METOS®

BY PESSL INSTRUMENTS

Dualex

User Manual

A Product of

Pessl Instruments

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Table of content

1. Dualex optical leaf-clip

1.1. Description

No.	Label	Description
1	Light Source	The head contains 5 LEDs that emit in different wavelengths: UV, Red, Green, 2x NIR
2	Light Detector	The head contains an optical filter and a photodiode.
3	Opening Handle	When pressed, the clip opens and the leaf can be placed between the two heads. When released, the heads hold the leaf allowing the measurement to be done. The testing position of the Dualex is with the clip closed.
4	LCD Screen	This displays all information
5	Keyboard	The 5 buttons on the keyboard are used to navigate through the software. The buttons have multitasking capabilities and every

		action depends on the state of the device. (Refer to detailed functions below; under Keyboard button functionalities)
6	Wrist-strap	A wrist strap can be attached to the Dualex unit to prevent the unit from falling.
7	USB port	USB port that allows downloading data, updating software and charging the Dualex device.

1.2. Button description

The 5 buttons on the **keyboard** are used to navigate through the software. The buttons have multitasking capabilities and every action depends on the state of the tool.

- The button  is used to switch on the Dualex with a long press. This button is also used to switch off the Dualex: one short press in the main menu, or a long press at any time.
- The button  is used to enter a selection in a sub-menu, to validate a selection or to make a measurement.
- The button  is used to cancel an action or a selection, and allows the suppression of the last measurement; in this case the software will come back to the previous state. A long press (3 seconds) returns back to the main menu.
- Buttons  and  are used to navigate in the menus, to increase the group rank and to change the side tag.

1.3. Dualex transport case

The Dualex is delivered in a shock resistant case. It contains the Dualex leaf- clip, a USB cable and user manual.

The Dualex is powered by an internal rechargeable Li-Po battery. The battery can be charged using the USB cable directly from the computer, or using a wall plug adapter (110-220V/50-60Hz).

2. Getting Started

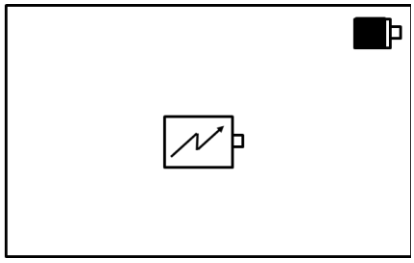
Unpack the Dualex and check that there are no damages. The Dualex is charged before delivery, however, depending on storage time, the battery may be discharged.

2.1. Charging the Dualex

To charge the Dualex, connect the USB cable to either:

- a wall plug adapter cable and plug it in a regular power supply (check that the voltage (110- 220V) and the frequency (50-60 Hz) are compatible),
- a USB port on a computer.

While connected, a charge indicator will appear on the screen:



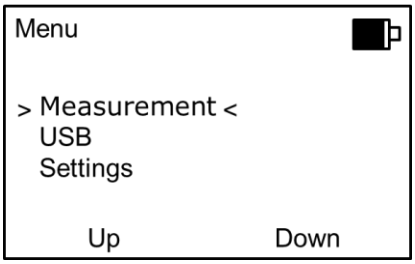
The Dualex unit can be operated while being charged. The full charge of the battery will be completed after 4 hours.

With a full charge, operating time is approximately 7 hours in continuous use (depending on number of measurements and GPS positions).

2.2. Switching on the Dualex

To switch on the Dualex, long press the power button  on the keyboard. A beep and a screen with Pessl Instruments image will appear shortly and then one is greeted with the main menu as shown below.

2.3. Main menu



The main menu includes 3 sub-menus:

1. Measurement: allows measurements,
2. USB: allows to download the recorded data and to update the device software from a computer,
3. Settings: give access to the different menu configurations like the GPS, Format, Measure, Date & hours, Contrast, Stand-by mode, Language and About.

The navigation among the menus is made by using buttons up and down on the keyboard.

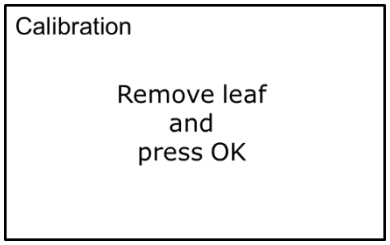
The selected sub-menu is marked by (> <). Use the button to select the sub-menu.

2.3.1. Sub menu ‘measurement’

To initialize a measurement sequence, select the sub-menu ‘Measurement’ and press button.

2.3.1.1. Calibration

When the measurement sub-menu is selected and before any measurement, the Dualex unit will ask for a short self-calibration. The following screen will appear:

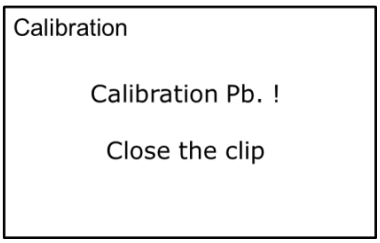


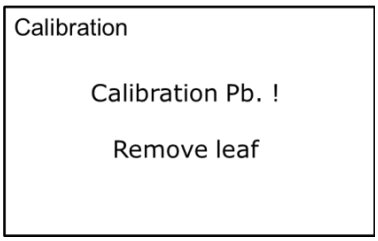
Be careful during the calibration process that there is nothing between the optical heads and that the clip is well closed.

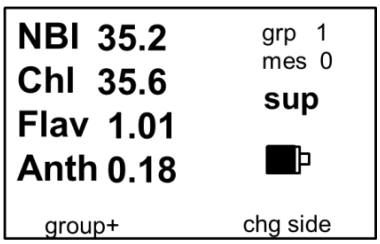
To start self-calibration, press on the button OK.

Warning: You can face three potential problems during the calibration:

- The clip is opened: close it and press on the button OK.







- There is a leaf between both heads: remove it and press on the button OK.
- Heads are dirty, clean them and press on the button OK.

2.3.1.2. Measurement

Once calibration succeeded, the Dualex unit is ready to measure and displays the following screen:

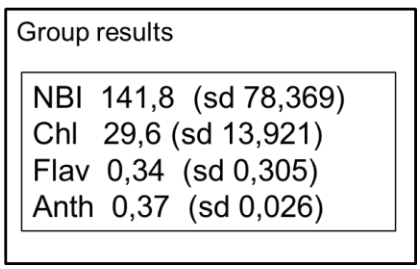
To make a measurement, open the clip by pressing the handle and place a leaf in-between the optical heads.

Release the handle, the measurement is automatically made. When a measure is taken, two types of beep can ring:

- A long beep which means that the measurement is well done and recorded.
- Three short beeps which mean that the measurement is wrong and not recorded.

If the reading succeeds, the indices values appear on the screen:

- **NBI**: or Nitrogen Balance Index. This index is the ratio between Chl (Chlorophyll) and Flav (Flavonol).
  The range of this index is 0 - 999. If the measured value is outside these limits, the value displayed on the screen is ***. This state is recorded in the memory of the device under the tag “NaN”. If the measurement is inconsistent, the displayed tag is –.
- **Chl**: chlorophyll content.
  The range of this index is 0-150. If the measured value is outside these limits, the displayed value on the screen is: ***. This state is recorded in the memory of the device under the tag “NaN”. If the measurement is inconsistent, the displayed tag is -.
- **Flv**: index of phenolics, mostly flavonols, content.
  The range of this index is 0-3.5 If the measured value is outside these limits, the displayed value on the screen is ***. This state is recorded in the memory of the device under the tag “NaN”. If the measurement is inconsistent, the displayed tag is -.
- **Anth**: index of phenolics, anthocyanins content.
  The range of this index is 0-3.5 If the measured value is outside these limits, the displayed value on the screen is: ***. This state is recorded in the memory of the device under the tag “NaN”. If the measurement is inconsistent, the displayed tag is -.
- **grp:** indicates the group rank. The measurements can be grouped into a set of measurements statistically connected. Press on  (group+) to increment the number of groups. The statistical results of the latest group are then displayed.



If the data are not valid, the statistical results appear under the tag ***. To return to the measure menu, press on  .

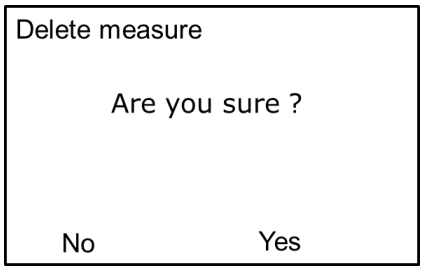
- **mes:** corresponds to the rank number of the measurement performed in the group. This value increases automatically with every measurement.
- **sup / inf:** the side of the leaf, adaxial or abaxial, and its associated epidermis – that is positioned against the light source head (upper head) – will be measured. To measure the opposite side of the leaf, you may flip over the leaf or invert the position of the Dualex heads.

  You can add the leaf side tag which will be associated with the next measurement: adaxial (**sup**) or abaxial (**inf**). To change this tag, just press on ▽. This information is stored with the measurement.

  Warning: there is no limitation to the measurements rank in a group. The capacity of the internal flash memory (1.8 MB) allows more than 10 000 measurements. Nevertheless, it's recommended to transfer the data by the command >USB< onto a computer after every campaign of measurements. After the transfer of the data file, you can erase it from the flash memory using your computer.

How to delete a measurement

The last made measurement can be deleted by pressing the button ⊗ (short press), the screen asks for confirmation. Press on the button △ (No) or ▽ (Yes):



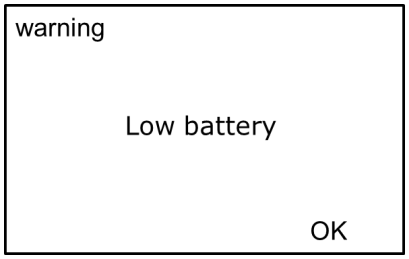
A long press on the button ⊗ leads to the main menu and saves the measurement.

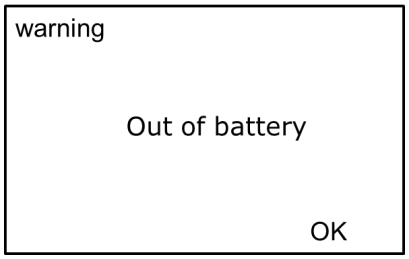
Power alarm

In order to avoid a loss of data, a double alarm informs you about the level of the battery.

The first alarm informs you that there is only 20% of the battery power left « Low battery ». You can continue your measurements for approximately 1 hour.

The second alarm informs that there is only 10% of the battery power left « Empty battery ». To avoid a loss of data, the device automatically shuts down. Measurements are not possible any more.



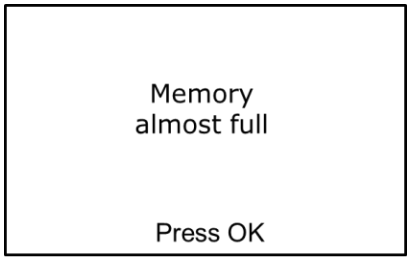


Memory management

The Dualex manages the capacity of the memory and displays two safety messages to ask to empty the memory card:

- « Memory almost full » between 200 kb and 2 kb free memory left
- « Memory full » with less than 2 kb free memory left (less than 15 measurements).

If you switch on the Dualex, when only between 200 kb and 2 kb free memory is available, the following message is displayed:



Press on the button  . Download the memory content to a computer. If you go to the submenu ‘measurement’, the message will be displayed a second time.

- When the Dualex is switched on, if less than 2 kB of free memory remains you cannot go up to the submenu ‘Measurement’. It is necessary to empty the memory of the Dualex.
- During the measurements, if the free memory decreases below 200 kb, the message «memory almost full» appears. Press the button  . You can continue the measurements but please empty the memory as soon as possible.
- During the measurements, if the memory decreases below 2 kB the message «memory full » appears. Press the button  . The last measurement is saved and the Dualex returns to the main menu. You cannot reach the submenu ‘measurement’. It is necessary to empty the memory.

Emptying the memory:

Download all measurements from the device to your PC using the USB cable. Disconnect the Dualex from the PC and in the menu, select Format option (see section 2.3.3.2). This will delete all the files internally stored on the Dualex. It is important to Format the Dualex drive as the FAT system can be fully occupied, even if you do not see any file in the Explorer on the PC.

2.3.2. Submenu ‘USB’

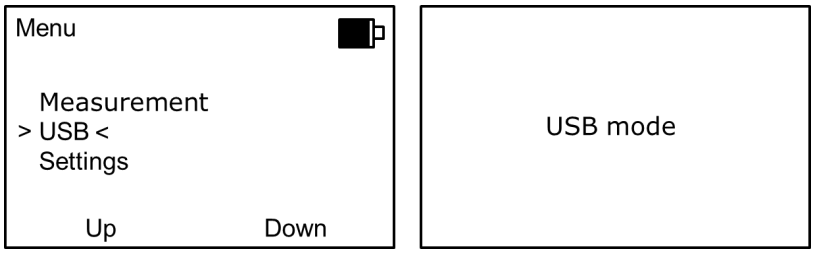
The submenu USB allows transferring the measured data to a computer and also it allows updating Dualex from a computer.

2.3.2.1. Connection

Connect the cable USB to the mini connector USB:

	The mini connector USB to be plugged into the Dualex's connector located at the bottom of the device.
	The connector USB to be plugged into the USB port of the computer.

In the main menu, select the sub-menu 'USB' with the buttons (top) and (bottom), and press the button :



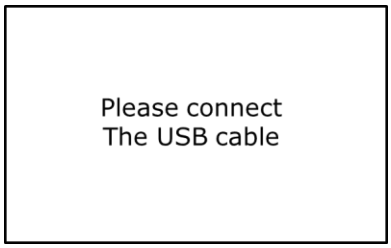
The Dualex behaves then as an USB device.

Use the file browser of your operating system (e.g. Windows Explorer) to transfer the file containing the measurements. In Dualex, one file is created per calendar day of measurement: all the measurements of the day are stored in this file, named « DX yyyymmdd.csv », where « yyyy » represents the year, "mm" the month and « dd » the day. Once you copied the CSV file onto your computer, the data can be analyzed using any data analysis software or application.

Note: When the Dualex Scientific is used in USB mode, no measurement can be realized. To go out of the USB mode, press on . The software returns then to the main menu. Before exiting the USB mode, make sure there are no read/write operations with the device on the computer.

2.3.2.2. Dualex update

WARNING:
In order to avoid a loss of data, please copy the files from the memory before proceeding to an update. The DUALEX will erase the memory at the end of the process.
The USB has to remain connected throughout the update. If the device is disconnected, the following message will be displayed:



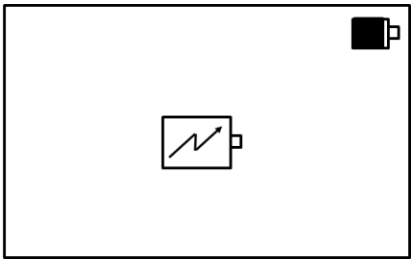
Switch on the Dualex® with the button .
Connect the cable USB to the mini connector USB. In the main menu of Dualex®, select the sub-menu >USB< with the button and . Press the button .
The Dualex behaves then as an USB device.
Transfer of the software: Copy the file DUxxx.DX4 (xxx corresponds to the number of the update version) in the memory of your Dualex.

WARNING: Do not do anything during the files transfer.

Software set up:

- Leave the USB mode once the file is transferred, by pressing on the button .
- Re-start the device by pressing on the button . The updating of the software begins.

  The following screens appear:



  After updating the Dualex device, it is recommended that you Format the internal storage of the Dualex to clear the storage memory for new measurements.

2.3.3. Submenu ‘settings’

The submenu ‘settings’ gives access to adjustable parameters:

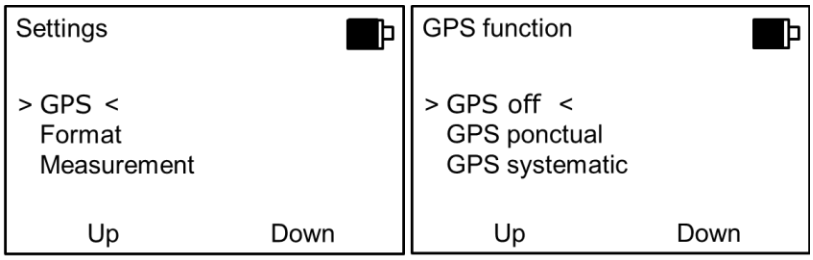
1. GPS: toggles GPS in modes Off, Light or Full.
2. Format: formates the flash memory.
3. Measurement: allows selecting the acquisition mode for measurements.
4. Date & Time: updates date and time.
5. Contrast: allows variation of screen contrast.
6. Standby: adjusts the time before standby mode.
7. Language: allows to change the language of the Dualex.
8. About: displays the version of the software and the Dualex serial number.

These parameters are validated by using the button 

. or left as previously by pressing on  , the software returns then to the main menu.

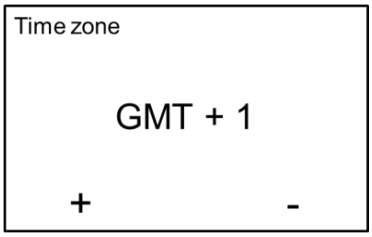
2.3.3.1. GPS

There are three ways to use the GPS:

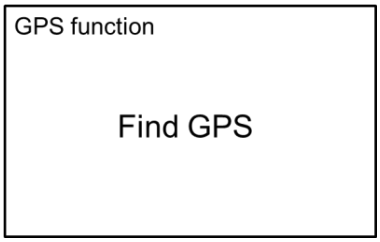


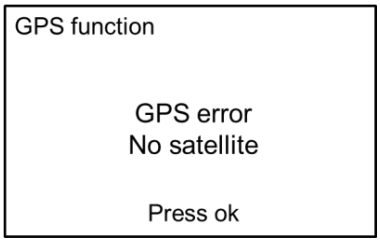
- GPS Off (by default): no GPS data saved.
- GPS punctual: GPS data are saved by pressing a few seconds on the button  during the measurement.
- GPS systematic: the GPS is active all the time, it saves GPS data for every measurement.

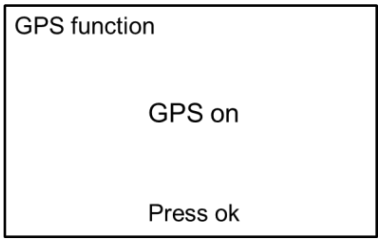
We can adjust the time zone in > Time zone <:



When the GPS is active in punctual or systematic mode, the device begins looking for the GPS with the aim to update the time and the date.





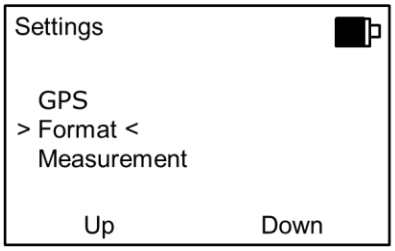


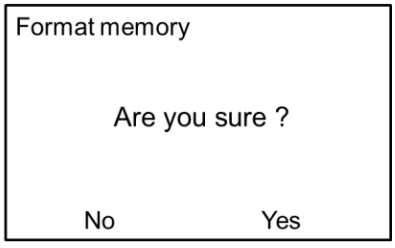
2.3.3.2. Format

The setting ‘format’ deletes all data from the memory of the Dualex.

WARNING: in order to avoid a loss of data, please copy the files from the memory before proceeding to an update. The Dualex Scientific will erase the memory at the end of the process.

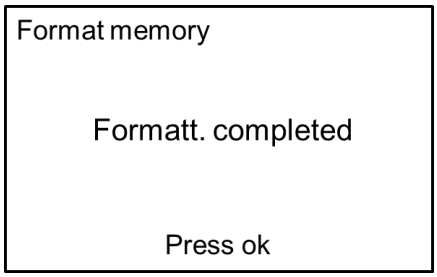
To format the memory, press on  the screen asks for a confirmation before formatting the memory. Press on the button  (No) or  (Yes):





If the buttons  (No) or  are selected, the data are left intact and the software returns to the main menu.

If the button (Yes) is pressed, all the data are erased from the memory:

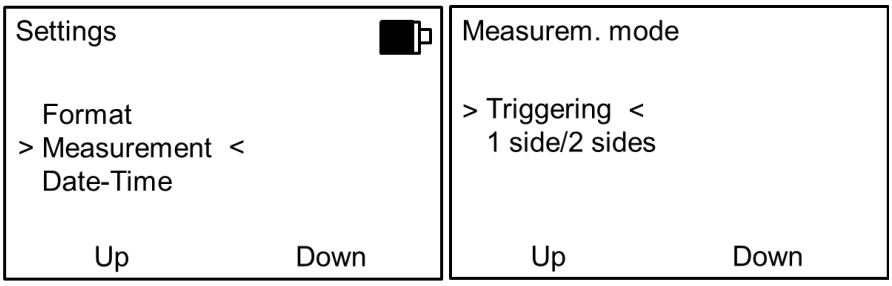


But if an error occurs during the formatting, the screen displays « Error format ». If this error appears, please switch off the device and load the battery. If the problem persists, please contact Pessl Instruments.

Press on the button , the Dualex returns then to the sub menu 'settings'.

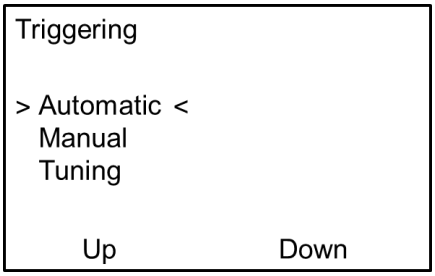
WARNING: The DUALEX uses the format FAT 12. Do not try to format your DUALEX' memory by using the formatting functions offered by your operating system; it could block the memory.

2.3.3.3. Measurement



Measurements can be performed by alternative ways:

a) Triggering

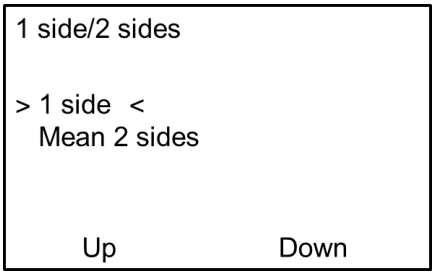


Automatic (by default): at every closure of the clip or a press on the button , a measurement is saved.

Manual: the recording of the measurement is only made once the button OK is pressed.

Tuning: this function re-adjusts the parameters to allow the automatic mode, depending on the clip aperture. Use it if automatic mode doesn't work.

b) 1 Side/2 Sides

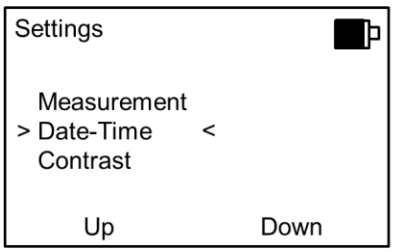


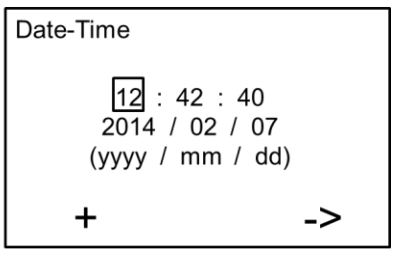
1 Side: at every closure of the clip or a press on the button OK, a measurement is recorded (following the triggering previously selected). At every measurement, values Chl, Flav, Anth and NBI **of the side** (adaxial **or** abaxial side) are displayed.

Mean 2 Sides: 2 measurements are needed to get values for one leaf (adaxial and abaxial side). Chl = mean of 2 values; Flav = sum of 2 values; Anth = mean of 2 values; NBI = Chl / Flav.

2.3.3.4. Date & Time

This setting allows adjusting the date and the time. To change the number, press on the button "+" and to change the next field, press on the button "->", once the date and the time are adjusted, press on OK to save it.



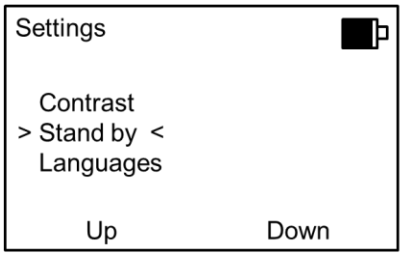


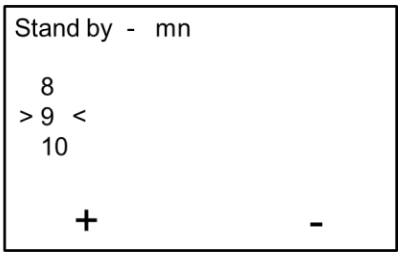
2.3.3.5. Contrast

You can adjust the contrast of the screen with the buttons  and  . After having adjusted the contrast, return to he main menu by pressing

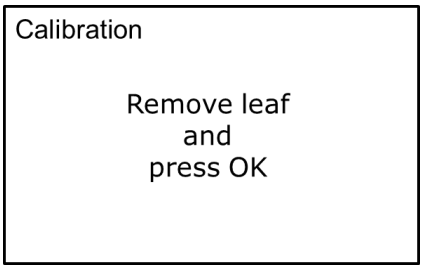
2.3.3.6. Standby

The time before Dualex enters the standby mode can be chosen. It can be adjusted between 1 and 10 minutes; the default setting is 5 minutes.





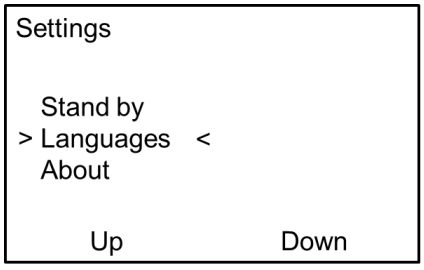
When the Dualex enters the standby mode, all measurements and settings are saved. When you restart the device by a long press on the button  , to measure, a new self-calibration is needed.

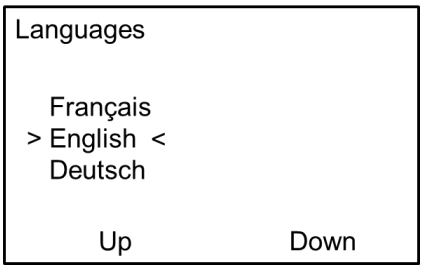


Press on the button  .
The standby function is disabled when you are in USB mode.

2.3.3.7. Languages

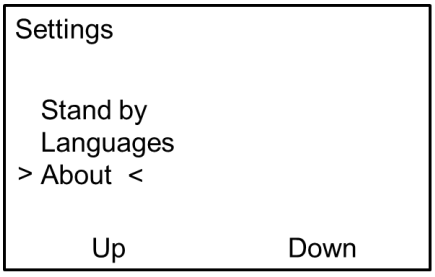
This mode allows the user to select one of the following languages: French, English, German or Spanish.

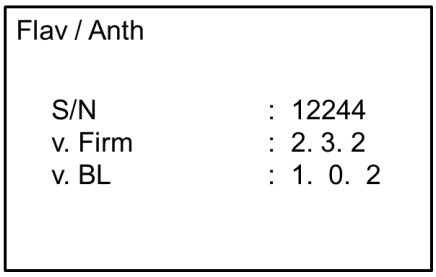




2.3.3.8. About

The submenu, ‘About’ displays the version of the software and the serial number of your Dualex.





3. Data file

The data generated by the Dualex have a .csv format. They are thus compatible with any spreadsheet and any operating system.

Some applications (example: MS Excel) automatically try to change the format of the cell value (from decimal number to date format etc.). If you see strange values in Excel, you can open the .csv file with your simple text editor (example: notepad) and you will see correct, original values.

A Dualex file opened with Excel:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	#Model.....:Dx4.5														
2	#SN.....:11_205														
3	#version.....:Sci. Flav/Anth														
4	#software....:2.2.7														
5	#yyyy/mm/d	hh:mm:ss	longitude	latitude	altitude	sat_qual	temp	group	measure	side	Chl	Flav	Anth	NBI	Calib
6	1/2/2013	0:14:17					21.00	1	1	sup	3.557	2.455	0.384	1.45	NEW
7	1/2/2013	0:14:21					21.00	1	2	sup	66.427	0.346	0.382	191.78	
8	1/2/2013	0:55:41					22.61	1	3	sup	16.449	0.152	0.38	108.27	
9	1/2/2013	0:55:45					22.61	1	4	sup	14.063	0.143	0.38	98.24	
10	1/2/2013	0:55:47					22.61	1	5	sup	14.509	0.155	0.378	93.46	
11	1/2/2013	0:55:48					22.61	1	6	sup	13.801	0.149	0.38	92.86	
12	#Group	Chl	Chl_sd	Flav	Flav_sd	Anth	Anth_sd	NBI	NBI_sd						
13	1	14.706	1.198	0.150	0.005	0.381	0.001	98.210	7.129						
14															
15	#yyyy/mm/d	hh:mm:ss	longitude	latitude	altitude	sat_qual	temp	group	measure	side	Chl	Flav	Anth	NBI	Calib
16	1/2/2013	0:56:04					22.62	2	1	sup	13.882	0.16	0.384	86.92	
17	1/2/2013	0:56:05					22.62	2	2	sup	14.69	0.155	0.382	94.62	
18	1/2/2013	0:56:07					22.62	2	3	sup	14.65	0.154	0.38	95.04	
19	1/2/2013	0:56:26					22.63	2	4	sup	16.485	0.157	0.38	104.68	
20	1/2/2013	0:56:27					22.63	2	5	sup	14.652	0.15	0.378	97.87	
21	1/2/2013	0:56:29					22.63	2	6	sup	16.646	0.159	0.38	104.95	
22	1/2/2013	0:56:31					22.63	2	7	sup	14.065	0.113	0.38	124.94	
23	1/2/2013	0:56:32					22.63	2	8	sup	12.636	0.096	0.378	130.98	
24	1/2/2013	0:56:34					22.63	2	9	sup	17.407	0.168	0.38	103.83	
25	#Group	Chl	Chl_sd	Flav	Flav_sd	Anth	Anth_sd	NBI	NBI_sd						
26	2	15.013	1.531	0.146	0.024	0.380	0.001	104.870	14.399						
27															
28	#yyyy/mm/d	hh:mm:ss	longitude	latitude	altitude	sat_qual	temp	group	measure	side	Chl	Flav	Anth	NBI	Calib
29	1/2/2013	0:57:42					22.68	3	1	sup	15.762	0.163	0.38	96.41	NEW
30	1/2/2013	0:57:52					22.69	3	2	sup	15.302	0.183	0.38	83.55	
31	1/2/2013	0:57:54					22.69	3	3	sup	14.015	0.168	0.378	83.4	
32	1/2/2013	0:57:55					22.69	3	4	sup	15.343	0.162	0.38	94.5	
33	1/2/2013	0:57:56					22.69	3	5	sup	13.518	0.169	0.38	79.9	
34	#Group	Chl	Chl_sd	Flav	Flav_sd	Anth	Anth_sd	NBI	NBI_sd						
35	3	14.788	0.966	0.169	0.008	0.380	0.001	87.555	7.394						

Cell value legend:

- sat_qual (F5): Quality of the GPS signal
- temp (G5): LED's temperature
- group (H5): Group rank
- measure (I5): measurement id
- side (J5): Side measured during the reading : adaxial or abaxial (tagged manually by the user)
- Chl (K5): measured chlorophyll index
- Flav (L5): measured flavonol index
- Anth (M5): measurement of phenolics, anthocyanins content
- NBI (N5): Nitrogen Balance Index
- Calib (O5): 'NEW' tagged when a new self-calibration is done
- Chl (B12): Group Chl mean
- Chl_sd (C12): Group Chl standard deviation
- Flav (D12): Group Flav mean
- Flav_sd (E12): Group Flav standard deviation
- Anth (F12): Group Anth mean
- Anth_sd (G12): Group Anth standard deviation
- NBI (H12): Group NBI mean
- NBI_sd (I12): Group NBI standard deviation

4. Dualex technical specifications

Measured material	Leaf
Measured parameters	4 measured indices: • Chl: Chlorophyll content • Flav: UV-absorbance • Anth: Anthocyanins content • NBI: Nitrogen Balance Index
Measurement process	Automatic or manual
Measured area	5 mm in diameter
Sample thickness	1 mm maximum
Measurement area access	8.5 cm maximum (half-leaf width)
Acquisition time	< 500 ms
Storage capacity	10,000 multiparametric measurements
Data classification	3 levels (file, group, and measurement numbers)
Temperature range	From 5 to 45°C
Light sources	5 LED: 1 UV-A, 1 green, 1 red and 2 NIR (near-infrared)
Detectors	1 silicon photodiode
User interface	LCD screen Sound warning
Data downloading	USB connection for data transfer
Battery	Li-ion rechargeable battery
Battery life	10 hours
Charge time	4 hours
Total weight	220 g (with battery)
Size	205 mm x 65 mm x 55 mm
Positioning	Internal GPS
Relative accuracy	< 2.5 m (CEP, 50%, 24 h static)
Languages	English, French, Spanish, German
Safety	Ring for leash
Updating	Remote program updating

Warning: as Pessl Instruments is continuously improving its products, technical specifications are subject to change without notice.

5. Precautions of uses

5.1. Environment of use

The Dualex is adapted to be used in various environmental conditions. The device is resistant to natural humidity of the plant material. In the range of 5°C to 40°C, the temperature is permanently measured.

5.2. Shocks and vibrations

During the use, it is important to avoid shocks as well as intense vibrations.

5.3. Storage

When you finish the measurements, please don’t forget to switch off the device.
Keep the Dualex in a dry (0 - 40°C non condensing), clean and dust free environment.

5.4. Cleaning

During every return in the laboratory, the Dualex should be cleaned by using a tissue slightly moistened with a mixture of water and alcohol.

The optical parts of the device must be carefully cleaned by blowing clean and dry air, and then with a cotton swab slightly moistened with ethanol.

5.5. Exchange of batteries

If the batteries of the Dualex need replacement, please contact Pessl Instruments. The batteries are especially designed for this device. The replacement of batteries by an unsuitable model can seriously damage the unit.

6. Conditions of guarantee

In the case of a normal use, the Dualex leaf-clip is guaranteed for 1 year (after delivery) against any defect or manufacturing defect.

Any attempt of modification or repair of this product by a non-authorized person renders the guarantee void and invalid.

The Dualex leaf-clip is a data acquisition instrument. Pessl Instruments GmbH is not responsible for any interpretations which could result from measurements realized by the Dualex leaf-clip.

In case of dysfunction, please contact Pessl Instruments GmbH for the return. The device should be sent back to the underneath address:

PESSL INSTRUMENTS GmbH
Werksweg 107
8160 Weiz
Austria

Tel: +43 31 72 55 21
e-mail: office@metos.at

To benefit from the guarantee, please get in touch with the company Pessl Instruments. The return policy is available on our website: https://metos.at/en/return-policy/.

For the whole repair/replacement/return conditions, please read our General terms and conditions, available on our website: https://metos.at/en/general-terms-and-conditions-of-trade/.

7. FAQ

Questions	Solution 1	Solution 2
The device does not start	Recharge battery	If the symptom persists, please contact Pessl Instruments
Display on the screen of "Format Error" after start	Recharge battery, then perform a new formatting of the memory	If the symptom persists, please contact Pessl Instruments
Too many measurements are out of the limits, frequent display of “ *** “	Apply a light pressure to heads during the measurement, or over the clip to avoid leaf veins.	Likely cause: your plant material is very concentrated in compounds