Register	Used for the FluorPen software registration.



Icon Explanation:



Download	Downloads data from the PlantPen to PC.
Load	Loads (opens) previously saved data files.
Save	Saves data to hard disc.
Export	Exports data in .txt format.

11.2.2 MENU SETTINGS

MENU > Setup > Settings

After Download – Memory Erase

If the box is checked the PlantPen memory is erased after each data download.

Data – Inverted

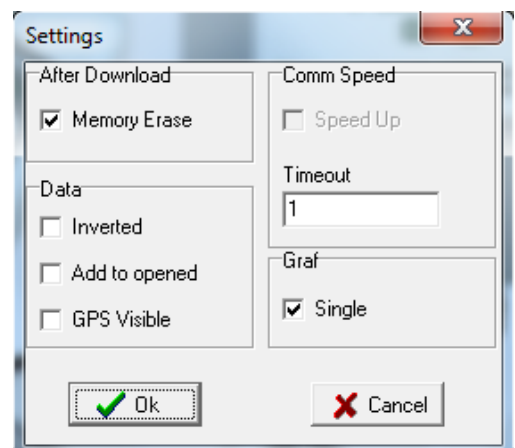
If the box is checked the polarity of data is inverted, e.g., multiplied by -1. This feature can be helpful for a certain type of experiment when the measured data are undesirably interpreted as negative values.

Data – Add to opened

If the box is checked the downloaded data are added to that of the current opened experiment.

Data – GPS Visible

This option is active only in older PlantPen version PP 100. In new version PP 110 the GPS data are automatically downloaded and paired with protocol measurements.



Graf – Single

This function is not available for PlantPen PRI or NDVI.

11.2.3 MENU ONLINE CONTROL

This function can be used for Online Control your PlantPen device after connection with your PC.

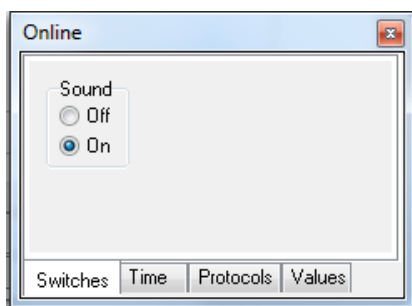
- Select: **Menu > Device > Online Control**

Online Control – Switches

Sound On/Off - choose On/Off for device beeping.

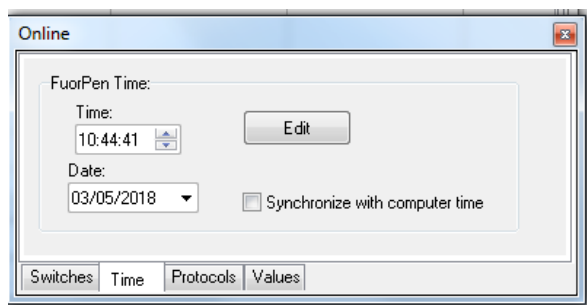
Measuring color – choose 455nm or 630nm for measuring fluorescence protocols. This function is active only in the PlantPen-C 110-C model.

Multi use averaging (YES/NO) – serves to confirm Repeat (number of repetitions) and Interval (time between measurements) Options for each measurement within Multi Option – select YES or NO.



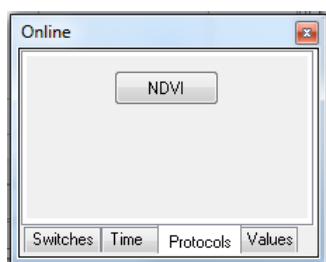
Online Control – Time

Set the PlantPen time a date. You can also synchronize time of PlantPen device with computer time.



Online Control – Protocols

Choose the protocol for measuring. PlantPen device start to measure. After measuring you can download data.



Online Control – Values

This function is not available for PlantPen PRI or NDVI.

11.3 DATA TRANSFER AND VISUALIZATION

1. Perform a measurement with your PlantPen. In Fig. 13 we did an NDVI measurement.
2. Click the **Download** icon or select **Device > Download**.
3. The Data table appears.

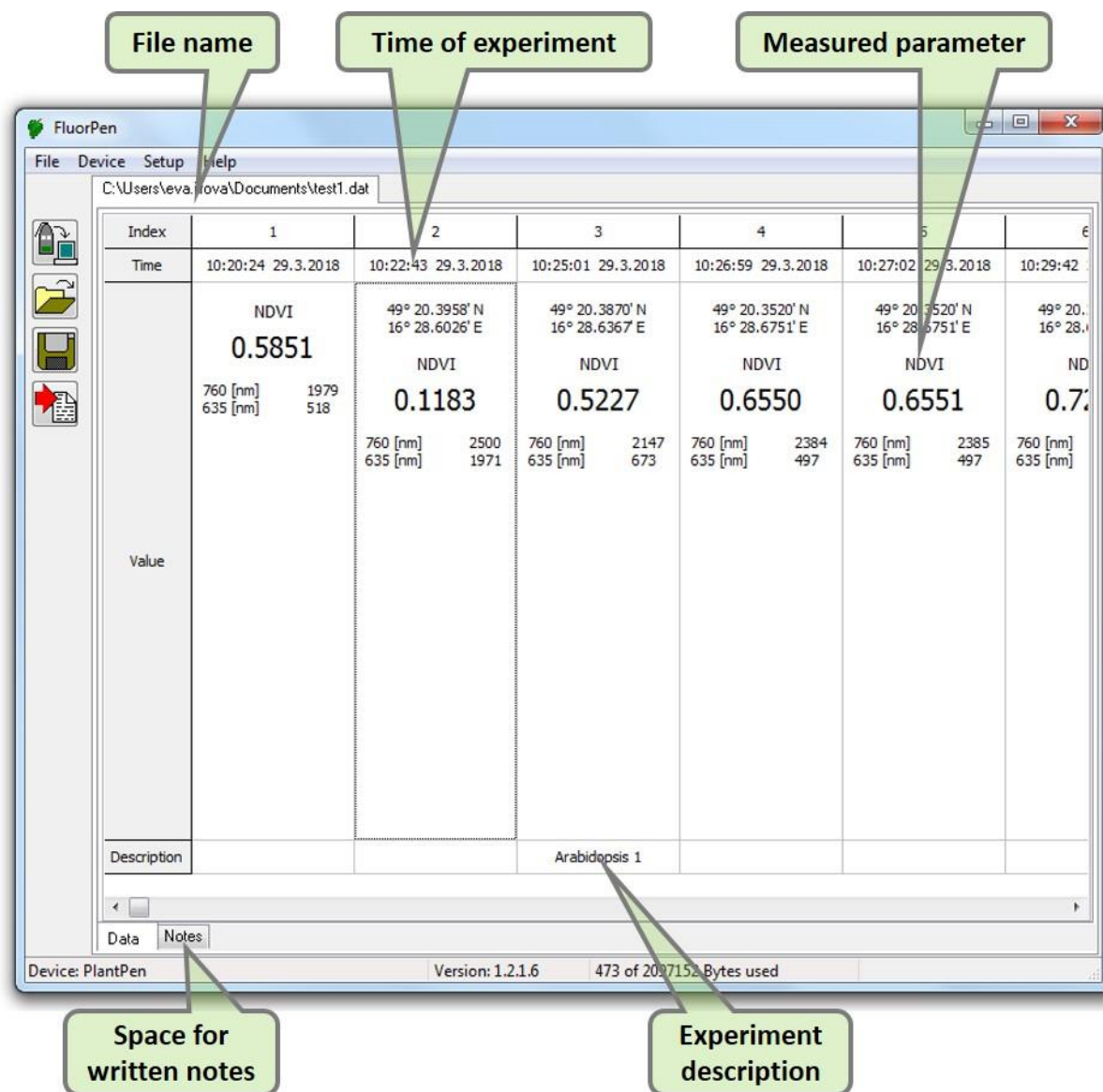


Fig. 13 Example of Data Transfer and Visualization.

4. For **export** press **File > Export** or **Export** icon, select what you want to export (NDVI or PRI) -Fig. 14.
Selected only – exports only one measurement that is selected by mouse, otherwise it will export everything.
Source data – exports raw data.
Description – exports the data description if any.
Computed values – export calculated data

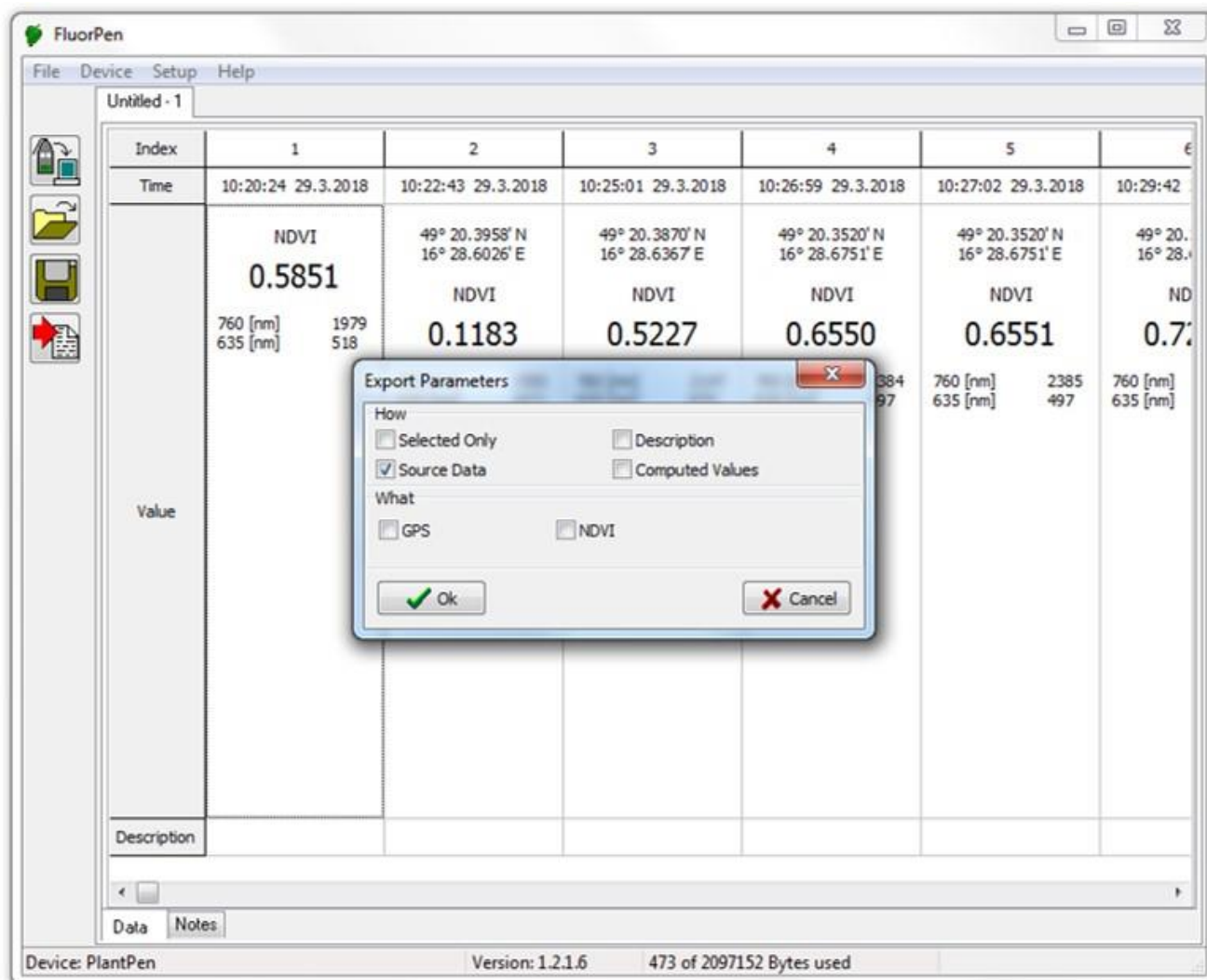


Fig. 14 Export data.

11.4 FIRMWARE UPDATE



All data in the PlantPen memory are erased during the firmware update!

Before starting any firmware update, export all your data from the PlantPen memory into your computer!

1. Starting Update

- Select: **Setup > Update Firmware From File** (Fig. 15).

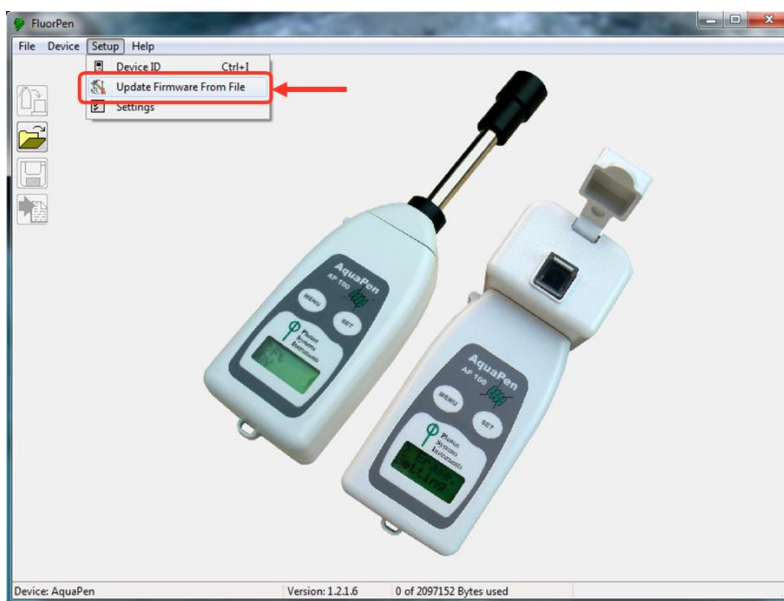


Fig. 15 Update Firmware.

2. Warning

- Select: **OK** to start update (Fig. 16).

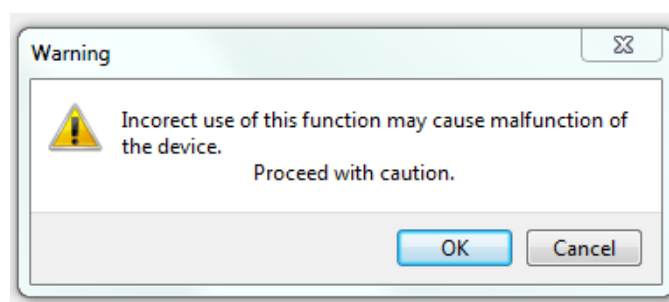


Fig. 16 Warning.

3. Selecting .bxn file

- Find: Binary file (with the extension .bxn) (Fig. 17).
- Select: Open.

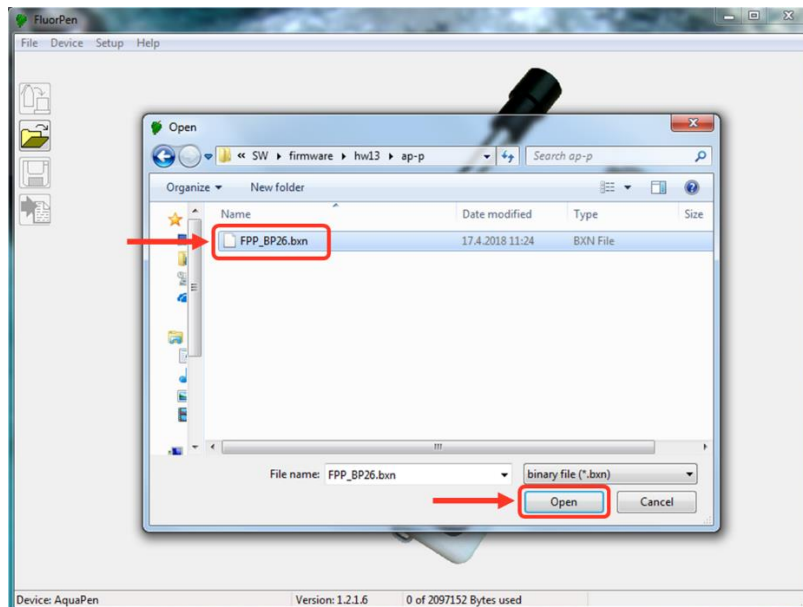


Fig. 17 Select .bxn file.

4. Finishing Upload

- Select: **OK** to start uploading of the update (Fig. 18).

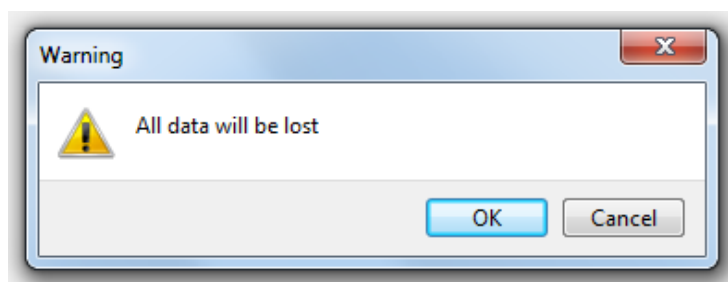


Fig. 18 Data loss warning.

- The bottom bar indicates the upload progress (Fig. 19).

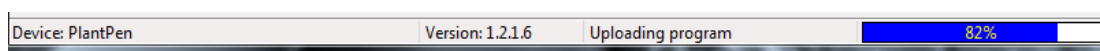


Fig. 19 Upload progress.

- Press: **OK** to finish upload (Fig. 20).

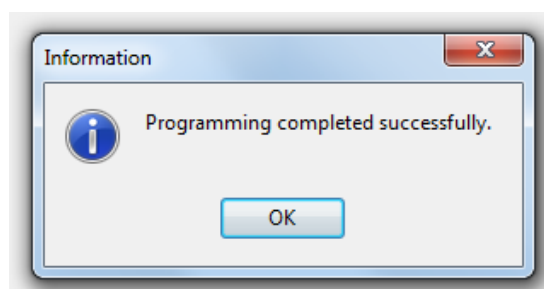


Fig. 20 Finish upload.

12 GPS MODULE

PlantPen device has integrated GPS module which can be turned on during the measurement and the GPS coordinated will be added to the downloaded data.



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

12.1 GPS / PLANTPEN OPERATION

1. Check the time setting in PlantPen device: **Settings > Date & Time**
2. Switch the GPS module on:
 - Select: **Accessories > GPS**
 - Press **SET** to confirm.
 - Wait until the GPS position is found – “**Starting GPS**”.
 - The GPS module is ready when the icon in upper panel change – see on Fig. 21.

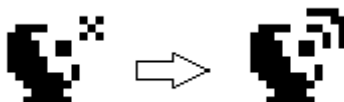


Fig. 21 GPS icons.

3. Go to **Measurement** and choose required protocol.



For prompt determination of the coordinates use the option **Accessories > GPS > Location**.



The device may need a clear view of the sky to acquire satellite signal.

Keep in mind that the PlantPen turns off automatically after about 8 minutes of no action.

Turning off the PlantPen always turns off GPS module.

12.2 DATA DOWNLOAD

1. Enabling Communication:

- Switch on the computer and the PlantPen. Set your computer to PlantPen communication: enable Bluetooth or connect to USB port.

2. Downloading Data from the PlantPen

- Start FluorPen program.
- Connect PlantPen device: **Setup > Device ID (Ctrl+I)**
- Download measured data from the PlantPen to your PC. Data measured with activated GPS module are downloaded with GPS coordinates (Fig. 22).

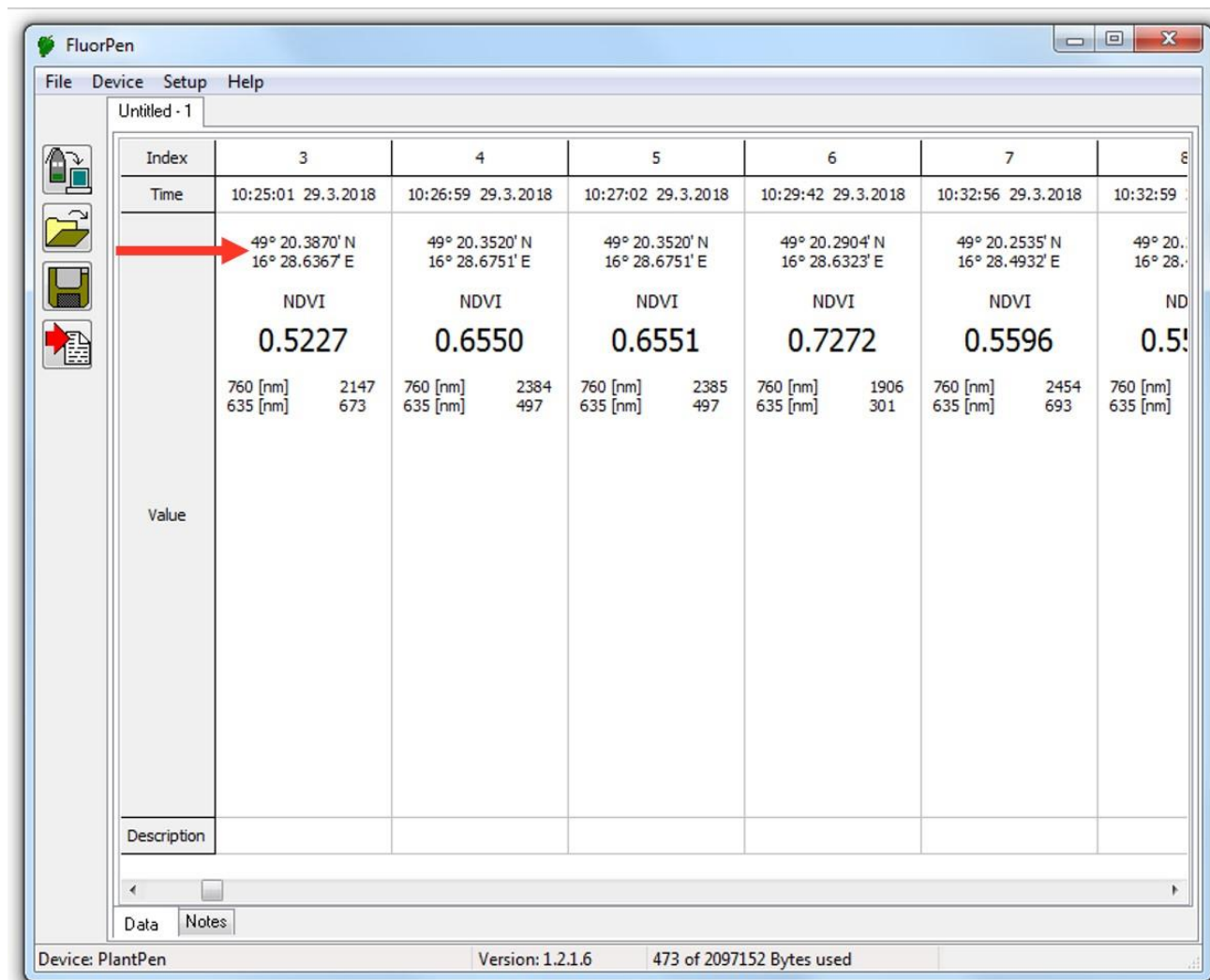


Fig. 22 GPS coordinates.

13 WARRANTY TERMS AND CONDITIONS

- This Limited Warranty applies only to the PlantPen 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.

14 TROUBLESHOOTING AND CUSTOMER SUPPORT

In case of troubles and for customer support, please, visit [FAQ](#) on our websites, write to support@psi.cz or contact your local distributor.